



Water Resources Center

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United States Department of Agriculture National Institute of Food and Agriculture

# The TMDL and Impaired Waters Process: A Survey of Needs

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

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## Summary

The goal of this study was to identify appropriate roles for the GLRWP and its partner universities to play in supporting the TMDL and impaired waters process.

In September 2011, 29 agency leaders and University faculty from across EPA Region 5 responded to an online survey about the TMDL and impaired waters process in their state. Participants were asked open ended questions about the four components of the Impaired Waters process:

- setting standards and criteria,
- monitoring and assessment,
- development of TMDLs, and
- implementation of restoration activities.

They were asked what was working well, what was not working well, and what roles the Universities could play to help support the process and ultimately to improve water quality.

### ***The need to focus for effect***

Respondents described many potential roles for the Universities. One arena where the GLRWP could make a particularly important contribution is helping to improve methods for targeting conservation, also called precision conservation or focusing for effect. Many of the survey responses related to the need for more and better methods for local project managers to effectively focus restoration activities for effect. Respondents identified several types of targeting: (1) identifying critical sites of pollutant delivery across the landscape at both the field and watershed scale, (2) predicting the site-specific impact and efficiency of various practices and combinations of practices, and (3) strategically implementing the right practices in the right places in the right order (this is a social science and a physical science challenge). A first step would be to assess needs for development of targeting methods at these three stages, and needs for training in use of the methods.

Additional recommended roles for the universities include

- Aim pollutant research directly at establishing standards.
- Improve monitoring methods.
- Evaluate curricula to support needed skills.
- Establish stronger communication between universities and agencies, and other partners.

## A) Background and Methods

The Great Lakes Regional Water Program (GLRWP) is a partnership among the Land Grant universities in Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin, and the NIFA National Integrated Water Quality Program (NIWQP). Each university has taken on various roles to support their respective state agency's Clean Water Act activities. To provide more helpful and coordinated support, the GLRWP undertook this study in the fall of 2011 to identify the most appropriate roles for partner universities as we aim to support the TMDL and impaired waters process across EPA Region 5. An online survey was prepared asking open-ended questions about the four components of the Impaired Waters process:

- setting standards and criteria,
- monitoring and assessment,
- development of TMDLs, and
- implementation of restoration activities.

For each component, participants were asked what was working well, what was not working well, and what roles the Universities could play to help support the process and ultimately to improve water quality.

We identified state agency leaders for each of four components, overall TMDL coordinators, and University faculty who have worked closely with the TMDL process. From among these, 37 people (about 6 from each state) were invited to complete the online survey. Twenty-nine surveys were completed.

We categorized and grouped similar responses. Numerical summaries would be inappropriate because of the small and non-representative sample. Unless marked by quotations, the responses reported below are paraphrases and not direct quotes.

## B) Who responded?

A link to an online survey was sent to a selected sample of 37 people including 4-to-8 specialists in each of the six states in EPA Region 5. Twenty-nine

responses were submitted, but one response represented the input of several people.

	Total responses	Agency Employee (specialty)					University
		TMDL Program Leadership	Standards	Monitoring	TMDL dev.	Implement-ation	
Illinois	5	1	1	1	1		1
Indiana	5	1	1	2	1		
Michigan <sup>#</sup>	2	1+					1
Minnesota <sup>*</sup>	7	1	1	1	1	1	3
Ohio	5			1	1	1	2
Wisconsin	5		1	1			3
<b>Total</b>	<b>29</b>	<b>4</b>	<b>4</b>	<b>6</b>	<b>4</b>	<b>2</b>	<b>10</b>

<sup>#</sup>In Michigan, several people worked together to complete one survey.

