‘Moving the Needle’:
Improving Water Quality in Minnesota
While Developing Our Agricultural Economy

Prepared for
The Honorable Mark Dayton
Governor of Minnesota
By
The Water Resources Center
University of Minnesota

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Contents

EXECUTIVE SUMMARY

Minnesota's lakes, rivers, streams, and groundwater are not as fishable, swimmable, and drinkable as we would have them be. Minnesotans have shown their commitment to healthy water by supporting the Clean Water, Land and Legacy Amendment, and the state has defined goals and strategies in the Minnesota Nutrient Reduction Strategy, Nitrogen Fertilizer Management Strategy, and other key reports and rules developed with broad stakeholder involvement and a solid scientific core.

Agriculture is among the state's most important industries and the largest land user. It is key to achieving healthy water because of the impact of agricultural land management choices on water quality. Most water impairments are defined by a handful of pollutants, including excess phosphorus and nitrates, bacteria, and suspended sediments. The state has a large body of scientific evidence that shows that the dominant source of most of these pollutants is due to current agricultural practices. In contrast to agriculture, point sources of nutrients from wastewater treatment plants, urban stormwater, and industry have measurably declined in the past several decades. The row crop agricultural contribution to water pollutant loads is not regulated under federal or state law, and mitigation efforts are largely voluntary and incentive based. While producers have widely engaged in voluntary efforts, these measures are insufficient to meet our long-term water goals given today's increasingly intensively managed crop production systems.

Agricultural practices have changed significantly over the last 70 years, with changes in the types and varieties of crops planted and significant modifications to hydrologic systems. There have been improvements in agricultural practices as well, such as conservation tillage, improved manure and nutrient management, and land set-aside, but the water quality benefits of these improvements have been offset by changes in precipitation timing and intensity, and market pressures to produce more corn for ethanol. Thus it will take some new policies and approaches to manage current problems into the future.

This report, developed through a series of Water Science and Policy Salons held by the Water Resources Center at the University of Minnesota, presents three policy initiatives with specific strategies to "move the needle" on improving water quality. These initiatives will provide significant movement towards meeting the goals put forth in the Minnesota Nutrient Reduction Strategy. We present these priorities to the Governor to consider as actions to give Minnesota a Clean Water Legacy. Our approach was to use some of the best minds in agriculture research, economics, policy, and agribusiness to develop strategies that would have measurable and meaningful impact, and focus on innovative approaches based more on markets than command and control regulations. Ultimately, "moving the needle" means restoring our impaired waters to their desired swimmable, fishable, and drinkable conditions.

The Salon Participants identified several principles to guide the development of our clean water policies:

- Protect and strengthen the agricultural economy in the course of protecting water quality – both are needed.
- Leverage existing agricultural markets and institutions and develop new markets that support clean water.

- Pursue scientifically-based strategies that are capable of reaching long-term water quality goals.
- Prevent further harm to water quality by examining impacts of the full range of state and federal farm and energy policies. Protect sensitive lands; prevent expansion of row-crop acreage to sensitive lands.

Criteria were developed to evaluate the policy initiatives. For each proposed policy initiative we asked (1) will the outcomes be effective; (2) will the outcomes be at an appropriate scale; (3) can the outcomes be realized financially and politically; (4) will the outcomes be socially just; (5) will the outcomes produce co-benefits; and (6) will the policy be sustainable and durable?

Based on these principles and criteria, the Salon Participants identified the following initiatives as being of the greatest impact, along with their detailed goals and strategies for implementation:

- *Diversify Minnesota's agricultural cropping systems* so the industry thrives on a minimum of 10% of row crop acres converted to perennial crops, and incentivize this through market approaches.
- *Manage agricultural water discharges* to reduce stream flow and nutrient loads.
- *Incentivize these changes through improved producer certification programs,* and link them to supply chain markets to change farm practices that support clean water.

There is no single strategy that will accomplish the goals of the state; rather a portfolio of actions is needed, including existing, well-established actions that are not mentioned here. For investment in the next biennium, the following strategies were identified as the highest priority (letters and numbers refer to those in main body of text):

A. Diversify the Cropping System

A.1. Goal – Transition over time the conversion of a minimum of 10% of corn/soy row crop acres to perennial plantings.

a. Develop markets to encourage adoption of alternate crops for food, fuel, fiber (i.e. go beyond ethanol). Target acres with negative or low return on investment currently.

A.2. Goal—Effect change in Federal Farm Policies to promote water quality; create upland habitat and benefit pollinators—while maintaining agricultural profitability.

B. Manage Agricultural Water Discharge

B.1. Goal – reduce effects of tile drainage on water resources

a. Revise Minnesota Drainage Law (103.E) to make Drainage Authorities accountable for discharges of public ditches.

C. Incentivize Changes through Producer Certification Programs

C.1. Goal – Raise the certification threshold in the Agricultural Water Quality Certification Program to achieve water quality improvement goals and align the scoring for certification with the Natural Resources Conservation Service Water Quality Index.

Additional initiatives for the Governor to consider are included. These are all highly valued and impactful but could wait until these first actions are undertaken.

I. INTRODUCTION

Minnesota's lakes, rivers, streams, and groundwater are not as fishable, swimmable, and drinkable as we would have them be. In fact, approximately 40% of Minnesota's surface water resources do not meet water quality standards and are out of compliance with state and federal law. Under the U.S. Clean Water Act, these waters are termed "impaired". While Minnesota has aggressively pursued programs and policies to address this large environmental problem, the number of impaired waters continues to increase over time. (See the MPCA Impaired Waters Page.) The Minnesota Pollution Control Agency (MPCA) added 318 new bodies of water in 2016, bringing the number of impaired waters in the state to over 4600. Less than half of the lakes and rivers in southern Minnesota meet water quality standards.

Minnesotans have shown their commitment to healthy water by supporting the Clean Water, Land and Legacy Amendment (2009). The majority of "yes" voters indicated that it was their desire for clean water that determined their support for the amendment.

The Issue. Most of these impairments are mainly due to a handful of pollutants, including excess phosphorus and nitrates, bacteria, and suspended sediments. The state has a large body of scientific evidence that shows that the dominant source of most of these pollutants is due to current agricultural practices (see Section II, below). This is not surprising, given the extensive land used by agriculture. In contrast to agriculture, point sources of nutrients from wastewater treatment plants, urban stormwater, and industry have measurably declined in the past several decades. This is because a regulatory path exists to manage point source pollutants under the Clean Water Act. However, the agricultural contribution to water pollutant loads from row crops is not regulated under federal law, and mitigation efforts are largely voluntary and incentive based. Our agricultural practices have changed significantly over the last 70 years, with a loss of small grains and hay through conversion to corn and soybeans, and significant modifications to hydrologic systems through subsurface tiling. There have been improvements in agricultural practices as well, such as conservation tillage, improved manure and nutrient management, and land set-aside programs, but the water quality benefits of these improvements have been offset by changes in precipitation timing and intensity, and market pressures to produce more corn for ethanol. Thus it will take some new policies and approaches to manage current problems into the future, all while protecting and enhancing agriculture's role in our economy. Ultimately, "moving the needle" means restoring our impaired waters to their desired swimmable, fishable, and drinkable conditions.

