WATER QUALITY TARGETING SUCCESS STORIES

How to achieve measurably cleaner water through U.S. farm conservation watershed projects

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FOREWORD

Farmers operate on 915 million acres of farmland, or about 40 percent of all land in the United States. They are critically important stewards of the soil, wildlife, and water resources sharing that landscape. The long-term viability of their farming businesses depends on the good management of these agriculturally influenced ecosystems.

But farmers are facing unprecedented challenges to meet food production demands, remain economically viable, and solve water quality problems associated with food, fiber, and energy production. Over 15,000 water bodies are listed as "impaired" because of pollution from excess nutrients associated with cropland, pastureland, grazing land, and animal feeding areas. And many more water bodies are impaired by agriculture-related sediment, livestock pathogens, and pesticides. These frequently invisible problems can limit the use of rivers and lakes for drinking water, recreational activities, aquatic habitat, and more.

These problems are solvable. With the right conservation systems placed in the right locations on the landscape, coupled with a focus on profitability rather than yields, it is possible for farmers to do well financially while reducing pollution. Numerous federal programs help farmers find the right conservation solutions for their farms. However, program shortcomings include a lack of program evaluation, limited farmer participation due to limited program funds, inefficient targeting of resources, and a focus on outputs rather than outcomes. And, only a few programs like the new Regional Conservation Partnership Program (RCPP) encourage a targeted watershed project approach that helps multiple farmers and conservation partners in a watershed to achieve measurable improvements in water quality in streams and lakes.

Water Quality Targeting Success Stories shows how conservation leaders in six watershed-scale projects worked with farmers to implement priority conservation practices and to document the resulting water quality improvements. The report identifies key factors that led to success, including having the right partners to reach and educate farmers and to operate effective water quality monitoring programs. Some projects also measured success by modeling field-level environmental outcomes. And one project documented that farmer participation led to increased farm profitability.

The leaders of hundreds of RCPP projects desire to achieve and document similar levels of success. However, these project leaders receive very little guidance on how to define, quantify, or report on environmental, social, or economic outcomes encouraged by RCPP.

This report recommends a set of actions that could be taken by USDA, EPA, Congress, charitable foundations, and the corporate supply chain communities to help RCPP projects realize their full potential. If these stakeholders make the program changes, provide the increased funding, and disseminate the technical guidance called for in this report, RCPP project leaders will be able to quantify conservation results, at both watershed- and field-scale. Not only will this demonstrate how farmers are good stewards of the land, but it will provide solid evidence that voluntary, incentive-based conservation works.

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EXECUTIVE SUMMARY

This report shows how projects in agriculturally influenced watersheds encouraged farmers to voluntarily adopt conservation practices and documented the resulting improvements in water quality. It features six successful projects. The report details how the projects achieved their results and explores how federal conservation programs can be improved to replicate this success.

Targeting conservation through watershed projects can achieve water quality outcomes

USDA's Natural Resources Conservation Service (NRCS) "provides America's farmers and ranchers with financial and technical assistance to voluntarily put conservation on the ground, not only helping the environment but agricultural operations, too."[1] This report focuses on water quality and poses two questions: how can federal conservation programs be even more successful in improving water quality, and how can those positive impacts be measured and documented?

In partnership with individual farmers, federal conservation programs have traditionally addressed agriculturally related water quality challenges by solving nutrient, sediment, pesticide, or pathogen problems on individual farms. This approach helps farmers meet their individual production and environmental goals. But successfully improving in-stream water quality often requires the actions of many individuals within the watershed to achieve a cumulative impact.

For measurable water quality improvements on a watershed scale, a more effective approach is to implement what this report is calling "outcomes-oriented" conservation, in which farmers, landowners, and partners within a watershed work together to develop a targeted watershed project that aims to achieve and document both individual farm outcomes and landscape-scale outcomes.

Such targeted watershed projects usually involve many government and nongovernment partners with expertise in problem assessment, watershed planning, and project management; farmer outreach and education; conservation planning and financial and technical assistance; and water quality monitoring (see Figure ES-1 on the following page).

Project partners within the watershed prioritize the fields and livestock areas that may be contributing disproportionate amounts of the pollutants causing the stream to be impaired. Then, in partnership with farmers and landowners managing those areas, they help operators implement practices that achieve the needed pollution reduction but are also acceptable from the farm management perspective. Prior to implementing the conservation activities, partners conduct in-stream water quality monitoring to establish baseline data so they can document water quality improvements attributable to the conservation practices over time.

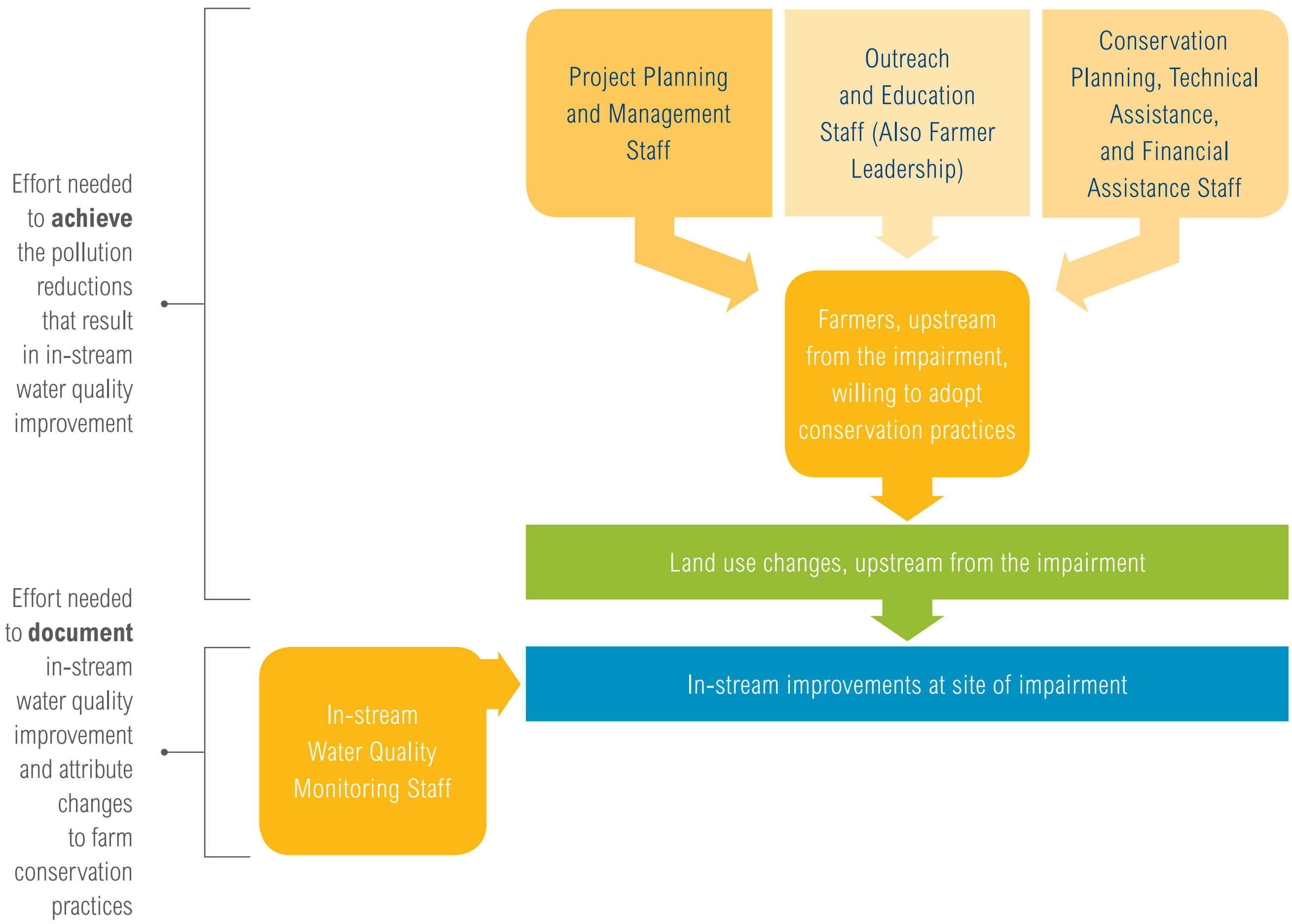
Targeting critical source areas within a project watershed not only helps achieve cleaner water but may also result in larger environmental gains than working solely with farmers who apply for assistance on their own (Meals et al., 2012c). Modeling analysis by the USDA Conservation Effects Assessment Program (CEAP) indicates that on average, "twice as much" per-acre sediment and nutrient losses can be reduced by targeting acres with "a high need for additional treatment" than by targeting acres with "a moderate level of need" (USDA NRCS, 2012a).

EPA projects monitor water quality outcomes

The Environmental Protection Agency (EPA) and its state water quality agency partners have successfully applied these targeting principles, as shown by the 674 (and counting) waterbodies that have been partially or fully restored and showcased on its "Nonpoint Source Success Stories" website.[2] The projects achieving these successes were implemented through the states' Clean Water Act Section 319 Nonpoint Source Management Programs. Other stories feature projects with waterbodies that are making "progress toward achieving state water quality goals" or achieved "ecological restoration."

Most projects focused on agricultural sources of pollution and documented water quality success due in part to partnerships with USDA and local conservation district field staff who provided additional financial and technical assistance to the farmers and landowners. Section 319 project managers are required to develop and follow a nine-element watershed-based plan, which enables effective problem assessment, subarea targeting, and deployment of a well-designed water quality monitoring program to track progress (USEPA, 2008). This planning process positions projects to be able to quantify their success through water quality outcomes.

Figure ES-1 | **Stakeholders and Changes Needed to Achieve and Document In-Stream Water Quality Improvement**



USDA NRCS is improving how the agency aims to achieve and measure outcomes

Due to supportive policy shifts in farm bill conservation programs, NRCS has improved the way it operates its farm research, demonstration, and financial and technical assistance conservation programs over the last decade. As part of these changes, NRCS began targeting specific resource concerns, such as water quality in impaired water bodies, by promoting farm conservation practices through watershed-based projects, including:

- research projects supported by the National Resources Inventory (NRI) and the Conservation Effects Assessment Project (CEAP);
- demonstration projects under the Conservation Innovation Grant (CIG) program; and
- financial assistance programs and initiatives such as the Mississippi River Basin Healthy Watersheds Initiative (MRBI), which is one of the flagship Landscape Conservation Initiatives, and the new Regional Conservation Partnerships Program (RCPP).

Many of the partners in the MRBI and RCPP watershed projects are aiming to use farm conservation practices to achieve improvements in their project streams and use in-stream monitoring to measure their conservation success (Perez and Walker, 2014; LMW, n.d.).[3] Thus, in some projects, partners are not only tracking success by counting financial assistance dollars spent and practices adopted (i.e., the traditional, administrative, and output-based metrics of success) but may also be measuring environmental and natural resource outcomes of the adopted farm conservation practices, such as:

- pollution load reductions in water bodies (e.g., nitrogen, phosphorus, sediment, pesticides, pathogens, etc.) or
- improvement in aquatic life parameters in water bodies (e.g., dissolved oxygen, water clarity, fish and macroinvertebrate counts, species abundance, habitat metrics, etc.).

Additional advances by NRCS in the MRBI and RCPP projects include offering edge-of-field water quality monitoring and prioritizing RCPP project proposals that measure the environmental, social, and economic outcomes of the adopted farm conservation practices.

NRCS also continues to use surveying and modeling techniques to assess national, regional, and state trends in land use, soil erosion, and wetlands. The 2012 NRI estimates that soil erosion has been reduced 44 percent nationwide since the first five-year survey was conducted in 1982 (USDA NRCS, 2015c). The CEAP project has used modeling techniques since 2003 to estimate the environmental effects of conservation practices on cropland in 12 very large river basins.

For example, in the Upper Mississippi River Basin, which covers parts of five states, CEAP estimates that practices designed to reduce soil erosion have reduced loadings to rivers and streams by 65 percent for sediment, 26 percent for nitrogen, and 41 percent for phosphorus. CEAP also notes that the opportunity for further improvement is significant. Targeting areas with a "high need for additional treatment"—defined as "acres most prone to runoff or leaching with low levels of conservation practice use"—could lead to an additional 74 percent reduction in sediment loads to rivers and streams, another 49 percent reduction in nitrogen, and 41 percent additional reduction in phosphorus (USDA NRCS, 2012a).

Despite the advances in NRCS conservation program design and evaluation, over 15,000 water bodies remain on the Clean Water Act's List of Impaired Waters.[4] These water bodies are impaired by excess nitrogen and phosphorus nutrients associated with cropland, pastureland, grazing land, and animal feeding areas (Hall et al., 2012).

Six projects with monitored water quality success

This report highlights successful watershed projects that have recently achieved monitored water quality improvements. The report reveals the factors that enabled them to succeed and details how they measured environmental and other outcomes. Relatively few NRCS projects have reported on documented water quality outcomes. NRCS has published three write-ups of projects associated with the Landscape Conservation Initiatives that have achieved monitored water quality outcomes. One of them, the Bay Delta Initiative (BDI), is featured in this report. The dearth of projects with monitored results may reflect

- a lack of systematic reporting to NRCS, or a lack of reporting by NRCS to the public;
- insufficient time for the MRBI projects, which began in 2010, to show results;
- projects unable to track their progress due to the technical challenges inherent to the task; or
- project unable to afford monitoring due to the increased costs or other "transaction costs."[5]

Discussions with many project leaders over the last three years indicate they are struggling to use monitoring to quantify landscape-scale success and are requesting assistance on how to define and quantify other environmental, social, and economic outcomes at a variety of scales and how to pay for that effort (LMW, n.d.).

Nevertheless, this report found six targeted watershed projects that have achieved and documented in-stream or tile drain water quality improvements through water quality monitoring:

- **CALIFORNIA'S WALKER CREEK PROJECT**—Achieved three years of no Chlorpyrifos pesticide exceedances, thereby complying with state regulations for irrigated cropland.
- **OKLAHOMA'S HONEY CREEK PROJECT**—Proposed delisting the stream (from the Oklahoma List of Impaired Waters) for *E. coli* impairment given a 51 percent load reduction, as well as load reductions in nitrate, total phosphorus, and *Enterococcus* by 35, 28, and 34 percent, respectively compared with the control watershed.
- **IOWA'S HEWITT CREEK PROJECT**—Documented a 60 percent decrease in turbidity (water cloudiness) and a 40 percent decrease in total phosphorus concentrations in the stream; quantified social and economic outcomes—e.g., created a "watershed community" and increased farmer profitability.
- **WISCONSIN'S PLEASANT VALLEY STREAM REHABILITATION PROJECT**—Proposed delisting the stream from the Wisconsin List of Impaired Waters for sediment impairment due to documented improvements in six metrics, including a 50 percent decrease in fine sediment material and increasing trout by 70 to 100 percent.
- **WISCONSIN'S PLEASANT VALLEY ON-FARM PHOSPHORUS AND SEDIMENT REDUCTION PROJECT**—Reduced total phosphorus storm event loads by 55 percent and sediment storm loads during unfrozen conditions by 66 percent, compared with the control watershed.
- **INDIANA'S SHATTO DITCH PROJECT**—Documented an 80 percent reduction in nitrate-N loss from tile drains through year-round sampling at the watershed scale.

Lessons from the successful projects

The leaders of the six projects identified factors they believed were critical to their project's success, such as identifying priority areas to target; gaining farmer and landowner participation; using modeling to quantify field- and project-scale outcomes; and ultimately quantifying water quality improvements.

Based on the case studies and the literature, the report presents 11 lessons about how project leaders developed and carried out their projects and quantified their successes:

Initiating and financing projects

- Policy signals, such as placement of a water body on a state impaired waters list or adoption of state agricultural regulatory requirements, can spur development of targeted watershed projects.
- Outreach and education, in-stream monitoring, conservation planning, and project management are all important to success, and there are alternative ways to perform those functions effectively.
- Farmer leadership can help gain buy-in, boost farmer participation, and lead to innovative and economical use of funds.
- Resources to implement the projects varied, indicating there are different approaches to covering project costs (funding was provided by federal, state, and local governments, as well as by farm trade associations, environmental organizations, charitable foundations, and corporations).
- Sustained funding is needed because project duration can be long (e.g., projects in this report range from 4 to 13 years), and the time needed for each project stage can vary.

Reducing pollution through targeted conservation practices

- Smaller watershed projects are more likely to be successful than projects spread out over large watersheds.
- Significant pollution reduction can be achieved by targeting areas with disproportionately high pollution sources.

Detecting outcomes through chemical, biological, and physical water quality monitoring

- Significant pollution reduction can be measured and reported quickly using well-designed in-stream monitoring programs in combination with effective conservation targeting.
- Regular reporting of biological and physical stream monitoring results inspires farmers and landowners and may foster a renewed land-water stewardship ethic.

Detecting field- and project-scale outcomes through in-field assessments

- Field-scale modeling tools provide farmers with agronomic and environmental information that motivates them to adopt conservation practices.
- In-field phosphorus metrics can be used to target efforts, improve farmer decision making, and evaluate environmental outcomes, and can be aggregated to report project outcomes.

Recommendations to support project success, monitoring, and quantification of outcomes

Based on the case studies of water quality successes (including the paucity of such cases), and on the insights from previous conservation targeting and water quality analyses, the report offers recommendations to help leaders of any targeted watershed project achieve and quantify in-stream water quality outcomes and other environmental, social, or economic outcomes.

Because most financial assistance to farmers participating within targeted watershed projects comes from the NRCS Landscape Conservation Initiatives and the new RCPP, these recommendations are meant to be particularly helpful to those projects and programmatic frameworks. However, given the number of stakeholders involved in helping targeted watershed projects achieve success, recommendations are also offered to project leaders, NRCS, EPA, Congress, the research community, and the charitable foundation and corporate sector communities.

The top recommendations in the report are:

- Watershed project leaders should heed available guidance on in-stream water quality monitoring and adopt appropriate field-scale modeling tools to quantify and report on modeled landscape-scale environmental outcomes.
- NRCS should provide additional guidance on water quality monitoring and quantification of environmental, social, and economic outcomes to watershed project leaders and set up a reporting system to collect success stories.
- EPA should offer training to disseminate its new 2016 guidance on water quality monitoring to help the leaders of targeted watershed projects in the Landscape Conservation Initiatives and RCPP programs develop and implement effective monitoring plans. It should also offer to help train NRCS staff to evaluate monitoring plans included in future RCPP proposals.
- The research community should analyze and better understand whether a “critical mass” of conservation practices or an “intensity” of treatment of each priority acre is needed before project leaders can expect to achieve measurable improvements in water quality.
- Congress should increase financial and technical assistance for NRCS’s Landscape Conservation Initiatives and RCPP and for EPA's Section 319 Nonpoint Source Management Program, as well as for the agenda proposed for the research community in the recommendation above.
- Charitable foundations and corporations striving to achieve sustainable supply chain goals should provide significant and sustained financial support to project leaders for project management and water quality monitoring, as well as other evaluation techniques to leverage the USDA funding and help drive this new outcomes-oriented conservation approach.

CHAPTER 1

INTRODUCTION

Nutrient and sediment pollution is widespread in U.S. streams, rivers, lakes, and estuaries. Sources include agricultural fertilizer, livestock waste, farmland soil erosion, wastewater treatment facilities, failing septic tanks, and urban and suburban runoff (USEPA, 2009). This paper focuses on agricultural sources of nutrient pollution.

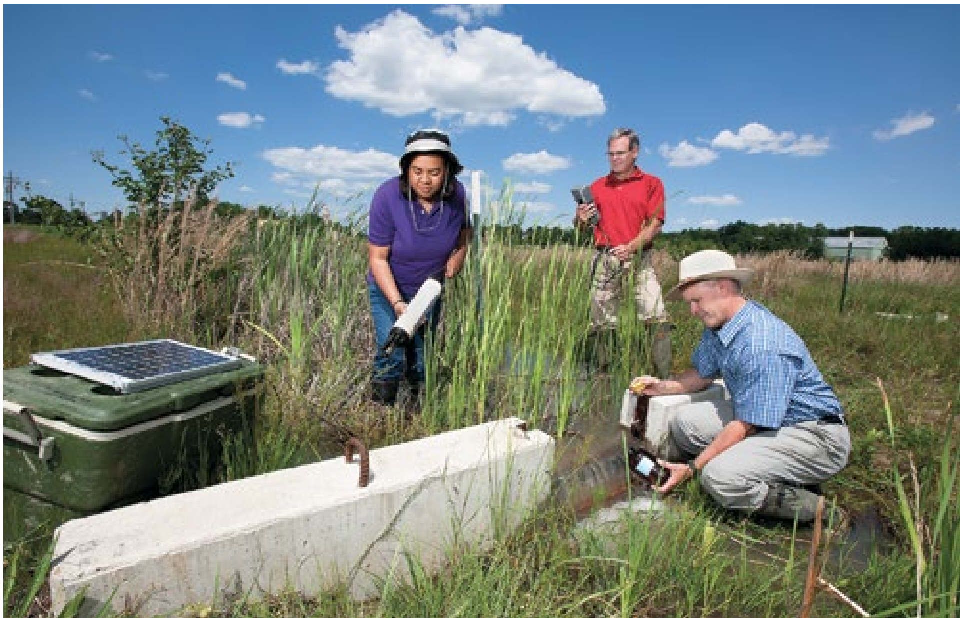
Over 15,000 water bodies are listed as "impaired" because of pollution attributed to excess nitrogen and phosphorus nutrients associated with cropland, pastureland, grazing land, and animal feeding areas, as determined by the Clean Water Act (Hall et al., 2012).[6] Many more water bodies are impaired by agriculture-related sediment, livestock pathogens, and pesticides. These frequently invisible problems limit the use of rivers and lakes for drinking water, recreational activities, aquatic habitat, and other uses.

The problems associated with nutrient and sediment pollution are garnering increasing public attention. In 2014, over 500,000 residents of Toledo, Ohio, lost their water supply when a toxic green algae bloom triggered by excess phosphorus from wastewater treatment discharge and agricultural runoff forced officials to shut down the water supply system (Yeager-Kozacek, 2014). In 2015, Des Moines Water Works, an Iowa water utility, sued agricultural drainage district managers for excess nitrogen pollution in the Raccoon River, the city's drinking water source (Meinch, 2015).

The federal government's efforts to address and ameliorate these unintended water quality consequences of agriculture are led by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Agriculture (USDA)—specifically, the Natural Resources Conservation Service (NRCS).[7] They have responded to agricultural nonpoint sources (diffuse pollution from farmland as opposed to discharge from pipes) with different approaches and funding levels, and with varying degrees of success.

Among its many activities, the EPA partners with its state water quality agency counterparts to develop state lists of "impaired waters" for water bodies that fail to meet designated uses per the Clean Water Act's Section 319 Nonpoint Source Management Program. To clean up the water bodies and remove them from the Impaired Waters List, the state agencies and their local government and nongovernment partners develop nine-element watershed-based plans. Section 319 projects, based on those watershed plans, concentrate and target EPA, state, and local funds, and often NRCS funds as well, to help farmers and landowners within the project's watershed adopt conservation practices that reduce the pollution impairing the stream. These projects follow program guidelines on watershed-based planning and water quality monitoring protocols to help them achieve the needed pollution reduction and measure the improvement in water quality.

NRCS encourages voluntary adoption of conservation practices on private lands by providing financial and technical assistance to farmers and landowners to improve their operations and benefit the environmental and natural resource conditions on individual fields, in livestock areas, and on whole farms. These conservation practices improve water quality on a field- or farm-scale, but because they can be scattered throughout a county (the jurisdiction in which the NRCS field office staff work) rather than concentrated above an impaired stream, they have gone unmonitored. Thus, we do not know the extent to which these practices are improving water quality in streams.



Within the last decade, NRCS has shifted toward programs to address agricultural issues within priority watersheds. Many of these projects now concentrate NRCS financial and technical assistance—as well as resources from state, university, and private partners—to address water quality within a watershed.

This report shares examples of projects that have achieved measurable improvements in water quality through what it calls "targeted watershed projects." Six successful projects are showcased to offer lessons on how they defined, measured, and achieved success, and recommendations are offered to key actors—including project managers, EPA, and NRCS—for supporting more outcome-oriented conservation.

Improving water quality through targeted watershed projects

A targeted watershed projects aims to

- improve and document changes in water quality in a targeted water body through a well-designed water quality monitoring program;
- target financial and technical resources to critical source areas within the watershed where a problem assessment has identified that a disproportionate amount of the agriculture-related pollutants that are causing the water body's impairment are stemming from; and
- encourage farmers and landowners operating fields and livestock facilities in these areas to adopt the most appropriate agricultural conservation practices that address the impairment but also fit the farm operation.

Over the last 30 years, numerous targeted watershed projects have been developed and implemented under an array of programmatic frameworks and with a range of goals and evaluation mechanisms. They have been led by stakeholders with a variety of expertise and have achieved different levels of success (Gale et al., 1993; Osmond et al., 2012a). Examples include:

- The Rural Clean Water Program, a 10-year joint project between EPA and USDA
- EPA's Clean Water Act Section 319 Nonpoint Source Management Program
- USDA's research grant programs (e.g., National Institute of Food and Agriculture–Conservation Effects Assessment Project)
- USDA's demonstration programs (e.g., Conservation Innovation Grants)
- State agricultural and/or water quality agency initiatives
- University extension service initiatives
- USDA's Landscape Conservation Initiatives
- USDA's Regional Conservation Partnerships Program

NRCS also has successfully used targeting and watershed planning to implement Watershed and Flood Prevention Operations Program (WFPO) projects since enactment of Public Law 83-566. Known as PL-566 projects, they are focused primarily on building or maintaining dams and other flood control and prevention structures but some also include on-farm conservation practices (see Appendix A).

EPA's approach to achieving and measuring water quality outcomes

The Clean Water Act in 1987 established the Section 319 Nonpoint Source Management Program which, directs EPA to provide grant money to state and tribal water quality agency partners to develop Section 319 projects that address diffuse nonpoint sources of pollution—such as runoff from cropland and pastureland and urban and suburban areas—as opposed to point sources of pollution from industrial and sewage treatment facilities. Section 319 projects also aim to remove streams from the state list of impaired waters. To measure the progress of Section 319 projects in cleaning up water bodies, EPA developed the Section 319 National Nonpoint Source Monitoring Program (NNPSMP) in 1991.

Among other things, the Section 319 Nonpoint Source Management Program offers the following:

- **Funding for project management** by state water quality agency staff and local nongovernmental organizations (NGOs) to match funds from state and local sources to organize Section 319 projects
- **Financial and technical assistance to farmers, landowners, and septic tank owners** (among other nonpoint sources of

pollution) within the watershed project to install conservation practices that reduce unintended pollutants to water bodies (e.g., fertilizer, manure, soil erosion from farmland or streambanks, pesticides, livestock bacteria, etc.) and correct failing septic tanks that leach nitrogen, phosphorus, and bacterial pollution

- **Funding for state water quality monitoring staff (and other monitoring or modeling partners)** and supplies to track and evaluate water quality outcomes of the Section 319 project
- **Guidance and protocols** to help Section 319 project staff develop the required watershed-based plan to initiate the project, set up rigorous water quality monitoring designs (USEPA, 1991; 2008; 2016a), and report Section 319 success stories. (See Appendix B for an outline of EPA guidance on developing a six-step, nine-element watershed plan to help project leaders effectively diagnose the water quality problem, develop conservation priorities, and design an in-stream water quality monitor system that can associate observed improvements in water quality with the management changes implemented on land.)

As of April 2017, EPA had reported that 674 water-bodies had been partially or fully restored by the Section 319 projects and published 405 corresponding success stories on its website. All 472 Section 319 success stories date back to 2005 and fall into three story categories: partially or fully restored water bodies, progress toward achieving state water quality goals, and ecological restoration.

At its highest level of funding, in 2008–10, the Section 319 program provided $201 million per year. However, in 2016, it was scheduled to provide only $164 million.[8] This funding provided resources for activities beyond the Section 319 projects themselves. Thus, the amount that EPA spends to address nonpoint sources of pollution, agriculture being a major source, is at most 40 percent of what the USDA may be spending annually on nutrient and sediment-related cropland and livestock practices (estimated at $435 million; see the "Limited funding" section below for more details). Thus, nearly $600 million in combined federal funds is spent annually to reduce agricultural nonpoint cropland and confined livestock pollution.

As of April 2017, EPA had reported that 674 waterbodies had been partially or fully restored by the Section 319 projects and published 405 corresponding success stories on its website.[9] All 472 Section 319 success stories date back to 2005 and fall into three story categories:

- **PARTIALLY OR FULLY RESTORED WATER BODIES**—After the project, the water bodies achieve some or all of their water quality standards or designated uses under the Clean Water Act.
- **PROGRESS TOWARD ACHIEVING STATE WATER QUALITY GOALS**—Water bodies are improved but do not yet meet the water quality standards required for removal from the state impaired waters list.
- **ECOLOGICAL RESTORATION**—Water bodies that were not on the impaired waters list (for unspecified reasons), nevertheless had one or more designated use, such as drinking, recreation, or fishing, restored.

Most of the success stories fall into the first category, but there are 54 success stories reflecting 95 waterbodies in the second category, and 13 success stories reflecting 13 waterbodies in the third.[10]

Section 319 projects rely on collaboration with state water quality agencies and often also include NGO partners and financial and technical assistance from local NRCS field staff. Sixty-one percent (1,968) of the 3,239 Section 319 projects initiated between 2008 and 2013 addressed agriculturally related water impairments (USEPA, 2016b). At the beginning of this study, no estimate was available for the number of Section 319 projects that used financial or technical assistance from the federal farm conservation programs. As part of a previous report, a review of the 435 success stories listed on the website in 2012 found that approximately one-third of the projects credited some of their success to USDA resources that supplemented EPA resources (Perez and Walker, 2014).[11] Recent estimates generated by EPA staff indicate that 48 percent (288/472) of all published success stories involved financial and/or technical assistance from the federal conservation programs.[12]

NRCS's traditional approach to addressing agriculture-related water quality problems

NRCS's traditional approach to addressing the unintended water pollution associated with agriculture largely focuses on voluntary financial and technical assistance conservation programs. This approach's ability to address the water quality impacts of agriculture is limited by four constraints: limited funding, limited participation, inefficient targeting, and a focus on outputs rather than outcomes.

Limited funding. Though NRCS does not regularly report spending information by nutrient or erosion resource concerns, NRCS CEAP staff calculated that spending by over 40 federal programs on nutrient and sediment practices on cropland averaged about $335 million per year from 2006 to 2011 (the most recent years of available data; Perez et al., 2014). Note that spending on water quality-related conservation practices on other types of agricultural land such as pasture, hay, and rangeland were not included in this estimate.[13] The Union of Concerned Scientists estimated that USDA's Environmental Quality Incentives Program (EQIP) alone spent $100 million per year to reduce pollution from concentrated animal feeding operations between 2002 and 2006 (Noble, 2010). Together, these rough estimates of $435 million in average annual spending to reduce nutrient and sediment water pollution from cropland and concentrated feeding operations make up only 9 percent of the roughly $5 billion provided from all USDA conservation programs annually. The rest of the spending focuses on other important resource concerns, such as water quantity, wildlife habitat, and air quality.

Limited participation. Limited funds for enticing farmers to adopt conservation practices, and even more limited technical assistance to support implementation, constrain farmer participation in the USDA voluntary conservation programs. USDA economists found that on average, only about 15–17 percent of farms participated each year from 2004 to 2010 in USDA conservation financial assistance programs addressing all resource concerns because of limited financial resources (Claassen, 2012). However, farmer interest in adopting conservation practices is high; many programs report that demand for financial assistance exceeds supply every year (EDF, 2001).

Inefficient targeting. Most important, the way USDA disburses most of its conservation funds may not lend itself well to cleaning up streams. The conservation programs supported by Congress have historically spread funding and technical assistance too thinly across the rural landscape to be able to result in the cumulative amount of pollution reductions needed to restore impaired water bodies (Walter et al., 2007; Tuppad et al., 2010; Perez and Walker, 2014). Cleanup of streams impaired by agricultural pollutants requires a targeted focus on the lands draining into the impaired streams and on critical source areas within the watershed contributing the greatest volume of the streams' pollutants (Meals et al., 2012c; Tomer and Locke, 2011). Instead of a focus on improving water quality conditions in specific streams, NRCS has traditionally focused efforts on individual farmers to help them adopt conservation practices that achieve farm- and field-scale environmental and natural resource success.

Focus on outputs rather than outcomes. With a focus on the farm rather than in the stream, USDA has traditionally quantified its achievements as outputs: financial assistance dollars spent, farmer contracts signed, acres or units of conservation practices adopted, and so on (see Box 1.1). A focus on landscape-scale environmental outcomes related to water quality would rely on improvements in water quality parameters such as lower pollutant loads (e.g., nitrogen, phosphorus, sediment, pesticides, or pathogens) and more desired aquatic life attributes of the water body to determine success (e.g., increased dissolved oxygen, improved water clarity, higher fish or macroinvertebrate counts, greater species diversity, and better habitat metrics).

BOX 1.1 | NRCS APPROACHES TO MONITORING OR MODELING OUTCOMES AT VARIOUS SCALES

This report is focused on efforts that aim to *achieve* and *measure* in-stream water quality outcomes through the voluntary implementation of farm conservation practices within specific watersheds and associated in-stream monitoring of specific streams. NRCS has recently pursued this targeted watershed project approach to improving water quality in the 2009 Landscape Conservation Initiatives and the 2014 Regional Conservation Partnerships Program (RCPP). Prior successful watershed work by the agency, focused primarily on flood control through small dam construction, is described in Appendix A.

However, NRCS has had a commitment to outcomes measurement at the national scale for decades. The agency has pursued national and state assessments of land use, soil erosion, and wetlands characteristics on nonfederal land through the National Resource Inventory (NRI) since 1982. Conducted every five years, the most recent (from 2012) NRI estimates that soil erosion nationwide is lower by 44 percent than in 1982 (USDA NRCS, 2015c). Since 2003, the Conservation Effects Assessment Project (CEAP) has provided national and regional assessments using modeling techniques to simulate the effects of farm conservation practices on cropland (and other assessments on wildlife, wetlands, and grazing lands).

NRCS has a more recent history with measuring outcomes at the watershed scale. CEAP also includes 42 watershed studies, many of which used in-stream water quality monitoring, which were initiated largely between 2004 and 2007 to gain insights into conducting farm conservation work at the watershed scale. In 2012, NRCS launched the National Water Quality Initiative (NWQI) with EPA and state water quality agencies in high-priority watersheds where additional conservation funds could complement already-existing conservation efforts, ideally in watersheds with on-going water quality monitoring programs.

NRCS continues to improve its efforts to achieve and measure outcomes at the field scale. In 2010, the Mississippi River Basin Healthy Watersheds Initiative (MRBI) allowed targeted watershed project leaders to pay for edge-of-field water quality monitoring systems through the Environmental Quality Incentives Program (EQIP) to document water quality improvements due to one or more practices on a field. In 2015, NRCS began piloting the Resource Stewardship Evaluation Tool (RSET) to improve conservation planning by helping farmers better prioritize opportunities to meet or exceed NRCS-based stewardship thresholds for water quality and other resource concerns.

These modeling and monitoring efforts to achieve and/or measure outcomes are helping to better understand the impacts of conservation practices. Additional outcomes measurement efforts—using a variety of methods at a variety of scales—could help answer the overarching question, "What are the results of the voluntary adoption of farm conservation practices aided by the financial and technical assistance provided by farm conservation programs?"

Multiple methods to address this key question are helpful, given each method has its shortcomings in approach and scale. For example, edge-of-field monitoring cannot reveal the cumulative effect of practice adoption within a watershed. The new RSET scorecard does not provide farmers with modeled estimates of the water quality benefits they are predicted to achieve at the edges of their fields, nor does it help conservation planners assess watershed-scale conservation needs to ameliorate in-stream water quality conditions. National and regional CEAP cropland modeling efforts are at very large scales and provide simulated estimates of environmental effects rather than measurement of the actual change in natural resource conditions—such as in-stream water quality in specific streams—which is the focus of this report.

NRCS's new approach to achieving monitored water quality outcomes

NRCS has initiated two new partnership-based funding frameworks since 2009 that promote targeted watershed projects and emphasize landscape-scale environmental outcomes. These efforts are an important shift away from a focus solely on farm-scale outputs to broader watershed-scale outcomes, but it is not yet clear whether they are achieving and measuring water quality outcomes.

Landscape Conservation Initiatives

NRCS launched its Landscape Conservation Initiatives program in 2009 to "more effectively address priority natural resource concerns by delivering systems of practices, primarily to the most vulnerable lands within geographic focus areas."[14] Seven initiatives focus on water quality:

- Mississippi River Basin Healthy Watersheds Initiative (MRBI)
- Great Lakes Restoration Initiative (GLRI)
- Gulf of Mexico Initiative (GOMI)
- Chesapeake Bay Watershed Initiative (CBWI)
- Illinois River Eucha-Spavinaw Initiative (IRESI)
- Bay Delta Initiative (BDI) in California
- National Water Quality Initiative (NWQI)

Each initiative involves a plethora of non-NRCS partners with local staff who possess a variety of skills, such as conservation outreach, conservation planning, and water quality monitoring or modeling.

One of the most prominent efforts is the MRBI, which in 2010, 2011, 2012, 2015, and 2016 dedicated farmer financial assistance to hundreds of projects lead by non-NRCS partners, many of whom pledged to quantify their water quality outcomes through a combination of edge-of-field, in-stream, or watershed outlet water quality monitoring.

Depending on the initiative, project applicants compete for funds from about four conservation programs[15] to provide financial assistance to farmers who agree to adopt conservation practices in the project watershed. However, the Landscape Conservation Initiatives do not provide financial support to the project leaders to cover their management or monitoring and evaluation costs. Thus, project leaders pursue funding for these multiyear costs from state or federal research or demonstration grants, or from grants from charitable foundations and corporations. Some leaders fund the project themselves through in-kind support.

Regional Conservation Partnership Program

More recently, NRCS launched a second partnership- and project-based effort to achieve measurable landscape-scale environmental outcomes. Congress enacted the Regional Conservation Partnership Program (RCPP) in the 2014 Farm Bill by consolidating several other initiatives and programs. The RCPP "encourages partners to join in efforts with producers to increase the restoration and sustainable use of soil, water, wildlife and related natural resources on regional or watershed scales . . . . Partners leverage RCPP funding in project areas and report on the benefits achieved."[16]

About half of the first year's funding for the RCPP went to targeted watershed projects that address water quality. Like the MRBI, the RCPP awards financial assistance to projects through a competitive rating process. One notable characteristic of the RCPP is that it prioritizes projects that pledge to achieve and measure environmental, social, and economic outcomes. Thus, it goes beyond the Landscape Conservation Initiatives' emphasis on landscape-scale environmental outcomes by recognizing the importance of also documenting social and economic outcomes, which helps provide quantitative proof, in addition to anecdotal evidence, of the many benefits associated with adopting conservation practices.

Why are there so few success stories from NRCS's new targeting approaches?

Achieving detectable levels of improvement in water quality parameters in streams and lakes is a complicated, resource-intensive, and time-consuming effort. Given that RCPP projects are still young, it is too early to expect results. However, many Landscape Conservation Initiatives projects, specifically the hundreds of MRBI projects, have

been under way for three to five years, and it is reasonable to expect that some would show water quality improvements.

A review of 60 percent of the awarded MRBI proposals from 2010 and 2011 found that 87 percent of the 45 projects set out to conduct in-stream or watershed outlet monitoring (or both) to measure their landscape-scale success (Perez and Walker, 2014). However, as of late 2016, NRCS had published only two MRBI success stories documenting monitored in-stream water quality improvements (USDA NRCS, 2013; 2015b). It also published one Bay Delta Initiative success story—California's Walker Creek Project—which is featured in this report (USDA NRCS, 2015a). This lack of success stories raises questions about the Landscape Conservation Initiatives projects, including the following:

- Were the intended monitoring programs put in place?
- Were the monitoring programs well-designed (e.g., did they collect at least a two-year baseline of water quality monitoring data before conservation practices were installed)?
- Is the delay due to natural lag times and/or the project leaders determining they need additional years before statistically significant results are realized?
- If there are no monitoring problems, is there a reporting problem? That is, is there a lack of reporting by the project leaders to NRCS on their documented outcome, or is NRCS not asking for such information from the project leaders?

The absence of documented success stories may be attributable to three factors: a lack of data collection on outcomes, a lack of guidance on data collection, and a confusion over the ends and the means.

Lack of data collection, communication, and information. It appears that so far NRCS lacks effective systems for receiving reports on project outcomes and communicating those outcomes to the public. As of 2016, the public knows very little about the outcomes of over 450 MRBI projects and the associated $260 million obligated to farmers.[17] NRCS has made only two announcements about these projects achieving monitored in-stream water quality improvements. Most "success stories" for these and other Landscape Conservation Initiatives projects on the NRCS website feature practices adopted by individual farmers rather than the landscape-scale effects of those practices. No information is provided about which or how many targeted watershed projects under the MRBI, the RCPP, or other Landscape Conservation Initiatives are collecting in-stream monitoring data or other outcome-oriented metrics.

Lack of upfront guidance to help projects demonstrate success. The Landscape Conservation Initiatives and the RCPP are important advances in institutional orientation for NRCS. However, they were established with insufficient guidance to help project developers deliver documented water quality success. In addition, a review of the RCPP's announcements for public funding reveals that "environmental, social, or economic outcomes" are not defined; metrics, tools, guidance, and protocols are not provided to help project developers set up effective, statistically sound outcome monitoring and evaluation plans; and no system for reporting outcomes to NRCS is stated.[18] The 2003 NRCS *National Water Quality Handbook* provides excellent in-stream monitoring guidance, but the agency has neither actively disseminated it nor provided trainings to ensure well-designed water monitoring programs are established.

Confusion of ends and means in institutional goals and identity. The state water quality agency staff who implement the EPA Section 319 program carry out conservation planning, technical assistance, and financial assistance as a means to an end: they use targeted watershed projects with water quality monitoring to accomplish their mission of delisting impaired streams. In contrast, some NRCS staff implement conservation planning, technical assistance, and financial assistance as an end in itself; they have interpreted their mission (see Box 1.2) as helping farmers solve field- or farm-scale environmental and natural resource problems. Even if NRCS is successful in fulfilling a goal of focusing only on farm-scale improvements, it may not achieve the concentrated and cumulative effect that is needed to restore in-stream water quality.