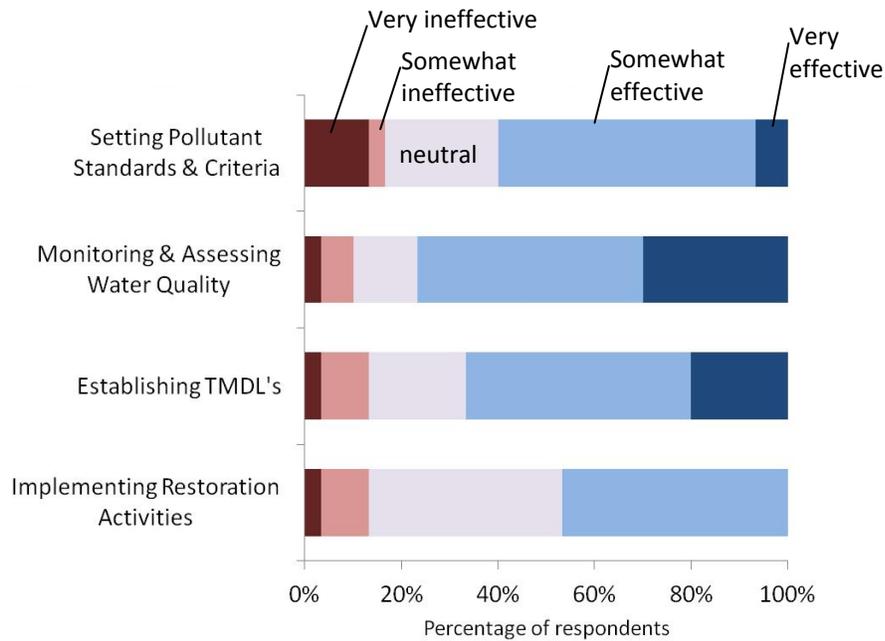
<sup>\*</sup>In Minnesota, one respondent is included here as both a program leader and a specialist in TMDL development.

## C) How effective is the process?

*“In your state, how effective is the Impaired Waters process for supporting clean water?”*

### **Key Point**

Implementation and setting standards were rated as the least effective components. Monitoring was rated as the most effective.



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## D) A summary of states' strengths

*“What is working well in your state that might be informative to other states?”*

### **Key Point**

The following are highlights of state programs, as reported by survey participants. Every respondent identified bright spots that could be replicated and built upon, either within the state or by other states.

### **Illinois**

#### Standards

- Standards Unit does an outstanding job
- Standards for DO, toxics, P in lakes, and nitrate in rivers and lakes.
- Reworked narrative criteria.

#### Monitoring and assessment

- A long history of monitoring and therefore sufficient data to designate impairments. Back to 1974 with monitoring every six weeks. Biological and chemical monitoring in a five-year rotation

#### TMDL development

- Good public meetings and public input. Landowner education on BMPs.

#### Implementation

- Success on some specific watershed-based, 319-funded implementation projects, e.g. in the DuPage Salt Creek Watershed.

#### General

- Good discussions between regulators and researchers

### **Indiana**

#### Monitoring and assessment

- Process for monitoring E. coli, and E.coli TMDLs
- Monitoring and follow-up monitoring. Statewide probabilistic monitoring of rivers and streams for 16 years has done a good job of identifying impaired waters. Subsequent TMDL related monitoring identifies impairments at a smaller scale. Monitor targeted locations to assess change.
- Good collaboration with Purdue. Indiana Water Monitoring Inventory website allows interested parties to view what data are being collected in the state, to reduce duplication. Purdue has compiled a listing of methodologies used by IN agencies to assist other groups interested in data collection and comparability.

#### Implementation

- Working with watershed groups, and stakeholder engagement in the TMDL process and NPS program
- Watershed-based implementation. Watershed Specialists team has the flexibility to work with groups who do not have Clean Water Act grants.

#### TMDL development

- Have begun to complete TMDLs using a watershed approach.

### **Michigan**

#### General

- Good collaboration with EPA and with other state agency programs (e.g. NPS)

#### Standards

- Rules allow us to develop some criteria without legislative approval each time

#### Monitoring and assessment

- Dedicated funding to support monitoring
- Stakeholders are monitoring at locations not covered by the regulatory agency.

