Iowa Nutrient Reduction Strategy Annual Progress Report

Prepared by:
Iowa Department of Agriculture & Land Stewardship,
Iowa Department of Natural Resources,
Iowa State University College of Agriculture & Life Sciences
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Reporting Period:
June 1, 2015 through May 31, 2016

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Highlighted Partner Updates

Water Quality Monitoring

IIHR—Hydroscience and Engineering deployed 30 nitrate sensors in the 2015 calendar year, and 45 in 2016.

The Iowa Department of Natural Resources (DNR) coordinated a collaborative paper to review the current network of water quality monitoring across Iowa (publication forthcoming).

NRS Measurement

12 member organizations of the Water Resources Coordinating Council and the Watershed Planning Advisory Committee and 4 other partners submitted reports on funding and efforts. These data contribute to tracking of Nutrient Reduction Strategy (NRS) progress.

The three-year NRS Measurement Pilot Project commenced, and has begun evaluation of protocols for improving NRS tracking.

A public-private partnership was formed between Iowa State University (ISU) and the Iowa Nutrient Research and Education Council (INREC) to tackle data challenges by surveying in-field practices through agricultural retailers and crop advisors.

A conservation practice mapping project conducted by DNR, Iowa Department of Agriculture and Land Stewardship (IDALS), and ISU has digitized over 9 million acres to map structural practices including terraces, ponds, grassed waterways, and water and sediment control basins.

Point Source Updates

DNR has issued permits to 86 point source facilities, up from 54 reported last year. The NRS requires permits for 149 facilities.

Water quality data are obtained from 41 publicly owned treatment works, up from 13 last year.

New Awarded Funding

Collaborative efforts have resulted in new funding availability for the 2017 reporting period, including:

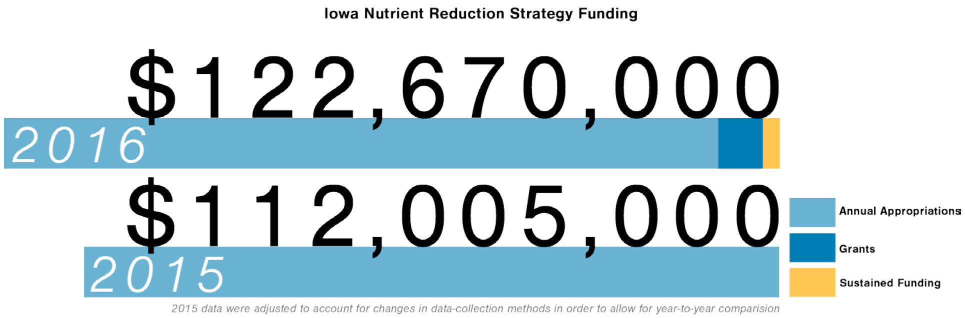
- $96.6 million from the U.S. Department of Housing and Urban Development for a five-year project focusing on flood mitigation and nutrient reduction.
- The Regional Conservation Partnership Program (RCPP), under U.S. Department of Agriculture, has awarded $9.5 million to the Midwest Agriculture Water Quality Partnership for conservation demonstration projects.
- An urban-rural partnership led by Charles City was awarded $1.6 million from RCPP to support the Rock Creek Watershed.

NRS Research

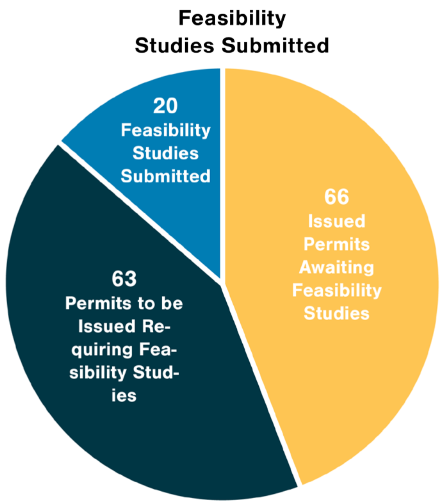
Three projects funded through the Iowa Nutrient Research Center have been completed. These projects shed light on the scientific processes behind nutrient loss and the effects of conservation practices.

Tracking Progress

Inputs



Approximately $10 million more in Nutrient Reduction Strategy (NRS) funding was reported by partner organizations for the 2016 reporting period than in 2015. The majority of this funding was sourced through annual appropriations, allowing for some predictability. Future analyses will explore the future availability of these programs and the capacity for accelerated NRS implementation. These figures do not account for Conservation Reserve Program rental payments, which totaled $225 million in 2016.

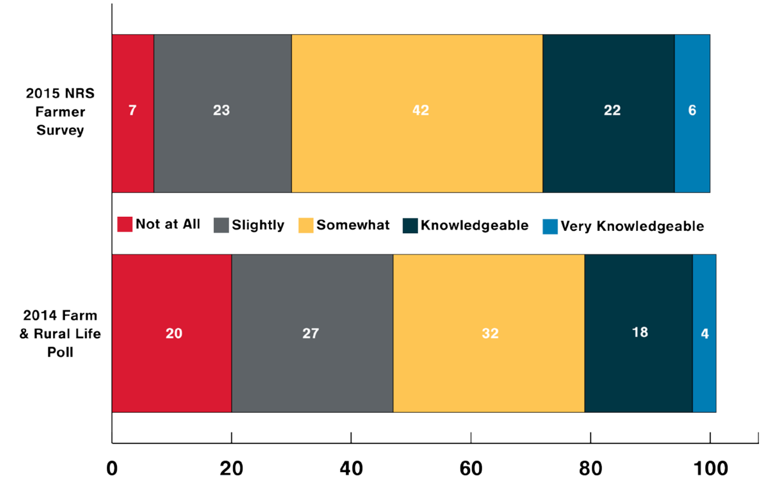


For the 149 wastewater treatment facilities currently listed in the NRS to receive new permits and conduct feasibility studies to explore improved technology and nutrient removal systems, 86 permits have been reissued. 20 facilities have submitted feasibility studies. 63 facilities remain.

Human

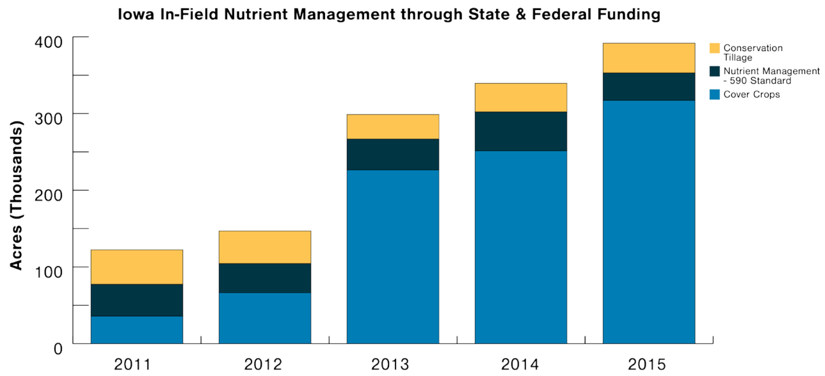
2015 Outreach Efforts			
	Number of Events	Average Attendance	Total Reported Attendance
Outreach (fairs, tours, community education)	98	140	14,375
Field Days	57	41	4,159
Workshops	19	34	1,172
Conferences	4	291	1,281
Total	**178**		**20,987**

In the 2016 reporting period, 178 outreach and education events were conducted by partner organizations. These events brought in approximately 21,000 attendees in total.



Early analyses of a new survey project showed a potential increase in knowledge of the NRS, when compared to an identical question asked in a 2014 survey. While these two surveys were conducted with different sampling techniques and should not be compared directly, the recently started farmer survey will continue for five years and will allow for more robust findings in the future. Additionally, this survey project will provide a greater understanding of how NRS knowledge affects farmers' attitudes and behavior related to nutrient management and water quality.

Land



State and federal cost-share programs provide financial assistance for applying nutrient-reducing practices on agricultural fields. Cover crop adoption has increased dramatically since 2011, showing some promise for further adoption. The NRS suggests that millions of acres of cover crops may be necessary to meet nutrient reduction goals, so this progress only scratches the surface.

In-field nutrient management practices are used by farmers outside of government financial programs. Efforts are underway to establish new protocols for collecting these data and painting a more complete picture of conservation in Iowa.

Selected Edge-of-Field Practices Installed Through Public Funding		
	2014	2015
Wetlands, CRP (acres treated)		99,309
Bioreactors (acres treated)	676	838
Terraces (feet)	16,076,690	19,821,659
Water and Sediment Control (#)	18,609	19,321

The table above displays current understanding of edge-of-field practices installed though cost-share programs. However, the units are inconsistently reported and the data are, in some cases, inaccurate. Collaboration is occuring between partners to address these data needs. Also, a project that maps various structural practices through aerial imagery is underway to record a baseline of Iowa's conservation efforts.

Water

Nutrient Load Reduction from Select Conservation Practices (lbs)		
	2014	2015
Nitrogen - Total		**3,830,000**
Cover Crops		2,356,000
CREP Wetlands		1,474,000
Bioreactors		6,000
Phosphorus - Total	**134,947**	**217,884**
Cover Crops	112,518	196,967
No Till	10,622	14,229
Reduced Till	345	7
Extended Rotation	1,463	6,680
Phosphorus - annual CRP fluctuations	-104,134	+56,311

Statewide nitrogen and phosphorus load reductions were calculated with a modeled estimate by factoring in the practices conducted through cost-share programs. Only selected practices could feasibly be incorporated into the calculations at this point, but improved practice data collection and development of appropriate units for the data will improve future calculations. The selected practices account for approximately 0.6 percent reduction in both nitrogen and phosphorus in 2015, when compared with the baseline estimates established for the NRS.

New data from wastewater treatment facilities' monitoring show substantial levels of nutrient removal and will contribute to improved understanding of point source contribution to Iowa's nutrient loads. (Table 11, page 33)

Introduction

The Iowa Nutrient Reduction Strategy (NRS) is a research- and technology-based approach to assess and reduce nutrients delivered to Iowa waterways and the Gulf of Mexico. The strategy outlines opportunities for efforts to reduce nutrients in surface water from both point sources, such as wastewater treatment plants and industrial facilities, and nonpoint sources, including farm fields and urban areas, in a scientific, reasonable, and cost-effective manner.

The NRS was developed in response to EPA recommendations provided in their March 16, 2011, memo, "Working in Partnership with States to Address Phosphorus and Nitrogen Pollution through Use of a Framework for State Nutrient Reduction." The Annual Progress Report provides updates on point source and nonpoint source efforts related to action items listed in the elements of the strategy and updates on implementation activities to achieve reductions in nitrogen and phosphorus loads. The NRS documents, including each year's annual progress report, can be accessed at http://nutrientstrategy.iastate.edu/.

Partners

The NRS and the annual progress report are collaboratively written by representatives of Iowa State University College of Agriculture and Life Sciences (ISU-CALS), Iowa Department of Natural Resources (DNR), and Iowa Department of Agriculture and Land Stewardship (IDALS). The Water Resources Coordinating Council (WRCC), a body of governmental agencies to coordinate around water related issues in the state, is presented with the annual progress report each year. Additional partners comprise the Watershed Planning Advisory Council (WPAC), which includes private organizations and non-governmental organizations. These partners, among others outside of WRCC and WPAC, voluntarily contributed valuable data that provided the basis for analysis of NRS funding, staff, outreach, and water monitoring to track efforts that have been conducted during the 2016 reporting period.

The logic model approach

The 2015 progress report introduced the "logic model" framework as the basis of considerations set forth by the WRCC Measures Subcommittee. The Logic Model is guided by measurable indicators of desirable change that can be quantified, and represents a progression towards goals for achieving a 45 percent reduction in nitrogen and phosphorus loads. This development of a measurement framework assists the annual reporting process, which was recommended by the 2011 EPA memo.

A significant reduction in nutrient loads is the ultimate goal of the NRS, and is represented by the right-most category of Figure 1. In order to affect change in water quality, there is a need for increased inputs, measured as funding, staff, and resources. Inputs affect change in outreach efforts and human behavior. This shift toward more conservation-conscious attitudes in the agricultural community is a desired change in the human dimension of water quality efforts. With changes in human attitudes and behavior, changes on the land may occur, measured as conservation practice adoption and wastewater treatment facility upgrades. Finally, these physical changes on the land may affect change in water quality, which ultimately can be measured through both empirical water quality monitoring and through modeled estimates of nutrient loads in Iowa surface water. The measurable indicators that correspond to each category provide quantified parameters in which to track year-to-year changes and continual trends to develop a standardized protocol for evaluating NRS progress.

In measuring progress of the NRS, the logic model serves as a comprehensive reporting tool to inform data collection, indicator development, and assessment of the successes and challenges associated with reducing nutrient loads from point and nonpoint sources. The logic model guides the assessment of not only a progression of changes, but also can inform improvements in each of the four primary categories. With continually refined measurement of each category, potential adjustments may be made to the inputs and efforts that partner organizations devote to the NRS in order to impact change over time.

Challenges associated with measuring change

Measuring NRS progress is a complex undertaking that is accompanied by a variety of challenges, a few of which are outlined here. First, measurable indicators that direct change toward the end-goal must be identified. In the case of the NRS, measurement efforts assess a wide variety of factors that are impacted by many stakeholders. In an effort to develop indicators that represent meaningful change in each logic model category, each indicator was evaluated based on available data, the trends or year-to-year changes that can be used to evaluate progress, and whether the indicator can inform management if progress is not made.

Second, data availability to accurately assess progress in each category of the logic model is a hurdle. For example, current analyses—as discussed in the "Land" section of this report—rely on public cost-share data to evaluate conservation practice adoption on agricultural land. There is limited knowledge of the extent to which farmers employ conservation without public financial assistance, but efforts are currently underway to capture this critical information.

The 2016 reporting period kicked off the three-year NRS Measurement Pilot Project, which aims to develop protocols for measuring annual progress of the NRS. As part of this project, ISU-CALS has partnered with the Iowa Nutrient Research and Education Council (INREC). INREC, a collaboration of agricultural businesses, organizations, and industries, will solicit information from agricultural retailers across Iowa who provide services to crop producers with a goal of gaining more insight into farmers' in-field nutrient management decision-making. These efforts will aim to address the challenges associated with reliable tracking of in-field practices, such as cover crops and fertilizer management.

The following sections discuss the evaluation of NRS logic model indicators and the progress that was made in since June 1, 2015. While indicators of each category and the related data sources are discussed, these factors are continually under evaluation and may be subject to change in the future.

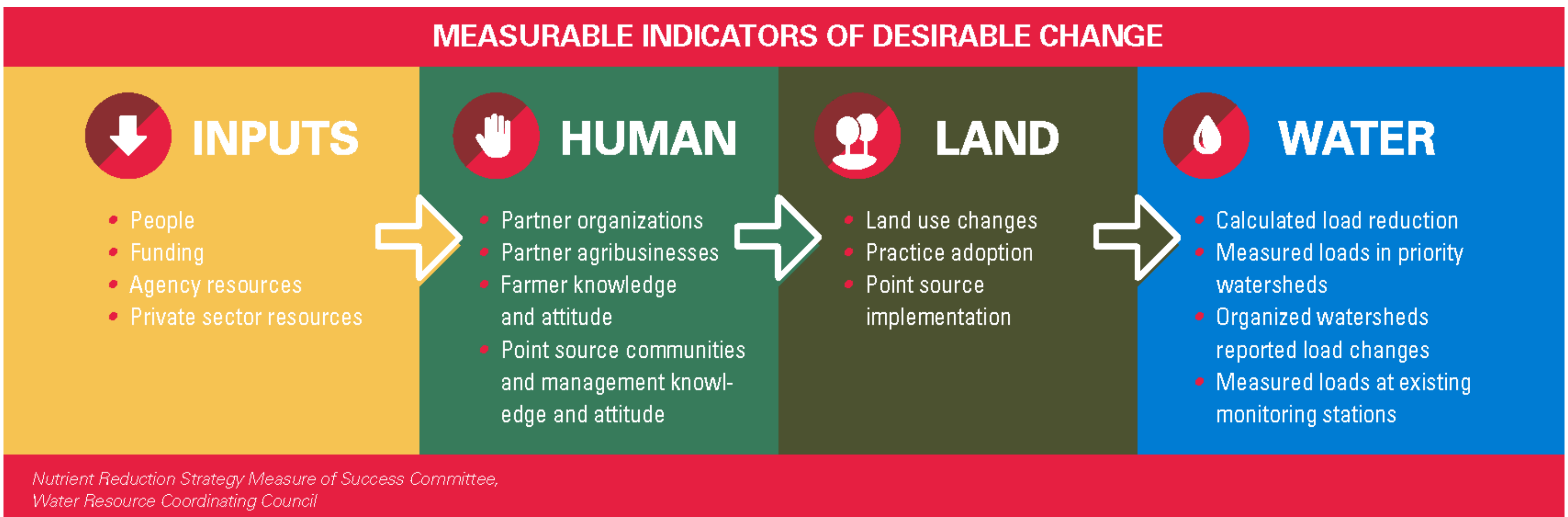


Figure 1: The logic model of the Iowa Nutrient Reduction Strategy, guided by measureable indicators of desirable change.