The institutional identity of NRCS is changing, as the five-year Strategic Plan (FY2011–15) announced that one of the agency's new "Performance Measures" will be to "eliminate and reduce impairments to water bodies and help prevent the designation of additional water bodies to the 'impaired' list" (USDA, 2011). Statements by NRCS Chief Jason Weller at the 2014 Soil and Water Conservation Society Conference, and by senior NRCS program staff at the 2015 Leadership for Midwestern Watersheds meetings, indicate that NRCS is trying to reframe its institutional identity and approach to conservation practices both as an end and as a means to an end. At these events, NRCS representatives stated their interest in achieving and quantifying the environmental and natural resource outcomes of its conservation programs, not just its spending outputs. This shift

BOX 1.2 | NRCS'S MISSION, VISION, AND AUTHORIZATIONS ALIGN WELL WITH WATERSHED-SCALE OUTCOMES

Trying to achieve and document in-stream improvements in water quality conditions should be viewed as well within NRCS's stated mission, which is "Helping People Help the Land." Per NRCS's policy directives, "'Help the Land' connotes that NRCS technical and financial assistance begins with an understanding of the land—the landscape as a whole." Furthermore, NRCS's vision is "Productive Lands – Healthy Environment," stating, "This is a vision of the landscape that Americans want – a landscape in which a productive agricultural sector and a high quality environment are both achieved."[1]

Furthermore, achieving and documenting in-stream success should also be viewed as meeting the conservation program authorizations provided by the Farm Bill. For example, the Farm Bill authorizes the Environmental Quality Incentives Program (EQIP), which is the primary donor program to the targeted watershed projects under the Mississippi River Basin Healthy Watersheds Initiative (MRBI) and the Regional Conservation Partnerships Program (RCPP):

> to promote agricultural production, forest management, and environmental quality as compatible goals, and to optimize environmental benefits, by – (1) assisting producers in complying with local, State, and national regulatory requirements concerning—(A) soil, water, and air quality (B) wildlife habitat; and (C) surface and ground water conservation; (2) avoiding, to the maximum extent practicable, the need for resource and regulatory programs by assisting producers in protecting soil, water, air, and related natural resources and meeting environmental quality criteria established by Federal, State, tribal, and local agencies; (3) providing flexible assistance to producers to install and maintain conservation practices that sustain food and fiber production while—(A) enhancing soil, water, and related natural resources, including grazing land, forestland, wetland, and wildlife; (B) developing and improving wildlife habitat; and (C) conserving energy; and (4) assisting producers to make beneficial, cost effective changes to production systems (including conservation practices related to organic production), grazing management, fuels management, forest management, nutrient management associated with livestock, pest or irrigation management, or other practices on agricultural and forested land.[2]

Sources: 1. USDA NRCS. 2006. Subpart A—Vision and Mission Statements and Guiding Principles. Amendment 15—October. eDirectives. https://directives.sc.egov.usda.gov/viewerFS.aspx?hid=19117
2. "Purpose of EQIP" at Sec. 1240 of the Food Security Act of 1985.

in interest responds in part to pressure from Congress, the Office of Management and Budget, and the public. However, by failing to provide guidance or to collect and report results of the Landscape Conservation Initiatives and the RCPP, NRCS is missing an opportunity to help its partners succeed and to document its ability to eliminate and reduce impairments to water bodies.

Lessons learned from previous assessments of targeted watershed projects

Many of this report's findings echo the findings of two assessments that detail the complex factors contributing to a project's ability not only to reduce nonpoint source pollution but also to measure the improvement in water quality in a specific water body.

In the first assessment, Gale et al. (1993) analyzed the lessons learned from the Rural Clean Water Program, a joint USDA-EPA effort from 1980 to 1990. Of the 21 watershed projects that implemented best management practices to reduce nonpoint source pollution and monitored water quality to evaluate the effects, only 11 reported their monitored water quality improvements.[19] Three of Gale et al.'s findings particularly resonate with this report:

- A good experimental design for water quality and land treatment monitoring is essential to document a relationship between land treatment and water quality changes. The paired watershed monitoring approach should be encouraged. (See Appendix C for four types of monitoring.)
- The critical area must be well defined and must encompass the major pollutant sources. Land treatment must be targeted to critical areas where best management practices will have the greatest effect on the primary pollutants of concern and water quality.
- Watershed-scale nonpoint source pollution control projects designed to document water quality changes due to best management practices should be funded only when there is a firm long-term commitment to water quality monitoring and evaluation.

In the second assessment, Osmond et al. (2012) analyzed 13 watershed projects implemented under the National Institute of Food and Agriculture–Conservation Effects Assessment Project. The projects aimed to "quantify the measurable effects of agricultural conservation practices on water quality patterns and trends at the watershed scale." Six projects documented changes in water quality attributable to land treatment, but none met their water quality targets. Among the study's many recommendations for project managers, seven are consistent with the recommendations in this report:

- Engage in deliberate and effective watershed planning
- Engage in deliberate conservation practice implementation
- Apply effective outreach education programs
- Improve incentives to promote conservation practice adoption
- Follow up after installation of conservation practices
- Couple water quality monitoring and land use/management tracking
- Integrate water quality monitoring, simulation modeling, and conservation practice implementation into coordinated activities that encourage communication and feedback among project participants throughout the project

About this report

This report is organized into seven chapters. Chapter 2 describes the methods used to identify targeted watershed project success stories, and Chapter 3 presents the results of the search for such projects. Chapter 4 through 9 present six case studies of the successful projects based on information collected from project leaders. Chapter 10 analyzes and compares the case studies to find lessons about developing and implementing successful watershed projects. Chapter 11 delves into challenges faced by some projects and reflects on alternative choices that projects could have made to accelerate success. Finally, Chapter 12 presents recommendations for key stakeholders in the conservation community based on the case studies and on lessons learned from past reports.

CHAPTER 2

METHODS: SEARCHING FOR SUCCESSFUL PROJECTS

Finding farm conservation projects that documented in-stream water quality improvements was not easy. We pursued many channels, including reviews of NRCS Landscape Conservation Initiatives websites and interviews with NRCS staff, literature reviews, appeals to hundreds of conservation and water quality colleagues via email and conferences, and interviews with over two dozen of those colleagues.

A targeted watershed project in an agriculturally dominated landscape, as defined in Chapter 1, identifies the critical subareas within the watershed contributing a disproportionate amount of the nonpoint pollution to the project's water body of concern; prioritizes those areas and farmers for receiving education, outreach, and if requested, on-farm conservation financial and technical assistance to achieve voluntary adoption of appropriate conservation practices to reduce pollution ailing the project stream; and monitors improvement of in-stream water quality.

To be considered a successful targeted watershed project (see Box 2.1) and be included in this report, a project had to meet a minimum of four criteria:

- In-stream water quality monitoring (chemical, biological, or physical) is present within the watershed, either within an impaired stream segment or at the watershed outlet.
- Monitoring data and statistical analysis indicate that the water quality is improving.
- The monitored improvements are linked to conservation practices adopted by farmers or landowners on farmland upstream from the monitoring locations.
- The project is either ongoing or was completed within the last two years and had not received national attention.

BOX 2.1 | DEFINING SUCCESS

This report regards monitored in-stream water quality improvement as the highest level of success for a targeted watershed project. For water bodies listed as impaired, the final goal is delisting, which can only occur when in-stream water quality improvement is measured.

However, there are also intermediate measures of success. At every stage of a targeted watershed project (e.g., project planning, financing, and management; conservation delivery and practice adoption; and measurement of outcomes), success can and should be recognized. Project success can be quantified as environmental, social, and economic outcomes and outputs. These outcomes and outputs can be measured by monitoring and modeling, or by simple survey and before-and-after comparison techniques. Furthermore, successes can be measured at a variety of scales, including within farm fields, at the edges of farm fields, from tile drains, within streams, on stream banks, at the watershed outlet, lakes or other water bodies; or at the watershed- or project-scale.

Though this report's primary focus is monitored in-stream improvements, other types of environmental, social, and economic successes unearthed during the investigation of the projects are also noted.

These criteria are consistent with EPA monitoring guidance for projects in its National Water Quality Initiative, implemented jointly with USDA.[20] The initiative encourages projects to use one of four rigorous monitoring approaches—above/below, trend, before/after, or paired watershed—to answer one of two research questions (Appendix C describes the EPA guidance and monitoring approaches):

- Have water quality-related conservation practices resulted in the observed changes in the water body?
- Have water quality conditions significantly improved over time in the water body?

This report relies on EPA monitoring guidance to identify successful targeted watershed projects because at the time of publication, NRCS had not widely disseminated water quality monitoring guidance[21] (see Box 2.2).

Any type of targeted watershed project, regardless of its programmatic framework, was eligible to appear in this report. This includes the seven water quality-related Landscape Conservation Initiatives, EPA Section 319 projects, state and federal demonstration or research grants programs, and nongovernmental organization (NGO) and university-extension-led projects. Water quality-related projects from the 2014 Regional Conservation Partnerships Program (RCPP) were not considered because they were only recently initiated.

Projects meeting the criteria for this study were sought through several channels, including the following:

- Websites for the seven water quality-related Landscape Conservation Initiatives
- Interviews with coordinators for the Landscape Conservation Initiatives and NRCS officials
- A literature review of peer-reviewed journals
- Appeals for case studies to hundreds of colleagues in conservation and water quality communities via email listservs and conferences
- Conversations with over two dozen conservation and water quality experts across the country

Twenty-three projects were initially identified; however, on closer inspection, seventeen failed to meet a minimum of four criteria (see Chapter 3), leaving six projects for further research.

To develop the six case studies, interviews with the project leaders covered nine topics:

- Descriptions of the watershed hydrology and type of farming present
- How the project got started
- Project approach, goals, and whether subwatershed targeting was involved
- Funding sources, amounts, and priority practices
- Monitoring approach and successful outcomes
- What role each institution played in the project partnership
- Key factors that project leaders say contributed to their success
- Challenges faced by the project partners
- Next steps for the project

Project leaders were interviewed by telephone and provided additional information through multiple follow-up calls and emails. Interviewees included one or more persons who filled the three key functions needed in a targeted watershed project: project management, conservation outreach or planning, and water quality monitoring and data analysis.

A review of project documents provided by websites and project leaders complemented the information collected during the telephone interviews. Each project leader reviewed multiple drafts of the case studies and comparison tables in the report and provided feedback, corrections, and comments. Limitations of the study are noted in Box 2.3.

BOX 2.2 | NRCS HAS NOT DISSEMINATED IN-STREAM WATER QUALITY MONITORING GUIDANCE TO ITS PROJECT PARTNERS

In 2003, NRCS published its *National Water Quality Handbook*, providing guidance on monitoring designs and statistical analysis for developing and implementing in-stream water quality programs. A scan of the websites for the water quality-related Landscape Conservation Initiatives and the Regional Conservation Partnerships Program (RCPP), and a review of NRCS's "Announcement for Public Funding" documents for the Mississippi River Basin Healthy Watersheds Initiative (MRBI) and Regional Conservation Partnerships Program, indicates that NRCS has not provided this handbook to project partners. The handbook is available on an NRCS website called "Water Quality Guidance Documents," where it is described as "the definitive NRCS resource for water quality technical information, guidance, and procedures."

In contrast, NRCS published and disseminated two edge-of-field water quality monitoring guidance documents in 2012. The agency provided this guidance to its MRBI project partners via webinars, press releases, and internal communications. In addition, the NRCS placed a temporary moratorium on all edge-of-field monitoring until the guidance documents could be published and disseminated. The guidance provides project leaders with the necessary technical information to ensure that well-designed edge-of-field monitoring stations are established and effective statistical analysis is conducted.

BOX 2.3 | LIMITATIONS OF THE STUDY

This report contains six case studies from California, Oklahoma, Iowa, Wisconsin, and Indiana, despite an extensive search for more. Because the sample is small, the findings may not fully represent the breadth of successful targeted watershed projects.

The report assumes that the projects' reported water quality monitoring results and conclusions were statistically credible; research for the report did not include a quality assurance/quality control review of each project. However, because the Iowa project leaders had not used one of the four water quality monitoring designs identified by EPA, Dr. Jean Spooner, a water quality monitoring expert from North Carolina State University's Water Quality Group,was contacted to help conduct additional statistical analysis. Future analyses and monitoring efforts by the NRCS and others should consider adopting a quality assurance/quality control process (as required by the EPA) to verify that reported results are as robust and accurate as possible.

Additional analyses

In addition to searching for water quality targeting success stories, this report draws from past targeting and water quality analyses, information gathered at annual conferences and meetings, reviews of meeting proceedings, and new literature reviews. Sources include the following:

- Leadership in Midwestern Watershed's annual meeting summaries (2011–16)
- Seminal farm conservation and targeted watershed project reports by Gale et al. (1993) and Osmond et al. (2012)
- Request for proposals (RFPs) from the Mississippi River Basin Healthy Watersheds Initiative (2009, 2010, 2011, 2012, and 2015) and annual progress reports (2010–14)
- Announcement for Public Funding (APFs) from the Regional Conservation Partnerships Program (2014/2015, 2016, 2017, 2018)
- The National Water Quality Initiative's website for guidance on water quality monitoring
- Numerous EPA guidance documents on geographic targeting (USEPA, 1993a), watershed planning and monitoring (USEPA, 1993b; USEPA, 1991; USEPA, 2008), and Section 319 National Nonpoint Source Monitoring Program projects (USEPA, 2011)
- Analyses of "precision (target) conservation" issues (Delgado et al., 2011; Carey, 2013; MDA, 2013)
- Key analyses on targeting and identifying critical source areas in watersheds (Meals et al., 2012b; Walter et al., 2007) and water quality monitoring of conservation practices (Meals et al., 2010; Meals et al., 2012a, 2012b, and 2012c; Tomer and Locke, 2011)
- USDA Economic Research Service reports on better targeting (Hansen and Hellerstein, 2006)
- Three water quality targeting analyses by Perez and Walker (2014); Perez et al. (2014); and Walker and Perez (2014)

CHAPTER 3

RESULTS OF THE SEARCH FOR SUCCESSFUL PROJECTS

Although a wide net was cast to find projects that had achieved and documented in-stream water quality improvements, only 23 were found. After investigating them further, only 6 projects met the report's criteria.

Of the 23 potential candidate projects initially identified, 17 were eliminated for the following reasons:

- Lack of water quality data:
    - One project had not yet fully established its monitoring program.
    - Two projects had not yet detected a positive change in water quality.
    - Four projects did not describe any water quality monitoring.
- One project did not have any on-farm practices, though there was positive in-stream monitoring due to in-stream restoration.
- Three projects were too "old" or had already extensively publicized their successful monitored outcomes. One was completed in 2005 and one in 2007. The third is ongoing but focuses on groundwater.
- Four projects had only edge-of-field monitoring success.
- One project used only modeling to estimate outcomes.
- Two projects had problematic geographic targeting issues: Although there was monitoring data, the newly implemented conservation practices were in an area of the watershed that was not hydrologically linked to a monitoring station.

Six targeted watershed projects achieved and documented in-stream or tile drain water quality improvements through water quality monitoring and are featured in this report:

- **CALIFORNIA'S WALKER CREEK PROJECT**—Achieved three years of no Chlorpyrifos pesticide exceedances, thereby complying with state regulations for irrigated cropland. This project is part of the Bay Delta Initiative, which is a project of the Landscape Conservation Initiatives.
- **OKLAHOMA'S HONEY CREEK PROJECT**—Proposed delisting Honey Creek from the Oklahoma List of Impaired Waters for *E. coli* impairment given a 51 percent load reduction, as well as load reductions in nitrate, total phosphorus, and *Enterococcus* by 35, 28, and 34 percent, respectively, compared with the control watershed.
- **IOWA'S HEWITT CREEK PROJECT**—Documented a 60 percent decrease in turbidity (water cloudiness) and a 40 percent decrease in total phosphorus concentrations in the stream and quantified social and economic outcomes (e.g., created a "watershed community" and increased farmer profitability).
- **WISCONSIN'S PLEASANT VALLEY STREAM REHABILITATION PROJECT**—Proposed delisting the stream from the Wisconsin List of Impaired Waters for sediment impairment due to documented improvements in six metrics, including a 50 percent decrease in fine sediment material and increasing trout by 70 to 100 percent.

- **WISCONSIN'S PLEASANT VALLEY ON-FARM PHOSPHORUS AND SEDIMENT REDUCTION PROJECT**—Reduced total phosphorus storm event loads by 55 percent and sediment storm loads during unfrozen conditions by 66 percent, compared with the control watershed.
- **INDIANA'S SHATTO DITCH PROJECT**—Documented an 80 percent reduction in nitrate-N loss from tile drains through year-round sampling at the watershed scale.

Landscape Conservation Initiative Projects

Because the Natural Resources Conservation Service's (NRCS's) Landscape Conservation Initiatives, launched in 2009 to conduct partner-led projects and in some cases monitor water quality results, the study team looked hard among its seven initiatives for projects with documented success. However, only two projects were found that met the initial screening criteria.

Gathering information about the projects under each initiative proved difficult because of a lack of systematic public project reporting. Furthermore, the initiatives' websites do not publish success stories about projects that have achieved and documented monitored water quality improvements. Given the lack of publicly available information, phone interviews with the director of the Landscape Conservation Initiatives and the coordinators of each initiative were conducted, which led to additional interviews with state NRCS staff and their partners in federal and state agencies and universities. The results of those investigations for each water quality-related initiative are reported below.

Mississippi River Basin Healthy Watersheds Initiative. (Arkansas, Illinois, Indiana, Iowa, Kentucky, Louisiana, Minnesota, Mississippi, Missouri, Ohio, South Dakota, Tennessee, Wisconsin). A review of the database supplied during an interview with the NRCS Mississippi River Basin Healthy Watersheds Initiative program coordinator suggests that almost half the initiative's projects may be attempting to detect environmental outcomes through some form of water quality monitoring (edge-of-field, in-stream, or watershed outlet).

Forty-one of the 100 projects reported conducting in-stream and/or watershed outlet monitoring: 28 projects had in-stream monitoring only and 13 projects had both in-stream and watershed outlet monitoring.[22] However, because there was no information about project status and no contact information for project leaders, it was not possible to ascertain whether projects were already detecting and quantifying water quality improvements.

Bay Delta Initiative (California). An interview with the Bay Delta Initiative coordinator proved fruitful since he knew that NRCS had just published a factsheet on the one success story associated with this initiative: Walker Creek Project. This project is featured in this report.

Great Lakes Restoration Initiative (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, Wisconsin). Interviews with the Great Lakes Restoration Initiative coordinator and U.S. Geological Survey partners, and conversations with researchers at Heidelberg University in Ohio, indicate that the project's monitoring is mostly edge-of-field, and Heidelberg's water-shed outlet monitoring is not yet showing water quality improvements.

Chesapeake Bay Watershed Initiative (Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia, District of Columbia). The leaders of all six watershed-based projects were interviewed in 2011 and 2012 during investigations for a report on the Mississippi River Basin Healthy Watersheds Initiative.[23] None of the projects was monitoring water quality (outlet, in-stream, or edge-of-field). The 2014 Farm Bill discontinued the Chesapeake Bay Watershed Initiative and made the Chesapeake one of the nation's Critical Conservation Areas under the new Regional Conservation Partnerships Program. State coordinators with information about water quality monitoring outcomes from three Chesapeake Bay Showcase Watershed Projects in Maryland, Virginia, and Pennsylvania could not be reached during the research for this report.

Illinois River/Eucha-Spavinaw Watershed Initiative (Arkansas, Oklahoma). NRCS Landscape Conservation Initiatives coordinators indicate that statistically significant improvements in water quality are occurring, particularly for in-stream pathogens, in this poultry and beef cattle pasture-dominated watershed on the Arkansas-Oklahoma border. However, the latest summary analysis was reported by the Oklahoma Conservation Commission in 2012—just one year after the NRCS initiative was launched. Improvements noted in the report are likely the results of Section 319 projects long under way (which also benefited from USDA funding from the Environmental Quality Incentives Program).

Gulf of Mexico Initiative (Alabama, Florida, Louisiana, Mississippi, Texas). NRCS headquarters staff did not know of any projects reporting water quality changes. They reported hearing from state NRCS offices that staff had met their "treatment goals and that people weren't really walking in the door anymore" (i.e., farmers appeared uninterested in further participation in conservation programs). Staff felt "coverage had been reached and they had treated everything they wanted to treat."[24]

National Water Quality Initiative (50 states, the Caribbean Basin, Pacific Basin). The National Water Quality Initiative was launched in 2012 as a partnership between EPA, NRCS, and state water quality agencies. Each of the 50 states is encouraged to identify one or more watersheds in which to direct initiative funding (i.e., Environmental Quality Incentives Program funds) for projects that, ideally, are already under way and have water quality monitoring in place. EPA has provided written guidance to the state's water quality agencies to encourage and outline their engagement in the initiative. In addition, it has posted several technical webinars on the National Water Quality Initiative website that provide guidance and education on effective water quality monitoring, some of which is featured in this report (see Appendix C).

The NRCS's National Water Quality Initiative coordinator provided a few short reports on completed projects.[25] However, this information either did not mention water quality monitoring or did not mention monitored outcomes. Careful investigation into a few promising projects revealed that while they had monitoring in place, the conservation practices were in locations that were not hydrologically linked to the monitoring stations and thus their potential impact on in-stream water quality could not be assessed. Interviews with National Water Quality Initiative staff found that states report the results of their project efforts to EPA as part of their annual Section 319 Program reporting, but results were not publicly available yet.

CASE STUDIES: SIX WATER QUALITY TARGETING SUCCESS STORIES

This section presents six case studies that describe how project leaders developed, financed, and implemented their projects and how they measured success. Each case study is organized into nine sections:

- The watershed hydrology and type of farming present
- The impetus for the project
- The project's approach and goals, and whether watershed targeting was involved
- Funding sources, amounts, and priority practices
- The monitoring approach and successful outcomes attained
- What role each institution played in the project partnership
- Key factors that project leaders identified as contributing to their success
- Challenges faced by the project partners
- Next steps for the project

CHAPTER 4

CALIFORNIA WALKER CREEK PROJECT CASE STUDY

A small 27,000-acre watershed project in northern California eliminated periodic exceedances in pesticide levels through a combination of leadership by area farmers, early implementation of requirements in the management plan by the local conservation district, and intensive outreach to the agricultural community to gain stakeholder buy-in.

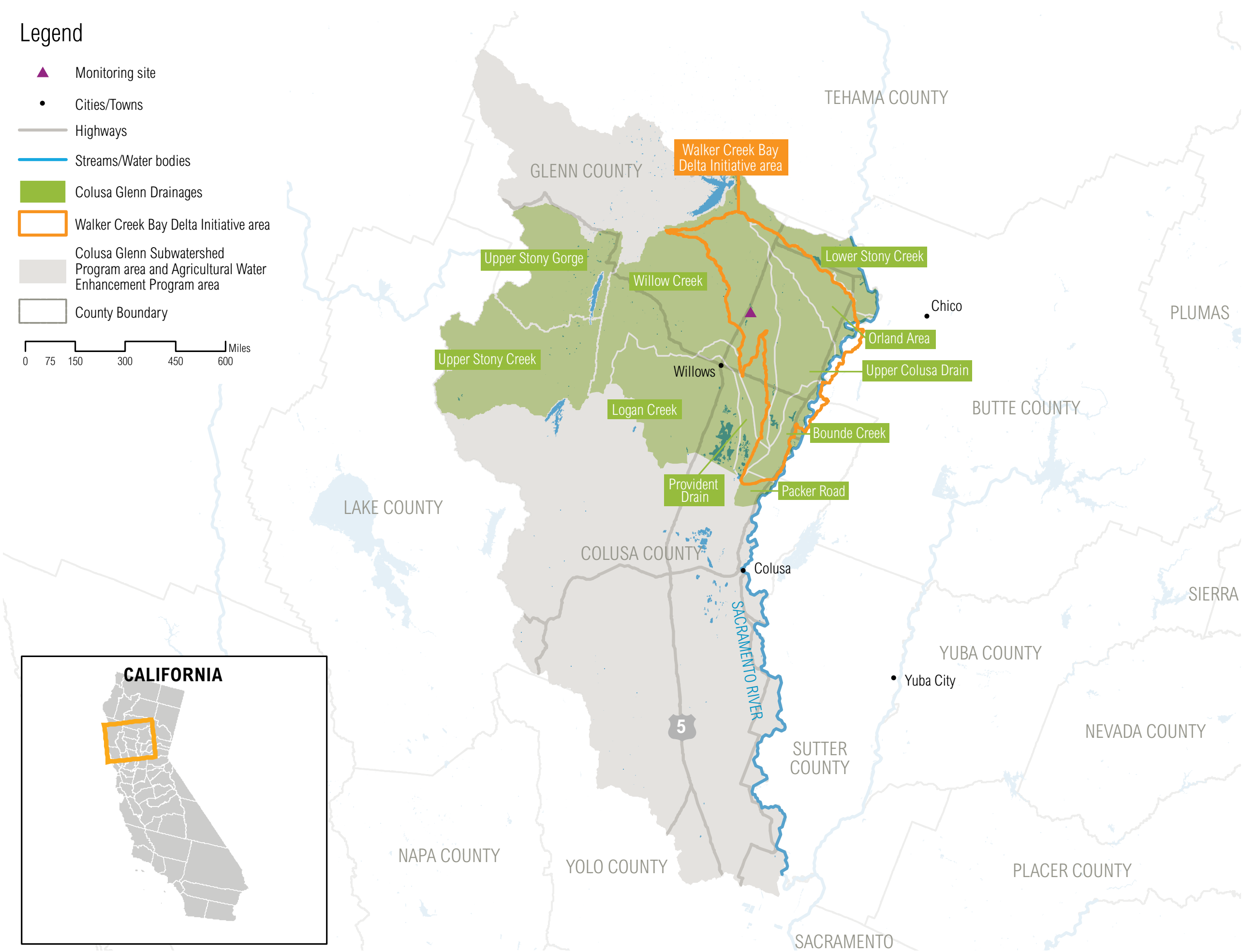
About the Watershed

Walker Creek is a small, 27,000-acre watershed in Glenn County, Northern California, within the 187,000-acre Willow Creek drainage area. About 300 farmers and landowners produce tree nut crops (mostly almonds and walnuts), rice, and alfalfa in the Willow Creek area. About 1,800 farmers operating 300,000 irrigated acres in Glenn County and neighboring Colusa County make up a regulatory jurisdiction called the Colusa Glenn Subwatershed Program (see Figure 4.1).

Most of the western areas of both counties are steep hills unsuitable for farming, while the eastern areas bordering the Sacramento River are low lying, highly productive agricultural fields. Given California's lack of rainfall between May and October, surface water irrigation is critical to farm production. The Central Valley Water Project supplies this water.

Three exceedances of EPA water quality standards (greater than 0.015 micrograms per liter [µg/L] or parts per billion [ppb])of the insecticide Chlorpyrifos were detected in Walker Creek in August and September 2007 and July 2009.[26] It was determined that Chlorpyrifos was toxic to *Ceriodaphnia* (water flea), a common sensitive organism representative of important, low ecological trophic levels on the food pyramid, in the September 2007 sample.[27] Chlorpyrifos is one of the most widely used organophosphate pesticides that is toxic to aquatic organisms (USDA NRCS, 2015a).

Figure 4.1 | **Map of the California Walker Creek Project**



The California Walker Creek Project, the Bay Delta Initiative area, and the Chlorpyrifos monitoring station.
Source: WRI, with data provided by Kandi Manhart, Glenn County Resource Conservation District.

Project Impetus

Before the exceedances were detected, California Farm Bureau leaders were already responding to the state's 2003 Irrigated Lands Regulatory Program, which sought to improve water quality. The new regulatory program subjected all irrigated agricultural acres in the Central Valley, from just south of Bakersfield to the Oregon border, to water quality regulations. The program, implemented by the Central Valley Regional Water Quality Control Board, encouraged the agricultural industry to form water quality coalitions made up of growers and smaller subwatershed groups to assist farmers with compliance. Fourteen such coalitions have formed since 2003.[28] The Sacramento Valley Water Quality Coalition located north of San Francisco, from the Bay Delta to the Oregon border, includes the Colusa Glenn Subwatershed Program as one of 13 subwatershed groups.

Larry Domenighini, then Glenn County Farm Bureau president and mayor of the city of Willows (2015), concluded that it was better for farmers to comply with the state law by forming the recommended farmer-led subwatershed groups than try to comply by themselves.[29] Domenighini spent hours explaining the Irrigated Lands Regulatory Program to farmers, offering them two options: join the Sacramento Valley Water Quality Coalition/Colusa Glenn Subwatershed Program and come into compliance as a collaborator with support and "great customer service," or go it alone with the Central Valley Control Board administrators. Eventually, the Colusa Glenn Subwatershed Program formed with five unpaid, elected board members, all of whom were past or present County Farm Bureau presidents or officers.

For farmers and landowners of irrigated acres in Colusa and Glenn Counties, complying with the state's Irrigated Lands Regulatory Program meant enrolling in the Colusa Glenn Subwatershed Program and paying membership dues ($0.50 per acre plus $25 per farm operation annually). The program retained a third of the dues; a third went to the Central Valley Control Board; and a third went to the Sacramento Valley Water Quality Coalition for management of the Irrigated Lands Regulatory Program. Part of the payment to the Coalition went to a consulting firm, Larry Walker Associates, to set up eight in-stream water quality

monitoring sites throughout the Colusa Glenn Subwatershed Program area. In 2007, the Colusa Glenn Subwatershed Program created a partnership with the Glenn County Resource Conservation District to help implement the Irrigated Lands Regulatory Program by providing outreach and educational services, including a point person to act as a subwatershed coordinator.

Project Approach, Goals, and Targeting

The detection of two Chlorpyrifos exceedances in 2007 at the Walker Creek monitoring station triggered the Irrigated Lands Regulatory Program's requirement for a source evaluation report (SVWQC, 2010a; 2010b) and a management plan (SVWQC, 2011) to address possible agricultural sources and ensure that exceedances did not recur. In November 2007, several stakeholders already participating in an ongoing pilot program to implement the Irrigated Lands Regulatory Program, including the Colusa Glenn Subwatershed Program, the Glenn County Conservation District, and the Glenn County Agriculture Department, analyzed the pesticide use reports that farmers must file with the California Department of Pesticide Regulation.[30] The analysis aimed to identify the fields in the watershed where Chlorpyrifos had been applied 30 days prior to the August and September exceedances.

Outreach calls and meetings first targeted the 40 landowners located above the Walker Creek monitoring site, especially those with property

Figure 4.2 | **Stakeholders Conduct a Watershed Tour and Visit the Walker Creek Monitoring Location**

The Colusa Glenn Subwatershed Program and the Glenn County Resource Conservation District engaged various federal, state, and local agricultural stakeholders throughout the duration of the project.

adjacent to the creek. Almond, walnut, and alfalfa growers, the primary users of Chlorpyrifos, were also targeted for calls and meetings. Over the years, the 131 Chlorpyrifos users in the larger Willow Creek drainage area, or about half the farm operations (300) in the watershed, were directly contacted (Guy, 2013; see Figure 4.2).

After the detection of Chlorpyrifos exceedances, farmers heard reminders about proper pesticide management techniques from chemical providers at many outreach and education workshops.

During an early 2008 meeting, the Glenn County Agriculture Department presented its analysis of the pesticide use reports, which included a map of fields where Chlorpyrifos had been applied prior to the exceedance. One farmer raised his hand and said, "I think it was me," explaining that his aerial application of Chlorpyrifos might have veered too close to the creek, directly depositing pesticide in the water.

According to Domenighini, such an admission was likely possible only because the farmer felt safe in the group. Over several meetings, the stakeholders encouraged farmers to reread pesticide-use labeling information and to redouble their commitment to practical pesticide handling, use, and management practices (e.g., not applying on windy days, not irrigating immediately after application, and using on-the-ground application techniques on fields next to ditches or surface water rather than aerial application).

In 2010, the source evaluation report developed by Larry Walker Associates, in cooperation with the Colusa Glenn Subwatershed Program, the Glenn County Agriculture Department, and the conservation district, concluded that agriculture was the probable source of most of the three exceedances, based on the timing and methods of Chlorpyrifos application and irrigation. In August 2011, the same group published a management plan focusing not only on Chlorpyrifos users in the Walker Creek drainage area, but on all Chlorpyrifos users with irrigated acres in 10 drainage areas that account for about half the Colusa Glenn Subwatershed Program jurisdiction.

The management plan required the following:

- Notification (through calls, meetings, and newsletters) that an exceedance was detected
- Mandatory attendance by all farmer members of the Colusa Glenn Subwatershed Program at outreach and educational workshops where pesticide management options were reviewed
- Completion of farmer surveys to "document awareness of the water quality problems and management practice alternatives, changes in practices and pesticide use"
- Reports on pesticide use to document changes in use and patterns
- Encouragement of farmer adoption of priority conservation practices to lessen the likelihood that another exceedance would occur
- Three consecutive years with no detected Chlorpyrifos exceedances, and five consecutive years with no detected *Ceriodaphnia* toxicity, in order for the management plan to be deemed "completed" by the Central Valley Regional Water Quality Control Board

The Walker Creek drainage area is known as the "representative drainage or site" and is the only area in the watershed where water quality monitoring for Chlorpyrifos is conducted. The management plan identified 10 other drainages adjacent to and within Colusa and Glenn Counties where Chlorpyrifos is used. These 10 areas are called "represented drainages," and their water quality is not monitored because the control board decided that Walker Creek monitoring will provide an adequate picture of water quality across the represented drainage area. The management plan encourages Chlorpyrifos users (as well as non-Chlorpyrifos-users who operate irrigated acres) in all 11 drainage areas to adopt priority conservation practices that could be cost-shared by federal conservation programs. Together, these 11 drainage areas make up about 38 percent of the 300,000 irrigated acres in Colusa and Glenn Counties.

Funding Sources and Priority Practices

Kandi Manhart, executive officer with the Glenn County Resource Conservation District and coordinator of the Colusa Glenn Subwatershed Program led development of two financial assistance requests:

- $6 million (2010–14) from the USDA Agricultural Water Enhancement Program, available to any farmer in the subwatershed program area;[31] and
- $1.8 million (2012–14) from the California Bay Delta Initiative's earmarking of Environmental Quality Incentives Program funds, available only to farmers in the Walker Creek drainage area and the 10 represented drainage areas nearby.

Payments to farmers in the Walker Creek watershed were not tracked locally, and thus Walker Creek–specific statistics—such as number of contracts, acres, and practices within the watershed—are unavailable.

Although $7.8 million was allocated under the NRCS's Agricultural Water Enhancement Program and Bay Delta Initiative, just over half ($4 million) was paid out to farmers. The $4 million covered 82 conservation contracts (about 5 percent of the 1,800 growers in the Colusa Glenn Subwatershed Program) and addressed 7,379 acres (about 2 percent of the 300,000 irrigated acres in the Colusa Glenn Subwatershed Program). The $4 million also helped pay for conservation practices counted as units rather than acres: sediment basins, well decommissioning, microsystems, sprinkler systems, and tailwater recovery systems (exact figures are not available). Data specifying the number of funding recipients that were Chlorpyrifos users, or the number of Chlorpyrifos-applied acres that were treated with conservation practices, was not available.

The source evaluation report and the management plan determined that the primary pathways of Chlorpyrifos to water bodies was through irrigation tailwater discharges (i.e., water runoff from irrigated fields) and wind drift from aerial applications of pesticides (Guy, 2013). Though data on specific acres or units of conservation practices

Figure 4.3 | **Almond Orchards without and with Cover Crops**

Almond orchard without cover crops shows bare soil (left), but cover crops (right) slow tailwater discharge from irrigation or runoff from rainfall and trap the Chlorpyrifos pesticide, nutrients, and sediment before the pollutants enter ditches or streams.

adopted in the Walker Creek watershed were unavailable, the most commonly adopted priority practices were:

- Conversion of surface water irrigation systems to more efficient sprinkler, micro, or drip irrigation systems
- Irrigation water management practices
- Integrated pest management
- Avoidance of aerial application of pesticides near surface waters
- Field borders (planting vegetation around fields)
- Cover crops (see Figure 4.3.)
- Nutrient management[32]

Project leaders estimated that 37 percent of the total project costs from 2007 to 2015 were associated with project management activities; 59 percent provided financial assistance to farmers and landowners, including out-of-pocket costs; and just 4 percent covered water quality monitoring, data management, and statistical analysis costs (see Table 4.1).

Monitoring Approach and Successful Outcomes

To help the Colusa Glenn Subwatershed Program comply with the Irrigated Lands Regulatory Program, Larry Walker Associates developed a long-term monitoring program (2004–07) using eight monitoring sites within the subwatershed. Coincidentally, in 2007—the same year Chlorpyrifos exceedances were detected at the Walker Creek station—the Central Valley Control Board agreed with the Colusa Glenn Subwatershed Program's request to discontinue five of the eight monitoring sites to focus on the Walker Creek site in Glenn County and two other sites in Colusa County.

The monthly sampling conducted by Larry Walker Associates detected Chlorpyrifos greater than the 0.015 µg/L (ppb) water quality objective in August

Table 4.1 | **Project Cost Estimates for the California Walker Creek Project, 2007–15**

DIRECT FUNDING	PROJECT MANAGEMENT (DOLLARS)	FINANCIAL ASSISTANCE TO FARMER (DOLLARS)	WATER QUALITY MONITORING (DOLLARS)	TOTAL FUNDING (DOLLARS)	PERCENT OF FUNDING
Natural Resources Conservation Service (NRCS) Bay Delta Initiative (BDI) (3 years: 2012–14)	150,000	1,496,992		**1,646,992**	24
NRCS Agricultural Water Enhancement Program (AWEP) (4 years: 2010–13; 2014 Inactive; Glenn County only)	200,000	1,717,703		**1,917,703**	28
Sacramento Valley Water Quality Coalition/Larry Walker Associates (10 years: 2006–15)			300,000	**300,000**	4
Colusa Glenn Subwatershed Program/ Glenn County Resource Conservation District (9 years: 2007–15)	360,000			**360,000**	5
IN-KIND SOURCES					
Farmers receiving BDI funds (3 years: 2012–14)[a]		374,248		**374,248**	5
Farmers receiving AWEP funds (4 years: 2010–13; 2014 Inactive; Glenn County only)[b]		429,426		**429,426**	6
Colusa Glenn Subwatershed Program Board of Director Outreach (9 years: 2007–15)	17,600			**17,600**	0.3
Glenn County Department of Agriculture (5 years: 2010–14)	625,000			**625,000**	9
Glenn County Resource Conservation District/Watershed Coordinator—AWEP (5 years: 2010–14)	14,976			**14,976**	0.2
Sacramento Valley Water Quality Coalition—AWEP (5 years: 2010–14)	1,139,710			**1,139,710**	17
University of California Cooperative Extension—AWEP (5 years: 2010–14)	4,000			**4,000**	0.1
Total	**2,511,286**	**4,018,369**	**300,000**	**6,829,655**	100
Percent	37	59	4	100	

a. For in-kind BDI and AWEP estimates of farmer contribution; it is estimated NRCS pays 75 percent while the farmers pay 25 percent of conservation practice.

b. For in-kind AWEP; these numbers reflect only those relevant to the Walker Creek Project.

and September 2007 and in July 2009 at the Walker Creek monitoring station. Only the September 2007 sample both exceeded Chlorpyrifos limits and was toxic to *Ceriodaphnia*.

Monitoring design. Because the exceedance occurred at the Walker Creek station (the representative drainage for 10 other drainages in Glenn and Colusa Counties), a representative and long-term monitoring design was developed to characterize water quality and detect exceedances of Chlorpyrifos and *Ceriodaphnia* toxicities.

Sampling regime. The Walker Creek station is located just north of the city of Willows, near a bridge over a public road. Monthly water and sediment grab samples are collected from January to September—the months that Chlorpyrifos is used in the production of almonds, walnuts, and alfalfa. About 11 samples are taken every year.

Water quality outcomes. Given that no Chlorpyrifos exceedances were detected for three years (2010–13), and no *Ceriodaphnia* toxicity was detected for five years (2008–13), the Sacramento Valley Water Quality Coalition requested that the management plan be deemed complete in 2013 (Guy, 2013). A year later, the Central Valley Regional Water Quality Control Board concluded the management plan had been completed (Creedon, 2014).

Cost of monitoring. Larry Walker Associates estimates that monitoring costs averaged about $30,000 per site per year, including sampling, analysis, and data management costs for a total of $300,000 over 10 years. This estimate excludes the costs of developing and implementing the management plan.

Project Partnerships

In addition to the project partners listed in Table 4.2, many farmers and landowners in the Walker Creek and Willow Creek drainage areas as well as the larger Colusa Glenn Subwatershed Program area volunteered to participate in the project, making the measured environmental outcomes possible.

Key Factors Contributing to Success

Project leaders said that the keys to the success of their project were the leadership role played by the area farmers, the management of the watershed plan by the conservation district, and intensive outreach to the agricultural community.

Farmer leadership convinced farmers to comply with regulations

Kandi Manhart, executive officer with the Glenn County Resource Conservation District and coordinator of the Colusa Glenn Subwatershed Program, credited the actions of the five Farm Bureau leaders in Colusa and Glenn Counties, who

Table 4.2 | **Partners in the California Walker Creek Project**

NAME	TYPE	ROLE
Colusa Glenn Subwatershed Program	Nonprofit 501(c)6 organization	Led by five elected current or past county Farm Bureau presidents or officers. Credited with early and ongoing leadership to convince farmers to join the program and come into compliance with the new Irrigated Lands Regulatory Program as a group. Lead: Larry Domenighini (president).
Glenn County Resource Conservation District	Special district of the State; directors are appointed by county government	Instrumental in providing additional outreach and communications to members of the subwatershed program and to all the major agricultural stakeholders in the Colusa Glenn Subwatershed Program area. Provided help completing required forms and surveys and bringing in financial assistance for adoption of conservation practices. Lead: Kandi Manhart (coordinator).
Glenn County Department of Agriculture	County office of state government	Conducted the analysis of the pesticide use reporting, allowing stakeholders to identify fields with Chlorpyrifos application prior to two summer exceedances. Introduced GIS analysis into local subwatershed program activities and was part of the pilot program memorandum of understanding between the Central Valley Regional Water Quality Control Board, California Department of Pesticide Regulation, State Water Board, and Butte County Agriculture Department.
Natural Resources Conservation Service (NRCS) field staff in Colusa and Glenn Counties	Federal government	Gave presentations at the many workshops about appropriate conservation practices to minimize the risk of exceedances, provided the conservation planning that accompanies applications for practices cost-shared by Agricultural Water Enhancement Program (AWEP) and Bay Delta Initiative Environmental Quality Incentives Program (EQIP) funds, managed the application paperwork, and disbursed the funds.
Sacramento Valley Water Quality Coalition	One of 14 state water quality coalitions	Provided facilitation and liaison between Central Valley Regional Water Quality Control Board and subwatershed groups; procured and managed all contractors to the Northern California Water Association (NCWA) (e.g., Larry Walker Associates). Created by a memorandum of understanding between NCWA and subwatershed groups. Lead: Bruce Houdesheldt (director of regulatory affairs for NCWA).
Northern California Water Association (NCWA)	Trade association	NCWA is the third-party to the Irrigated Lands Regulatory Program and provides program administration, representation, and cost-sharing for the coalition and the subwatershed groups. Lead: David J. Guy (president).
Larry Walker Associates	Private firm	Designed, implemented, and maintains the Irrigated Lands Regulatory Program's mandatory water quality monitoring program. Led development of the source evaluation report and the management plan. Lead: Claus Suverkropp (environmental scientist).

urged fellow farmers to comply with the Irrigated Lands Regulatory Program as a group, which was critical to achieving the desired water quality outcomes. The farm leaders made many phone calls and attended numerous meetings where they underscored that by joining the Colusa Glenn Subwatershed Program (and thus the parent, the Sacramento Valley Water Quality Coalition) farmers would receive "the best customer service," including help completing forms, notice of rules and meetings, representation before the Central Valley Regional Board, moral support, and technical and financial support if available. Using a carrot-and-stick approach, the farm leaders also made it clear to their fellow farmers that the control board could fine farmers up to $1,000 a day for every day that they "don't join a subwatershed program or don't comply as an individual."[33] As Domenighini put it, "As we're Farm Bureau, it was better that we were the bearer of bad news because we're their neighbors and it makes it easier to hear."

