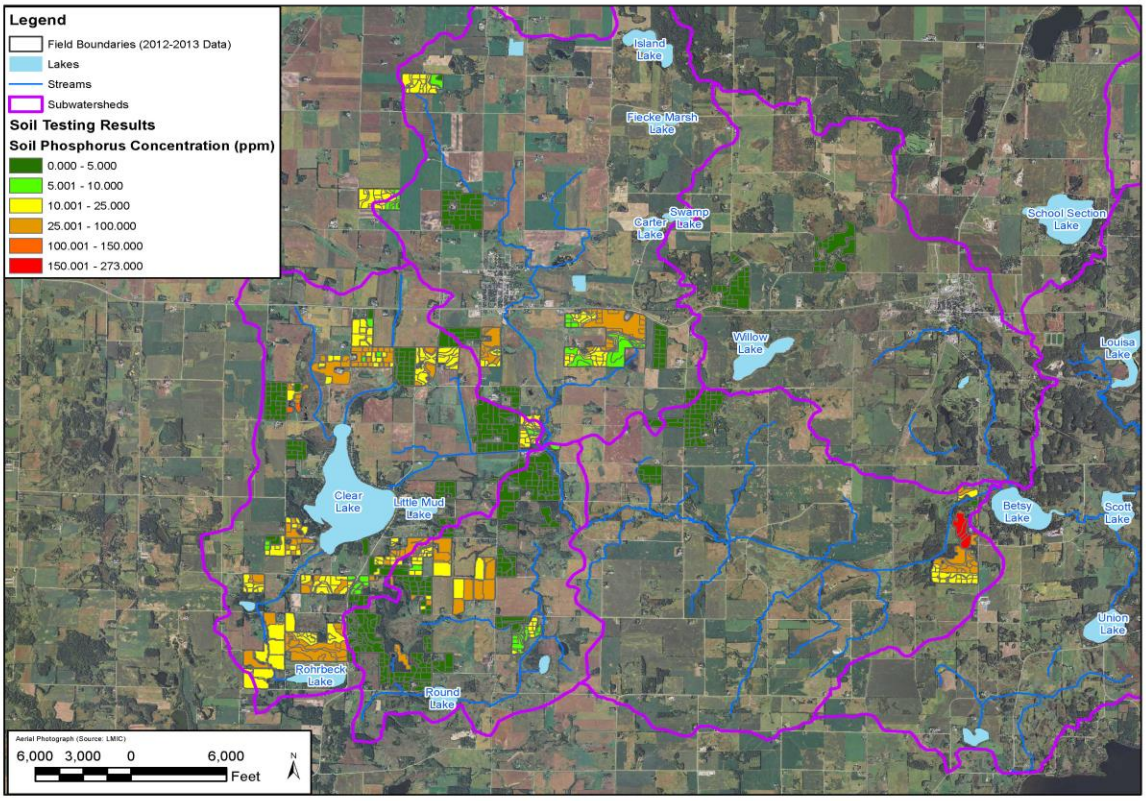
WENCK File #0002-207
September 2016

Targeted Fertilizer Application Reduction Project- Final Report



Prepared for:

Clearwater River Watershed District

75 Elm Street East,
Box 481
Annandale, MN 55302

Clearwater River
WATERSHED DISTRICT

WENCK
ASSOCIATES

Responsive partner.
Exceptional outcomes.

Prepared by:

WENCK Associates, Inc.
7500 Olson Memorial Highway
Suite 300
Golden Valley, MN 55427
Phone: 763-252-6800

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1.0 Executive Summary

This project was developed and implemented by the Clearwater River Watershed District (CRWD) and was made possible through a grant from the Unites States Environmental Protection Agency (EPA), Section 319 Nonpoint Source Management Fund via the Minnesota Pollution Control Agency (MPCA), and matching funds from landowners enrolled in the program and funds from CRWD.

The CRWD began watershed-wide Total Maximum Daily Load (TMDL) studies for all the District's impaired waters in 2003. Studies were completed and approved by the EPA in 2009. The MPCA approved the CRWD's Implementation Plan (Plan) in 2009. In addition, a Watershed Restoration and Protection Strategies (WRAPS) Report was approved for the major watershed in 2015.

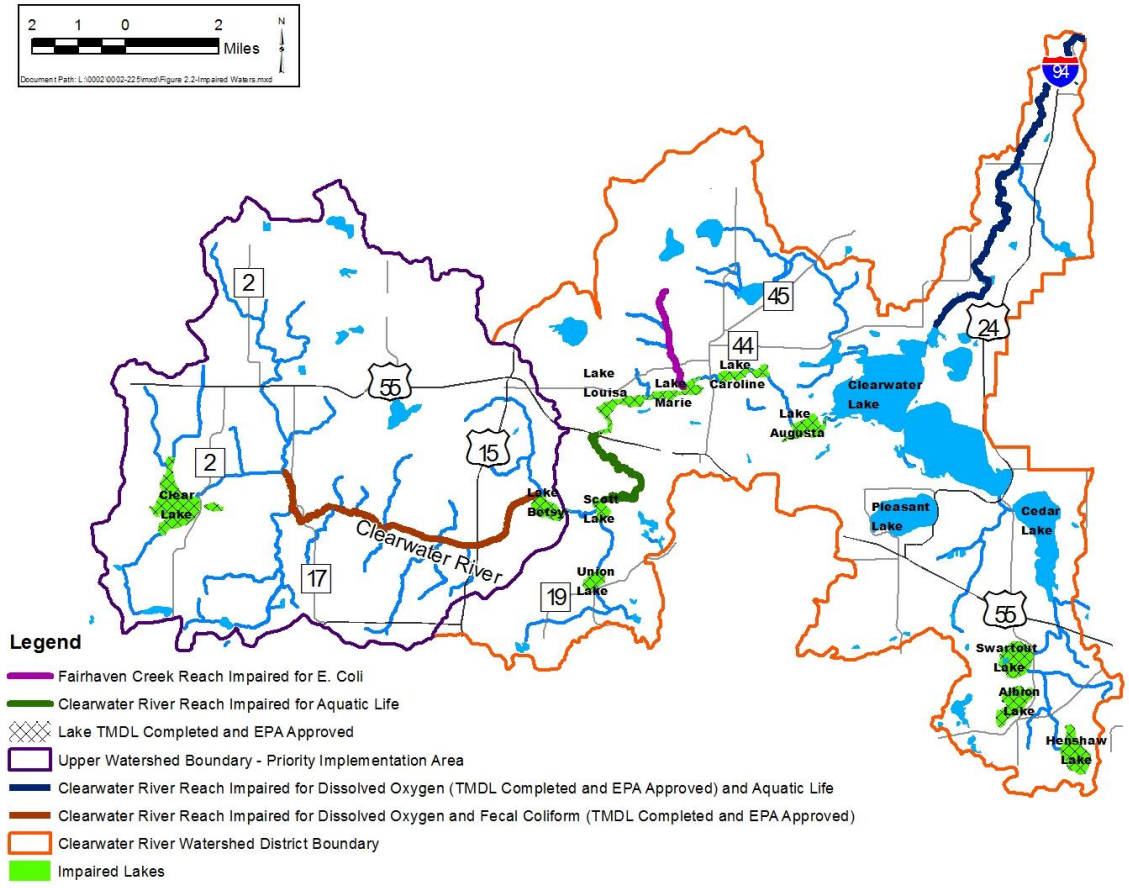
The Targeted Fertilizer Application Reduction Project was a key element of the CRWD's overall plan to protect and improve water quality and natural resources within the District. Other CRWD projects and programs build upon and continue the improvements achieved by this project:

1. **Kingston Wetland Restoration:** The project restored a 500 acre riparian wetland and the adjacent river channel by re-establishing multi-stage meandered baseflow and low flow channels adjacent to the wetland complex. This allows high flows to access the floodplain (wetland) while maintaining higher re-aeration rates and dissolved oxygen in the impaired channel. The restoration reduced the main channel low flow exposure to sediment oxygen demand, reduced soluble phosphorus export to downstream lakes, and maintained the wetland's assimilative capacity of particulate phosphorus in higher flows. The design also resulted in conditions that are closer to a pre-agrarian hydrology and riverine habitat to support a broader range of species. *Complete.*
2. **Alternative Tile Intake Program:** provide match cost and design services to establish alternative tile intakes that reduce downstream nutrient and sediment transport, demonstrate their effectiveness, educate area tilers, and establish these water quality- friendly intakes as general practices in the watershed. *Ongoing.*
3. **Clear Lake South**. A notch weir and iron sand filter was installed on the south side of Clear Lakes to remove soluble P entering Clear Lake. *Complete.*
4. **City of Kimball Stormwater Retrofit project (Phase I & II)**. One of the urban areas within the priority subwatershed had little or no stormwater management. The District partnered with the City of Kimball and won two grants from the Minnesota Board of Water and Soil Resources (BSWR) to retrofit the city with stormwater management to protect a trout stream and improve water quality in downstream lakes. *Complete.*
5. **Clearwater River Bank Stabilization Projects:** The District used rapid assessment and design to identify areas along the Clearwater River upstream of the Kingston Wetland which were in need of stabilization. The District partnered with Minnesota Conservation Crews to stabilize bank and toe and manage riparian vegetation. Several areas of the bank were eroded due to overgrown trees which shaded out stabilizing understory. *Ongoing.*

6. **<u>Buffer / Field Conservation Programs:</u>** The District has partnered with farmers and local Soil and Water Conservation Districts to provide matching costs to implement buffers and other water quality projects. *Ongoing.*
7. **<u>Internal Loading Reduction Plans</u>**: Develop, assess, fund, and implement techniques and technologies to address internal loading in several CRWD lakes in order to meet water quality goals. *Ongoing.*
8. **<u>City of Watkins Area Stormwater Retrofit Project</u>**: Construct a stormwater treatment system to treat runoff from a 6,500 acre urban and agricultural drainage area that drains into the Clearwater River above the Kingston Wetland. *In Progress.*
9. **<u>TSS and Bacteria Study</u>**: Conduct map and field assessments to identify potential project areas in the upper watershed to reduce sediment and bacteria loads to the Clearwater River. Design and install best management practices. *Ongoing.*

The target implementation area for this program was the upper, western portion of the watershed (outlined in purple in Figure 1-1). The CRWD focused implementation efforts in this portion of the watershed for two reasons: the upper watershed exported most of the pollutant loads to downstream waters, and water quality standards in downstream waters could not be met without first achieving water quality goals in the upper watershed.

Figure 1-1: Clearwater River Watershed, Impaired Waters & Upper Watershed



1.1 PROBLEM STATEMENT

Nutrient TMDLs completed for 11 impaired lakes in the CRWD identified the need to reduce phosphorus load from agricultural sources by 80% to meet state water quality standards. The EPA-approved TMDL Implementation Plan identified that aggressive agricultural BMPs are necessary to achieve in-lake water quality standards, and will require widespread farmer participation.

The Clearwater River Watershed is comprised of a chain of lakes on the Clearwater River. The flow-through nature of this system means that load reductions in the upper watershed have positive impact downstream. That is to say, water quality in the lakes upstream is the greatest predictor of water quality in downstream lakes. The watershed-wide approved Plan focuses early efforts on the upper watershed, the headwaters of the CRWD. This project focuses on the two headwater lakes of the Clearwater River (Clear Lake [47-0095] and Lake Betsy [47-0042]), the upper Clearwater River [07010203-549] and their tributary watersheds. Clear Lake and Lake Betsy were added to Minnesota's 303(d) list of impaired waters for aquatic recreation impairment due to nutrients in 2008. The upper Clearwater River was added to the 303(d) list for aquatic life and aquatic recreation impairment due to dissolved oxygen and fecal coliform in 1996.

