

Nutrients and Water Quality

A Region 8 Collaborative Workshop

February 15-17, 2011 • Salt Lake City, Utah

Workshop Summary and Recommendations



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Thank You to the Region 8 Nutrient Workshop Planning Committee:

Walt Baker, Utah DEQ-DWQ
 Tommy Bass, Montana State University
 Jim Bauder, Montana State University
 Troy Bauder, Colorado State University
 Jim Berkley, U.S. EPA
 Bob Brobst, U.S. EPA
 Bob Clement, U.S. EPA
 Scott Daly, Utah DEQ-DWQ
 Mike Ell, North Dakota Department of Health
 Jay Gilbertson, East Dakota Water Development District
 Nancy Grice, Colorado Water Institute
 Roxanne Johnson, North Dakota State University
 Julie Kallenberger, Colorado Water Institute
 Tina Laidlaw, U.S. EPA
 Mac McKee, Utah Water Research Laboratory
 Jennifer Meints, U.S. EPA
 Nancy Mesner, Utah State University
 Peter Monahan, U.S. EPA
 Jeff Ostermiller, Utah DEQ-DWQ
 Ginger Paige, University of Wyoming
 Shafiqur Rahman, North Dakota State University
 Adam Sigler, Montana State University
 MaryLou Smith, Colorado Water Institute
 Mike Suplee, Montana DEQ
 Dennis Todey, South Dakota State University
 John Ungvarsky, U.S. EPA
 Jan Urroz, Utah Water Research Laboratory
 Reagan Waskom, Colorado Water Institute
 David Waterstreet, Wyoming DEQ
 Mike Wireman, U.S. EPA

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Design, edits, and photos by Lindsey Knebel, Editor, CWI.

Common abbreviations throughout:

TMDL: Total maximum daily loads
 AFO: Animal feeding operation
 CAFO: Concentrated animal feeding operation
 NPS: Nonpoint source pollution
 Ag: Agriculture
 DEQ: Department of Environmental Quality

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Executive Summary

Why this Workshop?

Nutrients such as phosphorus and nitrogen can degrade water resources and create health and environmental risks, making nutrients a nationwide and regional concern. Nutrient problems arise not only from wastewater, stormwater, and agricultural discharges, but from naturally occurring sources as well. They affect our rivers, streams, lakes, and groundwater, and eventually our drinking water. Because the science of nutrients is complex and not completely understood, we need policy and management that can adapt and evolve as we learn more.

Often, regulators are seen as requiring controls and standards that do not seem practical or even effective to stakeholders who must abide by them. This workshop was designed to bring together stakeholders from the various contributing sectors and representatives from regulatory agencies, to create a shared understanding of the nutrients problem. The goal was to foster development of a more tightly linked community of regulators, researchers, practitioners, managers, and policy makers. With emphasis on what's practical, participants were challenged to consider a full range of societal values and weigh benefits against costs, while seeking to apply limited resources where they could achieve the most water quality improvement.

The workshop was divided into three sections to address three distinct questions.

- 1) What is the problem?
- 2) What are we doing about the problem?
- 3) How can stakeholders and agencies work better together to resolve the problem?

Workshop participants included scientists and stakeholders from the wastewater, drinking water, and stormwater sectors, and the nonpoint source, environmental, and agricultural communities.

What was the Outcome?

Was the workshop successful? Yes, by several measures. First, it drew the significant number of 221 participants from the six Region 8 states and beyond despite budget cuts and travel restrictions. Participants covered the full range of stakeholders and regulators, which allowed for comprehensive and meaningful dialogue. Second, the workshop succeeded in opening new channels of communication, and improving existing channels. Third, it culminated in a focused list of firm recommendations for how agencies and stakeholders could work better together in the future to tackle the nutrients problem. Virtually 100% of those completing a post-workshop evaluation agreed or strongly agreed with the statement "I believe the workshop brought emphasis to the need for improved interagency communication, collaboration and data sharing on the issues of nutrient management." Ninety percent are more knowledgeable about the challenges associated with nutrient controls and the network of people working on nutrient related issues. The same high percentage said they better understand other stakeholder perspectives and the importance of stakeholder involvement in the nutrient control development process. Eighty percent said they gained tools and information to improve how they approach nutrient issues.



Recommendations

Participants and speakers explored together a carefully chosen set of pertinent questions. The group dialogue was as important as the presentations. From this interchange came some focused recommendations—primarily for EPA and for state water quality agencies. While there was a consensus among workshop participants that there is a nutrient problem in the region, there were expressions of concern and strong suggestions about how nutrient controls and standards should be developed and implemented to increase likelihood that they will truly lead to cost-effective water quality improvements. Here is a summary of workshop recommendations.

Flexibility in Approach to Improve Water Quality

“One size will not fit all” was commonly voiced. Workshop participants believe real solutions will come from site-specific, sector-specific approaches, championed by those directly aware of local circumstances, allowing flexibility as more is learned. Specifically:

- We need to think and work smarter, to focus resources on issues and circumstances which will achieve the most benefit per unit of resources and effort expended, to learn lessons from others wherever possible.
- Adaptive management should be considered integral to any TMDL, nutrient controls and standards. We need to be allowed variances in dealing with nutrient sources and loads where appropriate.
- Regulatory agencies need to recognize and accept that 100% achievement may not either be possible or necessary with respect to controls and standards. For example, controls applied to a smaller percentage of sources may result in higher overall water quality results.

Building Relationships to Improve Water Quality

Much of the dialogue among workshop participants revolved around the need for building trust between stakeholders and regulators. Specifically:

- Communication, relationships, and trust should be established as foundational, involving all stakeholders. This would bring a new, improved image to the EPA and state agencies, and the cooperation it fosters at the local level would lead to water quality improvements.
- Regulators and regulated should work together in order to do away with the current us-versus-them attitude. Regulated groups should be connected to the process.
- Individuals from agencies interacting with stakeholders relative to nutrients should become more knowledgeable about day-to-day operations of stakeholders. Regulatory agencies and policymakers need to gain a better understanding and appreciation for stakeholders’ situations, perspectives, and financial means.
- Continuity in agency staff is needed to foster productive relationships to solve water quality problems.
- Education, information exchanges, and continued dialogue on nutrients are needed to provide continuity in the engagement of the public, stakeholders, and regulated entities.

Financing Improvements in Water Quality

Since current fiscal realities are not expected to turn around overnight, creative approaches will be needed. Specifically:

- We should investigate nutrient trading across sectors in order to achieve water quality goals.
- Means of financing the costs of nutrient controls and minimizing the economic burden to stakeholders need to be built into

any nutrient control program. Our society creates and externalizes our nutrient problems and will benefit from nutrient controls, thus society needs to bear the costs of control.

- ▶ The relationship between benefits and costs needs to be understood and communicated to stakeholders, ratepayers, and dischargers, along with discussion of who is going to bear the cost of controls.

Nutrient Controls and Standards to Improve Water Quality

Workshop participants from across all sectors were consistent in their assertion that nutrient controls and standards will benefit from enhanced local engagement.

- ▶ Nutrient controls and standards should be based on local level input and management constraints, with participation and involvement of local stakeholders through the entire process. Emphasis should be placed on protecting water resources and providing safe drinking water instead of just meeting regulations.
- ▶ On the other hand, uniform sampling and data collection protocols should be established for each sector involved in the nutrient control/nutrient management issue. Data sharing should be improved among all entities.
- ▶ Nutrient controls and standards should be based on sound science which elucidates relationships between nutrient loading, water quality impairments, and effectiveness of best management practices.
- ▶ Water quality improvement or protection through nutrient controls and standards should be marketed where appropriate, rather than mandated or regulated. To this end, education needs to be used as a complementary tool for achieving nutrient controls and standards. Education is needed for the general public, policymakers, stakeholders, and managers.

Finally, workshop participants unanimously recommended the need for the region, states and stakeholders to continue and sustain dialogue leading to creative and collaborative solutions to nutrient problems.

Read the Full Report and Check out the Electronic Appendix

The following pages contain more detail. The electronic appendix will take you to even more detail, including names of participants, poster topics, power point presentations, state website resources, and more: www.cwi.colostate.edu/nutrients



First Question:

What is the Problem?

Perspectives on the Problem of Nutrients in Water

Nancy Mesner, Utah State University, introduced two tasks: 1) to hear from several individuals with diverse perspectives and backgrounds on nutrients and water quality, and 2) to engage participants in a dialogue with five panelists with first-hand experience dealing with stakeholder challenges in nutrient controls. Nancy emphasized that the workshop would be highly interactive, with significant work to be accomplished by workshop participants. She challenged the speakers, the panel, and the participants to focus on addressing key questions: “What do we know, what are the unknowns, and what are some of the approaches being used to work toward solutions?”

The opening session speakers provided an overview of nutrient dynamics (specifically nitrogen and phosphorus); the challenges of developing and promulgating nutrient regulations; a status report of surface water quality conditions in Region 8, based on results of a decade-long USGS study; and then the complications, complexities, and challenges of nutrients in source water for drinking water supplies to municipalities.



Nancy Mesner introduces the day's discussion topics.

Nitrogen and Phosphorus Dynamics in Natural and Managed Systems

-John Stednick



John Stednick, Colorado State University, laid the groundwork for workshop participants' understanding of nitrogen and phosphorus presence

and behavior in water resources by describing similarities and differences in their respective cycles. He pointed out that both nutrients are essential for plant growth. Agricultural and urban landscape management practices often include the addition of nutrients in the form of fertilizer to increase productivity, but excess nutrients may result in degraded water quality. He said that in Colorado, mining is the most significantly reported cause of water quality impairment, but data is not complete or fully supported for 305(b) or 303(d)

listings. He also referenced other known sources of nutrients, such as the ash left in the wake of wildfires as a source of phosphorus. John explained that impairments can be excessive algae growth, decreased water clarity, changes in pH and dissolved oxygen, and alterations in the solubility and mobility of metals and other constituents in water.

“Why have forest environments historically provided exceptionally clean water quality?” he asked. It’s because the lack of overland flows cuts down on erosion, and because forest organic material retains nutrients. Many naturally controlled ecosystems and watersheds can achieve stable nutrient equilibrium. Research has shown that some high elevation watersheds, alpine in particular, are nitrogen-saturated systems, and yet nitrogen outputs are equal to

“Nutrient concentrations are dynamic, not static, and in many cases, reasons for nutrient impairment are unknown.”

EPA criteria vs. Barr Lake means

	EPA Proposal	Barr Lake
Total P, $\mu\text{g/L}$	33	550
Total N, $\mu\text{g/L}$	560	6,240
Chl <i>a</i> , $\mu\text{g/L}$	2.3	90
Secchi depth, m	1.3	0.7

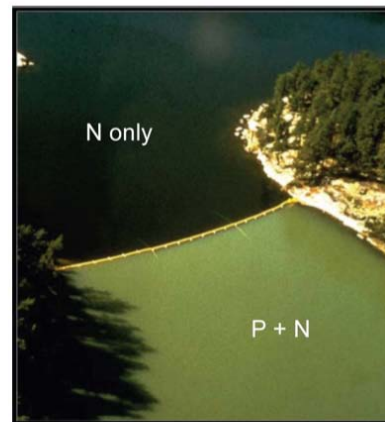
nitrogen inputs. And though timber harvesting in the Rocky Mountain region temporarily interrupts the nutrient cycle, effects on water quality have been minimal. In contrast, natural disturbance caused by the current bark beetle epidemic may affect nutrient concentrations, he said, and that could necessitate additional drinking water treatment. John used Colorado's Barr Lake, a reservoir dominated by municipal effluent, as an example of nitrogen and phosphorus enrichment that resulted in the state listing it as impaired due to algae.

John pointed out that data on water quality and nutrients may not always be consistent. He reported big differences in data on the Colorado Plateau when comparing EPA criteria with USGS and STORET data. Potential causes include lack of data collection coordination, limited communication, lack of clear monitoring purpose, and inadequate or inconsistent data collection and reporting.

Background concentration levels for nutrients have been defined by various statistical methods or models, and often conclude that "pristine sampling sites may not exist." He concluded by challenging workshop participants with a question: What if background level of nutrients exceeds standards? Nutrient concentrations are dynamic, not static, and in many cases, reasons for nutrient impairment are unknown. A particular impairment may not be a reflection of an immediate or obvious situation, but a remnant of activities long past.

Fundamental Issues for Nutrient Regulation

-Bill Lewis



ELA Lake 226 (D. W. Schindler).

Bill Lewis, University of Colorado-Boulder, began with a dramatic declaration that approximately 18% of the world's lakes are nutrient saturated, primarily through the influence of humans, and that nutrient regulation will be a shock for the states. He explained the interplay between nutrient enrichment and eutrophication, reaffirming John's comment that nitrogen and phosphorus are the significantly important nutrients with respect to eutrophication. However, phosphorus is not necessarily the 'master controlling nutrient' with respect to eutrophication, he said. Scientists have been placing the emphasis on phosphorus, but that has been wrong; lakes almost always respond equally to phosphorus and nitrogen, with an even greater response when both occur together. Hence, it is often the case that the ratio of nitrogen and phosphorus is the controlling factor with respect to the maximum degree of nutrient-stimulated eutrophication.



Lakes and streams respond to influx of nutrients, although lakes respond to the presence of nutrients at a lower threshold than the threshold at which streams respond to nutrients. Another difference between the way lakes and streams respond to influxes of nutrients is that in approximately 50% of the cases studied, streams are not nearly as sensitive to nutrient enrichment as are lakes. Asked if the difference in lake and stream response to nutrient loading is merely a consequence of residence time, Bill answered, “No, the difference in response characteristics has more to do with other controlling factors.” In streams, algal biomass is generally concentrated in the surface flow, while in lakes, the algal biomass is distributed through the water column. Consequently, controlling factors in a lake are likely much different than in a stream.

Lewis believes that to effectively manage the impact of nutrients in water bodies, it is necessary to appreciate the degree of manipulation or management required in order to get a desired response. In some cases, management will not result in a change in nutrient levels, and changes in nutrient levels will not result in changes such as algae reduction, until nutrient levels and nutrient ratios are reduced to below critical thresholds.

Lewis concluded his comments by indicating that he favors spending our resources on addressing point source nutrient pollution instead of nonpoint sources, given that knowledge of which control strategies and effectiveness of those control strategies for nonpoint sources are often limited and such strategies may be poor and ineffective. Spending time and money attempting to control nonpoint sources could detract from investment in controlling point sources.

Nutrients in the Nation’s Groundwater and Streams

-Lori Sprague

Lori Sprague, U.S. Geological Survey (USGS), reported the findings of a major assessment of nutrients in streams and groundwater of the United States conducted by the USGS between 1992 and 2004, with specific reference to water resources of Region 8. The primary objectives of the assessment were to determine the occurrence and concentration of nutrients in streams and groundwater, to find out where and when they occur in relation to factors that govern their sources and hydrologic transport, and to assess

“Nitrogen and phosphorus in most streams across the nation were found in concentrations two to 10 times greater than recommended for human health.”

whether nutrients are present at concentrations that could affect human health or aquatic life. Another objective was to determine how nutrient concentrations are changing.

Results of the 12 years of extensive data collection show that different nutrient sources can result in differences in



concentrations in streams and groundwater.

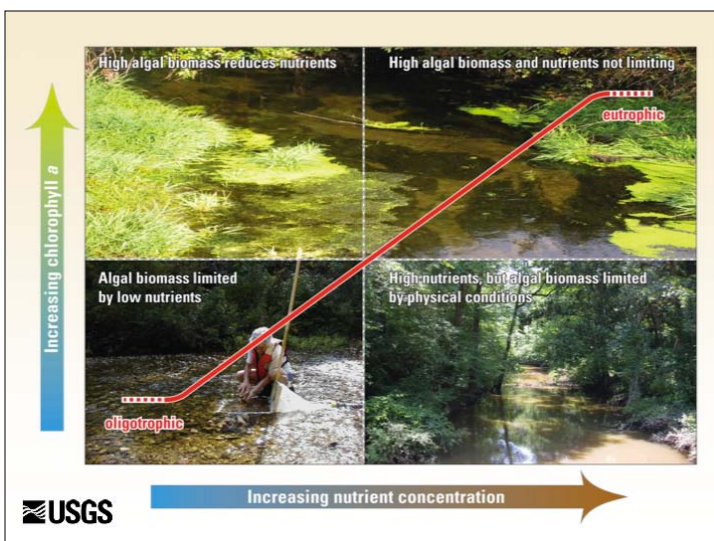
Human activities and natural features, such as geology, climate, hydrology and soil, can result in geographic differences in nutrient concentrations in water resources across the country. She pointed out, for example, in some agriculturally dominated areas of the U.S., the use of subsurface tile drains in agricultural management can influence the

concentration of nitrogen in streams. She also presented a figure showing a trend of increasing nitrogen concentration in groundwater, with the trend correlated to increasing use of nitrogen fertilizer.

Nutrient enrichment was found to be widespread in streams, with nitrogen and phosphorus concentrations two to 10 times greater than nutrient criteria recommended by the U.S. EPA for human health standards in most agricultural and urban streams across the nation. Contamination by nitrate was found to be a continuing human health concern in some groundwater used for drinking water, particularly domestic drinking water sourced from shallow wells in agricultural areas. Nitrate contamination was found to be less common in public supply wells, in part because of greater aquifer depths, longer travel times of nitrogen from the land surface to reach

deeper groundwater, and typically fewer nutrient sources in well source-water areas. And, although groundwater flows can contribute to in-stream nitrogen loads, high concentrations of nitrogen in groundwater wells don't necessarily correlate with high concentrations in streams.

Sprague said that though there are natural sources of nitrogen and phosphorus in the U.S., such as geologically sourced phosphorus in some rangeland areas, the highest concentrations of nitrogen and phosphorus in water resources are generally found to be in the areas of highest inputs; and the lowest concentrations generally are found where inputs are lowest.



Unfortunately, despite federal, state and local nonpoint source nutrient control efforts for streams and watersheds across the nation, trend analyses of the data collected suggest very limited progress was made in reducing nutrient concentrations during the study period. Instead, nitrogen and phosphorus concentrations remained the same or increased in many streams and aquifers across the country during the 1992-2004 period of study. Sprague concluded her remarks by stating that although these findings are somewhat disappointing, progress has been documented in local areas. For example, in the Bear River in Utah, total phosphorus decreased nearly 50% during this period, as a result of efforts to control both point and nonpoint nutrient sources. She said the concentrations there are now close to recommended nutrient criteria.

Understanding the Significance of Nutrient Loading to Drinking Water Treatment

-Bob Clement

Most of us would intuitively reason that finding and controlling the source of nutrient pollution makes more sense than waiting until it hits drinking water or wastewater treatment plants. But some have argued that since most nutrient pollution is nonpoint source, which is difficult to pinpoint and control, an alternative is simply to rely on treatment-based technologies.

Bob Clement, EPA, is of the first opinion. He believes the cost of treating nutrient-polluted water is likely to far exceed the cost of finding and controlling problems at the source, and treating merely deals with the symptom rather than finding



a long-term, sustainable solution. He said there are 300,000 species of algae and, like several of the previous speakers, pointed out that excessive nitrogen and phosphorus increase the level of algae, leading to algae blooms. This creates three categories of problems for drinking water treatment plants: non-regulatory, regulatory, and as yet unknown and unregulated health concerns.

An obvious non-regulatory impact is taste and odor problems from algae in water, as well as algae clogging intake

“The cost of treating nutrient-polluted water is likely to far exceed the cost of finding and controlling problems at the source.”

structures and filters, eutrophication of pre-sediment ponds (the process of nutrients creating algae blooms, which deplete oxygen in the system as they decomposes), and diurnal pH swings in water, that can cause commensurate swings in lead and copper releases in home plumbing. The clogging of filters by algae can lead not only to water quality problems, but also water supply problems, according to Clement. Clogging of intakes and treatment facilities slows down the filtering process. In extreme cases, this can lead to water restrictions. In addition, the need for increased backwashing of filters calls for extra processing water.