The resource conservation district drove implementation of the mandated management plan

Because the subwatershed program had no staff, the five elected farm leaders looked to the Glenn County Resource Conservation District to carry out the management plan. Resource conservation districts are commonly regarded as a liaison among farmers, landowners, land managers, and local, state, and federal government agencies. The conservation district led implementation of the management plan through outreach and education activities as well as by supporting the Colusa Glenn Subwatershed Program's application for federal cost-share funds for conservation practices. In partnership, the subwatershed program and the conservation district contacted the 300 farmers in the Walker Creek watershed to encourage them to attend meetings to discuss the exceedances, review the analysis of the pesticide use reports, and build trust that the subwatershed program and the conservation district were their partners in solving the problem.

Intensive outreach earned agricultural stakeholder community buy-in

The subwatershed program and the conservation district made a point of keeping in continuous contact with key agricultural players in the two counties. Together they took advantage of each institution's strengths and services to farmers: Agricultural Commissioners of the County Agriculture Departments, Farm Bureaus, Pesticide Control Applicators, the NRCS, University of California's Cooperative Extension Service, and the Northern California Water Association, which staffs the Sacramento Valley Water Quality Coalition. All the partners participated in the outreach meetings and newsletters, and repeated the same information, including reminders about following the pesticide product label information and adopting conservation practices to keep Chlorpyrifos out of streams. Thus, farmers heard the message consistently and frequently. They also saw a strong, collaborative front from all their agricultural community stakeholders and farm leaders.

Challenges

Developing the required source evaluation report and management plan in response to the 2007 exceedances in a timely manner proved challenging for stakeholders in the Colusa Glenn Subwatershed Program area. At the time, Larry Walker Associates and the larger Sacramento Valley Water Quality Coalition were busy developing a comprehensive management plan for Central Valley Regional Water Quality Control Board approval in 2009. This delayed development, review, and completion of the Walker Creek source evaluation report until 2010 and its management plan until 2011. However, due to effective leadership by the subwatershed program and the conservation district in conducting outreach and education within months of the exceedances, farmers improved their pesticide management before the management plan came into effect. In addition, the conservation district pursued financial assistance for structural, vegetative, and management conservation practices in 2009, also before plans were completed.

Next steps

After the 10-year Irrigated Lands Regulatory Program conditional waiver expired in 2013, the new 10-year program enacted in March 2014 called on the Sacramento Valley Water Quality Coalition and its subwatershed groups to develop new monitoring programs for both surface and groundwater quality, with a special focus on nitrogen management.[34]

The Colusa Glenn Subwatershed Program has begun meeting the new order's expectations by conducting outreach and awareness campaigns, and by raising membership fees to pay for the new management requirements (from $0.50 per acre and $25 per farm annually in 2003, to $2.35 per acre and $40 per farm in 2016).

CHAPTER 5

OKLAHOMA HONEY CREEK PROJECT CASE STUDY

A large 79,000-acre watershed project in northeastern Oklahoma delisted their stream from bacterial impairment and reduced nitrate and phosphorus loadings. Keys to success included establishing a local watershed advisory group, encouraging more farmer participation by offering lower cost-share rates, conducting a farm demonstration project, and targeting phosphorus hotspots within the watershed.

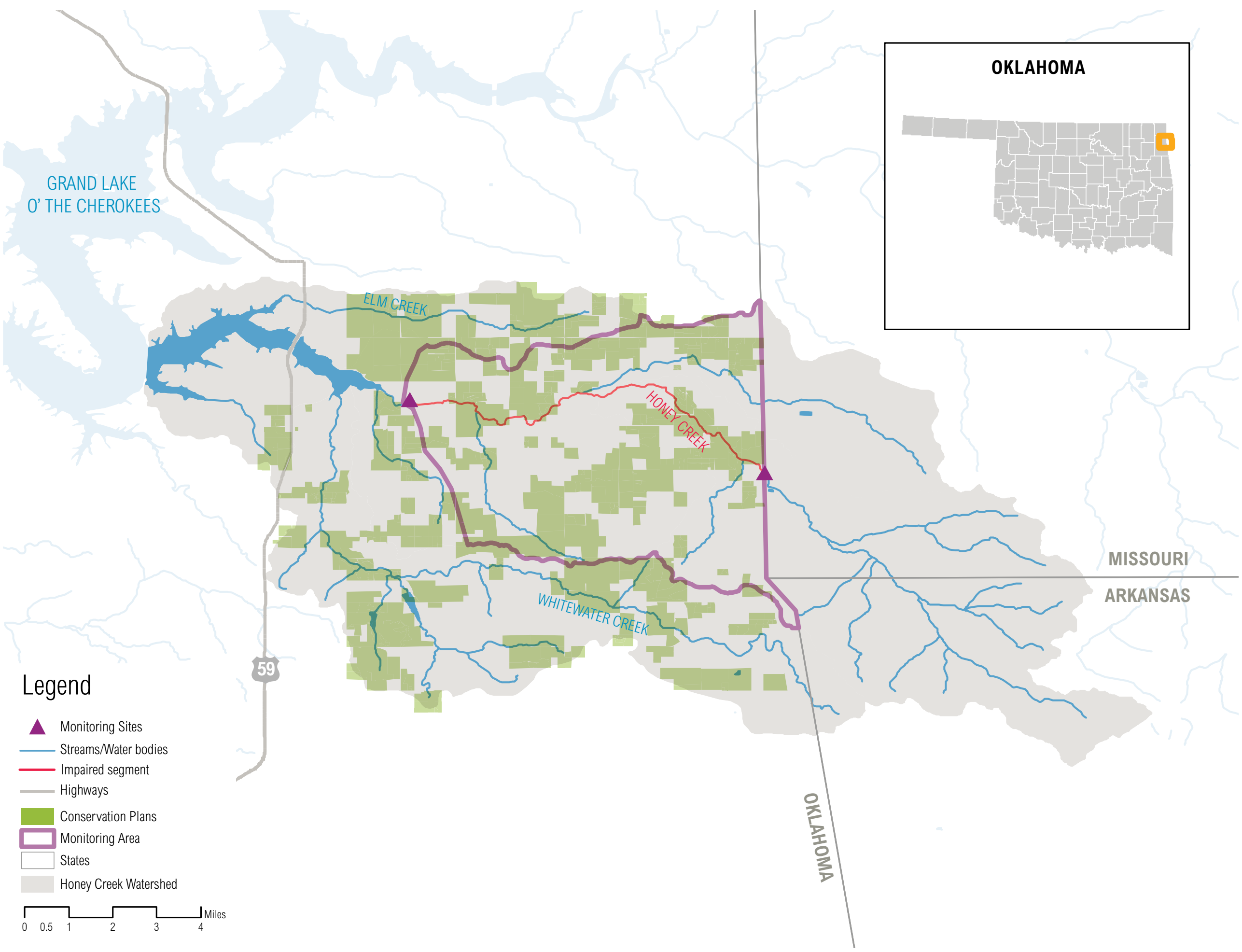
About the Watershed

Honey Creek watershed is located in northeastern Oklahoma. About 70 percent of this large, 79,000-acre watershed is in Delaware County, Oklahoma, while the rest is in McDonald County, Missouri, and Benton County, Arkansas. In addition to the Honey Creek Branch subwatershed, three other streams and their subwatersheds (Cave Springs Branch, Elm Creek, and Whitewater Creek) flow directly from the Honey Creek watershed into Grand Lake O the Cherokees. Grand Lake and Honey Creek branch supply public water for five communities and have five designated uses: drinking water, fish and wildlife propagation, agriculture, swimming, and aesthetic (see Figure 5.1).

The Oklahoma portion of Honey Creek watershed is dominated by pasture (57 percent) and forest (33 percent) with just 7 percent in cropland. About 70 percent of the stream miles in the watershed in Oklahoma run through pastureland that supports beef cattle and is fertilized with chicken litter from egg productions. Farms in this part of the state are generally small (about 100 acres).[35] Rainfall, at about 44 inches each year, is above average for the state, thus there is very little irrigation.[36]

In 2002, Grand Lake, Honey Creek, Cave Springs Branch of Honey Creek, and Whitewater Creek were placed on the state's list of impaired waters for pathogens (fecal bacteria), low dissolved

Figure 5.1 | **Map of the Oklahoma Honey Creek Watershed Project**



Honey Creek watershed's farm fields with conservation plans (green) and drainage areas being measured (red line) by the upstream/downstream monitoring stations (two purple triangles).

Source: WRI from data provided by Shanon Phillips, Oklahoma Conservation Commission.

oxygen, sulfate, total dissolved solids, and chloride. Also in 2002, the state's Beneficial Use Monitoring Program reported that Grand Lake was hypereutrophic during the growing season because of high turbidity and chlorophyll-*a* values (OCC, 2015a).[37]

Project Impetus

In 2005, Honey Creek watershed residents discovered fish kills in the Cave Springs Branch of Honey Creek. Scientists concluded that the primary cause was eutrophication triggered by the nutrient-laden wastewater discharge from the poultry processing plant on Cave Springs Branch in Missouri. However, other sources of excess nutrients, such as cattle that had free access to the stream, were also likely contributors. Although the Missouri Department of Natural Resources required the plant to update its wastewater treatment system, stream life continued to be impaired for several years. Given the ongoing impairment of the Cave Springs and Honey Creek branches, the Oklahoma Conservation Commission, the state agency responsible for implementing the EPA's Section 319 Nonpoint Source Pollution Control Program, decided to develop a Section 319 Watershed Implementation Project in 2006 to improve water quality and remove the stream from the impaired waters list.

Project Approach, Goals, and Targeting

Oklahoma Conservation Commission staff identified three core components to their Section 319 Watershed Implementation Project:

- Establishing a watershed advisory group
- Developing a farm demonstration project
- Targeting phosphorus "hotspot" fields in the watershed for priority conservation practice adoption

Watershed advisory group

The commission first established a locally led watershed advisory group to help gain buy-in to the project from stakeholders in the watershed. Because the commission had achieved success cleaning up streams in neighboring Beaty Creek and Spavinaw Creek with a watershed advisory group, its staff decided to try the same approach in Honey Creek and asked Joe Schneider, who had served as the commission's project coordinator in both watersheds, to replicate the successful technique.

Schneider asked the Delaware County Conservation District Board (comprising elected farmers) to help develop a list of potential members for the nine-person watershed advisory group. Ultimately, the group included a district board member, an NRCS representative, a state department of agriculture representative, a lakeside resident, a banker with agricultural loans in the watershed, and four landowners representing the main industries in the watershed (cattle and poultry).

The watershed advisory group convened in September 2006 to discuss its primary concerns in the watershed. Schneider explained how the watershed advisory group approach worked in the Beaty and Spavinaw watersheds, the practices those groups selected, and the cost-share rates they chose. Based on that information and on its understanding of local farmers, the Honey Creek Watershed Advisory Group developed its own list of best management practices in adherence with the Section 319 guidelines. On January 9, 2007, the group held a public meeting to encourage farmers and landowners to participate in the program (OCC, 2015a).

Farm demonstration project

The commission's outreach for the Section 319 project included working with a respected farmer with property adjacent to Honey Creek to develop a demonstration project showcasing the many conservation practices needed to address the nutrient, manure, and sediment problems in Honey Creek and Grand Lake. Some practices, such as fencing areas to limit cattle's access to the creek, were not popular with watershed residents. Neighbors were invited to several field days to see how the program offered a system of practices both to address pollution concerns and to replace services lost through the changes. Seeing the practices in place on a neighbor's farm helped watershed residents overcome concerns about the new watering techniques (e.g., water tanks, pipelines, drilled wells, pumping systems, or ponds) that could be cost-shared along with the stream fencing. Commission staff, NRCS staff, and the demonstration

Figure 5.2 | **Alternative Watering System Keeps Livestock Away from Creeks**

An alternative watering system with a heavy use protection area helps keep livestock out of streams and reduces erosion from streambanks and pastureland.
Source: OCC, 2015b.

farmer, all of whom spoke at the demonstration events, stated that these systems could provide cleaner, more reliable sources of water for livestock than Honey Creek (see Figure 5.2).

Schneider and other Oklahoma Conservation Commission staff at the field events asked attendees to indicate on the sign-in sheet if they were interested in learning more about the practices. Commission staff would follow up with these farmers to see what would work on their farms. "We got almost all who attended the demo event to sign up and we developed a conservation plan for each of them, helping them figure out what they could buy into with their own money," said Schneider.[38]

Goals and targeting

The objective of the Honey Creek Watershed Improvement Project was "to demonstrate the efficiency and effectiveness of voluntary efforts to improve water quality by installing practices that reduce runoff of bacteria, sediment, and nutrients" (OCC, 2015b). "The long-range goals of the Honey Creek Watershed projects were to restore beneficial uses to the water bodies within the Honey Creek watershed and to prevent future degradation of water quality in Grand Lake" (OCC, 2015b). Schneider said his goal was "to clean up the stream and lower the turbidity and nutrient content."[39]

Because this was a Section 319 project, a nine-element watershed-based plan accepted by EPA was required before it could begin (see Appendix A for a description of a watershed-based plan). The watershed-based planning process included watershed modeling, which estimated that an initial load reduction goal for phosphorus, sediment, and fecal bacteria of 20 percent within five years was needed to work toward an 80 percent reduction in phosphorus and sediment, and at least a 50 percent reduction in fecal bacteria. Thus, phosphorus loading in Honey Creek would need to drop 7,526 kilograms (kg) per year (or 16,592 pounds [lbs.] per year) within five years, and eventually to 1,881 kg per year (or 4,147 lbs. per year) (OCC, 2015a).

To achieve these ambitious goals as efficiently as possible, the commission hired a consulting firm to conduct a modeling analysis using the Soil and Water Assessment Tool (SWAT) to identify the most significant sources of phosphorus loading (phosphorus "hotspots") in the watershed. The SWAT model estimated that the top 45–55 percent of phosphorus loading was coming from just 27 percent (14,760 acres) of the Oklahoma portion of the Honey Creek watershed (OCC, 2015a). The phosphorus loading was then categorized as high, medium, and low, with the highest loads coming from riparian areas. "Targeting told us that soil type and proximity to stream are the most important factors driving loading," said Shanon Phillipps, director of the Water Quality Division of the Oklahoma Conservation Commission (Personal communication, January 21, 2016).

Schneider and his commission colleagues used the SWAT map to develop a funding application ranking sheet that prioritized applicants in descending order from high to low phosphorus loss locations. To reach all livestock farmers in the hotspots, the commission staff overlaid the hotspots map with a land ownership map from the county to generate a list of priority landowners. Commission staff mailed letters to every landowner asking them to contact the commission.

"The ones that did contact us, we visited with them and told them about the project, the practices, and the cost-share. The ones that didn't call us, we went and knocked on their doors," Schneider explained (Personal communication, January 20, 2016).

Eventually Schneider's team made personal contact with every person that had property on the stream in the hot spot areas.

Funding Sources and Priority Practices

The Honey Creek Watershed Implementation Project began on July 1, 2006, and ended August 1, 2014. The project was due to end in 2010, but the Oklahoma Conservation Commission received an extension because more farmers and landowners wanted to participate. The project began in earnest in 2007 when the Northeastern Oklahoma Demonstration Farm Project was developed to showcase the best management practices offered in the Honey Creek Project. Three rounds of EPA Section 319 and state funds totaling $2,214,632 were secured thanks to high interest from farmers and landowners who, in turn, provided $1,114,537 of their own funds to implement best management practices in the watershed (OCC, 2015b).

Because funds came from the EPA Section 319 program (rather than the USDA conservation programs), the state could set its own payment rates. The watershed advisory group deliberated over what cost-share rates of federal funds to offer. The conservation district board and the group decided it was important to start with a low rate of a cost-share of just 60 percent federal funds in order to provide funds to more people. Typical cost-share rates at the time for USDA NRCS programs were 75 percent and even 90 percent federal funding for some practices. In addition, the watershed advisory group adjusted the cost-share rates on the basis of a combination of water quality benefit and practice acceptance. A practice with a large water quality benefit but that landowners resisted (such as riparian area protection) had a higher cost-share rate (e.g., 90 percent). In contrast, a practice that landowners accepted but had a less pronounced impact on load reduction (such as pasture management or a waste storage facility) received a lower cost-share rate (e.g., 60–75 percent) than traditional programs often provided.

Over the eight-year project, 112 farmers and landowners managing 50 percent of all watershed acres in the Oklahoma portion of Honey Creek watershed received Section 319 funds to develop conservation plans and practices that included the following:

- 16 septic systems installed or upgraded
- 384 acres of protected riparian area established
- 44 ponds, 206 water tanks, and 72 wells installed for alternative water supply
- 25 cattle feeding/waste storage facilities built
- 231 concrete, geotextile, gravel areas for heavy use protection (in barnyards and in fields around hay troughs and watering areas)
- 296 acres of grass planted to improve pasture
- 310,656 feet of cross-fencing to improve pasture
- 2 storage facilities for poultry waste
- 26,627 pounds of poultry litter transported out of the watershed
- 134,888 pounds of poultry litter moved to appropriate areas

In all, 42 percent of the targeted, high-phosphorus-yield areas identified by the SWAT model adopted best management practices through this project (OCC, 2015a).

Oklahoma's Honey Creek Project leaders estimate that 17 percent of their total project costs were associated with project management activities, 67 percent provided financial assistance to farmers and landowners (including farmer out-of-pocket costs), and 16 percent covered the water quality monitoring, data management, and statistical analysis costs (see Table 5.1).

Monitoring Approach and Successful Outcomes

Monitoring design. The commission water quality monitoring staff used both a paired watershed and an upstream/downstream monitoring design to determine the effects of the Section 319 Honey Creek Watershed Implementation Project on water quality. The quantified water quality outcomes detected by the monitoring program reflects only a portion of the adopted practices. The upstream/downstream monitoring locations on Honey Creek stream detect changes occurring on land within the Honey Creek and Cave Springs Branch subwatersheds. All other practices implemented in the Elm Creek and Whitewater Creek subwatersheds are not measured by this monitoring design. However, the associated nutrient, sediment, and bacterial reductions of these practices do still help Grand Lake.

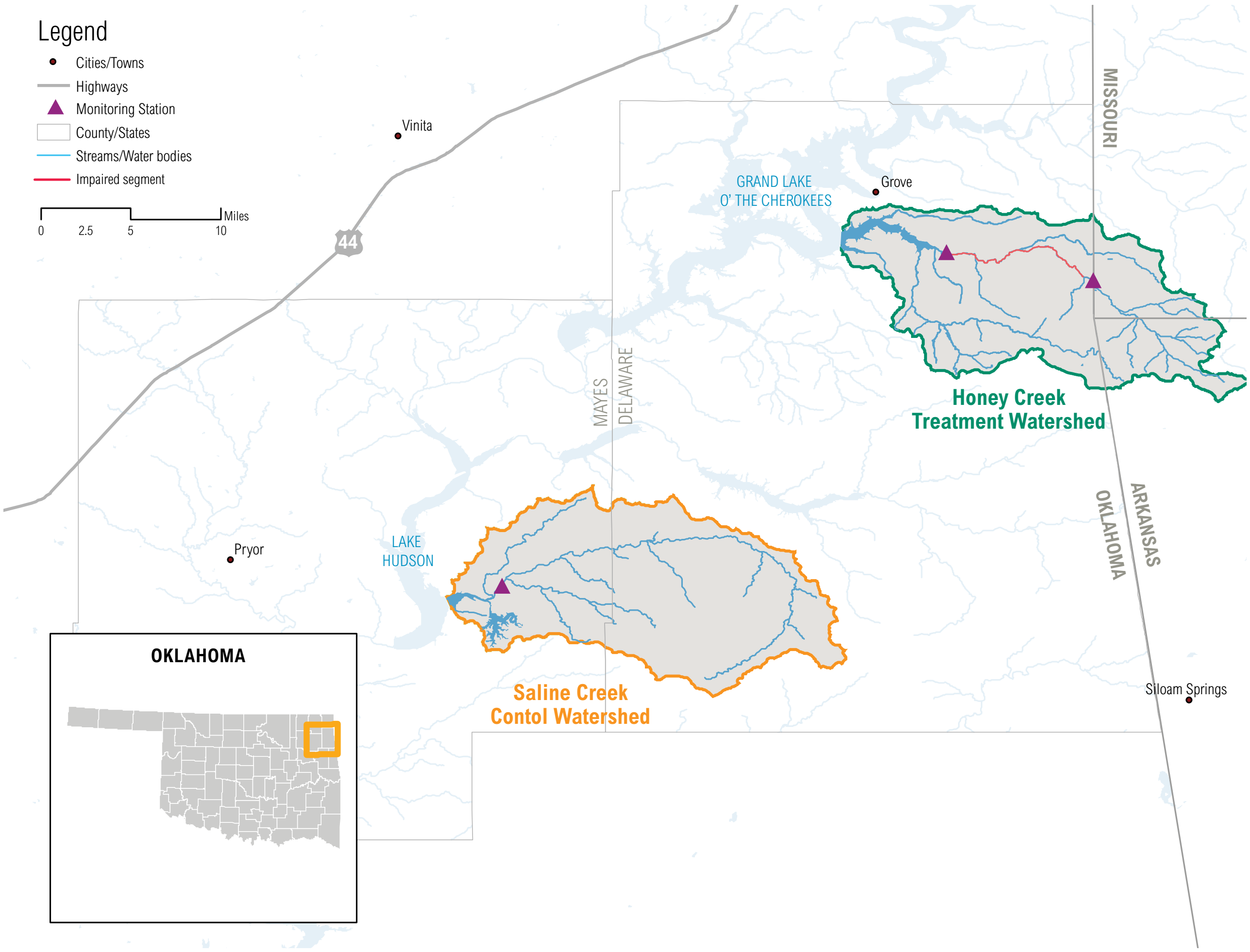
Sampling regime and monitoring locations. Nearby Saline Creek watershed served as the control watershed to ensure that any change in water quality was attributable to the project rather than to weather variation (see Figure 5.3). The upper monitoring location, on the Honey Creek branch at the border with Missouri, served as a secondary control to the paired control watershed, in case Missouri initiated conservation practices in the watershed, as well. The lower monitoring location on Honey Creek was sited upstream from Grand Lake to avoid backwater influences from the lake. Many retirement homes with septic systems surround Grand Lake and the Oklahoma Conservation Commission wanted to avoid measuring those sources of nitrogen since the program would have limited ability to address them.

Three automated samplers were installed to collect continuous, flow-weighted water samples from Honey Creek at sites upstream and downstream of the implementation area. Water quality samples were collected once a week. Data to establish a

Table 5.1 | **Project Cost Estimates for Oklahoma's Honey Creek Project, 2006–14**

DIRECT FUNDING	PROJECT MANAGEMENT (DOLLARS)	FINANCIAL ASSISTANCE TO FARMERS AND LANDOWNERS (DOLLARS)	WATER QUALITY MONITORING (DOLLARS)	TOTAL FUNDING (DOLLARS)	PERCENT OF FUNDING
EPA Section 319 (2006–14)	720,000	1,183,397	615,000	**2,518,397**	51
Priority Watershed Cost-Share Program State Match to Section 319 (2006–14)	100,000	1,031,235	180,000	**1,311,235**	27
IN-KIND SOURCES					
Landowner Contribution (2006–14)		1,114,537		**1,114,537**	23
Total	**820,000**	**3,329,169**	**795,000**	**4,944,169**	100
Percent	17	67	16	100	

Figure 5.3 | **The Honey Creek Project Treatment and Control Watersheds**



The Honey Creek treatment watershed (upper right) with two monitoring stations and the Saline Creek control watershed (lower left) with one monitoring station.
Source: WRI from data provided by Shanon Phillips, Oklahoma Conservation Commission.

water quality baseline was collected in 2005. The demonstration project officially started in 2006 and the bulk of watershed implementation began in 2007. Thus, the commission had approximately 1.5 years of calibration data as a baseline to evaluate water quality change. Statistical testing prescribed by the EPA Paired Watershed Study Design (USEPA, 1993b) determined that this was sufficient to evaluate future changes caused by adoption of conservation practices.

Water quality outcomes. In 2012, six years after the project started, the Oklahoma Conservation Commission officially reported the changes in water quality to EPA. In 2015, the Commission proposed that Honey Creek be delisted for *E. coli* on the 2016 Section 303(d) List of Impaired Waters (OCC, 2015a). In the 2015 final report on the project, the commission found that the following:

- Expected phosphorus loading was reduced by approximately 28 percent
- Expected nitrate loading was reduced by approximately 35 percent
- Expected *E. coli* and *Enterococcus* bacteria loading were reduced by nearly 53 percent and 34 percent, respectively

The term “expected” is used with the paired watershed design, indicating that since the treatment and control watersheds were similar to begin with, the implementation of best management practice changed the expected water quality results in the treatment watershed. "If there's a change in the relationship between the treatment and control watersheds after implementation, you can assume it's due to the implementation, rather than to weather patterns," said Phillips.[40]

Cost of monitoring. The commission estimates monitoring costs for the Honey Creek Section 319 project was $85,000–$100,000 per year.

Project Partnerships

In addition to the project partners listed in Table 5.2, 112 farmers and landowners in the watershed volunteered to participate in the project, making its environmental outcomes possible.

Key Factors Contributing to Success

Project leaders said the keys to the success of the project were relying on a local watershed advisory group, encouraging more farmer participation with lower cost-share rates, conducting a farm demonstration project, and targeting phosphorus hotspots within the watershed.

Conservation commission worked with local watershed farmers and residents to build trust and guide the project

The Oklahoma Conservation Commission's success in securing farmer participation was due in part to its method of working through the local conservation district board, which, at that time, had a member who owned land in the Honey Creek watershed, Schneider recalled.

Table 5.2 | **Partners in the Oklahoma Honey Creek Project**

NAME	TYPE	ROLE
Oklahoma Conservation Commission	State water quality agency	Led the development and implementation of the Section 319 watershed improvement project; hired the Soil and Water Assessment Tool (SWAT) modelers and developed the watershed-based plan with inputs from the local Oklahoma Conservation Commission project coordinator, the conservation district board, and the watershed advisory group. Lead: Shanon Phillips (director of the Water Quality Division).
Local Oklahoma Conservation Commission project coordinator	State water quality agency	All three coordinators conducted outreach and education with farmers and also prepared the conservation plans that accompanied each cost-shared practice (or suites of practices) paid for with the Section 319 funds. Lead: Joe Schneider (coordinator from 2006 until 2009, when he retired); Marti Medford (2009 until her retirement in 2013); Jill Ashbrener (2013–14).
Local Natural Resources Conservation Service (NRCS) field office staff	Federal government	In this Section 319 project, NRCS did not provide financial assistance but did attest to the benefits of the conservation practices at the farm demonstration events. NRCS provides the following assistance to Oklahoma Conservation Commission coordinators on an ad hoc and annual basis: conservation planning software, specification standards for the conservation practices, technical assistance for unusual engineering design challenges, annual certification of the commission Section 319 project staff to be able to prepare conservation plans.
Delaware County Conservation District	Local government	Helped form the watershed advisory group; worked in close coordination with the group; included articles about the project in its newsletters. In this specific Section 319 project, did not provide in-field technical assistance.
Honey Creek Watershed Advisory Group	Citizen's advisory body	The watershed advisory group lent support and credibility to the Section 319 project; helped develop the best management practice priority list; set the cost-share rates; and encouraged farmer and landowner resident participation in the project at a few meetings early on. The group continued its work during the first three years of the project.

"With him being local and the rest of the watershed advisory group either living in the watershed or somehow connected, that benefitted the whole project as it wasn't someone from Washington or from USDA telling you what to do but someone who was living and working in the same watershed," Schneider explained. "The members of the watershed advisory group would talk to neighbors over the fence line or at the coffee shop. That helped a lot. That was positive talk. You still get some negative talk like, 'It's my land. No one's gonna tell me what to do.' But the [group] helped get around that."[41]

A lower level of financial assistance was offered to reach more farmers in the watershed

Given the opportunity to decide financial incentive amounts, the locally connected watershed residents determined that involving as many farmers and residents as possible was more important than enticing people with high payment rates. Thus, they initially set a lower, overall maximum benefit per cooperator than similar Section 319 projects in nearby watersheds, and landowners still responded. In addition, they offered a higher than typical cost-share rate for practices with a large water quality benefit but low acceptance by landowners, and a lower than usual cost-share rate for practices that were widely accepted but had a smaller effect on phosphorus reduction.

A farm demonstration project showed successful conservation techniques

Project leaders felt that one of the most effective elements of this project was showing farmers how the riparian and alternative watering practices worked on a cattle farm with pastureland adjacent to Honey Creek. The practices were a significant departure from how generations of cattle farmers managed their farms, and the Oklahoma Conservation Commission, the conservation district board, and the watershed advisory group understood that farmers needed to see the practices in action and hear from the farmer who adopted them before they would make changes on their land.

Hard work and footwork reached the priority phosphorus hotspots

Schneider said that he and the rest of the Oklahoma Conservation Commission field staff were determined to visit every landowner in the phosphorus loading hotspot areas along all four branches of streams in the Honey Creek watershed. Finding the operators of these hotspot fields through the mapping exercise was a challenge, and reaching them through letters, calls, and in-person visits was even more challenging. But Schneider was proud of the outcome: nearly half of the priority area farmers agreed to adopt best management practices and the commission could determine that some priority areas were not phosphorus loading areas after all.

Challenges

At first, the watershed advisory group did not fully support the phosphorus hotspots targeting approach and urged the commission not to focus solely on priority farmers identified by the modeling. Phillips acknowledged the group's reluctance to target these areas and recalled it was largely a lack of faith in the computer model's ability to accurately pinpoint problem areas. Schneider and Phillips responded by emphasizing the importance of ground truthing the model before drawing conclusions, which Schneider and staff then did through site inspections of most of the riparian segments in the watershed. In a few cases, the

Projects similar to Honey Creek Project have begun in neighboring watersheds of Grand Lake through the USDA Regional Conservation Partnership Program.

priority areas identified by the model were wrong (i.e., forested areas, fallow pastureland, or other areas with no visible erosion problems). The staff also found poorly managed pastureland that was likely a significant source of phosphorus and sediment that had not been identified by the model as a hotspot.

Next steps

Funding for implementation of conservation practices through the Section 319 program is currently closed in the Honey Creek Watershed, although farmers can pursue funding through USDA conservation programs and through the local Oklahoma Conservation Districts. It is possible that comparable funds might someday be available in portions of Honey Creek to address the remaining pollutants that have kept the stream impaired, including total dissolved solids, dissolved oxygen, and turbidity. In addition, the Oklahoma Conservation Commission will continue to conduct education programs in the watershed and to monitor Honey Creek to determine whether water quality improves or declines as practices mature or as the program presence in the watershed becomes more distant. Projects similar to Honey Creek Project have begun in neighboring watersheds of Grand Lake through the USDA Regional Conservation Partnership Program.

CHAPTER 6

IOWA HEWITT CREEK PROJECT CASE STUDY

A small 23,000-acre watershed project in eastern Iowa documented in-stream and field-scale water quality outcomes, a social outcome (a "watershed community" was created), and an economic outcome (increased farmer profitability). Keys to success included having farmers establish their own watershed council that set project goals, using common agronomic-environmental diagnostic tools to foster peer discussions, and having farmers design the financial incentive system.

About the Watershed

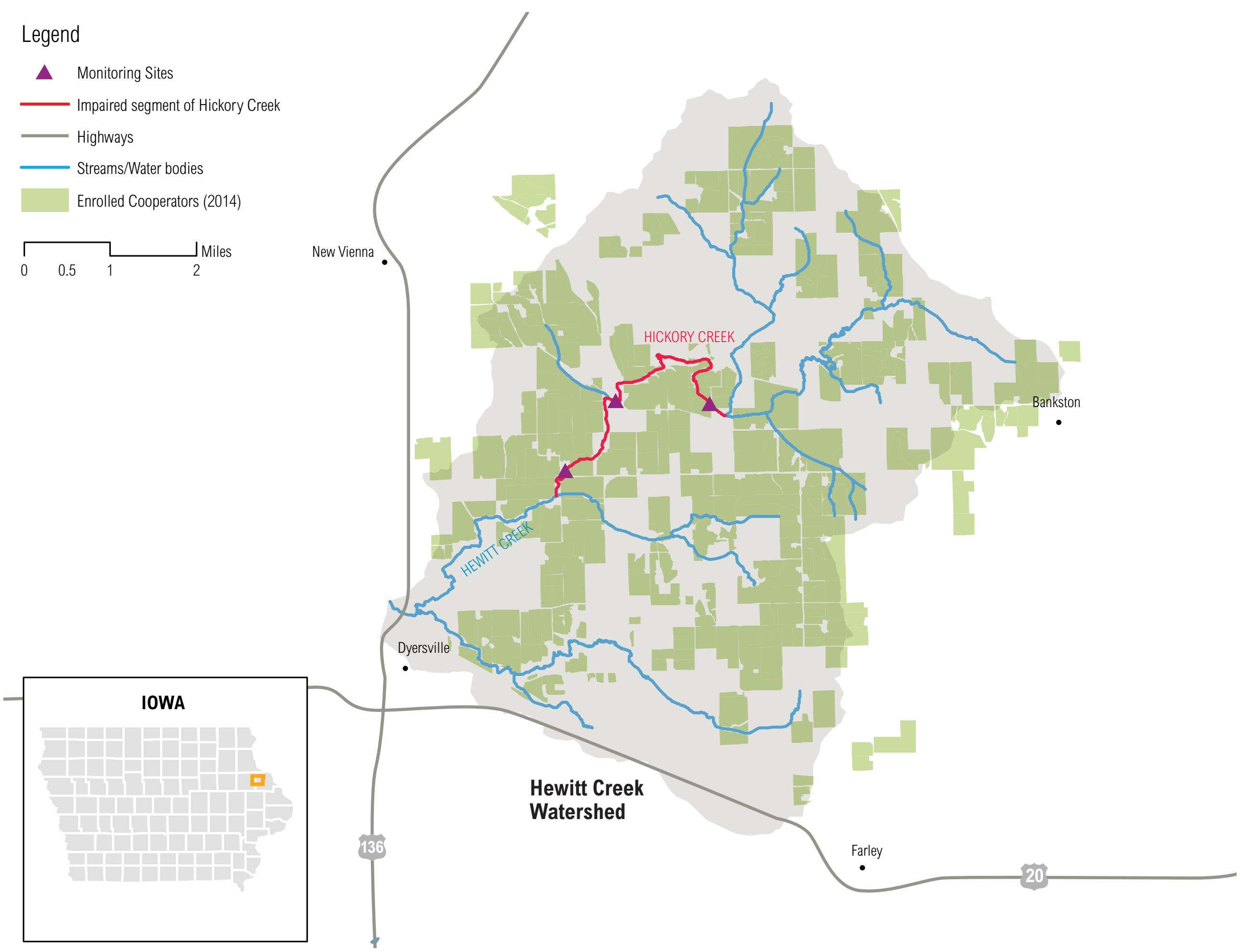
Hewitt Creek, a small 23,000-acre watershed in eastern Iowa's Dubuque County, is characterized by rolling hills and moderate rainfall (average 37 inches per year) (see Figure 6.1). Over 90 percent of the watershed is in agriculture. Most of that farmland (80 percent) is row crop production, primarily in continuous corn and corn-soybean rotations. The livestock sector includes confined beef, dairy, and swine operations, only a few of which are large enough to be categorized as concentrated animal feeding operations, as well as some beef pasture farms. Most farmers are owner-operators.

In 2002, the Iowa Department of Natural Resources listed the lower 4.4 miles of Hickory Creek, a tributary to Hewitt Creek, as "partially supporting" aquatic life because of impairments from siltation, habitat alterations, and organic enrichment and low dissolved oxygen.

Project Impetus

John Rodecap and Chad Ingels, program coordinators for the Iowa State Extension Service in Dubuque County, received a federal extension grant in 2006 to increase citizen interest in and responsibility for agricultural watersheds. They thought Hewitt Creek watershed—with its small

Figure 6.1 | **Map of the Iowa Hewitt Creek Watershed Project**



Iowa's Hewitt Creek watershed, "cooperator" fields, and three monitoring locations. Cooperator is the term the Hewitt Creek Farmer Watershed Council decided to use to describe a farmer who agreed to have his/her fields evaluated annually with at least one of the three field diagnostic tools used in the project.

Source: WRI from data provided by Chad Ingels, Iowa State Extension Service.

size, homogeneous land use, and impaired water quality—would be a suitable location for their effort. They approached Jeff Pape, a crop farmer, and about four other farmers in the watershed and informed them that the Hickory Creek branch of Hewitt Creek had been placed on the Iowa Impaired Waters List. Concerned that the Iowa Department of Natural Resources might impose a "total maximum daily load" plan for the creek, a pollution budget required by the Clean Water Act for water bodies on the impaired waters list that could restrict manure application and impose other requirements, the farmers decided to "fix the problem themselves."[42]

The group asked Rick Klann, biology professor at Upper Iowa University, to monitor three locations along the impaired segment to determine if the stream was equally impaired or if subwatersheds draining into the beginning, middle, or end of the segment were mostly responsible for the problem. The university confirmed the department's water monitoring data showing that the stream was consistently high in total nitrogen, total phosphorus, and sediment along the length of the impaired segment. Thus, as Pape says, "we learned we all had a hand in causing this problem so we all had to have a hand in solving it."[43]

In 2005, the Hewitt Creek watershed farmers formed the first of six farmer watershed councils in the state. Iowa State extension staff provided project management, fund-raising, outreach, and education functions for the councils. To formalize their organization and qualify for state funding, the Hewitt Creek farmers collectively filed articles of incorporation and bylaws as the Hewitt Creek Watershed Improvement Association, Inc., (called the Hewitt Creek Watershed Council by farmers).[44] Jeff Pape was elected president.

Project Approach, Goals, and Targeting

The Hewitt Creek Watershed Council's farmer members focused their conservation practice efforts on the phosphorus, sediment, and nitrogen issues in Hickory Creek by using three agronomic and environmental diagnostic tools:

- **The Phosphorus Index,** to determine which fields had high phosphorus levels and to target phosphorus management practices
- **The Soil Conditioning Index,** to determine the management impacts on soil quality and to target soil erosion control practices
- **The Corn Stalk Nitrate Test,** to determine nitrogen use efficiency and to target better nitrogen management practices

Every year, the extension specialists worked with about half (~40) of the watershed's farmers (~80) who volunteered to participate in the project to collect the field-scale data needed to run the indexes. Ingels then prepared watershed-wide summaries of the field-scale results and calculated project average values for each diagnostic tool.

Using the annual results of the three tools, the farmers and their extension partners developed a performance-based incentive approach to spend the limited financial assistance the council obtained from private and state sources as effectively as possible. "Cooperators"—farmers who agreed to have their fields evaluated annually with at least one of the diagnostic tools—could apply for varying levels of incentives based on the results of the tests. To avoid extensive paperwork council members committed to keeping the application to a single page.

The performance incentive system encouraged farmers with fields rating outside the ideal range of values for each diagnostic tool to adopt conservation practices that helped them attain the desired index values. For example, if a cooperator's baseline Phosphorus Index value was greater than 3, he would not receive an incentive payment.[45] But, if the farmer agreed to implement certain phosphorus management changes to bring the value down, he qualified for payments to help adopt those practices. Practices like grassed waterways, reduced tillage, or riparian buffers, could reduce the risk of erosion and particulate phosphorus loss enough to change a field's phosphorus index rating within a year.

Likewise, if a farmer's field rated below the ideal 0.6 value for the Soil Conditioning Index or outside the ideal 700–2,000 ppm range for the

Figure 6.2 | **Hewitt Creek Watershed Council Farmers Discuss Field Test Results**

Hewitt Creek Watershed Council farmers met several times per year to discuss in-field results of the three agronomic-environmental diagnostic tests: the Phosphorus Index, the Soil Conditioning Index, and the Corn Stalk Nitrate Test.

Corn Stalk Nitrate Test, and he pledged to adopt soil erosion control practices like cover crops and residue management or agreed to reduce nitrogen applications, he could receive performance incentive payments.

Farmer-to-farmer exchanges

Farmers agreed to display (through use of an anonymous code) their results with the diagnostic tools on the council's public website.[46, 47] Results were displayed every year from 2006 to 2013. About 8 to 20 farmer members of the council, as well as watershed residents and various project partners, met five to six times a year, primarily during the winter and summer, to discuss the field- and watershed-scale results, review the most recent water monitoring data, evaluate project progress, and fine tune the project to improve the conservation activities and the water quality (HCWIA, 2009; see Figure 6.2).

According to Pape, sharing the information publicly helped drive producer interest in the project because farmers are competitive.[48] The Corn Stalk Nitrate Test results for each field was displayed on the website from highest to lowest. Ingels reported that in the group meetings, "the guys with the highest numbers (above optimum) were asking questions about how to achieve the optimum readings while the guys with the lowest results were answering the questions. Thus, this approach was an effective way to facilitate peer exchanges and learnings."[49]

Pape recalled that the Corn Stalk Nitrate Test, which measures the amount of nitrogen in corn stalks after harvest to tell whether too much or too little nitrogen had been applied to the crop, helped farmers understand the degree to which manure met their nitrogen needs, enabling them to reduce their commercial nitrogen rates. Some livestock farmers eliminated purchased nitrogen altogether, achieving significant cost savings. The Corn Stalk Nitrate Test provided "one of the biggest bangs for the buck for many farmers," Pape said.

Quantitative goals

The overarching goal of the Hewitt Creek Watershed Council was to remove Hickory Creek from the Iowa Impaired Waters List. Accordingly, in-stream water quality monitoring tracked chemical and biological improvements in the stream. The council set a goal of achieving a high participation rate from farmers in the watershed, which it quantified as use of the annual nutrient and soil health diagnostic tools, and regular attendance at council meetings. The council also encouraged its cooperator farmers to set individual goals at the field scale for phosphorus, soil erosion, and nitrogen to be tracked by the diagnostic modeling tools.

When the council applied for a second five-year grant from the Iowa Water Improvement Review Board in 2010, a year after Rodecap retired, Ingels encouraged them to set specific watershed performance goals in addition to individual goals. They set 10 goals related to outcomes, practices, and fund-raising, most of which were met or nearly achieved. The goals are discussed in the monitoring and outcomes section below.