Inputs

Inputs represent the earliest indicators of change in Iowa's efforts to improve water quality within the state and downstream. Increase in inputs are necessary to encourage changes in human behavior and to promote water quality improvement and conservation in Iowa. Progress of the NRS is measured, in part, through the documentation of partnerships, annual funding, staffing, and continued sociological and scientific research. Positive changes in these indicators from year to year demonstrate initial progress of the NRS.

Partnerships

Collaboration, knowledge-sharing, and participation have been identified as necessary components to the NRS's integrative approach to reducing Iowa's nutrient load. These factors are difficult to quantify, so they are reported qualitatively; more quantitative methods of assessment are under examination.

At its core, the NRS framework and annual reporting are led by the Iowa Department of Natural Resources (IDNR), Iowa Department of Agriculture and Land Stewardship (IDALS), and Iowa State University College of Agriculture and Life Sciences. However, many other partnerships are vital to the implementation of the NRS, particularly those that cross the private, public, and civil sectors. Many of these partnerships exist as partnerships in grant-funded projects. Informal partnerships have also formed, facilitated by NRS and the emergence of common goals. Still, since the initial introduction of the NRS in 2012, some of these partnerships have been formed as formal institutions and initiatives, as described in Table 1 (page 5).

Funding

The total estimated funding for information, education and implementation that was dedicated to NRS implementation in the 2016 reporting period was an estimated $122,670,000 (Figure 2).This figure encompasses public and private funding and was estimated from the voluntarily submitted reports of WRCC and WPAC member organizations and by other partner organizations that conduct work contributing to NRS implementation. Of this total funding, 98 percent was appropriated through public funds, and two percent through private funds. The public funding was comprised mostly of federal and state programs that provide financial and technical assistance for implementation of conservation practices, primarily administered in partnership with the local Soil and Water Conservation Districts. This summary does not account for or estimate the contributions of private entities, farmers, or landowners to match public resources. Neither does it account for those practices that are financed completely by the farmer or landowner.

While the level of public funding for NRS implementation in the 2016 reporting period accounts for the vast majority of total funding, private organizations and partnerships reported approximately $2,760,000 of funding for NRS efforts during the year. Much of

Measuring Partner Efforts

Beginning in the 2015 reporting period, organizations affiliated with the Water Resources Coordinating Council (WRCC) and the Watershed Planning Advisory Council (WPAC) reported their NRS-related funding and efforts to be included in the annual report.

This data collection method was continued, but adapted, in the 2016 reporting period. In this report, funding, staff, outreach efforts, and monitoring efforts were collected through a standardized data entry process. This method reduced duplication of reported inputs and efforts that are performed collaboratively. For example, a grant that was disbursed by one organization and awarded to another may be reported by both organizations, but double-reporting was minimized by obtaining specific information about different funding sources. Similarly, outreach events that were held by two partner organizations were treated with care to prevent double-counting of one event.

Partner organization reports are included as an appendix to the online version of this annual report.

Table 1: Partnerships that have been formed to support the implementation of the Nutrient Reduction Strategy.				
Partnership	**Mission and Description**	**Affiliated Organizations**	**Outcomes in 2016 Reporting Period**	**Contribution to Logic Model Measurement**
Iowa Nutrient Research Center	Regent's center established by legislature with the purpose to identify and improve nutrient reduction practices.	Iowa State University, University of Iowa and University of Northern Iowa	Funded 11 research projects addressing nutrient loss and understanding water quality in the field and landscape. www.nutrientstrategy.iastate.edu/center	Inputs Facilitates and supports continued scientific research.
Iowa Agricultural Water Alliance	Aims to foster partnerships between urban and rural stakeholders while identifying and leveraging resources for implementation of the NRS.	Iowa Soybean Association, Iowa Corn Growers Association, and Iowa Pork Producers Association		Human Organizes water quality-centered outreach efforts.
Iowa Nutrient Research and Education Council	A private nonprofit organization formed of broad representation across the agricultural industry and focused on measuring and demonstrating environmental progress, fostering innovation and development of new technologies, and enhancing crop advisor and ag retailer roles as "change agents" working with Iowa farmers to achieve environmental goals.	Board members represent all facets of the agricultural industry, bringing together major farm and commodity organizations, fertilizer and crop production companies, agricultural retailers, and crop advisors.	INREC has partnered with ISU in a three-year pilot project to explore how to measure Iowa farmers' progress in reducing nutrient loss from agricultural fields.	Land Developing measurement protocols for evaluating statewide adoption of in-field conservation practices.
Iowa Soil and Water Future Task Force	The group is outlining a comprehensive approach to address the state's water quality challenges, with layers of solutions that may include legislation, education, and technology. The solutions are intended to position Iowa agriculture, Iowa communities, and Iowa businesses as global leaders in water quality and soil health.	Thought leaders in business, agriculture, public policy, and academia. For a full list of participating organizations, visit http://www.capitalcrossroadsvision.com/iowas-water-future/	Presented the state of Iowa with a document of strategic implementation, direction, and recommendations related to successfully carrying out NRS goals. These recommendations can be accessed at http://www.capitalcrossroadsvision.com/iowas-water-future/	Inputs Evaluating and creating recommendations for strategic planning and measurement of NRS implementation.

this funding was sourced from commodity check-offs and organizations' membership dues.

In 2015, organizations reported aggregated estimates of funding that was appropriated for the NRS, totaling approximately $112 million. [While $105 million was actually reported in 2015, the figure presented here is adjusted to account for estimated funding from organizations whose inputs were not reported in the 2015 annual progress report.] The reporting method and data processing for this figure differed from those of the 2016 reporting period, and should not be compared directly, but the results suggest that funding for NRS-related efforts increased from 2015 to 2016. To improve measurement of NRS progress since the framework's introduction in 2012, efforts are underway to retroactively estimate annual funding for the years 2011 through 2015 using similar data collection methods as employed for this annual report.

The Conservation Reserve Program (CRP) comprises a substantial public source of funding for land retirement through rental payments. CRP funding in Iowa totaled $225 million dollars during the 2016 reporting period, as reported by the Farm Service Agency. This source of funding supports perennial plantings that contribute to NRS goals of nutrient load reductions.

Substantial sources of funding have been announced for the coming fiscal year, some of which will support multi-year projects. The following list contains highlights of new funding awards that can be expected for NRS progress in the 2017 state fiscal year.

- The U.S. Department of Housing and Urban Development has awarded IA agencies with a total of $96.6 million to conduct a five-year demonstration of flood mitigation and nutrient reduction. Over $30 million will be spent in watersheds for structures. One focus of the project is financial support for conservation implementation in the watersheds that have been declared disaster areas.
- A public-private partnership came together, led by IDALS, IAWA, and DNR to request funding through the USDA-NRCS Regional Conservation Partnership Program (RCPP). In 2016, the Midwest Agriculture Water Quality Partnership was awarded $9.5 million for expanded use of practices on conservation demonstration projects. The project will leverage $4.75 million in state funding and $33 million from the private sector. Totaling nearly $47 million, this funding will provide a substantial increase in available conservation resources in targeted watersheds and build private sector capacity to deliver conservation planning and technical assistance.
- An urban-rural partnership, led by the City of Charles City, has received $1.6 million from the RCPP to leverage existing efforts in the Rock Creek Watershed, where a farmer advisory board is working with local partners to advance practice implementation according to goals set in the Rock Creek Watershed Management Plan. The project will implement conservation practices in agricultural areas and will also conduct outreach activities through partners to increase adoption of practices.

Current challenge: The capacity for acceleration

The NRS serves as a foundation for improved partnership and collaboration for water quality in Iowa. This summary represents a vastly more comprehensive assessment regarding inputs that has ever been assembled before, providing much greater prospective on the current status of state and federal program delivery. This is also likely the first attempt in Iowa to quantify non-governmental investments in advancing water quality improvements. Though not complete, as detailed previously, this effort will continue to be refined and improved to gather additional information from other sectors currently not covered in this assessment. Due to the complexity and scope of various programs, efforts to implement the NRS will require greater collaboration among the partners to assess and prioritize which inputs—funding, staff, and research—will be needed to advance implementation in the future. The capacity for accelerating the availability of these inputs is a distinct challenge. Short-term, grant-based funding, constitutes approximately one percent of current NRS funding, as reported by partner organizations. Annual appropriations, as potentially more reliable sources of funding with some uncertainty surrounding year-to-year availability, account for 99 percent of NRS funding, as reported by partner organizations. Funding sources that are stable, predictable, and incrementally increased may help government agencies, non-governmental organizations, and private industry develop a greater capacity to hire staff, fund long-term research projects, and conduct multi-year education curricula to better implement physical changes that will reduce nutrient losses to surface water. In short, stability and predictability of funding sources, coupled with increased funding, can assist the acceleration of NRS implementation.

The challenge of developing capacity for implementation will exist even as increased funding becomes available. Reducing nonpoint and point source nutrient contributions will require technical assistance, practice design, and, in some cases, construction. New staff will need training, and private contractors will need to be available to review and implement the practices that must occur across Iowa's landscape in order to reach the goal of 45 percent reduction of nitrogen and phosphorus loss. Current efforts operate this way to some extent, but the challenge will be to scale up these efforts and to incorporate new practices that are not widely deployed. Multi-year watershed projects and others that are supported by state and federal programs are helping to address this need for increased infrastructure and capacity for NRS implementation, but continued increases in capacity will be necessary.

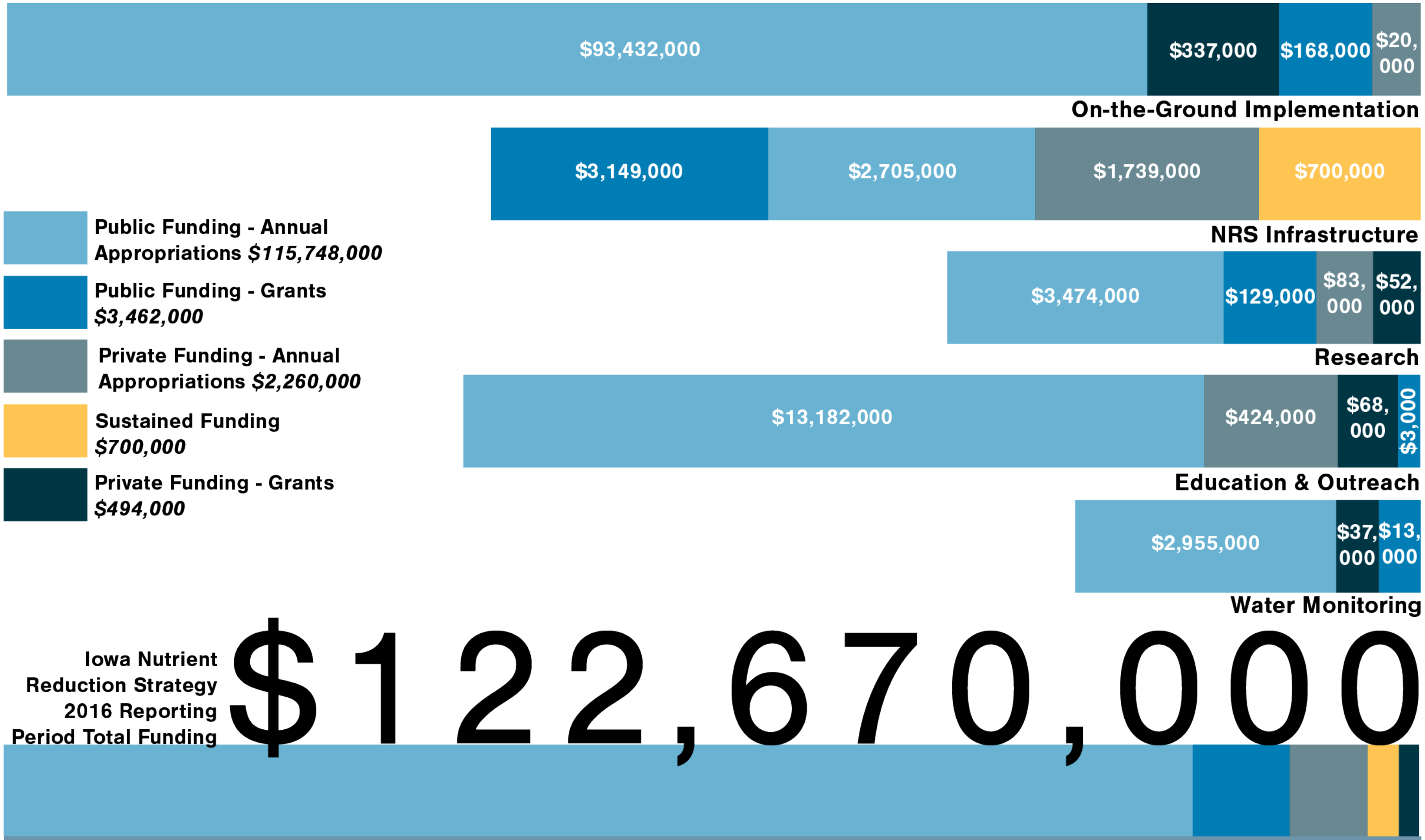


Figure 2: Funds supporting the Iowa Nutrient Reduction Strategy in the 2016 Reporting Period.

Staff

One indicator for NRS progress in Iowa is an increase in staff working to implement the strategy. There is a persistent need for administrative support, researchers, and technical staff including agricultural, conservation, and engineering specialists, for the continued installation of conservation practices in rural and urban landscapes.

Member organizations of WRCC and WPAC, as well as other partner organizations, reported having 226 full-time equivalent (FTE) staff members on NRS-related efforts (Table 2). Of these staff members, 124 comprise the infrastructure, or administrative and planning support, of the NRS. Eleven people comprise research staff, 80 conduct on-the-ground implementation of practices that reduce nutrient loss and improve water quality, and 11 were categorized as other forms of NRS support. Consistent with the analysis and discussion of annual funding, the personnel estimate cannot be compared directly to reports of staff in the 2015 reporting period. However, by counting only the staff that are funded directly by each reporting organization, duplication and peripheral data were minimized, and tracking of staff inputs will be conducted annually by this method.

Table 2: Nutrient Reduction Strategy Staff - 2016 Reporting Period			
FTE Staff For Infrastructure	FTE Staff for Research	FTE Staff for Implementation	FTE Staff for Other Areas
124	11	80	11
226 Full-Time Staff conducting work related to the NRS			

Current challenge: Accounting for contractors

Generally, the method by which organizations report the number of NRS-focused staff members accounts for permanent employees that are paid directly by the organization. This method fails to track a key component of Iowa's capacity for reaching NRS goals: contracted workers. The need for accelerated adoption of conservation practices to reduce nutrient contributions from point and nonpoint sources will require frequent hiring of contracted work. This need especially pertains to the installation of structural practices, such as terraces, bioreactors, and saturated buffers, which require skilled technical assistance, design, and construction. Options for measuring and tracking the extent of contracted work will be explored during the 2017 reporting period.

Continued water quality research

Continuation of research in the physical and social sciences will be necessary to better understand the processes driving and the conservation measures that can mitigate nutrient loss. It is difficult to quantify the research updates that address these knowledge gaps. In this section, a subset of research updates are discussed anecdotally, while more quantitative means of assessing progress in scientific research are under assessment.

The Iowa Nutrient Research Center (INRC) was established in 2013 by the State Board of Regents in response to legislation passed by the Iowa Legislature and signed by Governor Branstad. The center, administered by Iowa State University, is meeting the need for continued research and innovation to address Iowa's nutrient load concerns. Center research evaluates the performance of current and emerging in-field and edge-of-field practices, provides recommendations on implementing new or tested practices, and develops tools to aid decision-making in adopting effective management practices.

In 2015, the INRC funded 11 projects that address nutrient loss and aim to improve understanding of water quality in the field and landscape. Ten projects were funded in each of the previous two years. Of these research projects funded by the INRC, five projects have been completed; the private investigators have submitted impact reports as the final assessments. Of those completed projects, three have been summarized and made publicly available.

Measuring the effectiveness of stacked nutrient reduction practices

The objectives of this project were to work with Johnson County Soil and Water Conservation District to establish multiple NO3-N reduction practices within a sub-watershed of Rapid Creek; deploy stream-stage sensors and NO3-N probes at the outlets of the treatment sub-watershed and a control sub-watershed; and monitor continuous discharge and stream concentrations at the outlets of the paired sub-watersheds during a three-year deployment period to measure the effectiveness of stacked nutrient reduction practices to reduce NO3-N loads at the watershed scale. Bridge (stage) sensors and water quality sensors (NO3-N and turbidity) were purchased and installed at the outlets of treatment and control sub-basins in Rapid Creek watershed. Water quality data collected are displayed on the Iowa WQIS web page (http://iwqis.iowawis.org/app/). The stage and water quality monitoring data collection effort will continue in 2016 and 2017 as the data is leveraged with the Rapid Creek watershed project managed by the Johnson County Soil and Water Conservation District.

