Iowa Nutrient Reduction Strategy
A science and technology-based framework
to assess and reduce nutrients to Iowa
waters and the Gulf of Mexico

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Why? And why now?

• Iowa’s productive soils and cropping systems also contribute to water quality concerns
• Society and EPA expect more from cities, industry and agriculture
• Gulf Hypoxia Task Force requires plan to reduce N and P load to Gulf by 45%
• EPA requests strategy that emphasizes state implementation of new and existing N and P practices for point and non-point sources

Iowa has several streams and lakes listed as impaired waters. The Gulf of Mexico is a natural resource that is being impacted by excessive nutrients that arrive from the rivers that feed into it. The hypoxic or “dead zone” is an area in the Gulf that lacks oxygen and life. The corn and soybean system is “leaky” and Iowa’s high organic matter soils will lose nitrates even without fertilizer.
• There are several lawsuits against EPA for not enforcing the Clean Water Act, including one in the Mississippi River Basin. In the Chesapeake Bay, after many years of voluntary programs, EPA is increasing regulations.
• In 2008 the Gulf Hypoxia Task Force required each state on the Mississippi to develop a strategy by 2013 to reduce N and P loading to the Gulf.
• March 16, 2011 “Stoner Memo” from EPA outlined an 8-point framework that emphasizes state level implementation of new and existing practices and technologies to address N and P for point and non-point sources.
Iowa is a significant contributor of Nitrogen and Phosphorous to the Gulf of Mexico.
Voluntary because one size does not fit all and it is very costly to police. The strategy is based on sound science from research in Iowa and surrounding states with similar climate, soils and cropping systems to assure the results are applicable to Iowa.

This is the first time point sources (cities and industries with wastewater treatment plants) and nonpoint sources (mainly agriculture) have worked together on a common strategy. Too often the approach has been finger pointing and blaming the other. There are 102 of the largest cities with 55-60% of Iowa’s population and that treat 80% of Iowa’s wastewater, plus 28 industrial facilities that have high volumes of N and P.

The science assessment quantifies the amount of N and P load reduction per acre we should expect from adoption of practices. Then we can document the number of practices installed and number or acres protected. Using the ISU model we can aggregate across practices and across the state to estimate the load reduction.

The science assessment is based on published research results in, and applicable, to Iowa. As new technologies and practices emerge, research will be conducted to quantify the N and P load reduction and the cost estimates to provide farmers and society confidence, if adopted.
How it was developed

• Led by IDALS and IDNR with input from point and nonpoint source stakeholders who will make the investments to reach the goal
• The Science Assessment was led by ISU with scientists from IDALS, IDNR, USDA-ARS and NRCS, and other institutions
• Point source technical assessment by wastewater engineers and cities

• IDALS and IDNR with a small group representing wastewater plants and agriculture developed the policy document.
• Nonpoint source Science Assessment team included 23 individuals who spent two years evaluating published research and using their collective professional judgment to identify the list of practices. The team also estimated the number of applicable acres for each practice by Major Land Resource Area (MLRA). A model was developed that incorporates the practice effectiveness and adoption rate by MLRA and aggregates the load reduction at the state level.
• Point sources based the limit of technology on the biological removal rate for all plants.
What’s in the strategy?

- New responsibility for Water Resources Coordinating Council (WRCC)
- Watershed Prioritization & Goals
  - HUC 8s and 12s and determine goals
- Setting Priorities
  - Coordination & target watersheds and programs
  - Pilot projects
  - Explore nutrient trading

- Prioritization of watersheds – Water Resources Coordinating Council (WRCC)
  - HUC 8s (large watersheds) and HUC 12s (small watersheds)
  - Determine watershed goals – WRCC
- Setting Priorities
  - Conservation programs – coordinate focus to targeting nutrient reduction to waters, increase program delivery in straight-forward, flexible manner
  - Balance in-field and off-field practices – to optimize reductions of nutrients to waters
  - Establish small watershed pilot projects
  - Explore nutrient trading/innovative approaches
What’s in the strategy?

• Research and Technology
  – Encourage innovation, then validate
  – Public and private research and funding

• Improve Outreach, Education, Collaboration
  – Public-private partnerships and leadership
  – Enhanced role for CCAs
  – Identify market-driven solutions
  – Collaborate with other states

• Research and Technology
  • Policy framework that facilitates new technologies and creative solutions
  • Enhanced and consistent funding to develop new technologies, private-sector entrepreneurial opportunity for new technologies, sustained public funding of research
  • Support advancing the science of Gulf hypoxia

• Strengthen Outreach, Education and Collaboration
  • Enhanced public and private-sector roles – leadership, new technologies and services
  • Enhanced role of CCAs – consulting, advisory services, accountability and certification
  • Build broader awareness and information to farmers and landowners
  • Identify market-driven solutions to achieve nutrient reduction practices
  • Collaborate with other Mississippi River states, share information, experiences
What’s in the strategy?