Funding Sources and Priority Practices

Over the years, Rodecap and Ingels wrote many successful fund-raising proposals. Funding sources included:

- Iowa Farm Bureau grant: $90,000 over three years starting in 2005 for farmer payment incentives and water quality monitoring;
- Iowa Water Improvement Review Board grant from the Iowa Department of Agriculture and Land Stewardship: $159,294 over three years starting in 2006 for extension staff time, monitoring, and farmer incentives;

- The Water Improvement Review Board's second grant: $482,000 over five years starting in 2010. About 62 percent of the grant went to farmers through incentives and for a handful of expensive structural conservation practices (like bioreactors and animal waste facilities), 32 percent helped cover Ingels' time, 3 percent was for project administration costs, including travel, and 3 percent covered water quality monitoring costs; and
- In-kind contributions: About $250,000 worth of in-kind contributions were provided for the second Water Improvement Review Board grant from the cooperators ($211,000), Upper Iowa University ($21,000), the council ($17,000), and Iowa State University ($9,000; HCWIA, 2015).

The limited funds meant that only $45,000–$68,000 was available annually during the last five years for performance incentives and structural practices. The 52–62 cooperators participating every year have received only roughly $900 per farmer per year, on average. This is an extraordinarily small amount of financial assistance compared with typical federal Environmental Quality Incentives programs conservation contracts, which can range from a few thousand dollars to tens of thousands of dollars, and on occasion, several hundred thousand dollars (see Table 6.1).

Table 6.1 | **Annual Incentives Paid for Conservation Practices during the Last Four Years of the Hewitt Creek Project, 2010–14**

CONSERVATION PRACTICES	2010 ($)	2011 ($)	2012 ($)	2013 ($)	2014 ($)	TOTAL ($)
Phosphorus Index	5,240	7,435	10,055	8,170	7,820	38,720
Soil Conditioning Index	18,710	17,788	12,379	16,771	20,774	86,422
Nitrogen Performance	9,120	5,900	4,660	5,835	7,160	32,675
Grassed Waterways	6,380	7,205	6,198	4,855	4,170	28,808
Cover Crops	2,390	3,590	9,040	11,320	11,180	37,520
Feedlot Runoff (Animal Waste Facilities)	200	2,200	2,000	400	14,000	18,800
Demonstrations	—	1,000	—	1,000	—	2,000
Other Incentives	3,730	4,850	5,250	4,776	3,290	21,896
Total Incentives	**45,770**	**49,968**	**49,582**	**53,127**	**68,394**	**266,841**
Cooperators	**52**	**56**	**59**	**59**	**62**	
Average Incentive $/Cooperator	**880**	**892**	**840**	**900**	**1,103**	

Source: Chad Ingels, Iowa Extension Service.

According to Ingels, allowing more farmers to participate was a critical goal for the council. "Each year, except the final year, incentives for the Soil Conditioning Index were prorated for all producers, sometimes up to 60 percent of the enrolled incentive payment. The council determined early in the project that providing smaller incentives to as many as possible was more important than bigger incentives for fewer cooperators" (HCWIA, 2015).

During the last five years of the project the following results were realized:

- About 45 cooperators (about half the farmers in the watershed) conducted the Phosphorus Index, the Soil Conditioning Index, and the Corn Stalk Nitrate Test on about 10,000 cropland acres every year (about half of the watershed's 18,400 cropland acres).
- Over 12.67 miles (66,875 feet) of grassed waterways, broad, shallow channels designed to move surface water across farmland without causing soil erosion, have been installed by farmers either using payment incentives or without any financial assistance (see Figure 6.3).
- Cover crops were planted on 4,314 acres (23 percent of cropland).
- Farmers switched to no-till cultivation on 1,776 acres (10 percent of cropland).
- Two innovative, subsurface tile drain denitrifying bioreactors were installed.
- Three animal waste facilities were installed using Iowa Water Improvement Review Board funds.
- For more expensive structural practices such as manure storage structures, which cost $100,000 to $200,000 each, farmers partnered with the Dubuque County NRCS staff to develop five USDA Environmental Quality Incentives Program applications.

Additional manure storage structures have likely been built in Hewitt Creek watershed through a 2011 Mississippi River Basin Healthy Watersheds Initiative (MRBI) project. The Dubuque County Soil and Water Conservation District was awarded a $5 million project grant that included Hewitt Creek watershed, along with two other neighboring HUC12–size (about 40 square miles) watersheds.[50] However, local NRCS and county soil and water conservation district staff interpreted the 2014 Farm Bill's Section 1619 (addressing information disclosure about the location of conservation contracts or practices) as prohibiting them from disclosing to the council leadership and Ingels which farmers received contracts for which practices, or where the practices were implemented. Though Dubuque County NRCS reports that 10 manure storage structures have been installed and 8 more were planned in the overall MRBI area, the council and Ingels do not know how many are in Hewitt Creek watershed or where they are located.[51] (Section 1619 of the 2014 Farm Bill is discussed in Chapter 11 and in recommendations to Congress in Chapter 12.)

Figure 6.3 | **Grassed Waterway Practice**

Monitoring Approach and Successful Outcomes

Social and economic outcomes

The council and its extension partners have observed a variety of results associated with the project, which this report refers to as social and economic outcomes. Council members indicate that a "watershed community" developed within the first three years of the project as farmers and watershed residents took "ownership of the impairment issues, develop(ed) . . . remediation efforts and celebrate(d) . . . project successes" (HCWIA, 2015).

Results of a survey of project cooperators by Iowa State University sociologists at the end of the first three-year phase were positive. Ninety-four percent of respondents said the performance index program "encouraged production and environmental management changes." Respondents also noted economic outcomes, with all reporting "the performance program made their farming operations more profitable"(HCWIA, 2009). This response may indicate that farmers experienced lower fertilizer bills. While reducing fertilizer application rates was not a specific project goal, the council documented an average 44-pounds-per-acre nitrogen rate reduction due to the use of the Corn Stalk Nitrogen Test and increased attention to fertilizer and manure nutrient management.

Though changes in field ownership and retirements make it difficult to track the numbers of farmers in the watershed, the council estimated that on average, there are about 80 farmers in the watershed, and about 66 (82 percent) have participated in the project. Thus, the council feels it has achieved its 85 percent participation goal set in 2010. More important, on average, about 58 farmers (approximately 72 percent) participated every year during the last five-year period, either as a cooperator using the diagnostic tools or by adopting conservation practices.[52]

Environmental outcomes

When applying for the second Watershed Improvement Review Board grant in 2010, Ingels felt the council should redouble its efforts and commitment by setting ambitious quantitative goals, many of which this report refers to as environmental outcome goals. The council established four watershed-scale goals based on the field-scale diagnostic tool results or otherwise estimated by simple modeling techniques. It also set three in-stream nutrient and biological goals, which were tracked by in-stream water quality monitoring. The goals and associated results as published in the council's 2015 final report to the Watershed Improvement Review Board are shown in Table 6.2.

Overall, the council and its extension service partner were pleased with their modeled environmental metrics. The council achieved or nearly achieved all its ambitious goals.

Table 6.2 | **Hewitt Creek Project's Goals and Results, 2015**

GOAL	RESULT
Achieve a watershed average Phosphorus Index Value of 2.00	Achieved a watershed-wide Phosphorus Index value of 2.11, which is close to the 2.0 goal and down from 2.48 in 2006 when the project started.
Achieve a watershed average Soil Conditioning Index value of 0.6	Achieved this value each year for the last three years.
Achieve a watershed average Corn Stalk Nitrogen Test value of 2,000 ppm	Achieved once in 2010, when the watershed average Corn Stalk Nitrogen Test value was 1,976 ppm. The value was 3,457 ppm in 2013.
Reduce annual sediment delivery by an additional 8,000 tons per year as estimated by the Iowa Sediment Reduction Calculator	Achieved 6,000 tons per year sediment reduction to the stream (about 75 percent of the goal).
Reduce annual phosphorus delivery by an additional 10,400 pounds (the Iowa Sediment Reduction Calculator uses a phosphorus multiplier)	Achieved 7,800 pounds of phosphorus reductions (75 percent of the goal).

Because only practices funded by the council using the Water Improvement Review Board grant could be assessed in the evaluations, the findings underestimate the project's outcomes. Practices funded by the MRBI project, Environmental Quality Incentives Program, and Conservation Stewardship Program could not be assessed because NRCS and the Dubuque County Soil and Water Conservation District staff did not provide practice or location information to the council. (See discussion about the 2014 Farm Bill's Section 1619 in Chapter 11 and recommendation in Chapter 12.)

Despite barely missing some of the goals, the project achieved far more environmental success in its second five years than in the first because it set quantitative goals and aimed for watershed-scale performance, Ingels noted. For example, the council estimated it accomplished an additional 6,000 tons per year of sediment reduction during the second half of the project over the 4,033 tons per year during the first half, when the project focused on individual performance. Ingels concluded, "We found that if you aim to achieve water quality improvements in sediment, you get even better soil erosion and soil health results than just focusing on in-field erosion reduction."[53]

In-stream Water Quality Monitoring Program. Rick Klann, a biology professor at Upper Iowa University offered to develop and carry out a water quality monitoring program pro bono. The program included assessment of important indicators such as macroinvertebrate (insect) health and 11 chemical parameters, including nitrogen, phosphorus, suspended sediment, turbidity, and dissolved oxygen. Klann, although not a water quality monitoring specialist, developed field and laboratory skills by volunteering as a field station grab sampler in eastern Iowa for the Long-Term Resource Monitoring Program for the Mississippi River.[54]

Unfortunately, the project leaders discovered they were using a macroinvertebrate monitoring tool—the Family Biotic Index—that was inappropriate for Hickory Creek's warm water and discontinued data collection in 2011.[55] Nevertheless, Pape notes that residents are providing anecdotal evidence that aquatic life is improving in the stream. Pape describes watershed residents who reported seeing "eight-inch fish in the water, which hasn't been seen in years, and larger macroinvertebrates." He said one farmer, who lives very close to the creek, reported that "he saw eagles back fishing in the stream." According to Pape, "Water quality improvement is measured when everything is back in the stream and it's good again."[56]

Monitoring design. Klann developed a three-station grab sampling monitoring design based on a design for a trout restoration project in another northeastern county. Shortcomings in the monitoring design were discovered when research for this report turned to the question of whether the in-stream chemical monitoring program was generating answers to either or both of the research questions provided by the National Water Quality Initiative (see Chapter 2 and Appendix C).

Also, the monitoring program did not comport with any of the four monitoring approaches recommended by the National Water Quality Initiative (above/below, trend, upstream/downstream, or paired watershed), although it shared some characteristics with the first three. The monitoring program more closely resembled long-term surveillance monitoring than operational monitoring. Surveillance monitoring assesses long-term changes from natural conditions or widespread anthropogenic activity; it is often associated with monitoring programs that assess the status of water bodies regarding their designated uses and water quality standards. Operational monitoring assesses changes in water quality attributable to mitigation measures.

Sampling regime. Monthly grab sampling occurred between late March and September (the growing season) and after rain events of half an inch or more within a 24-hour period. This regime resulted in about seven monthly samples plus five to six rain-event samples per year. A probe device measured temperature, pH, conductance, and dissolved oxygen, while a nephelometer measured turbidity. Water samples were returned to the lab for immediate measurement of total phosphorus, total nitrogen, and suspended solids. Fecal coliform was also measured, using *E. coli* as an indicator organism.

Water quality outcomes. Data suggest a positive downward trend in annual in-stream nitrate and phosphorus concentrations. Regression analysis on all 11 parameters showed the following:

- Significant downward trends in two sediment-related in-stream metrics—turbidity and suspended solids—were statistically significant (at the $p = 0.05$ level) over the 10 years of data.
- Total phosphorus was also trending downward and statistically significant at the $p = 0.1$ level.
- Total nitrogen change was not statistically significant.

Unfortunately, the statistical analysis did not account for weather variation because the project leaders had not controlled for precipitation either in their monitoring design or as a variable in the regression analysis. Ingels obtained radar-estimated precipitation data near one of the watershed's monitoring stations, and with technical suggestions from Jean Spooner of North Carolina State University's Water Quality Group,[57] Klann conducted additional statistical analyses, which indicated the following:

- The turbidity and total phosphorus results did not demonstrate a relationship with precipitation data, and thus the project can be confident that the conservation practices adopted are associated with reductions in turbidity and total phosphorus concentrations.
- Suspended solids may nonetheless have had a relationship with precipitation, and thus the project cannot be certain that the reductions in suspended solid concentrations are attributable to the practices.

Cost of monitoring. Klann provided his labor pro bono and charged a nominal amount (about $1,500 per year) for chemicals, reagents, and mileage.

Project Partners

In addition to the project partners listed in Table 6.3, 40–60 farmers and landowners in the watershed volunteered to participate in the project every year, making its environmental, social, and economic outcomes possible.

Key Factors Contributing to Success

Project leaders said the key factors contributing to project success were having farmers themselves set project outcome goals, using common agronomic-environmental diagnostic tools to foster peer discussions, and having farmers design the financial incentive system.

Table 6.3 | **Partners in the Iowa Hewitt Creek Project**

NAME	TYPE	ROLE
Hewitt Creek Watershed Improvement Association, Inc. (referred to as Hewitt Creek Watershed Council)	Farmer trade association	Led outreach and education efforts with farmers in the watershed and peer exchanges with about 40 farmers who regularly attend meetings and conduct the three diagnostic tools. Organizes and leads field-day events for farmers and interested stakeholders. Lead: Jeff Pape (council president).
Iowa State University Extension and Outreach	Extension service	Raised funds and administered the project; conducted the three diagnostic analysis with cooperator farmers; prepared the tool results for display on the council website; facilitated council meetings and shared meeting notes on the website; provided conservation technical assistance to farmers; tracked the financial assistance and practice adoption; organized field-day events for farmers and interested stakeholders; and wrote annual reports. Lead: Chad Ingels (project coordinator and watershed specialist).
Natural Resources Conservation Service, Dubuque County field office staff	Federal government	Provided technical assistance on practices cost-shared through the Environmental Quality Incentives Program, assisted farmers with the program application process.
Upper Iowa University	University	Led the water quality monitoring program for the project, conducted the statistical analysis, and prepared the annual reports. Occasionally, Upper Iowa University students conducted the chemical and biological monitoring. Lead: Rick Klann (biology professor).
Dubuque County Soil and Water Conservation District	County government	Led the Mississippi River Basin Healthy Watersheds Initiative project, provided conservation planning and technical assistance to farmers and helped administer the Environmental Quality Incentives Program funding application process.

Farmers set outcome-oriented goals for the stream

About five farmers invited their fellow farmers to join them in forming a farmer watershed council to "remove Hewitt Creek from the [Iowa] Impaired Waters list." The motivation for this ambitious goal, at first, was to avoid possible EPA restrictions on manure application. Over time, the farmers developed a sense of pride in their stream and wanted to see its water quality improve. Outcomes were measured using chemical and biological in-stream monitoring approaches, erosion and phosphorus loading estimation models, and anecdotal evidence about the biological health of the stream.

The project employed commonly used nutrient and soil diagnostic tools and took advantage of the competitive nature of farmers and learning through peer exchanges

Farmers agreed to display the results from the Phosphorus Index, Soil Conditioning Index, and the Corn Stalk Nitrate Test from each field via anonymous field codes on a group website. These tools offered environmentally and economically important soil and nutrient insights to the farmers, who met to discuss the results quarterly. "When everyone can see the rating, no one wants to be on the wrong end of the scale and it's a natural thing for farmers to want to do better," according to Jeff Pape, president of the watershed council.[58] Farmers on the "wrong end of the scale" asked questions, and farmers on the optimum end offered insights from their experiences.

Farmer-designed performance-based incentive systems helped make effective use of limited financial assistance

With less than $100,000 to start, members of the watershed council knew they had to make wise use of the limited funds. Because private and state sources of funds were flexible, farmers could decide how to spend the money. Motivated to keep the process simple and performance oriented, the farmers designed a one-page application form providing a checklist of diagnostic practices, management practices, and a few structural practices. If money was close to running out, the already-small payment incentives were reduced to accommodate all requests. This financial assistance arrangement motivated farmers to adopt practices for surprisingly little funding.

Challenges

The council has acknowledged that it did not know how clean the water needed to be before its goal of delisting the stream for only "partially supporting aquatic life due to siltation, habitat alterations, organic enrichment/dissolved oxygen" would be met. The council and its extension service partners did not conduct a traditional Section 319 watershed improvement project in partnership with the state's water quality agency, which might have involved watershed-scale planning and modeling to determine, among other things, reduction targets for specific pollutants. Instead, the council and extension addressed the nutrient and sediment issues with which they were familiar, using tools they understood. The water quality monitoring program established in 2006 does not meet current standards. Finally, the council has yet to address the "habitat alterations" impairment in the stream, which would involve in-stream improvement projects.

Next Steps

Given that the last Iowa Water Improvement Review Board funds were consumed in 2014, the project has officially concluded. It remains to be seen whether members of the council continue their conservation practices without payment incentives. When Jeff Pape asked members which of them would maintain their adopted practices without payment incentives, "every single one of them raised their hands." (Personal communication, July 30, 2015).

CHAPTER 7

WISCONSIN PLEASANT VALLEY STREAM REHABILITATION PROJECT

A small 12,300-acre watershed project in south-central Wisconsin improved the trout classification of its stream and proposed that the stream be delisted from the state's Impaired Waters List for sedimentation. Keys to success included working in a small, concentrated area to achieve the desired farmer participation, using the right personnel to interact with farmers, and using both in-stream and on-farm conservation practices.

Wisconsin's Pleasant Valley Stream Rehabilitation Project

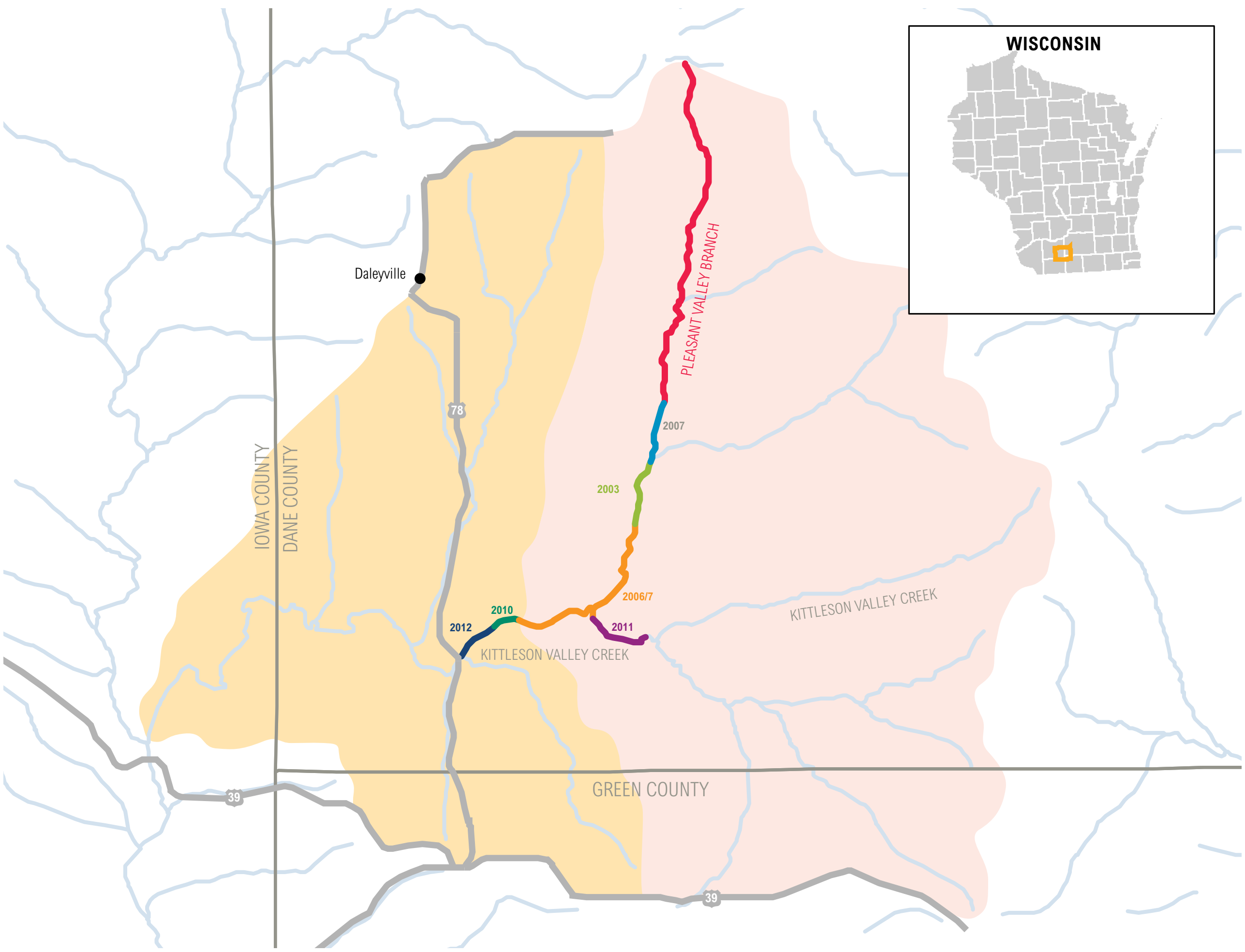
About the Watershed

Pleasant Valley Branch is a small, 12,300-acre (19-square-mile) subwatershed in Dane County, south-central Wisconsin. The Pleasant Valley Branch subwatershed drains into the Kittleson Valley Creek subwatershed and together the two subwatersheds compose the 21,200-acre (33-square-mile) HUC12 Pleasant Valley watershed. The area is hilly and dominated by ridge tops, steep slopes, and valley bottoms with numerous springs.

The Pleasant Valley Branch is a five-mile cold water stream that flows into Kittleson Valley Creek,[59] which is classified as a trout stream and eventually flows into the Pecatonica River. From there, the Pecatonica River enters the Rock River in Illinois and then the Mississippi River (see Figure 7.1).

The beef, dairy, and grain farms in this watershed are relatively small for the Midwest because of the topography. Numerous small, contoured fields averaging 5 acres grow corn, soybeans, alfalfa, and pasture. At the beginning of the project, the watershed was:

Figure 7.1 | **Map of the Wisconsin Pleasant Valley Stream Rehabilitation Project**



Pleasant Valley Branch subwatershed (shaded pink), the Kittleson Valley subwatershed (shaded gold), and the stream bank rehabilitation projects that were conducted on various stream reaches. Stream rehabilitation projects on Pleasant Valley Branch occurred in 2003, 2006–07, and 2007 while additional projects were conducted on Kittleson Valley Creek in 2010, 2011, and 2012. The Pleasant Valley Branch was listed as impaired in 1998 for degraded habitat due to sedimentation.

Source: WRI, with data provided by Curt Diehl, Dane County Land Conservation Division.

- 34 percent cropland;
- 28 percent grasslands (much of it in the USDA's Conservation Reserve Program, which retires marginal farmland);
- 11 percent pasture and pastured woodlands; and
- 22 percent woodlands.

Over the course of the project, cropland increased by about 800 acres due to the conversion of grasslands.

All five miles of Pleasant Valley Branch were listed by the Wisconsin Department of Natural Resources as impaired in 1998 because of degraded habitat caused by excessive sedimentation.

Project Impetus

The Wisconsin Pleasant Valley Watershed project comprises two staggered and unrelated interventions:

- a stream rehabilitation project (2002–13); and
- an on-farm conservation project focused on phosphorus and sediment reduction from cropland, pastureland, and barnyard sources (2006 to the present).

This case study features the stream rehabilitation project. The on-farm conservation project is discussed in Chapter 8.

In 2002 and 2003, Jim Amrhein, a water quality biologist with the Wisconsin Department of Natural Resources, conducted fish, insect, temperature, and habitat monitoring of the Pleasant Valley Branch to determine its status and potential. Kevin Connors, director of the Dane County Land and Water Resources Department, and Pat Sutter, a Dane County conservationist, had found mottled sculpin, a sensitive cold water fish species, in the system, suggesting that the Pleasant Valley Branch could become a trout stream. Amrhein said, "We recognized that since the stream was spring fed, it could be a quality cold water resource—if it wasn't overly wide, overly shallow, and full of sediment."

Project Approach, Goals, and Targeting

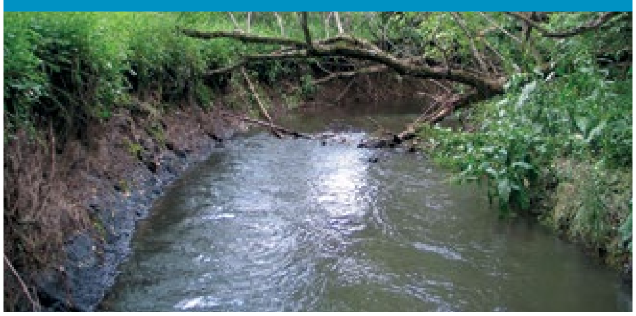
The goal of the stream rehabilitation project was to demonstrate that a variety of practices could reduce sediment in the stream and improve habitat and fish populations. To establish a baseline of information, the Wisconsin Department of Natural Resources conducted chemical, biological, and physical water quality monitoring on a middle segment along the Pleasant Valley Branch in 2002.

In 2003, the Dane County Land Conservation Division of the Land and Water Resources Department approached a farmer-landowner with a request to develop a stream rehabilitation demonstration project in the monitored segment. The farmer allowed the Land Conservation Division to address one mile of cropland and pastureland on the stream's edge, where banks were sloughing and habitat conditions were poor. The project involved many riparian and stream conservation practices, including sloping and seeding of steep banks to reconnect the stream to its flood plain, stabilizing the stream bank, planting a 30-foot buffer on both sides of the stream, and placing fish habitat structures in the stream (see Figure 7.2).

Over 12 years, the Department of Natural Resources and Dane County Land Conservation Division team worked with landowners on the Pleasant Valley Branch and Kittleson Valley Creek, one stream segment at a time and as funding became available. Word spread among farmers that fish were returning to streams adjacent to their property, inspiring others to participate. In all, the team and landowners constructed projects in 2003, 2006, 2007, 2010, 2011, and 2012, protecting nearly five miles of stream in addition to the one-mile demonstration site.[60]

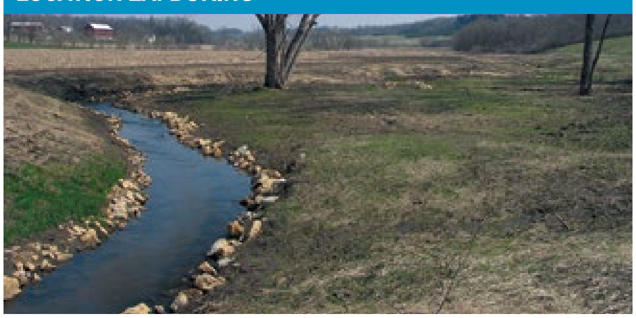
Figure 7.2 | **Stream Banks and Riparian Areas Before, During, and After Stream Rehabilitation**

LOCATION 1: BEFORE

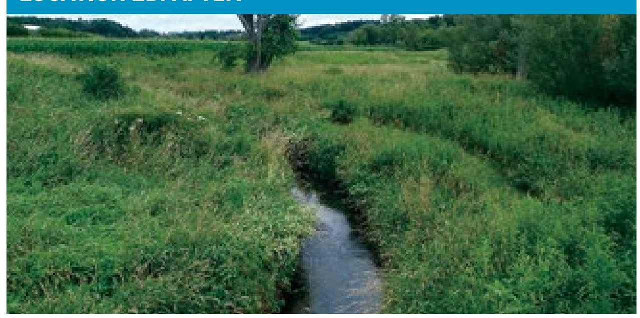


Stream banks and riparian areas before, during, and after the stream rehabilitation projects in three locations. Highly incised banks of streams in the Pleasant Valley watershed (Location 1) show where 30 percent of the watershed's soil erosion stems from. In stream bank rehabilitation projects, the eroding stream banks (Locations 2a and 3a) were shaped, sloped, and stabilized while the stream was narrowed to return conditions to a natural flood plain (Locations 2b and 3b). A 30-foot buffer of native vegetation was planted where appropriate (Locations 2b and 3b).

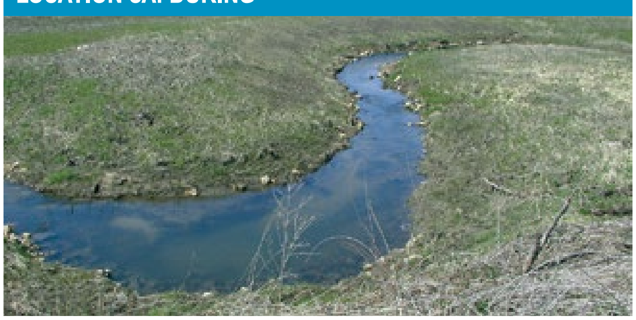
LOCATION 2A: DURING



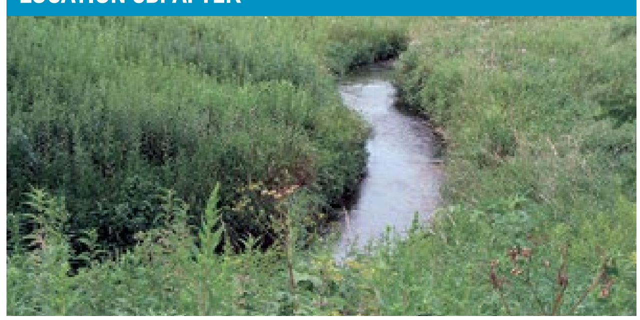
LOCATION 2B: AFTER



LOCATION 3A: DURING



LOCATION 3B: AFTER



Source: Jim Amrhein, Wisconsin Department of Natural Resources.

To address the sediment impairment, the team identified the best segments to target in the upper half of the Pleasant Valley Branch and Kittleson Valley Creek. During the site assessments, the team recognized that several headwater streams were too small to support large fish, which made them low priorities for rehabilitation, even though they were sources of stream bank sedimentation. Thus, the team worked with additional landowners on four more miles of smaller tributaries flowing into the Pleasant Valley Branch and the Kittleson Valley Creek to plant riparian buffers, fence cattle out of the stream, and provide stream crossings (not shown in Figure 7.1).

Funding Sources and Priority Practices

Project costs associated with the proposed delisting of the Pleasant Valley Branch from the Wisconsin List of Impaired Waters for sediment, including the 2005 stream rehabilitation demonstration site, plus implementing nine stream rehabilitation projects in 2006 and 2007, were $247,425. Together, these efforts resulted in 24,750 feet (or 4.7 miles) of restored stream bank at an average cost of $10 per foot.[61]

Funding sources and spending included the following:

- Wisconsin Targeted Runoff Management Program provided a grant ($105,000) aimed at reducing nonpoint source pollution through stream bank protection and habitat improvement.
- The Dane County Executive set aside county resources ($44,000) for the projects. Both state and county funds helped pay for grading and narrowing the stream and for seeding the stream bank.
- USDA NRCS provided $60,620 in Wildlife Habitat Incentives Program contracts to the landowners along the stream.
- U.S. Fish and Wildlife Service provided $3,791 for stream bank protection and habitat improvement.
- Deer Creek Sport and Conservation Club provided in-kind, matching funds ($14,828) to build “lunkers” structures (little underwater neighborhood keepers encompassing rheotaxic salmonids) to provide fish habitat. These funds were used to match participating landowners’ share for public access easement.
- A few landowners contributed $17,000 to avoid accepting a public access easement as their cost-sharing contribution to the county.

The project leaders estimated their project’s costs and sources of funding, as well as any in-kind or matching funds and associated spending costs. The estimate suggests that 38 percent of total project costs were for project management activities; 58 percent provided financial assistance to farmers and landowners; and 4 percent covered the water quality monitoring, data management, statistical analysis, and report writing costs (see Table 7.1).

Table 7.1 | **Project Cost Estimates for Wisconsin's Pleasant Valley Stream Rehabilitation Project, 2001–13**

DIRECT FUNDING	PROJECT MANAGEMENT (DOLLARS)	FINANCIAL ASSISTANCE TO FARMERS AND LANDOWNERS (DOLLARS)	WATER QUALITY MONITORING (DOLLARS)	TOTAL FUNDING (DOLLARS)	PERCENT OF FUNDING
Dane County Land Conservation Division (2001–07)		44,000		**44,000**	10
Wisconsin Department of Natural Resources (WDNR) Targeted Runoff Management Grant (2006)		105,000		**105,000**	25
WDNR Conservation Aids Program (2007)		2,200		**2,200**	1
U.S. Fish and Wildlife Service (2007)		3,800		**3,800**	1
USDA-NRCS Wildlife Habitat Incentive Program (WHIP) (2003)		60,600		**60,600**	14
Individual Landowners (2006–07)		17,000		**17,000**	4
IN-KIND SOURCES					
Wisconsin Department of Natural Resources	5,760		17,280	**23,040**	5
Deer Creek Sport and Conservation Club (2006–07) (labor)		14,830		**14,830**	3
Dane County Land Conservation Division (2008–13)	153,300			**153,300**	36
Total	**159,060**	**247,430**	**17,280**	**423,770**	100
Percent	38	58	4	100	

Monitoring Approach and Successful Outcomes

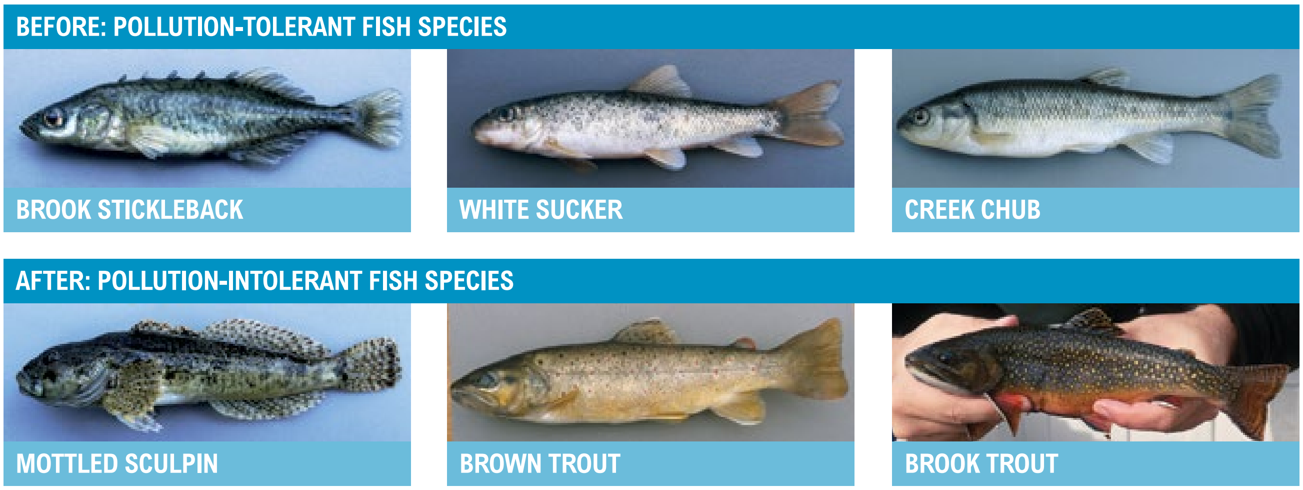
The Wisconsin Department of Natural Resources developed a before/after monitoring program (see Appendix C) for each stream rehabilitation project, which included a fisheries assessment and a quantitative habitat assessment, among other surveys. Follow-up assessments were conducted every year after implementation of each project and again after five years.

Significant outcomes were apparent after each project.

Fisheries assessment

Cold Water Index of Biotic Integrity. This index indicated that the stream reaches were "poor" at the beginning of each project and "fair" and "good" after project construction.

Figure 7.3 | **Before the Stream Rehabilitation Project, Pleasant Valley Branch Was Populated by Pollution-Tolerant Fish Species Whereas After the Project, Pollution-Sensitive Species Returned**



Before the project, the stream was dominated by species tolerant to disturbed habitat (suckers and stickleback). After the project, the fishery represented a healthy cold water resource with mottled sculpin, brown trout, and brook trout.

Source: Jim Amrhein, Wisconsin Department of Natural Resources. Photo credit: John Lyons, Wisconsin Department of Natural Resources.

Catch-per-unit of effort. Very few fish were found at project sites before restoration efforts, and most were pollution-tolerant species (e.g., brook stickleback, creek chub, and white sucker). Within a year of each project (and without stocking the stream), the team found pollution-intolerant species (brown trout and one or two rare brook trout; see Figure 7.3.)

Trout catch-per-unit of effort. Trout numbers increased by 70 to 100 percent. In some stream reaches, trout went from zero to two trout and from a few trout to 40–70 in the same length of stream.

Quantitative habitat assessment

Bank erosion. Before the projects, average bank erosion was about two feet of bare bank falling into the stream. After the projects, only about one inch continued to erode, on average, reducing bank erosion virtually to zero.

Percentage of soft sediment. An excess of soft or fine sediment in a streambed can harm the fishery. Before the projects, about 75 percent of materials in the stream water were soft sediments, whereas after one year, soft sediments were reduced to just 40 percent. In some segments, soft sediments dropped by up to 80 percent.

Habitat scores. Before project construction, habitat scores were *fair* and *good*, but after construction, scores rose to *good* and *excellent*.

According to Amrhein, “It was the classic case of ‘if you will build it they will come.’ When you narrow up the stream, build habitat structures, and stabilize the banks, the fish want to live there. When we were doing the fish survey, the farmer’s mouth was agape as he couldn’t imagine there would be that many trout in that little stream. He was excited to have contributed to it.” (Personal communication, January 28, 2016).

In 2014, Amrhein submitted a proposal to EPA to delist the stream for degraded habitat due to sediments. The proposal and associated “Success Story” write-up about the delisting is undergoing EPA review. Amrhein also recommended that state fisheries management staff consider designating Pleasant Valley as a “class II trout water” thanks to the significant improvement in the trout fishery (Amrhein, 2014), which was granted in 2017 by the Wisconsin Department of Natural Resources.

Table 7.2 | **Partners in the Wisconsin Pleasant Valley Branch Stream Rehabilitation Project**

NAME	TYPE	ROLE
Wisconsin Department of Natural Resources	State government	Led the biological, habitat, and sediment monitoring; prepared proposal to delist the stream for sediment. Lead: Jim Amrhein (water quality biologist).
Dane County Land Conservation Division (of the Dane County Land and Water Resources Department)	County government	Provided the outreach to farmers to encourage them to participate in the projects; installed and constructed the practices involved in each stream rehabilitation or buffer-fencing project. Leads: Pat Sutter (since retired, then county conservationist), Curt Diehl (conservation specialist), and Duane Wagner (soil and water conservationist, retired).
Natural Resources Conservation Service—Wisconsin's Madison Field Office	Federal government	Developed the Wildlife Habitat Incentive Program conservation contracts. Lead: Adam Dowling (district conservationist) and Terry Kelly (former district conservationist.)
Deer Creek Sport and Conservation Club	Nonprofit organization	Provided materials and labor to install the lunker fish habitat structures.

Project Partnerships

In addition to the project partners listed in Table 7.2, 10 farmers and landowners in the watershed volunteered to participate in the stream rehabilitation project, making its measured environmental outcomes possible.

Key Factors Contributing to Success

Project leaders said that the key factors in their project's success were working in a small watershed area, using the right personnel to interact with farmers, and using both in-stream and on-farm conservation practices.

It is easier to achieve and detect change in a small watershed

According to Amrhein, designing a small targeted watershed project was important to achieving success relatively quickly. "You need to do this work on a small concentrated scale, where you can see a difference. If we were working in a 40 to 60 square mile watershed, it would be challenging to coordinate enough farmer participation to the point we could see water quality changes. Pleasant Valley Branch subwatershed is part of a 19-square-mile HUC12 watershed and was a manageable size for us to obtain the farmer participation we needed to achieve stream improvements." (Personal communication, January 28, 2016).

Land conservation staff was the right messenger to farmers

Outreach by the Dane County Land Conservation Division was "instrumental to getting projects on the ground," according to Amrhein. Land Conservation Division staff knew many farmers and were best positioned to talk with them about stream rehabilitation practices. According to Amrhein, "Land conservation staff know what it takes for farmers to be profitable. They make farmers part of the process to implement the practices which fit what the farmers are currently doing, and can sustain or increase profitability. That way, the farmers feel a sense of ownership. It's a win for the environment and soil conservation, and the bottom line for farmers."

Combining stream rehabilitation with on-farm conservation efforts increased the likelihood that water quality benefits achieved by the first would be maintained by the second

Amrhein contends that though gains in water quality were evident from the practices implemented during both in-stream and on-farm projects, the combination of practices likely contributes to a sustainable level of water quality improvement. Had farmers and stakeholders implemented only the stream rehabilitation project, the fish that recolonized the stream could have been harmed by the continued on-farm soil erosion or manure losses from barnyards and cows into the stream. Thus, the on-farm conservation practices help avoid undermining the chemical, habitat, and biological water quality gains made by the stream projects. Likewise, had farmers and stakeholders in the Pleasant Valley subwatershed not addressed the stream bank erosion problems or provided improved habitat for fish, the water quality improvements generated by the on-farm conservation practices could have been masked by the continuation of stream bank erosion and lack of suitable habitat.

Challenges

One of the biggest challenges involved matching funding sources to the practices that were deemed appropriate for each stream bank site. For example, if the team wanted to conduct bank sloping and seeding on a certain portion of stream, but a funding source's specifications were inappropriate for that site, the team either had to find another funding source or proceed with the specifications of the funding entity.

A second challenge involved matching the timing of the funding to implementation of the project. In a few cases, the landowners would decide at the last minute that they wanted to install the recommended practices, forcing project partners to quickly apply for eligible funds, which then had to be used by a certain time. Sometimes, this timing did not fit with permit requirements from the state's water regulatory staff and Army Corps of Engineers or the ability of the contractor to get the job done. However, through the dedication of the County Land Conservation Division staff, the team managed to get most of needed conservation practices installed in a way that was (mostly) agreeable to all.

Next Steps

The Department of Natural Resources will monitor the fishery and habitat every five years, from the year each project began, to determine whether the system continues to improve or reaches a steady state.

One of the biggest challenges involved matching funding sources to the practices that were deemed appropriate for each stream bank site. If a funding source's specifications were inappropriate for a site, the team either had to find another funding source or proceed with the specifications of the funding entity.

CHAPTER 8

WISCONSIN PLEASANT VALLEY ON-FARM PHOSPHORUS AND SEDIMENT REDUCTION PROJECT

A second project in the same small 12,300-acre watershed in south-central Wisconsin reduced in-stream phosphorus by targeting conservation practices on fields with high and medium phosphorus index values. Keys to success involved building trust with farmers and providing them agronomic value, implementing watershed and subwatershed targeting, using a paired watershed monitoring program, and being flexible about priority practices.