A regulatory impact results when algae in abundance interferes with the disinfecting process, creating troublesome by-products such as trihalomethanes and haloacetic acids, nine types of which are currently regulated.


Under the category of as yet unregulated impacts, cyanobacteria toxins are created by some species of algae. While the impact of these toxins is not yet known, the World Health Organization has set levels for microcystin LR, the most common and well researched of these toxins, at 1.0 part per billion.

Clement emphasized that the cost to deal with nutrients is a very significant factor for water treatment plants. For example, one Colorado water treatment plant spent nearly \$100,000 on an engineering study to find a solution to algae passing through their filters when the algae proved resistant to treatment by copper sulfate and chlorine. The algae were coloring the water green, causing customer complaints. Eventually the treatment plant operators had to resort to an expensive proprietary algaecide, called Cutrine Plus, to control the problem.

Algae blooms are episodic events that exacerbate the problem, and few water treatment plants proactively monitor for algae in their source water since there are no regulations requiring them to do so. “Nutrients create such complexity in so many fields of science that the hope of a solution lies only in collaborative efforts,” Clement said. “We desperately need to collaborate.”

“Nutrients create such complexity in so many fields of science that the hope of a solution lies only in collaborative efforts.”

**Increasing Nutrient Loading of N & P –Unknown Impacts:
Cyanobacteria (blue-green algae) Toxicity to Humans**



The World Health Organization (WHO) set a level of 1.0 ppb for microcystin LR the most common and well researched cyanotoxin.

River Meadows, Bend, Colorado

At about 20 times that level, 52 people died from an algal bloom when it was fed intravenously to dialysis patients and caused liver failure. That incident led to a disease named after the city it occurred in called Caruaru Syndrome – a disease caused by cyanotoxins.

What is the Problem? -Panel Response

Five individuals from stakeholder groups each made a brief presentation overviewing their role in nutrient control issues. Each of the panel members had a voice in defining nutrient controls and standards, represented a stakeholder group that could be impacted by promulgation of nutrient controls and standards, or had direct experience in efforts to develop nutrient controls and standards to deal with water quality issues.



Todd Ambs, River Network and formerly Wisconsin Department of Environmental Quality

Wisconsin has a nutrient standards success story to tout, and Todd Ambs provided the details. While the state is now watching to see if recently adopted nutrient standards will result in “on the ground” reductions of nutrients, their story of getting those standards in place offered workshop participants some important lessons learned from the process. First, the cost: \$2-3 billion dollars so far. Second, motivators to act:

- 1) Wisconsin and its residents know that water quality is a must for its important tourism industry to thrive.
- 2) State water quality professionals were able to point to the EPA and say, “they are making us do it.”
- 3) A conservation ethic pervades the state: “world class resources deserve world class protection.”

Ambs related that Wisconsin faced the same nutrient management challenges as Region 8 states: identifying sources, complicated processes, and regulating point sources versus managing nonpoint sources (NPS). And, despite the fact that in 1991, Wisconsin’s point source discharge effluent limit for phosphorus had been lowered from 4mg/L to 1mg/L, twenty years later, approximately 40% of water bodies in the state were on the 303(d) list - something had to be done about this.

Establishing a more stringent numeric phosphorus standard in Wisconsin started as an attempt to respond to an EPA directive that said, “you move forward or we will.” It was also motivated by a friendly push from conservation groups who filed a “notice of intent” to sue—a move that highlighted the acute nature of the problem. The state’s first step was to spend

eight years collecting data on phosphorus in Wisconsin lakes, rivers, and streams.

Now the aggregate level limit established for phosphorus in Wisconsin’s waters is about 0.6 mg/L. To try to meet that limit, new concentrated animal feeding operation (CAFO) and urban stormwater regulations were put in place, and a phosphorus ban was placed on residential use of phosphorus-containing lawn fertilizers. Efforts were also moved forward to achieve phosphorus limits for agricultural NPS. University researchers working with agricultural producers developed a phosphorus index to evaluate the appropriateness and level of phosphorus fertilizer to be applied to all agriculturally cropped fields in the state. The process to accomplish all of this brings all contributors to the table, point and NPS contributors alike.

Some interesting arrangements have developed, including so-called nutrient trading within the state, whereby some point source contributors are being paid by NPS polluters to help meet nutrient standards goals – at least on paper. A suite of tools is being integrated by the state to achieve the new nutrient standard, including the total maximum daily loads process, nutrient trading, and watershed permitting. Additionally, the state must provide at least a 70% cost share for stakeholder implementation of nonpoint control best management practices, either with state or federal agency money, or agricultural producers cannot be required to change practices. The state is now facing the question of whether it needs to set a sunset date for such cost sharing mandates.

Putting these more stringent standards in place was successful partly because of highlighting the fact that everybody was part of the nutrients pollution problem, not just point source polluters who already faced a strict limit. Now the question is, will all these point source and NPS rules mesh together to significantly reduce nutrient pollution in Wisconsin’s water bodies? As Todd pointed out, the answer is yet to be seen.

Rick Fasching, USDA-Natural Resources Conservation Service (NRCS)

According to Rick Fasching, regional agronomist for the NRCS, his agency focuses its technical expertise on nonpoint source (NPS) nutrient issues, with a goal and approach of getting producers to voluntarily control their contribution to nutrient pollution. Much agency focus in this area has been on attempting to achieve nutrient management by addressing irrigation practices, drainage, animal feeding operation (AFO)/ concentrated AFOs (CAFOs), and erosion control. Peer pressure has been shown to significantly influence getting farmers to voluntarily control and manage their nutrient issues, but the most significant driving factor is economics.

NRCS has become the cost-share entity to assist producers in implementing nutrient management practices that can benefit



everyone – the environment, society, and the agricultural producer. When you ask a farmer to do something to benefit society in general, you need to give him the tools and help him with the resources to accomplish it, Fasching said. NRCS also realizes that nutrient controls must be cost effective for farmers to willingly adopt them. For example, farmers know that phosphorus fertilizer is

relatively inexpensive, convenient, and effective at enhancing crop yields. Any replacement needs to have those same benefits.

One tool NRCS uses is a voluntary manure management planning tool. The tool prints out a document to show producers the bottom line that results from varied practices. Demonstrating to producers that nutrient resources are reusable has also been effective. He gave the example of a commercial turkey operation that voluntarily implemented a commercial composting program in which other farmers could deliver their manure to the facility.

Fasching emphasized the necessity to customize management plans for each farm operation, because practices that reduce nutrient loading in one place may not yield the same benefit in another. It's also important to build trust with

stakeholders, to be forthright and open about expectations or intentions. An example of an approach that did not work, according to Rick, was when the USDA once conducted what amounted to almost covert operations to identify AFO/ CAFO operations contributing to point source problems. That approach seriously eroded needed trust between stakeholders and agencies. Alternatively, the combination of education and the voluntary nature of improved practices, supported by an NRCS cost share, has been effective at getting best management practices implemented on the ground and working toward achieving nutrient controls, he said.

Kristen Gardner, Blue Water Task Force, Big Sky, MT

Kristin Gardner initially explained a bit about the Blue Water Task Force, a non-profit watershed group in an Upper Gallatin River watershed of Montana. The task force has been working on data collection and water quality monitoring with the goal of protecting the quality of water resources in a unique, ecologically isolated watershed that is being dominated by affluent residential second-home development and recreational enterprises. Gardner provided an overview of the group's efforts to understand and respond to water quality degradation caused by nitrogen loads, which appear to be almost totally anthropogenic. The task force recently completed a total maximum daily loads (TMDL) assessment that documented in-stream nitrogen levels and algal growth exceeding state target levels. These nitrogen levels and algae production were attributed generally to wastewater discharge, golf course management, resort and residential developments,

and horse operations in the watershed.

The group understands the need to use the latest technology to both gain understanding of the source of nutrients and quantify the amount of nutrients coming from different sources in the watershed. They found that nutrient concentrations are not always the best indicators of source, especially during the summer growing season. There are often interfering or masking



biological factors that can influence nutrient levels in a stream, such as atmospheric deposition. Geology can be another source of nutrient loading, but is not necessarily incorporated into source loading calculations.

The task force has concluded that one of their biggest challenges is convincing stakeholders that there is a significant level of nitrogen in water resources of the watershed, what the sources are, and that there are strategies available to reduce or control nutrient levels. Another challenge is that stakeholders associated with each source of nutrient loading have their own agendas with socioeconomic implications. Bringing all of the stakeholders and contributors to the table to work on solutions is the task force's next step, one that they acknowledge is a significant undertaking.

Leland Myers – Central Davis (Utah) Sewer District

Leland Meyers, General Manager of Central Davis (Utah) Wastewater District, explained the difficulty of protecting the unique ecosystem of the Great Salt Lake, including the almost entirely human-controlled inflow to the lake and the connection between river flows into the Great Salt Lake. He explained that at low elevations, the Great Salt Lake system is really four lakes and bays with varying combinations of salt and fresh water, each operating differently. Most of the lake is hypereutrophic. In the most saline parts of the lake, brine shrimp proliferate, in part by consuming algae, which is often abundant throughout the lake. In turn, the brine shrimp are commercially harvested, and also serve as a food source for waterfowl.



He questioned whether regulatory agencies should look at one part of a watershed and ask how it functions or look at the entire ecosystem when attempting to achieve nutrient control. Significant investments of financial resources should be made to support research to understand how the Great Salt Lake functions. The

current prevailing approach to dealing with the problem is to battle politically and judicially over who is “right” about nutrient standards. He proposed that state regulatory agencies and the EPA could benefit and achieve nutrient control by developing a nutrient standard that is technologically based. This approach would eliminate any disagreement about what might be the ‘most appropriate’ or correct standard. Leland believes the EPA should work toward developing a wastewater nutrient standard that sets effluent limits based on treatment—a step that would put wastewater treatment under the industrial waste category.

Florence Reynolds – Salt Lake City Department of Public Utilities

Utah has a somewhat enviable situation with respect to drinking water supplies, according to Florence Reynolds, Salt Lake City Department of Public Utilities. Approximately 75% of Utah's citizenry gets drinking water from high mountain areas that are generally highly protected from direct discharges of nutrients from point sources. And most of this population resides within 100 miles of Salt Lake City. However, elsewhere in the state, especially in rural areas, groundwater is the primary drinking water source.

Typically, drinking water facilities don't monitor for nutrients, she said. Instead, “we monitor for the impacts of nutrients.”

The task drinking water providers are faced with is responding to nutrients in source water, i.e., treatment, and not necessarily to manage nutrient loading. She said that the most significant nutrient loading issue she deals with is nonpoint source (NPS), and that nutrient control can only be achieved by controlling NPS. She cited typical NPS as recreational facilities, golf courses, and summer cabins with septic systems, but said that the impacts of those sources are generally minimal and are addressed through treatment. Additionally, small communities whose groundwater is impacted by nitrogen don't have the economic base to respond.



Panel/Participant Dialogue

Conference participants were invited to offer additional comments and responses and present questions to the panel members, to which the panel members – and informed participants – offered responses. Nearly all of the questions and comments from the participants were directed toward stakeholders representing or involved with the nonpoint agricultural sector, i.e., NRCS voluntary nonpoint source control efforts and the Wisconsin P standard. Additionally interesting was that the presentations by these panel members (Todd Ambs and Richard Fasching) and their responses to questions primarily addressed agricultural fertilizer issues and associated efforts at nutrient controls by this stakeholder group.



Robert Brobst participates in workshop dialogue.

Current state of affairs.

Lori Sprague, USGS, was asked whether the data on nutrients in water were adequate to help address the issue of nutrient controls and standards. More specifically, the questions were: how wide-spread are the problems, who is collecting the data, do we have adequate data (or are there gaps), do we have big problems in Region 8 and if so, what are those problems, and where do we need to focus effort. In response, Juliane Brown, USGS Missouri River Basin, member of the SPARROW project, reported on modeling efforts to assess nutrient issues in surface water. SPARROW is a modeling tool being used for the regional interpretation of water-quality monitoring data. The model relates in-stream water-quality measurements to spatially referenced characteristics of watersheds, including contaminant sources and factors influencing terrestrial and aquatic transport. SPARROW empirically estimates the origin and fate of contaminants in river



Todd Ambs responds to questions about the Wisconsin River project.

networks and quantifies uncertainties in model predictions. The primary focus of the modeling efforts has been on nitrogen (N) and phosphorus (P).

River Network – the Wisconsin P standard effort.

A topic generating interest and questions was Todd Ambs' presentation of the Wisconsin River network effort to develop aquatic phosphorus standards. Included in the Wisconsin P standards are numeric water quality criteria for rivers, streams, and lakes. Wisconsin is the first state in the country to create such water quality standards. Concurrent with implementing

the standards, Wisconsin put into place an adaptive management approach that promotes cooperation among point source and nonpoint pollution to find the most cost-effective means to reduce phosphorus and other pollutants.

A question asked more than once was how Wisconsin gained support from the agricultural stakeholders in Wisconsin. Ambs indicated

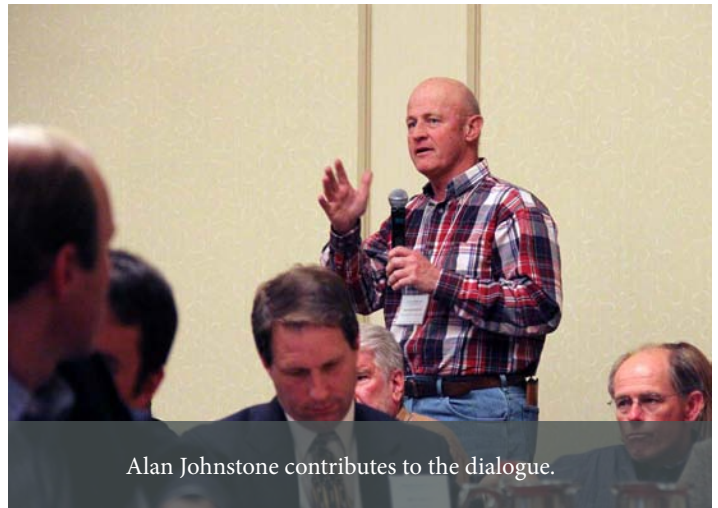
that the nutrient problem was not just an agricultural issue, but a lot of time was spent communicating and building trust with the agricultural sector, helping them appreciate that to define the standards and the nutrient controls necessary, that agricultural experts were going to play an active role, and that knowledge from the agricultural sector, along with modeling efforts, was going to be used to derive P indices. Stakeholders for the agricultural sector agreed that focus should be placed on the 'bad actors,' i.e., environments, practices, and practitioners responsible for a majority of the problems. Stakeholders agreed that as long as the nutrient controls and standards being proposed were achievable by responsible agriculture, the standards and controls would be acceptable.

A lot of time was spent communicating and building trust with the agricultural sector.

Prior to the current standard, Wisconsin had a 1 mg/L phosphorus standard for 20 years, applied to point source discharges. Ambs indicated a consensus that substantial effort and progress had already been made to manage point sources of phosphorus, and additional lowering of the 1 mg/L effluent discharge limit for point sources would be cost prohibitive. Consequently, the Wisconsin DEQ elected to focus attention on the nonpoint sources (NPS).

Another question raised was regarding the data used to arrive at the phosphorus standard: was there a state-wide data collection effort, was attention given to site-specific conditions, and how was it possible to develop a phosphorus standard without responding totally and directly to an EPA mandate of developing a standard? Did historic water quality data prove useful? Ambs indicated that data was gathered over an eight-year period for rivers and streams. Additional data collected from reservoirs, and data from an existing Minnesota database was also used. The Wisconsin DEQ made an effort to do a site-by-site assessment and develop site-specific standards but elected to move forward on a water-body type basis. Given the data and evidence of nutrient issues and water quality in Wisconsin's waters, there was little debate or resistance from the regulatory agencies, the policy makers, or the vested stakeholders about the numbers for receiving waters. Most of the debate was about how the standards were going to be achieved.

One participant wanted to know how the Wisconsin phosphorus control initiative related to NPS contributed from stormwater. Ambs indicated that it was necessary to increase fees, the revenue from which could be directed toward the stormwater issue. Additional staff was hired to deal specifically with stormwater regulation issues, with guidance to target the 'bad actors.'



Alan Johnstone contributes to the dialogue.

Agricultural influences and NPS – the fertilizer issue.

Richard Fasching was asked to what extent farmers actually soil test and subsequently use soil test information to fertilize at levels appropriate to yield expectations or estimates. Richard reported that one-third or fewer crop producers routinely soil sample. Decisions regarding fertilizing are often based on past experience, social influence (what their neighbors did), or guidelines reported by land grant university Extension services based upon soil tests. Consequently, less than one-third of crop producers are generally knowledgeable of residual soil fertility levels.

Two farm/ranch operators addressed the issue of soil testing and fertilizer. Both responded that they soil tested regularly, and almost without exception the soil test results confirmed that residual soil fertility was 'low.' The current cost of fertilizer precludes them and many other agricultural stakeholders from 'over-fertilizing.' Additionally, both of these producers spoke somewhat negatively of USDA and other cost-share programs that are directed toward essentially rewarding producers to implement nutrient control practices while ignoring or disregarding those producers who have already implemented nutrient control programs using their own financial resources. Richard concurred with the producers' opinions and responded that efforts should be made to figure out how to

reward those who are practicing by voluntary implementation as well.

One participant noted that a fair amount of data exist about nitrate in groundwater in the country, indicating that the principal source of nitrate in groundwater is inorganic nitrogen (i.e., fertilizer), and the second most significant source of nitrate is concentrated animal feeding operations (CAFOs). In many instances, agricultural crops cannot be produced at economically marketable levels without inadvertently introducing nitrogen into groundwater. However, there is still much uncertainty about quantifying how much nitrogen (as nitrate) is sourced from either agricultural crop production or CAFOs. It was also pointed out that other contributors of nitrogen in surface water and groundwater include conversion from flood to sprinkler irrigation and crop-fallow farming.

Monitoring – it's necessary, but expensive.

How do we pay for it? Florence Reynolds, Salt Lake City Public Utilities, was asked how water quality monitoring was being paid for in Salt Lake City. She responded by reporting that most of the funding came from the public health department through some creative use of DEQ-administered 319 funds, and from publicly owned and operated treatment works (POTW). She also reported that part of the Salt Lake City success has been through education and community support.

Kristin Gardner, with the Big Sky Blue Water Task force, commented that often, data collection technology is either inappropriate or lacks precision and refinement such that identifying and quantifying sources of nutrient impairment are almost impossible. She said that in the watershed she was dealing with, it still was not clear how much data needed to be collected after several years of intensive study and data collection. Significant challenges that Kristin dealt with, despite excellent community involvement in a well-defined watershed program, were seasonality in hydrology, nutrient sources, nutrient loading, and spatial variability across the watershed. Since few watersheds are static, data collection needs to be an on-going process.

General questions to which the panel did not offer responses.

Numerous questions and comments that the conference participants presented either were not directed to specific panel members or were actually rhetorical in nature, including:

- Are all of the significant stakeholder groups represented here? Reference was made to fertilizer companies, which often make recommendations to crop producers.
- Have efforts or advances been made in the use of biological agents to attenuate, consume, or enhance assimilation of nutrients in water, e.g., algae or brine shrimp?
- How much of a role can precision agriculture play in the agricultural NPS control arena? Are data being collected to document actual benefits of nutrient control (or increased efficiency of use of fertilizer) with precision agriculture?
- What's the point of using nutrient trading practices to pass the burden or ignore the nutrient source? Reference was made to developing and implementing effective nutrient controls for the NPS sector, rather than putting more stringent controls on the point source contributors.