Before designing new policy, one must understand the problem one is trying to fix. The problem in this case can be stated as: "Water quality is significantly impaired by excess nutrients and sediment." The main driver of this is current agricultural practices. Because clean water *and* agriculture are very important to Minnesotans, any policy must maintain the prosperity of the agricultural sector while improving the aquatic environment. This problem, often termed a "wicked problem", has not been successfully dealt with because it is highly multifaceted, has powerful stakeholders with divergent views and loyalties, and has an inadequate regulatory framework for finding successful solutions. Also, there are several disincentives in Federal law for producers to change their practices to be more protective of water resources (for example, subsidies to grow corn for ethanol pushes producers to plant corn on sensitive lands). Thus innovative, forward-looking policies are needed to overcome these barriers. It should not be a

question of choosing clean water *or* agriculture; solutions should provide for both clean water *and* a healthy agriculture economy.

This overall problem of excess nutrients and sediment is in fact a national problem for which Minnesota can provide national leadership. Other states will look at the results that we have developed here. The status quo is not acceptable; there is a great deal at stake for Minnesota and the rest of the nation.

A "Clean Water Legacy". Governor Dayton has declared his intent to leave a "Clean Water Legacy" as he completes his final two years in office. He challenged citizens of the state to provide actionable solutions that would "move the needle on water quality" in his February 27, 2016 Water Summit. Our Water Science Policy Salons focused on the "wicked problem" of agriculture and water quality as the most compelling issue to be addressed, and this document provides a set of bold, innovative solutions to be considered to achieve significant improvements in water quality while preserving the productivity of the agricultural sector.

So, What Does "Move the Needle" Mean? Our discussions converged on the following: As an outcome of these proposed policies, Minnesota would see (1) medium and long term gains in water quality, and concurrent reductions in phosphorus, nitrates and sediment that are consistent with the milestones and goals put forth in the Minnesota Nutrient Reduction Strategy and the Sediment reduction strategy for the Minnesota River Basin and South Metro Mississippi River; (2) These improvements and reductions would need to be enacted and managed at the watershed scale, but result in state-wide, measureable improvements; (3) and such changes would have to go hand-in-hand with measurable changes in behavior and culture by agricultural producers and their supply chains. In other words, success in meeting our state goals of double-digit reductions in loads of phosphorus, nitrates and sediment in coming years will require changes to our agricultural landscape, which can only happen with cultural and behavioral changes in our agricultural community.

Our Process. Our approach was collaborative, employing a series of three Water Science and Policy Salons during the fall of 2016 with the best professional minds from water and agriculture. Salon Participants had expertise in water and agriculture, drawn from University faculty and staff, scientists from the Science Museum of Minnesota, experts from non-governmental organizations, and leaders from the private agricultural sector (see Appendix A). Participants were not stakeholders that represented organizations, but participated as established professionals that used their collective knowledge and experience to design selected policy initiatives for the Governor to consider for his Clean Water Legacy. The participants engaged in structured discussions and input gathering activities during the Salons and also had opportunities to comment on earlier drafts of this report. However, the UMN Water Resources Center assumes the responsibility as the author of this report; endorsement of particular statements by any given participant is not implied.

The initial intent of our Salons was to find consensus on a few bold and innovative recommendations. However, innovative ideas by definition have unknown elements and require detailed analysis for a full understanding of their impacts. In part because of this uncertainty, we did not reach consensus among all participants. While we cannot present the ideas in this report as consensus recommendations, Salon participants derived them through hours of committed and thoughtful discussion. It is important to emphasize that we reached common ground on

principles, evaluation criteria, and overall goals. The remaining disagreements about policy proposals highlight that this is a "wicked problem" and that policies must be carefully designed and evaluated to achieve the agreed-upon outcomes.

Overarching Comments and Principles. The policy ideas in this report are oriented towards helping the state set significant trajectories for improved water quality *and* a healthy and diversified agricultural industry for the future. That said, it is critical for Minnesota leaders and decision makers to understand that there will be a significant time lag (many years to decades) between action now and future improvements in water quality. We have already put a lot of nitrogen and phosphorus on the land and in our sediments; it may take a long time for those load reductions to be realized. Similarly, changes to the agricultural industry will take time – it took decades to reach the high productivity of today's corn and soybean farms, and it will take time to transition changes in cropping systems or practices. However, positive outcomes in the future cannot be obtained without taking actions now.

Participants in the Water Science Policy Salons articulated a number of key principles in their discussions. One important principle is that the first step the State should take is "do no further harm" to our water resources. We must be vigilant in protecting sensitive lands and keep them out of row crop cultivation while providing producers with the right incentives to do so. Secondly, the public gains from policies that have co-benefits (sometimes called stacked benefits) – meaning that a policy would not only lead to improved water quality, but it would also lead to other parallel benefits such as improved habit for wildlife, pollinators, and butterflies. Third, policies must be targeted to get the most efficient outcomes – focus on the right tools for the right acres. Fourth, policies should build on existing institutions and programs to be most cost effective. Finally, these recommendations reflect the general principle of performance based standards of practice, rather than proscribed actions for producers to take. Farmers know their lands better than anyone else and agricultural industry is best positioned to develop efficient technology. Together, they can manage farms to meet standards that protect water quality, rather than responding to one-size-fits-all practice requirements (that may or may not help protect water quality).

Policy Priorities. There is no single strategy that will accomplish the goals of the state; rather a portfolio of actions is needed. The Salon participants identified three "Big" policy priorities, with 2-3 goals and strategies under each of them. These priorities reflect the degree to which they will "move the needle", and also indicate those measures that we encourage the Governor to consider for investment in the coming biennial budget. These strategies employ a combination of tools, ranging from public-private financial partnerships to public investments to regulatory actions. There are carrots, and there are sticks. Some strategies can be enacted by the Administration, and some will require actions by the Legislature.

Scope of Work and Next Steps. A number of participants identified the need for further analysis to better understand the impacts of the policies and the tradeoffs involved. In addition, many of the policy ideas do not have a great deal of detail on their implementation. Both of these activities were beyond the scope of the Salon process given timelines and resources, but could be conducted in the future relying in part on the data and resources noted in Section II below. The University of Minnesota (UMN) Water Resources Center (WRC) led this process and, consistent with its mission, stands ready to further assist the State by harnessing the vast expertise at the

UMN to conduct further analysis. We would be pleased to work further with the Governor and his staff to develop implementation recommendations on any or all of the initiatives he may wish to pursue. The WRC is highly regarded for meeting this mission in the past, and for serving as an objective, third party in assisting with science-based decision-making. The WRC is uniquely qualified to assist the Governor in identifying and prioritizing the most effective science-based water policy options. The WRC led the development of the nationally- recognized Minnesota Water Sustainability Framework in 2011.