• Increased Public Awareness and Recognition
  – Watershed and farmer recognition
  – Marketing and education campaign

• Funding
  – Effective use of existing programs
  – WRCC work with state to secure funds

• Accountability and Verification Measures
  – Framework to track progress
  – Establish reporting system for practice adoption

• Increased Public Awareness and Recognition
  • Watershed or farmer recognition program
  • Iowa Farm Environmental Leader Award program, nearly 70 recognized at Iowa State Fair in 2012
  • Statewide marketing and public education campaign

• Funding
  • Effective use of funding resources, rely primarily on existing or re-allocated funding sources initially
  • WRCC make recommendations to executive and legislative branches on most effective use of limited resources

• Accountability and verification measures
  • Develop new and expanded frameworks to track progress, beyond water quality monitoring
  • WRCC will collaborate with ISU nutrient science assessment team to support success measurement
  • WRCC will establish public-private reporting system that documents nutrient and conservation practice adoption
• Science team met twice a month for nearly two years to develop assessment.
Science Assessment

- Establish baseline – existing conditions
  - Major Land Resource Areas used to aggregate conditions
- Extensive literature review to assess potential performance of practices
  - Outside peer review of science team documents (practice performance and baseline conditions)
- Estimate potential load reductions of implementing nutrient reduction practices (scenarios)
  - “Full implementation” and “Combined” scenarios
- Estimate cost of implementation and cost per pound of nitrogen and phosphorus reduction
- Organized by Major Land Resource Area. Similar soils, topologic and cropping systems within MLRA.
• There is not a record of fertilizer application. This estimate method used County Based estimates from David et al. (2010) as base and adjusted for fertilizer for turf, nitrogen availability of manure, and manure from pastured livestock.

• Estimated average application rate is above the university recommended rate. Estimated application rates differ by MLRA.
• Estimated soil test phosphorous (STP) based on soil samples sent to the ISU soil lab.
Practice Review Process

- Extensive review of literature from Iowa and surrounding states
  - Used Iowa and surrounding states to try to have similar soils and climatic conditions
  - Reviewed and compiled impacts on nitrogen and phosphorus concentrations and loads
  - Reviewed and compiled impacts on corn yield
- Summarized expected practice performance
There are few practices that have a meaningful impact on reducing both N and P because the nutrients have different modes of transportation.
In-field practices are annual management practices. Rate, source and time of application have small average reduction and wide variability of effectiveness. N inhibitor is compared to applying N when soils are 50 degrees and cooling. Rye cover crop was used because of availability of research data.

Edge-of-field technologies have large upfront costs and relatively low annual costs. Higher and more predictable effectiveness. Large buffer number applies to the water that intersects the root zone of the buffer.

*Load reduction not concentration reduction

**Concentration reduction of that water interacts with active zone below the buffer

- Land-use changes reduce N loss because N is not added and is taken up by plants. Capturing income on these areas is difficult.

- In general:
  - Practice reductions not necessarily additive. For example, cover crop reduces N 31% before water gets to wetland which reduces the remaining N another 52%.
  - Other than cover crops, the average N reduction is relatively small and variability is wide. Biological systems are complex with lots of variables.
  - Taking land out of crops does not prevent N loss. Iowa soils are highly organic and release N with water movement.
This graph shows the relationship between N application rate (bottom axis) and Nitrate concentration is tile lines. The impact on N loss from a change in application rate depends on the starting point.

The reality is that we do not have good data on application rates so we don’t know the starting point or how much rates change on what percent of the acres. Confidential data measured on a watershed level is one of the recommendations.
• The Maximum Return To Nitrogen (MRTN) rate calculator is a tool developed by Land Grant University agronomists. It calculates the optimal amount of N to apply based on corn and N fertilizer prices. It also reports a range around the optimal.
• The science team used $5/bushel corn and $0.50/lb N prices in the estimation of recommended fertilizer rates.
• One challenge with the MRTN as the recommended level of N application rate is determining what price of corn and N to use for comparison purposes. This table shows that as the ratio of corn price to N price decreases, the MRTN rate increases.
• The estimated current N application rate including manure is near the upper end of the MRTN range.
• In-field: No P applied to soil with high or very high soil test P (STP) levels. Switching from conventional to conservation tillage or to no-till. Cover crops reduce erosion.
• Edge-of-field: buffers along streams.
• Land-use changes reduce P loss through reduced erosion. Capturing income on these areas is difficult.
• In general:
  • Easier to achieve P goal than N goal.
  • Higher average reductions, but still wide standard deviation.
The strategy and science assessment focus on field-to-stream transport of P and not P from stream bed and bank. What this means is that farmers can make significant reductions in field-to-stream P movement and have relatively little reduction in P reaching the Gulf, as P is moved from one place in the stream or river to another further downstream.