What is the Problem? -The Occurrence of Nitrate in Groundwater and the Connection to Nutrient Loading to Surface Water

Mike Wireman, National Groundwater Expert, EPA Region 8

A national groundwater expert, Mike Wireman covered the issue of nutrients in groundwater and how that results in nutrients in surface water. He said that during the past six to seven decades, nitrate contamination of groundwater has increased dramatically and is a widespread problem in numerous agricultural regions of the USA.



Mike said the most common sources of nitrate in groundwater are inorganic fertilizer, animal feeding operations (AFOs), septic tanks, and residual nitrogen in soil. Total inorganic nitrogen fertilizer application to the land surface in the

U.S. has increased from less than 550 tons per year in 1945 to approximately 12,000 tons/year in 2001. There are more than 260,000 animal feeding operations within the USA, of which more than 20,000 are concentrated animal feeding operations (CAFOs). Fertilizer use in the U.S. increased from 40 pounds per acre in 1965 to about 140 pounds per acre in 2005, and is not regulated at the state or federal level.

The primary human health problem associated with nitrate is methemoglobinemia, known as “blue baby” syndrome, Mike said. He also said that possible links to bladder and ovarian cancer from long term exposure to nitrate concentrations of 2 to 4 mg/L have also been suggested.

Nitrate in groundwater also contributes to high nitrate and nitrogen concentrations in streams and lakes, Mike said. Along gaining reaches of streams in agricultural areas, groundwater discharge (including return flows) can deliver significant loads of nitrogen directly to the stream or, more commonly to the stream bed. How much nitrogen in discharging groundwater contributes to nitrate in a stream is controlled by the complex geochemical and biological processes within the hyporeic zone, he said.

The situation does not appear to be getting better, Mike said. Based on recent data from around the U.S. it is clear that regulatory, voluntary and programmatic efforts to reduce nitrate contamination of groundwater have not been as successful as intended. A suite of best management practices (BMPs) have been developed to prevent or minimize leaching of fertilizers to the underlying water table and to streams, but their effectiveness is not clear.

Mike pointed out that the sustainability of water resources is both a water quality and water quantity issue. Those with expertise in water quality need to be communicating and working with those who have expertise in water quantity.

Are there any solutions? Mike proposed that we are not working hard enough to reduce nitrogen loading to shallow groundwater. Approaches he suggests:

- Limit nonpoint source loading
- Increase regulation
- Improve water resource monitoring
- Better science
- Evaluate and improve BMPs
- Tax fertilizer
- Regulate residual nitrogen in soil
- Delineate nitrate vulnerable areas
- Apply source water protection strategies in catchment basins.

Mike noted that most BMPs are typically designed to deal with runoff. We need to design and implement BMPs for groundwater protection, such as focusing on reducing load of nitrogen to groundwater, he said. He expressed the opinion that “you can’t grow irrigated corn without leaching nitrogen to groundwater.”

Second Question:

What is being done about the problem?

State Overviews

Jeff Ostermiller, Utah DEQ, moderated a panel of representatives from each of Region 8's state's water quality agencies. Each panelist briefly outlined his agency's efforts on developing nutrient criteria and standards. Though the states differ widely in the degree to which they are engaged in the nutrients issue, shared interests and concerns emerged, particularly in regard to fiscal difficulties in implementing improvements.

Montana Mike Suplee, Limnologist



It's not a simple process and it takes a lot of time, energy, human resource input, a serious reason, a champion, and a cautious two-step forward, one-step back, science-based approach to do it right, to paraphrase what Mike Suplee had to report about Montana DEQ's effort to develop nutrient criteria. But, it's working and Montana has made significant progress, using 10 years of work on the Clark Fork River to get a nutrient standard which has now been in place almost a decade. However, Mike will also be the first to declare that the standard is neither complete nor perfect, in as much as the current standard applies only to summer flows – in part due to winter's influence on flows in the Clark Fork and evidence of lack of nutrient loading during the winter. In addition, it's no simple task to achieve or meet the standard. As Mike said, "there seems to be no arguments about the science behind the standard, so now it's a matter of how do we get there."

These limitations of the standard – applying only to the Clark Fork and only during summer flow conditions – help point out some of the challenges of developing nutrient standards, and the considerations that must be made. The Clark Fork, an EPA-designated superfund site, was not an easy target, but an affordable target – a long history of data collection was available, since EPA had a keen interest and had financial support to offer in developing a nutrient standard. In the case of the

Clark Fork, the nutrient standards were developed around drinking water and recreational use criteria. The lesson learned – there need to be 'considerations' built into both the standards and criteria development process and in the implementation of practices to achieve the standard.

The Montana approach may not be unique, but it has been well-documented and clearly defined. More than a decade of studies on the Clark Fork revealed that stakeholder complaints about algae in the river during the summer matched nutrient data. Additional data pointed to only a couple of point sources as probable causes. Monitoring and data collection helped identify and connect stressors and responses, i.e., how drinking water quality and recreational use quality responded to nutrient inputs.

In describing in detail the process Montana DEQ undertook to develop a nutrient standard, Mike emphasized that although each water body is unique, it is not practical to develop unique nutrient criteria for each water body. Montana's approach was to identify ecoregions, areas in the state where water bodies in each region exhibited commonality of circumstances. The next step was to partition water bodies in each ecoregion into wadeable streams versus larger rivers, acknowledging

that nutrient criteria would need to be flexible enough to accommodate differences between lakes and streams. The issue of lake water quality hasn't been tackled yet, because of some significant data gaps relative to lake systems. The next step was then to try to identify and enumerate nutrient issues that were influencing suitability of water quality.

For example, in the case of the Lower Yellowstone River, one of Montana's largest rivers, suitability of water for



drinking purposes is influenced by total organic carbon (TOC) concentrations. Since it wasn't possible to physically measure all contributors and variables to the water quality issue, a number of models were employed to try to characterize and quantify stressors, responses, and how management of those stressors might ultimately influence TOC of drinking water supplies from the Lower Yellowstone. The model runs even allowed for assessment of the assimilative capacity of the Lower Yellowstone.

Like several of the other presenters, Mike stressed the importance of stakeholder involvement right at the onset. He also stressed the need for both flexibility and a good dose of reality, i.e., recognizing that there may be real gaps between what the agency or stakeholder group wants or thinks the standard should be and what is either technologically or

“There may be real gaps between what the agency or stakeholder group wants or thinks the standard should be and what is either technologically or economically feasible.”

economically feasible – whether through stressor management or through treatment. He also stressed that it's important to recognize that the 'first cut' approach may only get you started in the right direction and changes in approach may be needed along the way. Mike proposed that one approach to developing and implementing nutrient criteria might be to start with what is technologically and economically achievable for a specific water body or water use and then gradually work toward becoming 'more restrictive' over time.

The bottom line in Montana: as Mike stated, the vote is often 'red' but the state also thinks 'green.' The quality and value of Montana's water resources is broadly recognized and appreciated across Montana. The Montana DEQ has committed to engaging stakeholders in developing and implementing nutrient criteria and standards which are science based, while at the same time giving full consideration to the need for flexibility, ecological diversity, and an evolving approach to this issue. Montana DEQ is now at the point where it believes it can implement nutrient standards for many of Montana's wadeable streams and the Lower

Yellowstone River. Recognizing that there are potentially large gaps between proposed numeric standards and the limits of treatment technology, the most immediate step forward in establishing nutrient standards and achieving nutrient controls will likely be putting technology to the test until a better approach can be defined and implemented.

South Dakota

Patrick Snyder, Department of Environment and Natural Resources



Patrick Snyder, Environmental Senior Scientist with the South Dakota Department of Environment and Natural Resources (DENR), reported that the department has been relying on written narrative standards for nutrients as well as a rule that prohibits point source discharges directly to lakes instead of establishing nutrient criteria. South Dakota is not planning on adopting nutrient criteria with any urgency in the near future. Patrick stated that, “while we will not be adopting numeric nutrient criteria anytime soon, South Dakota is addressing nutrient issues within the state.” Snyder gave the example of a permit that includes a total phosphorus limit of 0.1 mg/L that was established based on a total maximum daily loads (TMDLs) developed for a lake many miles down stream from the facility.

One of South Dakota's key concerns is maintaining water quality that will support their recreational fishery. With that in mind, South Dakota's primary emphasis on water quality and nutrient conditions is directed towards lakes, and utilizing a water quality assessment tool called the Trophic State Index (TSI). TSI is a classification system designed to “rate” individual lakes, ponds, and reservoirs based on the amount of biological productivity occurring in the water. Using the index, one can gain a quick idea about how productive a lake is by its assigned TSI number. TSI values are being used to



assess whether a water body is able to support its designated use. Patrick reported that the South Dakota agency has used data gathered as part of TSI development to complete some TMDLs on South Dakota water bodies. Patrick was not hesitant to report that some conflicts have arisen between South Dakota's DENR and the EPA. EPA has expressed concerns about South Dakota's use of TSI approaches without being able to link such indexing to protecting beneficial uses of water bodies to which TSI has been applied. The disagreements have been sufficiently heated that South Dakota's DENR stopped using TSI and went back to assessing waters based on establish numeric criteria such as pH and dissolved oxygen.

Concentrated animal feeding operations (CAFOs) have received a lot of attention in South Dakota. The science behind nutrient issues and CAFOs is an issue – much of the debate centers around implementing practices and regulations. South Dakota's aggressiveness in dealing with CAFOs has actually caused some long-term problems. For example, the state rapidly moved ahead with developing a state statute requiring all CAFOs to obtain an NPDES permit as required by the 2003 federal rules. However, recent court decisions make a federal permit optional while South Dakota maintains their requirement for a permit.

The bottom line with nutrient criteria and South Dakota's DENR is something like a cautious, wait-and-see position. The process, however, might not fit a well-defined set of instructions. South Dakota acknowledges the importance of nutrient management and nutrient controls, as evidenced by its strong focus on CAFO management and regulation, its use of TSI approaches to assess the biological quality of many of its lakes and reservoirs, and the prohibition of discharges to lakes. The complicated and sometimes backlashing consequences of making hard and fast rules and regulations have contributed to some of this hands-off, cautious approach toward nutrient criteria establishment.

Wyoming

John Wagner, Department of Environmental Quality



John Wagner reported that Wyoming DEQ is aware of the emphasis being placed by EPA on states to move forward with action toward developing nutrient standards. Nutrients and

water quality impairment have neither surfaced frequently as an issue presently needing attention in Wyoming's sparsely populated state nor have been the focus of DEQ resource allocation other than ongoing water quality monitoring and data collection. Wyoming DEQ has supported a widespread effort to develop and support a certified water quality monitoring program, cooperative with Wyoming's association of conservation districts and the USDA-NRCS. Those monitoring efforts, along with routine DEQ monitoring, have primarily identified rangeland and livestock management as important entities that should be given consideration when developing nutrient controls and standards.



Despite Wyoming's politically conservative nature and well-recognized "cowboy" independence, Wyoming has experienced nearly explosive growth in coal and mineral mining, oil, and natural gas extraction industries in the past 10-15 years. As a result, severance and other tax revenues have put Wyoming's general fund in an enviable position. In response to this growing revenue source for Wyoming, much

For the time being, a narrative nutrient standard will be the guidepost by which Wyoming DEQ deals with nutrient issues.

of the financial and human resources of the Wyoming DEQ have been directed toward water quality and land resource management issues associated with these economically important industries in Wyoming. Consequently, nutrient management is presently a low priority for Wyoming DEQ. Wyoming DEQ has supported a widespread effort to develop

and support a certified water quality monitoring program, cooperative with Wyoming's association of conservation districts and the USDA-NRCS. Those monitoring efforts, along with routine DEQ monitoring, have primarily identified rangeland and livestock management as important entities that should be given consideration when developing nutrient controls and standards.

The Wyoming DEQ has not intentionally ignored the issue of nutrient standards, but rather the agency position is that information, science, and data gathered as part of the on-going monitoring program should drive the development of numeric standards for nutrients in the future, rather than allowing an event or set of circumstances to cause the state to develop such standards without a supportive data base.

So, where is Wyoming on the matter of nutrient standards and criteria? For the time being, a narrative nutrient standard will be the guidepost by which Wyoming DEQ deals with nutrient issues. Limited DEQ staffing, high priority on dealing with issues related to Wyoming's economically important coal, mineral, oil and gas industries, a strong stakeholder monitoring program providing ample evidence that nutrients in water don't appear to be an issue in this rangeland-dominated state, and a 'hands-off' posture with respect to EPA intervention or dictates all appear to be challenges or hurdles to any immediate additional attention to nutrient standards and nutrient criteria.

North Dakota

Mike Ell, Department of Health



In North Dakota, water quality issues – including nutrient controls, standards, and management – are addressed



through the Department of Health. Much like Wyoming, despite an economic surplus in the North Dakota state coffers from oil, gas, and coal extraction revenues, the staff and resources allocated to deal with surface water quality is limited. The

Surface Water Quality Management Program consists of nine staff, including Mike. This staff represents the unit of the Department of Health having responsibility for water quality monitoring, total maximum daily load (TMDL) development, Section 305(b) National Water Quality Inventory reporting to U.S. Congress, Section 303(d) listing of impaired waters needing TMDLs, and the administration of the Section 319 NPS Pollution Management Program.

Basically, the agency is short-staffed in the area of Surface Water Quality Management, including nutrient criteria development and management, and will likely remain short-staffed for the foreseeable future – state government hasn't supported agency growth. Much of their effort for monitoring, basic data collection, or nutrient standards development is largely funded in by EPA grants to the state. This speaks strongly to the conservative nature of the legislature and the people of North Dakota. North Dakota tends to use a cautious approach to developing and implementing regulations, emphasizing active engagement of stakeholders before any standards or regulations are seriously investigated, according to Mike.

In order to get the necessities of nutrient criteria development and nutrient issues accomplished, nutrient criteria development is blended and incorporated into on-going monitoring and database development on other water resource issues. For instance, nutrient and biological data is gathered and incorporated into a comprehensive database when exploring previously unmonitored lakes and when collecting biological data for the statewide biological assessment program administered by the department. In addition, some stressor response studies have provided opportunity for limited nutrient criteria development.

The conservative nature of North Dakota often puts state agencies at odds with the EPA on regulatory issues. Hence, progress is slow, and it will likely be a long time before nutrient standards are actually developed and officially set in motion in North Dakota.

The bottom line on nutrient standards and criteria in North Dakota: staff within the Department of Health understand the situation, but significant focus on developing nutrient criteria or standards for North Dakota surface waters is probably far off the horizon. Staff shortages, priority to other public health and natural resource management issues, agencies' and policy-makers' positions on the topic, and strong sensitivity to stakeholder engagement all will likely continue to influence progress on nutrient standards.

Colorado

Steve Gunderson,
Department of Public
Health and Environment



Steve Gunderson discussed the state's regulatory approach to nutrients. He said Colorado has had nutrient controls on several major reservoirs since the 1980s, and has been working on developing state-wide numeric nutrient criteria for lakes, reservoirs, and flowing waters for over ten years. A nutrient criteria rulemaking hearing with the Water Quality Control Commission was originally scheduled for June 2010, but has been delayed twice, most recently to allow time to conduct a cost-benefit study. The rulemaking hearing is now scheduled for March 2012. Numeric criteria and a proposal to address nutrients have been developed through a stakeholder work group that has an email distribution list of approximately 350 people with widely varied perspectives on nutrients. A group of dischargers has also created the Colorado Nutrient Coalition and has hired John Hall and Associates as well as a Colorado-based attorney to promote their interests.

Steve described the following CDPHE proposal under discussion:

- Adoption of Interim Numeric Values for phosphorus, nitrogen, and chlorophyll a
 - o Phosphorus and nitrogen values are scientifically based and set at levels that will protect beneficial uses.
 - o Interim numeric values could not be used broadly for adoption of water quality standards prior to 2022, but could be applied as standards in limited circumstances for waters located upstream of point sources with significant nutrient concentrations, to protect direct use water supply reservoirs where appropriate, or in other unique circumstances where the Commission has determined it is appropriate. Colorado has many high quality water bodies, especially at higher elevations in the mountains. Establishment of nutrient standards in these water bodies would assure that they would remain protected.
- Adoption of a Statewide Control Regulation



o Technology Based Effluent Limitations

- Establishes technology-based effluent limitations that would apply to all domestic wastewater treatment works as well as industrial discharges with significant contributions of nutrients. Biological nutrient removal (BNR) technology would be required to be installed at discharging facilities. This technology would significantly reduce levels of phosphorus and nitrogen from effluent, although not to the levels of the proposed numeric values. BNR can also serve as a platform for installing additional nutrient treatment systems, so as requirements became more stringent it will not be necessary for facilities to replace the entire treatment system.
- The effluent limitations must be implemented in a permit during renewal.
- Stricter effluent limits apply for new dischargers.

o Additional Considerations

- Domestic dischargers in small or disadvantaged communities are given until 2022 before the effluent limits would be implemented into permits to allow time to arrange adequate funding.
- Allows for compliance schedules and variances under certain circumstances.
- Effluent limits would not apply to dischargers that demonstrate the discharge has no reasonable potential to cause or contribute to ambient concentrations above the interim numeric values.
 - o Requires stormwater permittees to provide public education on nutrients and develop best management practices to prevent or reduce nutrient contributions.
- o Includes voluntary measures for reductions from nonpoint sources.
- o Monitoring: requires collection of data with the goal of quantifying sources of nutrients with the eventual goal of implementing necessary source controls.
 - Requires all point sources to monitor nutrient contributions in their effluent.
 - Includes provisions encouraging the state and nonpoint sources to collaborate on monitoring contributions from those sources.

Strategic Benefits of Colorado's Approach

- Under the proposed approach, Colorado will realize increased near-term nutrient reductions.
- The Colorado Water Quality Control Division believes that the proposed approach will achieve substantive and tangible improvement in water quality far faster than a more traditional approach. Under the traditional approach, use-based water quality standards are adopted into regulation, and then those standards must be adopted for each water segment during the course of five years of basin specific rulemaking hearings, after which effluent limits could be implemented in permits. Dischargers would likely obtain additional delay by requesting adoption of a temporary modification for the water bodies on which they are located. A temporary modification is a regulatory approach unique to Colorado and approved by EPA where a delay underlying water quality standards are delayed for a finite period so that site specific studies can be conducted to determine appropriate water quality standards for a specific water body. With the proposed approach, dischargers would begin to install advanced treatment for nutrient removal sooner.
- A statewide control regulation approach will significantly reduce transaction costs as compared with a traditional approach of adopting water quality standards and implementing those standards into each basin and then into each permit. It will further reduce costs for the Division early in the process because it will eliminate requests for discharger specific variances, development of TMDLs for nutrient impaired water bodies and supporting the rulemaking processes for requests to develop site specific nutrient standards.
- This approach is the logical first step towards the ultimate adoption of numeric nutrient standards on a statewide level.
- This approach provides a foundation from which Colorado will be able to focus on achieving reductions in priority areas.

Utah

Walt Baker, Division of Water Quality



By comparison, Utah's DWQ is somewhere between Montana and Colorado's aggressive efforts toward developing nutrient standards and Wyoming, South Dakota and North Dakota's current low-priority levels of focus on nutrient criteria and standards. Given the demographics of Utah, with a large



majority of the state's population living along the Wasatch Front, within 60-80 miles of either the Great Salt Lake or Utah Lake, urban-related nutrient management is one of the principal driving forces behind attention to nutrient criteria and standards. The other driving factor has been Utah's 'model' effort in inventorying and

working with animal/concentrated animal feeding operations (AFO/CAFO) and the Utah Farm Bureau's management of nutrients sourced from livestock operations. Both of these attention areas have been centered around the total maximum daily loads (TMDL) process.