II. BACKGROUND

The Pollutants, Their Sources and Trends. Excess nitrogen, phosphorus, and sediment are widespread water quality concerns across Minnesota and across the nation, as reported in a recent *EPA news release*. *Figure 1* and *Figure 2* illustrate the trends and sources of these pollutants.

Excess nitrate (from fertilizer, manure, and soil organic matter) has been the most intractable challenge among the major pollutants. Monitoring of waters across the state indicates that nitrogen loads in streams have been steady or rising since the 1980s. Corn production requires relatively high nitrate concentrations in the soil, and nitrate is highly soluble, easily leaching through most soils depending on application timing and precipitation events.

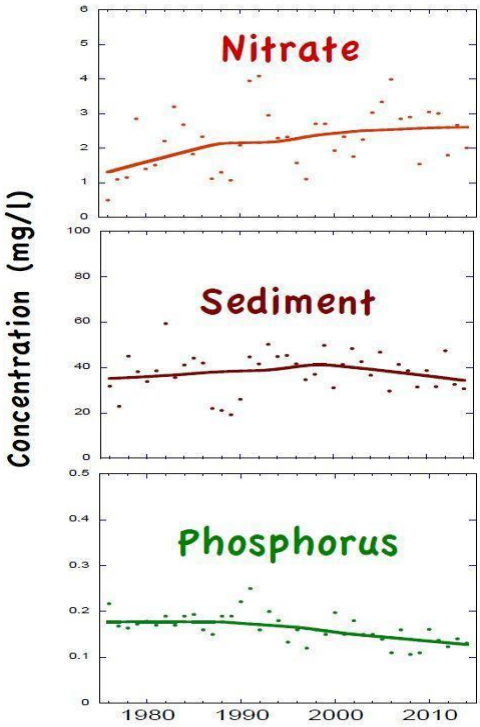

Figure 1. Water Quality Trends, Mississippi River at Prescott.

The result is two realities of nitrogen pollution: (1) it is very difficult or impossible to substantially reduce stream nitrate loads in agricultural areas of the state without reducing corn acreage in some of those watersheds. (See "Nitrogen in Minnesota Surface Water (2013)" for data.) Reducing nitrogen fertilizer applications to economically optimum rates is helpful, but still leaves a lot of nitrate exposed to leaching; and (2) because nitrate is so soluble, nitrate management largely becomes a water runoff management issue.

The studies done by the Minnesota Pollution Control Agency (MPCA) indicate that 78% of nitrates in Minnesota waters come from agricultural practices (*Figure 2*).

Sediment in streams, particularly from the Minnesota River basin, originates equally from stream bank, bluff, and ravine erosion, as well as field erosion. In-stream loads of sediment are determined by land use, watershed alterations, and the amount of water in streams, which has been heavily impacted by increased precipitation in recent decades. Reducing stream flow and sediment can be achieved in several ways: (a) changing land cover and protecting the soil by increasing the water that evaporates or transpires from land and plants, especially by adding

living plant cover in the springtime where soil would otherwise be bare; and (b) by retention or temporary detention of sediment and water on the landscape in ponds, wetlands, soil, and so on.

Phosphorus in streams originates from fertilizer, manure, and surface crop residues, as well as human and industrial waste. It is not highly soluble, and generally binds to and travels with soil sediment. In-stream loading has declined since the 1980's, largely due to improvements in wastewater treatment. However, agricultural field sources are thought to contribute about 40% of the source of phosphorus to Minnesota surface waters. Stream bank erosion, due in part to altered hydrology of agricultural land, contributes another 17%.

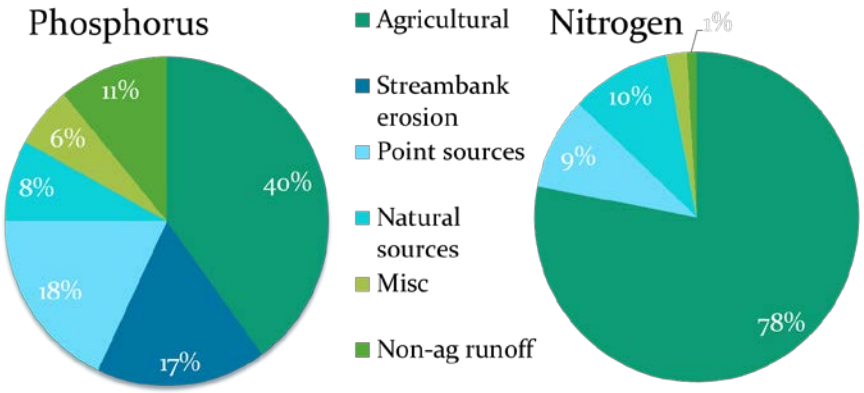

Figure 2. Sources of nutrients to Minnesota waters (MPCA studies).

Water Quality Goals. The Minnesota Nutrient Reduction Strategy (2014) establishes clear targets for in-stream loading reductions for nitrogen and phosphorus for each of the major river basins. *Figure 3* shows the goal for the Mississippi River basin. These goals are based on water quality targets stated in previous plans and policies. The MPCA has set a goal of 45% reduction of phosphorus by 2025 (from average conditions 1980-1996) to meet water quality standards. The goal for nitrates includes an intermediate milestone of a 20% reduction in nitrates by 2025, and a 45% reduction of nitrates by 2040.

Agriculture is Key Leverage Point for Managing Water Quality. If nutrients and sediment derive from a variety of point and non-point sources, why are we focusing on agriculture? The simplest explanation for the importance of agriculture to water quality is that farmers own and manage half the land in the state, and nutrients and sediment are land-based pollutants. Thus what happens on the land affects water quality. A second part of the explanation is the dramatic shifts in management that have occurred in recent decades resulting in changes in how agriculture impacts water quality and stream flow. The shifts include changes in crop diversity, distribution of livestock and loss of perennial crops (e.g. hay, pasture alfalfa), increased intensity of crop seeding and inputs, and increased intensity of hydrologic modifications. Several extensive reports have analyzed and summarized the current science describing the nature of agriculture's role in water quality degradation. The specifics of agricultural contributions are explained in Nitrogen in Minnesota Surface Waters (2013), the Minnesota Nutrient Reduction Strategy (2014), and the Sediment Reduction Strategy for the Minnesota River (2015).