#### TMDL development

- Stakeholder-driven TMDL's, good public engagement; early engagement with EPA and other stakeholders to define the extent of water quality impairments and to help with TMDL development

#### Implementation

- Implementation activities through the Soil Conservation Districts and watershed groups.

### **Minnesota**

#### General

- Clean Water Legacy funds
- Communication among federal, state, and local agencies. Cooperation among state agencies in sharing data

#### Standards

- Tiered Aquatic Life Use framework for designating beneficial uses to avoid under-protecting the highest quality waters and over-protecting
- Development of biological criteria and increasing use of biological data in making assessments.

#### Monitoring and assessment

- Watershed approach to monitoring and to assessing impairments. The Watershed Restoration and Protection Strategies (WRAPS) to protect unimpaired waters and provide a watershed approach to developing TMDLs. WRAPS includes intensive watershed-based monitoring and assessment, including biological and chemical measures and fixed load monitoring at the mouth of major watersheds.
- Sentinel Lakes program
- Wetland monitoring is advancing.
- Citizen volunteer lake and stream monitoring program
- Participation in national monitoring surveys
- Beginning effectiveness monitoring on the first TMDL completed years ago to assess progress.

#### TMDL development

- Completed a statewide mercury TMDL years ago

#### Implementation

- We have had some success in meeting standards through TMDL implementation, especially for smaller projects.

### **Ohio**

#### Standards

- Our new approach to nutrient criteria.
- Using multiple indicators (chemical, physical, biological) to set standards
- Biological assessments to determine watershed health. Establishment of Tiered Aquatic Life Uses and the use of ambient biological criteria (response indicators) to assess the uses. Biological criteria are used along with physical and chemical information to determine causes/sources.
- Identifying impairments due to impacts such as channelization, hydromodification and flow alteration

#### Monitoring and assessment

- Strong routine monitoring, and regularly revisiting basins

#### TMDL development

- Using models to establish TMDLs
- Adjusting TMDL requirements to fit with other program responsibilities to make efficient use of data.

#### Implementation

- OSU's Ag Research Center in Wooster worked with local farmers in the Sugar Creek watershed to help them understand the impacts they have on the land (Dr. Richard Moore).
- Focusing 319 funds on projects that will produce short-term water quality improvements

#### General

- Watershed Coordinator grant program that has put trained watershed coordinators in leadership positions to develop and implement watershed action plans
- Voinovich Center (through VISTA students) provides GIS, sampling, and other expertise to local citizen groups.

### **Wisconsin**

#### Standards

- A lengthy stakeholder input process to establish water quality criteria
- Numeric criteria for P for lakes and streams.
- Numeric criteria for temperature.

#### Monitoring and assessment

- Expansion of the volunteer monitoring program to supplement data collected by field staff.

#### TMDL development

- Using the SWAT model to identify high-loading sub-areas, and further development of the P-Index to identify fields.
- Taking on large scale (HUC 8) TMDLs
- Setting meaningful targets to ensure a TMDL would yield measurable water quality improvements.

#### Implementation

- Working one-on-one with landowners in targeted areas.
- Studies to help target BMP activity, such as the paired watershed study in the Pleasant Valley area in southern Wisconsin.
- Progressive laws addressing NPS pollution (<http://legis.wisconsin.gov/rsb/code/nr/nr151.pdf>, <http://legis.wisconsin.gov/rsb/code/nr/nr216.pdf>)
- New laws addressing point source discharges of P (<http://legis.wisconsin.gov/rsb/code/nr/nr217.pdf>)

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## E) What is not working well?

*“What is working less well?”*

### **Key Points**

Addressing non-point source pollution presents special challenges. Respondents identified several challenges that are of particular relevance to this study including: (a) targeting, i.e., identifying critical sites, key processes, and appropriate responses; (b) development of the complex standards (nutrient and sediment) and integrating multiple criteria to achieve better impairment assessments; and (c) improvement of monitoring designs and techniques for efficiency and effectiveness.