About the Watershed

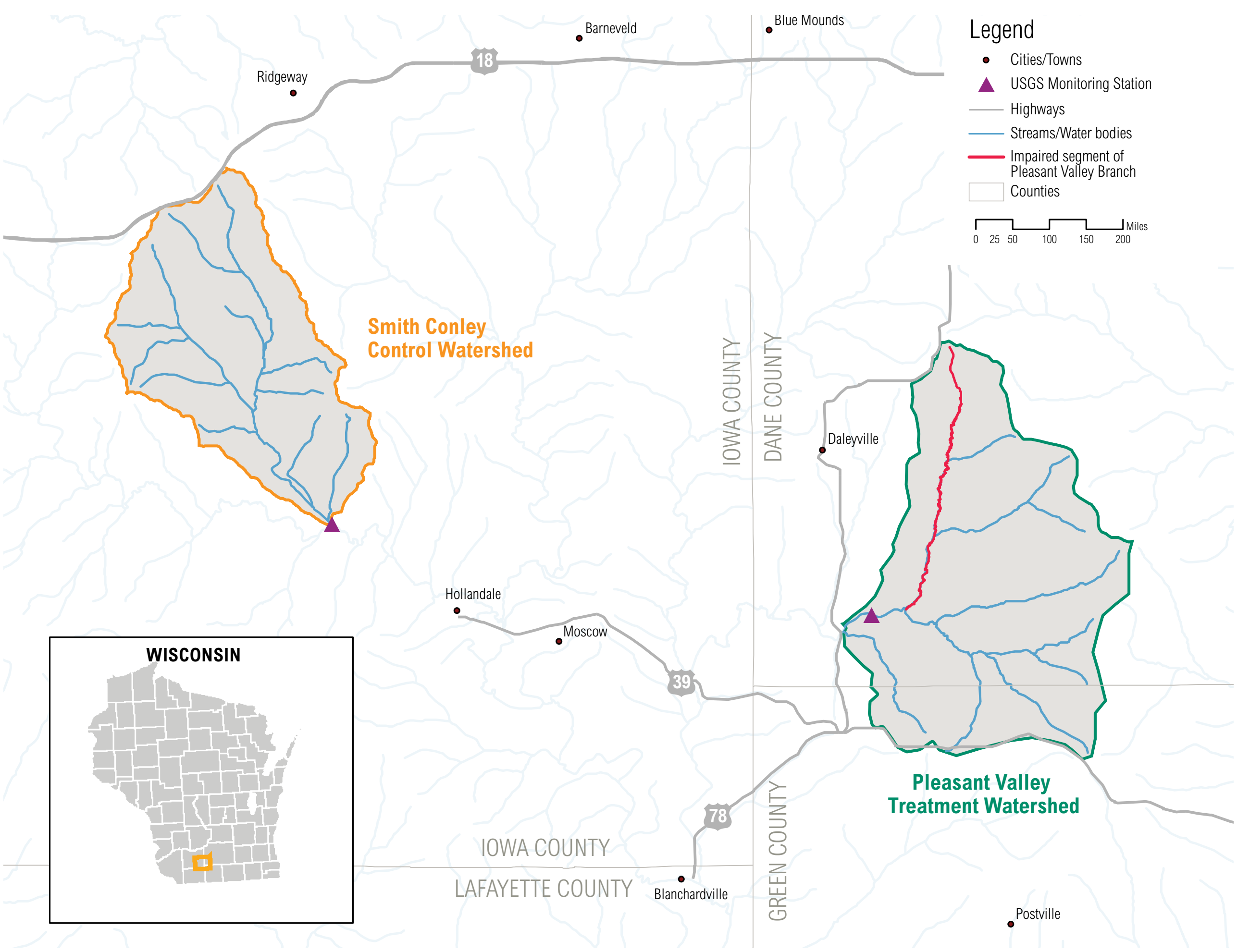
See the Wisconsin Pleasant Valley stream rehabilitation project case study (Chapter 7) for a description of the Pleasant Valley Branch watershed.

Impetus of the Project

While the stream rehabilitation projects were under way in the Pleasant Valley Branch watershed (2002–13), a second project was developed in 2006 and continues to the present (see Figure 8.1). It is a collaboration between the University of Wisconsin, The Nature Conservancy, the U.S. Geological Survey (USGS), Wisconsin's Department of Natural Resources, Dane County Land Conservation Division, and the Madison office of the USDA Natural Resources Conservation Service (NRCS).

The team developed a pilot project to implement recommendations from the 2005 *Wisconsin Buffer Initiative Report* (UW–Madison, 2005), which ranked Pleasant Valley watershed in the top 10 percent of Wisconsin watersheds whose water quality was likely to respond to conservation practices to reduce nutrients and sediment entering the stream. The report established a framework to inventory crop and livestock management practices using the Wisconsin Phosphorus Index[62] and the RUSLE2[63] soil erosion calculation. These tools helped leaders identify and prioritize fields and

Figure 8.1 | **Map of the Wisconsin Pleasant Valley On-Farm Phosphorus and Sediment Reduction Project**



Pleasant Valley treatment watershed and Smith Conley control watershed for the phosphorus and sediment reduction project.

Source: WRI, with data provided by Laura Good, University of Wisconsin–Madison, and Steve Richter, The Nature Conservancy.

pastures within the project watershed with a Phosphorus Index value over 6 or soil loss exceeding the NRCS's designation of "tolerable" that would offer the greatest opportunity for phosphorus and sediment reductions.

Project Approach, Goals, and Targeting

The project's goal was to test the concept of targeting to see if significant reductions in in-stream phosphorus and sediment could result from conservation practices on fields with high phosphorus index values. The USGS and the University of Wisconsin traced sediments to determine the proportion coming from upland agricultural sources versus stream bank erosion, and created phosphorus and sediment budgets for the watershed.

To determine where to target conservation efforts, a phosphorus and sediment assessment was conducted (2007–09) using the Wisconsin Phosphorus Index and RUSLE2 to inventory more than 90 percent of agricultural land in the small, 12,300-acre (19-square-mile) Pleasant Valley watershed. Owners and operators of 62 properties representing most of the watershed's crop- and pasturelands were interviewed about their crop, pasture, and barnyard practices by University of Wisconsin graduate student Katie Songer, an intern for the Dane County Land Conservation Division. Other Dane County staff completed the inventory with 25 additional landowners for a total of 87 landowners with crop fields, pastures, or fallow fields in the USDA Conservation Reserve Program. Songer and Dane County staff also coordinated soil sampling on each field (see Figure 8.2).

Information was entered into Wisconsin's nutrient management planning software, SnapPlus, which includes both the Wisconsin Phosphorus Index and the RUSLE2 soil loss calculator. By running the Phosphorus Index, Dane County staff identified areas with high soil phosphorus losses as the high-priority fields to target for adoption of conservation

Figure 8.2 | **Pleasant Valley Farmers Discuss Conservation Options with County Conservation Officer**

Family members of the Keller farm and Pat Sutter, Dane County Land Conservation Division (black shirt) discuss additional conservation options. Picture background shows their manure spreader and the use of the contour farming conservation practice on a hilly field. This field has a 6 percent slope, typical for the hilly Pleasant Valley watershed.

practices. With assistance from NRCS and University of Wisconsin Extension, Dane County staff worked one-on-one with 12 of the 13 farmers operating fields with Phosphorus Index values over 6 to evaluate which conservation practices were of interest to each farmer. Three more farms with fields with index values in the 3–6 range also wanted to improve their practices by converting their fields from conventional tillage to reduced tillage/no-till cultivation. Along with the Dane County staff, university staff and students ran the SnapPlus software to estimate how the phosphorus and sediment losses on these 15 farms might improve with each suite of conservation practice scenarios.

Funding Sources and Priority Practices

With most of the inventory completed in 2009, the Dane County Land Conservation Division received funding from the NRCS Cooperative Conservation Partnership Initiative to implement practices in the watershed. Having an inventory and plan already in place was critical for using this funding in a targeted manner. The enrollment period for the program was only six weeks, challenging conservation staff and farmers to make commitments quickly. Farms whose fields had Phosphorus Index values greater than 6 were ranked higher than those with values from 3 to 6. The Dane County staff focused on farms with the highest farm-scale phosphorus losses which reflected modeled phosphorus losses from crop and pasture fields, as well as from barnyards.

A variety of federal and private funding sources covered the costs associated with project management, financial assistance to farmers, and water quality monitoring. Wisconsin's Phosphorus and Sediment Reduction Project estimated that 30 percent of total project costs were associated with project management activities; 40 percent went to financial assistance to farmers and landowners (including their out-of-pocket costs); and 30 percent covered the costs for water quality monitoring, data management, and statistical analysis. However, much of the monitoring costs also went to the USGS research project described below that estimated the proportion of sediment stemming from fields versus stream banks, which was additional to the primary project (see Table 8.1).

To reduce phosphorus and sediment in the watershed as measured at the outlet of the watershed, the project addressed the cropland, pastureland, and barnyard sources of pollution, and stretches of eroding stream banks. From 2010 to 2013 (the conservation intervention period), 15 farmers in Pleasant Valley implemented conservation practices on fields that had high (above 6) and medium (3–6) phosphorus index ratings. In many cases, farmers anticipated the benefits of conservation practices, such as the time savings and soil health benefits of no-till cultivation, and decided to implement the practices on a majority of their acres, even in fields with lower risk of run off.

As of 2013, the following practices had been adopted on high-priority fields (i.e., high and medium phosphorus loss ratings) and nonpriority fields (i.e., low phosphorus loss ratings) in the watershed:

- 2,629 acres of fields were covered by nutrient management plans (63 percent of the 4,167 acres of cropland).
- 1,465 acres used no-till or reduced tillage cultivation (35 percent of 4,167 acres of cropland).
- 314 acres of cropland applied crop rotation changes (e.g., planting rye for forage after corn silage, adding one or more years of alfalfa into the rotation).
- Priority pasture management practices such as pasture reseeding and pasture management with fencing were implemented.
- Constructed practices included:
    - barnyard runoff systems installed on eight farms
    - eight livestock stream crossings and 13,758 feet of fencing installed, protecting 16,280 feet of stream (see Figure 8.3)
    - two small water control projects built
    - three grade stabilization structures constructed
    - stream bank restoration with fish habitat installed on one mile of stream
    - 2,010 feet (about 1/3 of a mile) of grassed waterways planted

Table 8.1 | **Project Cost Estimates for the Wisconsin Pleasant Valley On-Farm Phosphorus and Sediment Reduction Project, 2006–16**

DIRECT FUNDING	PROJECT MANAGEMENT (DOLLARS)	FINANCIAL ASSISTANCE TO FARMERS AND LANDOWNERS (DOLLARS)	WATER QUALITY MONITORING (DOLLARS)	TOTAL FUNDING (DOLLARS)	PERCENT OF FUNDING
McKnight Foundation grant to The Nature Conservancy (TNC) for Dane County Land Conservation Division (LCD) (2007–2009)	90,000	20,000	90,000	**200,000**	9
Monsanto Corporation gift to TNC (project management by Dane County LCD & TNC, financial assistance & water quality monitoring by USGS) (2009–2013)	400,000	100,000	160,000	**660,000**	31
NRCS Cooperative Conservation Partnerships Initiative (CCPI) to Dane County LCD (2009–2012)	100,000	500,000		**600,000**	28
Wisconsin Department of Natural Resources (2013) for USGS station monitoring & research		75,000	30,000	**105,000**	5
USDA National Institutes of Food and Agriculture for USGS monitoring ($60k over first 2 years) plus research (sediment fingerprinting & upland versus stream bank sourcing) (2009–2011)			250,000	**250,000**	12
University of Wisconsin–Madison for phosphorus & sediment assessment inventory by graduate student (2007 & 2008)	20,000			**20,000**	1
IN-KIND SOURCES					
Farmers' expense for practices		90,000		**90,000**	4
NRCS Wisconsin Field Office			35,000	**35,000**	2
Dane County Land Conservation Division		56,000		**56,000**	3
Kohler Trust for Preservation to TNC (2014–2016)	5,000			**5,000**	0
University of Wisconsin–Madison Soil Sciences (2006–2016)	25,000			**25,000**	1
USGS matching funds for stream gages (2008–2016)			60,000	**60,000**	3
Total	**640,000**	**841,000**	**625,000**	**2,106,000**	100
%	30	40	30	100	

Though none of the farmers adopted conservation or harvestable buffers, the practices that were implemented did result in statistically significant phosphorus reductions and a trend toward sediment reduction. The goal of the *Wisconsin Buffer Initiative Report* was to encourage farmers to adopt practices that fit their farming systems to keep phosphorus and sediment losses below threshold levels.

Edge-of-field practices such as vegetative buffers were considered a back-up if threshold levels could not be obtained with in-field practices (UW–Madison, 2005). However, because most cropped fields in the Pleasant Valley watershed are small (average 5 acres), farmers were not interested in adopting riparian buffers that might remove up to half an acre of cropland, depending on the field-stream configuration. Additionally, a nationwide trend to convert whole fields from grassland to cropland was under way in response to high corn prices. In fact, several landowners in Pleasant Valley and the project's control watershed (like farmers in the rest of the country) either terminated their federal Conservation Reserve Program grassland contracts prior to the expiration date or let them expire.[64]

Figure 8.3 | **A Fenced Stream Crossing with a Gate Keeps Livestock Away from the Stream**

Curt Diehl, Dane County Land Conservation Division (left), discusses conservation activities with Josh Judd, farmer, in front of a fenced stream crossing project with a gate that prevents livestock from accessing the stream.

Monitoring Approach and Successful Outcomes

Monitoring design

To assess the outcomes of the on-farm phosphorus and sediment reduction project, the team used a before/after and paired watershed water quality monitoring program (see Appendix C). A nearby watershed named Smith Conley (also called Ridgeway) served as the control (see Figure 8.1). Field and pasture management within both the control and treatment watersheds were tracked from 2007 through 2016 (e.g., conservation practices installed, Conservation Reserve Program acres converted to row crops, changes in animal numbers), and this information was used to update the calculations of average sediment and phosphorus loads from fields and pastures.

Sampling regime

As part of a separate research project, the U.S. Geological Survey (USGS) installed two in-stream gages in 2006 at the outlets of both Pleasant Valley and Smith Conley watersheds to monitor flow, sediment, and phosphorus concentrations during base flow and storm events. USGS staff collected fixed-interval samples (monthly November through February and biweekly March through October) and event-based samples (during periods of increased runoff due to precipitation or snowmelt) at each site and sent them for analysis to the Wisconsin Laboratory of Hygiene (see Figure 8.4).

From this pool of samples, the USGS project staff analyzed 111 paired stream observations (i.e., pairing a control sample with a treatment sample taken on the same day) obtained during storm events. A total of 52 events were observed during the calibration (baseline) period (October 2006–September 2010) while 59 were observed in the post-intervention period (October 2012–September 2016).

Water quality outcomes

Monitored water quality outcomes. The on-farm conservation project observed early and significant success. Median in-stream total phosphorus storm event loads were reduced by 55 percent, and sediment storm event loads, when the ground was not frozen, were reduced by 66 percent in Pleasant Valley watershed in the four years following practice implementation (2013 through 2016). This reduction is compared to what it would have been without the project as evidenced by comparison with loads in the Smith Conley control watershed during the same events, clearing the statistical hurdle with 95 percent confidence.[65] Total phosphorus and total dissolved phosphorus concentrations within the stream during low-flow (non-storm) conditions were also significantly lower.

Modeled water quality outcomes. The Phosphorus Index estimated that the no-till or reduced-tillage and residue management on 1,840 acres (44 percent of all cropland acres in the watershed) resulted in a 3,300-pound-per-year reduction in phosphorus runoff losses and a 2,000-ton-per-year reduction in soil erosion. In addition, the pasture conservation measures like stream crossings, fencing, and seeding management on 315 acres (23 percent of all pasture and pasture woodland acres) resulted in an estimated average reduction of 1,100 pounds per year of phosphorus loss and of 100 tons per year of eroded soil.

Overall, the Phosphorus Index estimates that the participating farms cut phosphorus runoff losses in half from nearly 8,000 pounds per year during the 2006–09 baseline timeframe to about 4,000 pounds per year in 2013. The largest estimated benefits came from management that reduced runoff and erosion from pastures and cropland.

Conversely, over the course of the project, management changes in some fields that originally had low Phosphorus Index and soil loss values caused increases in both phosphorus and soil losses. The biggest cause of fields moving from low- to high-losses was the conversion of Conservation Reserve Program grasslands to cropland (in response to rising corn prices). Over the baseline and implementation period, cropland acreage increased by almost 20 percent, with a corresponding decrease in grasslands.

Cost of monitoring. The project's water quality monitoring program budget was estimated at about $625,000, which included the installation and maintenance of the two USGS stream gage stations at the outlet of the control and treatment watersheds and the associated data management

Figure 8.4 | **Stream Gage at the Outlet of the Pleasant Valley Watershed**

U.S. Geological Survey (USGS) monitoring specialist Becky Carvin maintains the USGS stream gage at the outlet of the Pleasant Valley Watershed.

and statistical analysis. However, that estimate also includes costs associated with the additional USGS research project that estimated the proportion of sediment in the watershed originating from agricultural fields versus stream banks.

Economic outcomes

Cost-effectiveness outcomes were estimated from the modeled phosphorus results from three farms (dairy, beef, and cash grain) and their adopted agronomic practices (e.g., no till and nutrient management). The spending on pollution reductions was $5–$19 per pound of phosphorus reduced per year and $8–$31 per ton of sediment reduced per year, depending on farm type. Note that these calculations reflect public incentive expenditures only and omit spending by farmers, program administration costs, and technical assistance to farmers.

Research findings

The USGS and University of Wisconsin Biological Systems Engineering Department research included:

- 30 rapid geomorphic channel assessments in each watershed,

- automated in situ suspended sediment samplers in the stream, and
- an innovative sediment fingerprinting project.

The team concluded that approximately 70 percent of the suspended sediment in the stream at the watershed outlet came from agricultural land soil erosion while 30 percent came from in-stream bank and channel sloughing. They also estimated that about eight years' worth of annual export of suspended sediment is "stored" in soft sediment in the streambed. This soft sediment can be re-suspended in stream flow and contribute to future stream loads of sediment.

Project Partnerships

In addition to the project partners listed in Table 8.2, 15 farmers or landowners in the watershed volunteered to participate in the project, making its measured environmental outcomes possible.

Key Factors Contributing to Success

Project leaders said key factors contributing to their success involved building trust with farmers and providing them value, implementing watershed and subwatershed targeting, using a paired watershed monitoring program, and being flexible about priority practices.

Farmer participation was gained by building trust and providing value

To conduct the Phosphorus Inventory and Assessment, the team needed to earn the trust of farmers and landowners in the watershed. A University of Wisconsin graduate student "knocked on over a hundred doors" in the watershed to explain the project and offer farmers free soil testing. This outreach by "friendly and eager-to-learn" students combined with a free soil analysis helped gain farmers' trust and provided them with valuable agronomic information. "The farmers began inviting the student to sit down at the kitchen or their farm office table to inventory their crop rotations and their forage decisions and share their fertilizer and manure inputs and crop yields," said University of Wisconsin professor Laura Good (Personal communication, July 8, 2015).

Targeting the right watershed and then targeting priority areas within the watershed was critical

Once the Pleasant Valley Branch watershed was selected for the project, the team identified and prioritized the highest phosphorus loss fields, which were operated by about a quarter of the farms (11 of 45) in the watershed. Targeting allowed the project leaders to avoid "bothering" the majority of the farmers. The Nature Conservancy's Steve Richter noted another facet to targeting: "The team's approach to working with farmers in the watershed was to seek them out. We didn't wait. We went to their farms. That's what targeting is about, engaging folks without needing to wait for them to come into the NRCS or district office [for financial or technical assistance]. And also engaging the folks that don't have a history of coming into the office at all." (Personal communication, July 8, 2015).

Using a paired watershed design helped detect water quality improvements relatively quickly

"Without a doubt, we would not have seen an improvement so quickly if we had not used the paired watershed approach," (Personal communication, July 8, 2015) said Faith Fitzpatrick of the USGS. The team showed a 55 percent reduction in phosphorus loads in the third year of monitoring after the conservation implementation period. In addition, the paired watershed approach helped "neutralize" complicating factors such as extreme weather events (like the 2008–09 record rainfall and a 2012 drought) and the conversion of grassland to crops during the project time frame. These complicating factors were present in both the treatment and the control watersheds. "The research design of a control watershed is the beauty of this project as it leads to something rarely documented: statistical significance and 95 percent confidence when saying that the water quality results were attributed to farmers changing practices," said Richter (Personal communication, July 8, 2015).

Providing options and remaining flexible made the project more appealing to farmers

"There are no best management practices; there are only practices that work for each farmer," said the University of Wisconsin's Laura Good. "One important factor to our success was that we went to farmers with a suite of practice options rather than

Table 8.2 | **Partners in the Wisconsin Pleasant Valley On-Farm Phosphorus and Sediment Reduction Project**

NAME	TYPE	ROLE
The Nature Conservancy	Nonprofit organization	Provided funding for stream monitoring and the sediment and phosphorus budgeting, the inventory and assessment of conservation practices, and practice implementation costs. Also provided outreach, educational assistance, and project management. Lead: Steve Richter (director of conservation programs).
University of Wisconsin–Madison Soil Science and Biological Systems Engineering Departments and the Nelson Institute	University	Faculty, staff, and graduate students conducted the sediment and phosphorus budgeting analysis, as well as the inventory and assessment of conservation practices. Lead: Laura Good (associate scientist).
United States Geological Survey	Federal government	Led the project's in-stream water quality monitoring program and the sediment tracing assessments. Leads: Faith Fitzpatrick (research hydrologist) and Rebecca Carvin (physical scientist).
Dane County Land Conservation Department	County government	Provided outreach to the farmers, technical assistance with the conservation practice inventory and assessment, and technical assistance in the implementation of practices. Leads: Pat Sutter (since retired, then county conservationist), Curt Diehl (conservation specialist), and Duane Wagner (soil and water conservationist, retired).
University of Wisconsin Extension Service	University	Provided technical assistance to farmers and landowners to help them decide, plan, and implement the conservation practices.
Natural Resources Conservation Service–Wisconsin	Federal government	Provided financial and technical assistance to farmers receiving Environmental Quality Incentives Program funds.
Wisconsin Department of Natural Resources	State government	Provided assistance with stream channel assessment. Lead: Jim Amrhein (water quality biologist).

a prescriptive list for achieving phosphorus and sediment reductions. If something didn't work for their farm system, we encouraged them to look at something else. The county staff originally thought that harvested riparian buffers, which provide forage crops, would be an attractive option for the dairy farmers, but nobody was interested so they focused on other sediment control practices of interest to the farmers." (Personal communication, July 8, 2015).

Challenges

Given the project's goal to reduce phosphorus losses, gaining buy-in from crop consultants at the beginning rather than midway through the project would have been helpful. Farmers reported that their crop consultants questioned why project leaders were asking farmers who had already reached the state's phosphorus index threshold value of 6 to continue reducing phosphorus fertilizer, to lower manure application rates, or to adopt other phosphorus-reducing practices. Project partners had to explain to both farmers and crop consultants that additional reductions were necessary on fields with 3 to 6 index values, as well, to achieve the desired statistically significant improvements in the stream. Another challenging aspect of the project was keeping track of the many changes in field operators, crop rotations, and grassland conversions that occurred and continue to occur in the watershed.

Next Steps

Farmer interviews in summer 2016 found continued use of nutrient management plans and no-till or reduced-tillage practices. The team plans to continue documenting the project successes and share lessons learned with stakeholders in Wisconsin and beyond.

CHAPTER 9

INDIANA SHATTO DITCH CASE STUDY

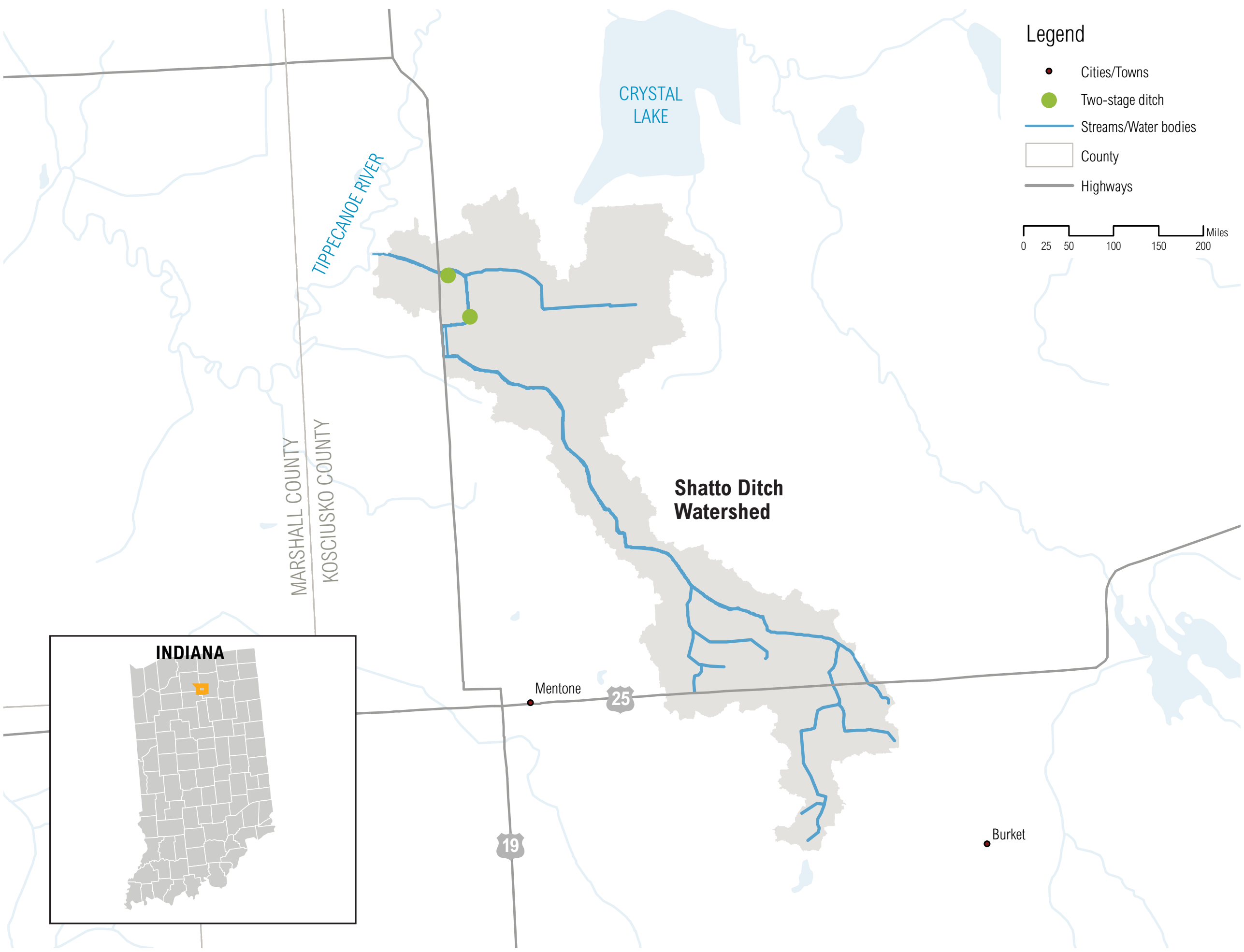
A very small 3,300-acre watershed project in northeastern Indiana documented increases in several biological water quality outcomes and improvements in tile drain water quality by installing a two-stage ditch and promoting widespread cover crop adoption. Keys to success included working within a small watershed, having a large practice adoption rate (i.e., 70 percent cover crop adoption), and conducting high frequency water quality sampling to document improvements.

About the Watershed

The Shatto Ditch is a perennially flowing seven-mile agricultural ditch within a 3,300-acre watershed in northeastern Indiana's Kosciusko County (see Figure 9.1). The ditch drains directly into the Tippecanoe River, which is known as a "biological gem" for its fish and freshwater mussels. Nutrients and sediments from the Shatto, and many other agriculture-dominated watersheds whose tributaries carry sediment-laden waters, may be linked to degradation of the Tippecanoe and the declining population of the river's endangered clubshell mussel.

About 85 percent of land use in the Shatto Ditch watershed is row-crop agriculture dominated by corn-soybean rotations in minimum tillage operations. Most cropland is not irrigated, but all crop fields are tile drained. About 30 farmers operate in Shatto Ditch, but 17 have less than 50 acres with the remaining 13 farming most of the cropland. The watershed is dominated by loamy sand soil types, and the terrain is flat. Though Shatto Ditch is not on the Indiana Impaired Waters List, it does have relatively high nutrient and sediment concentrations that are typical of agricultural streams and ditches.

Figure 9.1 | **Map of the Indiana Shatto Ditch Project**



Map of the project watershed showing the location of the two-stage ditch (two green circles representing the downstream and upstream ends of the practice).
Source: WRI.

Project Impetus

The Shatto Ditch project had two phases:

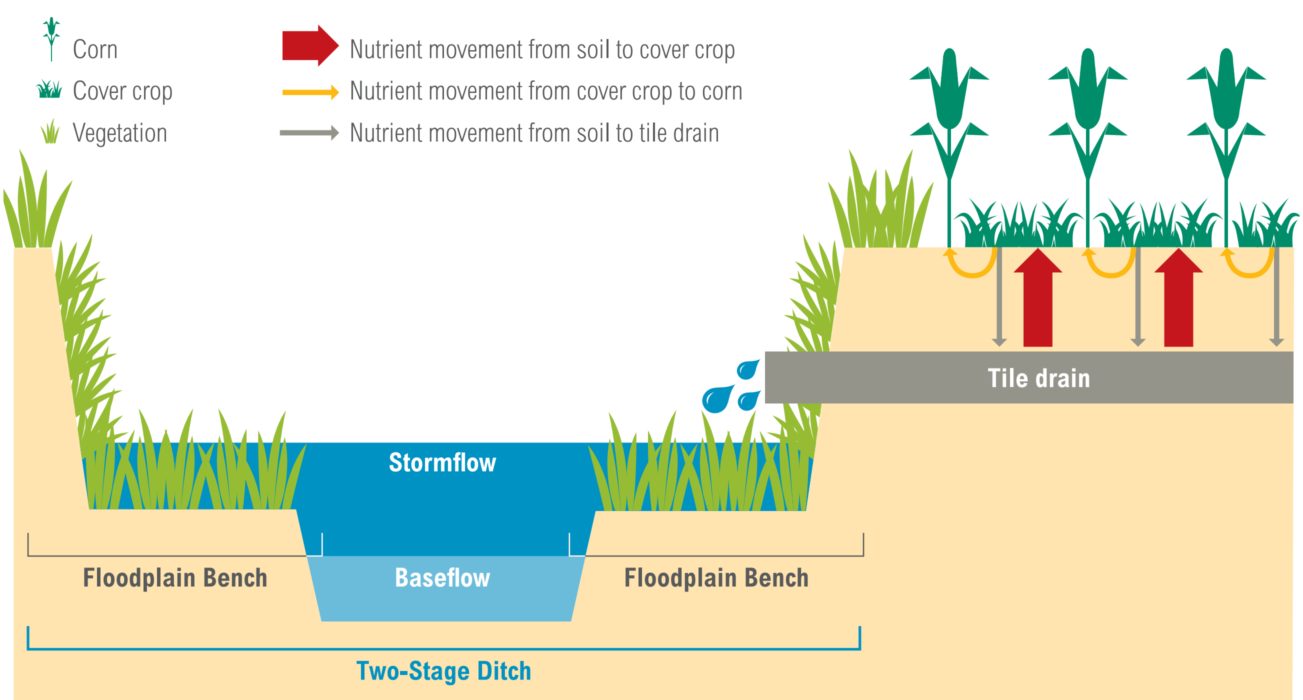
- Phase 1: Test the two-stage ditch in the stream (2006–present)
- Phase 2: Add cover crops on farms (a landscape-scale management practice) to the in-stream two-stage ditch practice (2012–present; see Figure 9.2.)

The first phase began in 2006 as a demonstration project by The Nature Conservancy (TNC). The project built two depths into the ditches—a deeper channel in the middle and shallower "inset floodplain benches" along the banks—to halt stream bank erosion and to filter water to reduce nutrient and sediment concentrations in streams. Many agricultural ditches in the Midwest have steep banks that can erode and require frequent dredging. The two-stage ditch is an in-stream conservation practice that transforms the steep ditch banks into vegetated, mini-floodplains by carving the benches into the banks to:

- Reduce bank erosion by increasing channel stability
- Improve water clarity by decreasing velocity on the benches during storm flows allowing sediments to settle out on the benches
- Reduce nutrient inputs from tile drains by "treating" tile water that discharges onto the benches
- Potentially increase fish and macroinvertebrate populations

Kent Wamsley of the Indiana Nature Conservancy office, in partnership with Sam St. Clair, with the USDA NRCS-Indiana; Dick Kemper, Kosciusko County surveyor; and Andy Ward, a professor at Ohio State University, selected Shatto Ditch for the demonstration project because of its proximity to the Tippecanoe River. The team hoped that a two-stage ditch would reduce sediment export that was smothering the Tippecanoe's endangered clubshell mussel population. Kemper was also interested

Figure 9.2 | **The Shatto Ditch Project Involved Constructing a Two-Stage Ditch in the Stream and Planting Cover Crops on Fields that are Tile Drained**



The Shatto Ditch project employed two practices: (1) a two-stage ditch was built in the stream to allow vegetation to stabilize the banks while deeper water continues to flow through the mainstem and (2) cover crops were planted on cropland overlying tile drains to stabilize the soil and retain nutrients.

Data Source: Jennifer Tank, University of Notre Dame; *Design:* WRI.

in testing solutions associated with ditch maintenance. Ditches were commonly maintained on a 5- to 10-year schedule, but in Shatto Ditch, dredging was more frequent (every 2 to 3 years) because several farmers were cropping directly adjacent to the stream, causing banks to slough off and deposit sediment in the stream. Jennifer Tank, a biology professor at the University of Notre Dame, was engaged to measure water quality (2006–present) while Greg Bright of Commonwealth Biomonitoring, a private consulting firm, provided biological monitoring.

The two-stage ditch produced several positive outcomes, including:

- **Aquatic life benefits.** An increase in the average Index of Biotic Integrity (which ranges from 12 to 60 with a higher number indicating improved biological water quality metrics) from 13 in 2006 (preconstruction) to 19 in 2008 (one-year postconstruction); a decrease in the percentage of pollution-tolerant macroinvertebrate species and an increase in the percentage of pollution-intolerant species.
- **Water quality improvements.** An increase in nitrate nitrogen (nitrate-N) removal via denitrification (Roley et al., 2012a; 2012b) and a decrease in turbidity, total suspended solids, and total phosphorus (Davis et al., 2015; Mahl et al., 2015).

However, because of very high nitrogen loading from the surrounding watershed (Roley et al., 2012a; 2012b), the half-mile stretch of the two-stage ditch was able to remove only about 10 percent of the nitrate in the stream. Thus, the team concluded that on-farm conservation practices would also be necessary to significantly reduce pollution loads to the Tippecanoe from the Shatto Ditch.

The second phase of the project started in 2012 when Darci Zolman of the Kosciusko County Soil and Water Conservation District, Kent Walmsley of TNC, and Tank received a USDA Conservation Innovation Grant to continue work in the Shatto Ditch. Previous research showed the potential of cover crops to significantly reduce nutrient transport from agricultural fields via tile drains (Kladivko et al., 2004; Kaspar et al., 2007); yet, little research had focused on the benefit of "stacking" or combining conservation practices at the watershed-scale. The team was also interested in cover crops; Indiana's new Soil Health Initiative focused on cover crops as a priority practice, and they had been planted on 320 acres, or about 14 percent of the acres in the small watershed, for several years. The team aimed for significant cover crop adoption in the watershed (over 50 percent of the cropland) and planned to examine the benefits of adding cover crops to the majority of acres within the half-mile of two-stage ditch to the water quality at the watershed outlet.

Project Approach, Goals, and Targeting

The goal of the initial two-stage ditch project was to determine if the practice could trap and filter sediments and nutrients thereby improving water quality and increasing the diversity and abundance of fish compared with the half-mile control segment upstream. The project team decided to install the two-stage ditch just a quarter mile from Tippecanoe River to assess whether the practice could provide sufficient habitat to allow fish from the river to find refuge in the ditch if water quality declined in the Tippecanoe River.

The goal of the second phase of the project was to quantify the in-stream and tile drain nutrient and sediment reduction benefits of cover crops—planted on the majority of the watershed's 2,300 cropland acres—paired with the half-mile of two-stage ditch. Given the watershed's homogeneity in crop production, tile-drain systems, and flat topography, no subsection of the watershed was prioritized. The partners aimed for a 50 percent cover crop adoption rate because the consistently poor water quality along all reaches of the stream required a significant "saturation rate" to make a difference in the monitored water quality. In contrast, the 2014 cover crop adoption rate in Indiana was about 8 percent of cropland.[66]

Funding Sources and Priority Practices

Funding for the first phase of the project to install and monitor the benefits of the two-stage ditch was provided by the Indiana Chapter of The Nature Conservancy ($120,000) and an EPA Section 319 grant from the Indiana Department of Environmental Management (nearly $120,000). The three farmers who were impacted by the construction of the initial half-mile of the two-stage ditch were not asked to provide out-of-pocket costs for the project, nor were they compensated for the cropland they gave up to widen the stream and build the ditch's floodplain benches. The initial half-mile project cost $14,000 to construct. The rest of The Nature Conservancy and Indiana Department of Environmental Management funds covered project design and management, biological water quality monitoring by Commonwealth Biomonitoring, and chemical water quality monitoring by the University of Notre Dame.

For the project's second phase on cover crops, a three-year USDA Conservation Innovation Grant ($368,000) was awarded in late 2012 for project activities through October 2015 (with a one-year, no-cost extension through 2016). This grant provided $130,000 for farmer financial assistance to plant cover crops. In addition, $200,000 was provided to the University of Notre Dame over four years ($50,000 per year) for chemical water quality monitoring. Costs included stipends for graduate students conducting the grab sampling and laboratory analyses on the water samples. The rest of the funds ($38,000) helped cover project management by the Indiana Chapter of The Nature Conservancy and by Kosciusko County Soil and Water Conservation District (SWCD).

Several institutions provided in-kind matching funds to cover costs of outreach, education, and additional project management support, including: the Indiana Chapter of TNC and Kosciusko County SWCD, at $90,000 each over three years, and by Arrowhead Resource Conservation District at $30,000 over three years.

The federal Environmental Quality Incentive Program helped five additional farmers adopt cover crops in the watershed during the project.

To reach the project's initial cover crop adoption goal, the partners reached out to the 13 farmers operating the largest crop farms in the watershed, and 8 agreed to join the project. They received financial assistance through the team's Conservation Innovation Grant to plant the cover crops, thereby achieving the project's 50 percent adoption rate. Five additional farmers adopted cover crops on their own or with assistance from the federal Environmental Quality Incentive Program, raising the average three-year adoption rate to 70 percent of the 2,300 cropland acres in the watershed. The partners credit the increasing farmer interest in cover crops to educational efforts by the state's Soil Health Initiative and to the project. The predominant cover crop planted was annual rye grass.

Cover crops were planted on 1,611 acres, in autumn 2013, 1,561 acres in autumn 2014, and 1,660 acres in autumn 2015. Cover crops were planted at the watershed-scale again in autumn 2016 and will continue for another four years using funding from a USDA-RCPP award.

Monitoring Approach and Successful Outcomes

Phase 1: Two-Stage Ditch Project

Monitoring design

BIOLOGICAL MONITORING

The Nature Conservancy hired Commonwealth Biomonitoring to monitor fish and macroinvertebrate species to assess the benefits of the two-stage ditch on biological communities.

CHEMICAL MONITORING

To assess the water quality benefits of the two-stage ditch, Prof. Tank and her students at the University of Notre Dame collaborated with The Nature Conservancy in collecting a suite of water quality parameters before and after two-stage construction. The two sampling locations were inside the reach containing the two-stage ditch and upstream in the control reach to achieve the before-after-control-impact (BACI) monitoring design.

Sampling regime

BIOLOGICAL MONITORING

A year before construction of the two-stage ditch in 2006, Commonwealth Biomonitoring monitored the half-mile section of the construction area, a half-mile directly upstream as a control location, and three other sites upstream. In the fall of 2006 and 2007 (preconstruction), the fall of 2008 and 2015 (postconstruction), fish and macroinvertebrate surveys were conducted, and a Fish Index of Biotic Integrity and a Benthic Index of Biotic Integrity were calculated. Habitat evaluations were conducted using the Qualitative Habitat Evaluation Index in all but the final year of monitoring.

CHEMICAL MONITORING

For the two-stage ditch water quality assessment (2006–12), the Notre Dame team, along with The Nature Conservancy, deployed and maintained Hydrolab minisondes monitoring equipment, which collected data every 30 minutes on turbidity, dissolved oxygen, temperature, pH, and conductivity. Light sensors near the two-stage ditch recorded photosynthetically active radiation so that information could be correlated to in-stream metabolism, which indicates the likelihood that the water can support aquatic life (i.e., gross primary production and respiration from dissolved oxygen measurements). The team also conducted monthly sediment sampling to determine denitrification rates in the main channel of the stream and on the benches of the two-stage ditch. Notre Dame also collected biweekly grab samples of stream water to measure nutrient concentrations, including ammonium, nitrate, and soluble reactive phosphorus concentrations in the two-stage ditch area and the upstream control reach.

Water quality outcomes

Results of monitoring at the two-stage ditch showed many different biological and chemical water quality outcomes (see Table 9.1).

Phase 2: Two-Stage Ditch plus Cover Crops Project

Monitoring design

Tank and her graduate students employed a before-after-control-impact (BACI) experimental design (see Appendix C) to conduct high-resolution water quality monitoring at tile drain outlets and stream sites.

Sampling regime

The team collected grab samples every 14 days at 10 stream sites, about every 0.5 mile, distributed longitudinally along the stream (see Figure 9.3) and at 23 tile drain outlets (about two per field), totaling over 2,400 water samples per year. Each sample was analyzed for ammonium, nitrate, and soluble reactive phosphorus. Additional ancillary variables were measured at each sampling location, including temperature, conductivity, and pH, as well as instantaneous discharge or flow (liters per second). At the top and bottom of the watershed, two automated instruments (datasondes) that provide near-continuous water quality data recorded dissolved oxygen, turbidity, temperature, pH, and conductivity every 30 minutes.[67]

Water quality outcomes (preliminary results)

Researchers at the University of Notre Dame found that in the pretreatment year of 2012, average nitrate-N and phosphorus concentrations from the tile drains under the few fields with a long history of cover crop plantings were 30–40 percent lower than samples from tile drains in fields without cover crops.

Figure 9.3 | **Graduate Student Takes Water Samples in Shatto Ditch**

Source: Brittany Hanrahan, University of Notre Dame.