In Walt's words, Utah is just out of the starting block with regards to nutrient issues and nutrient standards; no specific nutrient criteria have been developed or put in place to date. Where nutrients in water have really gained attention and where effort has been placed on defining circumstance-specific nutrient criteria has been with respect to the TMDL

“Nutrients in Utah's water resources are recognized as an issue to be dealt with – but maybe in a profitable way, as evidenced by attention to the concept of harvesting algae as a bio-fuel source.”

process. In this regard, the Utah Division of Water Quality has found its most useful and meaningful metric for dealing with the urban-related nutrient issue, as related to the TMDL process, to be measures of total phosphorus. And, this comes as no surprise, since these TMDLs have been associated with municipal wastewater treatment facilities.

Nutrients in Utah's water resources are recognized as an issue to be dealt with – but maybe in a profitable way, as evidenced by attention to the concept of harvesting algae as a bio-fuel source, from several Utah water bodies.



Two water bodies in Utah which have received a lot of attention are Utah Lake and the Great Salt Lake. Utah Lake is a shallow, sediment-laden water body with evidently high nutrient levels but without the often-associated algae problems. Efforts to deal with nutrient issues in Utah Lake have focused on using 319 nonpoint source funds to inventory AFOs which may be influencing nutrients in Utah Lake, to fund projects to curtail nutrients sources from agricultural operations getting into Utah Lake, and to support the cost of phosphorus removal from municipal wastewater treatment facility discharges that ultimately make their way to Utah Lake. Interestingly, and potentially a source of challenge in the future with regard to nutrient management in Utah Lake is the fact that the Utah Lake Commission has entertained discussions about the possibility of 'holding new wastewater treatment plants to higher standards and requiring plant operators to implement best available technologies' for nutrient control in wastewater discharges.

As for the Great Salt Lake, Walt said that it can best be defined as the enigma. Presently, the department is using a multimetric index to assess if nutrients and other pollutants are having an effect on the health of Great Salt Lake wetlands. This multimetric index, an EPA-defined approach to assessing watershed (or water body) health, combines indicators, or

metrics, into a single index value. Each metric is tested and calibrated to a scale and transformed into a unitless score prior to being aggregated into a multi-metric index. Presently the only standard which has been defined for the Great Salt Lake is for selenium concentrations.

Utah's Department of Water Quality is somewhat 'on the fence' with respect to dealing with nutrient controls and nutrient management issues. A commitment of \$1 million annually from state funds to bolster 319 funding directed toward dealing with nonpoint source (NPS) issues clearly acknowledges the recognition of the importance of NPS management. At the same time, the Department has backed a 'nutrient cost study' for the purpose of assessing all wastewater treatment plants in Utah to determine the cost of implementing various levels of nutrient control through water treatment. One of the surprising outcomes of this study, completed by CH2M Hill, has been the finding that it is actually cost-effective to substantially lower or remove nutrients from wastewater.

Utah Department of Water Quality clearly recognizes that nutrients in water are an issue to be dealt with, either because of the environmental consequence or because of emphasis being placed on the issue by EPA. What progress the department has made with regard to nutrient criteria has been in direct, one-on-one dealings with wastewater treatment plant operations integral to the TMDL process, or in directing substantial amounts of funding to implement NPS projects. Substantial attention has been given to AFO/CAFOs in Utah. Questions without answers seem to be a topic of discussion with many people having interest in nutrient standards and criteria in Utah. There seems to be some question of both the ecological benefits and economic costs of implementing numeric nutrient criteria, including questions about the cost-effectiveness of nutrient management through wastewater treatment. Other questions include the effectiveness of the current Utah 'best management practices' implementation system in place today.

What is being done? -Common Points Across States

Summary and Panel and Participant Dialogue



Steve Gunderson of Colorado responds to audience questions and comments during the states dialogue.

Summary

Region 8 state agency representatives each briefly reiterated insights into the current status of each state's efforts on developing nutrient criteria and standards. From the previous presentations and additional comments during the discussion period, it was evident that Utah, Montana, and Colorado have very active and aggressive programs and efforts underway to establish numeric water quality standards. This appears to be driven by a number of factors, including individual state water quality agency working relationships with EPA, demographic pressure on existing water resources (in the case of Colorado and Utah), and strong agency commitments to dealing with pressing water quality issues and preserving existing water resources (Montana).

One could speculate that at least in the case of Colorado and Utah, the departments of environmental quality are aware of the financial benefits of partnering with EPA, including access to EPA resources such as technical expertise, guidance, and financial assistance.

Montana has had a long-standing working relationship with EPA. The state legislature and DEQ have underlying environmental protection philosophies, which may give

them a bit of breathing room as they work toward nutrient standards—perhaps greater opportunity to involve stakeholders and “do it right” by the state's own choosing. Additionally, Montana has a huge superfund-supported program, which has offered some opportunities for commitment of staff and agency resources to data collection and nutrient criteria development that might not have otherwise been affordable. One example that Mike Suplee gave of this nature was the Clark Fork – one of the largest, most heavily funded superfund sites in the U.S. Financial resources and human resources are driving the process – along with highly qualified individuals. Obviously agency size and

financial resources dictate progress in some of the states of the region.

In contrast, South Dakota, North Dakota, and Wyoming are predominantly agricultural, low population density states. Considering their geography,

“South Dakota, North Dakota, and Wyoming are predominantly agricultural, low population density states where most water quality impacts are likely associated with nonpoint issues.”

predominant industries, populations and demographics, broad scale watershed/nonpoint sources issues appear to be more prevalent than point source issues at present. In addition, much of Wyoming and North Dakota water quality agency focus has been directed toward dealing with the rapidly growing oil, gas, coal, and mineral extraction industries. In these states, water quality, particularly in terms of nutrient standards, has gotten much less emphasis – partly because of lack of pressure from the populace, lack of either perception or data-substantiating nutrient issues, and domination by the agriculture and energy-extraction sectors.

Probably the single most consistently expressed issue among the states focused on working relationships between the state water quality regulatory agencies, stakeholders, and the EPA. Each speaker did express some degree of: 1) feelings of pressure from EPA to focus resources and make progress toward establishing nutrient criteria and standards, and 2) conflict with EPA – either about progress being made or approaches being used. North Dakota, South Dakota, and Wyoming are making efforts, but nutrient standards are not high priority issues with limited staff and budgets and other responsibilities. In those states, human resources and financial resources dictate where progress is made the fastest. There is some obvious conflict between what states are doing and



John Wagner of Wyoming discusses Wyoming's approach to nutrient level controls during panel discussions.

can do, and what EPA is pushing them to do. Less populated states seem reluctant to develop standards, don't necessarily acknowledge or recognize an issue of elevated concern, or don't have the resources to develop standards. In fact, almost everyone expressed the influence of a 'conservative' political system within the Region 8 states.

Several speakers announced that implementation of standards is as big a challenge as defining the standards. There needs to be some incorporation or inclusion of flexibility in the implementation of standards. Mike Suplee presented

the example of developing allowances for variances in implementing the standards.

From the perspective of the state water quality regulatory agency representatives

- There is a need for EPA to recognize that the problem of nutrients in water was not created overnight, but over decades, and it is going to take probably equally as long to define approaches to a solution, implement those approaches, and then be able to effectively monitor and make changes accordingly to then be able to seek outcomes. Finding solutions, setting standards, and achieving controls is and will continue to be an iterative, step-by-step process. As previously pointed out, in those states where significant progress has been made on nutrient standards, it has been a two-step-forward, one-step-back process that must be recognized by EPA – and approached with caution.
- Not all the states' water quality regulatory agencies in Region 8 have assigned the same priority to nutrient criteria development, nor do the agencies perceive or acknowledge that they have equality of nutrients in water issues. Compounding this disparity among the state agencies are complex demographic, political, social, economic, and staff resource differences among the states.
- EPA has been outspoken, vocal and generally clear about the necessity of the state water quality regulatory agencies to either begin or continue to move ahead with the task of defining nutrient issues, criteria, standards, and control measures. Yet some state agency representatives pointed out that neither is there a clear-cut, one-size-fits-all process for establishing nutrient criteria nor is there significant guidance or resource support from the EPA on this matter.
- It appears that EPA recognizes the differences, and the independent and generally autonomous nature of the individual state agencies, and is consequently watching from a distance. On one hand, this somewhat 'hands-off' posture of EPA is appreciated by the state water quality regulatory agencies, while on the other hand, there is expressed concern by some state representatives about lack of specific instructions or defined procedures from the EPA about how to move forward with developing nutrient criteria and standards.
- There has been a substantial amount of collaboration and data-sharing between states with common waters, although

this has not simplified the nutrient criteria development process. When it comes down to final actions, the process then falls back to the individual states, their agencies, and the political arena. Thus, there is not a lot of hope that interstate sharing of data and approaches will make the nutrient standard development process any easier – although it is helpful to know what neighboring states are doing and what approaches they are using.

- Although not unanimous, there is some opinion that the most effective, efficient, and expeditious way to achieve nutrient controls might be by defining and adopting technology-based effluent limits where applicable. This would be most applicable to drinking water providers and wastewater treatment operators.

From the perspective of the stakeholders

- Stakeholders frequently expressed the sentiment: “it’s not only important to give us a standard or numeric criteria to meet (referring to standards set by regulatory agencies), but give us the right number.” If a stakeholder is going to be expected to comply with a standard, it should be, maybe even must be, a number based on good science and credible data.

- Stakeholders need to be key players in the standards and criteria development – and how to achieve those standards or criteria. There should be key stakeholder input with respect to both standards development and implementation, and the entire process needs to be done with caution.

- Stakeholders clearly expressed the opinion that they want to take ownership of the nutrient management issue. Essentially, the states are best at dealing with this within the confines of their own political, legal, and agency situations. They also recognize that one size does not fit all circumstances – whether referring to all Region 8 states collectively or to collective water bodies within a specific state. One speaker commented: “EPA regulation is a scary prospect.”

- Stakeholders – and the water quality regulatory agency representatives – were quick to point out that a lot has already been done in the nutrient control and management area, and the absence of hard line criteria does not mean that the stakeholders and agencies are not working on this issue. Much progress has been made to address nutrient issues associated with AFO/CAFO, with nonpoint

source issues, with stormwater controls, and with wastewater management.

- Comments and input by numerous audience members

brought attention to perceptions about nonpoint sources, agriculture, other land uses and oftentimes lack of adequate data to provide a basis for establishing nutrient criteria associated with these stakeholders. Most entities involved in the nutrient management issue lack clarity and certainty about the contributions of point versus nonpoint sources of nutrients to various water bodies, i.e., there exists a significant data gap here. The sources of the nutrient problems in the metropolitan areas are pretty well defined/identified – wastewater and stormwater runoff. However, the metrics and numerics of various nonpoint contributors are not that well defined.

If a stakeholder is going to be expected to comply with a standard, it should be, maybe even must be, a number based on good science and credible data.

Recommendations that surfaced during the discussions

- The EPA needs to work with the states collectively to develop a guideline, answer the burning questions, and share ideas about how to deal with the nonpoint sources. But, don’t set mandates for either the state agencies or the stakeholders, and don’t force us to develop these standards on an EPA timeframe and under an EPA agenda.

- Working groups with multiple stakeholders need to be organized to work on standards development, including gaining appreciation for the need for nutrient standards to developing the standards, moving the standards forward, developing and implementing effective strategies and approaches for implementing standards, and following up with respect to impact assessment, data collection, accountability (i.e., has the implementation of standards made a difference or is it just a ‘make-work’ effort to achieve EPA needs to show progress on the Clean Water Act?)

- Agencies and organizations other than the EPA and the DEQs need to be brought into the process. NRCS, the front-line agency, the conservation districts, Ag associations working with Ag producers, and others need to be in the planning, development, and especially the implementation of voluntary nutrient management efforts in the Ag sector.

What is being done? -Nutrient Reduction and Control Tools - Case Studies

Bob Brobst, EPA Region 8, moderated a panel that provided case studies of what is being done across the various sectors dealing with nutrient issues. The case studies brought out insights ranging from nutrient credit trading, to precision agriculture, to “Don’t P on your lawn” campaigns.

Al Basile: Innovative Tools to Deal With Nutrients from Nonpoint Sources (NPS)



Al Basile, EPA, Denver, Colorado, shared with participants what EPA is doing in Region 8 to address NPS pollution from nutrients and tools being used both in urban settings and in agriculture. Since 1987, EPA has awarded about \$16M annually to Region 8 states to implement projects to reduce NPS pollution. Those funds are

often leveraged to bring in additional money, especially financial assistance programs in the U.S. Farm Bill. What kind of results is EPA seeing? Basile said that only considering projects funded or partially funded by EPA, in fiscal year 2010 alone reductions of phosphorus came to more than 210,000 pounds and of nitrogen more than 650,000 pounds. But even with these achievements, he said, a 2008 report shows that more than 7500 stream miles in Region 8 remain threatened or impaired because of excess nutrient loading. For lakes, reservoirs, and ponds in Region 8 that number comes to more than 470,000 acres. So the pace at which newly identified impairments are discovered greatly exceeds the pace of restoration.

What can we do? Al listed best management practices in use in both urban and agricultural settings that trap or attenuate nutrients already present in a given watershed and keep those nutrients from reaching lakes or streams. Urban examples include:

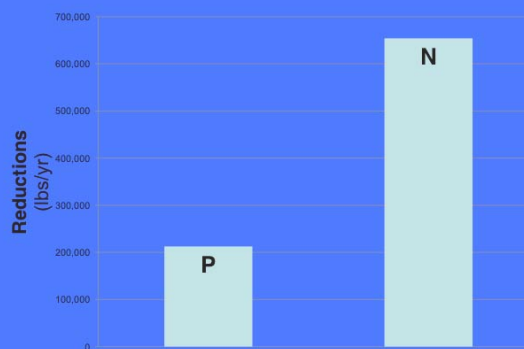
- Constructed wetlands (gravel wetland)
- Porous pavement
- Bio filtration (directing runoff from parking lots and roadways into vegetated areas where infiltration can occur)

Agricultural examples include:

- Low or no-till farming practices
- Grassed waterways
- Livestock exclusion
- Riparian buffers

These are all very important practices, but alone may not be enough to achieve reductions needed to restore water quality in many impaired waters. Al believes our best hope lies in putting greater emphasis on minimizing the amount of nutrients imported into watersheds, while at the same time continuing to implement on-the-ground BMPs. He detailed two innovative approaches that seek to minimize the amount

Region 8 Nonpoint Source Reductions (FY10)



of nutrients imported into watersheds: reducing the use of phosphorus on residential lawns, and carefully matching agricultural fertilizer inputs to crop needs through the use of precision agriculture.

“Don’t ‘P’ on your lawn” is the public education slogan used by the Lake George Association in New York State that encourages the use of phosphorus-free fertilizers on lawns. The City of Ann Arbor actually adopted an ordinance in 2007 restricting the use of phosphorus containing fertilizers on residential lawns. Just a year after implementing the ordinance, water quality studies documented a 28% reduction in total phosphorus concentrations in the Huron River, which drains the City of Ann Arbor and flows into Ford Lake. “These are the kind of reductions that can really make a difference,” Al said. Starting in 2012, phosphorus will be banned in most lawn fertilizers throughout the entire state of Michigan, and other states, counties, and municipalities are adopting such ordinances.

On the agricultural side, Al said, the potential for precision agriculture to reduce fertilizer use while at the same time increasing yield may turn out to be a very important tool. He described precision agriculture as the use of GPS and other technologies to match agricultural inputs, like fertilizer, to localized conditions within a field. Using real-time information, fertilizer application

“Our best hope lies in minimizing the amount of nutrients imported into watersheds instead of relying on trapping or attenuating nutrients that are already present.”

rates are adjusted on a very fine scale as opposed to uniformly applying fertilizer across an entire field or farmstead. Plants get what they need, producers have the potential to save money, and mobilization of nutrients from farm fields is reduced. As an example, Al cited that a number of producers in the Chesapeake Bay watershed are beginning to use real-time nitrogen sensors combined with variable rate applicators. Research from Virginia Tech University has shown that this approach, when used on corn, resulted in a 5% increase in yield and a 21% reduction in nitrogen.

In closing, Basile reminded participants that our hope lies in our collective ability to encourage the development of new technologies, while also considering all available tools when developing strategies, especially when they minimize the amount of nutrients that we are adding to our watersheds.

David L. Clark: Wastewater Nutrient Removal, Sustainability and Permitting

David L. Clark, Senior Vice President of HDR Engineering, Inc., addressed the many factors that combine to present challenges to wastewater utilities when it comes to controlling nutrient discharges to a greater degree than in the past. He also shared insights about controls on nutrients before they enter the wastewater treatment plant.



Nutrient Controls Before the Wastewater Treatment Plant

While wastewater utilities rely on those responsible for surface waters to manage their effluent, he pointed out that too stringent criteria at that stage can result in unforeseen costs/problems without a commensurate water quality benefit.

He said numeric nutrient criteria are being established as in-stream targets that reflect very low concentrations. The results may be new water quality impairment listings for streams, challenging targets for TMDLs, and restrictive effluent discharge permits. In fact, he said, when in-stream numeric standards are based on natural conditions, they can result in a number that is lower even than treatment technologies are capable of achieving if they are applied “end of pipe.”

The quality of the water discharged from point sources into a wastewater utility is regulated first under the NPDES permit program’s TMDL limits, David explained. Over-regulation at this point may have unintended consequences, including reducing in-stream flows, altering development patterns, and skewing economic impacts. Besides, he said, reduction in point sources alone will not protect surface water quality.



Sustainability Comparison of Point and Nonpoint Source Nutrient Controls				
Approach	Electrical Power	Chemical Use	Greenhouse Gas	Additional Watershed Enhancements
Point Source Advanced Treatment	+50% to +250% over secondary treatment	Alum, ferric, methanol, other carbon sources	+120% over secondary treatment	None
Nonpoint Source Best Management Practices ¹	None	None	Sequesters carbon	Enhanced habitat, aesthetics, sediment reduction

¹Conservation tillage, grass buffers, detention basins, wetlands

Treating for Nutrients at the Wastewater Treatment Plant

Once nutrients hit the wastewater stream, their removal requires additional treatment facilities beyond secondary treatment, which results in increases in both capital and operating costs. Costs for treatment plant retrofits for nutrient removal are highly dependent upon existing infrastructure and the extent to which facility modifications are required to meet effluent nitrogen and phosphorus limits.

David cited a November 2010 study by the Water Environment Research Foundation (WERF), “Striking the Balance Between Wastewater Treatment Nutrient Removal and Sustainability” which outlines and contrasts various levels of nutrient treatment in wastewater facilities.

1. Secondary Treatment (No nutrient removal)
2. Biological Nutrient Removal (BNR)
3. Enhanced Nutrient Removal (ENR)
4. Limit of Treatment Technology (LOT)
5. Reverse Osmosis (RO)

Advanced wastewater treatment facilities, including plants that remove and/or reduce nitrogen and phosphorus, require significant capital costs and operating expenses, including energy and chemicals, as well as complex operational expertise and staffing needs. There has been concern raised about the sustainability of these operations, the workforce needed, and increases in sewer and water rates to the public. In addition, there are issues related to the potential contribution to greenhouse gas emissions from the treatment process, energy shortages, the rising costs of fuel based polymers and chemicals, and climate change issues. Chemicals, such as alum and ferric compounds needed in some processes to remove phosphorus to very low levels, increase the quantities and affect the quality of the treated bio-solids that have to be managed.

David closed by concluding that while it is important to manage nutrients in many water bodies, appropriate nutrient effluent limits should be based on the capabilities of treatment technologies to produce the desired water quality without causing undesired consequences.

Progress made in wastewater load reductions may be lost to increases in other source loadings, specifically those from nonpoint sources.