Modeling of nitrate loads and concentrations in the Raccoon River

The main objective of this project was to develop statistical models to describe temporal changes in nitrate concentrations in the Raccoon River at Van Meter that relate the response variable (monthly nitrate concentrations) to predictors that are potentially useful in describing its variability. The predictors that were considered were related to climate and agriculture. The modeling results show it is possible to successfully describe monthly flow-weighted average concentrations for the Raccoon River over the 1974-2013 period. Plus, researchers found that base flow and planted soybean acreage are the two predictors most often identified as important.

Phosphorus loss from ephemeral gully formation and sediment transport

The goal of this project was to determine the quantity of phosphorus loss in 12 Iowa watersheds and the proportion of total phosphorus loss that originates from ephemeral gully formation. This research showed, in watersheds with 100 percent row crop, approximately 50 percent of total phosphorus loss was ephemeral gully sourced. The contribution of phosphorus loss from ephemeral gullies is reduced by an average of 50 percent in watersheds that contain perennial cover in strategic locations reducing ephemeral gully formation. Average loss of water-soluble phosphorus from ephemeral gullies also was reduced by 40 percent when perennial grasses were strategically placed to reduce ephemeral gully formation. This research was conducted on small watersheds managed with no-till and a corn-soybean rotation. The small watershed size requires caution when trying to uniformly apply results across the Iowa landscape. However, the evidence from this study supports other research indicating ephemeral gullies contribute a grossly disproportionate amount of sediment and phosphorus per unit land area compared to sheet and rill erosion on hill slopes in the watershed. The potential positive water quality impact of armoring the soil surface with perennial vegetation in relatively small locations that repeatedly form ephemeral gullies seems more effective at reducing phosphorus than other approaches.

More information about the INRC and the funded research projects can be found at www.nutrientstrategy.iastate.edu/center.

Nutrient trading: Recent innovative approaches

Interest in exploring nutrient trading has continued as the NRS implementation has moved forward. DNR, EPA, and several stakeholder groups continued discussions about the different aspects of successful trading programs. DNR has met with EPA to discuss NPDES permitting options to accommodate different styles of trading programs and is aware of several cities interested in the concept.

The Iowa League of Cities was recently awarded a USDA-NRCS Conservation Innovation Grant (CIG) to develop a water quality credit trading (WQCT) framework as a means to advance the goals of the NRS and beyond. Work over the last year included initial development of a “Nutrient Reduction Exchange” (NRE) that would serve as a tracking system and would allow nutrient sources across the state to register and track nutrient reductions resulting from installed best management practices (BMPs) that target NRS goals.

The three-year CIG will be completed with a formal NRE structure and WQCT framework by October 2018. As a result of these recent developments, Section 1 of the NRS has been updated to solidify the WRCC and its member organizations commitment to cooperate with and assist non-governmental organizations interested in developing a voluntary nutrient credit trading program in Iowa (see Appendix A for proposed updates to the NRS).

Prioritization of watersheds

The 2011 "Stoner Memo", through which the EPA urged states to develop plans for reducing nutrient loss, called for the identification of watersheds that account for a substantial portion of the state's nutrient load export through surface water and to the Mississippi River. Identification of these watersheds was conducted during the 2014 reporting period and has guided the prioritization of watershed-based activities across the state.

In an effort to establish targeted action in watersheds that carry the majority of Iowa's nutrient export, demonstration projects have been established in hydrologic unit code – 12 (HUC12) watersheds that lie within the priority HUC8 watersheds, with the goal of spreading awareness of nutrient reducing practices that can affect change in the nutrient load of these catchments. The Iowa Water Quality Initiative (WQI) provides targeted funding and support for 16 projects, three of which began in 2015 (Figure 3).

While these 16 projects target the priority watersheds, there are, in total, 81 ongoing watershed projects in 65 Iowa counties. The majority of these projects operate as locally led efforts, and are supported through leadership from Iowa's Soil and Water Conservation District commissioners, who, in partnership with watershed coordinators, tailor the projects to meet the specific needs, concerns, and values of the surrounding communities.

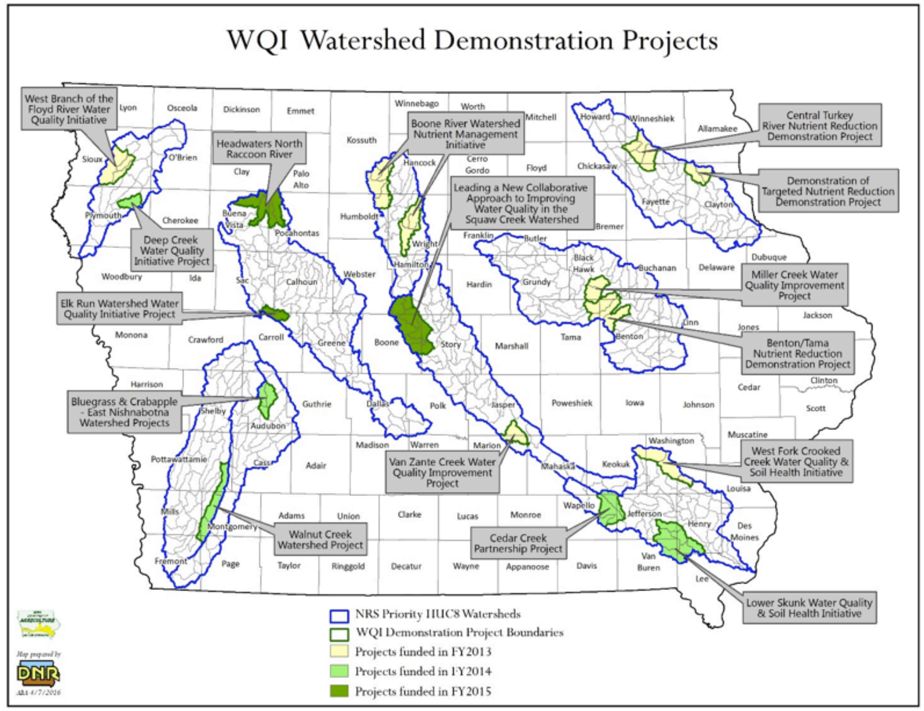


Figure 3: The distribution of watershed demonstration proejcts funded by the Iowa Water Quality Initiative (WQI).

Stormwater, septic and minor POTWs

The WQI has funded 22 urban demonstration projects, which highlight the conservation practices that focus on capture and infiltration of stormwater. These practices reduce the contribution of stormwater to water quality degradation, flash stream flows, and flooding. Nine of these demonstration projects received funding in 2015, and 13 have received funding in 2016. Efforts are underway to calculate estimates of nutrient reductions associated with these projects, and to update the Iowa Stormwater Management Manual to include recent technological advances and modifications related to stormwater management.

DNR and IDALS partner on the State Revolving Fund (SRF)-Sponsored Project program to leverage investments made by municipalities to upgrade wastewater facilities to include additional resources for urban and agricultural stormwater projects. This program is currently funding 57 projects, up from 38 reported during the 2015 reporting period.

Upgrading of failing septic systems continues through implementation of Iowa's "time of transfer" law that took effect in 2009. Database improvements continue to progress to better enumerate the success of this program. Approximately 16,000 out of ~26,000 time of transfer records have been entered into a database that allows systems to be sorted by condition and type. These records are uploaded to a cloud based storage system that will facilitate access to the records. A surge in home sales in late 2015 and in early 2016 means many more time of transfer inspections are being done this year.

In this reporting period, there are no updates to report on efforts related to minor publicly owned treatment works (POTWs)

Progress of point source facility permits

Steady progress has been made in issuing permits requiring the submittal of a nutrient reduction feasibility study to point sources listed in the strategy – the first step in advancing nutrient reductions by point sources. Good progress has also been made in issuing such permits to point sources in priority watersheds; 62% of these permits have now been issued. Table 3 provides a general summary showing targets, where applicable, and progress in implementing the NRS for point sources.

Table 3: Summary of NRS point source implementation

Metric	Number Required			Number Complete			
	2013-2014	2014-2015	2015-2016	2013-2014	2014-2015	2015-2016	Total
Permits issued	130	147	149	21	32	34	87
Permits issued in targeted watersheds	37	37	39	8	7	9	24
Feasibility studies submitted	-	-	15	0	1	19	20
Permits with construction schedule	-	-	-	0	0	2	2
Permits with limits	130	147	149	0	0	1	1
Nitrogen	-	-	-			1	1
Phosphorus	-	-	-			1	1
Permits meeting % reduction targets	-	-	-				
Nitrogen	-	-	-		9	14	14
Phosphorus	-	-	-		2	6	6
Total permits with nutrient monitoring (including those not in nutrient strategy)	-	-	-	169	201	?	?

There was a significant increase in the number of feasibility studies submitted during the past year, as facilities whose permits were issued in 2013-14 completed the required two years of raw waste and final effluent monitoring and evaluated alternatives for nutrient reduction technologies. As these feasibility studies are reviewed and approved by DNR, the schedules they contain for installing nutrient reduction technologies are added to facilities' National Pollution Discharge Elimination System (NPDES) permits by amendment. Once the construction outlined by the schedules is complete and treatment processes are optimized, facilities will sample total nitrogen and total phosphorus for 12 months. Effluent limits based on those results will then be added to the permit and become enforceable.

For the first time, enough data are available for point sources to compare actual treatment plant loadings and reductions with the assumptions made during the development of the INRS. This may be the most complete set of nutrient data available in the country for point sources, and the amount of data will continue to increase as more permits are issued. Using these data, we have determined what reductions in loadings of total nitrogen and total phosphorus are occurring today, even before nutrient reduction technologies are installed.

Additional facts and information on each of these measures as well as our preliminary analysis of data collected by point sources since the inception of the NRS is presented this report

How many NPDES permits have been issued that require feasibility studies?

The INRS established a goal for DNR to issue or reissue NPDES permits to at least 20 of the total point sources listed in the strategy each year. These permits include a requirement to complete and submit a nutrient reduction feasibility study (feasibility study) that evaluates the feasibility and reasonableness of reducing the amounts of TN and TP discharged by these larger publicly-owned treatment works (POTWs) and industries. Figure 1 shows that a total of 86 permits have been issued that require feasibility studies as of May 31, 2016; 21 permits in 2013-14, 33 during 2014-15 and 32 in 2015-16. The goal of 20 permits per year has been exceeded in each of the three years that the strategy has been in place and 58% of the 149 facilities affected by the strategy now have permits that require submittal of a feasibility study.

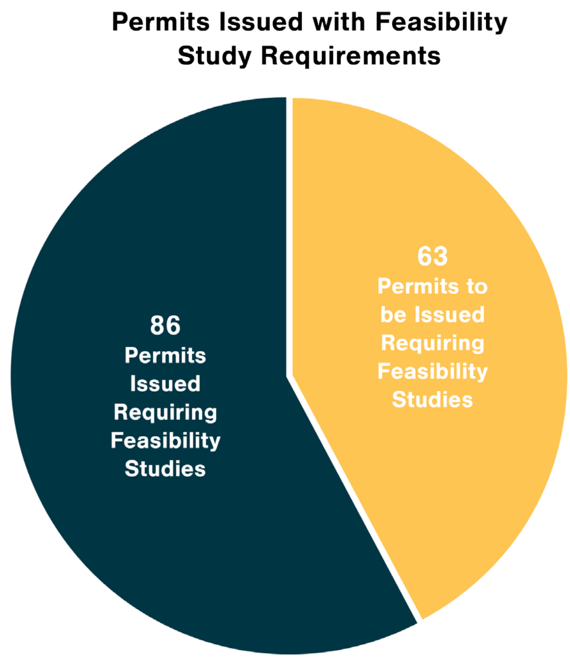


Figure 4: Of the 149 permits that are required by the NRS, 86 requiring feasibility studies have been issued.

The total number of facilities addressed by the NRS and therefore the number of permits that will require completion of a feasibility study changes slightly from year to year for several reasons:

- New industries begin operating. For example, Iowa Fertilizer Company and Iowa Premium Beef are new major industries that began operating facilities in Iowa after the NRS was released in 2013.
- Industries previously discharging to POTWs begin operating separately from the city. DariConcepts is an existing minor industry that constructed and began operating a biological wastewater treatment facility after having discharged its' wastewater to a city treatment facility for many years.
- An industry may cease operations altogether or dispose of it wastewater by means other than discharging to a river or stream. For example, Sioux Preme Packing Co. began land applying all of its

wastewater beginning in May 2015.

- City wastewater treatment facilities are replaced with new facilities or are expanded to treat larger volumes. If the new or upgraded facility is designed to treat 1.0 million gallons or more per day it becomes a major facility and is subject to the NRS. The City of Eldridge's South Slope treatment plant expanded to treat a larger volume in 2013.
- A city may downsize its treatment plant capacity as industries leave the city. If this downsize results in the design flow dropping below 1.0 million gallons per day, the facility is no longer classified as a "major" facility and is therefore not subject to the NRS. For example, in 2013 the City of Garner replaced its treatment facility that had a design flow of 1.05 million gallons per day with a new facility that has a design flow of 0.873 million gallons per day.
- A city may eliminate its discharge by connecting to another facility that provides treatment for its wastewater. The City of Ankeny began sending its wastewater to the Des Moines Water Reclamation Facility in January 2014. The City of Waukee is scheduled to do the same by January 2019.

How many NPDES permits have been issued to facilities in priority watersheds?

In 2013, shortly after the NRS became effective, the WRCC designated nine watersheds throughout the state as priority watersheds. These priority watersheds are intended to serve as areas in which to focus targeted conservation and water quality efforts through nonpoint source demonstration projects, implementation activities by nonpoint sources, and implementation of nutrient reduction technologies by point sources. Thirty-seven of the point sources listed in the strategy discharge in one of these nine priority watersheds. Permits have been issued to 23 (62%) of these facilities as of May 31, 2016. All of the facilities in the Boone, East Nishnabotna, Turkey and West Nishnabotna watersheds now have permits that require the submittal of a feasibility study. Figure 5 shows the progress to date in issuing permits to point sources in the priority watersheds.

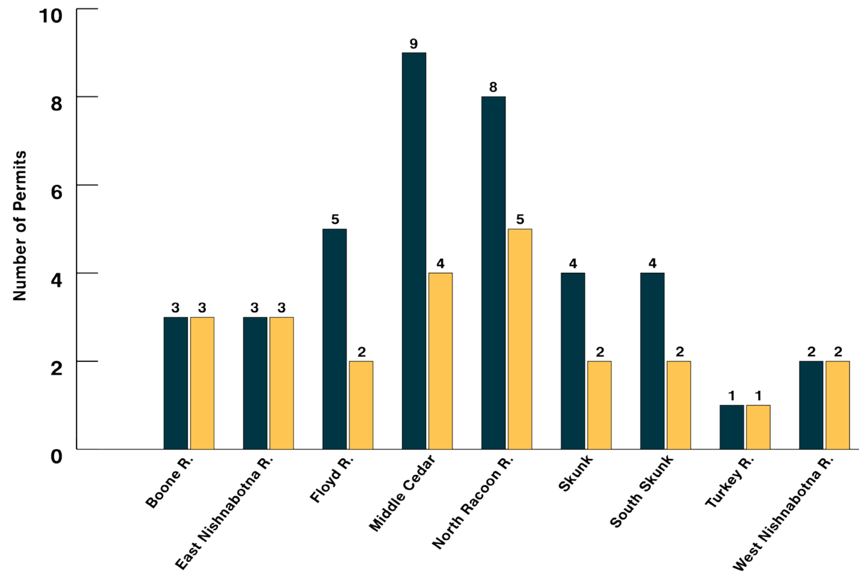


Figure 5: Point source progress in priority watersheds

How many nutrient reduction feasibility studies have been submitted?

Point sources listed in the strategy are required to monitor raw waste and final effluent for total nitrogen and total phosphorus during a two-year period following the issuance of the first NPDES permit requiring completion of a feasibility study. However, some industries (e.g. power plants) that do not have a treatment plant are required to monitor only the final effluent. A facility uses the data collected during this two-year period to evaluate the feasibility and reasonableness of reducing the amounts of nutrients discharged into surface water. The NRS establishes a target of reducing total nitrogen and total phosphorus from point sources by 66% and 75% respectively. The feasibility study must include an evaluation of facility operational changes that could be implemented to reduce the amounts of total nitrogen and total phosphorus discharged.

If the implementation of operational changes alone cannot achieve the targets, the facility must evaluate new or additional treatment technologies that could achieve reductions in the nutrient amounts discharged. Twenty (20) feasibility studies have been submitted as of May

31, 2016, and another 66 are required to be submitted in the next two years (Figure 6).