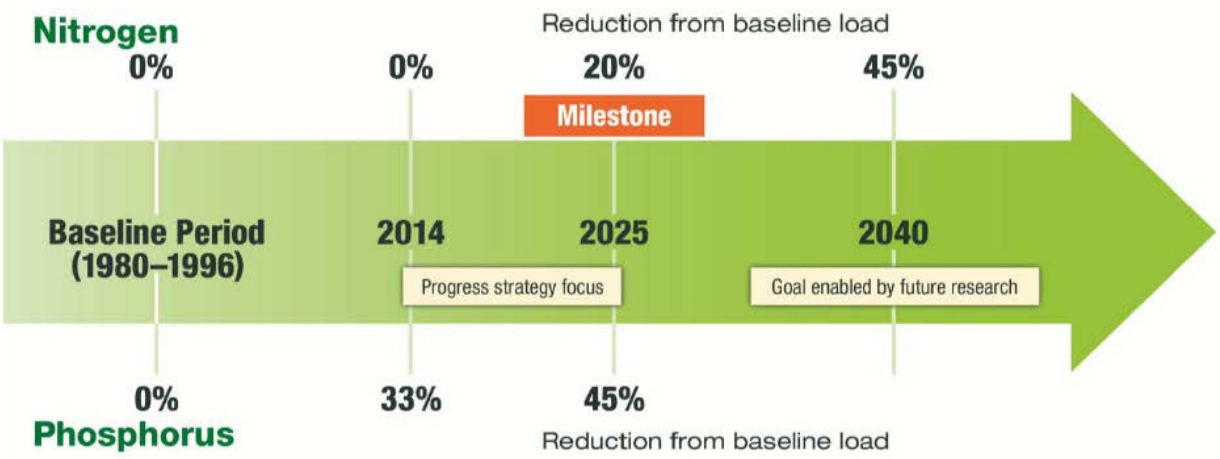

Figure 3. Timeline for achieving the Mississippi River milestone and goal (Minnesota Nutrient Reduction Strategy, 2014).

The changes in agriculture management combined with a trend towards increasing precipitation call for new approaches to supporting healthy water systems alongside a healthy agricultural economy.

Defining the Strategies. How can these ambitious goals be reached? Consistently, stakeholders identify three major categories of strategies for addressing water quality in agricultural regions:

1. In-field Nutrient Management: Optimizing in-field fertilizer application rates, timing, and form.
2. Tile Drainage Water Management: Slowing water movement across the land, increasing water storage across the landscape, and improving drainage water management and treatment.
3. Vegetation and Landscape Management: Increasing the amount of land covered with perennial crops, permanent vegetation, and inter-row cover crop plantings and shoulder season crops such as winter wheat or rye.

In-field nutrient management is necessary but not sufficient by itself for protecting water quality (*Figure 4*). It is the "low hanging fruit" because it returns economic benefits to the landowner who implements the practices. If best management practices for nutrient management were adopted on all suitable acres statewide, the MPCA has estimated there would be a 13% reduction in nitrates. Thus, on its own, this approach is unlikely to move us towards our water quality objectives.

Water management is essential in this era of increasing precipitation. It is challenging because collaboration across property boundaries is often required, and the immediate benefits are often to downstream stakeholders rather than to the implementing landowner. The MPCA predicts that if controlled drainage were used in combination with constructed or restored wetlands and bioreactors on those lands that are well-suited for such practices, the statewide nitrate load reduction to streams would be 5-6%. Load reductions in heavily tiled watershed could be reduced as much as 12-14%.

Vegetation management is necessary if the state is to reach its long-term nutrient loading goals. It is very expensive under current markets that provide limited economic return for perennial crop production. But by developing new crops and new markets, the economics of perennial-based, water-friendly agriculture could be much more lucrative. In addition, vegetation management can be an effective way to achieve hydrologic management through changes in evapotranspiration – thus, if done correctly, vegetation management can be implemented as a dual management strategy. By accomplishing landscape vegetation changes through building systematic changes to the agricultural economy, we should achieve truly transformational and fundamental changes in the state's water quality. The MPCA has estimated that statewide adoption of vegetation changes (maximum of 20% cover crop adoption; row crop removal from all buffer strips; and conversion of row crops on all marginal lands (estimated at 1.3 million acres) to perennials) would result in approximately a 25% reduction in nitrate loads statewide.

It is critical to understand that no one approach will work to meet Minnesota's water quality goals. It will take a combination of these approaches to meet the nutrient reduction targets of the state (*Figure 4*). It is also critical to understand that these approaches must be targeted to certain watersheds in order to provide the most gains.

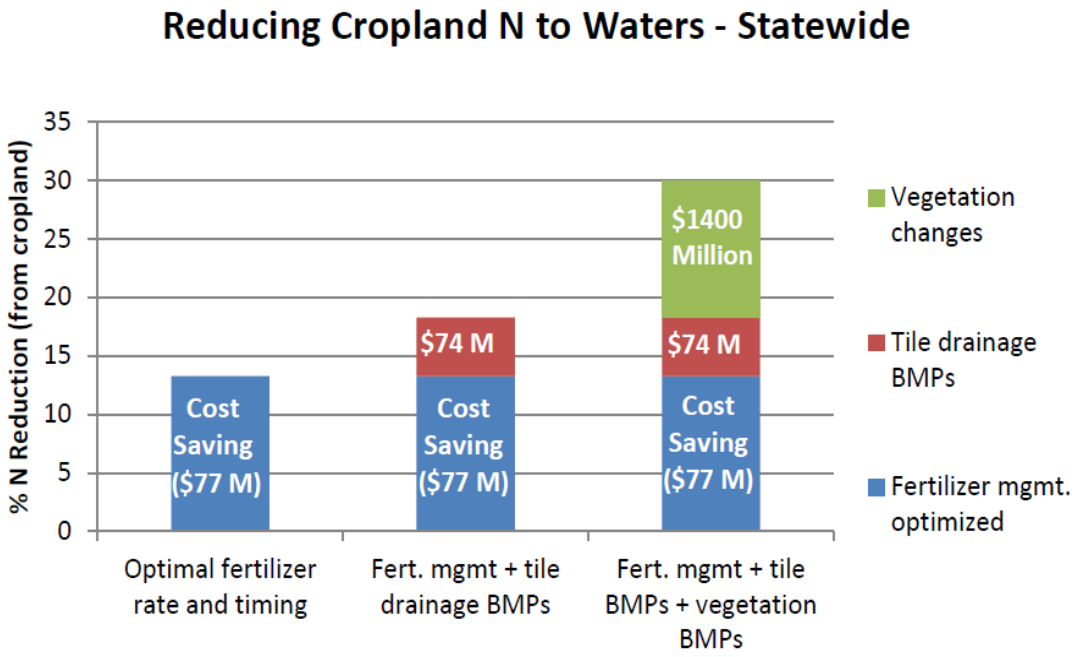

Figure 4. Taken from "Nitrogen in Minnesota Surface Waters"(2013), Appendix F-1. N reductions and cost estimates assume practices are adopted on all suitable lands (targeted) statewide. Costs include capital investments and annual maintenance costs, and do not include any new markets for vegetation changes. Model details and assumptions can be found in the referenced study.