Surface water nutrient discharges should receive special consideration in discharge permitting, he said, because unlike pollutants that can have acute effects in the aquatic environment, total nitrogen and phosphorus have seasonal impacts on receiving waters. He cited the case of Ruidoso, New Mexico where permit limits were adopted way beyond the limits of technology—a prime example of how limits that are too stringent create compliance issues. In that case, he said, EPA adopted an approach suitable for addressing toxins but not suitable for addressing nutrients. He said much of the existing EPA permit writer’s guidance is based on toxins. David believes that appropriate NPDES discharge permit structures for nutrients should be based on long averaging periods linked to the specific water body response to nutrient enrichment. He thinks limits should be seasonal, based on long-term average values, or total loading for the compliance period (e.g., total pounds discharged on an annual or seasonal basis).

“Appropriate nutrient effluent limits should be based on the capabilities of treatment technologies to produce the desired water quality without causing undesired consequences.”

Trace Robinson: Nutrient Removal from Stormwater, is it Practical or Only a Wish?

Trace Robinson, of Riverton City, Utah, proposed that it is probably not realistic, practical or achievable to remove nutrients from stormwater once it is there, but to prevent nutrients from getting into the stormwater in the first place is a much more achievable goal. A large percent of the nutrients found in stormwater is attached to sediment, so controlling sediment appropriately will reduce the amount of nutrients entering stormwater. He cited the six minimum control measures for preventing the introduction of nutrients into a stormwater system that are listed in the MS4 permit (MS4 refers to Small Municipal Separate Storm Sewer Systems):

- Public education and outreach
- Public involvement and participation
- Illicit discharge detection and elimination
- Construction stormwater runoff management
- Post construction stormwater management
- Pollution prevention/good housekeeping

In regard to construction related stormwater runoff management, Trace quoted the Utah MS4 regulation as stating

that the objective is “for the hydrology associated with new development to mirror the hydrology of the previously undeveloped site or to improve the hydrology of a redeveloped site and reduce the discharge of stormwater.” By placing emphasis on matching post-development conditions with pre-development conditions, you can limit the amount of runoff leaving a site, and prevent potential nutrients from entering the system, he said.



One method of nutrient removal and stormwater treatment used in his area, Trace said, is the use of constructed wetlands or wet ponds. However, continuous water flow is required, something which is hard

to come by in their desert climate. Other disadvantages are high construction costs, high maintenance requirements, limited available land, rodent/insect nuisance, and threat of drowning. These wetlands achieve high levels of nutrient removal during the summer months when the plant life is flourishing, Trace said. However, “when the plant life dies or goes dormant during the winter months, some of the nutrient load we worked so hard to remove will be released back into the water.” He said this can be avoided only through a significant maintenance of the wetlands to harvest and remove the plant life at the end of every growing season—an expensive proposition.

Trace favors striving toward controlling nutrients in terms of a “maximum extent practical” goal instead of being required to achieve defined water quality standards. He thinks such standards are not realistic, partly because there are too many factors for large scale control, and they would be expensive to achieve. In closing, he said “if we use the tools I have discussed which are part of the MS4 approach, it will be practical, realistic and achievable to keep nutrients out of stormwater, as long as the term ‘to the maximum extent practicable’ is accepted.”

“By placing emphasis on matching post-development conditions with pre-development conditions, you can limit the amount of runoff leaving a site, and prevent potential nutrients from entering the system.”

Cody Stanger: Nutrient Credit Trading: A Model for Success



Cody Stanger with CH2M-Hill discussed nutrient credit trading as a tool for reducing nutrient loads and improving the health of water bodies. He pointed out that state and local agencies across the country have adopted various nutrient reduction strategies to control eutrophication, targeting both point and nonpoint pollution sources. Setting total maximum daily loads (TMDLs) goals for point sources and load allocations for nonpoint sources are among the strategies implemented. When the necessary conditions are in place,

Cody said, nutrient credit trading has proved to be a successful strategy for meeting aggressive reduction goals. Essentially, credits created when an entity meets goals below the baseline, can be traded with those who have exceeded limits. The collective nutrient load for all participants remains at or below the collective baseline performance level.

Benefits of nutrient credit trading, according to Cody, are: 1) compliance can be more cost effective due to economies of scale, 2) benefits exist for both parties, 3) resources can be focused on the most effective point source or nonpoint source technique, 4) trading can create boundaries that target reductions on priority areas, and 5) trading provides stakeholders incentives to over comply with baseline, which can speed up restoration. He said that critics tend to be more concerned about lack of a real baseline than they are about the concept itself. Types of credits include point/point, point/nonpoint, and stormwater credit. Price is based on the price of controls. Because point and nonpoint source controls have such huge cost differentials, outside experts are used to estimate price and inspect best management practices. Under a reverse auction set up, entities propose BMPs as bids and a committee chooses them.

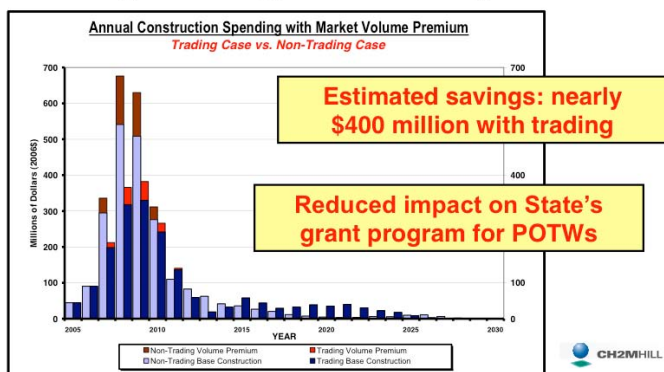
Cody described the Virginia Nutrient Credit Exchange, a point/point trading program for Chesapeake Bay which is completely voluntary and managed by dischargers. Trading cannot be done between basins feeding the bay. The program features TOM—Trading Optimization Model—an Excel-based tool created to determine credit availability and establish trade agreements among the point source dischargers participating in the program. TOM relies on an adaptive management approach and a framework that allows prediction of flows and concentrations over time. A credit ledger manages and tracks trades, while dual markets separate firm buyers and sellers from those who are tentative. Cody estimates the cost savings at \$400 million. He said that avoiding the construction ‘crunch’ for quickly upgrading systems accounts for much of the savings.

Cody closed by summarizing the prerequisite conditions of successful trading programs:

- The presence of a “driver” for action
- An understanding of water quality
- Availability of nutrient reduction alternatives
- A cost-effectiveness differential
- A sufficient scale for investment
- A stakeholder-endorsed framework

Show Me the Money \$\$\$

Trading offers significant savings



Ron Wiederholt: AFO/CAFO Regulations: What is Happening on the Ranch?

Concentrating more on animal feeding operations (AFOs) than concentrated AFOs (CAFOs), Ron Wiederholt, North Dakota State University, proposed that finding solutions for nonpoint source pollution is really about working with the people. We are too dominated by the hard sciences and not very adept at the sociology end of things, he said.

Wiederholt cited lack of involvement in the regulatory process by the people who are being regulated and encouraged turning that around. He said AFO/CAFO operators want

to do the right thing once they understand the issues. Producers in North Dakota are working closely with researchers and regulators to determine the actual impacts of AFO/CAFO runoff on water quality. They want to be innovators in adopting practices to lessen identified impacts, he said.



“By involving producers, we can identify which water quality improvement practices can give us the most bang for the buck.”

What does it mean to work with farmers? Ron asked. Are we preaching at them over the phone or are we out on their farms in the mud and the rain listening to what they have to say?

Ron also questioned what level of protection we should aim for. Can water quality impacts be reduced to zero? Should the target be determined based on real data collected on real farms and ranches or should it be arbitrarily set by people who think they know best? He believes that if the people who are being regulated have the opportunity to work with scientists, regulators, and the public, these questions can be answered in a way that satisfies all parties.

One effort detailed by Ron that appears to be meeting with success is the Discovery Farms project in North Dakota. Discovery Farms is a producer-driven project focused on intensive water quality monitoring of livestock operations and tile drainage, asking producers what they think might help solve water quality problems. They started by looking into the issues that need to be addressed, investigating what nutrients are coming off the AFOs, and identifying potential volunteer farms of different types. Of particular interest is the effect of tile drainage on the volume and the quality of run off.

This involvement will allow producers to do something on their own to try to solve problems. A member of North Dakota’s state nutrient management task force said, “This project is exactly what we need.” The task force is made up of producers, the Natural Resources Conservation Service (NRCS), agricultural and environmental organizations, and academia. At this point, the project is at the stage of collecting baseline data.

Ron closed by pointing out that most states have implemented regulations to improve water quality, but most of those who work with water quality at the state level probably agree that the effectiveness of regulations and practices range from being very effective to not very effective at all. He quoted Wisconsin professor Pete Nowak who asks, “How can we manage the resource if we do not understand the resource manager?”

“AFO/CAFO operators want to do the right thing once they understand the issues.”

What is being done? -Economic Cost/Benefit Assessment of Nutrients in Surface Water

Adam Sigler, Montana State University, moderated a panel that provided insights on the economic costs and benefits of dealing with nutrients in water. Topics ranged from an overview of how cost/benefit is typically measured to a very ambitious water treatment plant study in Utah and a planned study to determine how water quality affects use of recreational water bodies.

Assessing Costs and Benefits Related to Nutrients and Water Quality -Mary Jo Kealy



Acknowledging that the harmful effects of nutrients on many surface water bodies has been documented, Mary Jo Kealy of CH2MHill pointed out that reducing nutrient loading can be costly. She said that before we

embark on the path of establishing statewide nutrient criteria to reduce nutrient loading, we should first assess how much it costs to get the anticipated improvement in water quality, and what the resultant economic benefits are.

The process of benefit cost analysis (BCA) starts with measuring the changes in economic welfare caused by a proposed action. That involves comparing the level of market and non-market economic activity without the action (baseline) to the level of market and non-market economic activity with the action.

On the cost side of the ledger are higher costs of treating wastewater discharges, the cost of implementing best management practices for stormwater and nonpoint source contributors, and the cost of monitoring compliance and administering the program.

On the benefits side of the ledger are water quality improvements that result from reducing nutrient loads. When water quality improves, so does the value that people place on water-based recreation activities such as fishing, waterfowl hunting, boating, and swimming, and near shore

recreation/riparian green-way activities such as walking, wildlife observation, and picnicking. In addition, property values of waterfront and water-view locations are sensitive to water aesthetics related to water quality. Indirect and passive benefits include preservation/conservation and maintaining ecosystems for fish.

A study is being conducted by the Utah Division of Water Quality to determine costs and benefits of nutrient criteria implementation, Mary Jo said. Specifically, the division is asking, “Are nutrients adversely affecting Utah’s waters, resulting in economic losses to society?” Mary Jo cited some indicators, including the 2004 death of 18 cattle at Matt Warner Reservoir due to ingesting blue-green algae.

Mary Jo recommends that we refine statewide numeric criteria so that benefits exceed costs, and economic efficiency is improved—that we find the point where society is better off if an action is implemented, where the value is higher than what we are giving up.

She points out that we need to modify criteria based upon site-specific benefits and costs. In some cases regional criteria may be over or under protective for a given site. Rather than rely on a statewide aggregate cost benefit analysis, we should conduct site-specific analyses for areas where cost might be very large, or benefit might be very large. We need to look for the least cost solutions, for instance finding the optimal combination of point and nonpoint source control measures.

“Before we embark on the path of establishing statewide nutrient criteria to reduce nutrient loading, we should assess how much it costs to get the anticipated improvement in water quality, and what the resultant economic benefits are.”

Quantifying Recreation Benefits from Clean Water

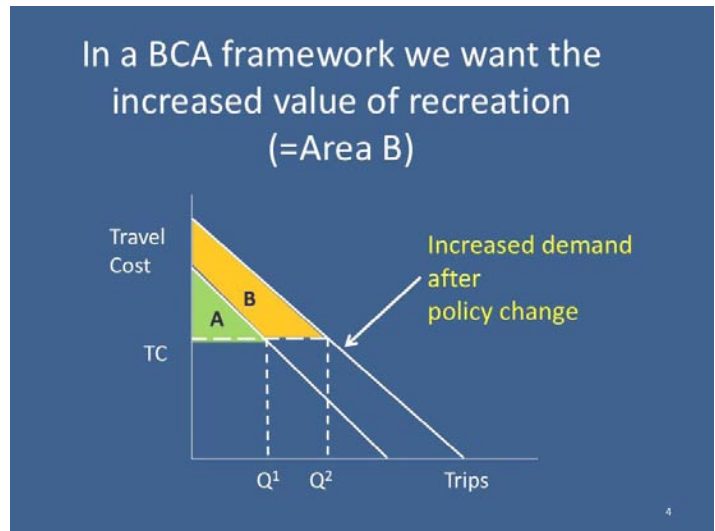
-Nanette Nelson

Efforts to achieve nutrient controls and define standards are generally directed toward the sources and causes, nutrient contributors, or those who end up with responsibility for achieving the standards – either drinking water, source water, wastewater, stormwater, or in-stream. According to Nanette Nelson, Wyoming Survey and Analysis Center, we don't often try to quantify the relationship between recreationists and water quality because it is not easy. However, those who engage in water-based recreation and near-shore activities will be key beneficiaries of improvements to water quality resulting from the adoption of nutrient criteria. But, key questions yet to be answered are, "How much does or will water quality influence a recreationist's behavior, choice of water-related activities? Will the recreationist be influenced in his/her water-related activities by water quality? How much value will recreationists put on improved water quality due to nutrient controls and nutrient standards?" The answers to these questions are the focus of Nanette's research efforts.

Clean water is not a commodity that can be 'traded' in commercial markets, and putting an economic value on 'clean' water has not been tested. Consequently, the lack of markets and therefore prices poses a challenge for natural resource managers, especially if they expect to demonstrate that the economic benefits of a proposed policy are at least equal to or greater than the costs. Nanette is currently studying the economic benefits of implementing nutrient criteria in Utah's waters used for recreation – specifically recreational sport fishing. She is currently surveying people who travel to Utah to recreational fish, using a combined revealed preference/stated preference approach in her survey. She is attempting to model changes in visitation patterns in response to changes in



policies related to water quality, and then link metrics used to model nutrients in water to the factors people evaluate when making decisions about recreation.



One would expect that fishermen would intentionally participate in more fishing trips with improved water quality, equating to improved recreationist benefits attributable to water quality improvements. However, it is questionable whether this has been proven. Nanette is currently assessing fishermen behavior, based on sites visited, number of visits, specific recreational activities, and distance fishermen travel to arrive at specific fishing sites. This information will allow her to characterize recreation demand under current conditions. She will then attempt to assess how fishermen visitation changes once nutrient criteria are implemented. In 2011 she will be asking fishermen what changes they will make when water quality is improved. Ultimately, the goal of her research is to determine through modeling the link between recreation demand and nutrient loading, and how this will be reflected in recreational activity throughout Utah. The final question then becomes, from all of this, can a value be placed on outcomes of nutrient controls, from the perspective of recreational use of water of improved quality?

The Cost of Nutrient Treatment at Wastewater Treatment Plants

-Paul Krauth



Other than actually achieving a nutrient control level or standard, probably the most stressful issue a wastewater treatment plant operator deals with is cost – cost of plant operations, costs to achieve treatment control, and added costs that would likely be associated with additional

or more stringent nutrient control requirements. Paul Krauth, outreach coordinator for the Utah Division of Water Quality, reported on a comprehensive study completed by the Division, in association with the State Water Quality Board, to assess the costs for removal of nutrients from all mechanical wastewater treatment plants in Utah. Costs for wastewater plant operation were categorized by level of nutrient removal required and type of facility being upgraded to achieve anticipated new nutrient controls. An even more ambitious endeavor underway is a study by the state to quantify the benefits the State will receive from changes in domestic wastewater nutrient removal efficiency.

One might ask: ‘why focus on mechanical treatment plants?’ Utah is the 2nd driest state in nation, despite being home to the fourth largest lake in the U.S. Utah is also the sixth most urbanized state in the U.S. Utah currently has in operation 30 mechanical plants and 29 discharging lagoons, discharging 300 MG/day wastewater. It is likely that some time in the not-too-distant future 75-85% of these facilities will be required to deal with nutrient control regulations.

The Water Quality Division was keenly interested in what would likely be the cost to Utah and stakeholders if these 30 plants and 29 discharging lagoons had to implement controls to achieve nutrient standards. So, the goal of the Division study was to work with POTW operators to determine realistic cost estimates for N and P removal in Utah’s POTWs; and to provide POTWs with facility-specific economic and technical information about how to achieve nutrient standards. The approach was to assess each existing facility, and determine how each facility would need to be modified. The treatment

goals that were considered were: 1.0 mg/L P, 0.1 mg/L P, 1.0 mg/L P + 20 mg/L N, and 0.1 mg/L P and 10 mg/L N. The baseline study consisted of 8 months of intensive influent/effluent sampling at treatment facilities. In addition, 84% of POTWs collected additional data, including TKN, NH4 and TP. The data were used to assess costs associated with three different scenarios: present (baseline) conditions (2009); estimated flows/loadings in 2029; and for treatment plant design capacity. Costs were included for a variety of present treatment technologies, upgrades to treatment technology, and changes in operating and maintenance costs with new treatment technologies.

Needless to say, the projected costs to achieve these more stringent nutrient standards were not cheap. For example, the cost for 30 mechanical plants to control discharges at 1.0 mg/L total P amounted to a stakeholder charge rate of \$1.19/month. Reducing the total P discharge standard to 0.1 mg/L resulted in an increase charge to stakeholders of \$11.08/month, a 930% fee increase. Reducing the total P + total N discharge standard from 1.0 mg/L and 20 mg/L, respectively, to 0.1 mg/L and 10 mg/L, respectively, resulted in change in stakeholder monthly service fees from \$2.99/month to \$13.58/month. For this same scenario, capital costs for improvements increased from \$139.7 million to \$1,040.1 million.

Results Statewide of the Study		
Four Effluent Scenarios 30 Mechanical Plants		
Costs	Total Phosphorus 1.0 ppm	Total Phosphorus 0.1 ppm
Capital	23.7 M	818.1 M
O&M	4.5 M / year	4.8 M
Rate	\$ 1.19 / month	\$ 11.08 / month

Paul reported that achieving these reduction scenarios could have a pretty significant impact on wastewater discharges. Maintaining discharge of four Salt Lake County wastewater treatment discharges at 1 mg/L phosphorus would result in a reduction of 1.42 tons of total phosphorus load per day being discharged. This could be achieved with an actual cost to each household supplying wastewater to

the treatment plant of about 1.3 cents per day. Maintaining discharge at 0.1 mg/L phosphorus would result in a reduction of 1.99 tons total phosphorus load discharged per day, at a cost of 23.9 cents per day per household. Controlling the nitrogen concentration in discharge water at 20 mg/L would result in a 4.14 tons per day reduction in nitrogen loading from wastewater at a cost of 4.9 cents per day per household. And, finally, controlling nitrogen discharges at 10 mg/L and phosphorus discharges at 0.1 mg/L would result in a 1.99 ton/day reduction in phosphorus loading and 10.4 tons per day reduction in nitrogen loading, at a cost of 30.5 cents per household/day.

What is being done? -Success Stories

Tommy Bass, a livestock specialist with Montana State Extension Service, introduced an upbeat panel ready to share their nutrients success stories. Storytellers came from a variety of settings: a Colorado mountain watershed, an eastern South Dakota groundwater district, a reclamation district in an upscale Utah community, and agricultural entities dealing with animal feeding operation (AFO)/concentrated AFO (CAFO) issues in Utah.