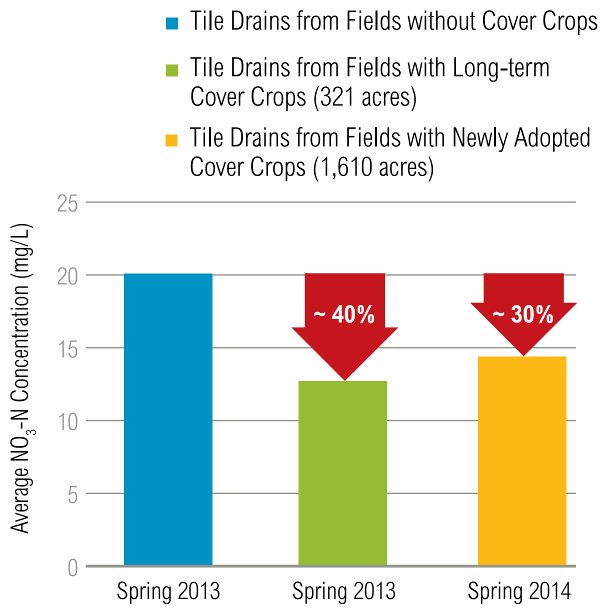
Table 9.1 | **Indiana's Shatto Ditch Project, Phase 1: Biological and Chemical Water Quality Outcomes of the Two-Stage Ditch Practice**

EVALUATION TECHNIQUE OR METRIC	RESULTS
BIOLOGICAL WATER QUALITY OUTCOMES	
Fish Index of Biotic Integrity (Fish IBI)	■ Fish IBI score of 13 in 2006 (preconstruction) was poor even for a managed ditch like the Shatto but improved by 68 percent to a score of 19 in just two years following two-stage construction. ■ In 2015, nine years after initial preconstruction sampling, the control area upstream from the two-stage area had a fair score of 24 and the two-stage reach had a score of 32, a good score for a managed ditch system.
Fish surveys	■ Only 15 fish species were observed in 2006 (preconstruction) in the length of Shatto Ditch versus 20 fish species in 2015. ■ Pollution-sensitive species, such as rock bass and smallmouth bass, were absent in 2006 but were found in 2015.
Benthic Index of Biotic Integrity (Benthic IBI) (macroinvertebrates	■ Scores within the two-stage ditch reach in 2015 remained the same as in 2006 and 2008. ■ Scores in the upstream control reach more than doubled, improving from 9 in 2008 to 20 in 2015. This significant improvement likely reflects the fact that the ditch, including the upstream control, had not been disturbed by dredging.
Macroinvertebrate surveys	■ Pollution-intolerant species, such as mayflies and caddisflies, were absent in 2006 (prior to construction). However, three mayfly species were found in 2008 after construction, and three mayfly and three caddisfly species were found in 2015, suggesting improved water quality after two-stage implementation.
Qualitative Habitat Evaluation Index (QHEI)	■ Habitat throughout the Shatto Ditch remains poor. The QHEI values ranged from 32 to 38 (poor) and were most affected by low substrate, cover, and riparian values. Pools and riffles were generally absent, and the bottom substrate was primarily sand and silt. Previous channelization had reduced the aquatic habitat value of the stream.
CHEMICAL WATER QUALITY OUTCOMES	
Nitrate-N	■ Removal via denitrification increased threefold with the increase in surface area from the presence of the two-stage ditch,[a] but due to the continued high loading of nitrogen from cropland, this equated to only a 10–15 percent reduction in the nitrate-N load.
Stream metabolism	■ Stream metabolism increased per unit length of stream[a] indicating additional nutrient processing potential in the future.
Turbidity	■ Turbidity was measurably reduced during floodplain inundation[b] resulting in water clarity improvement.
Total suspended solids (TSS)	■ TSS were measurably reduced during floodplain inundation[b] resulting in water clarity improvement.
Total Phosphorus (TP)	■ TP was measurably reduced during floodplain inundation[b] resulting in water clarity improvement.

a. Roley et al., 2012a and 2012b.

b. Davis et al., 2015.

Figure 9.4 | **Cover Crops Reduced Spring Nitrate Concentrations in Tile Drains by Nearly 30 Percent In the Shatto Ditch Project in the First Year of Planting**



Nitrate concentrations from water leaving tile lines draining fields with long-term cover crop planting (green bar) was 30 to 40 percent lower than tile lines draining fields without cover crops (blue bar). When nearly 70 percent of the cropland in the watershed was planted in cover crops, nitrate concentrations in the rest of the tile drains were similar to fields with long-term cover crop planting.

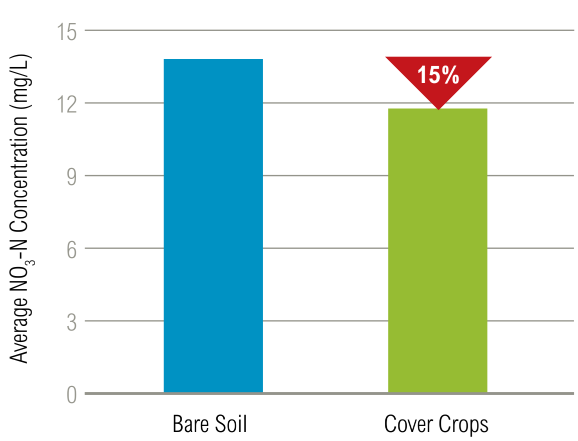
Data Source: Jennifer Tank, University of Notre Dame; *Design:* WRI.

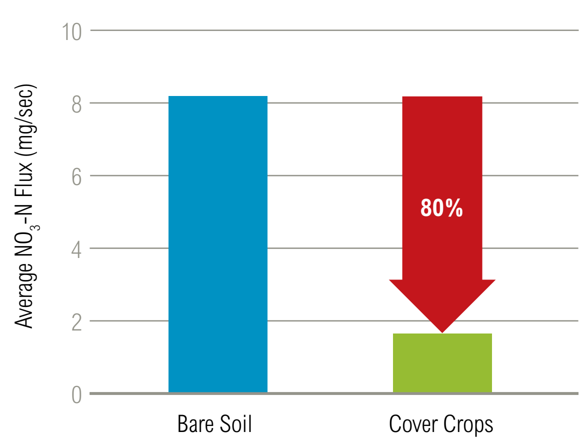
After the first treatment year (2013)—when the project successfully achieved watershed-scale implementation of cover crops, surpassing the original goal of 50 percent of acres in cover crops and demonstrating significant buy-in from local landowners and producers—a similar level of reduction (30–40 percent lower nitrate-N) was measured in tile drains with cover crops versus tile drains without cover crops. After the second treatment year (2014), similar levels of reduced concentrations from sites with cover crops than from those without was measured (see Figure 9.4).

After three years of cover crop adoption (2013–15) and four years of monitoring the majority of the watershed's tile drains year-round (2012–15), researchers found that nitrate-N concentrations were 15 percent lower. Furthermore, cover crops helped to lower the mass loss of nitrate-N from these tile drains by 80 percent (see Figure 9.5). Researchers are developing methods to statistically isolate the contributions cover crops made to reducing water flow to the tile drains.

Using a similar sampling approach for phosphorus, results of dissolved phosphorus are still being processed. In-stream water samples continue to be sampled at the top and bottom of the watershed but due to the dominance of groundwater in the system have yet to show a statistically significant decrease in nitrate-N concentrations or loads. Monitoring will continue and results will be forthcoming.

Figure 9.5 | **Year-Round Sampling over Four Years Shows Lower Nitrate Concentrations and Losses from Shatto Ditch Tile Drains Due to Cover Crop Plantings**





Data Source: Jennifer Tank, University of Notre Dame; *Design:* WRI.

Project Partnerships

In addition to the project partners listed in Table 9.2, a dozen or so farmers and landowners in the watershed volunteered to participate in the project, making its measured environmental outcomes possible.

Key Factors Contributing to Success

Project leaders said that choosing to work in a small watershed, gaining a high rate of practice adoption, and high frequency sampling were very important factors in their project's success.

Small watershed size, large practice adoption rate, and high-resolution sampling allowed tile drain water quality improvements to be achieved and measured soon after treatment

For the second phase of the project, Tank credits the detection of large changes in tile drain water quality within a year after cover crops were planted to three factors: a small watershed project area, a large cover crop adoption rate (about 70 percent of cropland acres), and high-frequency sampling. The small 3,300-acre watershed allowed for a longitudinal sampling system that covered the entire length of the stream and a representative subset of tile drain sites. According to Tank, "High frequency sampling, though laborious and thus rare, is key to (a) describing the interactions between conservation practices, weather, and water quality and (b) capturing fluctuations in nutrient concentrations in the stream, which can change in response to precipitation, temperature, and fertilizer application." As Tank points out, "Agricultural streams that receive tile drainage are very 'flashy,' and thus hydrologically variable. You need to sample regularly, frequently, and year-round, to capture patterns. Otherwise you may miss important changes."[68]

Treat a watershed-scale problem with a watershed-scale solution

The project partners learned that a short, half-mile segment with a two-stage ditch was insufficient to treat all the water at the bottom of the 3,300-acre watershed with 2,400 cropland acres contributing a high nitrogen load. They realized that it was going to take both in-stream and on-farm conservation practices to realize significant nutrient reduction benefits. Though cover crops were a single-practice approach, they were an effective intervention because they were implemented at saturation levels (nearly 70 percent of cropland acres versus the state adoption rate of 8 percent) across the watershed. Farmers were amenable to implementing such high levels of cover crops given their reputation for having in-field agronomic benefits to farmers as well as environmental benefits for the stream.

Challenges

Where The Nature Conservancy has attempted to install two-stage ditches outside of the Shatto Ditch area, it has faced challenges convincing farmers to adopt the practice. Landowners have voiced concerns that the practice is expensive and financial assistance programs are not adequate. In this project, The Nature Conservancy and the Indiana Department of Environmental Management paid for construction of the two-stage ditch, but they did not compensate farmers for the half acre of crop production lost to the practice. In other project watersheds, to cover construction of the two-stage ditch, The Nature Conservancy helped groups of farmers apply for and receive EQIP or Conservation Reserve Program funding. However, again, neither federal program provides compensation for lost production acreage.

Next Steps

The project was awarded a USDA Regional Conservation Partnerships Program (RCPP) grant in May 2015 for $1.2 million over four years. The project will continue work in Shatto Ditch and replicate its efforts in Kirkpatrick Ditch in Jasper County. These two demonstration projects will be compared with two nearby reference (control) watersheds. New USGS gauging stations have been installed at the bottom of the project watersheds.

A new element in RCPP projects is an economic analysis estimating the full costs and benefits for public and private interests of the cover crop practices. The team will collect agronomic and cost data from the farmers to help assess the economic impacts of adopting the practice with the hopes of being able to encourage annual and persistent adoption of the practice without cost-share incentives.

LESSONS, CHALLENGES, AND RECOMMENDATIONS

Given the range of agricultural land uses, watershed characteristics, and water quality conditions in each of the preceding six case studies, this next section compares the projects and discusses lessons learned, a few key challenges, and recommendations for the many stake-holders in the conservation community to build on and replicate the successes featured in this report.

CHAPTER 10

LESSONS LEARNED

This chapter draws information from the case studies and from other projects that involved conservation targeting and water quality analyses to highlight 11 lessons that are likely important for all targeted watershed projects pursuing outcome-oriented conservation.

This chapter draws information from the case studies and from other projects that involved conservation targeting and water quality analyses to highlight elements that are likely important for all targeted watershed projects pursuing outcome-oriented conservation. It focuses on the following points:

- Why the projects were initiated
- How they were organized and financed
- How they reduced pollution through conservation practices
- How they measured water quality outcomes
- How they modeled in-field and project-scale outcomes

Why Projects Were Initiated

Policy signals (e.g., a stream being placed on the list of impaired waters or state agricultural regulatory requirements) can encourage stakeholders to initiate projects and set goals.

In four of the six case studies, projects were developed in response to a policy or a regulatory signal. Three streams (Oklahoma, Iowa, and Wisconsin) were placed on the state impaired waters list and one stream (California) was affected by state agricultural regulation. In each project, a specific, well-defined problem brought stakeholders together. Goals across all six projects focused on quantifying water quality improvements in streams, while the four projects with policy or regulatory signals also set goals of removing their stream from the impaired waters list or preventing another pesticide exceedance (see Table 10.1).

How Projects Were Organized and Financed

Between 4 and 10 partners, offering different skill sets, participated in each successful project

Implementing targeted watershed projects requires that a variety of roles be filled, including the following:

- Project development, planning, management, and reporting
- Farmer outreach and education
- Conservation planning and technical assistance
- Financial assistance administration
- Project evaluation with water quality monitoring or modeling techniques

In five of the six projects, these functions were performed by a range of institutions: farmer-elected trade associations, local conservation districts, state water quality or natural resources agencies,

Table 10.1 | **Why the Projects Were Initiated**

	CALIFORNIA	OKLAHOMA	IOWA	WISCONSIN		INDIANA
	WALKER CREEK	HONEY CREEK	HEWITT CREEK	PLEASANT VALLEY WATERSHED STREAM REHABILITATION	PLEASANT VALLEY WATERSHED ON-FARM CONSERVATION	SHATTO DITCH (TWO PHASES)
IMPAIRMENT(S)	In 2007 and 2009, Chlorpyrifos pesticide exceedance and *Ceriodaphnia* (water flea) toxicity; violation of the Central Valley Regional Water Quality Control Board's Irrigated Lands Regulatory Program (ILRP)	In 2002, placed on state impaired waters list for pathogens (fecal bacteria), low dissolved oxygen, sulfate, total dissolved solids, and chloride	In 2002, 4.4 miles of Hickory-Hewitt Creek placed on state impaired waters list for only partially supporting aquatic life due to siltation, habitat alterations, and organic enrichment/ dissolved oxygen	In 1998, Pleasant Valley Branch of the Pecatonica River placed on impaired waters list for degraded aquatic habitat due to sediment		Not on impaired waters list but concern about high nitrogen, phosphorus, and sediment concentrations in stream flowing into Tippacanoe River with endangered clubshell mussel
PROJECT GOALS	■ Help producers achieve regulatory compliance ■ Improve water quality by eliminating water toxicity ■ Prevent pesticide runoff ■ Reduce irrigation tail-water discharge	Remove Honey Creek from impaired waters list and restore its designated beneficial uses (water supply, fish and wildlife propagation, agriculture, recreation, and aesthetics	■ Remove Hewitt Creek from the impaired waters list ■ Achieve in-stream quantitative goals for nitrate and total phosphorus ■ Achieve watershed average goals for Phosphorus Index, Soil Conditioning Index, and Corn Stalk Nitrate Test	Remove stream from impaired waters list by stabilizing banks, reducing in-stream sediment, and improve habitat for cold water fishery.	Test the recommendations from the Wisconsin Buffer Initiative Report to target conservation practices based on field load quantification of phosphorus to reduce phosphorus and sediment loads to stream.	Phase 1: Quantify nutrient, sediment, and aquatic life results from installation of two-stage ditch Phase 2: Quantify same constituents from >50% adoption of cover crops

Table 10.2 | **Types of Core Project Partners in Each Case Study**

	CALIFORNIA	OKLAHOMA	IOWA
	WALKER CREEK	HONEY CREEK	HEWITT CREEK
Natural Resources Conservation Service (NRCS), as financial assistance provider	X		X
NRCS, as technical assistance provider	X		X
NRCS, as project developer			
U.S. Geological Survey			
State water quality agency		X	
State natural resource agency			
State agricultural agency	X		
University faculty & students			X
Local extension service			X
Local conservation district	X	X	
Farmer elected association	X		X
Watershed citizens group		X	
Private nonprofit environmental organization			
Private water quality consulting firm	X		
Private water quality modeling firm		X	
Private farm consultants	X		

Note: Excludes institutions that provided funding only.

extension services, nongovernmental organizations (NGOs), and universities. Only in the Oklahoma project were all the primary functions carried out by one institution: the Oklahoma Conservation Commission. Most of the technical assistance across the projects was delivered by local conservation districts and extension specialists and, to a lesser degree, by Natural Resources Conservation Service (NRCS) field office staff when NRCS funds were provided (see Table 10.2).

California's Walker Creek project leaders pointed to another benefit of multiple stakeholder buy-in: Farmers received the same consistent messages from many sources about the importance of participating in the Colusa Glenn Subwatershed Program and of being vigilant with good conservation management practices.

Table 10.2 | **Types of Core Project Partners in Each Case Study, continued**

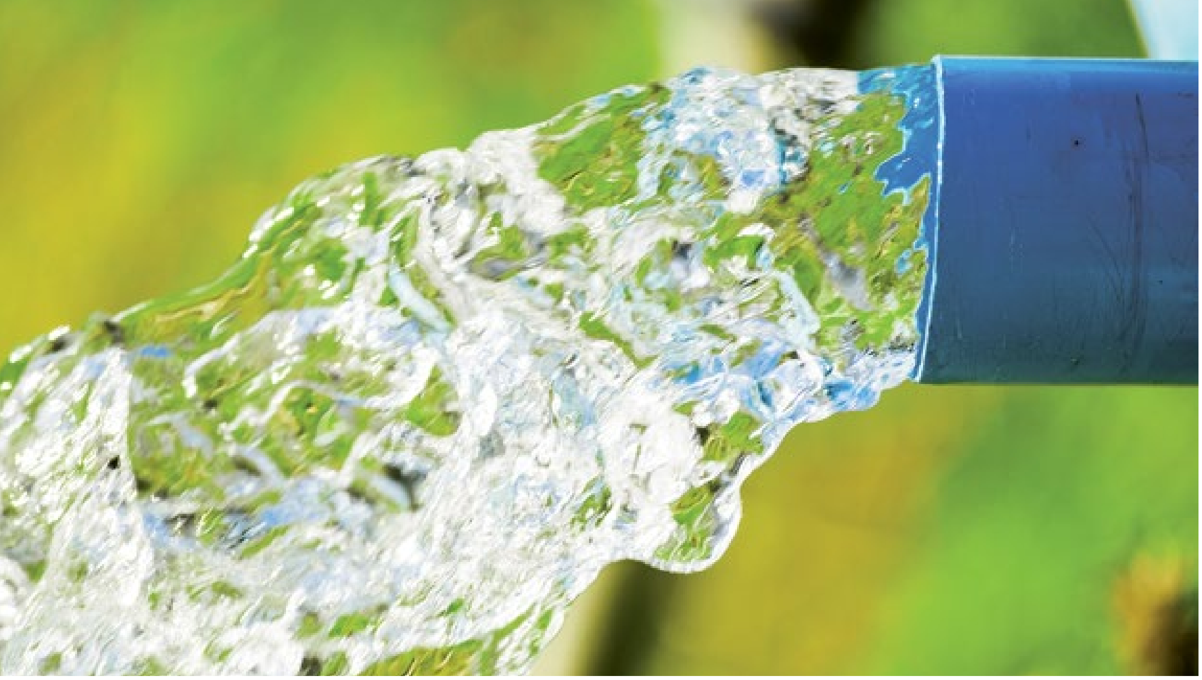
	WISCONSIN		INDIANA	
	PLEASANT VALLEY WATERSHED STREAM REHABILITATION	PLEASANT VALLEY WATERSHED ON-FARM CONSERVATION	SHATTO DITCH TWO-STAGE DITCH	SHATTO DITCH TWO-STAGE DITCH PLUS COVER CROPS
Natural Resources Conservation Service (NRCS), as financial assistance provider	X	X	X	X
NRCS, as technical assistance provider	X	X	X	X
NRCS, as project developer			X	
U.S. Geological Survey		X		
State water quality agency				
State natural resource agency	X	X		
State agricultural agency				
University faculty & students		X	X	X
Local extension service				
Local conservation district	X	X	X	X
Farmer elected association				
Watershed citizens group				
Private nonprofit environmental organization		X	X	X
Private water quality consulting firm			X	
Private water quality modeling firm				
Private farm consultant				

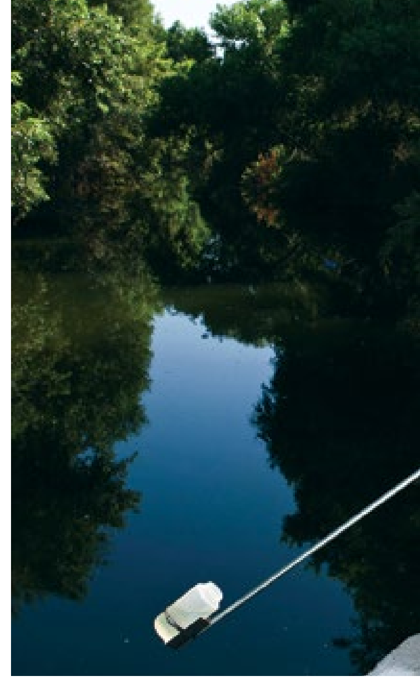
Note: Excludes institutions that provided funding only.

Leadership by a few key farmers can encourage buy-in from the farming community, boost participation, and result in innovative and efficient use of funds

Three projects (California, Oklahoma, and Iowa) cited the involvement of farmer leaders as one of their "key factors of success."

In the California and Iowa projects, farmers established nonprofit organizations led by farmers who served on an annually elected board of directors. The California Colusa Glenn Subwatershed Program was critical to initiating farmer compliance with the irrigated lands law as well as a rapid response to the detection of Chlorpyrifos exceedances in Walker Creek. In partnership with the local resource conservation district and many





other agricultural stakeholders, they were able to contact all of the farmers and landowners above the monitoring station and hold several outreach and education meetings to diagnose the problem and to encourage farmers to redouble their pesticide management efforts. The Iowa Hewitt Creek Watershed Council, in partnership with the county extension service, convinced the vast majority of farmers (nearly 85 percent) to adopt nutrient and sediment reduction practices at some point over the course of the 10-year effort. The Watershed Council was integral to most facets of the project, including initiating the project, setting ambitious in-stream and in-field outcome-based goals, designing the performanced-based incentive system and application form, holding winter and summer meetings, and conducting outreach efforts.

Leaders of the Oklahoma project cited the trust and buy-in gained by involving farmers and residents in the watershed advisory group as a "key factor to their success." Although the group persisted for only the first 3 years of the 9-year effort, the project leaders believe that empowering cattle and poultry producers and other watershed residents to become informed about the problem and help make decisions was helpful. The group helped the state water quality agency implementing the Section 319 project to select priority practices and cost-share rates. In addition, it helped win acceptance of the watershed modeling analysis that identified hotspots with high phosphorus losses that would be prioritized through the financial assistance ranking system.

In the two cases where farmer financial assistance did not include federal NRCS funds, the farmer-led watershed advisory group in Oklahoma and the Iowa Watershed Council developed innovative financial assistance schemes. Because Oklahoma used Section 319 funds and Iowa largely relied on state farm bureau and state agricultural agency funds, both projects were able to decide on their own payment systems. In both cases, farmer leaders opted for payment rates that were lower than those used in NRCS conservation programs to reach as many farmers as possible. Both projects reported this decision as a factor in their success; farmers felt that their leaders valued inclusivity in spending the limited resources.

In the Iowa case study, farmers in the Hewitt Creek Watershed Council designed a performance-based incentive system, in part to make effective use of limited financial assistance funds (on average about $55,000 per year). This meant the farmers received, on average, $900 per year to participate in the annual agronomic-environmental diagnostic tests and to adopt nutrient management, no-till, grassed waterways, and cover-crop practices. And because the farmers were in charge, they decided that limiting paperwork was a priority and designed a streamlined application form. By taking responsibility for the stream impairment in the watershed, the Hewitt Creek Watershed Council was empowered to implement conservation as "a means toward an end," and to test and achieve success with an innovative performance incentive system.

Sources and amounts of financial resources varied widely by project, indicating there are many approaches to covering project costs

At least three major categories of costs are involved in developing and implementing targeted watershed projects: project management costs (includes project development and management, outreach and education, conservation planning and other technical assistance, and evaluation and reporting); financial assistance costs to farmers and landowners; and water quality monitoring costs.

A variety of federal, state, local, and nongovernment institutions provided financial assistance for farmers, including the following:

- NRCS financial assistance conservation programs: Environmental Quality Incentives Program (EQIP), Wildlife Habitat Incentives Program (WHIP), Bay Delta Initiative (BDI EQIP), Mississippi River Basin Healthy Watersheds Initiative (MRBI EQIP), Agricultural Water Enhancement Program (AWEP)
- NRCS demonstrations programs: Conservation Innovation Grant (CIG) for Indiana's cover crop project
- USDA research program: Cooperative State Research, Education, and Extension Service (CSREES) for Wisconsin's on-farm project
- EPA Section 319 programs in Oklahoma and Indiana
- State water quality or natural resource agency programs in Wisconsin
- State agricultural agency programs in Iowa
- County environmental grant programs in Wisconsin
- State farm trade association in Iowa
- An environmental nonprofit organization in Wisconsin and Indiana
- A charitable foundation to the environmental organization in Wisconsin
- A seed corporation to the environmental organization in Wisconsin

Except for the NRCS financial assistance conservation programs, these funding sources also provided support for project management and monitoring and evaluation costs. Whenever NRCS provides financial assistance to farmers, the local NRCS field staff also provides conservation planning services to the farmers and technical assistance to help implement the planned conservation practices.

Estimates for project management costs (direct funding and in-kind contributions) ranged from $580,000 for the 11-year Wisconsin on-farm phosphorus and sediment reduction project to $2.5 million for the 8-year California Walker Creek Watershed project.

Financial assistance payments ranged from $130,000 in Indiana's Shatto Ditch project for three years of cover crop adoption to $4 million over five years mostly for improved irrigation efficiency systems in California's Colusa Glenn Subwatershed Program's area.

Estimates of water quality monitoring costs ranged from $1,600 a year in Iowa (for chemicals, reagents, and mileage as staff time was pro bono) to $85,000 a year in Oklahoma (for staff to implement the paired watershed and above/below monitoring design with year-round biweekly plus rain event sampling).

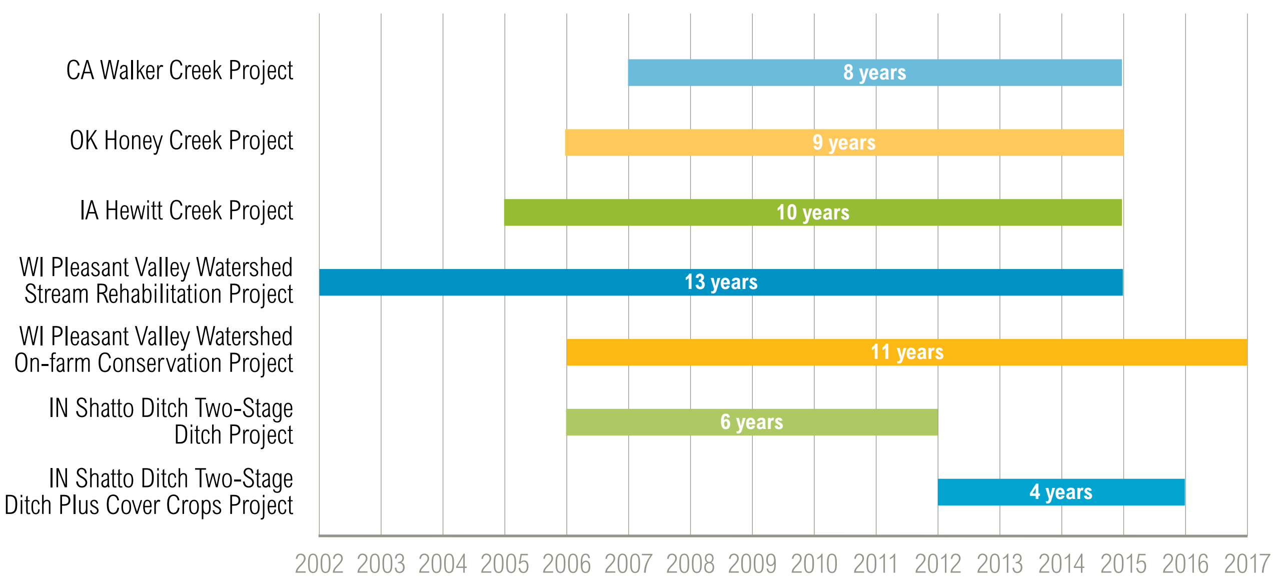
Costs per unit

Attempts were made to normalize the dollars spent on a per-contract or per-acre basis so projects could be compared despite the different watershed sizes. However, there was insufficient data to meaningfully do so. In addition, even with sufficient data, results could be misleading. For example, calculating an average spending rate per contract or per acre could make some projects—like Wisconsin's, which had fewer acres and contracts than others—look less economically efficient; whereas, in fact, the Wisconsin project aimed to get "a bigger bang for the buck" by targeting priority areas with disproportionately high pollution losses—an economically efficient approach.

Sustained funding is needed because projects may have long lifespans (8–13 years for those in this report) and the time needed for each stage can vary

Most projects featured in this report have run for between 8 and 13 years, significantly longer than the 3–5-year cycle of the Mississippi River Basin Healthy Watersheds Initiative and Regional Conservation Partnerships Program (see Figure 10.1). Adequate funding for project management, financial assistance, and monitoring costs made these relatively long project lifespans possible. Indeed, interviews with Iowa Department of Natural Resources Watershed Program Supervisor Allen Bonini indicate that many Iowa Section 319 watershed improvement projects "stall out" because of inadequate funding.

Figure 10.1 | **Project Duration Can Be Long**



The project experiences featured in this report plus past analyses (Perez and Walker, 2014; Osmond et al., 2012) suggest the following:

- At least two years are needed before a targeted watershed project starts to establish a baseline of water quality data.
- One to three years are needed for farmers to adopt conservation practices (and/or for the vegetative practices to grow and fully function).
- One to three years of in-stream and/or watershed outlet monitoring are needed to evaluate the results once all the desired practices have been adopted.

Water Quality Baseline Phase. Three of the five projects that involved on-farm conservation practices completed at least two years of baseline water quality monitoring before practice implementation began. California conducted mandatory monitoring for three years prior to the Chlorpyrifos exceedance detection, and Indiana conducted chemical monitoring of the stream prior to the installation of the two-stage ditch, providing a six-year dataset before the cover crop practice began. Wisconsin's continuous water quality monitors were installed three years before practice implementation started. Oklahoma completed a year and a half of baseline monitoring before the demonstration farm adopted its practices, while Iowa completed one year of baseline monitoring before farmers started adopting grassed waterways.

Practice Implementation Phase. The implementation phases varied, but most were long (i.e., more than three years). In some cases, the availability of financial assistance dictated when practice implementation occurred. For example, Wisconsin's stream rehabilitation projects were constructed when funding became available in 2003, 2006, 2007, 2010, 2011, and 2012. In contrast, leaders of the on-farm conservation project in Wisconsin set and stuck to a three-year practice implementation timeline. In Indiana, the two-stage ditch was constructed in a year, and its nutrient removal efficiencies improved over time. For the Indiana cover crop project, 8 Indiana farmers adopted conservation practices the first year, while 13 farmers adopted cover crops in the second and third years of the project. In California, Oklahoma, and Iowa, farmers adopted practices over the course of 5, 7, and 10 years, respectively, due primarily to continued interest from farmers and the availability of funds.

Monitoring and Evaluation Phase. All the projects continued monitoring throughout the project rather than stopping during the practice implementation stage.

- California's regulatory program required continuous monitoring and allowed declaration of success only after three consecutive years of no exceedances and five consecutive years of no toxicities.
- Oklahoma felt comfortable recommending that Honey Creek be delisted for *E. coli* nine years after the demonstration farm project was launched, though considerable improvements in nutrient, sediment, and bacteria parameters were observed within three years of the launch.
- Wisconsin's stream rehabilitation project saw dramatic improvements the year after each project was constructed. But it wasn't until 2014, 10 years after the first demonstration stream rehabilitation project, that the state Department of Natural Resources recommended the Pleasant Valley Branch be delisted for sediment.
- Through comparison with a control watershed, Wisconsin's on-farm conservation project saw a 37 percent drop in total phosphorus runoff event loads in the stream in the first year after the 3-year practice implementation phase. By the end of the 3-year postimplementation period, the project had achieved a 55 percent reduction.
- Indiana saw about a 30 to 40 percent reduction in nitrate-N concentrations from tile drains in the spring just 1 and 2 years after the first round of cover crop adoption. After 3 years of cover crop plantings, an 80 percent reduction in nitrate-N loss from tile drains was documented. While the tile drain results were immediate, the researchers continue to monitor in-stream nitrate-N concentrations and stream flow to tease apart the complex interactions of environmental factors (weather, etc.) and groundwater that influence nitrate-N export from the watershed.

Table 10.3 | **Comparing Watershed Sizes**

	CALIFORNIA	OKLAHOMA	IOWA	WISCONSIN	INDIANA
	WALKER CREEK PROJECT	HONEY CREEK PROJECT	HEWITT CREEK PROJECT	TWO PLEASANT VALLEY WATERSHED CASE STUDIES (TWO UNRELATED PROJECTS)	SHATTO DITCH CASE STUDY (TWO RELATED PROJECTS)
Watershed size (in acres)	27,000	79,000; 55,000 in Oklahoma	25,000	12,300	3,300
Hydrologic unit code (HUC)	Approximates HUC12 (HUC12 = about 40 square miles)	Four HUC12s total, with three in Oklahoma	HUC12	About half an average HUC12	Much smaller than a HUC12

How Projects Achieved Pollution Reductions through Targeted Conservation Practice Adoption

Smaller watersheds allow for a greater likelihood of project success

In each case study except Oklahoma, the project watershed was about 25,600 acres or up to 40 square miles (an HUC12-size watershed; see Table 10.3). Oklahoma's portion of the Honey Creek watershed comprised about three HUC12-size watersheds.

Project leaders in Wisconsin and Indiana thought the very small sizes of their watersheds were key factors of their success. Wisconsin leaders recognized that working in a small watershed enabled them to reach and persuade the key farmers owning land adjacent to the stream to participate in the stream rehabilitation projects and the key farmers who operated the acres with the highest risk of phosphorus losses to participate in the on-farm conservation project. Indiana project leaders noted that because the watershed was small, they only had to persuade a few farmers who operated most of the cropland acres in the watershed to adopt cover crops. In addition, the Indiana leaders pointed out that the small watershed allowed them to implement a high-frequency monitoring program that could quickly detect results in the stream.

As pressure and ambition rise to improve water quality in larger rivers or to improve downstream water quality in lakes, bays, or estuaries, developers of targeted watershed projects may need to modify their designs to account for the potential disadvantage of working in a larger area. Alternatively, project leaders could determine how to geographically locate and schedule start times of several small targeted subwatershed projects in a larger watershed to result in measurable improvements in downstream water quality.

Significant pollution reduction can be achieved by targeting conservation efforts to areas with disproportionately high pollution losses

Four of the five farm conservation projects targeted source areas within their project watershed. Iowa and Wisconsin project leaders used their state Phosphorus Indexes to identify and prioritize fields that were losing phosphorus at disproportionately high rates.

Iowa targeted fields with a high risk for phosphorus loss for financial assistance to address the most problematic areas.

In Wisconsin, project leaders wanted to see if limiting conservation treatment to the most problematic areas would achieve significant water quality benefits. Furthermore, Wisconsin targeted the Pleasant Valley watershed because the 2005 Wisconsin Buffer Initiative Report identified it as being in the top 10 percent of watersheds that would likely respond well to phosphorus- and sediment-control practices (UW–Madison, 2005).

Oklahoma project leaders used a watershed modeling analysis to identify and prioritize the highest phosphorus loss areas in the watershed for conservation outreach and funding priority.

California initially targeted its conservation outreach and education efforts after a Chlorpyrifos exceedance to farmers and landowners upstream from the Walker Creek monitoring station.

Indiana was the only project that aimed to implement its cover crops conservation practice as broadly as possible. The project leaders felt that significantly improving the water quality in their homogeneous (corn-soybean rotation, tile drained) watershed required cover crops to be adopted on a large majority of the cropland acres.

How Projects Measured Water Quality Outcomes through Water Quality Monitoring

Significant pollution reduction can be measured and reported relatively quickly if well-designed monitoring programs are used in combination with effective conservation targeting

The projects in Oklahoma, Wisconsin, and Indiana ensured that their pollution reductions would be detected by robust and rigorous in-stream monitoring programs (see Table 10.4.)

Indiana's Shatto Ditch experienced the fastest water quality improvement of all the projects. Preliminary findings indicate that after just nine months—in the spring after the cover crops were planted in the fall—the project documented a 30 percent average reduction in nitrate concentrations from tile drains compared with the previous spring. After year-round monitoring of the majority of tile drains in the watershed reflecting three years of cover crop plantings, a 15 percent reduction in nitrate-N concentrations and an 80 percent reduction in nitrate-N loss has been documented. The project's success stems in part from the ambitious, before/after monitoring design that relied on high-frequency grab sampling every two weeks and after storm events, up and down the length of the stream and at 23 representative tile drains, resulting in about 2,000 water samples per year. Because the watershed was small, project leaders could implement this robust and rigorous monitoring program with the help of paid graduate students.

In Wisconsin, project leaders carefully developed a paired watershed monitoring approach using two continuously monitoring USGS flow gages at the outlet of each watershed. Pleasant Valley (treatment) and Smith-Conley (control) were considered effective paired watersheds because they were close to each other; almost the same size; characterized by similar land uses, weather events, and water chemistry; and experienced the same regional trend in Conservation Reserve Program conversion from grassland back to cropland. The paired watershed approach removed variability associated with those factors from the analysis to discern a 55 percent reduction in total phosphorus in runoff events attributable to practice adoption in the Pleasant Valley watershed project.

Oklahoma's Honey Creek project also used a paired watershed approach, but coupled it with an above/below monitoring design to isolate the effect of project practices from changes that might be occurring in the Missouri and Arkansas portions of the Honey Creek watershed. The paired watershed approach allowed the project leaders to determine the "minimum detectable change" prescribing the amount of data needed to be collected and how much change is need to overcome the natural variability before statistically significant results can be claimed. Though the Oklahoma project did not prioritize treating acres within the above/below subwatershed, it did prioritize areas with the highest risk of phosphorus losses. The project leaders believed they had detected statistically significant improvements in the stream within three years of the first practice adoption activities in the farm demonstration project, but waited seven years to report the improvements to EPA, in part because of farmers' continued interest in conservation. In 2015, Oklahoma claimed load reductions of 53, 34, 28, and 35 percent, respectively for *E.coli*, *Enterococcus*, phosphorus, and nitrate prompting the Oklahoma Conservation Commission to propose delisting Honey Creek for *E. coli* in 2016.

Research into Oklahoma's Honey Creek Project also unearthed 48 nonproject-based water quality success stories that were made possible by the state's long-term nonpoint source monitoring program. See Box 10.1 for more details.

Table 10.4 | **In-stream Monitoring for Chemical Water Quality Outcomes**

	CALIFORNIA WALKER CREEK PROJECT	OKLAHOMA HONEY CREEK PROJECT	IOWA HEWITT CREEK PROJECT
Monitoring design	Representative and long-term monitoring design required by the state's Irrigated Lands Regulatory Program, conducted by Larry Walker Associates to characterize water quality, detect exceedances, identify priority management needs, and monitor outcomes	**Paired watershed** approach plus **above/below** monitoring design by Oklahoma Conservation Commission (state water quality agency implementing U.S. Environmental Protection Agency Section 319 program)	Monthly and rain-event sampling to detect any differences year to year and between three sampling locations within impaired segment by Upper Iowa University professor and undergraduate students
Sampling location(s) and what was sampled	One site, off a public road bridge in Walker Creek watershed, just north of the City of Willows for Chlorpyrifos concentration and *Ceriodaphnia* toxicity levels	Three automated samplers collected continuous, flow-weighted samples once a week for suspended sediment, phosphorus, dissolved phosphorus, nitrate, temperature, pH, dissolved oxygen, fecal coliform (*E. coli*), *Enterococcus*, etc.: ■ Upstream site: On the Honey Creek branch at the border with Missouri. ■ Downstream site: On Honey Creek branch above Grand Lake ■ Paired control site: Watershed outlet of nearby Saline Creek	Three sites along the impaired stream segment (10 years) and one site at unimpaired segment (5 years) for nine parameters: temperature, pH, conductance, dissolved oxygen, turbidity, total phosphorus, total nitrogen, suspended solids, and fecal coliform (*E. coli*)
Timing	Jan–Sep when Chlorpyrifos is used	Year round	Mar–Sep during the growing season
Frequency and method of sampling	Monthly grab samples	Continuous, flow-weighted automated samplers collected weekly samples and extra samples during rain events	Monthly grab samples and during rain events
Average number of samples collected per year	About 11	52 weekly flow integrated samples and 1–5 additional rain-event samples = 53–57 samples per year	About 12 samples: 7 monthly and 4 to 9 during rain events
Time to show change	Completion of the management plan requires no pesticide exceedances or related toxicity to be detected for three years in a row	Within three years, data was found to be consistently statistically significant	About five years
Amount of improvement	No Chlorpyrifos exceedance for three years (2010–13) and no *Ceriodaphnia* toxicity for five years (2008–13) so management plan was deemed complete in 2014	■ After six years, paired watershed approach indicates that conservation practices resulted in 28% phosphorus load reduction, 35% nitrate reduction, 53% *E. coli* reduction, and 34% *Enterococcus* reduction compared to control watershed ■ Conservation Commission proposed Honey Creek be delisted for *E. coli* in 2016.	In-stream goals: ■ Achieved below 10 ppm in-stream total nitrogen goal 4 of last 5 years of the 10-year project; ■ Achieved below 1 ppm in-stream phosphorus goal in 2 of last 3 years

Table 10.4 | **In-stream Monitoring for Chemical Water Quality Outcomes, continued**

	WISCONSIN **PLEASANT VALLEY WATERSHED ON-FARM CONSERVATION PROJECTS**	**INDIANA** **SHATTO DITCH CASE STUDY COVER CROP AND TWO-STAGE DITCH PROJECT**
Monitoring design	**Paired watershed** approach with **before/after** monitoring by U.S. Geological Survey (USGS)	**Before/after** control impact experimental design to conduct high-resolution monitoring at tile drain outlets and stream sites along entire length of stream. University of Notre Dame conducted the monitoring.
Sampling location(s) and what was sampled	USGS fixed stations established at the watershed outlets of the test and control watershed recorded continuous flow (discharge). Samples analyzed for suspended sediment, total phosphorus, and dissolved phosphorus concentrations and loads calculated based on flow. **Paired control site:** Watershed outlet site in nearby Smith-Conley watershed.	■ 10 sites longitudinally from top to bottom of the watershed every half mile on seven-mile main stem for ammonium-N, nitrate-N, total N, and soluble reactive phosphorus. ■ Same monitoring at 23 representative tile drain outlets. ■ Two datasondes at top and bottom of watershed record continuous dissolved oxygen, turbidity, temp, pH, and conductivity.
Timing	Year round	Year round
Frequency and method of sampling	Base flow samples collected monthly at outlet of both the test and control watersheds; additional samples during storm events and spring snow melt	Biweekly grab samples in stream and tile drains; every 30 minutes at two data sondes
Average number of samples collected per year	60 biweekly, storm, and snowmelt samples for each treatment and control watershed.	More than 2,000 grab samples per year
Time to show change	The first year (2013) after two years (2011–12) of conservation practice adoption	April, about nine months after planting cover crops in August–September
Amount of improvement	55% median reduction in phosphorus loading during storm events in the Pleasant Valley branch during four years post practice implementation monitoring.[a]	About 30% reduction in spring nitrate-N concentrations in tile drains one year after widespread cover crop adoption. Over 4 years of year-round monitoring, 15% reduction in nitrate-N concentrations and 80% reduction in nitrate-N loss from all tile drains.

Note: a. Based on 59 sample points for runoff events during the postimplementation phase in comparison to 52 event samples during the calibration phase at the 95 percent confidence level.