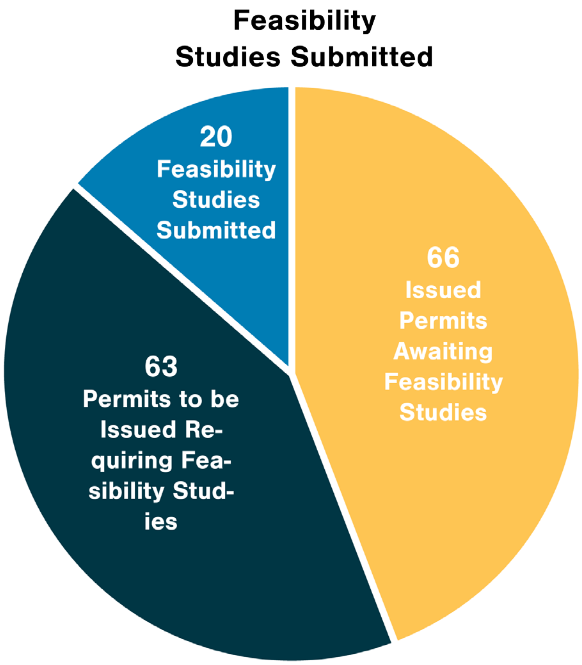


Figure 6: The progress of issued permits and submitted feasibility studies among the total required facilities.

How many NPDES permits have been amended to include schedules for constructing nutrient removal technologies?

The feasibility study must include a proposed schedule for implementing the operational changes and/or installing new or additional treatment technologies found to be feasible and reasonable. Upon approval of the proposed schedule by the DNR, the NPDES permit is amended to include the schedule for construction and/or implementation of changes. Currently, two permits have been amended to include construction schedules and one draft amendment is waiting to be finalized.

How many permits have been amended to include nutrient limits?

One permit was amended in 2015-16 to include effluent limits for both total nitrogen and total phosphorus. Manildra Milling made operational changes at their wastewater treatment facility and determined that it was meeting the targets established in the INRS.

There are a total of 123 permits that have been issued, primarily to facilities that are not affected by the NRS, which specify limits for one or more nitrogen compounds (excluding ammonia nitrogen). There are two permits that have been issued to facilities that are not affected by the NRS which specify limits for one or more phosphorus compounds. Limits in these permits are either required by federal effluent standards in the case of certain industries (e.g. meat processing, fertilizer manufacturing, etc.) or are based on a total maximum daily load (TMDL) developed by DNR to address an identified water quality impairment. In many cases these limits do not require a reduction in the amount of nitrogen discharged, but the limits also do not allow for an increase in the amount discharged.

How many nutrient reduction facilities are in place or under construction?

Several POTWs and industries have constructed or are presently constructing biological or chemical nutrient reduction facilities. Many others are planning to construct facilities in the coming years.

Previous annual reports have highlighted the City of Clinton who completed construction and began operating a new wastewater treatment plant in 2013 that utilizes biological nutrient removal processes as envisioned by the INRS. In Clinton's case this involves anaerobic treatment to remove TP and anoxic treatment to remove TN in addition to typical biological treatment to reduce conventional pollutants. Samples collected and analyzed by the City every other month since December 2014 show that the effluent TN concentration has averaged 8.84 mg/L compared to an annual average target of 10 mg/L listed in the INRS. During the same time period, the average effluent TP concentration was 1.7 mg/L compared to a target annual average of 1.0 mg/L. Neither the percentage removals achieved nor the total pounds of pollutants removed during this period could be determined due to a lack of raw waste data.

Iowa City and Sioux City both operate newer wastewater treatment plants designed to remove total nitrogen and will be evaluating opportunities to reduce total phosphorus as part of their feasibility studies. The annual average effluent concentrations of total nitrogen for the period from 5/1/2015 through 4/30/2016 were 9.66 mg/L (range 2.90 – 23.20) for Iowa City and 16.20 mg/L (range 2.58 – 139.0) for Sioux City. Annual average effluent total phosphorus concentrations for the same time period were 1.09 mg/L (range non-detect – 3.73) and 4.40 mg/L (range 0.14 – 19.90) for Iowa City and Sioux City respectively. Overall, the Iowa City treatment plant removed approx. 894,075 lbs of TN and 138,533 lbs of TP during this 12 month period while Sioux City removed approximately 2,171,162 lbs of TN and 629,921 lbs of TP.

Removal rates were almost identical for the two treatment facilities at 75 percent for total nitrogen and 81 percent for total phosphorus at Iowa City and 78 percent and 80 percent at Sioux City. Both facilities exceeded the target percentage removal goals for total nitrogen and total phosphorus established in the NRS of 66 percent and 75 percent respectively. While Iowa City met the annual average effluent target concentration for total nitrogen of 10 mg/L, and was close to meeting the total phosphorus target of 1.0 mg/L, Sioux City did not. The reason appears to be that the average raw waste concentrations for both parameters at Sioux City were significantly higher than at Iowa City. This is likely attributable to differences in the characteristics and amounts of industrial wastewater that are treated by the two facilities.

Funding was approved in 2016 for the Des Moines Water Reclamation Authority to install an Ostara process. Although the main reason for proceeding with this project at this time is to significantly reduce the buildup of struvite, which causes operation and maintenance problems and increases treatment costs, it is also projected to result in a significant decrease in total phosphorus in the final effluent. Installation of this technology is scheduled to be completed in 2019 and is expected to remove approximately 365 tons or 730,000 pounds per year of phosphorus from the wastewater.

The Tyson Fresh Meat, Inc. industrial wastewater facility in Perry, IA is constructing chemical phosphorus removal and additional nitrogen removal upgrades with a planned operational date of August 2017.

Human

Inputs are applied to affect change in nutrient loads, which will require widespread adoption of conservation practices to reduce nutrient loss from nonpoint sources. In order to implement nutrient-reducing practices and cut nitrogen and phosphorus loss by 45 percent, attitudes of people must first shift to affect a change in perspectives and behavior related to water quality.

There are currently three factors that have been analyzed in order to measure the progress of human attitudes related to the NRS: education and outreach events; media pieces for spreading awareness; and farmer attitudes and perspectives.

Increased public awareness, education and outreach

Outreach and education events

Outreach and education events that were held across Iowa during the 2016 reporting period reflect the efforts by partner organizations, both public and private, to spread awareness and educate the public about nutrient reduction options for water quality improvement.

These events, which provide information to make informed decision about conservation practices, were self-reported by WRCC and WPAC members, and include four types of events: general outreach, including fairs, tours, and community education; field days, which often serve to educate farmers and landowners; workshops, which entail training in a particular skill or topic area; and conferences, which facilitate knowledge-sharing, networking, and partnering. During the 2016 reporting period, partner organizations hosted 98 outreach events, 57 field days, 19 workshops, and 4 conferences (Table 4).

Table 4: Summary of the education and outreach events held by partner organizations between June 1, 2015 and May 31, 2016			
	Number of Events	Average Attendance	Total Reported Attendance
Outreach (fairs, tours and community education)	98	140	14,375
Field Days	57	41	4,159
Workshops	19	34	1,172
Conferences	4	291	1,281
Total	**178**		**20,987**

Media pieces for spreading awareness

Media pieces that were released by partner organizations are another measure of the extent of outreach related to the NRS. These pieces include online newsletters, printed materials, and television and radio spots, and serve to inform the public and spread awareness of the NRS, water quality, and conservation practices that reduce nutrient loss.

At 1360 reported pieces, online content, which include newsletters, blog posts, and videos, was the predominant form of media outreach in the 2016 reporting period, (Figure 7). There were 322 print articles, 90 radio spots, and 16 television pieces. These outreach methods will be tracked annually to identify changes in the extent of NRS-focused media in Iowa.

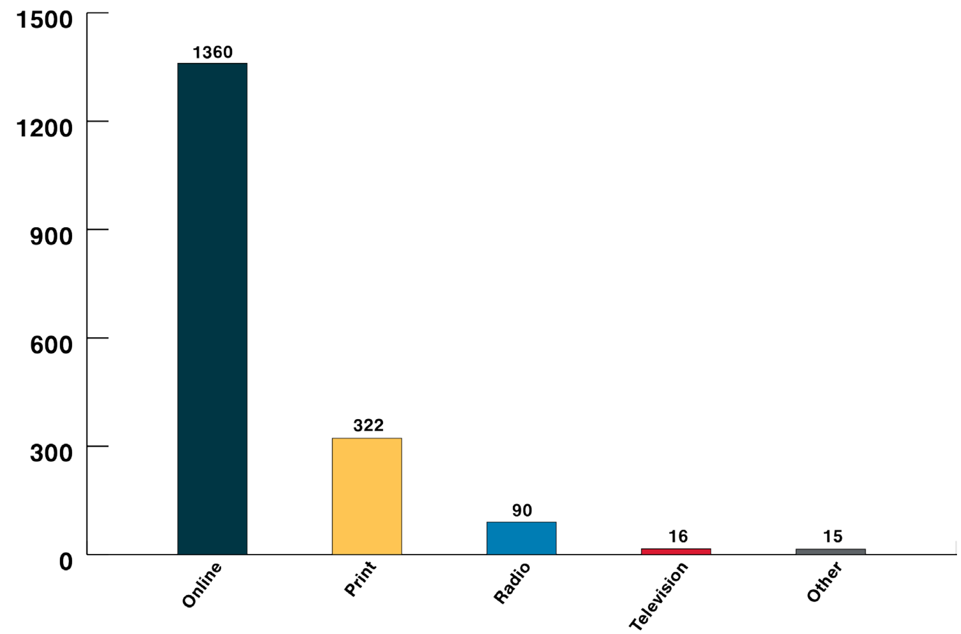


Figure 7: Media pieces for NRS outreach released during the 2016 reporting period, as reported by partner organizations.

Farmer knowledge and attitude

In an effort to better understand farmer knowledge, attitudes, and behavior, a five-year survey funded by IDALS and conducted by ISU researchers has completed its first round of data collection. This survey, which will assess farmers' understanding of and attitudes toward the NRS, is conducted in select priority and non-priority HUC8 watersheds, so as to track changes in both over time. The design of the survey and its first-year results will be available through ISU-CALS in August 2016.

Figure 8 illustrates the knowledge of the NRS that farmers reported in 2015. About six percent of respondents reported that they were very knowledgeable of the NRS, and 22 percent rated themselves as knowledgeable. The largest category, at 42 percent, was "somewhat knowledgeable," while 23 percent and seven percent of farmers reported that they were slightly knowledgeable and not at all knowledgeable, respectively. These results show a greater level of knowledge of the NRS compared to the results of the same question in the 2014 Farm and Rural Life Poll conducted by ISU researchers. The sampling techniques differ between the two studies, so the results should not be directly compared. In particular, the 2015 study surveyed farmers in selected watersheds, while the 2014 study surveyed farmers across the state. However, the greater levels of knowledge of the farmers surveyed in the 2015 NRS Farmer survey suggest a possible general increase between 2014 and 2015.

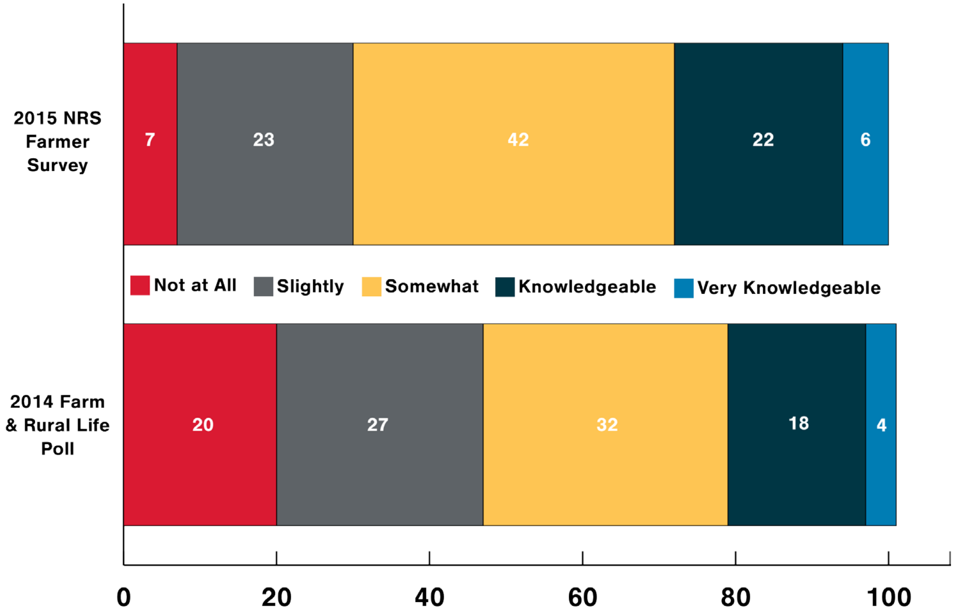


Figure 8: Percent of respondents describing their knowledge of the NRS. These data were obtained from the 2015 NRS Farmer Survey and the 2014 Farm and Rural Life Poll conducted by ISU researchers. Sampling techniques differed between the two studies; the two sets of results should not be compared directly, but this figure serves to illustrate a possible shift in farmers' knowledge of the NRS.

As this survey is conducted in select watersheds in the coming years, this question will monitor change in farmers' awareness of the NRS. As Nutrient Reduction Strategy-related extension and outreach efforts increase, farmers' knowledge is expected to increase. Additionally, annual data on NRS knowledge will be compared to other questions in the survey to better understand whether increased knowledge correlates with behaviors related to water quality and soil conservation.

These values will be further examined as the subsequent rounds of the survey are conducted to document changes or stagnation of NRS attitudes that may occur among the farmers and landowners in the target watersheds.

The survey also aims to explore farmers' attitudes toward the NRS and water quality in Iowa. There were many statements presented and respondents expressed their level of agreement with each statement. Three of these statements are of particular interest in measuring progress of the human dimension of the NRS. The statements and their corresponding percentages of responses are shown in Table 5 (page 18).

The first and second statements received high levels of agreement from farmers, at 83 percent and 75 percent, respectively, when the "Strongly Agree" and "Agree" responses are added together. These figures are promising. With most farmers having at least some knowledge about the NRS, and with statements regarding awareness and concern over Iowa water quality receiving agreement from more than three-quarters of those surveyed farmers, there appears to be foundation for increasing conservation and water quality knowledge, concern, and intent to act among the surveyed group. The next rounds of this survey will aim to identify whether a change is occurring in farmers' perceptions of water quality concerns among this sample of respondents.

Table 5: Responses to statements related to attitudes toward water quality and nutrient management. These results, and others, are discussed further in the 2015 Nutrient Reduction Strategy farmer survey report.

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
	Percent				
I am concerned about agriculture's impacts on Iowa's water quality	1.2	4.2	11.7	64.1	18.7
I would like to improve conservation practices on the land I farm to help meet the Nutrient Reduction Strategy's goals	1.3	2.2	21.3	59.9	15.3
The nutrient management practices I use are sufficient to prevent loss of nutrients into waterways	0.4	3.1	39.2	48.9	8.4

Other statements exploring attitudes toward water quality focused on respondents' own management decisions. Fifty-seven percent of the surveyed farmers agreed that "the nutrient management practices I use are sufficient to prevent loss of nutrients into waterways," suggesting a level of contentedness surrounding status quo practice implementation. Future analyses of these data will explore the relation between farmers' attitudes and their behaviors, such as use of conservation practices, to explore whether conservation is associated with the reported attitudes toward nutrient loss and the NRS. A change in these responses over time may serve to indicate successful educational programming and communications about the practices that contribute to or mitigate nutrient loss from agricultural fields. With increased concern over nutrient management decisions may come increased adoption of conservation practices to improve water quality in Iowa.

The second iteration of the survey was conducted in Spring 2016. The responses will be analyzed and reported in Fall 2016. As the survey is conducted in various watersheds throughout Iowa, statistical analyses will also be conducted to determine whether significant differences in farmer knowledge, attitude, or behavior arise in priority watersheds as compared to non-priority watersheds. Some targeted outreach and education programming, particularly through the WQI, is currently designed for watersheds that contribute greatly to Iowa's nutrient export; the future results of this farmer survey will potentially serve as a partial evaluation of the effectiveness of this programming, and may help facilitate improved curricula for the communities in those watersheds.

Opportunity for surveying landowners

The NRS farmer survey is instrumental in gauging farmer knowledge and attitude related to the NRS, and may contribute to improved curricula design to target the population that was sampled (i.e. operators who farm owned or rented land). However, it will be necessary to reach non-operator landowners, as well, to achieve NRS goals. In 2014, 81 percent of Iowa's agricultural landowners were non-operators. This subset should be considered when designing future survey projects to capture the perspectives they have on water quality, the NRS, and their role in affecting change in the landscape. Extension and outreach programming focuses heavily on farmers, but there is an opportunity for designing curricula that target landowners specifically.