Bear Creek Watershed, Colorado -Russ Clayshulte



The Bear Creek Watershed, located in the Colorado counties of Jefferson, Clear Creek, and Park, is a nutrient management and control success story motivated by public perception, according to Russ Clayshulte, manager for the Bear Creek Watershed Association. The association was formed in 1988 to 'protect and restore water and environmental quality from the effects of land use within the Bear Creek Watershed'. At

the time, phosphorus levels of water in Bear Creek watershed were considered to be the most significant cause of impaired water quality, with the sources being identified as wastewater discharges, septic systems, geologic contributions, stormwater, human waste in recreation areas, and atmospheric deposition.

The association approved a plan to develop a monitoring-based program, both for baseline data collection and for best

“The association adopted an active load trading program, whereby entities that were able to achieve actual discharge loads below load allocations could ‘on paper’ accept some of the load allocation of other entities struggling to meet load allocations.”

management practice (BMP) implementation effectiveness. A total of 64 monitoring sites were identified, including inputs and outputs to Bear Creek Reservoir, and the Bear Creek and Turkey Creek drainages. In stream monitoring was targeted to selected stream segments, while other monitoring attempted to quantify phosphorus loading from wastewater discharges, and from an adjacent wilderness area.

Russ reported that the association established a watershed-wide phosphorus control regulation in 1992, targeting

What we learned

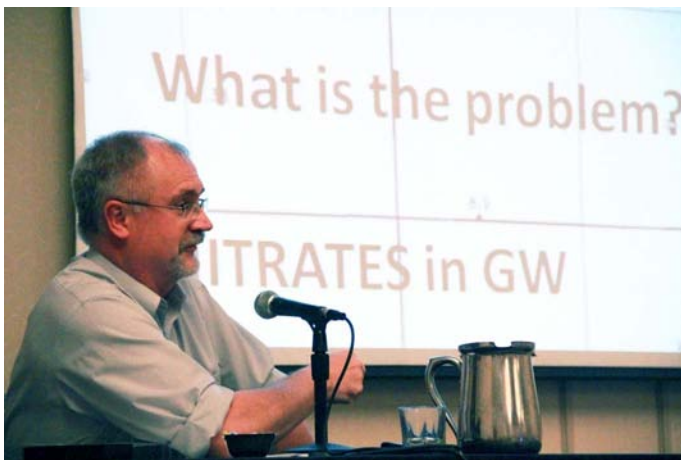
- ▶ Think watershed, not just bracketing treatment plants
 - Nutrient management starts at a watershed level
 - Total Phosphorus is manageable
 - Nitrogen looks more difficult
- ▶ Monitoring must be flexible & affordable
 - Data collection need not be scary
- ▶ Be careful, the data can surprise you
- ▶ Difficult to produce convincing data
 - Be adaptive – not everything will work

wastewater treatment plants, whereby discharge could not exceed 1 mg/L total phosphorus. Additionally, the association adopted an active load trading program, whereby entities that were able to achieve actual discharge loads below load allocations could ‘on paper’ accept some of the load allocation of other entities struggling to meet load allocations. The consequence – between trading, a coordinated erosion-stormwater control program, and treatment plant alterations and upgrades – was a phosphorus discharge load reduction from 5,255 pounds of phosphorus per year to 1,334 per year in 2010 from the watershed. By 1994, measurable reductions in phosphorus loading from both Turkey Creek and Bear Creek inflows were reported.

Success doesn't come without a price, however, as Russ advised. Adaptive management based on a flexible, comprehensive and continuous data collection and management program, coordinated by a watershed manager, was essential. In addition, the project required commitment, involvement and active participation from no fewer than 16 wastewater discharge facilities (which included municipal districts, schools, commercial facilities, and private businesses). The estimated cost for necessary up-grades and modifications to the wastewater treatment plants to achieve 1 mg/L or less phosphorus discharge and operate at new performance levels was \$18.7 million.

What's next? The watershed association is considering whether septic systems should be treated as point source loading factors, and whether to expand watershed monitoring, factor in land use practices and conduct a complete watershed development review. Russ concluded with several key points of advice for the workshop participants: think watershed, not just wastewater treatment plants—nutrient management should be done at the watershed level; monitoring must be flexible and affordable; it is not always easy to produce convincing data, but without data, progress and conviction come slowly. The single most important factor to work into the process at the onset is building trust at local level, with all stakeholders, including POTW operators and regulators.

Eastern South Dakota Groundwater -Jay Gilbertson



Residents, water suppliers, and regulatory agency personnel have known for a long time that groundwater quality in eastern South Dakota frequently tests high in nitrate. In an area where annual rainfall is 2 feet or more, crop farming and

livestock production are the predominant land use practices, and aquifers are relatively close to the land surface, nitrate has a high likelihood of being present in groundwater. Jay Gilbertson, with the East Dakota Water Development District, knows this only too well. But, he also knows that over time, and with BMPs strategically placed and used on the landscape, nitrate concentrations in groundwater can be reduced.

In eastern South Dakota, more than one-third of the population relies on shallow groundwater as their primary domestic water supply – sourced either from a private well or from a municipality which taps into these shallow aquifers. In the past, nitrate concentrations in groundwater have tested as high as 130 mg/L.

The only approach that the communities being affected by these high nitrate levels thought would work was to establish regional groundwater protection areas with groundwater protection ordinances. Areas were established where there were believed to be major hydrologic contributors to both the nitrate and water recharging the aquifers being pumped for drinking water supplies. Once the areas were established, it became a matter of getting stakeholder buy-in, cooperation, and teamwork to identify BMPs that might help reduce nitrate loading to groundwater. Fortunately, only a small number of areas seemed to be needing protection.

The approach seems to be working. For instance, in 1994 water at the Big Sioux Community water system had nitrate concentrations in production wells at 10 mg/L. By 2010, nitrate concentrations in water at the Big Sioux Community water system were down to 1-2 mg/L. How was this accomplished? A watershed protection plan was put into place:

- 1) Purchasing some 'high risk' land to be permanently taken out of crop production
- 2) Supporting farmer enrollment of some targeted crop lands into the USDA CRP program
- 3) Underwriting the cost to farmers of switching to crop rotations that required lower N inputs than traditionally grown crops
- 4) Soil testing to determine conservative fertilizer requirements

Concluding this success story, Jay stated with pride: "Tools do exist to protect public water supplies. It just takes an informed community, good data, a trusting relationship, partnerships, and putting the right BMPs in place at the right places on the landscape."

Park City, Utah Wastewater Treatment Facility

-Michael Luers

What do you do when you have an under-sized wastewater treatment facility in a rapidly expanding, financially well-off recreation and second-home dominated watershed discharging nutrient-rich wastewater into a small flow trout stream that is often dewatered downstream by pre-



existing irrigation water rights? Michael Luers and Michael Boyle, with the Snyderville Basin Water Reclamation District, were faced with this challenge in 1999. Eutrophication was an obvious problem in the stream down stream from the permitted wastewater plant discharges. And, it appeared the cause of the problem was too much inflow and too much load for the existing wastewater treatment facility

to handle – due both to pre-existing wastewater treatment technology which was not doing the job needed, and to facility capacity. The result: the stream was listed on the 303(d) list for impaired dissolved oxygen levels—caused by nutrient based eutrophication.

The problem got fixed, but not without some serious costs and incorporation of some serious state-of-the-art wastewater treatment. Recognizing that the inflow loading was likely to increase as the watershed community continued to develop and that relatively stringent nutrient controls were likely to be imposed in the future, the decision was made to build an advanced tertiary treatment facility, at a cost of \$18 million to the community. The new facility has the capability to control phosphorus levels in discharges to less than 0.05 mg/L, which more than adequately achieves the discharge limit of 0.1 mg/L. The new facility, which incorporates biological nutrient removal, has capacity to treat four million gallons of wastewater per day.

So far, so good – as Michael reports. The new treatment facility has been able to keep monthly average and 90-day mean actual phosphorus concentrations well below either the yearly

loading limit or the 90-day mean permit limit of 0.1 mg/L. But, despite all these efforts, some challenges still exist. As Michael explained, ‘small hiccups’ in consistency in laboratory analyses every once in a while result in reported – yet unexplainable – outliers in the discharge water phosphorus concentrations.



In addition, the receiving stream does not have a ‘protected base flow.’ Stream flows upstream of the treatment plant have shown a decline over time, and at times the stream has actually dried up. When that happens, the entire flow downstream of the treatment facility is from discharge of treated wastewater.

With some degree of frustration, Michael explained, “We’ve spent millions on a new treatment facility and now we have an acute ammonia toxicity issue downstream because of reduced in-stream flows.” Clearly, to make this a true success story, a watershed-scale approach needs to be incorporated into the planning.

“Recognizing that the inflow loading was likely to increase as the watershed community continued to develop and that relatively stringent nutrient controls were likely to be imposed in the future, the decision was made to build an advanced tertiary treatment facility, at a cost of \$18 million to the community.”

Utah Strategy to Control Pollution from Animal Feeding Operations

-Mark Petersen



Some situations requiring nutrient control measures need a champion. Though Mark Peterson, Environmental Issues Specialist with the Utah Farm Bureau Federation wouldn't necessarily take credit, it is clear that he is the champion behind the success story of Utah's strategy to control nutrient impairment from livestock feeding areas.

As Mark tells the story, a partnership was formed in Utah in 1998 to develop a strategy to address pollution from animal feeding operations. This partnership, with a foundation between the Utah Department of Agriculture and the Utah Department of Environmental Quality also included state and federal agencies, farm and ranch organizations, and farm livestock commodity groups. For two years after organizing, the partnership worked together to develop a plan for success, which was published by the Utah Division of Water Quality in the spring of 2000. The plan was specifically

designed to reduce pollution from livestock operations in Utah, while focusing on three goals: 1) restore water quality where impaired by livestock operations; 2) assure that the agricultural sector would remain economically viable; and 3) assure that decisions made and actions taken were done by and at the local level. The partnership wanted to achieve nutrient and pollution controls as much as possible through voluntary processes.

One of the partners, the Utah Farm Bureau Federation (UFBF), hired a full time specialist to coordinate the agricultural partners' portion of the plan, including an inventory and assessment of animal feeding operations in Utah; help operators develop mitigation plans and implement actions where animal feeding operations were found to be unacceptable with respect to pollution control; and develop nutrient management plans, where necessary. An additional part of the plan for success was creating and maintaining a Utah AFO database to track nutrient management implementation progress and reporting on the progress of each AFO toward implementing and achieving control.

Some of the provisions for success included identifying known corrective actions and helping provide funding and partial cost-offsets to livestock operators implementing corrective actions. Another provision was to encourage livestock operators to implement corrective actions voluntarily. Only when that failed was a regulatory approach resorted to. Trust was built with stakeholders by assuring them that only the Utah Farm Bureau Federation would have access to data collected. To help answer questions livestock producers might have, manure management workshops and farmer-to-farmer tours were held throughout the state.

A total of 2935 animal feeding operations were inventoried, 55 were identified as concentrated animal feeding operations (CAFOs) and 393 were identified potential CAFOs. Through this trust-building process that encouraged voluntary control, 391 CAFOs developed nutrient management plans to correct identified problems that might be impairing water quality.

This voluntary, incentive-based program has been very successful. As of last July, 98 percent of the operations inventoried as needing to correct unacceptable conditions have developed and implemented nutrient management plans. Mark concluded by reporting that large successes can come from step-by-step efforts with willing partners. And, despite a recent court ruling which resulted in EPA changing 'the rules' about AFOs and nutrient controls, the partnership plans to move ahead with a Phase 2 of the Utah AFO strategy. Not surprisingly, an underlying key to this new effort is development of a 'voluntary' Permit by Rule (PBR).

PROGRESS In 2010-2011

- 13 Manure Management Workshops for Farmers
- 9 New Rule – NMP Workshops
- Re-assessed 1052 AFOs
- 7 Farmer to Farmer Tours

Third Question:

How can stakeholders and agencies work together in managing the problem?

Perspectives on Working Together

“How can stakeholders and agencies work together in managing the nutrients problem?” This session featured comments by a diverse range of presenters - a hog farmer who serves on a state agriculture commission, a turkey farmer who serves on a state water quality board, a representative of a major fertilizer producer and distributor, a water utilities manager, and a member of a “nutrients coalition” formed as a means for stakeholders to express their opinions to a state water quality agency.



Jeff Ostermiller facilitates the “working together” panel.

Alan Blaylock, Agrium: Lessons Learned

adopting practices in the areas of rate, time, place and form. Agrium emphasizes to its Ag producers that if you change one of the Rs you need to change the others. As you would expect,



Alan Blaylock is associated with Agrium, a firm which produces fertilizer nutrients for agricultural use. He shared with participants what his company is doing to promote environmentally sound use of its products. Perhaps the greatest challenge faced by the nutrient industry today is communication, he said. Nutrient use and best management practices are often complex and difficult to communicate to stakeholders. But working with stakeholders is critical, he said. Indicative of Agrium’s commitment to reduce the impact of its products on the environment after it leaves their hands, is their promotion of a 4R Nutrient Management System – right product, right rate, right time, right place. This science-based system identifies best practices for producers who apply nutrients. Its use allows growers to meet sustainability goals by

Agrium does not generally support urban bans on nutrient application, favoring, instead, this 4R approach.

Alan pointed out that his company is very supportive of the Certified Crop Advisor Program. He noted that NRCS often requires that plans it supports with funding be developed by these certified advisors. He also talked about new nutrient technologies, including controlled release and enhanced release delivery systems, and the use of precision agriculture to apply just the right amount of fertilizer.

“Caring for our Watersheds” is a program which Agrium conducts for grades 7-12 in communities such as Loveland, Colorado. Students submit essays on how to improve watersheds. Agrium also works with the International Plant

Nutrient Institute, participating in an international nitrogen initiative to maximize the positive aspects of nitrogen and reduce its negatives.

Tad Foster, Colorado Nutrient Coalition: How Can Stakeholders And Agencies Work Together In Managing The Problem?



Tad Foster shared the perspective of a Colorado group of stakeholders which seeks to have a voice as the Colorado Water Quality Control Division prepares its response to EPA requirements for nutrient standards and controls. He said the Colorado Nutrient Coalition (CNC) is a loose association of Colorado municipalities, special districts, wastewater and stormwater associations, water conservation and conservancy districts, home builders associations and professional associations. It formed in 2010 to engage in mutual education and analysis of Colorado Water Quality Control Division positions on the subject of nutrients and water quality, including eventual rulemaking to adopt nutrient standards. Though the group has been accused of bashing the WQCD, Tad said it has sought to support a proposal the Denver Metro and WQCD has recently made to the EPA. That proposal suggests a limited set of nutrient values and seeks control regulations that reduce phosphorus effluent and increase the monitoring data to enable more sophisticated setting of water quality standards in future basin hearings.

Tad attempted to answer, from CNC's perspective, how stakeholders and agencies could work together better to manage the nutrients problem. He said:

1. Collaboration takes time and cannot be rushed.
2. Stakeholder meetings must be characterized by talking

among and not being talked to; data from the state is necessary; education by the state is necessary; the regulated community must employ experts to assist them to ask the questions, if they do not know the questions to ask. If no one is asking questions, it is not a collaborative process, it is a one sided dictate.

3. Those participating in stakeholder sessions must work at talking among and not talking past each other. That means:

- Have time to ask questions and follow up questions.
- Be sure answers are responsive to the questions asked.
- Recognize that collaboration does not mean concession and can mean conflict.
- The more time given the collaborative process, the less blunt and bruising the conflict will be.
- It takes time to put preliminary information into writing, and it may change, but the elevation of understanding is the goal.
- Written questions deserve written responses designed to educate. Nothing is as persuasive as good facts.

Tad shared the CNC point of view that this is the worst of times for EPA to push nutrient standards because resources are tied up in responding to other water quality compliance issues. The nutrients discussion should be structured as a risk assessment process, the CNC believes. The risk analysis should be performed and provided in sufficient and credible detail that it can be used by a public works director standing before a city council to justify millions of dollars for not only wastewater treatment plant upgrades but also stormwater controls.

Credibility comes from providing local and watershed specific data, and answering questions such as:

- Where are the downstream reservoirs at risk?
- What are the data and trends between the reservoir and the urban areas and upstream, too?

“Stakeholders are concerned about potential impairment listings that require TMDLs that are too complex and too expensive to do.”

- Where are the uncontrolled nonpoint sources that can frustrate the effectiveness of urban area controls? Are they uncontrollable natural or human conditions that justify ambient based standards?
- Where are the nonpoint sources upstream that might be cheaper to control than the urban area sources or other nonpoint sources on a watershed basis?
- What monitoring programs will be required?

Tad said that CNC has discussed the inducements it needs to collaborate in funding monitoring on a watershed basis. He said, “It’s easy if there is recreational value of a trout stream!” But it is harder if the vision is to enhance the stream for future generations by improving morphology, habitat and appearance even if it only supports dace and stonerollers. Still, a reasonable vision may be to take care of what we have, as it is all we’ve got—to be aware of our impacts. We need to articulate and come to agreement on the vision, Tad said. We need a legal structure to outline that agreed upon pathway.

CNC believes we need to recognize that in some cases EPA’s eco-regional based criteria are exceeded by USGS background levels already. Stakeholders are concerned about potential impairment listings that require TMDLs that are too complex and too expensive to do. Time is needed to develop more sophisticated nutrient water quality standards for the multitude of ecoregions in each state, standards that consider the influence of confounding factors that preclude algae despite high concentrations.

CNC recommends that watershed based monitoring throughout the state set a baseline of existing conditions above and below dischargers—and beyond, if funding can be found. They recommend watershed based collaboration, including water quality stakeholder roundtables.

We need to select priority basins or watersheds and do more in-depth monitoring that leads to segment or ecosystem or watershed relevant water quality standards, Tad said. Pending such standards, and based on the assumption that effluent concentration reductions are necessary in most cases, we should require 80-85% reduction of total phosphorus starting as soon as possible.

How to pay? CNC suggests agencies enable dischargers to follow a financing plan, set in a 30-year incremental treatment plan, to do phased improvements or significant one time upgrades, or combinations that enable a platform that can expand to support more stringent nutrients removal should future standards require it. Tad said we should recognize that the huge shortfall of SRF funding (EPA Clean Water

State Revolving Fund) will significantly draw out the implementation of technology based limits. He said we should recognize that the increasing rates for managing water, wastewater, and stormwater should be considered cumulatively in determining affordability. He suggested we should begin to investigate the development of special Watershed Drainage Districts with taxing, zoning or advisory powers to fund construction of nonpoint source controls in combination with point source controls. Tad closed by expressing appreciation for the workshop because it gave dischargers an opportunity to voice their important points of view.

Alan Johnstone, Shields River Watershed Group

Alan Johnstone believes watershed groups have a lot to offer in meeting the challenges of nutrient management and control. The Shields River Watershed Group in south central Montana started in the late 1990s with the threat of an endangered species listing of the Yellowstone cutthroat trout. The group began working with state agencies to see what they could do. Their first action was to take 1000 cows off the creeks by setting up a big tank to provide them water. Even though the endangered species listing wasn’t pursued, the group continued to work to improve the watershed.

Answering the question “how can stakeholders and agencies work together in managing the nutrients problem,” Alan related his group’s experience working with water quality agencies. In 2002 their watershed group got funding to the tune of \$100,000 to collect information for a nutrients TMDL study. They got permission from landowners to check the reference sites, collected the data, and turned in their results. They didn’t hear anything back until two years later when they were notified that they had two weeks to sign the



TMDL. There were conditions in the TMDL they didn't like, for instance, the requirement of a Wetlands Recovery Project (WRP) by a fish biologist.

Agency personnel turnover has made working with the agencies difficult, Alan said. With a new person every year it was hard to make progress. Another issue was that though the watershed group had promised the landowners anonymity, that promise got lost in the process due to the change of personnel. Through this process, a lot of landowners are starting to drop out. "What's crazy," Alan said, "is that many of the BMPs the landowners have adopted to improve things aren't even in the TMDL." He said the point source model is not good for dealing with nonpoint source situations. It's just too hard to monitor nutrients from nonpoint sources, especially when your river is 50 miles long, and you are all volunteers.