BOX 10.1 | NONPROJECT WATER QUALITY SUCCESS STORIES IN OKLAHOMA: HOW WE KNOW THE TRADITIONAL CONSERVATION APPROACH CAN IMPROVE STREAM WATER QUALITY

A well-designed long-term nonpoint source monitoring program in Oklahoma demonstrates that in some cases, the traditional conservation approach—local NRCS staff working one-on-one with farmers—rather than the targeted watershed project approach, can result in significant stream water quality improvements.

Shanon Phillips, director of Water Resources for Oklahoma's Conservation Commission, pointed out that Oklahoma has published on the U.S. Environmental Protection Agency's (EPA's) Section 319 website 48 success stories of impaired streams that were delisted, but were not part of a Section 319 project or any other type of targeted watershed project.

Instead, the streams were delisted thanks to long-term monitoring by Oklahoma's nonpoint source monitoring program that had operated for decades at the outlets of the 48 watersheds. The monitoring detected in-stream improvements attributable to the traditional conservation efforts of farmers and landowners who adopted practices encouraged by the local NRCS. In most cases, the NRCS staff did not know that water quality monitoring was occurring, but the in-stream impacts of their one-on-one work with farmers could be evaluated due to the following:

- The county-focused financial and technical assistance efforts occurred sufficiently within the watershed boundary.
- Ongoing monitoring at the watershed outlet measured the effects of the conservation practices.
- The soil erosion, nutrient, and manure management conservation practices being implemented were reducing pollutants (e.g., turbidity and *E. coli*) and improving other beneficial water parameters (e.g., dissolved oxygen) that were measured by the monitoring program.

Details about Oklahoma's nonpoint-source-focused long-term monitoring program and an example of one of the 48 success stories are provided in Appendix D.

Biological and physical stream monitoring can inspire landowners, and may foster a renewed land-water stewardship ethic

Four projects (Oklahoma, Iowa, Wisconsin's stream rehabilitation project, and Indiana) used biological or physical monitoring. The details of the Wisconsin and Indiana monitoring programs are shown in Table 10.5. Oklahoma's program details are not featured because fish populations were healthy at the beginning and end of the project and biological parameters were not the primary focus. Iowa project leaders began a biological monitoring program, but then stopped when they realized the protocol was inappropriate for the stream.

Unlike chemical water quality monitoring, which can detect invisible improvements in nutrients, pesticides, and pathogens, biological and physical water quality monitoring measures aquatic life, habitat, and stream structure metrics; it can provide farmers and project leaders a visual indication that the project is working. Furthermore, seeing more organisms in the streams and no longer seeing dramatic problems like stream banks sloughing off, fosters positive feelings in farmers and gives them tangible reasons to take responsibility for problems and pride in the solutions.

In the Wisconsin stream rehabilitation project, project leaders witnessed surprised and pleased responses from farmers and landowners when they saw that the narrowed channel, stabilized banks, and fish structures had resulted in clearer water and plentiful fish adjacent to their property, just one year after solutions had been implemented. Project leaders and farmers alike were hopeful that the increase in brown trout could draw more trout anglers to the state.

Although the Iowa project did not succeed in its biological monitoring effort, project leaders underscored the importance of farmer interest in the biological condition of Hewitt Creek. Project leaders reported that the watershed farmers were excited and proud to share stories about spotting

Table 10.5 | **In-stream Monitoring for Biological and Physical Water Quality Outcomes**

	WISCONSIN	INDIANA
	PLEASANT VALLEY WATERSHED STREAM REHABILITATION PROJECT	**SHATTO DITCH TWO-STAGE DITCH PROJECT**
Monitoring design	**Before/after** monitoring approach for each stream rehabilitation project (preconstruction and postconstruction) conducted by Wisconsin Department of Natural Resources.	**Before, during, and after construction** of the two-stage ditch: Fish Index of Biotic Integrity (IBI), Benthic IBI, and Habitat Qualitative Survey conducted by Commonwealth Biomonitoring (a private consulting firm).
Sampling location(s)	Fish community and quantitative habitat analysis was conducted at various locations on Pleasant Valley Branch (and Kittleson Valley Creek) where stream corridor work was done. Seven sites were surveyed on Pleasant and Kittleson Valley and two sites on Smith-Conley (control site).	Within the half-mile stretch of the two-stage ditch and the half-mile control reach above the practice; 3 sites upstream in Shatto Ditch.
Timing, frequency & type of sampling	Assessments at all sites were conducted before/after work on each segment was completed, with a final survey conducted in 2013 after all riparian work had been completed.	Fish IBI, Benthic IBI, and Habitat surveys conducted in 2006 (preconstruction), 2007 (construction) & 2008 (postconstruction). Only a Fish IBI and Benthic IBI conducted in 2015.
Time to show change	Within one year of each stream rehabilitation project, both fish assemblage and habitat assessments showed significant improvement.	Immediately during the construction year.
Amount of improvement	▪ Average stream bank erosion (length of eroding bank) dropped from 25 inches to about 1 inch ▪ Soft fine sediment in stream dropped from 75% to 40% ▪ Habitat scores (and/or IBI) rose from fair to good and in other places from good to excellent ▪ Trout numbers, normalized for effort, increased 70%–150% and in some cases well over that by taking areas that held few or no trout to the point where they held 40–70 fish over the same station length. Wisconsin Department of Natural Resources proposed delisting the Pleasant Valley Branch for “degraded aquatic habitat due to sediment” in 2014. The EPA decision is expected in 2017.	2015 Fish IBI within two-stage ditch was 32 (better) versus 2015 Fish IBI upstream in the control segment of only 22 (worse); In 2015, there were 20 fish species found while only 15 species were identified in 2006. Pollution intolerant species found in 2015 while none found in 2006 (e.g., smallmouth bass and rock bass). Benthic IBI in 2015 was 20 versus just 9 in 2008.

eagles perched in trees and eyeing the new Hewitt Creek fish. Others said they spied eight-inch fish in the stream—a sight not seen in generations. Such stories have bolstered the farmers’ pride in the conservation practices adopted in the watershed. They have also bolstered the conviction of many council members who pledged to maintain their conservation practices, even without financial assistance.

How Projects Modeled Field- and Project-Scale Outcomes through In-Field Assessments

Field-scale modeling tools provide farmers with agronomic and environmental information that motivates adoption of practices

The three projects (Iowa, Wisconsin, and Indiana) that used one or more in-field diagnostic tools, such as the Phosphorus Index, the Soil Conditioning Index, or the Corn Stalk Nitrate Test, reported that farmers found the data sufficiently compelling to motivate management changes. In addition, the results generated by these tools provide farmers with agronomic and environmental information specific to each farmer's fields. This, in turn, helps build trust between project leaders and participating farmers. Though the projects did not directly link the data to financial information, the project leaders and farmers interpreted the data showing nutrient losses in soil organic matter as having detrimental financial implications, and soil improvements as having beneficial implications. Thus, all three projects offered educational, business, and environmental services to the participating farmers, which informed the farmers' conservation decisions.

In-field phosphorus metrics can be used to target efforts, improve farmer decision making, and evaluate environmental outcomes, and can be aggregated to report project-level outcomes

To target areas with the greatest phosphorus losses, Wisconsin's on-farm conservation project leaders used the Wisconsin Phosphorus Index to find fields losing six pounds of phosphorus per acre a year or more. The farmers operating these fields were approached first to participate in the project, and were offered free soil sampling and nutrient analyses. These tools helped the farmers identify conservation practices that offered the greatest phosphorus loss reductions while also fitting their operations and financial commitments.

The Wisconsin Phosphorus Index also allowed the project leaders to calculate and communicate the watershed-wide benefits of the conservation practices adopted in the project. For example, they estimated that the 1,840 acres of cropland conservation practices achieved 3,300 pounds per year of phosphorus runoff reduction and 2,000 tons per year of soil erosion reduction. Similarly, the Phosphorus Index estimated that the 315 acres of pastureland practices achieved 1,100 pounds per year of phosphorus runoff reduction and 100 tons per year less erosion (see Table 10.6).

The Iowa project tracked individual field metrics (coded for confidentiality) from the Phosphorus Index, Soil Conditioning Index, and Corn Stalk Nitrate Test and published them on the Hewitt Creek Watershed Council's public website, arranged from high to low. During the council's winter and summer meetings, farmers discussed the displayed values. This information-sharing approach harnessed the farmers' naturally competitive nature, and peer-to-peer discussions allowed them to learn better agronomic and environmental management options from each other. Iowa project leaders also calculated the average overall values for all participants. This motivated farmers to reach collective quantitative outcome goals for each phosphorus, soil erosion, and nitrogen metric (see Table 10.6).

Table 10.6 | **Field-Scale Assessments of In-Field and Project-Scale Environmental Outcomes**

	IOWA	WISCONSIN
	HEWITT CREEK PROJECT	PLEASANT VALLEY WATERSHED ON-FARM CONSERVATION PROJECT
Assessment design	Project leaders used the Iowa Phosphorus Index (PI), the Soil Conditioning Index (SCI), and, to a lesser extent, the Corn Stalk Nitrate Test (CNT) to identify fields with high or outside the optimum range of values for each test. Conducted by Iowa Extension specialists.	Project leaders used the Wisconsin Phosphorus Index (WPI) in Wisconsin's SnapPlus nutrient management planning software to conduct (1) a phosphorus loss inventory and assessment to identify the fields at highest risk of phosphorus loss in the watershed (≥6 lbs. P/ac./yr.), (2) work one-on-one with farmers to analyze which suites of conservation practice would work best to reduce phosphorus losses, and (3) estimated watershed-wide results of the adopted practices. Conducted by University of Wisconsin–Madison students and staff with Dane County Land Conservation Division.
Assessment location(s) and what was analyzed	Fields that had had PI and SCI tests conducted annually reflect about 10,000 acres managed by about 40 cooperators over last five years of project. The fields were located both within the Hickory Creek Branch subwatershed and outside but within Hewitt Creek watershed.	Conducted farm inventories and SnapPlus runs on fields owned by 97 landowners. First prioritized 13 farmers with fields rated as "high," eventually working with 12 of these 13. Worked with 3 more farmers with fields rated "medium" ($\leq 3x < 6$ lbs. P/ac./yr.)
Time it took to show changes	Measured changes annually over 10-year project timeline.	First year after the 3-year practice implementation phase.
Project-level outcomes estimated	Average watershed-wide PI, SCI, and CNT values calculated as an average of all the cooperator fields and tracked annually over time.	Used Phosphorus Index in SnapPlus nutrient management software to estimate phosphorus and sediment outcomes of all adopted conservation practices that can be assessed by the model.
Amount of improvement	Watershed-wide in-field goals: ■ Nearly achieved 2.0 PI goal (2.11) ■ Achieved SCI 0.6 goal ■ Nearly achieved CNT 2,000 ppm goal	Phosphorus Index estimates that practices on cropland, pasture, and barnyards cut runoff phosphorus losses in half from nearly 8,000 lbs./yr. during the 2006–09 baseline time frame to about 4,000 lbs./yr. in the 2013 post-practice monitoring year on lands operated by participating farmers.

CHAPTER 11

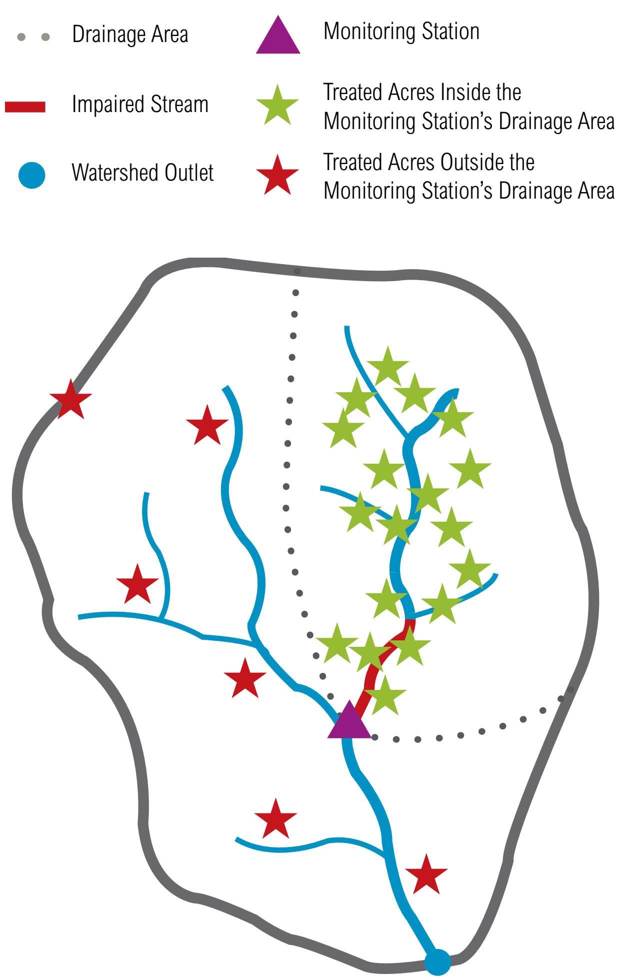
HINDSIGHT IS 20/20: CHALLENGES TO ACHIEVING AND MEASURING OUTCOMES

This chapter offers observations about three important challenges that arose in several case study projects: social considerations and budgetary pressures, adequate water quality monitoring guidance, and the confidentiality rules in Section 1619 of the Farm Bill. Leaders of other targeted watershed projects may also experience these challenges. As hindsight is 20/20, these observations might inform the design and implementation of similar efforts.

Social considerations and budgetary pressures can hamper efforts to prioritize subwatersheds that drain into in-stream monitoring locations

When trying to detect water quality improvements in specific stream segments, the location of the conservation practices in relation to the monitoring station matters. If monitoring occurs at the watershed outlet, it will reflect the cumulative pollutant load from the entire watershed. Monitoring at this location is appropriate if the entire watershed is a conservation treatment area. In contrast, if monitoring occurs in a specific stream segment, conservation treatment need only occur upstream from (and draining into) that stream segment to achieve detectable pollution reductions (see Figure 11.1).

Figure 11.1 | **Effective Conservation Targeting and Monitoring to Improve Water Quality in an Impaired Stream**



By targeting farm fields draining into the impaired water body and installing in-stream monitoring in the impaired stream, a targeted watershed project will have a better chance of achieving and documenting in-stream improvements in the impaired water body than if practices were dispersed across the watershed.

Source: WRI.

However, treating acres outside the subwatershed being monitored may be unavoidable in a voluntary targeted watershed project because project partners find it understandably difficult to say "no" to farmers who ask for help and volunteer to implement practices, even if their fields are outside the priority area. In addition, "treating all comers" may be the cost of doing business to avoid a potential backlash by farmers outside the priority area.

Treating acres outside the monitored subwatershed may be "good conservation on the ground," but if these areas are not hydrologically linked to the stream of concern and the monitoring station, treating them does not help solve the problem at hand. Furthermore, treating such acres consumes finances and project management resources that could otherwise go toward the primary project goals of achieving measurable in-stream improvements. Finally, treating acres outside the monitored subwatershed complicates efforts to calculate average costs per treated acre and interpret the meaning of such a metric.

In contrast to the Wisconsin and Indiana projects, where monitoring occurred at the watershed outlet, the Iowa, Oklahoma, and California projects monitored an impaired steam segment within a watershed. However, none of the Iowa, Oklahoma, or California project leaders restricted or even prioritized conservation funding and technical assistance to only farmers operating fields upstream from and draining into the monitored stream. Instead, they were eager to respond to any watershed farmer's interest in conservation and were motivated "to get more conservation on the ground."

In Wisconsin, project leaders experienced social and budgetary pressures that made it difficult to strictly adhere to their initial plan "to test conservation targeting." The original concept of the Wisconsin Buffer Initiative project was to treat acres with high phosphorus or high sediment losses in order to detect improvements at the watershed outlet monitoring station (UW–Madison, 2005). However, for a variety of reasons, many low-priority fields—some operated by farmers who also had high-priority fields—received conservation treatment and funds. Thus, the numbers of adopted conservation practices and treated acres reported by the project reflects all practices and acres, not just the priority acres.

Wisconsin project leaders explained that the NRCS Cooperative Conservation Partnerships Initiative funding application ranking systems were altered to favor high-priority fields, but the modifications did not exclude funding for nonpriority fields. In addition, administrators of the federal conservation funds (i.e., local NRCS and conservation district staff) were given very little time to sign up farmers and their acres. The budgetary pressure to allocate all of the available funds within a limited window, lest they lose the resources, prevented project leaders from funding—and tracking practices on—only high- and medium-priority acres.

Without adequate water quality monitoring guidance, interpreting monitored outcomes is challenging

Iowa's Hewitt Creek project experienced difficulty in conducting chemical and biological monitoring. Its experience may reflect the struggles of other targeted watershed project leaders under the Landscape Conservation Initiatives and the new Regional Conservation Partnerships Program, and the importance of adequate water quality monitoring guidance.

Project leaders did not have significant monitoring experience prior to development of the project, and when the Hewitt Creek project was initiated in 2005, the project leaders were not aware of the EPA's 1991 guidance document on watershed monitoring for the Section 319 program nor the NRCS's *National Water Quality Monitoring Handbook* published in 2003.

The Hewitt Creek project leaders adopted monitoring techniques that were developed for a nearby county conservation district project. The techniques were best suited to "surveillance" monitoring, which is used to investigate overall ambient status of water quality bodies and develop long-term trends. This approach stands in contrast to the "operational" monitoring that pollution reduction projects use to assess the effects of mitigation measures.

In addition, because the Iowa Hewitt Creek project was developed outside the state's Section 319 program framework, no watershed-based planning or watershed modeling was conducted. Had these analyses occurred, they would have helped establish criteria for how much improvement was needed for each parameter to allow a proposal to delist the stream for "partially supporting aquatic life due to impairments from for siltation, habitat alterations, and organic enrichment/dissolved oxygen."[69]

The project leaders initially concluded that they had met their goals of reducing total nitrogen to below 10 ppm for four of the desired five years and reducing total phosphorus to below 1 ppm for two of the desired three years. However, when asked if the differences were statistically significant, the leaders said such analyses had not been conducted. Furthermore, when asked if the nutrient reductions and two sediment-related water quality parameters (turbidity and suspended solids) were attributable to the project's conservation practices or linked to weather variation, project leaders reported they had not accounted for rainfall or flow.

After two rounds of additional analyses prompted by this report, and with guidance from a water quality monitoring expert and the inclusion of a precipitation dataset, the project leaders can now conclude that the conservation practices are associated with statistically significant reductions in turbidity and total phosphorus concentrations. However, reductions in total nitrogen concentrations are not statistically significant, and the reduction in suspended solids concentrations cannot be unequivocally attributed to the project alone—rainfall might have played a role in the change in this parameter.

The confidentiality rules in Section 1619 of the Farm Bill can hamper conservation targeting and outcomes evaluation

Section 1619, "Information Gathering," of the Food, Conservation, and Energy Act of 2008 (the 2008 Farm Bill) states that the

> *Secretary, any officer or employee of the Department of Agriculture, or any contractor or cooperator of the Department, shall not disclose "(A) information provided by an agricultural producer or owner of agricultural land concerning the agricultural operation, farming or conservation practices, or the land itself, in order to participate in programs of the Department; (B) geospatial information otherwise maintained by the Secretary about agricultural land or operations. . . .*

The provision provides confidentiality to farmers regarding the location of conservation practices that are paid for in part by the federal conservation programs. Insertion of the provision into the 2008 Farm Bill was very controversial, in part, because many scientists, environmental journalists, watchdog groups, as well as companies in the farmland appraisal and crop insurance industry complained that the loss of previously available public information about spending of taxpayer dollars hindered their ability to do their jobs (Ristino and Steier, 2016; Woodard and Chiu, 2016; SEJ, 2009. Agri-Data, Inc., n.d.). On the other hand, many farmers and farm industry representatives welcomed the provision as necessary to overcome farmer reluctance to participate in federal conservation programs due to fear of increased environmental regulatory scrutiny.

Contractors and cooperators, such as agricultural chemical retailers, crop consultants, and even targeted watershed project partners, can receive detailed farm operation and conservation information by signing "Certification of Natural Resources Conservation Service Conservation Cooperator" agreements.

Staff at the NRCS field offices and at the local soil and water conservation districts that help administer federal funds may interpret Section 1619 differently. In some states, staff feel it is important to provide the nonfederal partners in targeted watershed projects (e.g., nongovernment organizations or academic partners) with sufficient information to implement the project with their federal partners. In this approach, public reporting of funding and practice information must sometimes be aggregated and restricted to the watershed or county scale, but more granular data is shared, in private, with the nonfederal partners. In other states, NRCS and soil and water conservation district staff tightly guard the information and do not share details about the funding and practices.

The Section 1619 provision can have at least three negative ramifications on targeted watershed projects:

- **SUBSTANTIVE**—Project leaders no longer know the extent, location, distribution, or intensity of conservation treatment on farmland within the project. In addition, they cannot tell how well the practices are being maintained. Such information is critical not only to developing a watershed-based plan, but to updating it throughout the project. Without this information, project leaders may struggle to determine the best locations to target with the limited conservation funds and technical assistance. In addition, without access to practice adoption or maintenance information, project leaders will find it difficult to interpret water quality data or be able to link the effect of practices to measured improvements in stream water quality.
- **PARTNERSHIP**—If federal, state, local, and nongovernment partners cannot coordinate effectively, project outreach to farmers will be less efficient. The 2014 review of the Mississippi River Basin Healthy Watersheds Initiative revealed that several nongovernmental project leaders were frustrated with Section 1619, because they felt it interfered with the effectiveness of partnerships that the initiative was trying to foster (Perez and Walker, 2014). Some questioned whether their outreach and education efforts with farmers might have been in vain. They worried that despite the time and effort spent "priming" interested farmers to apply for NRCS conservation contracts, they would not receive feedback from NRCS about the completion or awarding of contracts, or which practices were ultimately adopted.
- **POLITICAL**—Project leaders cannot adequately inform the public about the conservation effort in the watershed, nor are they able to adequately demonstrate how state taxpayer dollars are leveraging federal taxpayer dollars.

These negative consequences of the Farm Bill's confidentiality provisions can constrain the effective use of federal conservation funds in a targeted watershed project to achieve and measure environmental outcomes.

In contrast, the two projects in this report that had funding sources other than the Farm Bill conservation programs—the Oklahoma Honey Creek Section 319 project and the Iowa Hewitt Creek project—could display the field locations where conservation plans were developed and where conservation practices were adopted. This information helps not only project leaders but also the research community and the public more fully understand how targeting did and did not occur in both projects and draw lessons for their own efforts.

CHAPTER 12

RECOMMENDATIONS

The following recommendations are designed to help leaders of any targeted watershed project who are pursuing outcomes-oriented conservation to quantify in-stream water quality outcomes as well as other environmental, social, or economic outcomes. They reflect the experiences documented in the case studies, the efforts to find water quality success stories to feature in this report, and previous conservation targeting and water quality analyses in the literature.

Because most project-based conservation financial assistance to farmers is currently supporting projects under the U.S. Department of Agriculture (USDA) Landscape Conservation Initiatives and the new Regional Conservation Partnership Program (RCPP), these recommendations are meant to be particularly helpful to those projects and program coordinators. And, because many institutions are involved in helping targeted watershed projects achieve success, recommendations are also offered for USDA's Natural Resources Conservation Service (NRCS), the U.S. Environmental Protection Agency (EPA), the U.S. Congress, the research community, and the charitable foundation and corporate sector communities.

Recommendations for targeted watershed project managers

The experiences and analysis presented in this report will help project managers of existing and future targeted watershed projects apply the right conservation practices in the right locations to generate sufficient pollution reductions to solve impairments in water bodies of concern. But equally important, for projects that include in-stream water quality monitoring in their project evaluation plan, these lessons can encourage the design of effective monitoring programs to quantify improvements in the stream, thereby demonstrating that conservation practices and programs can achieve landscape-scale environmental outcomes.

Make sure monitoring protocols match the objectives of the project. Regardless of a targeted watershed project's programmatic framework, project managers should review their in-stream monitoring protocols to make sure they meet the objectives of their project or program. This report identified two basic research questions that all projects attempting to assess the water quality impacts of agricultural conservation practices for nutrients, sediment, and/or pathogens with in-stream water monitoring should try to answer: (1) Have the water quality-related conservation practices implemented in the project resulted in the observed changes in the water body of concern? (2) Have water quality conditions significantly improved over time in the water body of concern?

This report also identifies four monitoring designs that increase the likelihood of being able to answer these questions: above/below, before/after, paired watershed, and trend (see Appendix C).

If project managers are (a) unsure whether their monitoring efforts will meet their monitoring objectives, (b) unable to answer either research question, or (c) not implementing one of the recommended monitoring designs, they should appeal for technical guidance and capacity-building resources (e.g., materials, workshops, trainings, tools, etc.) from NRCS, EPA, the EPA regional offices, their state's Section 319 programs, universities, and others.

If possible, use in-field diagnostic tools. If appropriate to their project's water quality objective, project leaders should use in-field diagnostic tools—such as the Phosphorus Index, the Soil Conditioning Index, the Cornstalk Nitrate Test (among others)—and watershed modeling tools, such as the Soil Water Assessment Tool (SWAT) (among others). These tools not only help projects identify opportunities to target conservation resources to critical areas of concern but also help them quantify environmental outcomes at the field-scale allowing them to be aggregated and reported at the project-scale to reflect landscape-scale improvements.

Projects can use in-field modeling techniques to quantify and report environmental outcomes on a shorter time frame than the in-stream monitoring program. In addition, these environmental metrics will be especially helpful to projects that did not set out to conduct in-stream water quality monitoring, enabling them to report environmental outcomes rather than only output data. Project leaders interested in quantifying and reporting these and other environmental, social, and economic outcome metrics should appeal for technical guidance and capacity-building resources (e.g., materials, workshops, trainings, tools, etc.) from NRCS, USDA's Agricultural Research Service, universities, and others.

Recommendations for the Natural Resources Conservation Service

Offer guidance on monitoring. NRCS should disseminate its 2003 *National Water Quality Handbook* or collaborate with EPA to disseminate that agency's updated 2016 water quality monitoring guidance to all existing and future water quality-related project partners through webinars. The handbook is an excellent resource for partners trying to quantify landscape-scale outcomes of conservation practices though in-stream water quality monitoring. NRCS should also consider developing more-specific guidance and protocols for in-stream chemical, biological, and physical monitoring for the water quality-oriented Landscape Conservation Initiatives and RCPP projects—either on its own, or in collaboration with EPA, USGS, state water quality agencies, or university experts. While that effort is under way, the agency should encourage the Landscape Initiatives and the RCPP projects that opted to use in-stream monitoring to check if they satisfy already available guidance. NRCS should consider placing a temporary moratorium on all future announcements for program funding (APFs) for water quality-related initiatives and RCPP projects until this guidance and protocols are disseminated to all potential project partners through capacity-building workshops and training webinars.

In 2012, NRCS put a temporary moratorium on Mississippi River Basin Healthy Watersheds Initiative (MRBI) projects with edge-of-field monitoring and did a commendable job of developing new edge-of-field water quality monitoring protocols required for any existing or future MRBI projects (USDA NRCS, 2012b; 2012c). NRCS needs to provide the same leadership for future Landscape Initiative and RCPP projects that wish to conduct in-stream monitoring—or entrust this work to another federal or state agency, university, or a private third party—to help these projects succeed.

Provide guidance, protocols, and reporting requirements for project leaders so they can collect and report on environmental, social, and economic outcomes. NRCS should pursue this recommendation in collaboration with its sister USDA agencies, the Agricultural Research Service and the Economic Research Service, as well as EPA, USGS, state water quality and agricultural agencies, university agronomists, sociologists, and economists, and nongovernment organizations.

Though in-stream water quality monitoring may be the most effective method to quantify and report on landscape-scale environmental outcomes of farm conservation practices, the technique requires partners with significant monitoring and statistical analysis skills, adequate funding, and time. In addition to or instead of monitoring, targeted watershed projects should be encouraged to quantify a variety of other environmental outcomes at a variety of scales. In some cases, alternative environmental outcomes may be less costly and time-consuming to quantify than in-stream metrics, and the partners with the necessary skills may be more readily at hand.

For example, in-field agronomic-environmental metrics provided by the Phosphorus Index, the Soil Conditioning Index, the Cornstalk Nitrate Test, and other agronomic-environmental diagnostic tools are commonly implemented by extension specialists, local soil and water conservation districts, and NRCS field staff. Edge-of-field nutrient and sediment reduction estimates can be provided with RUSLE2, a commonly used conservation planning tool, and with the more specialized USDA Nutrient Tracking Tool. Watershed-scale nutrient and sediment reduction estimates can be generated by models such as the Soil Water Assessment Tool (SWAT) among others, which many state water quality agencies and land grant university staff are able to run. Where appropriate, in-field and edge-of-field metrics of success should be aggregated so the project leaders can report on project-scale or watershed-scale success.

NRCS should also provide guidance, protocols, and reporting requirements on social and economic outcomes, such as attitudinal change and on-farm economic benefits of conservation practices. NRCS should encourage surveys at the beginning and end of the project that ask farmer and landowner participants questions about awareness, understanding, and attitudes about agricultural-environmental issues. Changes in these social metrics from the beginning to the end of the project could be reported as social outcomes of targeted watershed projects. In addition, questions could be asked about the economic outcomes, both costs and benefits experienced by the farmer or landowner from participating in the project; there are indications that some conservation practices can save time and increase profits through a variety of mechanisms, including higher crop yields, fewer inputs, fewer passes over a field, and better animal health. Summary statistics could be reported on social and economic outcomes of the project.

Set up an annual reporting system to receive reports on all the environmental, social, and economic outcomes achieved and quantified by the projects. This conservation outcomes reporting system will enable the agency to report these achievements to Congress, the Office of Management and Budget, and the public, bolstering the institution's ability to justify conservation investments.

Fund project development, outreach, and monitoring. Explore collaboration with EPA, USGS, states, charitable foundations, and corporations with sustainable supply chain goals to create a new grant program that funds project development and management; farmer outreach and education; technical assistance; water quality monitoring; and quantification of environmental, social, and economic outcomes. Some of the existing Initiatives or RCPP projects may not be achieving success because they lack the resources to hire and maintain high-quality project management and water quality monitoring staff over the life of the project, which can be 5 to 10 or more years.

Prioritize funding to certain projects. Set projects up for success by improving the Announcement for Public Funding (APF) for any targeted watershed project applicant in any of its water-quality-related conservation programs. NRCS should prioritize projects that

- focus on impaired water bodies with or without total maximum daily loads, or other important water bodies of concern (to be defined and justified by the applicant);
- focus on impaired (or other allowable) water bodies with two or more years of water monitoring data that effectively establish the baseline chemical and/or biological conditions in the water body; and
- allow sufficient time to achieve success in at least three stages of the project. A reasonable timeline would be:
  - two years for collecting in-stream water quality monitoring data to establish an effective baseline (geographic targeting analyses as well as outreach and education activities could be conducted with farmers during this time);
  - one to three years of practice adoption (the project may need to conduct monitoring during this time); and
  - two to three years after conservation treatment for collecting water quality monitoring data to determine if the practices improved the water quality indicators of interest.

Thus, one to three years of financial assistance funds are needed to support farmers adopting practices, and 5 to 8 years of project funding is needed to support project management, conservation outreach, technical assistance, and monitoring and evaluation of outcomes. This timeline may be accelerated under special circumstances, but projects in larger watersheds, with lower conservation treatment rates, or less rigorous monitoring designs, may need 10 years to show definitive results.

In watershed projects that need two or more years to collect baseline monitoring data, NRCS should explore opportunities to allow project leaders to delay implementation of conservation practices and associated payments until after the baseline period.

Offer staff guidelines on sharing Farm Bill Section 1619 confidentiality requirements. Clarify to state and field staff the intent of the confidentiality requirements of Farm Bill's Section 1619. In some situations, NRCS field staff may be misinterpreting the provision regarding conservation practice information and location. Withholding such information from the targeted watershed project leaders, who sign the "Certification of Conservation Cooperator" agreement to comply with Section 1619 requirements, can negatively impact watershed planning at the beginning of a project, conservation practice implementation during a project, and evaluation of outcomes throughout the project.

This undermines the scientific and social integrity of these partnership-based projects by preventing each partner from knowing what conservation practices are being adopted and where. In addition, this opacity makes it more difficult to evaluate program effectiveness and to improve projects over time through adaptive management.

Recommendations for the U.S. Environmental Protection Agency

Offer training on water quality monitoring. Partner with NRCS to disseminate its newly published 2016 Water Quality Monitoring Guidance to existing targeted watershed projects under the Landscape Conservation Initiatives and RCPP but also to any projects regardless of programmatic framework. By offering webinar trainings to any watershed project leaders, EPA may be able to help projects improve the likelihood that in-stream water quality improvements can be documented at a satisfactory level of statistical confidence. Given that many non-Section 319 targeted watershed projects share the same goals as Section 319 projects—to measurably improve water quality—EPA should help build their capacity to respond to the basic research questions: Have specific water quality parameters improved? If so, is the improvement due to the conservation practice effort?

Offer to help train NRCS staff on how to identify proposals with effective water quality monitoring. NRCS staff who review project proposals for the Landscape Initiatives and RCPP program should be able to identify projects with effective water quality monitoring programs. For project proposals with less robust monitoring programs, NRCS staff could encourage project leaders to seek additional technical assistance from EPA, USGS, state water quality agencies, and other monitoring experts.

Recommendations for Congress

Increase investment in the water-quality-related Landscape Conservation Initiatives and the Regional Conservation Partnerships Program. Congress should explore how it can provide additional funds, not just for conservation financial assistance, but also for conservation technical assistance by NRCS field staff and other partners, as well as funds for partners to carry out effective project management, water quality monitoring, and other outcome evaluation techniques.

Increase investment in EPA's Section 319 Nonpoint Source Management Program so state water quality agencies and local watershed partners can hire more conservation and monitoring staff, and carry out more Section 319 projects that are rigorously designed and monitored. It should also increase Section 319 funding to help build state water quality agency and EPA regional office staff capacity to train non-Section-319 project managers to carry out the Section 319 watershed-based planning and monitoring protocols.

Amend Section 1619 of the Farm Bill to allow collection of targeted watershed project summary information while safeguarding farmer confidentiality. Several projects in this report indicated that the Farm Bill's confidentiality provision is interfering with the watershed-based planning process, undermining the impact and cost-effectiveness of targeting, preventing adequate project evaluation, and eroding social cohesion among project stakeholders.

Provide sufficient federal investment in the research agenda outlined below.

Recommendations for researchers

The conservation and water quality research community should analyze existing and completed projects to determine if there are minimum thresholds of conservation practice adoption that must be achieved before streams show water quality improvements. Given that most targeted watershed projects do not include in-stream monitoring in their evaluation plans, such thresholds could help assure leaders of projects lacking in-stream monitoring that their project is likely to achieve meaningful water quality improvements. For example, there may be a minimum threshold of the percentage of relevant acres that should be treated or a minimum threshold of intensity of treatment (e.g., number of practices, amount of management change, or pounds of pollutant reduced, etc.) needed on each treated acre within a project watershed before improvements in water quality could be expected. Thresholds may differ depending on agricultural land uses, watershed characteristics, water quality conditions, or agro-ecoregions. Determining if such thresholds exist would help conservation program and water quality monitoring agencies focus their resources and staff time on the projects that aim to meet the thresholds.

Recommendations for charitable foundations and corporate sustainability supply chain leaders

Provide funding for project managers and water quality monitoring experts. The foundation community and corporations with sustainability goals should consider providing significant financial support to two critical, yet commonly underfunded, functions of targeted watershed projects: project managers and water quality monitoring experts. Without adequate funding to attract and retain quality personnel, many projects fail. And without adequate funding to attract and retain water quality monitoring experts, projects that do succeed at restoring water quality may not know it.

Fund workshops on outreach, technical assistance, and monitoring. Foundations and corporations could provide financial support for training workshops to improve the capacity of targeted watershed project leaders. Workshops could be offered to the following:

- Conservation outreach and education leaders, on how to develop temporary watershed advisory groups or long-term farmer-led watershed councils to gain buy-in and trust from farmers in the watershed
- Conservation technical assistance and project evaluation leaders, on how to use available agronomic-environmental diagnostic and watershed tools (e.g., the Phosphorus Index, RUSLE2, Soil Conditioning Index, SWAT, etc.) to improve farmer decision making during assessment of various conservation options, quantify field-scale and then project-scale nutrient and sediment reduction outcomes, and conduct geographic targeting analyses
- Water quality monitoring leaders, on how to establish and implement successful monitoring programs and statistical analyses.

GLOSSARY

Anonymous code: A series of digits, sometimes randomly assigned, to a farm field or a farm to display information about the field or farm in a public setting without revealing the identity of the owner or operator of that field or farm.

Biological in-stream water quality monitoring: Evaluation of surface waters for biologically related water quality indicators such as benthic macroinvertebrates, fish, habitat, water quality, and/or basic geomorphic assessments in order to define and document baseline conditions of in-stream biology, measure spatial and temporal variability of population and community attributes, and describe water quality and physical impacts from land-use changes caused by agriculture, forest practices, or urbanization.

Chemical in-stream water quality monitoring: Evaluation of surface waters for the water quality chemistry during storm events and at base flow via grab samples or composite storm sample measurements, including, but not limited to, the following water quality indicators: conductivity, water temperature, pH, dissolved oxygen, chlorophyll-*a*, nitrate, phosphorus, pesticides and pathogens (e.g., *E. coli*) to describe water quality and impacts from land-use changes caused by agriculture, forest practices, or urbanization.

Field-scale outcomes: The results or impacts of conservation practice(s) on a farm field's environmental outcomes. Depending on the measurement tool, a field-scale outcome—reductions in phosphorus losses or reductions in the phosphorus loss risk values from cropland or pastureland acres, for example—may be measured in the field or at the edge of the field.

Hydrologic Unit Code (HUC): A hierarchical classification system for watersheds on the basis of size. The larger the HUC digit, the smaller the watershed size. Thus, a 12-digit HUC watershed (HUC12) averages about 40 square miles while an 8-digit HUC watershed (HUC8) averages about 700 square miles.

In-stream water quality monitoring: Evaluation of surface waters to assess whether water quality and/or the biological condition related to nutrients, sediments, or livestock-related pathogens has improved and whether the improvement can be associated with agricultural conservation practices or other mitigation measures. This can include biological, chemical, or physical water quality monitoring.

Landscape-scale outcomes: The results or impacts of many conservation practices adopted by many farmers and landowners within a watershed or other area. In the case of water quality, a landscape-scale outcome could be the improvement in specific water quality indicators monitored in streams within a watershed or at the watershed outlet.

Nonpoint source pollution: Occurs when rain runs off farmland, forestland, city streets, construction sites, and suburban lawns, roofs, and driveways and enters waterways. This runoff often contains harmful substances, such as toxins and pathogens, and excess nutrients and sediments. It is referred to as nonpoint source pollution because it comes from multiple sources rather than a single point source, such as a sewage treatment plant or an industrial discharge pipe, thereby making it difficult to control.

Operational monitoring: Assesses changes in water quality attributable to mitigation measures implemented by pollution reduction projects.

Output: A measure of output is the calculation, recording, or tabulation of the results of an activity, effort, or process that can be expressed in numbers (quantitatively). In the case of federal conservation programs and initiatives or watershed-based projects, this report regards outputs as administrative products: financial assistance dollars spent, conservation contracts signed with farmers, number of acres (or units) on which practices were adopted, and so on. See definition of *outcome* for comparison.

Outcome: Something that follows; a result or consequence. A measure of outcome is the determination and evaluation of the results of an activity, plan, process, or program and their comparison with the intended or projected results. In the case of federal conservation programs and initiatives or watershed-based projects, this report regards outcomes as the environmental, social, or economic results of the program, initiative, or project. Environmental outcomes may be measured in-stream to determine improvements in water quality (i.e., chemical, biological, or physical) and in the field or at the edge of the field (e.g., improvements in the phosphorus losses or phosphorus risk values from cropland or pastureland). Social outcomes may be measured through farmers' opinions or behavioral changes regarding agro-environmental science and policy topics. Economic outcomes may be measured through survey or interview responses from farmers about the economic effect that adoption of a conservation practice(s) has had on their farm operations. See definition of *output* for comparison.

Physical in-stream water quality monitoring: Evaluation of surface waters for the physical characteristics of a water body, including flow volume, suspended sediment in the water column, stream bank or channel soft sediment deposit.

Surveillance monitoring: Assesses the overall ambient status of water quality and the long-term changes from natural conditions or widespread anthropogenic activity. Surveillance monitoring can be used to describe the states' Clean Water Act Section 303(d) monitoring programs, which assess the status of water bodies regarding their designated uses and water quality standards. The results of conservation measures are better monitored by operational monitoring (see above).

Tailwater discharges: In this report, refers to excess surface water draining especially from a field under cultivation, usually with irrigation.

Tile drain monitoring: A method of evaluating the chemical water quality of shallow groundwater and agricultural drainage water from tile lines to determine the effectiveness of conservation practices.

Water quality monitoring: Commonly defined as the sampling and analysis of water from lakes, streams, rivers, estuaries, or oceans to determine the conditions of the water body. Water quality monitoring can evaluate the physical, chemical, and biological characteristics of a water body in relation to human health, ecological conditions, and designated water uses.

ABBREVIATIONS

APF	Announcement for Public Funding
AWEP	Agricultural Water Enhancement Program (NRCS)
BDI	Bay Delta Initiative (California NRCS)
CBWI	Chesapeake Bay Watershed Initiative (NRCS)
CEAP	Conservation Effects Assessment Project (NRCS)
CIG	Conservation Innovation Grant (NRCS)
CNT	Corn Stalk Nitrate Test
CRP	Conservation Reserve Program (USDA)
EQIP	Environmental Quality Incentives Program (NRCS)
GLRI	Great Lakes Restoration Initiative (NRCS)
GOMI	Gulf of Mexico Initiative (NRCS)
HUC	Hydrologic Unit Code
IBI	Index of Biotic Integrity
IRESI	Illinois River Eucha-Spavinaw Initiative (NRCS)
LMW	Leadership for Midwestern Watersheds
MRBI	Mississippi River Basin Healthy Watershed Initiative (NRCS)
NGO	Nongovernmental Organization
NIFA	National Institute of Food and Agriculture (USDA)
NNPSMP	National Nonpoint Source Monitoring Program (USEPA)
NRI	National Resources Inventory
NWQI	National Water Quality Initiative (USDA-USEPA)
OCC	Oklahoma Conservation Commission
RCPP	Regional Conservation Partnerships Program (NRCS)
RCWP	Rural Clean Water Program (USDA-USEPA)
RSET	Resource Stewardship Evaluation Tool
SCI	Soil Conditioning Index
SVWQC	Sacramento Valley Water Quality Coalition (California)
SWAT	Soil and Water Assessment Tool
SWCD	Soil and Water Conservation District
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
WFPO	Watershed and Flood Prevention Operations Program
WIRB	Water Improvement Review Board (Iowa)

APPENDIX A: NRCS'S PL-566 PROJECTS

The Watershed and Flood Prevention Operations Program (WFPO)[70] oversees what are commonly referred to as PL-566 projects (shorthand for Public Law 83-566, the Watershed Protection and Flood Prevention Act and Public Law 78-534, the Flood Control Act of 1944). Since its first year of funding in 1947 ($2.1 million) to its heyday of $199 million in 1994, over 1,700 watershed projects have addressed water-related natural resource concerns at the watershed scale, involving watershed planning and targeting of resources to the highest priority issues and areas within a watershed, and developing projects in partnership with locally led sponsoring organizations. About 365 projects are still active though no funding has been authorized since FY2010.[71]

A primary focus of the PL-566 projects has been building large-scale water control projects. "Eleven thousand watershed dams have been built by local project sponsors with assistance from NRCS. Most of the dams were built primarily for flood control, but they also provide fish and wildlife habitat, and recreation. Some dams supply water for communities or for agricultural water management."[72] These projects also offer significant water quality and wildlife benefits through soil erosion reduction and wetlands restoration. The practices that are the focus of this report—on-farm conservation practices and streambank restoration practices adjacent to farmland—could be also be (an albeit minor) component of PL-566 projects.