### **Standards and criteria**

- Several respondents noted that **nutrient and sediment standards** are not adequately developed. This prevents proper development of TMDLs and leaves local government units without guidance. (Turbidity standards are difficult because it has multiple causes.) “We lack sufficient promulgated standards (e.g., biological standards, nutrient standards in streams, total suspended solids standards, sediment standards) from which to assess against. . . and make use impairment calls.” (5 respondents from 3 states.)
- Various **biological criteria** are not well-developed or not adequately incorporated into impairment assessments. One respondent noted that people are not comfortable with E. coli criteria. (5 respondents, 5 states)
- Biological, chemical, physical, and habitat **characteristics need to be better integrated to assess impairments**. “Not enough attention is paid to hydrologic and geomorphological processes.” “If all of our streams are designated for warm water aquatic community, but a third of them have been straightened and their banks denuded of vegetation, I don’t know how we could expect a well-balanced aquatic community in those streams. I’m not sure that our standards communicate the expectation for that.” (7 respondents, 4 states)
- Multiple standards need to work together, e.g. standards for different water bodies, the methodology for listing an impairment, and permit limits. (1 respondent)

### **Monitoring**

- Several states felt they **needed different monitoring designs** to make better impairment decisions and to evaluate changes. Some wanted monitoring that was more frequent, denser, better targeted/prioritized, or more consistent. One mentioned the need for systematic baseline monitoring. “Monitoring is adequate, but more is needed; this is the greatest limiting factor.” (8 respondents, 4 states)

### **Developing TMDLs**

- Several respondents from all six states expressed frustration with **political and administrative** factors that prevent effective protection and restoration. These include lack of enforcement, favoritism, and appearances of favoritism that compel funders to stop funding a particular area. One person said the TMDL process has become overly prescriptive, and noted there is no administrative outlet for unachievable TMDLs. A few states complained of gridlock caused by legislative and gubernatorial politics. One state will not use 319 funds for septic system improvements, so it has been difficult for watershed groups to find funding for these. (8 respondents, 6 states)
- A few people were discouraged (or worse) about the usefulness of the **overall TMDL process** for impacting water quality. The most common source of concern was the link between TMDL plans and the will or ability to **effectively implement** restoration and monitor effectiveness. “TMDLs don’t do much that is useful.” (7 respondents, 5 states)
- Five states identified lack of **targeting** as a significant barrier to TMDL development and implementation. This means having adequate models, public engagement, and other tools to choose the most appropriate implementation activities and distribute them on the landscape. Also, recommendations for addressing NPS pollutants are not specific enough to guide local activities. (7 respondents, 5 states)

- Lack of **staff or expertise** was cited by a few people, including “consultants that produce generic TMDLs”, reliance on a handful of technical experts to help with rulemaking, lack of modeling expertise, and especially a lack of staff to do all that is asked regarding standards, TMDL development, and implementation. Funding is inadequate – sometimes at the state level, and sometimes at the local level. Turn-over of local staff is a serious impediment because of the importance of building local relationships and building expertise. (7 respondents, 4 states)
- A couple states mentioned the challenges of **public engagement**. (5 respondents, 2 states)
- Developing TMDLS is very **slow**.
- “TMDLs for **PCBs, Hg, and other persistent** bioaccumulating or biomagnifying substances” are not working well. (1 respondent)

### **Implementation**

- Addressing **non-point sources** presents a much greater level of challenges than point sources. There is a **lack of nonpoint source laws and standards** to address common issues. (4 respondents, 4 states)
- A few people perceived a lack of help and flexibility by the **USEPA**. Another respondent noted that the USEPA encourages a watershed approach, but their databases do not accept watershed-based data. (4 respondents, 3 states)
- Lack of money to do what is required and requested: adequate monitoring, implementation, lack of state and local support to match the federal dollars. (4 respondents, 3 states)
- Several people noted the need for better **tracking of implementation activities and evaluating their effect** on pollutant reductions and water quality improvement. (4 respondents, 3 states)
- Some observed flaws or conflicts in **program design**. “Farm Bill weighted toward production,

not conservation.” “A focus on short-term results has led to a site-based approach to implementation,” in contrast to a watershed-based approach. Also while several states have watershed-based activities, there is still a **disconnect between TMDL activities and watershed activities**. “We still see a disconnect between TMDLs and our watershed management plans/groups. . . I don't know how the University can help with this, but we need to do something.” (3 respondents, 2 states)