What's most important to the watershed group is to find out what they have to do to get off the EPA's 303(d) list. Alan said even the state DEQ hasn't been able to answer that question. Still, the group feels good about what they have accomplished, even though it's hard to quantify.

"EPA should stick to the big issues like Chesapeake Bay and the Gulf of Mexico and leave the small watersheds to the states," Alan said in closing.

Jay Olsen, Ag Producer, Utah Water Quality Board



From his double vantage point of being a turkey farmer from central Utah as well as chair of the Utah Water Quality Board, Jay Olsen shared his views on the importance of listening to farmers and involving critical

stakeholders as we try to manage the nutrients problem. He pointed out that today, 75% of the water in Utah is controlled by agriculture, down from 85% in the past. He questioned whether we are pulling in the agricultural sector and listening

“We need to factor in the value of our food supply when we make decisions about nutrient standards.”

to what they have to say. Though agriculture uses most of the water, Ag producers make up a small percentage of the population, he said. “Maybe it's the farmer who should be on the endangered species list,” he quipped.

How do we get the message out about nutrients, he asked. The workshop has been very beneficial, but we need more farmers to hear that message, he said. Nutrients aren't all bad, he pointed out—“we need them to grow food.” And we need to factor in the value of our food supply when we make decisions about nutrient standards.

On the subject of narrative or numeric standards, Jay suggested we need both. But factored in must be the value of the water we are trying to protect—and the fact that we are told that by 2050 food production needs to double in order to feed the world.

As we balance these values, we need to remember that wildlife can have a negative effect on water quality too, but we don't seem to factor wildlife into the equation. In closing, Jay reminded us, “We need to figure out a way to listen to our farmers.”

Florence Reynolds, Salt Lake City Department of Public Utilities

Florence Reynolds represented the drinking water point of view, wearing her public utilities hat. She pointed out that the drinking water sector has a double burden because they have to monitor the raw water and the finished water. And they face a triple threat: stream water, wastewater, stormwater. That's expensive, she pointed out. "Salt Lake City can handle it," she said. "It's the small municipalities who have the problem."

"The drinking water sector has a double burden because they have to monitor the raw water and the finished water."

Looking at source waters for the problem is most important, Florence said. We should address the source of the problem instead of the place it shows up, she said. Funding removal at the source would allow us to look at geologic differences, she said. She

wonders if nutrient standards will lead to water conservation districts being able to enforce source protection programs. She thinks that is needed.

Florence thinks we need to be careful deciding where to put our efforts. For instance, we shouldn't be removing phosphorus if it doesn't have any effect. "Will one ton of phosphorus removed solve the problem?" she asked.

Don Rutledge, Colorado Agriculture Commissioner

Don Rutledge farms and ranches in Eastern Colorado and serves on the Colorado Agriculture Commission. Agencies and university people should come out to the farm and see how things really work, he said. He suggested we could go a long way toward gaining the respect of farmers if we were to hold meetings out in the field. If that's a bit far-fetched, we could at least schedule the meetings for times other than planting and harvest.

Don asserted that most agricultural producers pay a great deal of attention to how much fertilizer they are using, pointing out that dealer reps and crop consultants are often used in eastern Colorado to perform soil testing and advise regarding irrigation scheduling. He mentioned the availability of electronic sensors in the field, but said few use them because of their expense.



Sometimes farmers are afraid to speak out because of fear of retribution of regulatory agencies, Don said. He referred to a 2000 ballot initiative passed to control hog operations, in which one side resorted to the motto "do you want swine urine in your water?" Now hog farmers have to do extensive testing which is very expensive. The only control we have in agriculture, Don said, is our input costs. We can't control the weather or the market costs. He joined Jay Olsen is asserting that we should pay more attention to the problems wildlife causes (for instance geese) in terms of nutrients. For this reason, Don suggested that the Division of Wildlife be a stakeholder in nutrient management discussions.

How can we work together? -Stakeholder Small Group Sessions

Identifying Barriers, Recommending Remedies

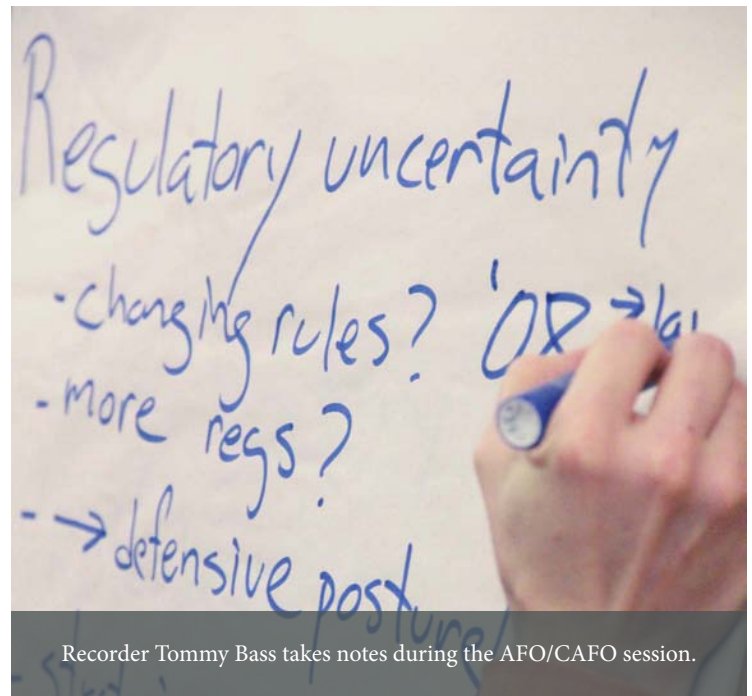
Given the strong emphasis on stakeholder/agency interaction during this collaborative workshop, the sessions devoted to sectors identifying barriers and recommending approaches to solving them were deemed a high point. All the speakers and all the participants gathered in small groups by sector to focus on the “nitty-gritty” of their respective sector’s problems dealing with nutrients. Later, sectors met again to pin down concrete recommendations for approaching those problems and obstacles. The results from those sessions are reported below by sector. First—the obstacles. Second, the recommendations.

AFO/CAFO: Key Problems/Barriers to Nutrient Control

Nutrient control and management with respect to point-source livestock production has been a central focus since the official AFO/CAFO (animal feeding operations/concentrated animal feeding operations) designation. Regulations and requirements have likewise been a point of contention between livestock producers and regulatory agencies. In the discussion, it quickly became apparent that stakeholders are not necessarily resistant, but clearly hesitant to attempt more specific nutrient control and management. There was also evidence of an underlying “us versus them” posture between stakeholders and regulatory agencies.

The stakeholder breakout session focused attention on a broad and diverse suite of issues, problems, uncertainties, and challenges that need to be addressed or considered and that need to be the focus of additional data collection before nutrient control is addressed. Participants identified the following as key issues and uncertainties that deserve attention: regulatory uncertainty, communication, inadequate databases, agency management, educator and technical assistance, impact on the AFO/CAFO industry, policy, and the permitting process. As the session concluded, stakeholders and agricultural producers also vocalized some of the specific concerns and opinions of this stakeholder group.

Interesting, and perhaps also revealing, was the fact that the first issue brought up was uncertainty. Participants expressed a fear of ‘regulatory uncertainty’ – circumstances in which producers find themselves having to respond to frequently changing nutrient controls and growing numbers of rules and regulations. Another uncertainty is associated with data: has the data collection been appropriate, is the effectiveness of best management practices (BMPs) really well-understood, and



Recorder Tommy Bass takes notes during the AFO/CAFO session.

are the impacts of AFO/CAFO and nonpoint sources (NPS) truly understood? Additional uncertainties: not knowing the expected outcomes of adopting control mechanisms, not knowing whether regulatory agencies have the means to evaluate effectiveness of control adoption, and not knowing the amount of flexibility granted to make changes to achieve desired outcomes. This all contributes to a defensive posture on the part of the Ag sector.

Communication has been a long-standing issue between stakeholders of the agricultural sector and regulatory agencies. Consequently, agricultural producers have little reason to believe that their voice, their opinions, and the lessons they have learned from on-the-ground experience ever make it back to EPA, or that EPA is willing or able to be responsive. Fortunately, communication is at a better level between the respective state regulatory agencies and the agricultural

producers. Contributing to communication breakdowns are apparently high employee turnover and lack of literacy about agricultural ‘reality’ within the regulatory agencies. These make it difficult for stakeholders to develop relationships and trust with agency personnel. It also makes it difficult for stakeholders to see continuity in standards, controls, and practices development.

Stakeholders were quick to point out that even when standards and nutrient controls are developed with sound data and knowledge of agricultural practices, communicating changes to agricultural operations that might help achieve controls can be difficult, especially when technical support to communicate is lacking, which is often the case. By the same token, agricultural producers may not readily appreciate that their individual operations might, in some way, contribute to a larger, watershed, regional, or national issue. Added to this is often a reluctance to sign onto a new way to do things.

When it comes to the actual process of declaring and

“Agricultural producers have little reason to believe that their voice, their opinions, and the lessons they have learned from on-the-ground experience ever make it back to EPA.”

implementing nutrient controls or standards, the agricultural sector faces some additional challenges: limited resources, including financial, time, and human resources for implementing new practices and record-keeping in a timely manner; lack

of financial and technical assistance to implement a practice from which society as a whole is the beneficiary; uncertainty of the cost and benefit, whether economic or environmental, of implementing new practices; and the sustainability of new practices. Added to this are producer concerns about loss of privacy and possible subjugation to litigation from a sector that generally lacks literacy regarding agricultural AFO/CAFO and NPS issues.

In concluding remarks, stakeholders participating in the AFO/CAFO breakout session vocalized some key points that they felt should not be overlooked. Livelihood from agriculture and animal production is intricately and explicitly tied to the environment – these stakeholders do not want to be associated with water quality impairment. The stakeholders do have a desire to engage in nutrient controls, all the way from data collection and draft standards development to implementation, monitoring, and modifications – to meet realistic and achievable standards. AFO/CAFO stakeholders

expressed concern that all too often, policy development and implementation happens at the highest levels of government or the regulatory agency. Nutrient controls and standards specific to AFO/CAFOs need to be developed with full inclusion and involvement of the affected stakeholders.

AFO/CAFO: Recommendations

The participants in the breakout session identified as AFO/CAFO were not solely individuals with a vested interest in nutrient controls and standards applicable to AFO/CAFOs, but rather a diverse group of stakeholders with broad interest representing the agricultural sector. The recommendations have implications relative to AFO/CAFOs, nonpoint nutrient sources from agricultural lands, agricultural nutrient (fertilizer) management, and rangeland management. The recommendations were addressed primarily to the EPA and state regulatory agencies.

- Both development and implementation of nutrient controls and standards should be done by adaptive management, i.e., a systematic process for continually improving standards and nutrient control practices by learning from the outcomes of previously employed control practices and follow-up monitoring.
- Nutrient controls and standards, particularly with regard to AFO/CAFOs, need to account for ‘one size does not fit all’ and the fact that one set of controls, practices, and standards will not be appropriate to all AFO/CAFOs. EPA and state regulatory agencies need to recognize, acknowledge, and develop controls and implement standards based on a foundation of site-specific (local) decision-making and management.
- EPA should acknowledge the benefit and opportunity of local level (on farm, watershed specific) decision making and nutrient management, based on local data and knowledge. This means building trust and relationships with Ag producers and engaging vested stakeholders at the local level in development of recommendations for controls and standards based on local or watershed circumstances, not with a broad ‘one-size-fits-all’ brush stroke. This can best be done through the state-level counterparts to the EPA.
- EPA and state regulatory agencies need to do a better job engaging and interacting at the local level, where

practices and controls are targeted to be put in place. Controls should be developed specific to local watersheds or producer groups, with their involvement, to capitalize on how nutrient issues can be uniquely addressed in differing communities.

- Given the importance that is being placed on nutrient issues, the EPA, state regulatory agencies, and other agencies with staffing interacting with the agricultural sector need to do a better job of assuring that their staff are both knowledgeable of agricultural settings and are sure and consistent in their interactions with the agricultural sector – whether explaining data, benefits and outcomes of nutrient controls, importance of standards, or policies and regulations.
- EPA, state regulatory agencies, and other agencies seeking to achieve nutrient control need to do some serious cost-benefit analyses and beneficial outcome analyses (the most bang for the buck) to clarify societal and environmental benefits that can be achieved from implementation of nutrient controls and standards, the cost of achieving those benefits, and who will bear the burden of those costs. Cost should not be totally borne by the agricultural sector when the benefits are enjoyed by society and the environment as a whole.

they perceive to be key problems and barriers to successful implementation of strategies to deal with nutrients in water:

- 1) an increasing number of contaminants and toxic agents in drinking water; 2) issues related to more stringent regulation of drinking water suppliers; 3) communication and interaction between drinking water treatment and wastewater treatment operations; 4) lack of data sharing, resulting in limited knowledge; 5) groundwater challenges; and 6) dealing with uncertainty.

The stakeholders pointed out that the drinking water sector has had a long but necessary history with water quality standards where the only options available to address drinking water problems in the past have been either to impose treatment or seek alternative water supplies. National Primary Drinking Water Regulations (NPDWRs or primary standards), which have been in place for a long time and which are routinely being updated, are legally enforceable standards that apply to public water systems. The contaminant list includes microorganisms, disinfecting agents, inorganic chemicals, organic chemicals, and radionuclides. Neither phosphorus (P) nor nitrogen (N) are identified as primary contaminants and hence no standards have been established for these contaminants in drinking water. (Standards have been established for nitrate and nitrite, derivatives of nitrogen). Primary standards are established to protect public health by limiting the levels of contaminants in drinking water.

Monitoring indicates that there is an increasing presence of nutrients in water, including N, P, chlorophyll and ammonia. This increased presence, given that standards have not been promulgated for either N or P, presents a challenge to drinking water suppliers. Increased nutrients add to both the cost of treatment and the complexity of treatment. Additionally, in the case of disinfectant products used to deal with microorganisms, organic nitrogen-containing wastewater treated with chloramines can lead to the production of N-Nitrosodimethylamine (NDMA) at potentially harmful levels, which can subsequently enter into drinking water treatment facilities. Another complication that adds challenge and could become a barrier to dealing with nutrients in water is the presence of cytotoxins, the effects of which can be expressed in airborne illness, skin and breathing issues, and impairment of aesthetic quality of drinking water (taste, odor).

This growing number of drinking water impairments gives rise to needs for new, additional methods of detection, added economic burden, and more expertise requirements at the water treatment level. More stringent regulations also lead to increased cost for water treatment. An indirect consequence is often lack of interest on the part of drinking water suppliers

Drinking Water: Key Problems/Barriers to Nutrient Control

Stakeholders in the drinking water breakout session did not necessarily welcome the notion of nutrient standards and controls with open arms; in fact, there were some expressions of resistance among the stakeholder group. During discussions, the group identified six issues which



A participant in the drinking water breakout session points out to Mike Suplee barriers to nutrient regulation while Roxanne Johnson takes notes.

and a resistance to regulation. Stakeholders in wastewater treatment facilities expressed this same posture.

Stakeholders representing the drinking water sector expressed concern over the lack of data shared between agencies. They felt that this lack of data sharing can reduce drinking water quality, and can also undermine trust from the public sector. The lack of data sharing, the lack of awareness of other entities, and agencies monitoring and doing research all limit the drinking water sector's knowledge of the nutrients in water issue. Admittedly, some of the lack of data sharing is a consequence of legal restrictions and proprietary rights to data.

A circumstance that might often be considered a Pandora's box for drinking water providers is groundwater as a source of drinking water supplies. Although the general notion is that groundwater is somewhat insulated from impairments introduced at the land surface, consequences of actions on the land surface may not be reflected in groundwater quality until well after treatment plant design is completed and put in place. Additionally, tools are lacking to assure broad-scale groundwater protection or implementation of best management practices (BMPs) to address the diversity of landscape issues across entire watersheds. Efforts have been advanced to promote well-head and source protection programs, yet the benefits are often hard to document.

The concluding session comments were related to the inability to accurately project the future, from quantity and quality of drinking water supplies to population changes, industrial and commercial developments within a watershed, and changes in understanding consequences of impairments and the need for such in drinking water.

Drinking Water: Recommendations

- Instream nutrient standards need to be established with monitoring of TN, TP, chlorophyll a, NH_4 at plant intake
- Data sharing needs to be a priority
- Improved communication within the watershed, including ALL stakeholders, need everyone's participation
- Funding for voluntary source water protection programs at the local level

Nonpoint Source (NPS)-Agriculture: Key Problems/Barriers to Nutrient Control

Stakeholders in this session presented a broad and diverse suite of problems and barriers. Comments revolved around a few key topics: lack of available resources, challenges of the total maximum daily load (TMDL) process, lack of clear understanding of best management practice (BMP) effectiveness and benefits, uncertainties about agency directions and outcomes of BMP implementation, lack of consideration of local expertise and circumstances, data inadequacies and lack of clearly defined cause and effect relationships, and lack of trust and clear direction.



Jennifer Meints leads discussions in the NPS-Ag group.

Stakeholders and agency representatives alike expressed the lack of available resources as an issue. Agency representatives explained that in the present economic downturn, lack of agency money is and will likely continue to be limiting factor to what can be done with nutrient standards, whether working on data collection and analyses, BMP development, assisting producers and stakeholders, educating stakeholders, or interagency collaboration. Producers and stakeholders, as well, may not at times have the necessary technical or financial resources needed to implement BMPs. In addition, educational resources are often limited because of funding shortfalls. This will often limit the achievement of a desired management or control level. In some instances, lack of clear understanding of how nutrient control practices should be implemented may result in incorrect or inappropriate application.

Stakeholders were quick to point out that most of the present cost-share and financial assistance programs that are in place do a good job of targeting problem areas or 'easy to fix' issues, but little is being done to provide incentive to

those stakeholders who have already personally borne the cost of implementation of control practices, particularly in the NPS area. Almost all of the recognizable benefit of BMP implementation serves either society in general or the environment, with little recognizable or immediate benefit to the stakeholder, and all of the cost usually borne by the stakeholder. Stakeholders may recognize and appreciate the environmental benefit gained from a nutrient control practice, but often question what cost, input, or sacrifice society makes to enjoy the benefit.

“Cause and effect in regard to nutrient impairments and BMP implementation is not very well defined.”

Flaws and inadequacies in the TMDL process for addressing NPS issues are significant barriers to moving ahead with developing nutrient control strategies for agricultural land. The way we identify and think about the problem is still influenced by the mentality or approaches of dealing with point sources in the TMDL process. Point sources are easily quantified and dealt with, through effluent discharge limits and the National Pollutant Discharge Elimination System (NPDES). However, agricultural NPS do not fit into this approach – in part due to the lack of certainty about NPS contributions and lack of clarity and specificity of nutrient control practices applicable to NPS contributions. Added to this is the time lapse often associated with initiating NPS nutrient control practices and measurable responses. Stakeholders wanted to know: What do you do if a stakeholder implements a BMP or nutrient control practice, and the TMDL is not achieved? Is there any assurance to the producers involved that the effort will still be recognized?

All of this leads to the need for an adaptive management approach and flexibility in developing, implementing, assessing, and reconfiguring nutrient controls and standards. As one stakeholder reported: “It takes time to implement, to gather data, to analyze data, to validate impacts of new control measures.” Additionally, agricultural producers must play an active role in defining issues, explaining local conditions, and identifying processes integral to achieving nutrient control at the local, farm-scale level.