During the 1970s until the early 2000s, the program received hundreds of millions of dollars each year to support locally led projects to leverage state or local funds.[73] Funds could be used to develop (1) watershed and river basin survey studies and flood hazard analyses, (2) a watershed plan, and (3) project implementation (design and construction). During this time frame, NRCS staff were the primary watershed planners developing the plans in addition to private firms with watershed planning and dam construction expertise.

In addition to the targeting and watershed planning that occurred in the PL-566 projects, NRCS has also estimated environmental and economic benefits of these watershed-scale efforts. In 2008, NRCS estimated and published a variety of benefits, including: 44,293 miles of streams with improved water quality, 89,611,699 tons of annual soil erosion reduced, and 4,534,534 tons of animal waste properly managed.[74] A 2016 report by NRCS to Congress also included an estimated $2.2 billion in average annual benefits across the country based on the benefit cost analyses that are completed for each watershed project prior to implementation and which monetize the estimated annual benefits for the project (USDA NRCS 2016).

Unfortunately, Congress has not authorized funding for the program since 2010. However, in 2016, six Regional Conservation Partnership Program (RCPP) projects were awarded and approved to use RCPP-related funds to fulfill PL-566 functions in projects that remain viable with state or local funds. Thus, PL-566 projects continue in a few cases.

APPENDIX B: COMPONENTS OF A WATERSHED-BASED PLAN

The U.S. Environmental Protection Agency (EPA) outlines six steps in the watershed planning process, along with nine minimum elements (a through i) to be included in watershed plans for impaired waters funded through the Section 319 Nonpoint Source Program (USEPA (2008).

Step 1. Build Partnerships

Identify key stakeholders; identify issues of concern; set preliminary goals; develop preliminary indicators; conduct public outreach.

Step 2. Characterize the Watershed

Gather existing data and create a watershed inventory; analyze data; identify causes and sources of pollution (element a); identify data gaps and collect additional data if necessary; quantify pollutant loads.

Step 3. Set Goals and Identify Solutions

Set overall goals and management objectives; develop indicators/ targets; determine load reductions needed (element b); identify critical areas; identify management practices to achieve goals (element c).

Step 4. Design and Implementation Program

Develop an implementation schedule (element f); develop interim milestones to track implementation of management measures (element g); develop criteria to measure progress toward meeting watershed goals (element h); develop monitoring program (element i); develop information/education component (element e); develop evaluation process; identify technical and financial assistance needed to implement plan (element d) (e.g., characterization and analysis tools like GIS, monitoring, models, databases, load calculations); assign responsibility for reviewing and revising the plan.

Step 5: Implement the Watershed Plan

Prepare work plans; implement management strategies; conduct monitoring; analyze data; conduct information/education activities; share results.

Step 6. Measure Progress and Make Adjustments

Review and evaluate information; prepare annual work plans; report back to stakeholders and others; make adjustments.

APPENDIX C: PRIMER ON MONITORING OBJECTIVES AND DESIGNS

The U.S. Environmental Protection Agency (EPA) has provided many guidance documents and technical webinars to project partners involved in National Water Quality Initiative (NWQI) projects to help them succeed.[75] The guidance is useful to all projects that share the goal of "Assess[ing] the water quality impacts of agricultural conservation practices for nutrients, sediment, and/or pathogens in watersheds," regardless of the programmatic framework.

To accomplish this goal, two water quality monitoring objectives, stated as research questions, should be asked and answered by the project leaders:

Objective 1: Have water quality-related conservation practices resulted in the observed changes in the water body?

Objective 2: Have water quality conditions significantly improved over time in the water body?

Objective 1 establishes a causal relationship and requires more conservation practice information (when practices started and stopped in which part of the watershed) or at least good baseline data or a paired control watershed where practices are not implemented during the project. Objective 2 establishes an "associative relationship" between the level of implementation and changes in water quality. The strength of the association can be measured by regression analysis or explained using a preponderance of evidence approach. Multiple lines of evidence can be provided by biological, chemical, and physical (e.g., flow, scouring, and habitat parameters) and other indicators. Conservation practice information is still needed, but possibly at a lower level of detail.

Four monitoring approaches available to answer the two water quality monitoring questions

The four monitoring designs, initially described by the EPA for the NWQI projects, should be useful to any watershed project wishing to determine if adopted farm conservation practices that help reduce nutrient, sediment, and pathogen loadings to streams are achieving in-stream improvements in water quality.

Before/after monitoring. The purpose of before/after monitoring design is to evaluate the effects of practice implementation in the watershed and to assess changes in relationship between water quality and climate variables due to the conservation practices. It involves monitoring a site downstream of the treatment area before and after the treatment. The statistical design includes tests to determine the difference between means (e.g., t-test) and an analysis of covariance (e.g., differences between slopes and intercepts of regression relationships for pre- and post-conservation implementation periods or multivariate regression using flow or climate variables). Sampling can occur from a single station, using grab samples, storm events, or composites, as well as biological sampling. For projects with total maximum daily loads specifying load reductions (and other watershed plans), projects need to measure the water flow and take samples during storm events.

The advantages of before/after monitoring design are that it involves just one monitoring station, it is relatively easy to apply, it can evaluate projects relatively quickly (two to six years), and it can support trend analysis. The disadvantages for watershed project evaluation are that it is vulnerable to climate variability, and it can be difficult to distinguish whether climate or conservation practices caused the water quality changes. The design can be strengthened by (a) increasing pre-and post-best management practice monitoring periods, (b) adding covariates (e.g., flow, which is needed to estimate pollution loading and load reductions), (c) ensuring the practices are implemented within the designated time period to draw a sharp divide between pre- and post-monitoring periods, and (d) collecting detailed practice implementation data.

Trend monitoring. The purpose of trend monitoring design is to determine if practices improved water quality or to determine any water quality changes over time (e.g., change in *E. coli* levels, change in load under a total maximum daily load (TMDL). Trend monitoring is similar to the single watershed before/after design, but it may include projects that lack as distinctive an implementation period as in before/after studies. A monotonic trend analysis may be desirable if practice implementation does not occur within the designated time frame. In addition, trend monitoring may continue for a much longer period (10 or more years) than the 2 to 6 years of before/after projects.

The advantages of trend monitoring are that it involves just one monitoring station, it is widely applicable, practices can be implemented gradually, it accounts for lengthy lag times in environmental response to the practices, and it is consistent with TMDLs if loads are measured. The disadvantages for watershed project evaluation include the fact that land use, land treatment, precipitation, and flow data must be tracked; it can take many years (often 10 or more); there cannot be any gaps in the dataset; it is vulnerable to major land use changes; and the project cannot change sampling and analysis methods over the entire study period.

Above/below monitoring. The purpose of above/below monitoring design is to assess the water quality impact of isolated pollution sources or to determine the effectiveness of practices on isolated sources. Two stations—one located above the treatment area and one below the treatment area—are needed. The statistical designs for above/below monitoring can include paired t-tests (above and below), nonparametric t-tests, and a comparison of regression analysis for parameters above and below (e.g., concentration versus flow). Paired sampling occurs at the two stations. Grab, storm, or composite sampling are options, and biological monitoring can occur too. For TMDL watersheds, flow and storm events must also be measured.

The advantages for watershed project evaluation are that above/below monitoring designs are not as vulnerable to climate variability as the single watershed (i.e., before/after and trend) designs; it is widely applicable; it is useful for isolating critical areas; and the project can be treated as paired watersheds if sampling occurs before and after best management practices. The disadvantages of the above/below design are that it can suffer from upstream impacts on downstream water quality, and differences in station data may be caused by geology, interactions between conservation practices and the watershed, and the practices themselves. Using pre- and post-practice monitoring can address these issues.

Paired watershed monitoring. The paired watershed approach involves two watersheds that are ideally nearby and similar in size, land use, and topography and have monitoring stations located at each watershed's outlet. In the "control" watershed, no purposeful efforts to encourage conservation practice adoption are undertaken by the project leaders. In the "treatment" watershed, conservation practice adoption is vigorously encouraged. The statistical design for the paired watershed monitoring approach includes the before/after design because sampling needs to occur before and after practice implementation in both the control and treatment watersheds. Regression relationships are developed between the two watersheds for both the calibration and the practice treatment periods. Analysis of variance is used to test for significance between paired observations, and analysis of covariance is used to determine the significance of the effect of the practices in the treatment watershed.

The advantage of the paired watershed design is that it helps control the inherent watershed differences and hydrologic variation between the watersheds and allows for attribution of any water quality improvements to the practices adopted. Disadvantages include: twice the expense as single watershed designs; longer durations needed to implement the monitoring; difficulty in finding control watersheds; difficulty in ensuring farmers in the control watershed do not adopt similar practices as in the treatment watershed.

APPENDIX D: HOW WE KNOW THE TRADITIONAL CONSERVATION APPROACH CAN RESULT IN IN-STREAM WATER QUALITY IMPROVEMENTS: THE POND CREEK STORY IN OKLAHOMA

Most funds from the federal conservation program are disbursed by staff in the county Natural Resources Conservation Service (NRCS) and local conservation district offices to individual farmers in their county jurisdictions in what this report refers to as the traditional conservation approach—as opposed to targeted watershed projects. Traditional programs measure their success by counting outputs associated with that spending (e.g., contracts signed, practices implemented). This report found 48 Section 319 success stories attributable to the traditional conservation approach because, unbeknownst to the NRCS or local conservation district staff, in-stream water quality monitoring was occurring and was able to quantify their water quality outcomes.

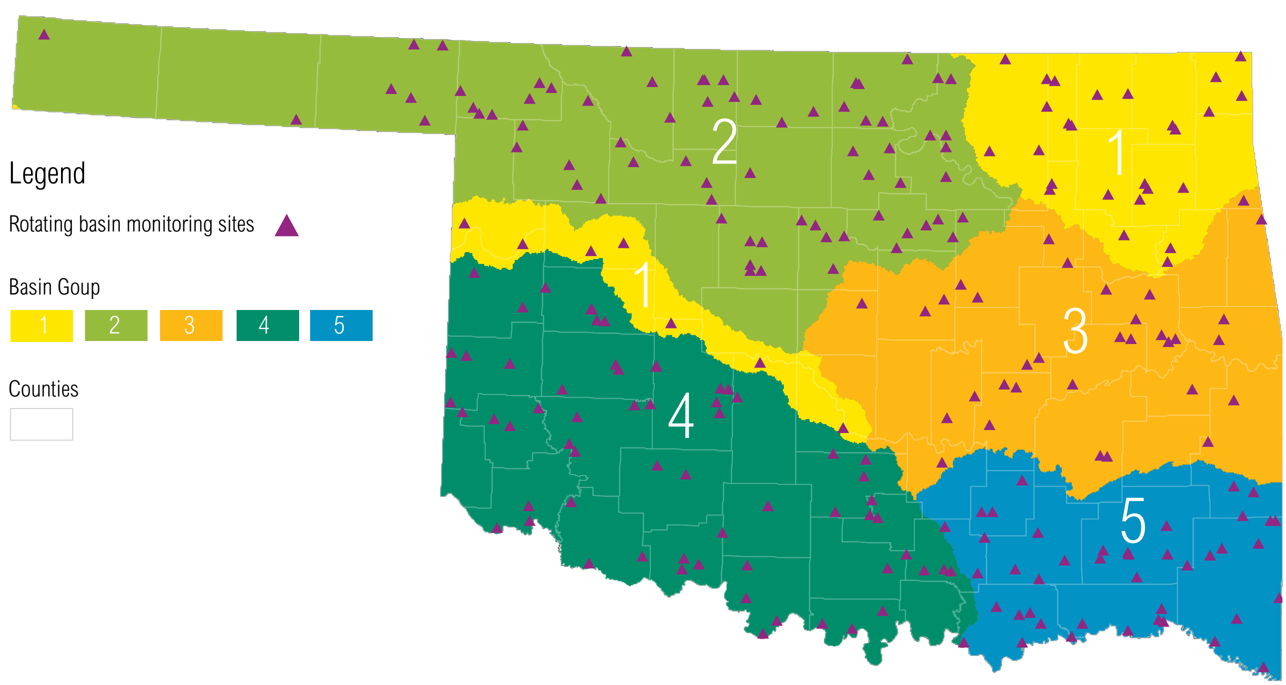
Shanon Phillips, director of the Water Quality Division of the Oklahoma Conservation Commission, believes there are at least four reasons why Oklahoma has had so many traditional project Section 319 success stories:

- The Oklahoma Conservation Commission implements a monitoring program that is designed to detect improvements in nonpoint source pollution within small watersheds across the state (see Figure Appendix D-1).
- The 48 non-project success stories all had significant conservation practice adoption by farmers and landowners—due to financial and technical assistance from NRCS field office staff—within the county occupying the monitored watershed.
- The county jurisdictions where the NRCS field staff operate comprised the majority of the monitored watershed.
- Although many of the 48 water bodies had very poor water quality, most of the streams were impaired by pollutants with short latency periods (i.e., bacteria and sediment). This meant such streams were relatively "easy" to clean-up and delist in comparison to water bodies impaired by nutrients, which have a much longer period of impact.

According to Phillips, the commission and its state partners implement two monitoring programs that were designed to serve different functions:

- A fixed-site rotating basin monitoring program (which resulted in the 48 streams being delisted):
  - is designed to evaluate nonpoint sources of water pollution solely;
  - includes approximately 250 locations at the outlet of agriculturally dominated, HUC11-sized watersheds;[76]
  - uses a before/after monitoring design wherein grab samples are collected every five weeks over two years; and
  - monitors each basin every five years (see Figure Appendix D-1).

Figure Appendix D-1 | **Map of Oklahoma's Nonpoint Source Fixed-Site Rotating Basin Monitoring Program**



Oklahoma conducts water quality monitoring for two consecutive years in watersheds dominated by nonpoint sources of pollution before moving to watersheds in another basin. *Source:* WRI, with data provided by Shanon Phillips, Oklahoma Conservation Commission.

- A Clean Water Act Section 305b Monitoring Program:
  - is required by the Clean Water Act to determine if water bodies are meeting their designated uses and to establish long-term trends in water quality; and
  - often places stations in very large watersheds that are dominated by point sources of pollution (i.e., industrial facilities or municipal waste water treatment plants, which have federal permit requirements).

Phillips explained that most states implement only the Section 305b Monitoring Program and thus are unlikely to be able to detect water quality improvements from traditional conservation program efforts. "When we talk to partners in other states, they can't believe that we have so many successes listed. I explain to them it's because our fixed-site rotating basin program monitors the state holistically but targets smaller watersheds dominated by nonpoint sources. Unlike other states, we are not focused on the Section 305b program mentality, that is, whether waters are meeting or not meeting their designated uses. Instead, we're focused on developing the Section 319 nonpoint source assessment reports." (Personal communication, January 21, 2016).

When asked why Oklahoma is trying to conduct more Section 319 watershed implementation projects like the Honey Creek project featured in this report rather than mainly relying on the rotating basin monitoring approach with traditional conservation efforts, Phillips said, "The 48 success stories were low hanging fruit. That is, perhaps their water quality was not very poor to begin with or stemmed from just a few sources and thus, the problems could be easily solved—versus nutrients which are more challenging to reduce. We still have 700 water bodies on the impaired list so we have a long way to go. We need to use the Section 319 watershed-based improvement project approach because it works. And, we think our local watershed advisory groups have a lot to do with our Section 319 projects' success." (Personal communication, January 21, 2016).

Pond Creek Watershed, Oklahoma: An example of the traditional conservation approach resulting in monitored water quality improvements

Pond Creek is one of the 48 profiles recently published as Oklahoma Section 319 Program success stories of traditional projects. Because one of the state's "fixed-site, rotating basin monitoring program" sampling locations was located at the watershed outlet to Pond Creek and because local NRCS staff were actively engaging scores of farmers across Grant County surrounding most of the watershed, the state's monitoring program detected statistically significant improvements in water quality, which allowed the Creek to be delisted.

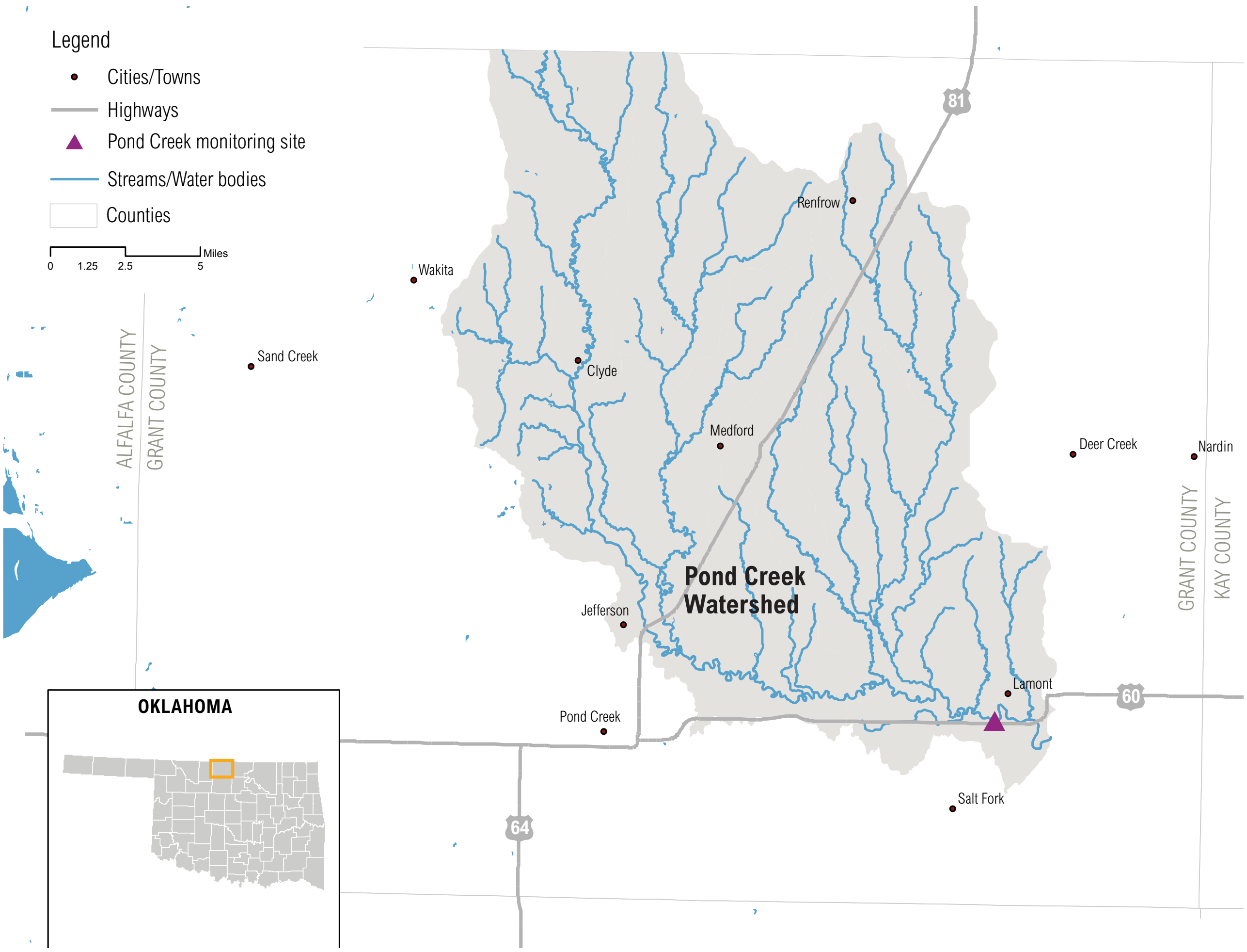
Pond Creek is a very large 198,000-acre watershed comprising nine HUC12 watersheds, which takes up most of Grant County (see Figure Appendix D-2). In 2004, Pond Creek was listed as impaired for bacteria, and in 2006, it was listed for turbidity and low dissolved oxygen. A passionate NRCS field office staff member, Karla Stephenson, who had the support of a very active Grant County Conservation District Board of elected farmers, was able to help farmers put in tens of thousands of acres of conservation practices in Grant County, which coincidentally, were mostly in the Pond Creek watershed. Stephenson helped farmers access $1.23 million from four federal conservation programs (Environmental Quality Incentives Program, Conservation Stewardship Program, Wetlands Restoration Program, and Conservation Reserve Program) and general technical assistance funds in 2005–09, plus $2.74 million in 2010–14.

During the first period (2005–09), the farmers and Stephenson installed 9,226 acres of prescribed grazing on pastureland, 9,755 acres of proper nutrient management on cropland, 13,936 acres of integrated pest management on cropland, and enrolled 16,474 acres of cropland into "upland wildlife habitat management," and 200 acres into wetland restoration and enhancement. In addition, 15 ponds, 8 water tanks for alternative water sources, and 9,770 feet of pipeline were installed to keep livestock out of streams. During the second period (2010–14), an additional 40,049 acres of cropland received no-till and reduced-till cultivation, cover crops, and conservation crop rotations, 71,796 feet of terraces, 79 acres of grassed waterways, 21 new ponds, and 9,864 acres of prescribed grazing on pasture and rangeland.

While Stephenson was doing her job of "getting good conservation on the ground,"[77] Brooks Trammel of the Oklahoma Conservation Commission was doing his job of implementing the rotating basin monitoring program in the Pond Creek watershed. Two-year sampling efforts occurred in 2004–06, 2008–10, and 2012–14). Trammel also conducted fish, macroinvertebrate, and habitat assessments every five years in Pond Creek. Neither Stephenson nor Trammel knew about each other's efforts.

Dissolved oxygen and turbidity parameters responded quickly to treatment and have met applicable criteria since 2010. Pond Creek was removed from Oklahoma's List of Impaired Waters for turbidity and dissolved oxygen impairments in 2010, restoring its designated use for fish and wildlife propagation. In contrast, *E. coli* bacteria was very high and it took until 2014 to meet the criteria, at which time Pond Creek's *E. coli* impairment was removed. Thus, nine years after the traditional conservation program approach began in Grant County, the monitoring program allowed the state to detect that all three of Pond Creek's impairments had been resolved.

Figure Appendix D-2 | **Map of Pond Creek Watershed in Grant County, Oklahoma**



APPENDIX E: WHY IT MAY TAKE SOME TARGETED WATERSHED PROJECTS LONGER THAN OTHERS TO DETECT WATER QUALITY SUCCESS (OR WHY THEY MAY NEVER SHOW SUCCESS)

There are at least eight reasons why attempts to improve water quality in streams or other water bodies may take a long time to succeed or may never succeed. The following list is derived from the findings of this report and from previous targeting and water quality monitoring analyses focused on reducing farm-related nutrients, sediment, and pathogens (Gale et al., 1992; Meals et al., 2010; Meals et al., 2012a, 2012b, 2012c; Osmond et al., 2012a; Perez and Walker, 2014; Walker and Perez, 2014).

Insufficient conservation treatment is occurring upstream from the water quality monitoring location. Many projects find it difficult to turn away farmers located downstream or outside the area draining into the monitoring location. Thus, financial and technical assistance is spent on practices that cannot contribute to the project's goal of improving water quality in a monitored segment of stream. This may leave the priority treatment area insufficiently saturated with the right conservation practices.

This could occur in two ways. First, an insufficient percentage of the priority cropland or pastureland acres of concern are receiving the right conservation practices. This could mean that too few farmers, who operate too small of a percentage of the farmland, are participating. Alternatively, a sufficient percentage of the priority acres of concern are being treated, but the "intensity" of the treatment is inadequate (i.e., only one practice is adopted when two or more may be needed to address the volume or transport of pollution). In both cases, the reduction in pollution is insufficient to influence the monitored stream segment.

The conservation practices do not match the problem. Some projects focus on commonly accepted and understood practices, such as sediment control ponds and terraces. However, if the water quality concern in the stream is nitrogen and/or the monitoring is set up to track nitrogen concentrations or loads, then financial and technical assistance for sediment-focused practices is unlikely to significantly contribute to the project's goal of reducing nitrogen in the stream.

Focus is on farms while effort is also needed in riparian areas and within the stream. Some projects focus on streams that are listed as impaired for problems that stem from on-farm causes (e.g., siltation and organic enrichment/low dissolved oxygen) and from riparian or in-stream problems (e.g., habitat alterations). In this situation, projects that focus solely on on-farm sources of soil erosion and phosphorus losses that are commonly associated with siltation and organic enrichment may achieve success for only two of the three stream problems. Without addressing the many biological and physical problems caused by habitat alterations (e.g., dredging, bank sloughing, channel straightening, lack of pools and riffles for habitat, insufficient tree cover for shading to cool the water temperature, etc.), the project may not address a key problem preventing the stream from recovering and being delisted for all impairments.

Water quality monitoring is too infrequent or is limited to the growing season, indicating the project is not using one of the four EPA-recommended water quality monitoring designs. Monthly monitoring with or without storm events often proves to be too infrequent to detect statistically significant changes in the stream. Projects that limit sampling to the growing season (e.g., March–August) can miss important winter processes (especially for nitrate-nitrogen). EPA has provided guidance on four monitoring designs that offer credible monitoring approaches for targeted watershed projects (i.e., before/after, trend, above/below, or paired watershed). These designs help projects to answer the two research questions set out in EPA's guidance: Have water quality-related conservation practices resulted in the observed changes in the water body? Have water quality conditions significantly improved over time in the water body? (See Appendix C for details.)

Surveillance monitoring is occurring rather than operational monitoring. Surveillance monitoring assesses the long-term changes from natural conditions or widespread anthropogenic activity. This type of monitoring is akin to the states' program monitoring under Section 303d of the Clean Water Act, which seeks to assess the status of water bodies regarding their designated uses and water quality standards. In contrast, targeted watershed projects require operational monitoring, which assesses changes to water bodies resulting from specific mitigation measures.

Lag time can pose challenges. The lag time between when conservation practices are adopted and when their pollution reductions cause chemical or biological changes in the water can be especially long if hydrology in the watershed is dominated by groundwater and subsurface flows. Lag time can also occur if the preponderance of conservation practices implemented are vegetative (e.g., grass or forest riparian buffers) and need time to mature before they can prevent nutrients, sediment, and pathogens from entering the stream, for example. Lag time can also become a problem if farmer participation and practice adoption is slower than expected. Ideally, many conservation practices are adopted by the right farmers in the right locations within the first one to three years of the project.

Projects stalled because of a lack of funding to maintain quality project management staff. Many projects stall because they lose their project management staff. Too few funds may be marshalled to provide the level of salary and benefits to attract the staff with the technical and social skills needed to carry out the project and maintain the partnerships. In addition, funding may be limited to three or five-year grant cycles whereas many projects need 7 to 10 years or more to achieve success. Projects need leaders and partners who can participate as part of their regular occupational duties, and not have to worry about additional fund-raising to cover their time and travel. Alternatively, project leaders and partners should develop funding proposals that cover some or all their time and travel on the project, as well as monitoring costs. Funding sources for these costs are currently limited to USDA Conservation Innovation Grants (demonstration); USDA National Institute of Food and Agriculture–Conservation Effects Assessment Project (research); funds from farm and environmental nongovernmental organizations, which reflect membership dues; and grants from charitable foundations and corporations.

Project leaders did not explain their watershed-scale project goals to participating farmers. Eight project leaders interviewed for the 2014 review of the Mississippi River Basin Healthy Watershed Initiative report indicated that they failed to make a point of telling farmers about their project's ambition to achieve quantified reductions of nutrients or sediment in the water body of concern (Perez and Walker, 2014). Instead, they maintained the traditional conservation message that "good conservation on the ground" is good for the farmer and for the land. Thus, some projects may miss an opportunity to develop a "watershed community" with a collective sense of ownership of the project's goals. Thus, farmers may lack a sense of urgency or special purpose other than securing more conservation in the ground, which may translate into slower-than-expected adoption of conservation practices.

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ENDNOTES

1. "About NRCS," NRCS website: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/about/.

2. "EPA's Section 319 Nonpoint Source Success Stories," EPA website: https://www.epa.gov/polluted-runoff-nonpoint-source-pollution/nonpoint-source-success-stories. Accessed April 17, 2017.

3. WRI reviewed a database from an NRCS MRBI program coordinator that included information about water quality monitoring for 100 MRBI projects initiated in FY10, FY11, or FY12 that were scheduled to come to their five-year designated "end" (i.e., stop receiving funding through MRBI) in FY14 and FY15.

4. Clean Water Act, Section 303(d).

5. Monitoring in-stream responses to targeted watershed projects can be very costly depending on the monitoring design. In addition, transaction costs can be costly too and can include the costs for information, contracting, and implementation (McCann et al., 2005; McCann and Easter, 2000). Targeting is dependent on information and developing information on where conservation practices can have the largest environmental gains can be costly. Numerous transaction costs are involved in a targeted watershed project—some of which are already part of the traditional conservation approach while other costs are intrinsic to a watershed project. Costs can include: identifying the priority farmer operators and landowners within a targeted watershed project, educating them about their individual conservation opportunities as well as contribution to the larger watershed project, convincing them to adopt the desired practices, measuring the water quality outcomes in stream, and measuring other environmental, social, and economic outcomes. The more than 600 Success Stories on EPA's Section 319 website indicate that many state water quality agencies, local NRCS and SWCD field offices, and nongovernment project partners have found the benefits of targeting do exceed the additional costs required to target and monitor the improvements in streams.

6. Section 303(d) of the Clean Water Act.

7. The term *agriculture* in this report includes the production of food, feed, fiber, and biofuel energy.

8. "EPA's 319 Grant Program for States and Territories. 319 Grant Funds History," EPA website: http://www.epa.gov/polluted-runoff-nonpoint-source-pollution/§319-grant-program-states-and-territories.

9. "EPA's Section 319 Nonpoint Source Success Stories," EPA website: https://www.epa.gov/polluted-runoff-nonpoint-source-pollution/nonpoint-source-success-stories. Accessed April 17, 2017.

10. Personal communication, Katie Flahive, Environmental Scientist, Nonpoint Source Management Branch, U.S. Environmental Protection Agency, April 26, 2017.

11. Lara Bryant, formerly with World Resources Institute, now with Natural Resources Defense Council, led the analysis of the Section 319 projects for the report by Perez and Walker, 2014.

12. Personal communication, Katie Flahive, Environmental Scientist, Nonpoint Source Management Branch, U.S. Environmental Protection Agency, April 26, 2017.

13. See pages 22 and 24 and endnotes 17 and 18 in Perez et al., 2014 for a discussion of methods and lists of the programs and practices included in this NRCS CEAP estimate of average annual financial and technical assistance expenditures on nutrient and sediment related conservation practices on cropland nationwide.

14. "USDA Landscape Conservation Initiatives," NRCS website: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/home/?cid=stelprdb1042113.

15. The four conservation programs are the Environmental Quality Incentives Program, the Conservation Stewardship Program, the Wildlife Habitat Incentives Program, and the Wetlands Restoration Program.

16. "About RCPP," NRCS website: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/farmbill/rcpp/?cid=nrcseprd1308280.

17. Estimate based on NRCS data provided upon request to American Farmland Trust (2016).

18. Memo by Michelle Perez (World Resources Institute) and five representatives from American Farmland Trust, Iowa Soybean Association, and University of Wisconsin provided to USDA NRCS Chief Jason Weller and 11 NRCS staff. February 2015. Unpublished. Available upon request.

19. This assessment reflects the author's review of the Gale et al., 1993 report.

20. "EPA's National Water Quality Targeting Initiative," EPA website: https://www.epa.gov/polluted-runoff-nonpoint-source-pollution/nonpoint-source-national-water-quality-initiative.

21. Even newer guidance on monitoring and evaluating nonpoint source watershed projects was published by EPA in May, 2016.

22. The database included information about 100 Mississippi River Basin Healthy Watersheds Initiative (MRBI) projects that started in FY10, FY11, or FY12 and most had ended or were scheduled to come to their five-year designated "end" (that is, stop receiving funding through MRBI).

23. Perez and Walker, 2014. However, because none of the six CBWI projects were conducting water quality monitoring, we decided not to feature those projects and focused our analysis solely on the MRBI projects.

24. Personal communication with Martin Lowenfish, team leader, Landscape Conservation Initiatives, March 25, 2015.

25. Three documents about completed National Water Quality Initiative projects in three states were provided, comprising four half-page summaries from one state, a four-page project summary from a second state, and a three-page summary from a third state.

26. Micrograms per liter (µg/L) is also expressed as parts per billion (ppb).

27. Toxicity to *Ceriodaphnia* (water flea) was also detected in April 2007, but it was determined that Chlorpyrifos was not the cause. (Personal communication, Claus Suverkropp, environmental scientist, Larry Walker Associates, January 12, 2016.)

28. Fourteen water quality coalitions have formed, including rice water quality programs managed through the California Rice Commission. (Personal communication, Lester Messina, consultant, Colusa Glenn Subwatershed Program, June 20, 2016).

29. Personal communication with Larry Domenighini, mayor of Willows, president of Colusa Glenn Subwatershed Program, November 12, 2015.

30. The pilot program was a short-term collaboration created in 2005 to help stakeholders implement the Irrigated Lands Regulatory Program. The program involved the Central Valley Regional Water Quality Control Board, State Water Board, California Department of Pesticide Regulation, and Glenn and Butte County Agriculture Departments. The program provided technical services not yet in place by the coalition or Colusa Glenn Subwatershed Program. For example, the Glenn County Agriculture Department assisted by (a) providing county information and maps, (b) inspecting, assessing, and documenting management practices used in agricultural operations to protect water quality, (c) assisting the Central Valley Control Board in evaluating appropriate sample monitoring sites for agricultural wastewater discharges, (d) helping to coordinate and conduct outreach to farmers on best management practices that protect water quality, and (e) providing overall, technical services to create a process for when exceedances occur.

31. Note that the Agricultural Water Enhancement Program was absorbed into the Regional Conservation Partnerships Program in the 2014 Farm Bill.

32. Personal communication, Kandi Manhart, subwatershed coordinator, Colusa Glenn Subwatershed Program, July 2, 2015.

33. Personal communication, Kandi Manhart, subwatershed coordinator, Colusa Glenn Subwatershed Program, July 2, 2015.

34. Irrigated Lands Regulatory Program, 2014, "Waste Discharge Requirements for Growers within the Sacramento River Watershed That are Members of a Third-Party Group, Order No. R5-2014-0030." Order issued March 14.

35. Personal communication, Shanon Phillips, director of Water Quality Division, Oklahoma Conservation Commission, January 21, 2016.

36. "Climate of Oklahoma," website: http://climate.ok.gov/index.php/site/page/climate_of_oklahoma.

37. A hypereutrophic lake is characterized by excessive nutrient concentrations with algal blooms, periods of oxygen deficiency, and minimum transparency making the water body an undesirable source of drinking water.

38. Personal communication, Joe Schneider, (retired) watershed project coordinator, Oklahoma Conservation Commission, and Jill Ashbrener, WPC, OCC, January 20, 2016.

39. Personal communication, Joe Schneider, (retired) watershed project coordinator, Oklahoma Conservation Commission, and Jill Ashbrener, WPC, OCC, January 20, 2016.

40. Personal communication, Shanon Phillips, director of Water Quality Division, Oklahoma Conservation Commission—multiple conversations, January 21, 2016.

41. Personal communication, Joe Schneider, (retired) watershed project coordinator, Oklahoma Conservation Commission, and Jill Ashbrener, WPC, OCC, January 20, 2016.

42. Jeff Pape, president, Farmer Watershed Council, Presentation, Hewitt Creek Watershed Tour, August 5, 2015.

43. Jeff Pape, president, Farmer Watershed Council, Presentation, Hewitt Creek Watershed Tour, August 5, 2015.

44. Personal communication, Chad Ingels, watershed specialist, Iowa State Extension, January 18, 2016.

45. Note that Iowa's Phosphorus Index is unit-less and 3 represents the threshold level for "high" P levels. The state recommends lowering the high designation below 3 to reduce the risk for P losses to the environment.

46. Watershed Summary for 2013 for individual PSI, SCI, and CSNT results by anonymous field ID numbers: https://hewittcreek.files.wordpress.com/2011/06/2013_cooperator_baseinformation.pdf.

47. "Hewitt Creek Watershed Improvement Project," website: https://hewittcreek.wordpress.com/.

48. Personal communication, Jeff Pape, president, Hewitt Creek Watershed Council, July 30, 2015.

49. Personal Communication, Chad Ingels, watershed specialist, Iowa State Extension, July 15, 2015.

50. A HUC12 watershed averages about 40 square miles in size. HUC stands for Hydrologic Unit Code.

51. Personal Communication, Chad Ingels, watershed specialist, Iowa State Extension, July 6, 2015.

52. Personal Communication, Chad Ingels, Watershed Specialist, Iowa State Extension, July 6, 2015.

53. Personal Communication, Chad Ingels, watershed specialist, Iowa State Extension, July 15, 2015.

54. The LTRM is a USGS program that aims to develop a better understanding of the Upper Mississippi River system and its resource problems. For more information: http://www.umesc.usgs.gov/ltrmp.html.

55. Rick Klann. 2014. “North Fork of the Maquoketa River Watershed Water Quality Monitoring; Summary 2005–2014,” Upper Iowa University, October 17.

56. Jeff Pape, president, Watershed Council, Presentation, Hewitt Creek Watershed Tour, August 5, 2015.

57. Personal communication, Jean Spooner, Water Quality Group leader, North Carolina State University Water Quality Group, March 3, 2016, and Spooner et al,. 2014.

58. Personal Communication, Jeff Pape, president, Watershed Council, July 30, 2015.

59. Though only Pleasant Valley Branch is listed as impaired for sediment, Amrhein and others feel that Kittleson Valley Creek is similarly impaired and should be listed.Personal communication, Jim Amrhein, water quality biologist, Wisconsin Department of Natural Resources, January 12, 2016.

60. Note that only the 2003, 2006, and 2007 projects were sited on the Pleasant Valley Branch stream. All other project years occurred on the Kittleson Valley Creek. The 2011 project was located on Kittleson Valley Creek above the USGS gage station at the mouth of the Pleasant Valley subwatershed. (Data from Amrhein, 2014 and Amrhein interview, January 28, 2016.)

61. Data provided by Jim Amrhein, Wisconsin Department of Natural Resources, January 28, 2016.

62. Note that phosphorus Indices vary by state. Thus, Iowa’s PI differs from Wisconsin’s PI.

63. RUSLE2 stands for Revised Universal Soil Loss Equation version 2.

64. The CRP contracts pay farmers to convert marginally productive fields to grass or to trees.

65. A 95 percent confidence interval gives the probability that the interval produced by the method employed includes the true value of the parameter.

66. NASS Tillage Transect 2014: https://secure.in.gov/isda/files/Cover_Crop_Trends_2011-2014_Statewide.pdf.

67. During the USDA CIG project, stage was recorded every 10 minutes and discharge was measured manually as often as possible. A stage-discharge relationship was established and used to estimate daily discharge at the bottom of the watershed. Instantaneous discharge was also measured in each tile drain when sampling for water chemistry occurred. With these discharge measurements, flux (mass loss per time) of nutrients from the stream and tile drain could be calculated.

68. Personal communication, Jennifer Tank, professor, University of Notre Dame, July 22, 2015.

69. Iowa DNR’s ADBNet-305(b) Water Quality Assessment Database. Hickory Creek. 2004 Water Quality Assessment: Assessment Results from 2000 through 2002. Release Status: Final. https://programs.iowadnr.gov/adbnet/assessment.aspx?aid=5216.

70. “NRCS Watershed and Flood Prevention Operations Program,” NRCS website: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/wfpo/.

71. “NRCS’s Watershed Operations Historical Appropriations, 1947–Present,” NRCS website: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1048252.pdf.

72. “NRCS’s Watershed Projects Authorized by the Watershed Protection and Flood Prevention Act (PL83-566); Helping Communities Solve Natural Resource Issues,” NRCS website: file:///C:/Users/mperez/Documents/Success%20Stories%20Report/PL566%20projects/stelprdb1042258%20Watershed%20Benefits%20March%202008.pdf.

73. “NRCS’s Watershed Operations Historical Appropriations, 1947–Present,” NRCS website: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1048252.pdf.

74. “NRCS’s Watershed Projects Authorized by the Watershed Protection and Flood Prevention Act (PL83-566); Helping Communities Solve Natural Resource Issues,” NRCS website: file:///C:/Users/mperez/Documents/Success%20Stories%20Report/PL566%20projects/stelprdb1042258%20Watershed%20Benefits%20March%202008.pdf.

75. The information in this appendix is adapted from highlights of an NWQI webinar in July 2013 by Tetra Tech, Inc., a water quality consulting firm that is contracted to help EPA implement its Section 319 Nonpoint Source Programs. https://www.epa.gov/sites/production/files/2015-09/documents/nwqi-monitoring-webinar-7-18-2013.pdf. Additional technical notes prepared by Tetra Tech, Inc. for EPA’s Section 319 program can be found at the website maintained by the North Carolina State University Water Quality Group: http://www.bae.ncsu.edu/programs/extension/wqg/§319monitoring/TechNotes/technote2_wq_monitoring.pdf.

76. HUC11 watersheds are Oklahoma-specific and are on average about 26,000 acres or 21 square miles, which is similar to HUC12 watersheds.

77. Personal communication with Karla Stephenson, district conservationist, Oklahoma Natural Resources Conservation Service, January 8, 2016.

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ABOUT THIS REPORT

This report provides in-depth analysis of six case studies that achieved monitored in-stream or tile drain water quality improvements attributable to the adoption of farm conservation practices by farmers and landowners.

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ABOUT AMERICAN FARMLAND TRUST

American Farmland Trust (AFT) is the largest national organization dedicated to protecting farmland, promoting sound farming practices, and keeping farmers on the land.

AFT unites farmers and environmentalists in developing practical solutions that protect farmland and the environment. We work from "kitchen tables to Congress"—tailoring solutions that are effective for farmers and communities and can be magnified to have greater impact. Since our founding, AFT has helped to protect more than five million acres of farmland and led the way for the adoption of conservation practices on millions more.

AFT has a national office in Washington, D.C., and a network of field offices across America where farmland is under threat. For more information, visit us on the web at www.farmland.org.

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World Resources Institute is a global research organization that turns big ideas into action at the nexus of environment, economic opportunity, and human well-being.

Our Challenge
Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

Our Vision
We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our Approach
COUNT IT
We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT
We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT
We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.

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