### **General**

- Our understanding of and attention to **hydrologic complexities** is limited. There is a lack of “understanding the role of hydrologic - flow quantity as it governs channel erosion and near channel processes of erosion, sediment loading and corresponding turbidity.” “[In modeling and scenario analysis,] there seems to be little consideration of the drainage network and how it may act as a source or sink of pollutants.” (2 respondents, 2 states)
- If you “got deeply into the TMDL process in my state, [you] would see that the effort expended produces almost no results. Maybe some landowners get educated along the way and maybe these people put some practices in place that do some good, but in no way does this solve any problems. If you could learn enough about the program to be a **voice for change**, that would help.” (1 respondent)
- “Our three biggest challenges are. 1) improving the public's understanding of how standards are set and what they mean; 2) improving public participation in TMDL development, particularly on a major watershed scale; and of highest concern, 3) accelerating the adoption of voluntary best management practices in agricultural areas. . . **We need better strategies to address this problem and we need them quickly.**” (1 respondent)

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## F) Staffing and training needs

*“Do you have enough people with adequate expertise in the right positions? If not, what do you need?”*

As might be expected, most respondents expressed a need for more staff to work on all four components. Some said there were indeed enough staff to meet minimal expectations, but no more.

The most consistent message was the need for **monitoring** staff. Generally it seemed that the expertise was available, but funding for the necessary field staff was not.

Many respondents identified a need for more **implementation** staff, but most were not specific about what kind of expertise or positions were needed. The responses that were specific identified the need for **enforcement, management and**

**support, engineers to design practices, follow-up staff, “new ideas”, and technical expertise:**

“Adequate expertise is needed; staff are general project managers, not engineers or ecologists.”

Greater expertise in **modeling** and statistics was identified as a need for setting standards, monitoring, and developing TMDLs. One person mentioned the need for expertise in using **CADDIS**.

For **TMDL development**, one respondent emphasized the need for better **project management and outreach** skills. Another said there was not enough staff to **document the causes/sources** of impairments.

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## G) Roles for Universities in the TMDL and Impaired Waters Process

This section summarizes responses to five questions. For each of the four components of the impaired waters process we asked, *“What new or expanded role could the University play to help improve [this component]?”* At the end of the survey we asked, *“Do you have any further thoughts about gaps or deficiencies in the TMDL process where you would like to see University involvement?”*

### **Key points**

Respondents noted that the strengths of the Universities lie in research and providing neutral outreach.

Many respondents requested **research** on topics related to targeting, including clarifying the dynamics of pollutants and sources, developing methods for identifying key sites on the landscape, and identifying the most effective and cost-effective treatments for those sites. A second important research arena identified was the development of meaningful standards and methods for assessing impairments.

Regarding **outreach**, respondents noted that Universities are in a position to facilitate bridges between industry, state agencies, local government, private organizations, and individual landowners and citizens.

Some respondents were looking for University **involvement in specific projects** – either to provide technical support, or as contractors to conduct the monitoring, TMDL development, or implementation

projects. Others pointed out that it is challenging to balance project work with research objectives, so it is more important for Universities to ensure students acquire the skills needed to do project work.

A few respondents felt **communication channels** need to be strengthened between the University and agencies so faculty and staff understand the components of the Clean Water Act and can better connect their work to needs.

### **General observations**

The three most commonly requested roles for Universities were in research/development (22 respondents), outreach/training (14), and lending expertise or conducting specific implementation or TMDL projects (15). Five people suggested improving college curricula.