Agricultural Community is Engaged. Farmers are the direct managers of half of the land in Minnesota, and thus, of our water. Researchers, policy makers, and conservationists are only indirect managers. Many farmers and agricultural organizations have demonstrated their interest in addressing water quality problems. For decades, many farmers have been using water-friendly practices including reduced tillage, grassed waterways, stream and ditch buffers, fertilizer and manure management best practices, and more. The Minnesota Corn Growers Association recently announced an initiative committed to the vision that "Minnesota's corn farmers will become the most sustainable and environmentally responsible corn farmers in the United States." They consistently support water quality research and outreach at the University, most recently stepping up to fund development of guidance for the Buffer Law implementation. The Minnesota Agriculture Water Resource Center is a coalition of farmer organizations that hosts the Discovery Farms program and other agricultural water management research and education. MCGA and the MAWRC support and promote the Nitrogen Smart program providing ongoing training in responsible nitrogen management to farmers across the state. Last spring, Land O' Lakes, Inc. announced a partnership to promote the Agricultural Water Quality Certification Program through their cooperative network. The GNP Company is pursuing several environmental initiatives including participating in the Field Stewards program to reward farmers for protecting water quality. This is just a sample of how the agricultural industry and farmers are engaged in water quality issues and demonstrate a willingness to partner on addressing the challenges.

Build on Existing Work and Existing Institutions. Minnesota has invested a tremendous amount towards protecting and restoring water resources. With the complexity of water issues, it is essential that efforts be coordinated and targeted. Thus, any new or refined policies should be aligned and consistent with existing reports, goals, plans, and statute, including:

The Minnesota Nutrient Reduction Strategy. 2014. https://www.pca.state.mn.us/water/nutrient-reduction-strategy

The NRS is meant to guide the state in reducing excess nutrients in waters so that in-state and downstream water quality goals are ultimately met. It includes clear targets for in-stream loading for nitrogen and phosphorus for each of the major river basins.

Nitrogen in Minnesota Surface Waters. 2013. https://www.pca.state.mn.us/news/report-nitrogen-surface-water

This is the scientific basis for much of the Nutrient Reduction Strategy. It describes the sources of nitrogen in surface water and summarizes results of modeling various strategies for reducing loads. Figures on pages F1-17 and F1-18 show that it may be possible to meet interim nitrogen reduction goals by improving nitrogen fertilizer management, but vegetation changes are essential if we are to meet the 2040 goals aimed at protecting human and ecological health.

Nitrogen Fertilizer Management Plan. 2015.
http://www.mda.state.mn.us/chemicals/fertilizers/nutrient-mgmt/nitrogenplan/draftplan.aspx

This plan was developed and updated through a robust stakeholder process to create a blueprint for preventing or minimizing impacts of nitrogen fertilizer on groundwater.

Sediment Reduction Strategy for the Minnesota River Basin and South Metro Mississippi River. 2015. https://www.pca.state.mn.us/water/sediment-reduction-strategy-minnesota-river-basin-and-south-metro-mississippi-river
This is a companion to the Nutrient Reduction Strategy, establishing sediment reduction goals for the Minnesota River.

Minnesota's Clean Water Roadmap. 2013. http://www.mda.state.mn.us/protecting/cleanwaterfund/cwfreports.aspx

The Clean Water Roadmap is meant to guide Clean Water, Land and Legacy Amendment spending by providing a set of goals for protecting and restoring Minnesota's water resources during the 25-year life of the amendment.

Agricultural Drainage Statute 103E. https://www.revisor.mn.gov/statutes/?id=103E

Animal Feedlot Rules. (Administrative Rules Chapter 7020)

Buffer Law. (Statute 103F.48. See also the BWSR Buffer Program.)

Unintended Consequences – the Example of Ethanol. It is critical to appreciate the relationship between growing corn for ethanol and its substantial impacts on water quality. Approximately 32% of Minnesota's corn crop is used for ethanol production and another 40% is used for animal feed. Because of the increased demand for corn driven by the federal Renewable Fuel Standard (RFS) mandates for ethanol production and the subsidies for ethanol production, producers have converted non-corn acres to corn acres, and in some cases have planted corn on sensitive lands that were previously not in production. Increases in corn acres means increases in fertilizer application, increases in tile drainage that contains excess nitrogen, and greater movement of excess phosphorus and sediments to water (the more sensitive the land, the more erosion and nutrient runoff). So the upside of increased corn production for ethanol has a downside for water quality. The RFS mandates a certain amount of corn-based ethanol per year; the standard also mandates a certain percentage of renewable biofuels to be made from cellulosic feedstocks rather than corn. The RFS mandates that cellulosic biofuels to be 44% of all renewable biofuels by 2022. However, cellulosic ethanol production has not kept pace with expectations; only one commercial facility currently exists in the United States. Cellulosic feedstocks can include perennial grasses like switchgrass or alfalfa; but the expected feedstock is corn stover. Corn stover is the un-harvested portion of the corn plant and this material when left in the field prevents soil erosion and builds soil health. Unfortunately, removal of corn stover to sell to the eventual cellulosic market will have the negative effect of again increasing water quality problems because of increased erosion and runoff of nutrients. The answer to this conundrum is to encourage growers to produce perennial or non-corn feedstocks in place of some of their corn through incentives (e.g. tax credits, subsidies). This has the added benefits of erosion protection and habitat creation. But one must then find a way to compensate for the difference in growing corn on that land vs. growing a less valuable crop until markets can be developed to make the perennial feedstock more profitable. The market different between corn stover and new perennial crops is large and will be expensive to address. But make no mistake – the current practice of using corn or corn stover for ethanol production is a major driver of reduced water quality in Minnesota, and the current proposal to increase the mandate from the current 10% ethanol in gasoline to 15% ethanol ("E15") may have additional harmful effects on Minnesota's water unless the additional 5% is derived from perennial crops.

III. STAKEHOLDER ANALYSIS

Policy changes affect different populations, communities, and socio-economic groups in different ways, and to differing degrees. Some stakeholders will be affected positively, and some may be affected negatively. In general, a primary goal of these policies is to maximize the stakeholders that will be affected positively. Below we list the main stakeholders to be considered as these policy changes are considered and evaluated.

- Producers – most affected. Policies need to minimize negative impacts on them. There will still be some losers and some winners.
- Agricultural businesses (e.g. implements, seed companies, coops) - equally vulnerable, although diversification of cropping systems would also present opportunities for this sector.
- Agricultural supply chain (e.g. commodity buyers, food manufacturers, food wholesalers, food retail companies) – presents challenges but also opportunities.
- Consumers – may experience some higher prices for food, but perhaps more choices.
- MN Residents and voters – may see tax increases, but they would also be the big winners – the state will have improved water quality, better recreational opportunities, increases to the tourism economy, better drinking water quality and lower costs for nitrate removal. In addition, taxpayer burden for upgraded drinking water and wastewater treatment plant operations can be reduced, as more cost-effective reductions are secured from larger agricultural sources.