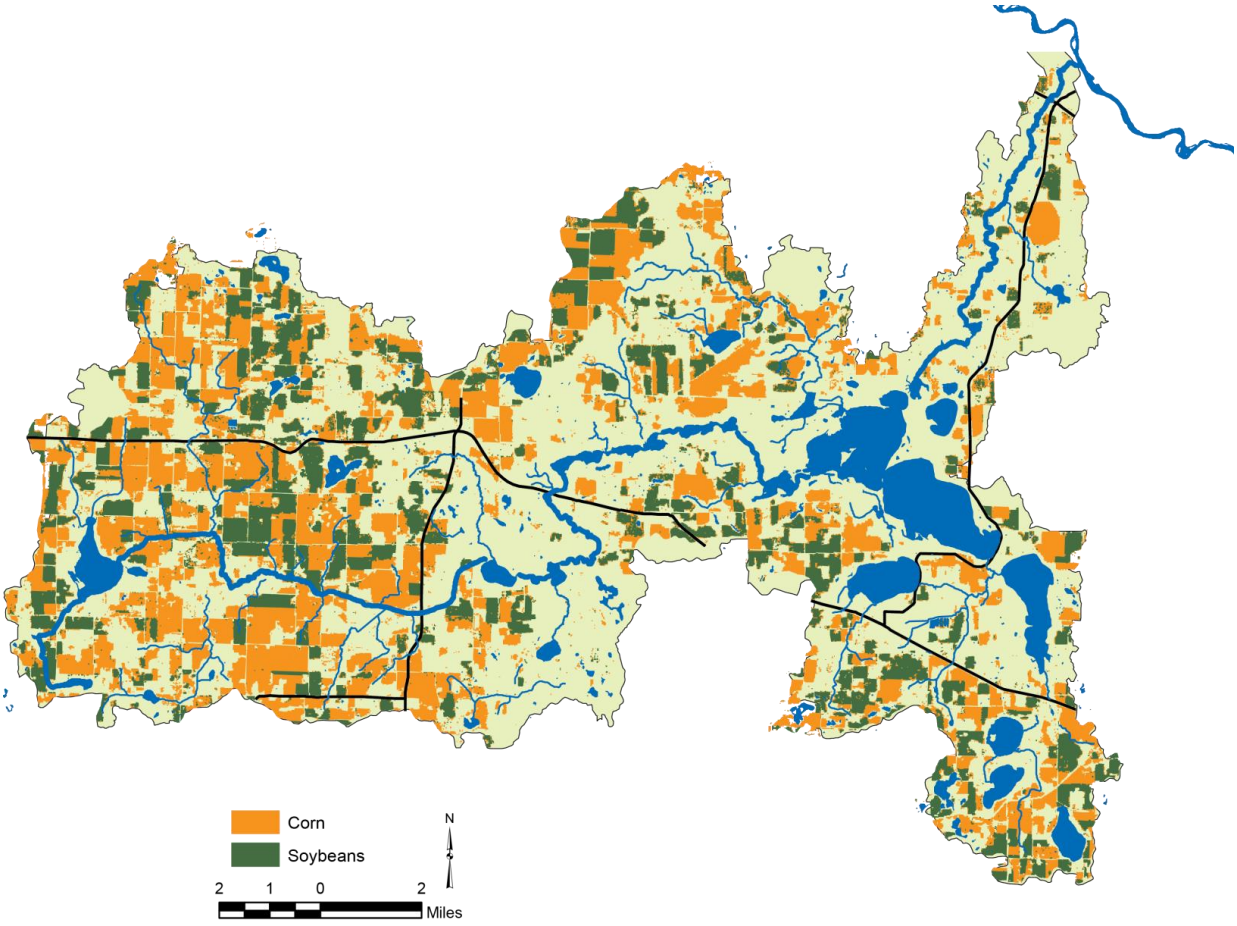
Soil fertilizers are used on corn and soy fields throughout the watershed (Figure 1-2). Standard practice in this watershed has been to apply fertilizer to fields at a uniform rate, even though soil nutrient levels, soil type, and pH may vary significantly across the field. This project entailed systematic gridded soil phosphorus testing to assess fertilizer needs and variable rate GPS-aided application to reduce application rates of di-ammonium phosphate (DAP) fertilizer.

The project goal was to use variable rate fertilizer application to limit organic soil phosphorus concentrations closer to the ideal range, which reduces the excess soluble phosphorus available for runoff. It does not however have an effect on soil bound phosphorus that is mobilized downstream due to soil loss and erosion. From a water quality perspective, managing nutrient inputs is part of a field-by-field load reduction strategy; preventing soil loss is also a key element.

Priority cropland includes fields located in the upper watershed that drain to Clear Lake and Lake Betsy that can export significant phosphorus load based on proximity to water bodies, slope, erodibility and soil type. These criteria are specifically in line with the CRWDs approved TMDL Implementation Plan.

The CRWD implemented a pilot program in 2009 to evaluate the impact of gridded soil phosphorus testing in the watershed on fertilizer application rates prior to receiving the federal grant. Results of the pilot program helped to set target implementation goals for the grant. This project targeted a sustained 10% annual reduction in fertilizer application rates from 16,000 acres of priority (upper watershed) crop land (a 3,200 lb/ annual phosphorus load reduction). The goal was to achieve 13% of the non-point source load reduction required for nutrient-impaired Lake Betsy as identified in the TMDL and approved Plan, as well as provide additional nutrient load reduction in eight (8) other nutrient impaired downstream lakes and the Clearwater River, which is impaired for low dissolved oxygen and bacteria.

Figure 1-2: Corn and Soy Crops in the watershed.



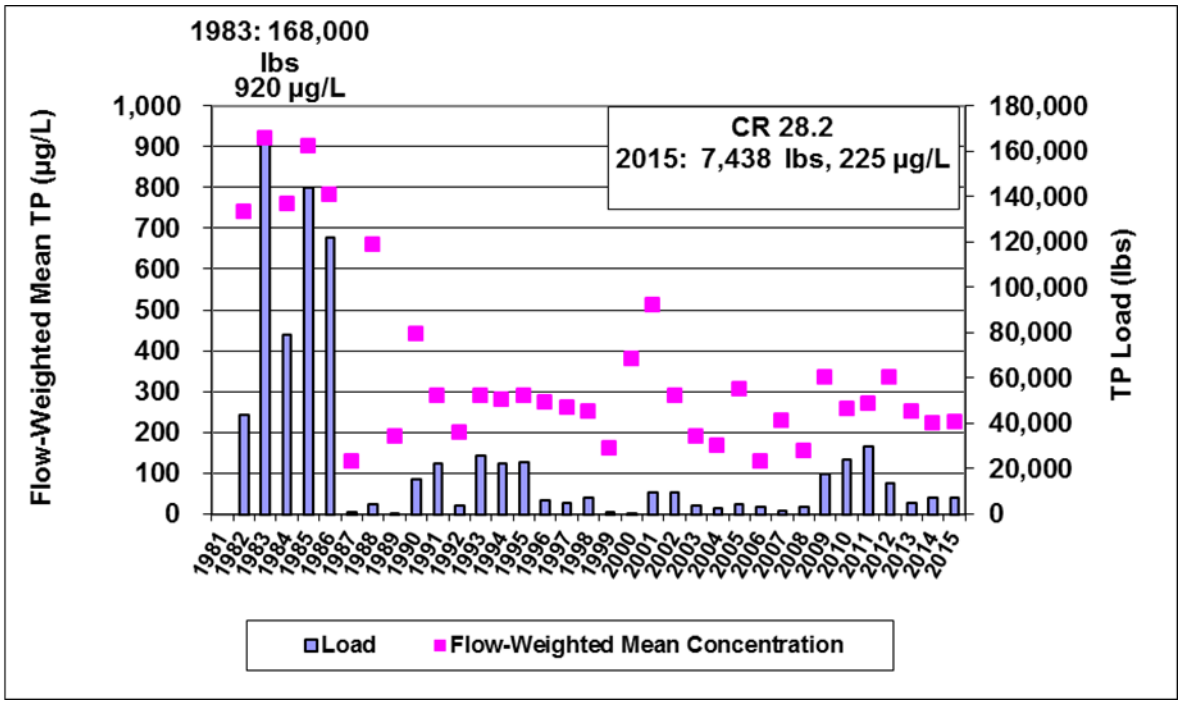
1.2 WATER BODIES IMPROVED

The Latitude/Longitude for Center of Project Area: 45º 15' 48.30"/94º19' 21.53".

The water bodies improved are located in Meeker County Minnesota in the CRWD, within the Upper Mississippi St. Cloud (HUC: 07010203).

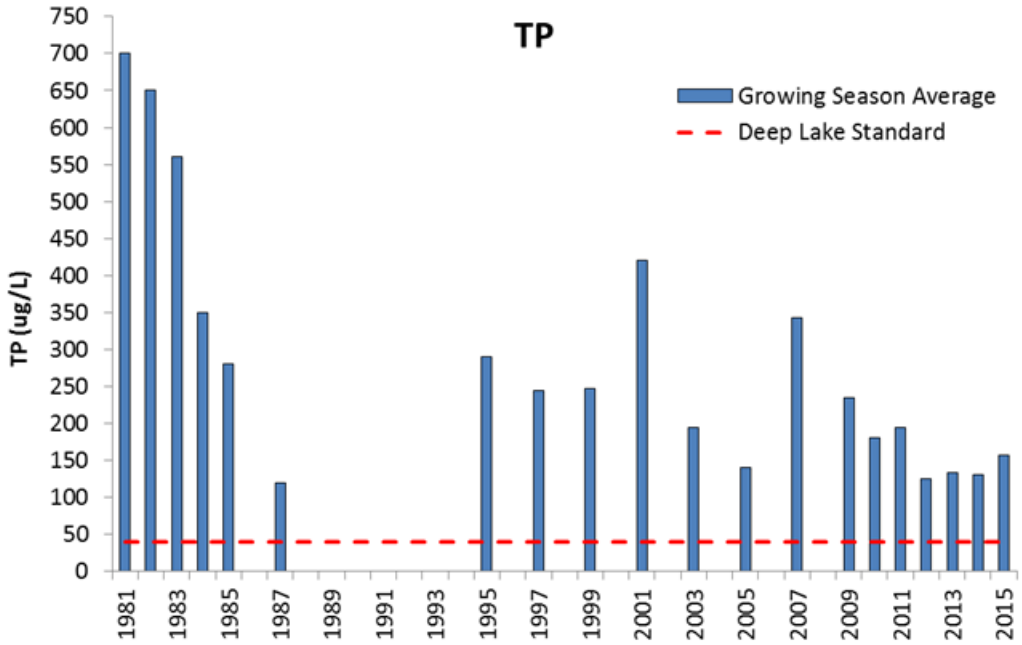
Clearwater River (ID #07010203-549): The monitoring station on the Clearwater River directly downstream of the implementation area is also a long-term monitoring station (CR 28.2). Phosphorus loads in the river and flow weighted mean concentrations are measured and reported annually. Figure 1-3 shows water quality monitoring results.

Figure 1-3: Water Quality Trends Downstream of Implementation Area (CR 28.2).



Lake Betsy (ID #47-0042): This lake is located directly downstream of the project. Average summer surface TP concentrations in the lake have improved dramatically since project implementation (Figure 1-4). This is due in part to this project as well as a reduction in the soluble phosphorus export from Kingston Wetland due to the restoration, and other projects and programs in the upper watershed.

Figure 1-4: Water Quality Improvements in Lake Betsy Downstream of the Project.