A few respondents said **University contributions should be limited** because Universities raise the cost of implementation by doing research instead of just “getting the job done”. Also, Universities should avoid regulatory work and politics. “I’m not sure

university involvement in the TMDL process is a good idea. TMDLs are a regulatory phenomenon; lots of politics. Universities should focus on ways to improve water quality: improving the science, educating the populace, being an honest broker of information. Maybe then we wouldn't need so many TMDLs."

### **Research roles**

Some of the research requests were for basic research, but most related to improving techniques for defining standards, monitoring more efficiently and effectively, and targeting implementation activities to the most effective sites and practices.

The following is the list of research suggestions. Underlined ideas were mentioned multiple times.

**Regarding setting standards and criteria:** show definitive relationships between nutrients and water body impairments; research on fate and transport of contaminants in the environment; collect data to form the basis of new standards; toxicity tests that could be done in a timely manner; literature and compilation of data; help make reasonable and attainable standards; assist with methodology for setting standards for constituents that vary with season and discharge according to watershed conditions; and establish criteria that go beyond existing chemical, habitat, and biological indicators.

**Regarding monitoring and assessment:** development of tracking tools, methodologies for assessing headwaters, more cost-effective sampling (e.g. automated and remote sensing technology), biological assessment procedures, methodology for defining impairment, and more effective or efficient monitoring design.

**Regarding completion of TMDL studies:** modeling; basic understanding of the dynamics of pollutants and of watershed sources and contributions; development of successful stakeholder processes; effects of stream modifications on headwater streams.

**Regarding implementation activities:** improve targeting, i.e., define critical areas, appropriate BMPs, and greatest cost effectiveness (targeting); prompt new ideas "so we don't get stuck doing the same old thing"; track implementation and impact; expand the list of BMPs; determine efficiencies; incorporate BMP efficiencies into models; improve BMP adoption rates; develop mitigation strategies

that address flow rates; and how to track reasonable assurance.

### **Policy analysis roles**

One respondent thought the Universities could play a role in clarifying the content of a TMDL. "It seems as though different EPA Regions and states within the same EPA Region are dealt with very differently. . . . It would be very helpful for a neutral entity to assess the key questions for states involved in the development or implementation of TMDLs and to prepare a comprehensive guide that clearly articulates the boundaries and flexibilities afforded by federal law."

Another suggestion was to analyze conflicts between drainage law and water quality standards.

### **Outreach and training roles**

Respondents suggested several different outreach and training roles for the Universities. One agency requested **training and coordinating volunteers** to collect and interpret data "similar to how they do it in Rhode Island". Some *agency personnel* requested training for professionals on **watershed thinking** and on **project management**. "If at least 6-8 staff and management were trained properly in 'project management' and management was committed to operating according to a project plan, TMDL production would likely increase. . . and it is very likely that consistency and efficiency would increase."

*University* respondents suggested they should provide professional training in **understanding agriculture, monitoring techniques, data analysis, and TMDL assessments**.

**Outreach** was considered an important role because Universities could provide an "unbiased" voice to help stakeholders understand the complexity of water issues. Suggested audiences included **legislators, the general public, land owners, and local project managers** who make implementation decisions. One respondent suggested that the University could help bridge the knowledge (communication?) gap between agriculture and agencies. Another respondent thought opposition could be reduced through better education of business and industry about the importance of standards and criteria.

"Greatly increase their cooperative extension efforts and similar programs such as Sea-Grant."

“How can the Universities participate in a discussion to resolve that conflict [between drainage law and water quality standards] so that all interests can be accommodated?”

**Contributions to project work**

Respondents described several ways that universities are or could be directly involved in **specific TMDL and implementation projects**. Some wanted more involvement in providing the technical and scientific knowledge to support studies, especially to understand the unique dynamics of each watershed. Others were looking for more involvement in actually conducting the TMDL studies and implementation projects.