IV. CRITERIA FOR EVALUATING POLICY OUTCOMES

Our policies were compared by projecting each policy's potential outcomes and then evaluating the projected outcomes against selected criteria. The responses to the criteria are based on expert judgment and a qualitative narrative. The criteria are value-based, and the responses to them are also value-based.

The Salon participants reviewed "typical" criteria used in most policy analyses, and added to them and tailored them to reflect the values of interest regarding the policies presented here. Our external reviewers were instructed to make these criteria central to their evaluations.

The criteria below are not presented in any particular order of importance or priority, with one exception (#1). The make-or-break criterion is whether the projected outcome will in fact achieve the overall goal of these policies – to significantly and measurably improve water quality in Minnesota.

- Are the outcomes effective?
  1. Will the long-term result be significantly and measurably improved water quality?
  2. Will the outcomes significantly help meet implementation goals? (e.g. Nutrient Reduction Strategy (NRS) milestones)
  3. Are the policies efficient in meeting water quality goals? Are benefits achieved with the least inputs of time, money, etc?

- Will outcomes be at the right scale?
  4. Spatial scalability –Will outcomes occur at the needed scale to have broad impact? Will the impact be widespread and significant?
  5. Time scale – How soon can the policies be implemented? How soon will they have impacts? (aim for both short and long-term approaches)

- Can the outcomes be realized?
  6. Are the financial resources to implement the policy fully accounted for (who pays, what mechanism)?
  7. Are the outcomes technically feasible?
  8. Are they socially acceptable – will the public support it?
  9. Are the outcomes legally feasible? Would some existing statutes have to be altered?
  10. Are they politically feasible? Is it politically resilient? What is the nature and intensity of likely opposition? Could it be reversed easily?
  11. Is more research needed to develop and implement the policy?
  12. Will farmers be supported with tech support, education, and finances for implementation?

- Are the outcomes socially just?
  13. There are winners and losers – does the outcome maximize the winners? Is it equitable (not the same as equal) in its impact?

- Will the outcomes be effective in the larger context?
  14. Does it have other environmental benefits (co-benefits) beyond water quality (especially habitat, soil, and climate; also environment, society, economy)?
  15. Do they harness consumer markets? Will they be consistent with existing initiatives, e.g. the MN Nutrient Reduction Strategy (NRS)? Are there impacts on other economic sectors (e.g. tourism, food production)?
  16. Will outcomes be sustainable and last into the future? Will the new practices and their benefits persist or will they require continued reauthorization, refunding?
  17. Are the outcomes durable? Are they adaptable to future changes?

V. THE SALON PROCESS

We began by sifting through the agriculture-related ideas generated during the Governor's Water Summit (February 2016) and grouped them into ten strategy approaches. Salon participants were asked to independently rate each approach for its feasibility and impact, and contribute additional ideas not addressed by the initial list.

At the first Salon in September, participants shared their visions for the Minnesota landscape and economy and then used the feasibility/impact ratings as a starting point to identify strategies to pursue. Consensus emerged about the high impact of changing cropping systems towards more perennial crops. No other strategy reached that level of support. Increasing water storage on the landscape was rated high impact by most, but not all, of the group. Promoting certification programs that leverage market forces and employing precision agriculture technology also

generated a lot of interest. Fertilizer management strategies rated mostly high for feasibility, but mixed for impact, depending on the specific target and approach. Several participants felt they did not have the right technical expertise to evaluate several of the ideas, underlining the need for diverse disciplines to address water issues.

At the second Salon in October, participants clarified what "move the needle" on water quality meant to them, and worked on developing the priorities identified in September.

At this point, we asked two external reviewers to comment on the draft policies and to join the discussions of the last Salon in December. Our external reviewers were both agricultural economists with complementary expertise – Professor Otto Doering from Purdue University and Professor Cathy Kling from Iowa State University. The Salons were professionally facilitated by University of Minnesota staff (Ann Lewandowski, Water Resources Center and Cynthia Hagley and John Bilotta, Minnesota Sea Grant).

VI. POLICY ALTERNATIVES to "MOVE the NEEDLE"

A. Diversify the Cropping Systems

As stated in the Background section (II above), the Minnesota Nutrient Reduction Strategy (2014) concludes that changes to Minnesota cropping systems are necessary to meet the goal of a 45% reduction of phosphorus and nitrates by 2025 and 2040, respectively. This strategy is needed in addition to nutrient management and water management. A win-win strategy is to develop a more diverse set of crops, reduce some of the row-crop acreage, and incentivize these changes financially until the markets can be developed to support these changes. Our water and our agricultural systems will be better off in the end. Perennial crops such as alfalfa or switchgrass can deliver significant water quality benefits in addition to important co-benefits such as providing habitat for wildlife and pollinators. When these crops replace corn or soybeans on marginal lands, significant water quality benefits can be realized.

Long Term Expected Outcomes: The state would make significant progress towards its goals of reducing phosphorus and nitrates by 45% by 2020 and 2040, respectively. This would be accomplished by converting at least 10% of corn/soy acres to perennials. New markets would be developed for these perennials and cover crops for food, fuel, and fiber. Perennial feedstocks would be used for more than 50% of ethanol produced in Minnesota.

Timeframe: Parts of this initiative should be started immediately, and need to start now to see the payoffs in the long term. The full benefits to water quality and shifts in agriculture practice and economy will take 1-2 decades. The group recommends that investments for this initiative be included in the 2017-2019 biennium budget.

A.1. Goal – Transition over time the conversion of a minimum of 10% of corn/soy row crop acres to perennial crops.

a. Develop markets to encourage adoption of alternate crops for food, fuel, fiber (i.e. go beyond ethanol). Target the acres currently yielding negative or low return on investment. (*High Priority; High Investment*). This is a long-term investment without an immediate water

quality impact – crops must be identified and markets developed. Still, the group agreed that expansion of perennials is the most impactful win-win for agriculture and water quality. Specific actions include:

- The Governor should establish a Blue Ribbon Task Force of agricultural supply chain and industry representatives, agricultural economists, crop specialists, producers, and water resource scientists and charge them to identify potential crops, their market potentials, and strategies for developing them. Ideally, the private sector would develop the markets and the producers would follow those markets; using a Task Force to brainstorm on these questions would jumpstart this process and focus on development in markets for Minnesota crops that are water-friendly.
- Incentivize the establishment of selected markets using appropriate policy tools. Develop commercialization grants program (e.g. US Department of Agriculture Small Business Innovations Research program). Provide incentives to supply chain industries – these could be modeled after the tax break/incentives for the grain ethanol industry from 2005. Develop a mechanism for consumer packaged goods and food marketing companies to screen their supply chains to exclude crops from lands that score low in Certification programs (see section C below). Explore these options using pilot projects. Antitrust and data privacy issues would need to be addressed.
- Incentivize producers to change and diversify crops with tax credits (property or income). Use the Working Lands Watershed Restoration Program[1] feasibility study and program plan currently underway at the Board of Water and Soil Resources (BWSR) to model how to provide subsidies for conversion to perennial crops. Link diversification of crops by producers to Certification programs (see C below).
- Fund research on market development (connect food industry to markets), crop efficacy (crops that will have market value), cover crops, etc. to support the overall market diversification. Research is needed to increase the quality of perennial vegetation with respect to desirable market traits (protein, cellulose, nutritional value, etc.). Economic analyses are also needed on markets, financial costs and benefits, etc. Account for fertilization of perennials in the economic analysis of costs. Research programs that are focused on developing winter-annual and perennial crops such as Forever Green at the University of Minnesota need additional and long-term state investment, to develop crops that are successful in the field, are scalable to large areas of the state, and have commercial value.

b. Incentivize the expansion of Minnesota-grown perennial forage crops (such as hay and alfalfa) for meat and dairy production. Conduct economic analysis research on land conversion, price increases, and costs to make this a viable option for livestock producers. Determine the total productive acres needed for pasture systems. Focus on developing systems that have synergies with co-products, such as the Main Street Project. Resources should support the development of scale appropriate production capabilities that enable the

1 In 2016 Minnesota adopted legislation creating the Working Lands Watershed Restoration Program and funding a BWSR study to figure out how it would work. The program is determining what it would cost to pay producers in two target watersheds the difference between what they would be paid for raising a crop for perennial feedstock and what they would have been paid for raising a corn crop and then harvesting the stover for feedstock. This information can inform costs related to future ethanol production policy.

consistent and safe delivery of products to consumer markets. Create certifications to stimulate the market, link pasture livestock production to WRAPS and provide tax incentives to producers who demonstrate a high level of water quality improvements using pastured/grass/alfalfa based systems. (*High Priority*)

c. Focus on an existing market – biofuels. Reduce corn acres used for biofuels by encouraging production of non-corn feedstocks. About 32% of MN corn is used for ethanol, so more immediate gains can be made by focusing policy on this existing market to exchange corn-for-ethanol to perennials-for-ethanol. These strategies should be pursued carefully to avoid unduly disadvantaging the Minnesota ethanol industry compared to that of other states.

- Use General Fund investments to pay for technical assistance to help producers switch to perennial fuel feedstock grown on previous row-crop lands. Use the results of the Working Lands Watershed Restoration feasibility study to determine the cost gap and offer payments to farmers to make the switch (see footnote 1).
- In the case of a mandated adoption of E15 in Minnesota, require that 5% or more of the blend be from Minnesota grown perennial crops that replaced row-crops. Provide subsidies to offset the differences in cost, as for (i) above. Target the acreage that is converted to perennials to those acres of negative or low revenue value. Link the outcomes to MPCA's Watershed Restoration and Protection Strategies (WRAPS). Require a certain amount of acreage conversion in those watersheds that are designated as having Impaired Waters, thus targeting problem areas in the state rather than all corn production areas.
- Connect ethanol corn sourcing requirements with the state standards for protecting water quality by encouraging ethanol customers to support the Field Steward's program as a way to offset all the corn acres need for ethanol production in MN with acres that are certified under AWQCP.

A.2. Goal—Effect change in Federal Farm Policies to promote water quality; create upland habitat and benefit pollinators—while maintaining agricultural profitability. (*High Priority*)

a. Encourage the Governor and the Minnesota Congressional Delegation to advocate for changes to the 2018 Farm Bill. There may be significant opportunity for Minnesota to influence the next Farm Bill, given its leadership on Congressional agricultural committees and its stature as a top corn and soybean producing state. It is also recommended that the Governor work with other Midwest farm state governors to harmonize regional approaches to the suggestions below and to all the recommendations in this report.

- Extend Conservation Compliance to include nutrient management standards and erosion control on all working lands. (Conservation Compliance is a current eligibility requirement for many Farm Bill programs mandating wetland conservation and erosion control only on highly erodible land.)
- Link additional conservation practices directly to crop insurance eligibility and payments. These funds already exist at the federal level ($12B), provided by US taxpayers. They currently cover approximately 63% of a farmer's annual crop insurance costs. Funds used for insurance subsidies can be re-aligned to reward the adoption of beneficial practices, alternative crops (particularly perennials), and perennial conservation acres that promote

water quality and habitat outcomes. For example, all farmers might get a baseline (for example, 50%) crop insurance subsidy, but those who add additional beneficial practices to their operation receive even greater insurance subsidies.

- Create a task force within the Farm Bill to develop strategies and markets to make perennial crops profitable, especially where switching to perennial crops has a high impact on water quality and other co-benefits. For example, give tax credits to companies that sell food products created from perennial crops (e.g. alfalfa-fed dairy, pasture-fed beef, winter wheat-fed pork).
- Within the Farm Bill, expand scope and funding of research efforts, such as Forever Green, that study and develop alternative crops and cropping systems that provide perennial cover.

B. Manage Agriculture Water Discharge

This set of initiatives is aimed at slowing water movement off the land and reducing the pollutants in the water, thus reducing impacts downstream. Policy initiatives focus on subsurface tile drainage, water storage, and flow reductions, particularly in spring (April-June).

Long term Expected Outcomes: Many detrimental effects of tile drainage will be mitigated. Water storage will be increased in targeted areas, and provide co-benefits of habitat restoration and protection for birds and wildlife.

Timeframe: Changes to Drainage Law could take place immediately, with compliance phased in over the next few years. Water quality benefits would take a decade to be realized. Regulatory changes to tile discharge could also take place immediately.

B.1. Goal – Reduce effects of tile drainage on water resources

a. Revise Minnesota Drainage Law (103.E) to make Drainage Authorities accountable for discharges of public ditches. (*High Priority*). Specific recommendations to changes in the law are below:

   - Add a definition for "adequate outlet" to mean no degradation of the water body receiving water from a public drainage system due to increased peak flows (stream bank erosion) or higher nutrient concentrations as the result of a drainage system improvement.
   - Any public drainage system improvements shall include mitigation of downstream degradation of water quality and stream bank stability caused by the improvements. The cost of mitigation, including the addition of water storage, shall be assessed to the directly benefited parties in the watershed.
   - Require monitoring by Drainage Authorities of public drainage outlets to natural surface waters in watersheds having more than 30% agricultural land, and require them to meet water quality goals in accordance with any WRAPS in those watersheds as a result of impairments. Assessments by the Drainage Authority would be used to cost share restoration and mitigation, such as building water storage structures or installing bioreactors. This is a targeted approach that focuses action on the areas in watersheds with the most water quality problems.

b. Implement a set of regulations that can reduce flow rate and volume, and nutrient and sediment transport, through artificial drainage. Measures could include:

- Require permits for all new tile installation. Charge a fee and use as described below.
- Link permit approval to performance measures. Drainage design (depth, spacing, etc.) should be taken into account. For water quality improvements, require installation of conservation best management practices that limit volume and dissolved nutrients in tile effluent on tile outlets. Start with requirements on new tile only and phase in over time to include legacy drainage systems. These requirements could be incorporated into WRAPS nutrient reduction goals and targeted to watersheds with drainage-related impairments. Approval could be linked to the drainage coefficient. The Bois du Sioux watershed has adopted such a measure that uses the design drainage coefficient to regulate new tile.
- Use new tile permit fees to support technical assistance to producers and/or to retrofit existing tile systems.