Average Summer Surface TP in Lake Betsy:

TMDL 1998-2007:	269 ug/L TP
Recent 10 year, 2005-2014:	184 ug/L TP
Recent 5 year, 2010-2014:	151 ug/L TP ← Program began in 2009 with a pilot study
Recent 4 year, 2012-2015:	137 ug/L TP

**Dramatic reductions in lake phosphorus were achieved between 1981 and 1985 due to other restoration efforts in the same watershed.*

Other Waters: Because of the riverine nature of the watershed, continued improvements of water bodies downstream are also expected in impaired lakes: Scott Lake ID#86-0297, Lake Louisa ID#86-0282 and Lake Marie ID#73-0014. Lake Caroline ID#86-0281, Lake Augusta ID#86-0284 Clearwater Lake (East and West) ID#86-0252 and Grass Lake ID#86-0243 are also downstream and will likely benefit from the project in the coming years.

The CRWD's 2013, 2014 and 2015 water quality monitoring reports contains data on the other downstream lakes in the chain. It is likely that response in these downstream lakes to this project will express more slowly than in upstream lakes.

1.3 RESULTS & PROJECT HIGHLIGHTS

The project began in 2011 with the CRWD meeting with the three local farmer cooperatives to review the project and discuss administrative items to ensure optimal project operations. These cooperatives were key partners in instituting the project:

- Centra Sota Cooperative- Watkins, MN
- Cold Spring Cooperative- Cold Spring, MN
- Consumers Cooperative Association- Litchfield, MN

Field enrollment in the project opened spring 2012 and concluded spring 2016. Gridded soil tests were taken on a 2.2 acre grid across 16,000 acres of cropland in the target watershed to determine crop nutrient requirements. The fertilizer applicator then used the soil test results and GPS technology to apply the precise amount of fertilizer in each grid of the field as opposed to traditional uniform rates commonly used in the area.

This project accomplished the following:

- Assisted in developing a market for the practice for local cooperatives: Both soil testing and GPS-aided variable rate fertilizer application are proven technologies. However, before the CRWD's pilot study and this project, the use of this management practice was limited in the target watershed due to a lack of proven market for the service. The project provided local farmer cooperatives with a stable market base to invest in and ramp-up efforts to offer this service/ practice.
- Demonstrated value of practice to farmers' operations: The project provided a fiscal incentive to local farmers to investigate whether the practice would provide added value to their overall operations by assisting with optimization of fertilizer application. Surveys taken of enrolled farmers at project end indicated that producers realized the expected value of the practice and plan to continue its use as part of their operations.
- Higher than typical uptake of incentivized agricultural BMP at low administrative cost: Many agencies offer best management practices geared towards improving water quality or making farming practices more efficient. Not all programs are fully utilized, and many programs require intensive recruiting which means a high demand on agency staff time. Further, not all programs can be limited to the areas where they will have the most impact to downstream waters- many are first come/ first served. This program was unique in that it leveraged existing relationships between the local farmer cooperatives and farmers to promote the project, which reduced administrative burden on the Watershed District. The result was 61% uptake of the practice in the area (17,728 unique acres and 23,310 total acres of corn and soy rotation in the target areas).
- Impacts beyond the service area: One of the project goals was to serve as a demonstration project to promote uptake of the practice beyond the target area. Funding provided for this grant allowed local farmer cooperatives to invest in the technology and equipment needed for implementation. As a result of this program, local cooperatives were able to promote the practice beyond the boundaries of the watershed. Anecdotally, the availability of the practice has spread throughout the service areas of the three cooperatives involved. Practice use data outside of project area was not available. Further, some farmers in the service area elected to enroll in the practice without officially participating in grant funding- these growers did not receive grant funding and their results are not included here. Finally, the CRWD has already shared the preliminary results of the project at several events throughout

the region in order to promote the practice as a water quality improvement method that meshes well with modern agriculture, and plans to continue this promotion.

- Contributes to Phosphorus Reduction Goals Downstream: Reducing the amount of phosphorus available for runoff should result in a reduction in load to downstream waters. The target implementation area is directly tributary to Lake Betsy, Clear Lake and the Clearwater River. The system's riverine nature means meeting water quality goals in Lake Betsy is critical to meeting goals in five other downstream lakes.

Overall reductions relative to standard DAP application rates were not significant; some areas showed a need for higher application rates, and some lower. The overall result was the optimization of phosphorus application for fields in the program.

Sensitive areas (areas adjacent to water bodies) with high soil P saw major reductions in recommended fertilizer application relative to typical recommended application rates. Comparing the standard application rates in sensitive areas to the application rates based on gridded soil testing- there was a reduction in P application (not DAP, but phosphorus) annually of between 900 and 7,600 lbs.

Direct reductions cannot be measured, but downstream water quality showed an improvement over the project lifecycle. This wasn't the only program/ project at the time and so 100% of the improvements cannot be attributed to this program. CRWD continues to track water quality annually as part of its robust water quality monitoring program.

In terms of the target load reductions in this watershed, Lake Betsy requires a 4,100 lb reduction from the upstream watershed to meet state water quality goals. This program may provide 10-30% of that load reduction assuming only a small percentage of the not-applied phosphorus would have migrated downstream.

1.4 GRANT PROJECT SUMMARY

Project title: Targeted Fertilizer Application Reduction Project

Organization (Grantee): Clearwater River Watershed District

Project start date: 10/1/2012 Project end date: 9/30/2016 Report submittal date:

Grantee contact name: Cole Loewen Title: Administrator

Address: 75 Elm Street East | PO BOX 481

City: Annandale State: MN Zip: 55302

Phone number: 320.274.3935 Fax: 320.274.3975 E-mail: cole.loewen@crwd.org

Basin (Red, Minnesota, St. Croix, etc.): Upper Mississippi River County: Meeker

Project type (check one):

- ☐ Clean Water Partnership (CWP) Diagnostic
- ☐ CWP Implementation
- ☐ Total Maximum Daily Load (TMDL) Development
- ☒ 319 Implementation
- ☐ 319 Demonstration, Education, Research
- ☐ TMDL Implementation

Grant Funding

Final grant amount: $227,607.36
Final total project costs: $413,820.09

Matching funds: Final cash: $148,062.02
Final in-kind: $38,150.71
Final Loan: $0.00

Contract number: SWIFT #54720, PRJ #07899
MPCA project manager: Phil Votruba

For TMDL Development or TMDL Implementation Projects only

Impaired reach name(s): Lake Betsy, Clear Lake, Clearwater River

AUID or DNR Lake ID(s): 47-0042, 47-0095, 07010203-549

Listed pollutant(s): Nutrients; Dissolved Oxygen, , Fecal Coliform

303(d) List scheduled start date: N/A
Scheduled completion date: N/A

AUID = Assessment Unit ID
DNR = Minnesota Department of Natural Resources

Executive Summary of Project (300 words or less)

Problem: Several water bodies within the Clearwater River Watershed District are impaired for excess nutrients. The dominant land use in the area is row crops (corn and soy beans). Limiting nutrient application, especially in sensitive areas adjacent to water bodies, is one way to reduce downstream loads. Many farmers in the area were using uniform application rates for fertilizer. Using gridded soil testing and variable rate fertilizer application in order to identify and apply the exact field needs can optimize nutrient use and minimize export.
Water Bodies Improved: The Clearwater River between Clear Lake and Lake Betsy as well as Lake Betsy and Clear Lake are the direct receiving water bodies within the target program area. However, given the riverine nature of the system, downstream waters also benefit from load reductions in upstream waters.
Project Highlights: This grant project established a best management practice known to optimize nutrient inputs to farms in an area where the practice had not been widely adopted. Implementation of this practice assists in reducing nutrient loads downstream while helping to optimize yields. Further, the program used a novel delivery approach in that instead of having government staff registering program participants, it relied on the local cooperatives and their existing relationships with farmers.
Results: This project resulted in the enrollment of 17,728 unique acres of corn and soy beans in the target area (61% uptake of the practice), as well as additional uptake outside

the practice area driven by the success of the practice in the target area. 23,310 total acres throughout the study were included in the gridded soil testing and variable rate application (some of the fields that enrolled early participated twice over the entire period of the study).

Partnerships (Name all partners and indicate relationship to project)

Farmers in priority areas- enrolled in the program and reported results.

Local farmer cooperatives supported project implementation by promoting program. These cooperatives conducted soil testing, variable rate application and reported results.

- Centra Sota Cooperative, Watkins, MN
- Cold Spring Cooperative, Cold Spring, MN
- Consumers Cooperative Association, Litchfield, MN

Clearwater River Watershed District & District Engineer Wenck – Project Owner and Project Engineer

Pictures

Pictures of the water resources are included in submitted documents to MPCA.

2.0 Work Plan Review

The project work plan is included as Appendix A. This section lists each of the goals identified in the work plan and describes the outcomes.

GOAL: Reduce nutrient loads to CRWD water resources from agricultural lands by reducing fertilizer application through outreach, education, and recruitment of farmers into a program to perform gridded soil tests and GPS-aided fertilizer application of fertilizers. Achieving this goal will provide measurable progress towards water quality goals for several of the Districts impaired waters.

OBJECTIVE 1: Project Coordination

Task 1.1 Recruit Participants

Identify and recruit program participants through county parcel and land use data and customer information provided by the cooperatives. Applicants to the program will be prioritized based on their location within the watershed and proximity to receiving waters.

Task 1.2 Coordinate with Partners

This task entails coordination with the project partners which include area farmers, cooperatives and counties to communicate project goals and objectives, get buy in, and facilitate implementation of the project in the target areas.

Task 1.3 Education and Outreach

This task entails preparation, distribution and presentation of materials for education and outreach to facilitate recruitment of program participants and provide the education about the project goal.

OBJECTIVE 1 Timeline: (2012) August-October, (2013-2015) April-September, (2016) April-September

Responsible Parties: CRWD Board of Managers, CRWD Staff, CRWD Farmers

OUTCOME:
Each task of Objective 1 was completed; the program through identification of priority areas, coordination with partners, and education and outreach enrolled 444 participants covering 23,310 acres of land (17,728 unique acres).

OBJECTIVE 2: Project Implementation

Task 2.1 Gridded Soil Testing

Collect soil samples from participant's fields on a 2.2 acre grid across up to 16,000 acres of critical crop land to determine the fertilizer needs for each field.

Task 2.1 Timeline: (2012) October-November, (2013-2015) September- November, (2016) March-June

Task 2.2 GPS- Aided Fertilizer Application

Use GPS-aided fertilizer application technology to apply fertilizer at variable rates consistent with needs identified in Task 2.1 (gridded soil

testing). Fertilizer application will avoid tile intakes, providing a 50 lineal foot buffer where no fertilizer is applied.
Task 2.2 Timeline: (2013-2016) March-June
Responsible Parties: CRWD Staff, cooperatives, CRWD Farmers

OUTCOME:
Each task of Objective 2 was completed -- 8238 soil samples were analyzed to determine phosphorus needs, and fertilizer was applied with variable rate applicators to 23,310 acres of land (17,728 unique acres).

OBJECTIVE 3: Demonstrate Results

Task 3.1 Water Quality Monitoring

Water quality monitoring will be conducted at drain tile outlets from selected fields including both farms that are and are not participating in the program. Flow will be monitored as well as total and soluble phosphorus, nitrogen series, total suspended solids and field parameters. In addition to testing loads from individual fields, receiving water quality will also be tracked. Stream flow and water quality will be measured at 3 to 5 locations in the upper watershed to track changes in nutrient loads and concentrations resulting from implementation of the program. Flow, total phosphorus, soluble phosphorus, total suspended solids, nitrogen series and field parameters will be measured. Annual average lake water quality will also be tracked by measuring total phosphorus, chlorophyll-*a*, Secchi depth and field parameters. The lab used for follow-up monitoring will be Water Laboratories Inc. in Elk River, and/ or MVTL for any work that cannot be done by Water Laboratories Inc.