Cover Crop Survey

In 2014 and 2015, IDALS conducted a cover crop user survey facilitated through the local Soil and Water Conservation District offices. Participants using cover crops (with or without financial assistance) were asked to complete the survey. The goal of the survey was to learn from these cover crop users their management practices; assess their understanding of cover crops; examine what would help facilitate expanded acreage of cover crops on their operation and/or on other farms in their area; and to inform program design and operation.

One question that carried over from the 2014 to the 2015 survey asked respondents whether they planned to use cover crops the subsequent year. In 2015, 77 percent said that they were planning use cover crops the following year, 23 percent said that they were unsure, and less than one percent said that they would not. These results showed no functional change from the 2014 survey results.

In 2015, the survey asked respondents whether owned, rented, or managed the fields in which they seeded to cover crops. Most farmers, 62 percent, owned and operated the field in which they seeded to cover crops. Twenty-five percent reported that they were the tenant or operator on their cover crop fields, but that the landowner did not request the practice be implemented. Nine percent reported that they were a tenant or operator, and that the landowner had requested the practice be implemented on their fields. These results support the view that landowners present an opportunity for adapted outreach efforts that may facilitate increased adoption of cover crops, and other conservation practices.

A list of the 2015 survey questions and a summary of responses can be found in Appendix C, available in the online version of this report at http://nutrientstrategy.iastate.edu .

Recent innovations in NRS outreach

The Iowa Watershed Academy

A project was initiated in 2014 to develop and implement hands-on training for watershed coordinators, project managers, and conservation leaders in Iowa to improve the effectiveness of watershed scale projects to achieve water quality results. The first Iowa Watershed Academy training event was held May 24-25, 2016, at the Field Extension Education Laboratory west of Ames. Twenty-five watershed and basin coordinators participated in hands-on, collaborative learning sessions featuring the following topics: nitrogen sources and products, the Maximum Return to Nitrogen calculator, choosing nitrogen management practices, cover crops, water monitoring, in-field measurement tools, project management, budget management, communication strategies, partnership opportunities, field day and event planning, project and event evaluation, Agriculture Conservation Planning Framework and setting measurable project goals and objectives. The evaluation feedback was very positive and the participants found the hands-on field sessions and small group discussion sessions to be especially effective. Plans are underway for a fall 2016 event. The training was provided at no cost to the participants through grants and sponsorship from the Iowa Natural Resources Conservation Service, Soil and Water Conservation Society, North Central SARE, Iowa State University Extension and Outreach, Conservation Districts of Iowa, Iowa Department of Agriculture and Land Stewardship and Iowa Agriculture Water Alliance.

Iowa Watershed Academy
Select participant comments:

"You got my mind thinking of other ways to really look at my watershed and maybe expand my focus area."

"Good use of varied discussion and group planning methods."

"Content was great overall. Very diverse and helpful - especially for new coordinators!"

"Thought conent was VERY relevant to what my project goals are."

"Liked having indoor and outdoor sessions; hands-on is a must."

"Beneficial to have trainings like this so we can meet with other coordinators and exchange struggles/ideas."

retaiN

The retaiN project seeks to give farmers the tools and information they need to make conservation decisions on their land, starting by helping farmers test for, understand and take steps to retain their nitrogen. The nitrate test kits facilitate farmer engagement in collecting on-farm nitrate concentration data. The project, funded by the State Soil Conservation Committee, is a partnership between Conservation Districts of Iowa, ISU Extension and Outreach, Iowa Learning Farms, and with support from the IDALS Division of Soil Conservation and Water Quality. In 2015, 500 nitrate concentration test kits and supporting materials developed and distributed to producers through existing watershed projects and ISU Extension field specialists in 2015. The retaiN project is designed to build awareness the nitrogen concentrations in tile outlets and does not maintain a database of measurements. The evaluation feedback from farmers, watershed coordinators, and ISUEO specialists was overwhelmingly positive. One farmer wrote, "The kit is quick, very simple to use and gives you immediate results. It helps me determine if I am losing any nitrogen".

While the discussion of the data allows farmers to understand the nitrogen loss on their field, these efforts also represent a potentially valuable outreach strategy that should be considered for helping farmers make informed decisions about employing conservation practices suitable for their operations.

Land

The current landscape in Iowa

Iowa's landscape is predominantly agriculture. According to the United States Department of Agriculture's census, Iowa had 30,622,700 acres of farmland in 2012. In 2015, these acres were comprised of 13,218,900 acres of corn and 9,720,900 acres of soybeans. The remaining acres were dedicated to other agricultural operations, including small grains, pasture, and Conservation Reserve Program (CRP) enrolled acres.

Land use and cropping systems impact the loss of nutrients to surface water, but must be balanced with the economic viability of farmer operations. With time and widespread adoption of practices, changes in land use, nutrient management, and soil stewardship on agricultural fields can have significant, positive effects on Iowa's water quality.

The NRS is a collaborative, research-based framework, so its success relies heavily on the cooperation between all stakeholders including, but not limited to, state/federal agencies, NGOs, private companies, farmers, landowners, and point-source facilities to take stock of the nutrient loss that can be mitigated through improvements to in-field and edge-of-field management. The following discussions explore the extent conservation practices have been voluntarily adopted in Iowa agricultural operations.

Data sources for conservation practices

In order to accurately track the annual adoption of conservation practices that reduce nutrient loss, three data sources were analyzed:

1. Farm Service Agency – Crop acreage data, reported by producers. The FSA data provide the information concerning land use in Iowa.
2. USDA-NRCS – The adoption of select conservation practices through financial assistance and cost-share programs (e.g. EQIP).
3. IDALS – The adoption of select conservation practices through financial assistance and cost-share programs (e.g. REAP).

Baseline and Temporal Scale: Annual totals of conservation practice adoption, on a calendar year cycle. Land-based conservation has been tracked back to 2011 as the year of EPA reccomendations and NRS initial nutrient load estimates.

Note: The cost-share measure accounts for a portion of new practices added but does not account for existing practices that were removed. This concern will be factored into future attempts to address data challenges.

Nonpoint source nutrient reduction for water quality improvement

Within Iowa's agricultural system, dominated by corn and soybean production, a variety of practices can be implemented to mitigate the loss of nutrients from farm soils. Employing effective strategies for reaching out to producers and landowners, educating the public on the options available for nutrient loss reduction, and adjusting efforts as farmer perspectives become better understood, will accelerate the adoption of conservation practices on farms. Quantifying the extent to which these practices are adopted each year, and how the use of these practices changes from year to year, provides a series of metrics for measuring progress of the NRS. These practices are categorized into three general forms of management: land use change, in-field nutrient management, and edge-of-field practices.

Land use changes are comprised of substantial alterations to the conventional cropping system, including perennial establishment for land retirement, pastures, and extended rotations. In-field nutrient management practices encompass tillage; fertilizer application methods, timing and rate; and cover crops. They are techniques that are applied within the field boundaries. Edge-of-field practices mitigate soil and nutrients from exiting the field. Terraces, wetlands, buffers, bioreactors, and drainage water management are included in this category.

A brief discussion of the practices that comprise these categories and their estimated impacts on crop yields and on the loss of nitrogen and phosphorus can be accessed in "Reducing Nutrient Loss: Science Shows What Works," an ISU Extension & Outreach publication.

A more detailed discussion of nutrient-reducing practices can be found in the Science Assessment of the Iowa Nutrient Reduction Strategy, at http://www.nutrientstrategy.iastate.edu/.

Table 6: Conservation land use in Iowa. Alternative field crops (e.g., alfalfa, rye, and wheat), pasture, and conservation reserve program (CRP) acres were obtained from the Farm Service Agency crop acreage data. †The adoption of cost-share perennial vegetation since 2011 were calculated from federal and state cost-share data. This perennial vegetation was calculated from new installations of critical area planting and conservation cover, both of which are NRCS-standardized practices.

	Land Use (Acres)				
Year	2011	2012	2013	2014	2015
Total alternative field crops and pasture	2,180,000	2,131,000	2,258,000	2,819,000	2,830,000
Total CRP	1,043,000	1,047,000	1,531,000	1,456,000	1,464,000
Installation of perennial vegetation, non-CRP†	12,347	29,968	41,450	51,021	58,413

Land use change and land retirement

Land use in Iowa and the extent of extended crop rotations, pasture, and perennial native plantings have a substantial effect on nutrient loss. The NRS Science Team of researchers have estimated that pastures reduce nitrogen loss by about 85 percent and phosphorus loss by nearly 50 percent, compared with conventional corn and soybean rotations. Alfalfa can reduce nitrogen loss by over 40 percent. Perennial systems can play a significant role in reducing nutrient losses from the acres enrolled in programs such as the federal Conservation Reserve Program (CRP), which have been shown to reduce nitrogen loss by 85 percent and phosphorus loss by 75 percent.

In 2015, there were an estimated 2,830,098 acres of alternative field crops and grassland (Table 6). Alternative field crops are a sum of the planted area of oats, alfalfa, rye, and wheat. Grassland includes pasture, turn areas, and planted grasses. The extent of grassland and alternative field crops has increased by about 650,000 acres since 2011. Efforts are underway to further refine this data collection method to improve accuracy and avoid double counting.

The USDA-FSA program, CRP, compensates landowners through land rental payments in exchange for planting and maintaining native plant mixes. These types of programs benefit water quality, wildlife, and soil health. In 2015, 1,463,759 acres in Iowa were enrolled in CRP, about 400,000 acres more than in 2011. Additionally, between 2011 and 2015, 58,413 acres were enrolled in perennial vegetation government cost-share programs—not CRP.

Since 2011, there has been some increase in land use change that benefits of nutrient loss reduction and water quality improvement, although future tracking efforts will explore the drivers for these land use changes and the roles that they play in overall nutrient reduction. The NRS Science Assessment evaluated potential for different scenarios that would feasibly meet NRS goals. Within those scenarios, maintaining at least 1.2 million acres of land retirement can contribute to success in meeting the goals of 45 percent reduction of nitrogen and phosphorus, when employed with other combinations of conservation practices.

Table 7: The annual implementation of in-field practices under cost-share programs

	In-Field Nutrient Management (acres) Federal and Iowa Cost-Share Programs				
	2011	2012	2013	2014	2015
Cover crops	35,909	66,433	226,473	251,622	317,132
Nutrient Management, 590 Standard	41,472	37,993	40,329	50,637	35,797
Conservation Tillage	45,079	42,714	32,105	37,354	39,016

In-field nutrient management

Nutrient and soil management practices conducted within field boundaries to mitigate the loss of nutrients from row-cropped acres are discussed as in-field nutrient management. These practices are applied at various stages before, during, and after the annual growing season.

Cover crops have been adopted at a rapid pace in recent years. In 2015, 317,132 acres were planted through government financial assistance programs, a stark increase from 35,909 acres in 2011 (Table7). Cover crops are estimated to reduce nitrogen loss by around 30 percent and phosphorus loss by 29 percent. It is certain that cover crops have also been adopted without the use of cost-share. While adoption has increased dramatically since before 2011, there is not currently an effective process to collect total acres of cover crops annually in the state absent state/federal programs. Acceleration of cover crop adoption will need to continue this trend to achieve the NRS goals.

Nutrient management, which incorporates an improved rate, source, placement, and timing of fertilizer application,, has received fluctuating adoption through cost-share programs. In 2015, 35,797 acres had nutrient management, a slight decrease from the 41,472 acres in 2011 and a sharp decrease since 2015, which had 50,637 acres (Table 7). This management system has been widely promoted through the "4Rs" campaign largely led by industry, agency, and conservation groups. While it reduces nutrient loss to a lesser extent than do cover crops and perennial vegetation, adoption of the 4Rs are considered economically feasible and environmentally beneficial, and thus are encouraged on cropland through multiple agricultural retailers, cooperatives, NGOs, consumer facing companies, and government agencies. Currently, adoption of the 4Rs is certainly employed on many more acres than are reflected by cost-share data, but comprehensive data collection to assess the private use (i.e., without government assistance) would be necessary to better estimate the extent of the 4Rs among Iowa farmers.

Conservation tillage, through reduced till and no-till operations, can potentially reduce phosphorus loss by 30 to 90 percent and is also considered a relatively low-barrier conservation practice. The use of conservation tillage, however, is also difficult to estimate due to the fact that many farmers have adopted no-till and reduced-till management without government assistance. In 2015, 39,016 acres received reduced or no tillage through cost-share programs. This rate of reduced tillage through cost-share assistance is down significantly than in previous years (Table 7), but this decrease can be attributed to a variety of potential factors. For instance, a shift in focus of cost-share programs toward other practices, coupled with the possible adoption of tillage without government assistance, may explain this decrease. Improved data collection will help with more accurate measurement of the extent to which these practices are adopted each year. USDA National Agriculture Statistics Service (NASS) surveys show, in Iowa, nearly 7 million acres of no-till in 2012 with an additional 8.7 million acres under use of conservation tillage [https://www.agcensus.usda.gov/]

Edge-of-field practices

Edge-of-field practices were also assessed through their implementation under cost-share programs. These practices are structural and help prevent the loss of nutrient from boundaries of agricultural fields. Phosphorus loss is mitigated by erosion control methods, including terraces [Although terraces are constructed within the field, they are evaluated alongside other edge-of-field practices due to their capacity for sediment loss reduction and due to the fact that they are a structural practice], sediment control, and perennial buffers, which reduce phosphorus loss by 77, 85, and 58 percent, respectively.

Table 9: The cumulative installation of structural edge-of-field practices between 2011 and 2015. ‡CREP wetlands are reported as acres treated. †The standards for bioreactors and saturated buffers are still under assessment, and so have had limited adoption.

	Edge-of-Field and Erosion Control (acres) Federal and Iowa Cost Share Programs				
	2011	2012	2013	2014	2015
Drainage Manage-ment	0	0	15	279	544
Wetlands, CREP					99,309‡
Bioreac-tors†	0	236	501	676	838
Saturated Buffers†	0	0	0	0	0
Perennial Buffers†	29	37	38	51	118
Terraces (feet)	4,556,460	8,378,866	11,906,248	16,076,690	19,821,659
Water and Sediment Control (number)	1,181	7,588	13,649	18,609	19,321

Since 2011, 19,822,000 feet of terrace have been constructed under cost-share programs (Table 8). Similarly, cost-share programs have funded the rapidly increasing construction of water and sediment control basins, at 19,321 basins installed between 2011 and 2015. While these figures indicate an increase in adoption of these practices, future data collection will aim to estimate the total number of acres benefited. Collaboration between representatives at ISU, NRCS, and IDALS will aim to address these data collection concerns to identify and use a standardized unit that describes these practices' impacts on NRS goals and to tackle minor data quality concerns.

Nitrogen loss is mitigated by wetlands, bioreactors, saturated buffers, and drainage water management. Wetlands, when designed and constructed under Conservation Reserve Enhance Program (CREP) standards, can reduce nitrogen loss by 52 percent. In 2015, approved CREP wetlands projects treated an estimated 99,000 acres (Table 8).

Bioreactors reduce nitrogen loss to surface water by 43 percent on tile-drained land. Between 2011 and 2015, 838 acres of bioreactors were reportedly installed, although this estimate is limited by some data quality concerns and should reflect between 50 and 75 individual bioreactors. Future data processing efforts will attempt to accurately report the total treated acres of this practice, which is a more meaningful unit for tracking estimated nitrogen load reductions.

As illustrated in the NRS, it will require a systems approach to reach the goals set forth. Edge of Field practices have been identified as an area needed for expanded implementation to meet the goals of the NRS. However, there are current challenges to scaling up these practices. These challenges include, but are not limited to, the following: these practices are relatively new and not as familiar to landowners as are traditional practices like terraces and grassed waterways; and there are currently efforts underway by multiple partners to build capacity to deliver these practices at a greater scale to provide site location, outreach, technical assistance and verification to expedite delivery and installation of these key practices.

Perennial buffers, which can reduce nitrogen loss by 91 percent and phosphorus loss by 58 percent, are an effective practice for reducing nonpoint source pollution and improving surface water quality. This practice presents an opportunity for improved data collection and processing. Many buffers are installed under CRP, but the reliable CRP data presented in Table 6 does not distinguish between stream buffers and in-field perennial plantings. Therefore, a significant portion of perennial buffers is not highlighted in these data. Table 10 shows the cumulative installation of non-CRP buffers from 2011 to 2015, but these figures are presumed to be vastly lower than the total acres of stream buffers in Iowa.

Addressing data availability challenges

These estimates of conservation practice adoption represent a big step in beginning to enumerate the collective effort of state and federal program funded practices. However; this information is still incomplete when considering the additional practices that are implemented outside of local, state, and federal programs. While they are relatively accurate in illustrating the increasing use of cost-share and other governmental financial assistance for applying agricultural practices that reduce nutrient loss, there are a few challenges to painting the entire picture of conservation in Iowa.