As in the AFO/CAFO discussions, stakeholders in this session expressed reluctance to make changes when control practices are not fully evaluated or proven. In order to get producers on board, the process of developing nutrient standards needs to be clearly explained to the stakeholders, and stakeholders need to be involved and informed. Regulatory agencies are not readily trusted by Ag sector stakeholders, and in order to build trust and credibility with producers, regulatory agency staff need to be able to answer specific questions. There needs to be a plan that can be used to guide producers, keeping them informed of the path and the expectations.

Stakeholders in this breakout session reported that agency staff involved in the science associated with BMP and nutrient standards development need to be knowledgeable about producer practices, including production costs. Lack of literacy regarding agricultural practices continues to be an impediment to good working relationships.

There was considerable discussion about data – sources of data, data sharing, adequacy of existing data, and difficulty and expense of knowing which data to collect and collecting such data. Stakeholders expressed that there appears to be a lack of clarity of what “baseline data” needs to be collected. An abundance of data is also lacking to confirm the effectiveness of alternative BMPs. Cause and effect in regard to nutrient impairments and BMP implementation is not very well defined. There is also a lack of clear understanding of some of the mechanisms between nutrient sources and nutrient transport. Consequently, agricultural producers are often reluctant to participate or express opinions regarding nutrient management and nutrient controls unless they can be certain there are benefits without significant adverse consequences. All of this has been the basis for a significant level of apprehension by producers about getting involved or participating with EPA and regulatory agencies in the past.

NPS-Agriculture: Recommendations

Much like the outcomes of the discussion among stakeholders in the AFO/CAFO session, the recommendations arising from the stakeholders participating in this breakout session were directed to the EPA and state regulatory agencies with responsibilities for developing nutrient control measures, best management practices (BMPs), and nutrient standards. And, numerous of the comments and recommendations were reiterations of comments and recommendations arising from the AFO/CAFO breakout session – just with different wording.



Troy Bauder makes comments during the recommendations portion of the NPS-Ag session.

- EPA needs to communicate and build trust with Ag producer stakeholders on their turf, their available time – not during critical farm and ranch operation times for the Ag producer. This means EPA needs to work to gain a better understanding of the circumstances Ag producers deal with – constant regulations, program requirements.
- EPA should not make more work for Ag producers unless you're willing to pay for it or pay someone else to do the additional work – whether BMP implementation, reporting, record keeping, monitoring.
- EPA needs to develop mechanisms, working groups, strategies which insure that Ag producers are involved at the very onset and throughout the entire process in nutrient management problem assessment, BMP development, implementation, assessment, modifications.
- EPA should evaluate current internal EPA funding approaches and also develop collaborations with other agencies, including state regulatory agencies, NRCS, watershed councils, state Agriculture Departments to both coordinate and direct more funding to data collection and analyses, 'on-the-ground' BMP implementation, effectiveness assessment, follow-up education, cost-share incentive programs, acknowledgement of successful implementation.
- Regulatory agencies seeking voluntary implementation of NPS-BMPs need to work on developing incentive, reward programs and marketing strategies which reward those who have already implemented, and those who agree to implement; a novel possibility for rewarding those who do voluntarily participate might be tax credits.
- The regulatory agencies need to engage in more agronomic education and training in advance of working with Ag producers. The agency folks need to get a good on-the-ground understanding of Ag producer operations, including the physical, social, environmental, and economic implications to Ag producers of instituting a NPS-BMP. What does it cost the producer – financially, time, labor, resources, equipment – and can it actually be done.
- EPA, DEQs and others developing and attempting to direct BMP implementation should investigate watershed level conservation agreements (with Ag producers) with assurances of protections, confidentiality, privacy, and future indemnification while including more science representation, environmental group representation in the NPS-BMP process.
- EPA, DEQs developing nutrient standards and management plans need to take an adaptive management approach and build flexibility into the process and approach to BMP implementation
- EPA, DEQs developing nutrient standards, BMPs for NPS-agriculture need to do lessons learned assessments to benefit from what is already known, to avoid making mistakes already made.
- EPA and state regulatory agency staff need to become smarter about targeting data collection, strategy development, control practices implementation – where nutrients come from, how they enter into waterways, what nutrients need to be dealt with, what are the critical nutrient levels that need to be targeted?
- EPA and state regulatory agencies need to focus some data collection on confirming that NPS-Ag source issues that are being targeted are critical and that nutrient controls and BMP implementation are effective.
- EPA and state regulatory agencies need to be able to assure the NPS-Ag stakeholders that the right data is being collected, that effort is being focused on critical issues at the local level – dealing with those issues and control mechanisms that produce the most bang for the buck.

Stormwater: Key Problems/Barriers to Nutrient Control

Stakeholders participating in the session on stormwater management identified a number of obstacles to both developing nutrient standards and achieving nutrient controls in stormwater discharges: 1) lack of resources needed to achieve goals; 2) lack of data; 3) ineffective and/or inadequate outreach and education; 4) physical limitations of existing storm drain systems; 5) challenges of the existing regulatory framework; and 6) overcoming social barriers and changing public attitude.

Limited existing data makes it difficult to either quantify the significance of stormwater impacts on nutrient loads or to assess what best management practices (BMPs) might be effective and what level of nutrient reductions might be achievable from such BMPs.

Limited staffing, lack of qualified personnel, and limited operational funding can all contribute to the inability of municipal departments and utilities to adequately and effectively manage stormwater quantity, let alone deal with nutrient control issues. Insufficient site visits to storm collection and discharge structures, combined with limited opportunity and resources to complete necessary inspections, can affect department credibility. The consensus expressed by the stakeholders was that most municipalities lack either the political will or political influence to secure additional resources to deal with stormwater issues, unless crisis dictates such. Some municipalities have assessed fees to residential developers to cover additional costs associated with stormwater system maintenance. However, this has been met with substantial resistance in most instances.

As with the AFO/CAFO, Ag-NPS, and wastewater treatment stakeholders, lack of data was cited as a significant obstacle to addressing the issue of nutrient controls associated with stormwater discharges. The type of spatial and temporal data needed to understand both the significance of nutrients in

stormwater and how/when stormwater needs to be managed for nutrient control does not exist. Added to this lack of data is the extreme variability in stormwater characteristics due to complexity of storm events and runoff patterns, both at individual sites and throughout municipalities and watersheds. Limited existing data makes it difficult to either quantify the significance of stormwater impacts on nutrient loads or to assess what best management practices (BMPs) might be effective and what level of nutrient reductions might be achievable from such BMPs.

The public, which could play a significant role in nutrient controls and BMP implementation relative to stormwater collection and management, is ill-informed about stormwater in general. This is partly a consequence of limited historic outreach and education and a lack of data to be shared. This also seems to hold true for engineers, designers, and planners involved in project design and development and water managers dealing with stormwater issues. Stormwater management has historically focused entirely on dealing with quantity, and quality has not been considered an important



A participant in the stormwater breakout group points out problems with nutrient management.

issue. This becomes clearly evident when attempting to deal with old, antiquated storm drain systems and matching new construction designs to these antiquated systems.

Stakeholders in this breakout session pointed out that stormwater discharges aren't easily addressed within existing regulatory frameworks, a challenge to establishing nutrient controls. Stormwater originates as a nonpoint source by many accounts, then enters a pipe and becomes a point source, but still does not lend itself to existing permitting structure or to conventional treatment. Although there is ample evidence of the effectiveness of natural and constructed wetlands for achieving nutrient control (nitrogen and phosphorus) and

sediment control in stormwater, antiquated systems were not designed to take advantage of such treatment options, and designers and developers are often reluctant to incorporate such features into development because of cost, liability, and space requirements.

Not only does stormwater not fit into existing regulatory frameworks, but progress has been slow to either advance policy or develop requirements or regulatory framework to address stormwater discharges. Along with this are a lack of regulations addressing residential discharge issues, a lack of clearly defined regulations and standards, and a lack of consequences for violations.

At the conclusion of the breakout session, the discussion reverted to the topic of data. Two important points emphasized were: 1) presently neither the EPA, state regulatory agencies, nor stormwater managers have sufficient data or knowledge about nutrients in stormwater to accurately relate control practices or BMP implementation to nutrient reductions and associated consequences; and 2) the limits of current stormwater management technology and understanding of the effectiveness of that technology make it difficult to appreciate that further stormwater quality improvements can be made where BMPs are doing as they are designed to do.



Steve Gunderson also addresses points in the stormwater group.

Stormwater: Recommendations

The stormwater breakout session developed a list of recommendations which fell into three main categories: education, data, and watershed approach. All of these recommendations could be directed to the same audience which includes EPA, state regulatory agencies with oversight for stormwater management, other funding entities and stormwater managers at all levels.

- Substantial emphasis needs to be placed on education. Additional financial and human resources (or redirection of existing resources) should be targeted to educating the general public, local municipality officials, policy makers, zoning commissions on stormwater issues.
- Educational programs should be developed to educate local officials and zoning commissions regarding effects building and zoning ordinances can have on stormwater planning and management. Similarly, educational programs should be developed to educate policy makers about the benefits of green space and/or recreation corridors that may be created through stormwater infrastructure.
- Uniform protocols and guidelines for collecting data to characterize stormwater quality (with respect to nutrients) and to quantify stormwater impacts on receiving water bodies and wastewater treatment plants should be developed (where stormwater connects directly to wastewater treatment infrastructure). Resources (financial and training) should be made available to stormwater managers to encourage the collection and sharing of stormwater quality and quantity data.
- Monitoring protocols should be established for assessing the degree of stormwater BMP implementation, the consequences or outcomes of BMP implementation, and the persistence of BMPs through time to determine if practices continue to function.

- Models should be developed or modified and used where applicable to quantifying benefits from stormwater BMPs. The models could start with BMP effectiveness data from focused studies and allow for calibration and modification by managers in small watersheds. Extent of different BMP implementation could be input and estimated.
- Flexibility needs to be integral to the TMDL planning process and establishing nutrient standards where stormwater is concerned, because it does not fit perfectly into either the point or nonpoint source categories of the Clean Water Act.
- Mechanisms, opportunities, and flexibility need to be sufficient to allocate resources to projects within the watershed such that the biggest benefits will be recognized, whether stormwater, agricultural nonpoint source, or wastewater.
- Stormwater should be considered in nutrient trading policies to allow for allocation of funding to projects where the biggest nutrient reductions can occur most cost effectively.

wastewater from municipalities. Essentially all POTWs are managed under guidelines and effluent standards established in either state regulatory or EPA authorized National (or state) Pollution Discharge Elimination System (NPDES) permits. These NPDES permits typically establish effluent discharge limits for the nutrients nitrogen (N) and phosphorus (P).

The WWTP breakout group initially focused attention and discussion on some of the complexities of nutrient loading. It was pointed out that focusing on point sources of wastewater nutrient loading may help address the issue of nutrients in water, yet point sources typically do not constitute a high enough percentage of nutrient contributions from a watershed to have a significant impact on resulting water quality. On the one hand, at times, point sources (POTW discharges) are 100% of the flow in a receiving stream. In contrast, in areas such as the urban rural interface, septic systems can be a significant nutrient-loading source, yet little data are available (as to quality, quantity, and location). Nutrient limits and controls will most likely have to be site specific, since most circumstances are somewhere between the two extremes exemplified here.

Another circumstance which points to the need for site-specific limits and controls and flexibility in setting controls and standards is the frequent disparity in facility size and the number of households needing to bear the cost of construction, operation, and maintenance of such facilities. Adding to this is the challenge associated with seasonal variation in wastewater loads, seasonal variation in permitted discharges, and unpredictable weather variations. These stakeholders also pointed out the need to be able to specifically target or apportion some of the cost of wastewater treatment to industrial contributors, such as food processors.

The stakeholders then directed their discussion to what the group considered to be 'implementation issues,' circumstances which are either requirements which take time and resources, hindrances, or barriers to developing nutrient controls and standards tied to wastewater treatment operations. Some of these included the complexities and challenges of the permitting process, varying requirements of permitting under differing state programs, increasing costs of facilities construction, uncertainties about what control standards will be established in the future and whether existing facilities will be able to meet those standards. This discussion concluded with a recommendation that flexibility needs to be incorporated into the approaches to establishing nutrient standards and achieving nutrient controls. No single approach

Wastewater: Key Problems/Barriers to Nutrient Control

Wastewater Treatment Plant (WWTP) operators (of publicly owned treatment works (POTW)) constitute a small number of stakeholders, yet their role in nutrient management and control can be significant, since these individuals are responsible for point-source effluent discharges of treated



Robert Brobst presents recommendations collected from the wastewater group to other workshop participants.

will fit all circumstances of wastewater treatment and nutrient control.

The concluding discussion focused on what the stakeholders considered to be issues, with respect to WWTPs, which contribute to the present lack of clearly defined limits or standards. Question was raised on whether limits on WWTP discharges should be technology based, i.e., treatment-based effluent limits (TBEL), or tied to specific water quality criteria and thresholds. Additionally, stakeholders asked whether control measures should be independently established for each nutrient (N, P) or whether nutrient concentration combinations were more critical in achieving control.

Consistent with comments from stakeholders in some of the other breakout sessions, participants of this session addressed the issue of building trust through communication – between and among WWTP operators, regulatory agency staff, municipality staff, and individual homeowners. The stakeholders pointed out that trust building takes multiple interactions with all stakeholders involved. Regulators, POTWs, and stakeholders must first listen and must communicate clearly.

(long term average), and 5) reduction of P to 0.1 mg/L and N to 6 mg/L (long term average).

- EPA and state regulatory agencies should allow for variances in timing and magnitude of staged reductions or targeting of control levels to accommodate POTW size variances.
- Any planned control achievement strategies should be watershed based and should include all stakeholders.
- Financial resources and targeting of wastewater treatment should be directed toward those entities and processes which produce the greatest or most significant degree of control per unit of expenditure.

Wastewater: Recommendations

The wastewater treatment stakeholder breakout session presented a list of specific recommendations, focusing on timeframes, approaches to defining and establishing nutrient standards, and communication.

Specific recommendations were directed to EPA and state regulatory agency staff with responsibility for defining nutrient controls and establishing nutrient standards for wastewater discharges.

- EPA and state regulatory agencies should develop and follow an adaptive management approach for establishing nutrient standards and working with WWTP/POTW operators on approaches to achieving nutrient control;
- EPA and state regulatory agencies should consider developing a technology-based, cost-effective continuum (essentially steps or stages) for implementation of nutrient reduction at point sources. For example, a sequence with respect to phosphorus might consist of: 1) no net increase, 2) reduction of P concentration to 1 mg/L, 3) reduction of P to 1 mg/L and N to 12 mg/L, 4) reduction of P to 0.1 mg/L

Financial resources and targeting of wastewater treatment should be directed toward those entities and processes which produce the greatest or most significant degree of control per unit of expenditure.

Summary of Workshop Recommendations

While there was a consensus among workshop participants that there is a nutrient problem in the region, there were expressions of concern and strong suggestions about how nutrient controls and standards should be developed and implemented to increase likelihood that they will truly lead to cost-effective water quality improvements.

Flexibility in Approach to Improve Water Quality

“One size will not fit all” was commonly voiced. Workshop participants believe real solutions will come from site-specific, sector-specific approaches, championed by those directly aware of local circumstances, allowing flexibility as more is learned. Specifically:

- ▶ We need to think and work smarter, to focus resources on issues and circumstances which will achieve the most benefit per unit of resources and effort expended, to learn lessons from others wherever possible.
- ▶ Adaptive management should be considered integral to any TMDL, nutrient controls and standards. We need to be allowed variances in dealing with nutrient sources and loads where appropriate.
- ▶ Regulatory agencies need to recognize and accept that 100% achievement may not either be possible or necessary with respect to controls and standards. For example, controls applied to a smaller percentage of sources may result in higher overall water quality results.

Building Relationships to Improve Water Quality

Much of the dialogue among workshop participants revolved around the need for building trust between stakeholders and regulators. Specifically:

- ▶ Communication, relationships, and trust should be established as foundational, involving all stakeholders. This would bring a new, improved image to the EPA and state agencies, and the cooperation it fosters at the local level would lead to water quality improvements.

- ▶ Regulators and regulated should work together in order to do away with the current us-versus-them attitude. Regulated groups should be connected to the process.
- ▶ Individuals from agencies interacting with stakeholders relative to nutrients should become more knowledgeable about day-to-day operations of stakeholders. Regulatory agencies and policymakers need to gain a better understanding and appreciation for stakeholders’ situations, perspectives, and financial means.
- ▶ Continuity in agency staff is needed to foster productive relationships to solve water quality problems.
- ▶ Education, information exchanges, and continued dialogue on nutrients are needed to provide continuity in the engagement of the public, stakeholders, and regulated entities.

Financing Improvements in Water Quality

Since current fiscal realities are not expected to turn around overnight, creative approaches will be needed. Specifically:

- ▶ We should investigate nutrient trading across sectors in order to achieve water quality goals.
- ▶ Means of financing the costs of nutrient controls and minimizing the economic burden to stakeholders need to be built into any nutrient control program. Our society creates and externalizes our nutrient problems and will benefit from nutrient controls, thus society needs to bear the costs of control.
- ▶ The relationship between benefits and costs needs to be understood and communicated to stakeholders, ratepayers, and dischargers, along with discussion of who is going to bear the cost of controls.

Nutrient Controls and Standards to Improve Water Quality

Workshop participants from across all sectors were consistent in their assertion that nutrient controls and standards will benefit from enhanced local engagement.

- ▶ Nutrient controls and standards should be based on local level input and management constraints, with participation

and involvement of local stakeholders through the entire process. Emphasis should be placed on protecting water resources and providing safe drinking water instead of just meeting regulations.

- On the other hand, uniform sampling and data collection protocols should be established for each sector involved in the nutrient control/nutrient management issue. Data sharing should be improved among all entities.
- Nutrient controls and standards should be based on sound science which elucidates relationships between nutrient loading, water quality impairments, and effectiveness of best management practices.
- Water quality improvement or protection through nutrient controls and standards should be marketed where appropriate, rather than mandated or regulated. To this end, education needs to be used as a complementary tool for achieving nutrient controls and standards. Education is needed for the general public, policymakers, stakeholders, and managers.

Finally, workshop participants unanimously recommended the need for the region, states and stakeholders to continue and sustain dialogue leading to creative and collaborative solutions to nutrient problems.

You can download this report, including the electronic index, at www.cwi.colostate.edu/nutrients

Electronic appendix includes:

- Speaker Abstracts and Presentations
- Speaker Biographies
- Posters and Abstracts
- Questions Related to Nutrients and Water Quality
- Workshop Participant List
- Workshop Photos
- Workshop Survey

Next Steps

Based on the recommendations developed by nutrient workshop participants, the following next steps are suggested.

- Establish a small work group of the regulated stakeholder representatives and the regulators in Region 8 to draft and champion implementation of concrete, actionable next steps based on the recommendations from the workshop.
- Encourage states to initiate internal dialogues among stakeholders, regulators and the regulated communities that build on the learning of the workshop and deal with state specific issues.
- Stage educational and relationship building opportunities such as tours in which the regulated and the regulators travel together to farms, treatment plants, and impacted water bodies, to see what's working and what isn't working. Learn from the tours, build relationships, get inspired to act.
- Pilot projects such as nutrient trading between nonpoint and point source contributors in specific watersheds within Region 8 to demonstrate the possibilities for working partnerships that can effectively address nutrient issues.
- Establish a user-friendly, online regional nutrient information clearinghouse that provides tools, literature, educational opportunities and links on nutrient success stories.
- Choose five exemplary stakeholder/agency cooperation examples and honor them—use this for a press release to get the word out about these stories.
- Encourage stakeholder groups to foster communication with other EPA Regions to find out what they are doing that could be useful in Region 8.
- Distribute the Nutrient Workshop report in a meaningful, aggressive way.
- Establish a Speaker's Bureau with a Power Point presentation available for workshop participants to use for approved presentations to same targeted groups above