**Note**

- Phosphorus assessment does not include stream bed and bank contribution – this is a symptom of hydrologic change brought about by alterations in land use and stream straightening and channelization.
Reaching the 45% goal

- Point sources achieve maximum biological removal rate: 4% N and 16% P
- Nonpoint source goal becomes 41% N and 29% P to achieve 45% goal for Iowa
- Requires high adoption of full suite of practices to reach the goal
  - Not simple
  - Not impossible

Point and nonpoint sources work together to achieve state goal.
- Point sources remove N and P to the limit of technology.
- Nonpoint sources work to achieve the remainder
- The goal is difficult, but achievable
  - No silver bullets; few, if any, win-win solutions
  - Requires high adoption rate of many practices to reach goal
Cost Estimation

• Focus on farm-level costs
• Some practices have recurring annual cost and some have primarily an up-front cost
• Equal Annualized Cost approach used with a design life of 50 years and discount rate of 4%
• When appropriate, considered cost of the practice and impact on corn yield
• Cash Rental Rate Survey used if land taken out of production

• Farm cost only. No overhead or agency cost to implement. No benefits from improved water quality.
• Annual cost examples: cover crops (seed, burn down, yield drag), savings of reduced fertilizer application, rent on buffers etc. Up-front cost examples: wetlands, bioreactors, installing buffers, etc.
• Equal Annualized Cost includes the annual operating cost plus the annualized cost of the initial investment. Life of structures are equalized to 50 years.
• Corn yield examples: positive yield from switching from fall to spring N assuming same application rate; negative example from rye cover crop yield drag on corn crop.
• Cash rent calculated on MLRA on land taken out of production.
• Examples for illustration only, not for recommendation. It shows that to achieve the 41% N and 29% P targets for nonpoint source, it will require a high adoption rate of several practices.
• Remember that Equal Annualized Costs (EAC) includes the annualized initial investment, so you cannot add initial investment and EAC.
Examples for illustration only, not for recommendation. It shows that to achieve the 41% N and 29% P targets for nonpoint source, it will require a high adoption rate of several practices.

Remember that Equal Annualized Costs (EAC) includes the annualized initial investment, so you cannot add initial investment and EAC.

The low EAC for this example is due to no P application on soils that have high or very high soil test phosphorous. That savings helps pay the costs of the other practices in this statewide example.

- The farmer then makes a large initial investment, may not have high STP and thus will not get the P cost savings.
- If high STP is due to manure application, the livestock farmer may have higher cost to move manure to additional fields.
• Remember that Equal Annualized Costs (EAC) includes the annualized initial investment, so you cannot add initial investment and EAC.
• These three examples provide a range in costs from low initial investment with high EAC to a high initial investment with low EAC.
• The low EAC for this example is due to no P application on soils that have high or very high soil test phosphorous. That savings helps pay the costs of the other practices in this statewide example.
  • The farmer then makes a large initial investment, may not have high STP and thus will not get the P cost savings.
  • If high STP is due to manure application, the livestock farmer may have higher cost to move manure to additional fields.
Future Needs

• Better tracking of practices currently in place, plus put in place in the future
• Discover and validate technologies and practices
• Understand and monetize economic benefits of improved water quality or other ecosystems services.

• Land use, crop rotations, nutrient applications, tillage, and conservation practices. What is our starting point and how do we verify adoption of practices?
• Encourage innovation and have a system in place to do research to prove the effectiveness and costs.
Future Needs - N

- Variable nitrogen rate application
- In-season sensor-based nitrogen application
- Nitrogen and manure additives, inhibitors, and slow release products
- Better estimates of actual nitrogen application rates (including fertilizer and manure), and on a geographic-specific basis.
- Two-stage ditch designs
- Directing tile drainage water through riparian buffers

These are examples of technologies that exist today or that are coming into practices. However, we do not have research about their impact on N reaching surface waters of the state.

Farmers may invest in these practices for economic reasons, but before farmers invest thinking they will have a water quality impact, or before the state strategy recognizes them as effective, there needs to be research about their effect.
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Where to start

• Learn more about the Strategy and comment by January 4, 2013 at www.nutrientstrategy.iastate.edu
• Consider the practices outlined
  – What makes sense in your farming operation
  – How can you support adoption

• The full Iowa Nutrient Reduction Strategy is available at this website. View online or download parts or all. The Executive Summary and Policy statement is approximately 20 pages. The summary of the nonpoint source is the first 9 pages of the Science Assessment. The point source document is 16 pages. Leave comments at the site or mail them to Nutrient Reduction Strategy, ANR Program Services, 2101 Agronomy Hall, Ames, Iowa 50011-1010.
• Document what you are doing now and think about which practices make sense on your farm.
Why is strategy important?

- Based on sound science in Iowa, for Iowa
- Meaningful and measureable progress
- Builds on current programs and targeted watersheds
- Progress and success avoids regulation
- Improves water quality in Iowa and Gulf

• Strategy was developed by Iowa point and nonpoint source stakeholders who will have to make the investments to achieve the goals. Science assessment based on research applicable to Iowa.
• Practice based strategy is tangible and allows for proof of progress. Model will be compared to long term monitoring.
• Improves coordination of existing programs across agencies. Prioritizes watersheds and encourages pilot projects and innovation.
• EPA embraces practical approach where the state emphasizes implementation and rewards progress toward goal.
• Benefits Iowa water quality and the Gulf.