Data for in-field practices

It is certain that practices are adopted and maintained without the use of governmental financial assistance. For example, some estimates suggest that there were nearly 500,000 acres of cover crops planted in Iowa in 2015,   though cost-share programs financed only about 317,000 acres in 2015. This rough calculation has significant limitations, but suggests that there are more acres of cover crops than are funded by government programs. It is also certain that other nutrient-reducing practices, including no-till and nutrient management (4Rs), are also in use by farmers who did not utilize federal or state cost-share.

In partnership with ISU, the Iowa Nutrient Research and Education Council (INREC) will explore how to measure Iowa farmers' progress in reducing nutrient loss from agricultural fields. In the three-year pilot project, INREC will solicit information from agricultural retailers who provide the bulk of services to producers. The aggregation of field-scale data will contribute to efforts to track conservation practice adoption in Iowa. By combining the information gathered into an anonymized dataset, a more accurate view of nutrient-reducing practices and product implementation will be formed. This project, through a public-private partnership, will contribute to an improved understanding of the extent to which farmers employ practices recommended by the NRS. This project will rely upon the existing roles of Iowa's agricultural retailers—1300 certified crop advisors and an estimated 5000 total advisors—who demonstrate a capacity for widespread one-on-one consultations with farmers. INREC will work to enhance retailers' roles by providing increased outreach and training to help these professionals with advising farmer decisions regarding environmental technologies and practices. While assessment of the 2016 reporting period relies on the limited availability of conservation practice data, the NRS Measurement Pilot Project and the associated INREC project will facilitate improved reporting in coming years.

Data for structural practices

To date, there have been various challenges associated with the collection and processing of cost-share data pertaining to structural edge-of-field practice adoption. These practices are recorded consistently by specific units. However, the acres treated by these installations are of greater utility when tracking the practices' contribution to meeting NRS goals. These values have been reported inconsistently and the units are not standardized among different data sources. Collaboration between ISU, NRCS, and IDALS aims to standardize the data collection process and build cost-share databases to provide improved metrics for NRS progress.

In an effort to help support progress measurement and accountability efforts of the Iowa Nutrient Reduction Strategy, IDALS and DNR are collaborating with ISU to conduct GIS analyses in selected watersheds to identify and enumerate the aggregate amount of certain structural conservation practices, independent of government programs, outlined in the NRS Science Assessment. Practices include terraces, water and sediment control basins, grassed waterways, pond dams, contour buffer strips, and contour strip cropping. These practices are identifiable by use of LiDAR elevation data and aerial photos, thereby enabling an accurate accounting of the practices present on the landscape.
Beneficial outcomes include:

- Establish a baseline of practices established
- Assign nutrient and sediment load reduction/prevention amounts to current and future practice levels
- Analysis is blind of public/private investment – as such it encapsulates all activity
- Track progress going forward from LiDAR baseline years (2007-2010)
- Hindcast to past conditions using historic photos to show progress made over time
- Utilize for planning purposes to target resources to areas most in need of select BMPs
- This analysis is complementary to other similar spatial analysis work to document conservation practices that is being funded by the Iowa Nutrient Research Center. Efforts will be cross-coordinated to maximize efficient use of resources

This project will pilot efforts into the WQI Demonstration Watershed Projects and other areas to begin utilizing the tool to ground truth, test the effectiveness and capabilities of the tool, and help validate its usefulness. An additional 202 HUC12 watersheds were completed in the past year.

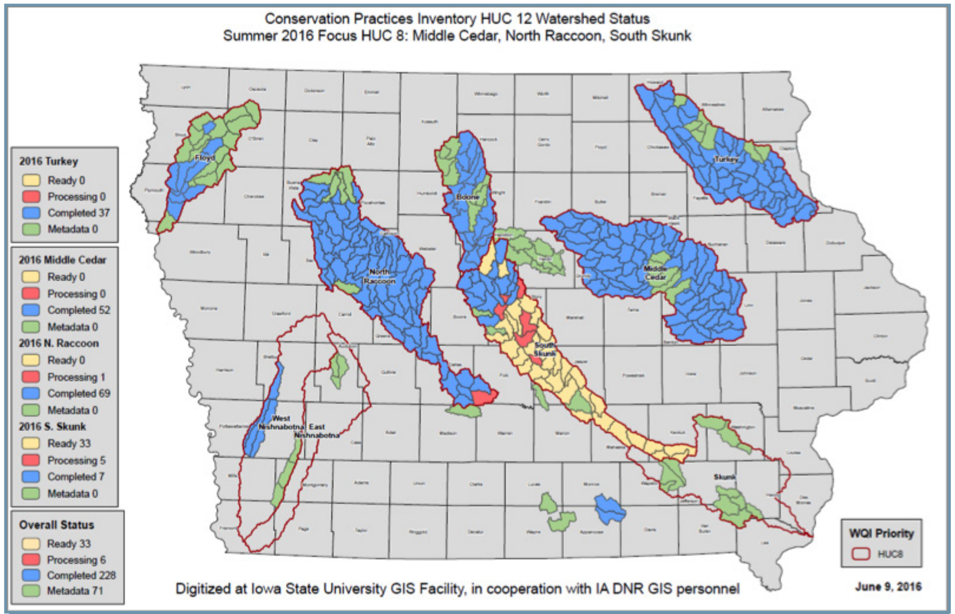


Figure 9: The progress of the DNR, ISU, and IDALS collaborative project to map selected conservation practices in selected watersheds.

The information generated by this project will supplement cost-share data and will paint a more complete picture of conservation in selected watersheds and future installations can be tracked against this baseline. Figure 9 displays the progress of this project's mapping efforts as of May 2016, and the current aggregated results are shown in Appendix B. The baseline practices will contribute to improved estimates of nutrient load reductions in future analyses

Water

The NRS establishes a goal of reducing the amounts of nitrogen and phosphorus leaving Iowa by 45 percent each and outlines a process for achieving this goal through increased efforts by both point sources and non-point sources to control nutrient losses due to human activities. As displayed in the NRS logic model (Figure 1), nutrient reduction will result from effective changes in human behavior, land use, and point source nutrient removals.

One of the key elements of the NRS is to develop new and maintain existing programs to measure water quality and the changes that occur over time as nutrient reduction practices are implemented by both point sources and non-point sources.

The 2015 NRS annual report states that "efforts are underway to improve understanding of the multiple nutrient monitoring efforts that may be available and can be compared to the nutrient WQ monitoring framework to identify opportunities and potential data gaps to better coordinate and prioritize future nutrient monitoring efforts."

During the 2016 reporting period, DNR coordinated and drafted a collaborative report titled "Stream Water-Quality Monitoring Conducted in Support of the Iowa Nutrient Reduction Strategy," that describes the current network of surface water monitoring in Iowa, details the challenges and data gaps associated with water quality monitoring, and suggests ways to improve and coordinate the collection and evaluation of water quality data for these purposes. This is consistent with the WRCC commitment "to continue to coordinate and evaluate opportunities for monitoring locations and focused study areas in order to track progress". This section provides a summary of many of these discussions.

Current known stream nutrient monitoring efforts in Iowa are reported in the context of the Nutrient Water Quality Monitoring Framework presented in Figure 10. The Nutrient Water Quality Monitoring Framework was developed to graphically show that the length of time needed to show a measurable change in water quality increases as the size of the watershed increases. Generally less time and fewer samples are needed to measure a change in the quality of runoff from an individual field of ten to a few hundred acres in size following implementation of nutrient reduction practices, whereas more samples collected over a longer period of time to show a change in water quality at the terminus of a larger watershed that consists of tens of thousands of acres or more. There are a variety of reasons this is the case, pertaining to challenges to monitoring surface water quality, but, in general, as the watershed size increases there is an increase in the number of factors that affect water quality. Natural systems become more complex as size increases.

Edge-of-field monitoring

Agricultural fields, particularly if they are tile-drained, serve as small catchments where water quality measurements can be obtained on fine spatial and temporal scales. These monitoring efforts are practical for better understanding how conventional management and conservation practices impact the concentrations of nutrients and sediment in water that leaves the field. An array of projects and outreach strategies utilize edge-of-field monitoring.

ISU researchers conduct studies on multiple sites to assess the impacts of NRS conservation practices on the loss of nutrients from farms. The Iowa Soybean Association (ISA) also conducts an array of monitoring projects and edge-of-field studies on farmland. In coming months, the extent of edge-of-field monitoring across the state will be evaluated to continue to track progress of this scale of water quality monitoring.

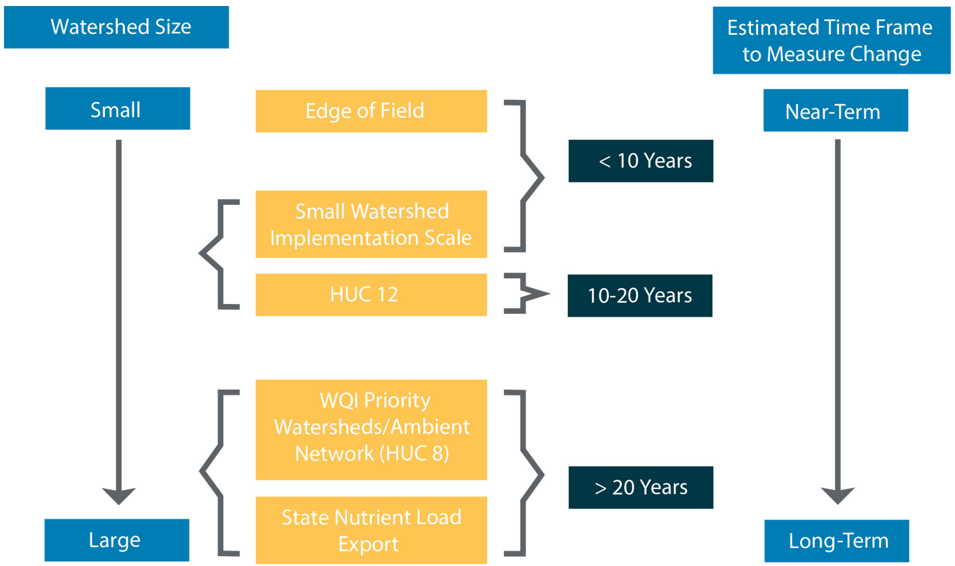


Figure 10: A framework of nutrient and water-quality monitoring, and the approximate time frame in which change in water quality may be measured and detected.

Small watershed-scale monitoring

Iowa Water Quality Initiative

The Iowa WQI was established during the 2013 legislative session to help implement the NRS. The WQI seeks to harness the collective ability of both private and public resources and organizations to rally around the NRS and deliver a clear and consistent message to the agricultural community to reduce nutrient loss and improve water quality. A number of demonstration projects have been established to promote increased awareness and adoption of available conservation practices and technologies. Projects serve as local and regional hubs for demonstrating nutrient reduction practices and providing practical information to farmers, peer networks, and local communities.

A total of 45 demonstration projects are currently located across the state. This includes 16 targeted watershed projects, 7 projects focused on expanding the use and innovative delivery of water quality practices and 22 urban water quality demonstration projects (Figure 3). Eighteen of these projects focus on small scale targeted watershed areas for agricultural based conservation practice implementation in alignment with the INRS. These projects were initiated as demonstration and engagement projects with the eventual goal of scaling conservation implementation progress and efforts both within and beyond the current project watershed areas. Consequently, water quality monitoring conducted by the majority of these projects focuses primarily on informing watershed stakeholders of nutrient loading and targeting resources for effective conservation implementation and planning decisions. A subset of the watershed and practice-based projects currently conducting water quality monitoring is shown in Figure 6. The frequency of sample collection and analysis for nutrients and other parameters varies but is generally weekly or bi-weekly throughout the monitoring season and includes monitoring of tile lines as well as steam water quality. Information about each of these demonstration projects can be found at http://www.cleanwateriowa.org/practice-demonstration-projects.aspx.

National Water Quality Initiative

In 2012, the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) launched the National Water Quality Initiative (NWQI), in collaboration with the Environmental Protection Agency (EPA) and state water quality agencies, to reduce nonpoint sources of nutrients, sediment, and pathogens related to agriculture in small, high-priority watersheds in each state. A key part of the NWQI targeting effort includes the implementation of conservation systems that avoid, trap, and control run-off in these high-priority watersheds.

In Iowa there are currently four NWQI watershed projects; Wall Lake Inlet/Black Hawk Lake, Badger Creek, Lower South Fork Chariton River and Lost Branch – Chariton River. Only one of these, the Wall Lake Inlet/

Black Hawk Lake project measures surface water quality and there is too little data available so far to begin to identify changes, if any, in nutrient concentrations or amounts.

Paired Watersheds

Paired watershed projects involve the selection of two watersheds of similar size and land use characteristics. In one watershed conservation practices are extensively implemented while the other receives few new conservation practices. Stream water quality is monitored in both watersheds to assess the effect on water quality of the installed practices. There are four examples in Iowa, of the use of the paired watershed approach to evaluate water quality effects associated with nutrient reduction conservation practices. Three of these projects were completed prior to the 2016 reporting period, but the Black Hawk Lake project commenced in 2015 under the NWQI. This five-year project will aim to determine if water quality improvement strategies have been effective at reducing sediment and nutrient loads in the watershed.

Conservation Reserve Enhancement Program

The Iowa Conservation Reserve Enhancement Program (CREP) is a joint effort of the Iowa Department of Agriculture and Land Stewardship (IDALS) and the USDA Farm Service Agency in cooperation with local Soil and Water Conservation Districts that provides incentives to landowners to voluntarily restore wetlands targeted for water quality improvement in the heavily tile-drained regions of Iowa.

The goal of the program is to reduce nitrogen loads and movement of other agricultural chemicals from croplands to streams and rivers. A representative subset of wetlands is monitored and mass balance analyses performed to document nitrate reduction. In addition to documenting wetland performance, this allows for the continued refinement of modeling and analytical tools used in site selection, design, and management of future CREP wetlands. In 2015 a total of 20 CREP wetlands were monitored, up from approximately 12 a few years ago.

The monitored wetlands are instrumented with automated samplers and flow meters to measure inflows and outflows. Water levels are monitored continuously at outflow structures in order to calculate changes in pool volume and discharge and wetland water temperatures are recorded continuously for modeling nitrate loss rates. An annual report has been prepared each year since 2007 that document the results of that year's monitoring and evaluates performance measures such as patterns in nitrate concentrations and loads and patterns in nitrate loss. Additional information including copies of each annual report can be accessed at http://www.iowacrep.org/

Conservation Learning Lab

The Conservation Learning Lab is a three-year pilot project between the Iowa Department of Agriculture and Land Stewardship (IDALS) and the Natural Resources Conservation Service (NRCS) designed to answer "Can the high levels of implementation necessary to meet the goals of the NRS be obtained on a small watershed scale?", and "Can water quality improvements be documented accordingly?"

The NRS Science Assessment estimated the potential reductions in nitrogen and phosphorus loads that could be achieved by a wide range of in-field and edge-of-field conservation practices. These estimates were based on a careful review/assessment of the published research on the effectiveness of various practices and their potential applicability. However, most of the studies used in developing the NRS were conducted at the plot scale. While these studies were essential, the report highlighted the critical need for studies that scale up the area of practice implementation in order to better assess water quality impacts across landscapes and with multiple practices.

Nutrient loads and load reductions at the plot scale can differ substantially from loads actually delivered to surface waters. For example, phosphorus in subsurface tile flow at the plot scale can be substantially lower than at the scale of even a few hundred acres. Nutrient loads at larger watershed scales (HUC 12 and above) can also differ substantially from loads actually delivered to surface waters due to the effects of in-stream processes (for example, the effects of bed and bank erosion and phosphorus exchange with stream sediments). Most prior work on practice performance and nutrient loads in Iowa has been done at either the plot scale or larger watershed scale (HUC 12 and greater). However, the most appropriate scale for assessing agricultural nonpoint source loads to surface water is the scale at which the load is actually delivered. This is the scale on which the proposed Central Iowa Conservation Learning Lab is focused.

The focus will be on extensive implementation of nutrient reduction practices in two small watersheds; one in Story County (~1400 acres) and another in Floyd County (~650 acres). The nutrient reduction practice most likely to be implemented is planting of cover crops. In addition to widespread practice implementation, the project will evaluate corresponding nitrogen and phosphorus loads delivered to surface waters and relate these loads to land use, nutrient management and soil test phosphorus. In the long term, this demonstration should improve the predictability of practice performance, improve the understanding of practice uncertainty, increase farmer implementation of practices through outreach and education, and validate load reduction tools developed to evaluate progress toward nonpoint source load reduction.

Large watershed-scale monitoring

Fixed-Station Network

The primary source of data for determining changes in statewide nutrient load export and the contributions that designated priority watersheds make to the statewide nutrient load is the fixed-station stream monitoring network.