Task 3.2 Report Results

Results will be reported annually for each year of the program in the CRWD's Annual Monitoring Report, and in an annual update brochure. The report will detail not only the extent of program application and reductions in fertilizer application over standard practice, but also corresponding water quality results. The evaluation and reporting will also entail recommendations as to any course corrections needed to optimize the program implementation and achieve the maximum load reduction possible. A major element of reporting the results will be to include a section on cost savings for farmers in terms of using this method of fertilizer application versus the standard. The goal of reporting and widely distributing these data is to make this type of nutrient management the normative behavior among agricultural producers in the area without supplying additional funding. Simply put, the goal of the project is to demonstrate the benefits so that that this practice is self-sustaining.

Objective 3 Timeline: (2013-2016) March-September

Responsible Parties: CRWD Staff, CRWD Farmers, CRWD Engineer, CRWD Lab

OUTCOME:
Each task of Objective 3 was completed. CRWD collected water quality samples at drain tile outlets annually. They also monitored downstream water quality in the Clearwater River at CR 28.2- the downstream end of the target area for the program. Water quality in Lake Betsy, downstream of CR 28.2 was also tracked throughout the program. Water quality in several other streams, including County Ditch 20 in the program target area was also monitored.

CRWD published results annually within their water quality monitoring reports published 2013, 2014 and 2015- they reported on acres enrolled as well as water quality monitoring results.

OBJECTIVE 4: Fiscal Management and Administration

Task 4.1 Fiscal Management
Track, manage, and report on project finances as necessary and required.
Task 4.1 Timeline: (2012) November-December, (2013-2015) January-February & November-December., (2016) January- September

Task 4.2 Administration
Track, manage, and report on administrative project elements as necessary and required.
Task 4.2 Timeline: August 2012 – September 2016

Responsible Parties: CRWD Board of Managers, CRWD Staff

OUTCOME:
Each task of Objective 4 was completed, CRWD staff tracked, managed and reported on finances and administrative elements.

3.0 Grant Results

This project is an integral element of CRWD's strategy to reduce nutrient loads to impaired lakes and to restore the Clearwater River. The CRWD considers the project a success because of the high uptake and enrollment in the program and the cooperatives / farmers reported intent to continue this practice that leads to reduced fertilizer application in sensitive areas. The sections below describe the implementation area soil characteristics, program enrollment, soil testing, fertilizer application results, field level sampling results and changes in soil phosphorus over time for enrolled fields. Education and outreach results including a summary of a survey conducted are summarized in Section 4.

3.1 PROJECT ENROLLMENT

Once grant agreements were signed, the CRWD staff identified the local farmer cooperatives providing service in the target implementation area and contacted them to discuss the program. The cooperatives agreed to promote the program, implement the soil testing and conduct the variable rate fertilizer applications. The cooperatives and the farmers were required to sign agreements with the watershed district to provide GIS data of gridded soil testing results as well as recommended application rates. CRWD and co-op staff coordinated on acquiring permissions for the field level water quality testing as well.

The program targeted enrollment of 16,000 acres was achieved. Enrollment is summarized in Table 3-1 and Figure 3-1 below.

From 2012 through the spring of 2016, 17,728 unique acres were enrolled in the program, representing approximately 61% of cropland in corn and soybean rotation in the watershed tributary to Lake Betsy.

Table 3-1: Enrollment Summary

Year	Annual Enrollment (acres)	Total New Enrollment (acres)
2012	7,279	7,279
2013	1,713	1,713
2014	8,252	5,966
2015	1,693	1,218
2016	4,373	1,552
Totals	23,310	**17,728**

Figure 3-1: Enrollment Summary

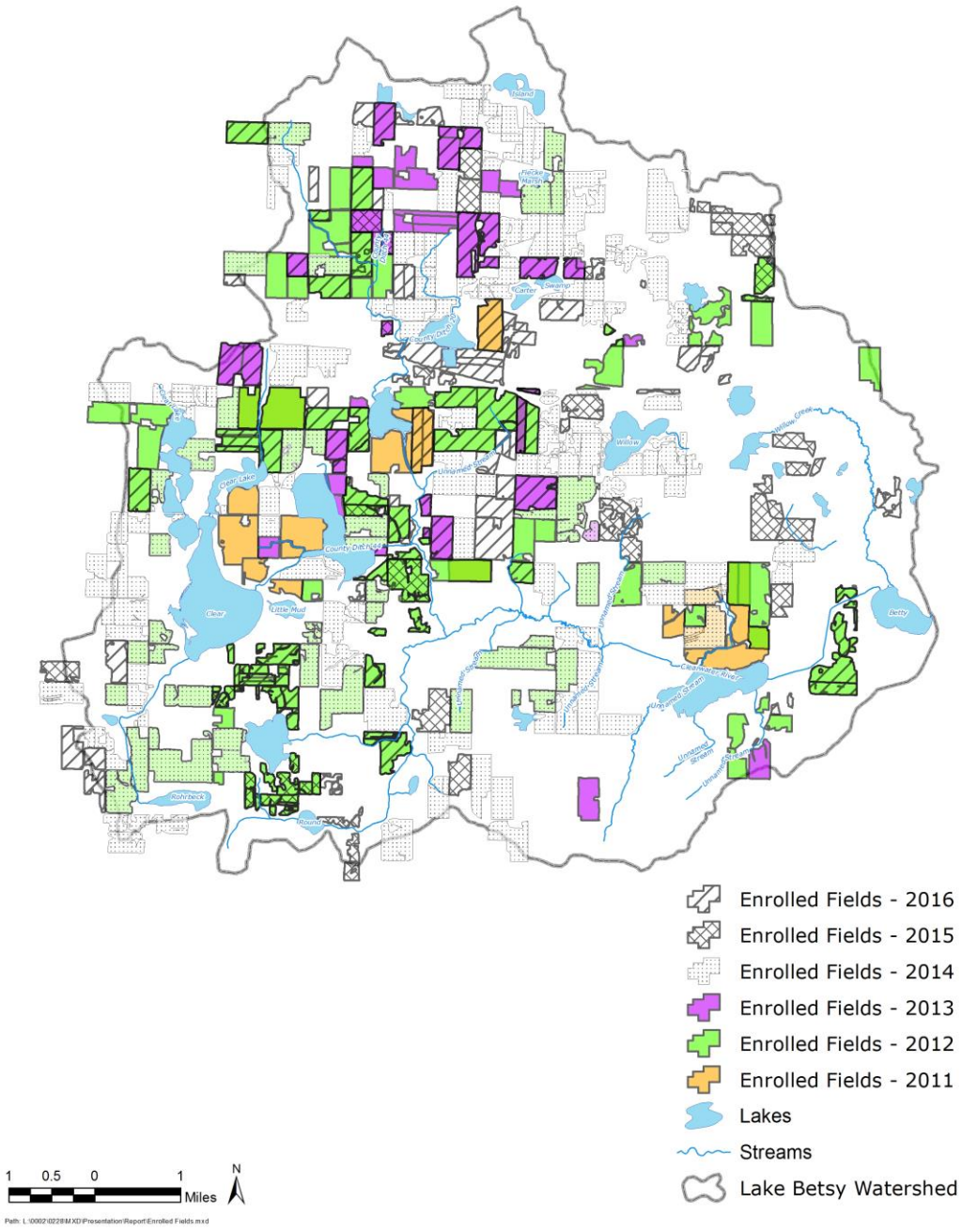
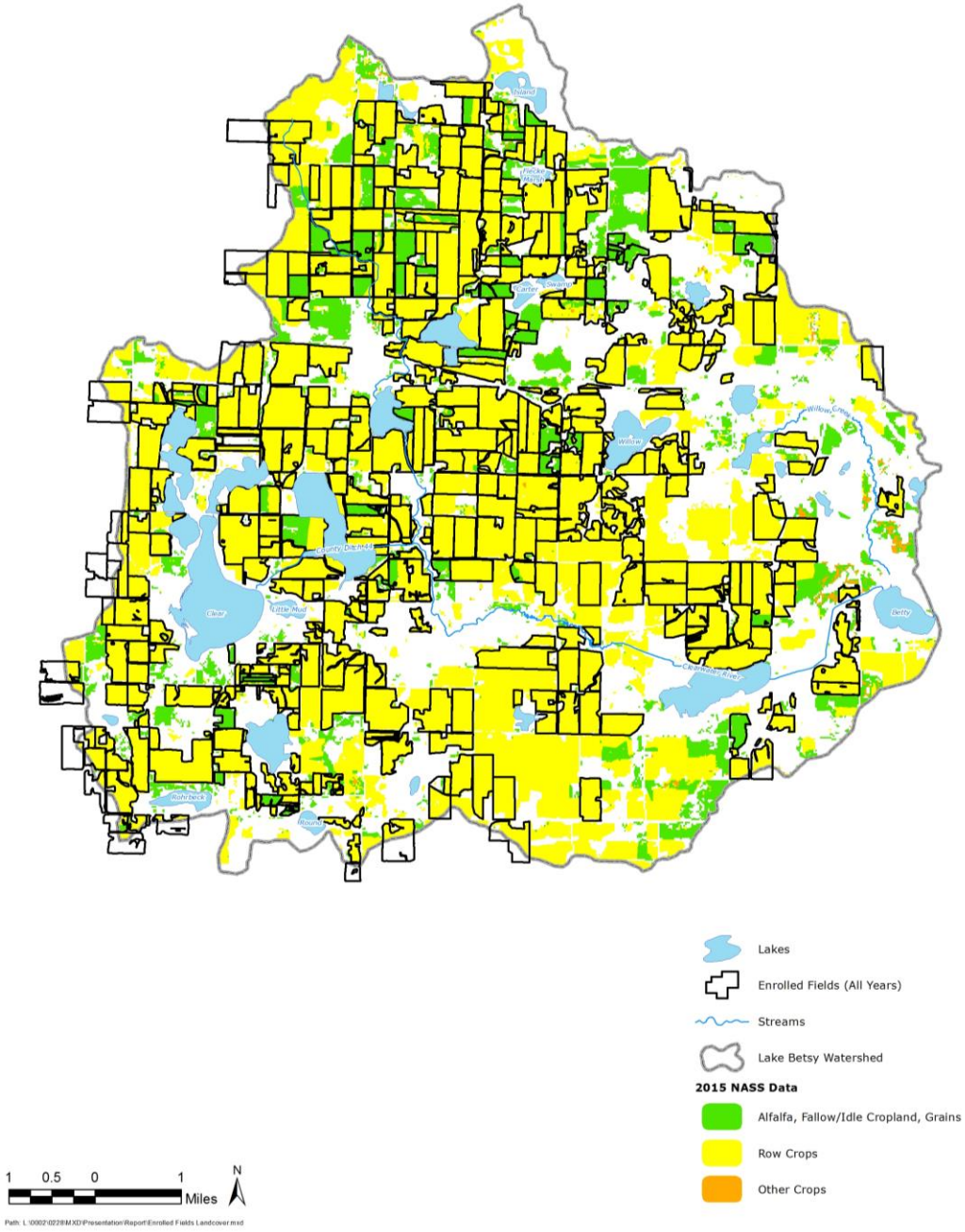


Figure 3-2: Enrollment and Land Cover



3.2 PROJECT AREA SOILS

The study area covered sections of Stearns County and Meeker County in Central Minnesota. Soil Survey Geographic Database (SSURGO) was used to obtain soil series/soil type and hydrologic soil group information for the farm fields. SSURGO data was available in vector format for ArcGIS uses. The soil type on enrolled farms is mostly loam and

dominated by A and B/D hydrologic groups. Soils in hydrologic group A have low runoff potential when saturated. Soils in the dual group B/D have moderately low runoff potential but are less than 2 feet from the water table. Table 3-2 shows the hydrologic soil group and Table 3-3 shows the top five dominant soil series.