With regard to **monitoring**, one agency respondent described a long record of hiring and contracting with students and faculty. “Universities are the one entity that we still have the ability to get contractual dollars to and work from. We have had some good successes, and some failures, which is totally dependent on the drive and professionalism of the individual.” Universities can play a role in site specific and more intense monitoring and evaluation, in contrast to state monitoring programs which are designed to answer broad impairment questions.

A representative of another state thought Universities might be able to perform fixed-station work and lab work at a lower cost than what agencies currently pay.

A respondent from Wisconsin described the "SWAT" team concept they are exploring. “SWAT = Surface Water Assessment Team. A team of 2-3 technicians would be assigned a particular area of the state and would conduct the vast majority of monitoring needed. These staff would become very efficient at conducting routine monitoring and would work independent of local field biologists for the majority of their work. A small percentage of their time would be made available for special projects of a very local nature to ensure that local field biologists could be attentive to key local issues.”

**Curriculum changes**

Four agency staff and one University employee said the Universities could **improve curriculum** to better support the impaired waters and TMDL process. One person strongly advocated for curriculum that prepares students to be employment-ready for environmental jobs. "Purdue University's

Environmental Science degree program is one of the few I've seen that actually" does this. Other curriculum suggestions included:

- better training in design and statistical analysis of water quality data,
- Masters-level groups that assess and plan restoration for a watershed. (E.g. the M.S. program at the University of Wisconsin Water Resources Management Program sponsored by the Gaylord Nelson Institute (<http://www.nelson.wisc.edu/>) .)
- having each University in a state adopt a major watershed that would be used for coursework in many disciplines, and
- training in integrated watershed sciences.
- “First off, take EPA's courses on water quality standards and get a grip on what the actual components of water quality standards are and have been since 1972.”

*“Which component of the TMDL process could University research, education, and outreach contribute most to?”*

When asked open-ended questions about what roles the Universities could play, respondents had the most suggestions for Setting Standards and for Monitoring. Yet, when asked which component the University could contribute most to, the response was Implementation (see table).

	# of respondents
Implementing restoration activities	9
Monitoring and assessing water quality	4
Establishing TMDL's	3
Setting pollutant standards and criteria	1

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## H) Draft recommendations

The responses summarized above point to many potential roles for the universities in EPA Region 5. Based on this study, the GLRWP leadership recommends focusing on the following activities because they are both critical to the success of water protection/restoration efforts and are well suited to the strengths of Land Grant universities.

### **Help improve methods for focusing conservation for effect.**

Three types of targeting, or focusing, were raised in this survey:

- (1) identifying critical sites of pollutant delivery across the landscape at both the field and watershed scale. This requires clarifying the dynamics of pollutants and sources, and developing methods for identifying key sites.
- (2) predicting the site-specific impact and efficiency of various practices and combinations of practices, to help managers choose the most cost-effective treatments, and
- (3) strategically implementing the right practices in the right places in the right order. This is a social science and a physical science challenge.

A first step might be to assess existing methods and needs at these three stages, and needs for training in use of the methods.

### **Design pollutant research that supports establishing standards.**

Pollutant research can meet multiple basic and applied goals, including helping to refine and understand the impacts of agency standards. Nutrient and sediment standards are especially complex to define. In addition, more work is needed to integrate multiple criteria to achieve better impairment assessments.

### **Improve monitoring methods.**

Agencies need to get the maximum information possible from limited monitoring budgets. This means establishing effective monitoring designs and lower-cost efficient technology

### **Evaluate curricula.**

The GLRWP might consider a region-wide evaluation of how well curricula prepare students to work in TMDL-related positions.

### **Establish stronger communication between universities and agencies, and other partners.**

Communication between universities and agencies is critical for researchers to understand the constraints and needs of the agencies, and for agencies to fully utilize existing research.

Universities are in a position to facilitate bridges between industry, state agencies, local government, private organizations, and individual landowners and citizens. Consider research and education about techniques for building networks and community capacity.