Monitoring at fixed-station stream water quality monitoring sites in Iowa began in the late 1970s. The number of monitoring locations, the frequency of monitoring, and the parameters monitored have varied over time for a variety of reasons including changing objectives and available funding. Sixteen locations have been monitored on a monthly basis since 1986 thus offering a 30-year continuous record of water quality monitoring at these locations. Until 2000, the majority of the approximately 95 active and discontinued locations represented by the fixed-station network were monitored on a quarterly basis. Since 2000, all fixed stations have been monitored monthly for water quality parameters including both nitrogen and phosphorus.

In 2015, the fixed-station monitoring network included 60 sites that were monitored monthly and served primarily to provide data to evaluate water quality status and trends in Iowa's interior rivers and streams. Figure 11 shows the locations of these sites, and Appendix A lists each site with information on location (e.g. county, river basin) and identifies those sites used in the 2014 nitrate load calculation. Monitoring objectives have evolved throughout the history of the stream monitoring program. Initially, the focus was to provide data to characterize water quality in large rivers and reservoirs. However, these monitoring locations were biased toward measuring water quality impacts from large point source discharges and runoff from urban areas. The network was modified in 1986 to provide a broader geographic representation of streams that drain medium and large-size watersheds across the state thus eliminating those earlier biases. Drainage areas at these current locations range from 34 mi2 to 14,038 mi2 and the median size is 820 mi2.

Data from these sites is used to prepare the biennial report of Iowa's water quality for the U.S. Environmental Protection Agency (US EPA) and the public. The data also support water programs within the DNR, such as water quality standards and wastewater permitting, and has been used more recently to evaluate long-term trends in levels of nutrients and other water quality parameters.

Samples from these monitoring sites are collected and analyzed by the State Hygienic Laboratory following a US EPA-approved Quality Assurance Project Plan and US EPA approved test methods. This data is available to the public from the Iowa STORET/WQX water quality database (https://programs.iowadnr.gov/iastoret/).

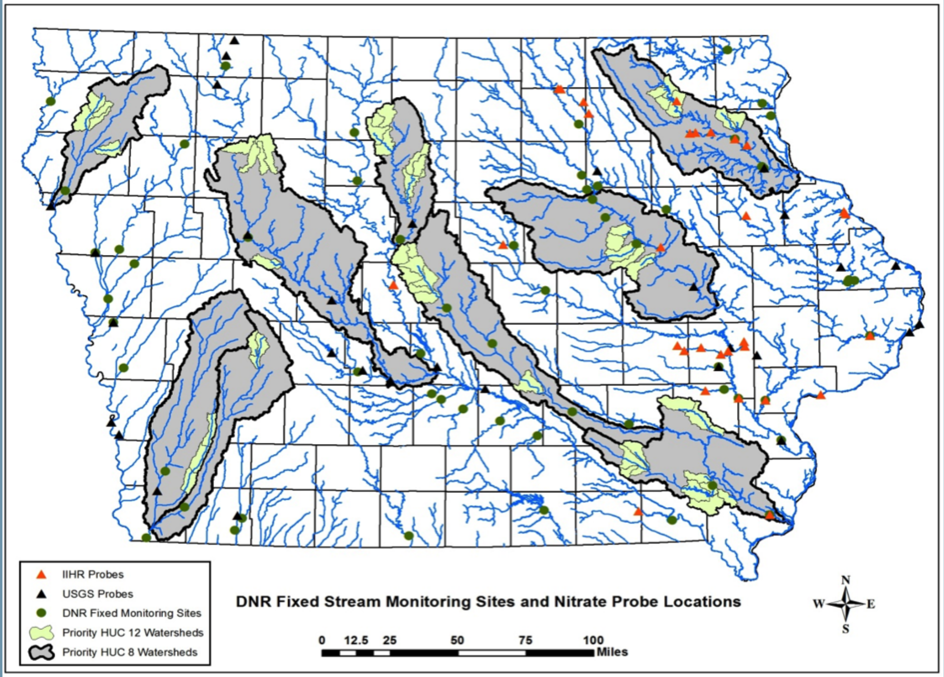


Figure 11: The distribution of fixed stream monitoring sites and nitrate probes operated by DNR, the U.S. Geological Survey (USGS), and the Iowa Institute for Hydraulic Research (IIHR).

IIHR Hydroscience and Engineering

The IIHR – Hydoscience and Engineering (IIHR) center at the University of Iowa conducts research in a variety of areas including hydraulics, hydrology, and water quantity and quality. IIHR operates a continuous water quality monitoring network that has steadily increased in size since 2012. Remote sensors installed throughout Iowa provide near real-time data, which are relayed back to the center every 15 minutes. The sensors measure nitrate, dissolved oxygen, water temperature, specific conductance, turbidity and pH.

Sensors were deployed at 30 locations throughout the state in 2015 and the network will expand to 45 sites in 2016 (Figure 11). The number and location of IIHR monitoring sites can vary from week to week depending upon research needs, equipment maintenance, and other factors. Sites are selected based on a number of factors including:

- Sensing equipment funded specifically for a research proposal or project in a selected watershed.
- Major interior river sites based on their strategic importance for nutrient load estimations.
- Significance of the stream for recreation, municipal water supply, or other designated uses.
- Suitability of the site for sensor equipment, i.e. security, water depth, etc.
- Requests from outside stakeholders.

The sensors that are positioned to provide data to assist in determining statewide nutrient load estimates are located in close proximity to a U.S. Geological Survey (USGS) gaging station to provide the stream flow information needed to calculate loads. Other sensors are located to provide information to monitor nutrient reduction progress in targeted watersheds.

The IIHR has developed the Iowa Water-Quality Information System (IWQIS) to disseminate water quality data from remote sensors as well as climate data such as rainfall amounts and frequency, daily snow melt data and air temperature. IWQIS displays near real-time data on nitrate and other water quality variables in a Google Maps interface. It provides researchers, agencies, and land-owners with a tool they can use to directly monitor the impact of land-use strategies/changes on downstream water-quality, enables watershed stakeholders to understand the fate and transport of nutrients in Iowa's waterways; and helps in measuring the impact of the NRS on water quality. Users can see the total amount of nitrate being carried along a waterway at a certain time, and can compare those levels to previous years. All archived IIHR water quality data is also made available to interested persons upon request. IWQIS can be accessed at https//iwqis.iowawis.org.

Challenges associated with water quality monitoring

Water quality monitoring presents challenges with estimating nutrient load exports from Iowa's watersheds. These challenges are discussed fully in the draft collaborative report on Iowa stream monitoring efforts, and are summarized in this report to highlight the need for increased research into options for addressing these challenges.

- Legacy nutrients, which are present in the soil and groundwater from natural and anthropogenic sources, are released to surface water through bank erosion and groundwater movement. These legacy nutrients can be detected in surface water under a variety of landscape conditions, and so distort the effects that conservation has on surface water nutrient loads.
- Lag time, or the difference in time between conservation implementation and measurable change in water quality, occurs on a variety of scales. Lag time is often dependent on watershed size, and the inappropriate design of monitoring projects can impact the capacity to detect change in surface water quality.
- Variable precipitation and stream flow, extreme weather events, including heavy rainfall and flooding, lend to drastic variability in measured nutrient concentrations. Increased intermittent heavy rainfall will make it more difficult to detect reductions or trends in nutrient export.
- The importance of having comprehensive data on nutrient reduction practice implementation.
- The value of long-term monitoring to measure progress and the importance of properly situated and maintained monitoring locations.

These concerns related to reliable water quality monitoring and estimated nutrient export contribute to concerns that measurable change in statewide nitrogen and phosphorus loads will not be detected in the short term. Therefore, this annual report assesses the current monitoring network in Iowa and highlights progress in establishing new and informative water quality monitoring efforts.

Statewide nutrient load estimates

The NRS called on the DNR to convene a technical work group beginning in 2013 to define the process for providing a regular nutrient load estimate (i.e., nutrient budget) based on the fixed-station stream water quality monitoring network. This was to include specifying the most appropriate estimation method, the acceptability of existing data with which to evaluate methods, and a process for making future adjustments based on the latest information and advancements in science and technology. An interdisciplinary team of Iowa scientists and engineers from state, federal, university and commodity groups was assembled to evaluate and recommend a nitrate load estimation procedure for the State of Iowa. Representatives from DNR, ISU, IDALS, ISA, USGS, and University of Iowa first met on December 3, 2013. The work group first developed a methodology to compare the six most commonly used nitrogen load estimation models and also assembled a single standardized data set to use in comparing model results. Individual work group members were assigned to calculate a load estimate using the standardized data set and one of the load estimation methods. The full work group then compared the results obtained using each method.

The work group recommended using the linear interpolation method because it provides the simplest and most straightforward approach to estimate loads. Linear interpolation fills data gaps between measured concentrations by a straight line. Because of its simplicity different users can expect to produce approximately the same load estimate from a given set of data. Linear interpolation was also found by others to provide the overall best results for load estimation in agricultural and mixed-use watersheds. However, linear interpolation requires consistent sample collection to be effective. Missing sampling periods that lengthen the interval between measurements will result in greater potential error in load estimation.

After accepting the work group recommendation, the linear interpolation method was used to develop statewide nitrate load estimates for calendar years 2013 and 2014. Data from 63 fixed-station monitoring sites were used for the 2013 estimate and 50 sites for the 2014 estimate. Linear interpolation was used to fill in daily concentrations between measured monthly sample results. Interpolated daily concentrations were then multiplied by corresponding daily stream flows to obtain daily nitrate loads. In addition to recommending that the linear interpolation method be used for estimating nitrate loads, the work group recommended that the sampling frequency for nitrate increase from the current once per month to a minimum of biweekly at each of the fixed-station locations to enhance the ability to quantify changing water quality due to implementation of nutrient reduction practices.

A similar effort to that undertaken for estimating nitrate loads is underway to develop a method for quantifying phosphorus loads. However, quantifying phosphorus loads has challenges distinct from those associated with quantifying nitrogen loads. A work group has compiled multiple phosphorus data sets to be used to evaluate different load estimation methods. The data sets indicate that the monthly frequency of monitoring at fixed-station sites is not sufficient to estimate phosphorus loads because the amount of phosphorus in rivers and streams changes very rapidly with changes in stream flow. It is unlikely that phosphorus load estimates can be obtained without event-based sampling or continuous monitoring. Unlike nitrate however, there are no in-stream phosphorus sensors available that can help overcome this challenge. The work group is exploring the possibility of using a surrogate parameter—possibly turbidity—that can be measured with currently available and deployed sensors. Evaluation of potential surrogates is expected to be completed in 2016.

Finally, it may be possible to eliminate altogether the need for load estimation models for both nitrate and phosphorus by using in-stream sensors (Feng et al., 2013; Davis et al., 2014). Although sensors require periodic maintenance and calibration they provide actual measurements of pollutant concentrations on a nearly continuous basis. When coupled with stream flow measurements made at or near the location of each sensor, loads can be measured rather than estimated

Table 9 outlines the baseline loads estimated for the NRS in 2012. While this baseline, an average of 2000 to 2010 modeled estimates, serves as the reference for evaluating NRS progress, particularly pertaining to the impact of conservation practices on nutrient export, future analyses will incorporate more frequent calculations of nutrient loads using the linear interpolation method for nitrogen and, eventually, methods that are under assessment for modeling phosphorus loads. Additionally, the load estimate will improve based on the extensive database that has been built as a result of the monitoring conducted by wastewater treatment facilities.

Table 9: The loads of nitrogen and phosphorus in Iowa calculated as an average from 2000-2010 data, and the respective goals for reductions from nonpoint sources (NPS) and point sources (PS).

Baseline Estimates from the NRS	Nitrogen	Phosphorus
Statewide baseline load (tons)	307,000	16,800
Load reduction needed for 45% reduction	138,150	7,560
NPS portion of load reduction	125,870	4,872
PS portion of load reduction	12,280	2,688
% of target load reduction from NPS	91.1%	64.4%
% of target overall load reduction from PS	8.9%	35.6%

Calculating nutrient load reductions

The NRS Science Assessment evaluated the effects of conservation practices on nutrient losses from nonpoint sources. Load reductions were calculated for the subset of practices based on the relative ability to enumerate the reductions. Efforts are underway to address the lack of data and information that would support more robust calculation of load reductions. Table 10 displays the pounds of nitrogen and phosphorus reduced by selected practices. Nitrogen reductions were calculated based on the cover crop acres reported through cost-share programs in 2015, and based on the total acres treated by CREP wetlands that had been installed in Iowa. Bioreactors were also factored in, but few have been installed to date and so the resulting reduction was negligible compared to those of cover crops and wetlands. With projects underway to address the challenges of gathering data on in-field practices adopted without government assistance programs, future practice data will likely show greater rates of nitrogen load reduction.

Phosphorus reductions from in-field practices were calculated based on cover crops, extended rotations, and no-till and reduced till practices. Calculations were conducted using cost-share data from 2012 through 2015. The adoption of these practices reduced the statewide phosphorus load by an estimated 217,884 pounds in 2015. This heightened reduction over four years was driven by the rapid rate of cover crop adoption.

Table 10: Load reductions from estimates of selected conservation practice implementation in 2014 and 2015. Nitrogen was calculated as reduction of nitrate-N. Efforts to complete the calculations of nitrogen reduction for years prior to 2015 are underway. †The phosphorus load reductions caused by CRP acres are calculated based on the change from the previous year's CRP acres. Negative phosphorus reductions indicate an increase in phosphorus load due to a decrease in CRP acres.

Nutrient Load Reduction from Select Conservation Practices partially funded through State & Federal Programs (pounds)		
	2014	2015
Nitrogen - Total		**3,830,000**
Cover Crops		23,560,000
CREP Wetlands		1,474,000
Bioreactors		6,000
Phosphorus - Total	**134,947**	**217,884**
Cover Crops	112,518	196,967
No-Till	10,622	14,229
Reduced Till	345	7
Extended Rotation	1,463	6,680
Phosphorus - annual CRP fluctuations†	-104,134	+56,311

Separate phosphorus reductions were also calculated based on the annual extent of CRP acres, which fluctuates from year to year. These reductions should be interpreted as a comparison to the previous year, because much of the retired land stayed in CRP from year to the next. However, the fluctuation in total CRP acres drove a fluctuation in the effect on phosphorus load reductions. Some CRP was removed between 2013 and 2014, resulting in a relative gain in phosphorus loads attributed to that practice. However, an increase in CRP acres between 2014 and 2015 resulted in a relative decreased in phosphorus loss attributed to the practice. In 2015, phosphorus loss was reduced by net CRP acres by an estimated 56,311 pounds. This figure will monitored annually, and stresses that conversion of CRP back to crop production can contribute to an increase in phosphorus loss from one year to the next. This assumes that CRP was returned back into row crop production and not an alternative cropping or long-term perennial use (e.g. pasture), which would have a lower impact on nutrient loss.

In the future, phosphorus reduction calculations will aim to assess the effects of terraces and other structural practices that reduce sediment loss. This is important because a large proportion of funding is directed to these practices, and has been historically; the exclusion of these practices skews load reduction estimates. Current inconsistencies among state and federal cost-share data reporting methods currently prevent the capacity to calculate standardized totals that would assist load reduction calculations. However, coordination between partner organizations aims to standardize data collection in the future to identify units that would improve the ability to calculate load reductions from these structural practices. Efforts are underway to address these challenges in data standardization. Additionally, efforts to map structural practices in priority watersheds will provide a separate database for calculations within select areas (Figure 9).

Nutrient criteria development

DNR continues to collect and analyze lake nutrient data as part of the ambient lake monitoring and the lake restoration programs. The development of quantitative indicators of lake health, including nutrient status, remains a high priority within these programs. Additionally, DNR continues to collect and analyze stream nutrient data to evaluate draft recommendations for wade-able streams and to support the development of recommendations for headwater creeks and large rivers.

Nutrient monitoring by point sources

When permits are issued to facilities listed in the Strategy they require that those facilities monitor effluent total nitrogen and total phosphorus once per week. There are currently 86 facilities listed in the Strategy that are required to monitor their effluent for total nitrogen and total phosphorus and this number will continue to grow as additional permits are issued that require this monitoring. In addition to these facilities, all cities and industries that treat the volume of wastewater generated by the equivalent of 3,001 or more people are required by rule to monitor effluent (but not raw waste) total nitrogen and total phosphorus. There are currently a total of 147 facilities monitoring for total nitrogen or total phosphorus or both and this number will continue to increase as more permits are reissued.

Treatment facility performance

At the time the NRS was developed, little monitoring data was available for the amounts of total nitrogen or total phosphorus discharged by point sources in Iowa. Assumptions were made based on respected engineering literature that Iowa POTWs treat raw wastewater that contains approximately 25 mg/l total nitrogen and 4 mg/L total phosphorus. These values were used together with a percentage of the wastewater treatment plant design flow to estimate the loads being discharged by each of the point sources listed in the strategy and assuming that facilities at that time were not removing any total nitrogen or total phosphorus. Estimates were also made of the amounts that would be discharged if the target concentrations of 10 mg/L total nitrogen and 1 mg/L total phosphorus were achieved.