B.2. Goal – Reduce magnitude and duration of peak water flows. High intensity, high volume precipitation events largely bypass subsurface tile drainage (infiltration rates are limiting when soil is saturated) and move across the surface quickly to ditches and streams carrying excess nutrients and sediment. This excess surface flow, as well as high rates of subsurface tile flow, commonly occurs in spring (April-June).

a. Consider incentive measures for surface water storage to reduce flows and help improve water quality. In addition to increasing spring evapotranspiration through cover crops and perennial crops, practices for surface water storage include water and sediment control basins, constructed and restored wetlands, ponds, terraces, weirs, etc. (see "Fields to Streams"). It should be noted that while water storage remedies have been shown to be highly effective for reducing flows and nutrients, there are significant barriers to scaling them up spatially to make a difference at a statewide level.

C. Incentivize Changes through Producer Certification Programs

Minnesota is one of the few states that have implemented an Agricultural Water Quality Certification Program (AWQCP). Salon participants were generally in agreement that the program has some deficiencies that need to be addressed, but it presents an opportunity to build on an existing program and improve it, rather than start from scratch. In addition, there are other state and federal programs that can be used to change producer behaviors resulting in better water quality. These programs can address many strategies in a coordinated manner, including nutrient management, water management, and cropping system changes. However, certification programs must have standards that are clear and transparent, and are directly linked to the goal of water quality improvement.

Long Term Expected Outcomes: Expanded certification programs, linked to agricultural supply chain purchases and requiring demonstration of water quality outcomes, will result in far greater participation and measureable improvements in water quality. Co-benefits will include expanded diversity of crops, transitioning new crops into the corn/soy rotation, and better water management.

Timeframe: Changes and improvements to the AWQCP could begin immediately and be implemented over several years. Once improvements are made to the AWQCP, then expanding

participation and linking certification to the supply chain should follow. Water quality benefits will accrue after that.

C.1. Goal – Raise the certification threshold in the AWQCP to achieve water quality improvement goals. Align the scoring for certification with the NRCS Water Quality Index, to allow for harmonization with regional and national certification programs. (*High Priority, High Investment*)

a. Refine scoring such that farms which continue to contribute to impairments cannot be certified. Tie the certification threshold to meeting WRAPS load reductions in a given watershed. Provide credits in scoring for converting corn to perennial production, and require perennial crops and/or living cover crops be present on some minimal degree on the land to receive certification. The certification tool should be able to address BMP effectiveness for different climate, landscapes, soils, and management systems. The Minnesota Department of Agriculture (MDA) should convene a balanced public-private committee consisting of agricultural commodity purchasing company technical representatives, UMN agriculture and water resource specialists, and agriculture industry technical representatives to evaluate and make recommendations to improve the Water Quality Index scoring to meet state interim and long term water quality goals at the individual farm level. Research is needed to verify the accuracy of the certification tool. Specific modifications may include:
   - Change score for nitrogen and phosphorus application to align with the Natural Resources Conservation Service (NRCS) Water Quality Index (WQI) scoring protocol.
   - Change score bonus/penalty for artificial drainage to align with the NRCS WQI scoring protocol.
   - Require that tile water treatment practices be in place on all certified farms with installed drain tile.
   - Ensure that scoring incentivizes adoption of cover crops.
   - Ensure that scoring rewards practices that indeed address key pollutants of concern.
   - Adjust certification contract time to allow for progressive improvements.

b. Phase in new requirements from C.1.a above. Require them for new applicants after a certain date and for currently certified producers as their 10-year contract expires.

C.2. Goal – Enhance participation by providing additional incentives.

a. Expand the value of certification to encourage greater producer participation. Link certification to the supply chain – especially high value premium consumer crops. In other words, work with supply chains to purchase crops from certified producers only.

b. Incentivize landowners to certify their rented lands. Provide financial incentives to landowners to minimize financial impacts on renters (e.g. discourage landowners passing costs on to renters by increased rental rates).

c. Provide agricultural lenders a tax deduction for loans to AWQCP certified producers.

C.3. Goal – Expand and leverage the agricultural supply chain using the Field Stewards program.

Field Stewards is a market based incentive program for water quality protection in the commodity crop supply chains. Participation is based on the AWQCP standard. Any expansion of the Field Stewards program should wait until the AWQCP is improved as per C.1. above. Participating food companies purchase certificates to offset the water quality impacts of their products. Farmers who have been certified by the AWQCP can enroll their acres with Field Steward and receive direct payments for those acres. The concept is similar to renewable energy credits ("RECs"); an acre of certified crop land is essentially a "REC" for water quality on commodity crop acres. The long term goal is to create a third party water quality certification for commodity crop inputs with robust guidelines and clear claims that allow consumers to support brands that help support water quality.

The Field Stewards program would like to develop a national standard for crop production across the Midwest. Furthermore, the standard needs the ability to be updated to accommodate new production systems (perennials and pasture) or other changes. Eventually, we recommend that Minnesota lead an effort to harmonize national certification programs and sustainability efforts such as the "Field to Market" program and regional efforts such as Midwest Row Crop Collaborative. Pilot programs could be developed with Minnesota food companies and producers to develop the implementation specifics of existing national frameworks. A national program would be preferable to a hodgepodge of state certification or sustainability programs.

VII. CONCLUSION

Minnesota has the unique opportunity to demonstrate an interagency and transdisciplinary approach to agricultural water quality challenges. Salon Participants brought forth ideas seeking to balance the demands for agricultural production efficiencies with the actions necessary to move the needle on water quality. The priorities that emerged are to diversify the cropping system to include more perennials and incentives to develop markets for these new crops, encourage the Governor to work for improvements to the next federal Farm Bill, offer specific changes to regulations that would improve water management from drainage tile and finally, encourage the Governor to build on the AWQCP to make it work for water quality improvements statewide. We present these priorities to the Governor for his consideration as we continue to work towards a Clean Water Legacy for Minnesota.

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APPENDIX A. Salon Participants

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The Salon Participants engaged in structured discussions and input gathering activities during the Salons and had opportunities to comment on earlier drafts of this report. However, the UMN Water Resources Center assumes the sole responsibility as the author of this report; endorsement of particular statements by any given participant is not implied. One participant requested anonymity.