Table 3-2: Hydrologic Soil Group in Project Area

HydrolGrp	Percent
A	48.73%
B/D	32.16%
A/D	9.57%
B	7.21%
C/D	1.26%
C	0.88%
Water	0.19%

Table 3-3: Top 5 Dominant Soil Series in Project Area

Soil Series	Percent
Koronis loam, 2 to 6 percent slopes	23.54%
Koronis loam, 6 to 12 percent slopes, moderately eroded	13.57%
Marcellon loam, 0 to 3 percent slopes	9.53%
Barry loam, 0 to 2 percent slopes	7.64%
Forestcity, overwash-Forestcity complex, 1 to 4 percent slopes	7.57%

The soil runoff potential indicates that there will not be significant amount of particulate phosphorus loss due to runoff which is consistent with overall low TSS concentrations in the Clearwater River.

Other soil properties affect soil phosphorus concentration as well. Web Soil Survey was also used to obtain additional information on soil properties. Soils in the project target area have a moderate erodibility factor (K factor) on average (around 0.24), indicating moderately susceptible to detachment and produce moderate runoff, which agrees with the conclusion made from hydrologic soil groups. The project area has moderate erodibility.

3.3 GIS DATA MANAGEMENT & ANALYSIS

The GIS database was used to quantify the benefits of application rates based on soil testing. The methods are described here.

3.3.1 Database Administration

Cooperatives within the Lake Betsy subwatershed created tabular and spatial datasets for farmers enrolled in the Target Fertilizer Application Study. Cooperatives provided field boundaries, recommended application rates of DAP (di-ammonium phosphate), and soil phosphorus testing results. Other datasets included potash application and secondary soil test results for potassium, organic matter and pH. GIS analyses utilized the DAP application rates and soil phosphorus for participants in the study area.

Field boundaries were provided by the cooperatives for the DAP application and soil phosphorus testing. In some instances, field boundaries were delineated from the DAP file or the outer limits of the soil phosphorus testing. The attribute information for each

boundary included the field identification. The data was organized into a file geodatabase where non-contiguous field ownership was reflected, along with an area calculation. DAP data was provided with most field boundaries and was originally in a polygon vector format. The original dataset was laid out as a gridded area with an application rate and area for each cell. Most of field boundaries contained dozens of cells, and smaller fields may only have one application rate. The DAP data was related back to field boundaries using a one-to-one spatial relationship method. Following the join, all of the data was merged into a single file with the DAP application rate, ownership, and field identification by year of participation.

Soil phosphorus testing results were available for most field boundaries as a vector point format. Similar procedures were used to join the attribute information from the field boundaries with the soil phosphorus concentrations. Some of the soil testing points contained additional attribute information including potassium, pH, organic matter, and potash. All of the datasets were organized in a geodatabase by year and can be related back to one another.

3.3.2 Data Analysis

Following organizing and compiling the original datasets, the data was converted to a raster format. The original DAP dataset provided by the cooperatives was in vector polygon. In order to perform analysis, the polygons were converted to points from the centroid of each cell. A raster interpolation method was used to aggregate the DAP application rate over the whole field. Barriers were created to end the interpolation based on the field boundary and prevent adjacent fields influence on DAP application rates. The raster created a continuous application surface that varied based on the application rate by point. Similar methods were used for soil phosphorus to create a surface of concentrations over the field.

Following the conversion of vector data to raster data, summary statistics were created for each field. ArcGIS Spatial Analyst was used to determine the mean soil phosphorus concentration and DAP application rate based on the field boundaries.

Analysis was continued to determine DAP rates in sensitive areas. Sensitive areas were defined as 300 feet from perennial and intermittent stream, 1000 feet from open water bodies. Areas with high potential for soil erosion were not considered sensitive for this application as these areas are typically upland with depleted soil P and the primary transport here is erosion, not soluble P migration. However, areas of high potential for soil erosion were identified using the revised universal soil loss equation (RUSLE). Sensitive soil areas were buffered 20 feet to create a generalized area. The data was reclassified into percentiles. Buffers for streams and lakes were combined with the sensitive soil areas and intersected with field boundaries in the study area. DAP application rates were summarized for sensitive areas within the fields participating in the study.

3.4 SOIL TESTING

Soil phosphorus was sampled in enrolled fields on a 2.2 acre grid to assess soil phosphorus needs for crops. Results are summarized in Figures 3-3 through 3-7 below. University of Minnesota Extension recommends fertilizer application at concentrations below 25 ppm (yellow and green in maps below) the local cooperatives recommend application at concentrations below 40 ppm (all shaded areas except orange).

The cooperatives usually use a yield goal of 180 bushels/acre. The recommendation by cooperatives takes into consideration of maintaining a longer term soil phosphorus level, which may result in higher application rate in some years. Additionally, cooperatives generally focus more on yield while Extension considers downstream impacts. Therefore, the cooperative recommendation for application rate is generally higher than that of the Extension.