Table 11: Performance by all facilities with 10 or more months of data.

	Estimate (Target)	POTW (range)	Industry (range)
Total Nitrogen (average)			
# of facilities		41	6
raw waste (mg/L)	25	28.7 (0.1 – 285.0)	107.1 (3.63 - 748.0)
final effluent (mg/L)	10	15.2 (0.2 - 220.8)	22.6 (0.0 - 15.5)
% removal	66	44.7 (10.8 - 89.1)	74.7 (60.6 - 87.3)
Total Phosphorus (average)			
# of facilities		41	9
raw waste (mg/L)	4.0	4.4 (-3.0 - 419.8)	27.5 (0.53 - 200.0)
final effluent (mg/L)	1	2.2 (0.0 - 23.9)	17.2 (0.05 - 176.0)
% removal	75	43.0 (-34.0 - 80.6)	51.4 (-40.9 - 89.2)
Annual Load Reduction (2015-2016)			
Total N (tons)	-	2,949	115
Total P (tons)	-	599	99

Results of weekly monitoring are now available for 86 facilities whose permits have been issued since the strategy was released. Data in Table 11 reflect the actual results from 41 POTWs for which at least 10 months of weekly sample results are available for both raw waste and final effluent and nine industries with at least 10 months of data for raw waste, final effluent or both. Not all industries operate wastewater treatment plants and therefore not all have raw waste data.

16 of the 41 POTWs had an average annual effluent concentration for total nitrogen equal to or less than the target of 10 mg/L while 5 had an average total phosphorus concentration equal to or less than the target of 1.0 mg/L.

Ten POTWs met or exceeded the target percent removal for total nitrogen (66%) and four met or exceeded the target for total phosphorus (75 percent) although it is likely that if data were available for Clinton that it would also show that it met these targets.

By subtracting the average pounds/day in the raw waste discharged by each POTW from the average pounds/day discharged in the final effluent then multiplying the resulting value by 365 reasonable approximations of the total pounds of total nitrogen and total phosphorus removed by each of the 41 POTWs during 2015-2016 could be calculated. Adding the calculated values for all of these individual facilities shows that they removed approximately 2,949 tons of total nitrogen and 599 tons of total phosphorus in a 12 month period. Industries removed approximately 115 tons per year of total nitrogen and 99 tons per year of total phosphorus.

Treatment performance by type of treatment

Table 12 provides a summary of raw waste, final effluent and percentage removal data for both total nitrogen and total phosphorus for the same 41 POTWs and nine industries used to develop Table 11 but breaks down the data by the type of treatment system in use today.

Table 12: Performance by treatment type for facilities with 10 months or more of data.

Treatment Type	#	Total Nitrogen			Total Phosphorus		
		Raw (mg/L)	Final (mg/L)	%R	Raw (mg/L)	Final (mg/L)	%R
POTW	41						
Aerated Lagoon	2	18.1	8.9	54.1	3.4	1.5	57.1
Activated Sludge	16	34.6	18.8	43.1	5.4	2.3	48.6
No Biological Treatment	0	0	0	0	0	0	0
Rotating Biological Treatment	3	18.7	11.6	37.5	2.5	1.6	34.1
Sequencing Batch Reactor	6	23.7	7.3	69.3	3.9	1.6	56.5
Trickling Filter	14	32.2	17.3	38.5	4.8	3.1	34.0
Industry	9						
Aerated Lagoon	0	0	0	0	0	0	0
Activated Sludge	6	65.4	22.9	68.4	19.1	8.9	59.5
No Biological Treatment	1	30.3	5.6	81.4	51.1	17	66.7
Rotating Biological Treatment	0	0	0	0	0	0	
Sequencing Batch Reactor	1	65.7	16.7	74.5	56.5	79.5	-40.9
Trickling Filter	1	350.5	44.4	87.3	25.9	5.2	80

It is difficult to draw firm conclusions from this data because so few facilities are represented for most of the treatment types. For example, while the lowest raw waste and final effluent concentrations and the second highest removal percentages for POTWs were for aerated lagoons, the data is from a single facility which may not be representative of all aerated lagoon systems. Sequencing batch reactors had the highest percentage removals with the average removal for total nitrogen slightly exceeding the target removal of 66 percent and raw waste concentrations less than typical domestic sewage. Activated sludge and trickling filter treatment plants had almost the same raw waste, final effluent and percent removals.

It is even more difficult to draw general conclusions with respect to industries because there are so few facilities represented by the data. The one industry with a sequencing batch reactor does not currently have the capability for removing biosolids from the treatment process and instead recycles them to the head of the plant. This causes phosphorus levels to continue to build-up in the effluent resulting in a negative removal efficiency; a condition one would not expect to find in other treatment systems. The reason for the high raw waste concentrations and high percentage removals for the single industry that does not have a biological treatment plant cannot be explained with the information currently available

Estimates vs actual data

The available data show that the actual raw waste concentrations of total nitrogen and total phosphorus for POTWs are only slightly higher on average than the estimates used in preparing the NRS but that those for industries are significantly higher. In the case of POTWs considerable literature was available that described the characteristics of normal domestic sewage that could be used as a starting point for preparing estimates. That was not the case for industries where the NRS acknowledged that "data on the amounts of nitrogen and phosphorus discharged by industries is not readily available but likely varies significantly based on the type of industry." Several factors can affect the nutrient content of industrial waste including:

- Type of industry;
- Production processes and flow rates;
- Whether process wastewater is treated by the industry itself or discharged to a POTW for treatment;
- Types and amounts of chemicals used;
- Government regulations

For example, phosphoric acid is the most common chemical used by food processing establishments for cleaning in order to meet USDA regulations for cleanliness. The amount of cleaning required and the type of equipment cleaned using phosphoric acid likely has a bearing on the amounts of total phosphorus in both the raw waste and final effluent. A meat processing facility will have higher amounts of both nitrogen and phosphorus due to the nature of wastewater produced than a power plant. An industry that sends its process wastewater to a municipal system for treatment and discharges only cooling water and other utility waste streams will discharge lesser amounts of nutrients than the same type of industry that treats its own process wastewater.

Perhaps the most surprising numbers in Table 12, and the greatest departure from initial estimates, is the removal percentages being achieved by some treatment facilities. It is noteworthy that significant reductions in the amounts of total nitrogen and total phosphorus occur even before most facilities have installed or implemented specific nutrient reduction measures. It was assumed at the time the strategy was developed that treatment facilities removed little, if any, total nitrogen or total phosphorus unless they were specifically designed and constructed for biological and/or chemical nutrient removal. However, the data show that POTWs on average remove about 45 percent of the total nitrogen and total phosphorus entering the treatment plant despite not having been specifically designed to do so. Industries appear to be achieving even higher rates of removal than POTWs although the data for industries represents only a small number of facilities and caution should be exercised in drawing conclusions based on this limited data.

Seasonal variability in effluent nutrient levels was expected since biological treatment plants are generally less efficient during cold weather. Figure 12 shows the variability in both raw waste and final effluent concentrations for a single POTW.

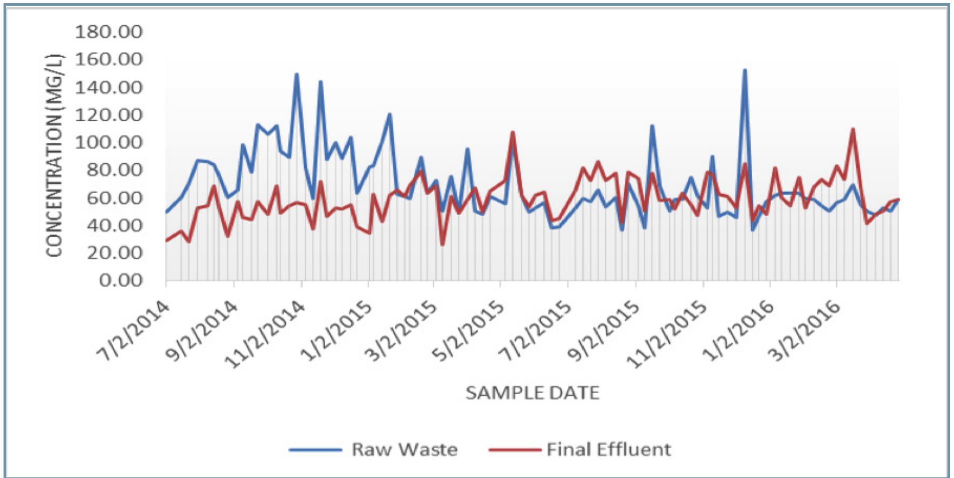


Figure 12: Seasonal variability in raw waste and final effluent total nitrogen at a Publicly Owned Treatment Works (POTW).

Updating information for point source contributions in the INRS

With data now available to calculate annual raw waste and final effluent concentrations and percent removal rates for total nitrogen and total phosphorus for approximately 40 percent of the POTWs listed in the strategy, it is an appropriate time to reassess the estimates made of the total contribution of total nitrogen and TP from major point sources, and the reductions that can be expected as treatment facilities are upgraded or replaced to include nutrient removal processes.

The NRS states that "Discharges from wastewater treatment plants contribute approximately 8% of the total nitrogen and 20% of the total phosphorus entering Iowa's streams and rivers annually." The NRS also projected that if the 147 wastewater treatment plants listed in the strategy were to meet the goals by reducing total nitrogen loads by two-thirds and total phosphorus by three-fourths that would reduce the amount of nitrogen discharged by 11,000 tons per year and the amount of phosphorus by 2,170 tons per year. These figures represented a four percent reduction in nitrogen and 16 percent reduction in phosphorus in the total estimated statewide amounts entering Iowa's rivers and streams from both point sources and nonpoint sources.

These estimates of point source load contributions were derived by multiplying raw waste concentrations of 25 mg/L total nitrogen and 4 mg/L TP by two-thirds of the average wet weather design flow for each treatment facility and assuming no removal of total nitrogen or total phosphorus by treatment plants. The concentrations were values for typical domestic sewage taken from a respected engineering text. No removal was assumed because no treatment plants at the time were known to have been constructed with nutrient removal capabilities. While it was recognized that a number of plants were designed to treat ammonia nitrogen, this process simply converts ammonia to nitrate but does not remove total nitrogen from the wastewater. Since each facilities' annual average (long-term average day) flow was unknown at the time an approximation was derived using a peaking factor table in the EPA Nitrogen Control Manual (Table 13).

Table 13: Comparison of estimated versus actual nutrient levels. *Estimated loads for POTWs at average annual flow and 25 mg/L TN and 4 mg/L TP. Industrial loads were not estimated.

Estimated or Actual	TN	TP
Estimated potential PS load reductions	11,000 T/yr	2,170 T/yr
Actual load reduction in 2015-16 for 41 POTWs and 9 industries	3,064 T/yr	698 T/yr
Estimated % removals w/BNR	66	75
Actual % removals by POTWs today	44.7	43
Actual % removals by industries today	74.7	51.4
Estimated raw waste concentrations*	25 mg/L	4.0 mg/L
Actual raw waste concentrations: POTWs	28.7 mg/L	4.4 mg/L
Actual raw waste concentrations: industries	107.1 mg/L	27.5 mg/L

The actual raw waste concentrations for POTWs for both total nitrogen and total phosphorus are quite similar (Table 13). Those for industries differ significantly. The original estimates failed to take into account the significant amounts of nutrients already being removed even though most facilities have not yet installed nutrient reduction treatment technologies.

Looking Ahead

- The list of affected facilities in Section 3.3 of the NRS will continue to be reviewed and updated annually as new facilities become subject to the strategy and facilities are dropped from the list because they are no longer meet the criteria established for inclusion.
- Permits will continue to be issued to facilities listed in the NRS that will specify requirements to complete and submit nutrient reduction feasibility studies with a goal of issuing at least 20 more permits within the next year.
- DNR will timely review nutrient feasibility studies as they are submitted and amend NPDES permits to include construction schedules for installing nutrient reduction treatment technologies. Where a feasibility study concludes that it is not feasible and/or reasonable to meet the targets identified in Section 3 of the INRS, the facility's permit will be amended to require submittal of another feasibility study 5 years from DNR's approval of the first study.
- DNR will continue to analyze raw waste and final effluent data for nutrients as data from more facilities becomes available to evaluate performance of treatment facilities both before and after operational changes are made or additional treatment is installed.
- DNR will attempt to correct and/or explain anomalies in data submitted by treatment facilities. Such anomalies can include but are not limited to the reporting of negative removal efficiencies, single high or low concentrations that are inconsistent with other reported data and apparent data entry errors.

Public comment

Iowans are invited to review the updated Iowa Nutrient Reduction Strategy and supporting documents. The Iowa Department of Agriculture and Land Stewardship, the Iowa Department of Natural Resources and Iowa State University seek to continue to broaden the engagement of stakeholders and further advance the strategy.

The public is invited to provide feedback on implementation of the strategy and comment on additional partnerships that could help strengthen the strategy and help achieve the goals of continuous improvement and broad participation by all stakeholders. The comment period will be ongoing.

Areas of focus include:

Strengthen collaborative local, county, state, and federal partnerships

- Are there additional partners with a demonstrated ability to advance implementation of nutrient reduction technologies and conservation practices to improve water quality?

Identify additional opportunities for accelerating cost effective nitrogen and phosphorus load reductions from both point and non-point sources.

- Are there additional or emerging practices and/or technologies that should be considered for inclusion in the NRS Science Assessment? The WRCC annual report on the strategy identifies a process for these new and emerging practices and technologies to be included in the list of practices.
- Are there additional delivery methods and opportunities that should be considered to increase the rate of adoption?

Electronic:
Please submit your comments at nutrientstrategy.iastate.edu/comments

Mail:
ANR Program Services
attn: Nutrient Reduction Strategy
1151 NSRIC
1029 N University Blvd.
Ames, Iowa 50011-3611

Comments and contact information submitted here are considered public and are subject to Open Records Law requests from the media or others.

Comments received to date can be found at www.nutrientstrategy.iastate.edu/public

Appendix A: Iowa Nutrient Strategy Updates Evaluation

IDALS, ISU and DNR collaborated on identifying needed updates to the text of the Iowa Nutrient Reduction Strategy. Updates were identified as necessary to keep the text of the strategy up to date based on current information and status of efforts related to the strategy. Following is a summary of the updates that were identified.

Point Source Updates:

1. Section 3 – Providing clarification to #5 New Dischargers in the Implementation Plan Details section.
2. Section 3 – Providing clarification by adding #6 Power Plants in the Implementation Plan Details section.
3. Section 3 – Providing clarification to #4 Treatment Impracticable in the Implementation Plan Details section.
4. Section 3 – Providing clarification to the "Revisions to Section 3.3 – List of Affected Facilities" section.
5. Section 3 – Annual updates to the List of Affected Facilities.
6. Section 1 – Update trading section to be reflective current efforts within the state.

Appendix B: Progress of the Conservation Practice Mapping Project

BMP Mapping for WQI Watersheds (as of June 9, 2016)											
HUC 8 Name	HUC 8	HUC Acres	HUC 12 Mapped	# Pond Dams	Grassed Waterway (acres)	# Terraces	Terraces (miles)	WASCOBs (number)	WASCOBs (miles)	Contour Buffer Strips (ac)	Strip-cropping (acres)
Boone	07100005	581,186.0	29	63	1,247.8	127	28.4	309	25.7	314.3	0.0
Floyd	10230002	586,570.0	23	168	2,840.1	13,558	2,608.6	851	37.3	1,367.9	760.8
Middle Cedar	07080205	1,545,363.0	68	671	21,109.1	5,041	842.8	2,444	223.5	8,914.1	1,528.6
N Raccoon	07100006	1,579,997.0	75	593	5,399.9	2,110	404.0	2,998	289.7	1,236.7	652.8
Skunk	07080107	1,044,443.0	11	1,165	3,740.3	2,942	417.6	7,366	323.9	1,167.6	217.1
S Skunk	07080105	1,179,099.0	15	141	2,056.5	565	84.7	808	63.4	1,064.7	78.7
Turkey	07060004	1,083,426.0	53	1,131	11,176.4	9973	1,622.1	2,793	148.7	40,537.9	7,163.9
E Nishnatbotna	10240003	734,993.0	2	109	894.3	1381	259.4	53	2.1	1,526.3	0.0
W Nishnatbotna	10240002	1,057,490.0	8	50	341.6	2713	554.3	163	8.3	879.7	6.7
Total		**9,392,567.0**	**284.0**	**4,091.0**	**48,806.0**	**38,410.0**	**6,821.9**	**17,785.0**	**1,122.5**	**57,009.2**	**10,408.6**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