Figure 3-3: Soil P Testing Results, 2012

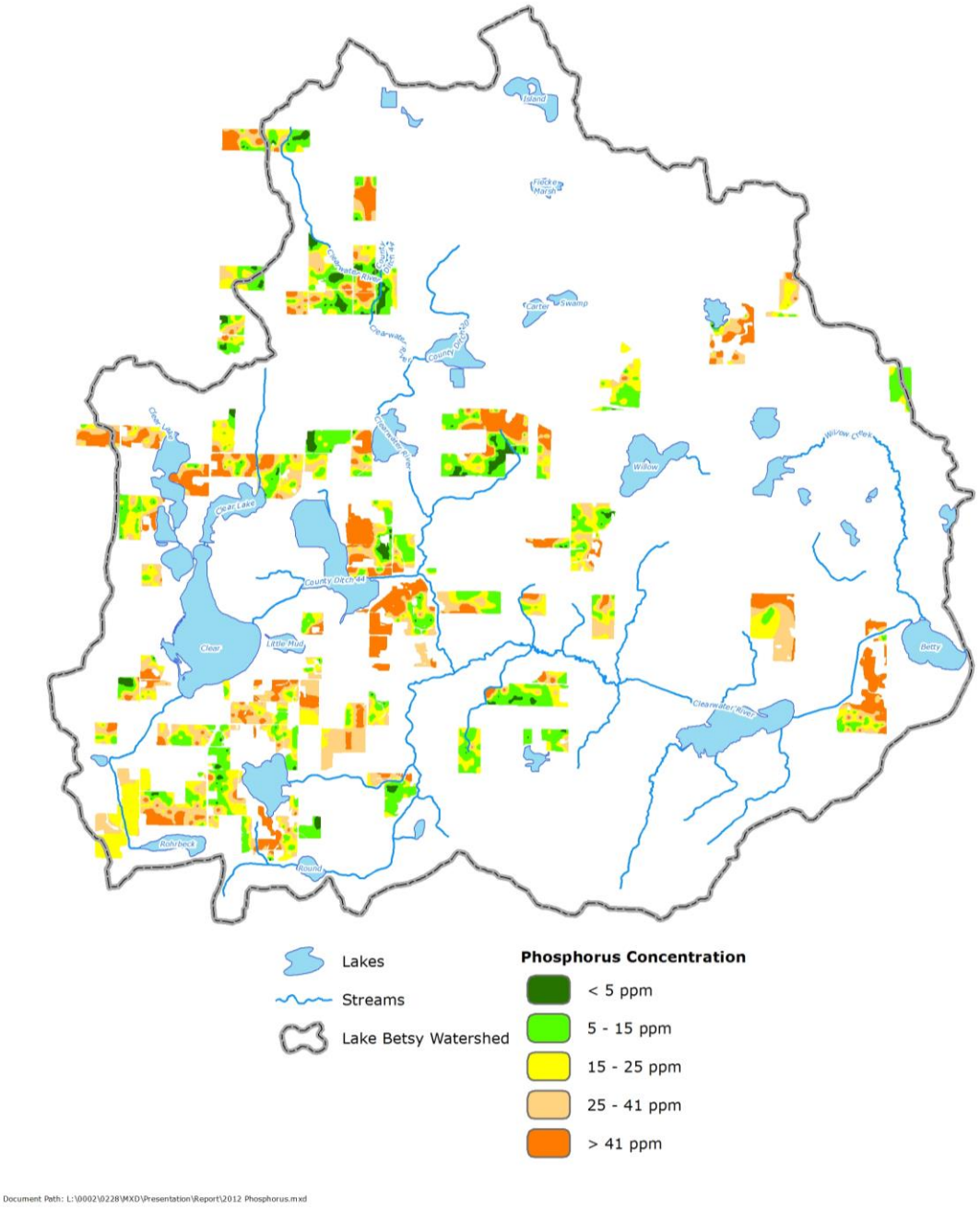


Figure 3-4: Soil P Testing Results, 2013

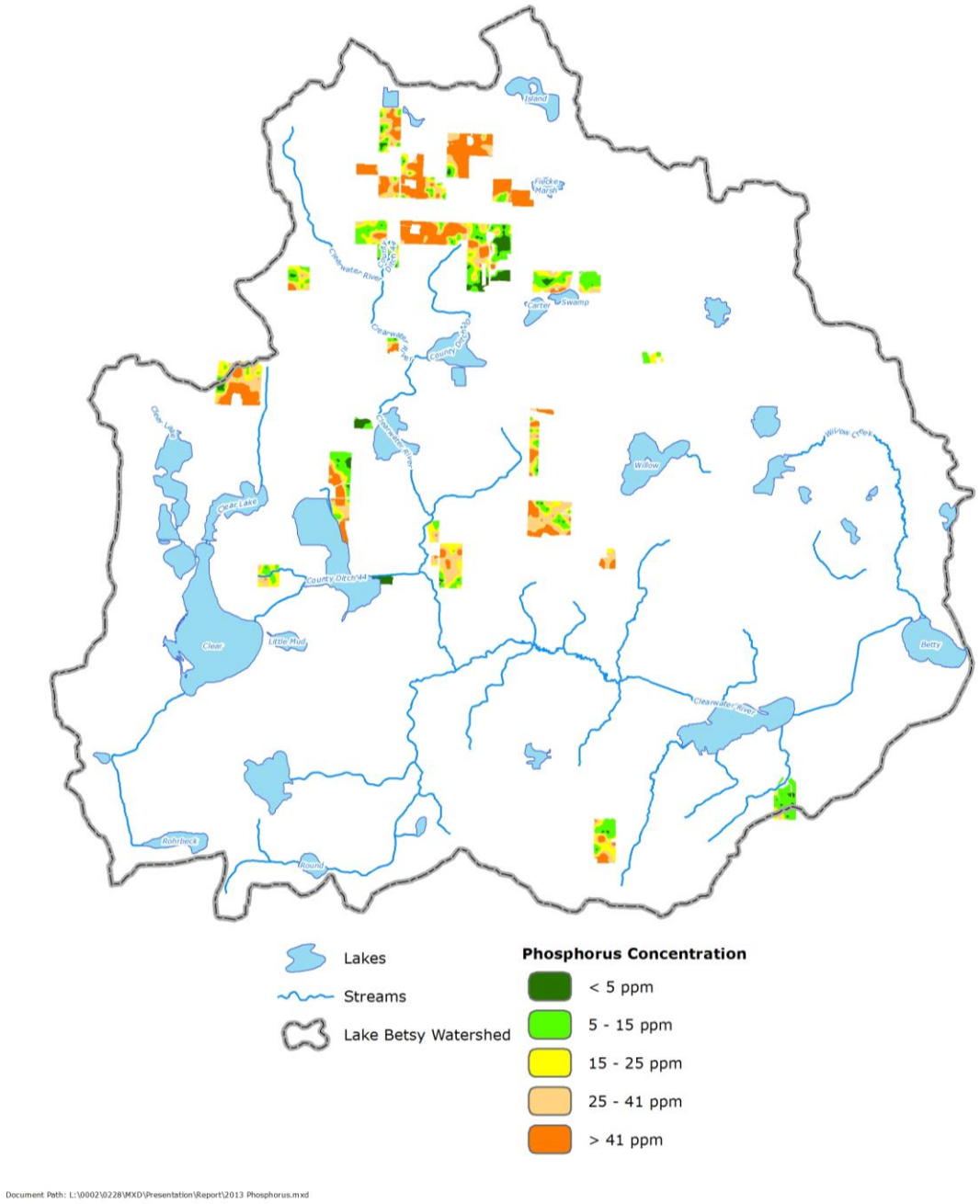


Figure 3-5: Soil P Testing Results, 2014

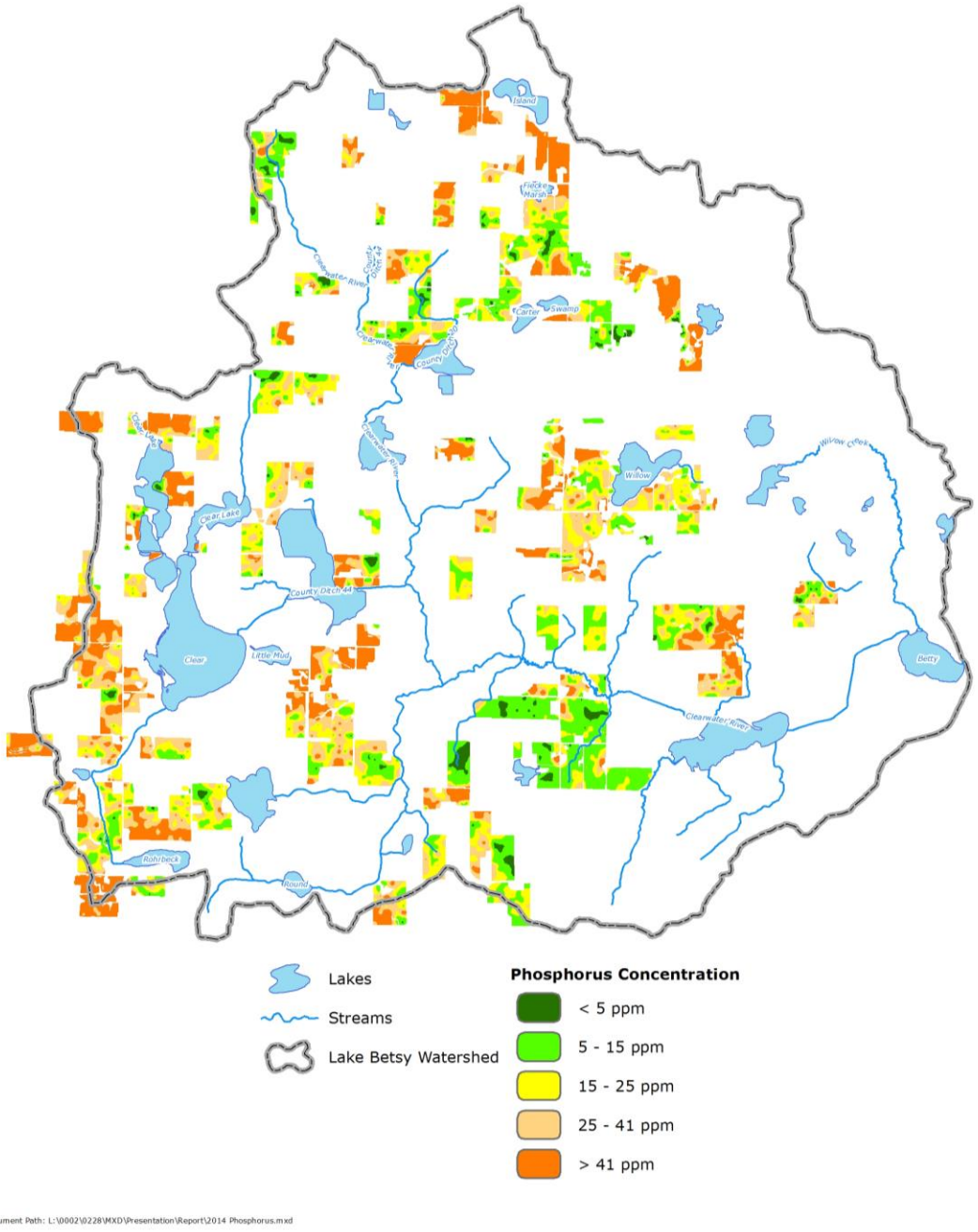


Figure 3-6: Soil P Testing Results, 2015

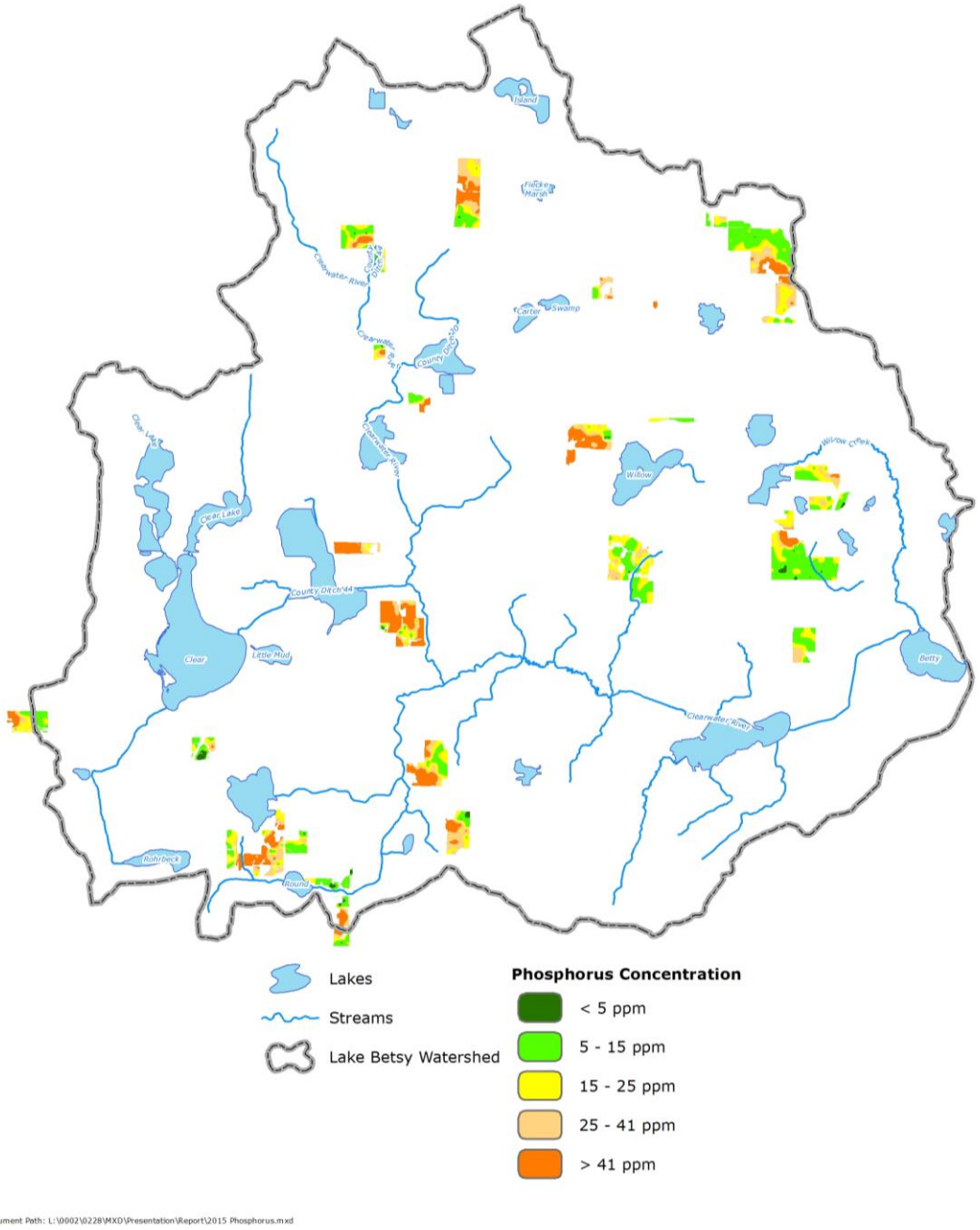
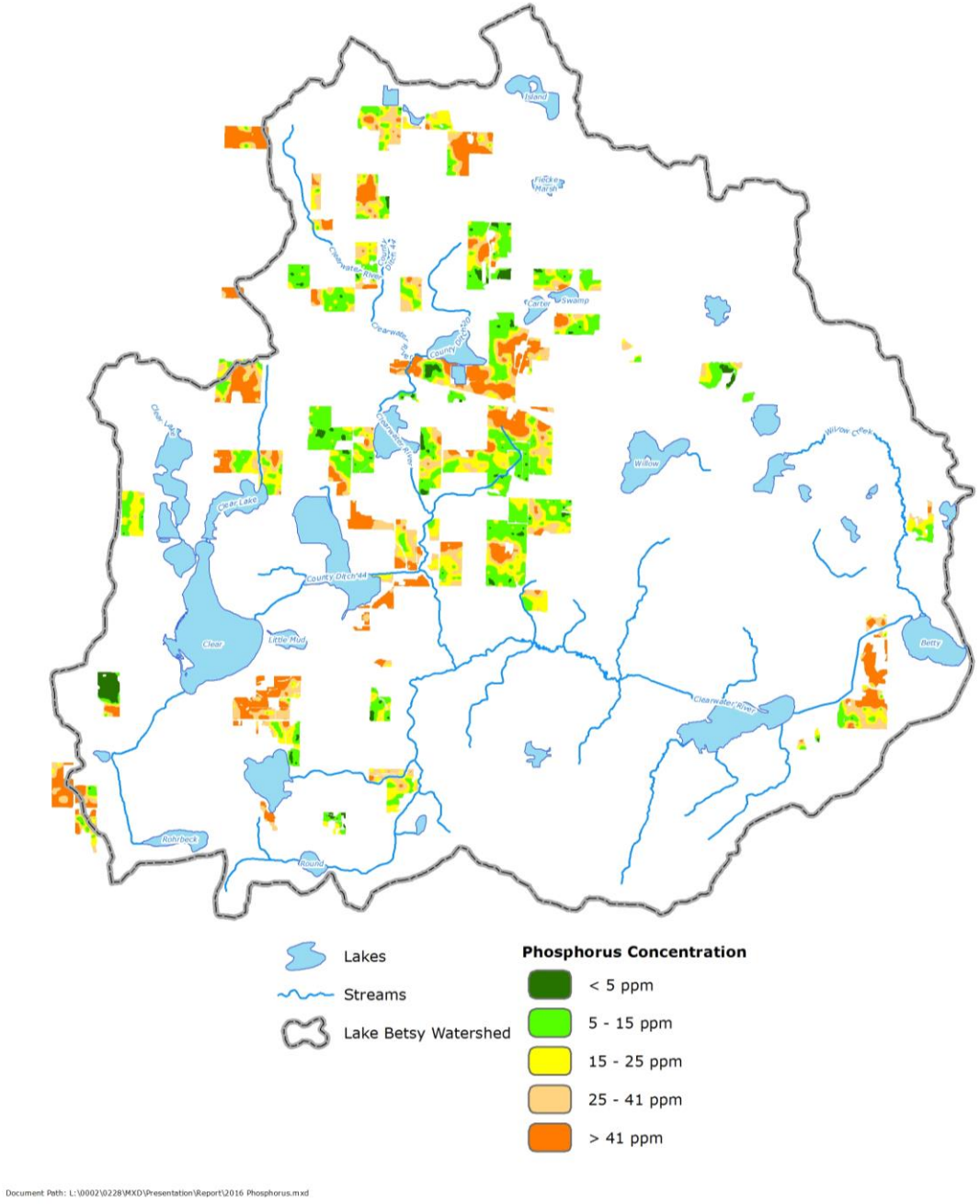


Figure 3-7: Soil P Testing Results, 2016



The data were reviewed in aggregate over the study area, and timeline as well. Many fields were enrolled for multiple years allowing us to track changes in soil phosphorus over the study. This was of particular interest for the participants to ensure they were not depleting their soil P by participating. This was identified as a critical factor for sustaining this practice going forward. The rate of change of soil P over the term of the study is shown in the figures below:

Figure 3-8: Rate of Change in Soil P, 2012 to 2014

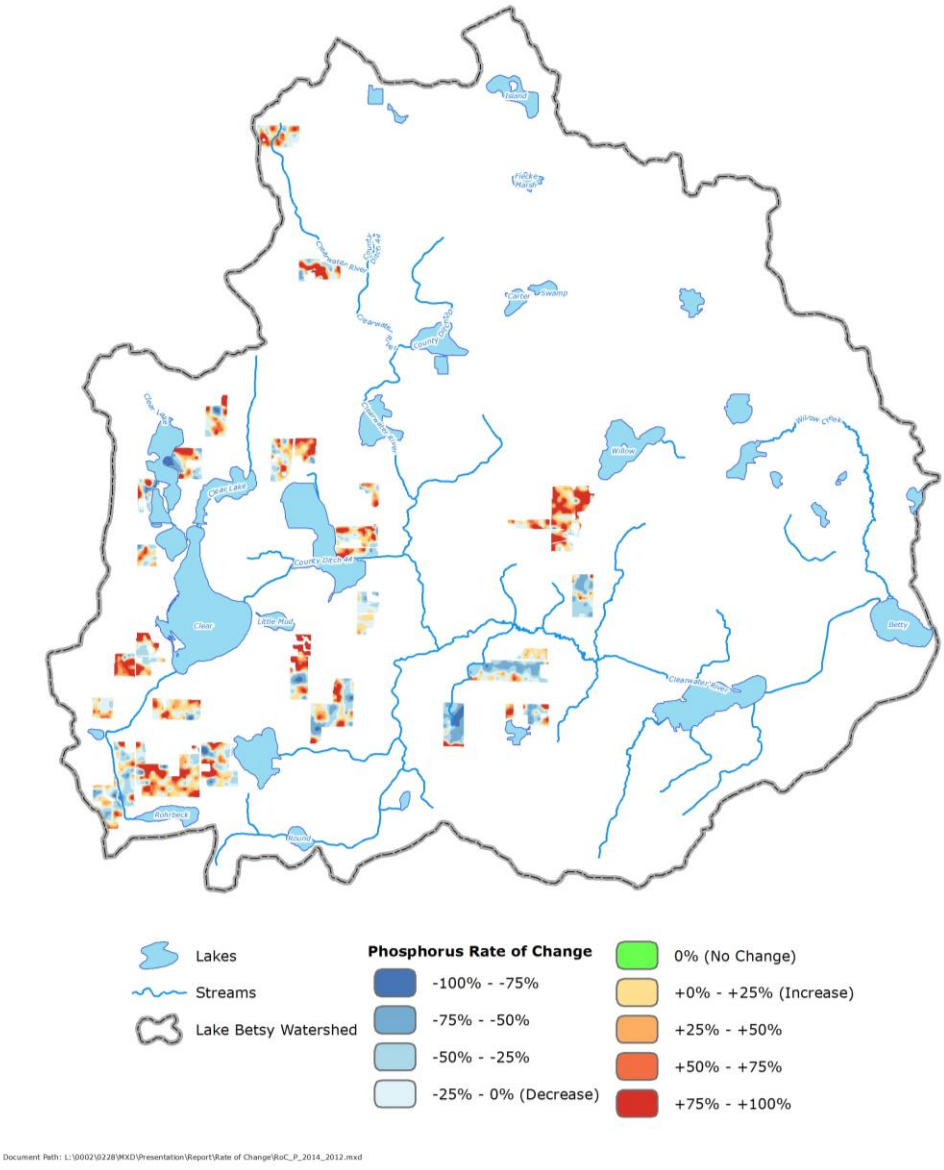


Figure 3-9: Rate of Change in Soil P 2013 to 2015

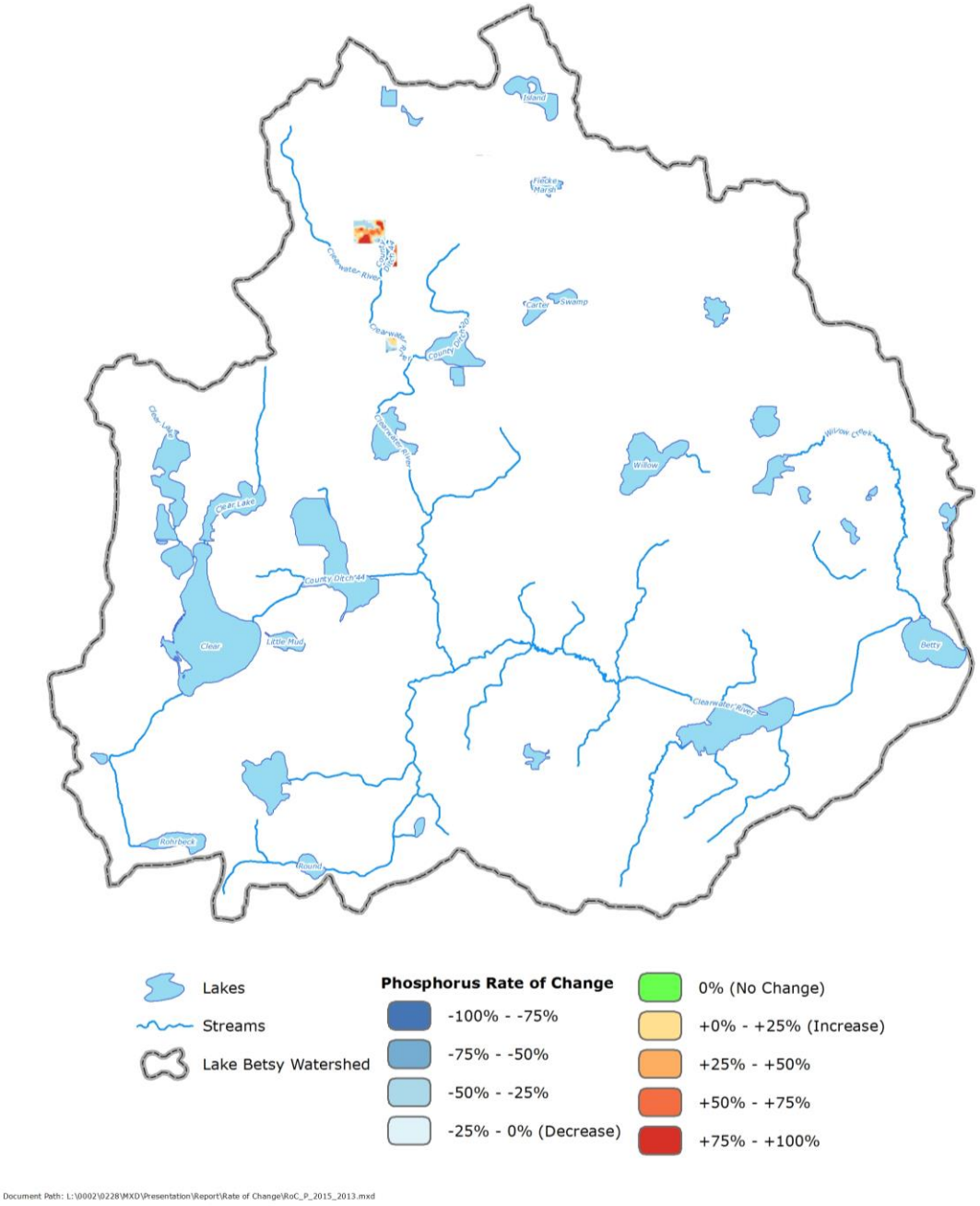


Figure 3-10: Rate of Change in Soil P 2012 to 2016

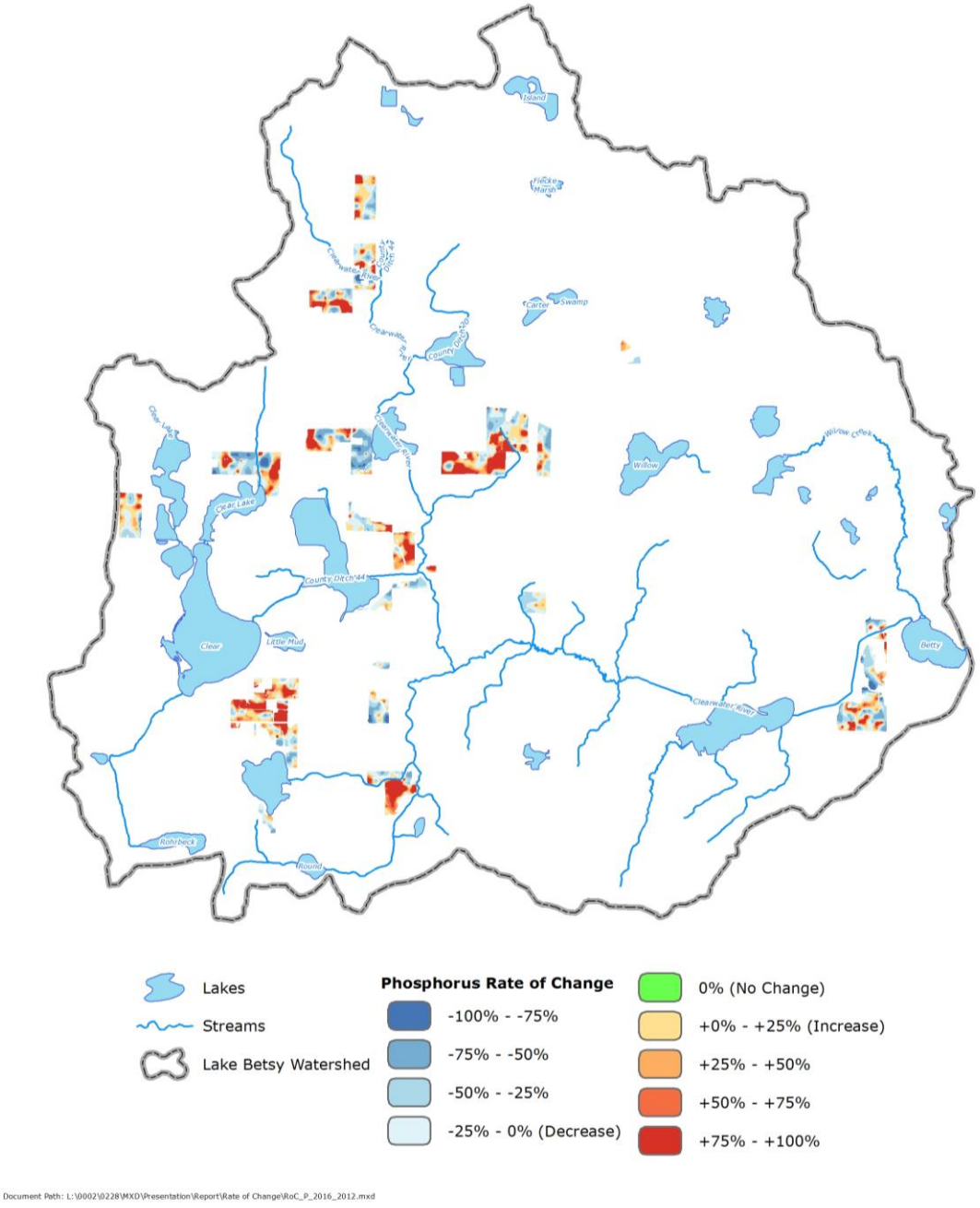


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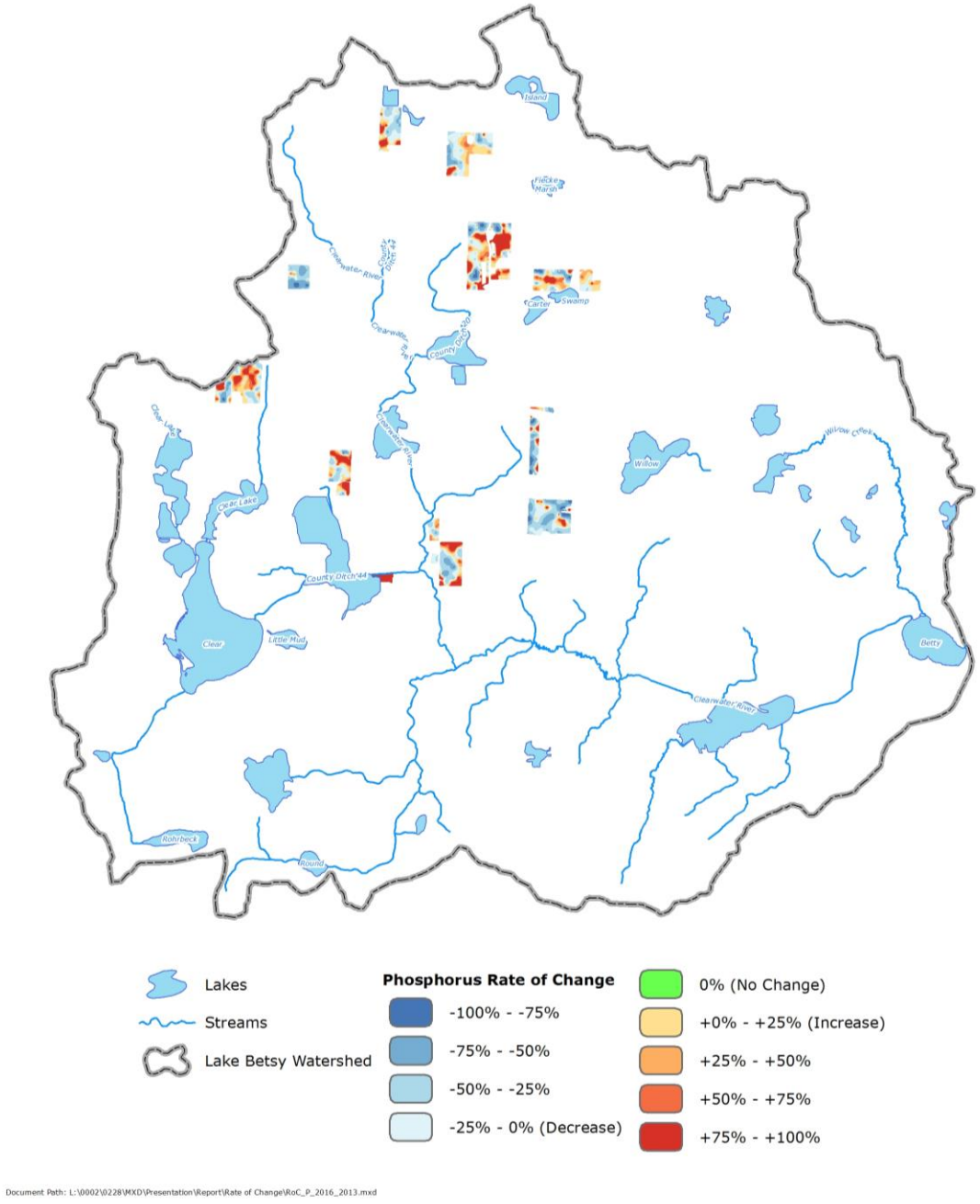
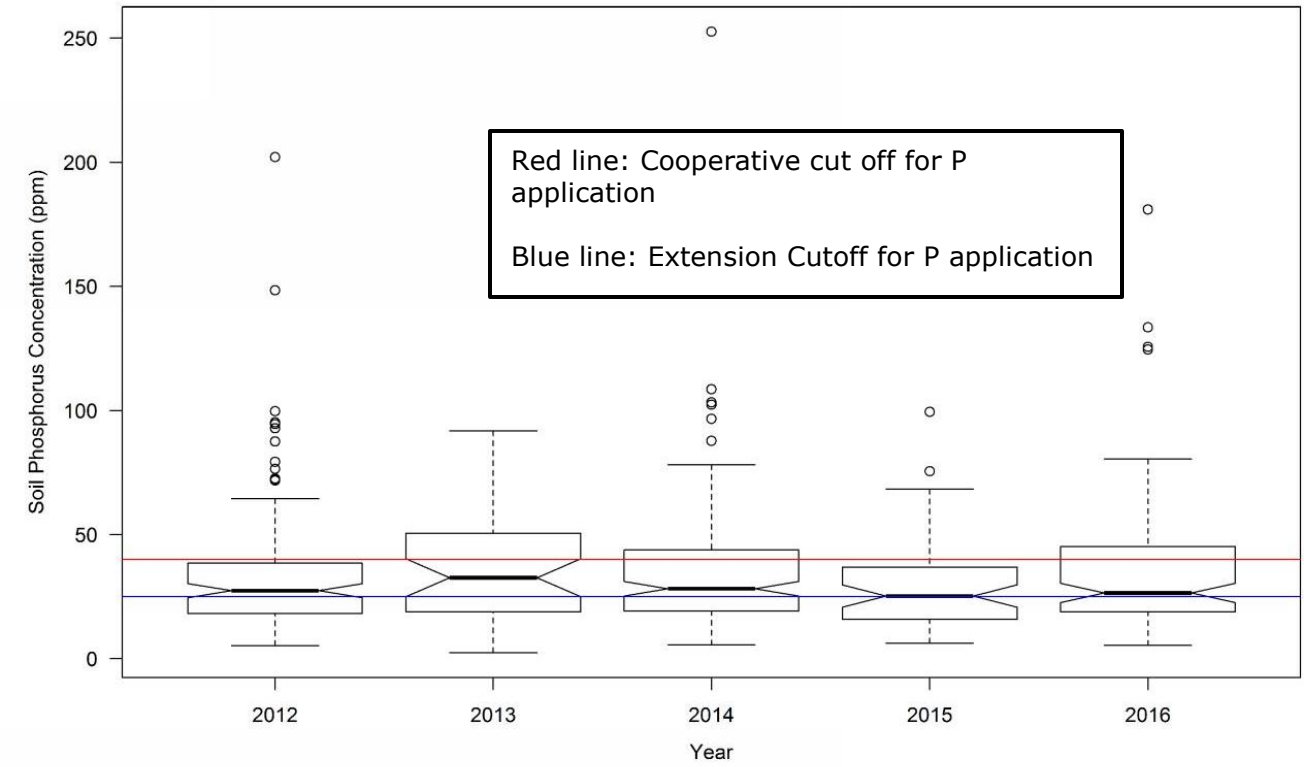
Figure 3-11: Rate of Change in Soil P 2013 and 2016



The data shows a high rates of variability in soil P concentrations across the study area, and even in individual fields highlighting the ongoing need for gridded soil testing.

Figure 3-12: Distribution of Soil Phosphorus Concentration over Target Area*

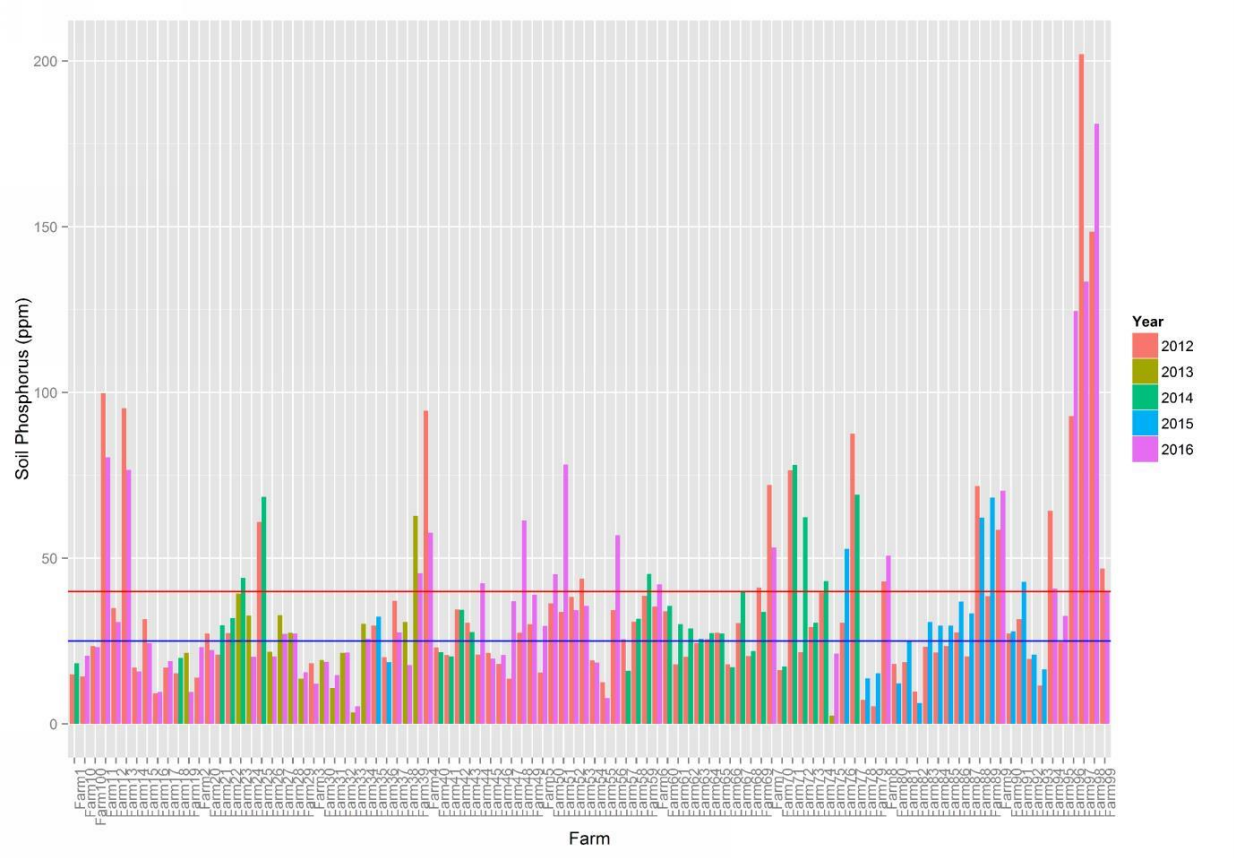


**Box and whisker plots are a visual distribution of data to showing central tendencies, in terms of mean, confidence intervals and ranges.*

Figure 3-12 shows the distribution of soil P data annually across the study. The mean concentration was consistently at or above the soil P concentration where University of Minnesota Extension advises additional P application is needed (<25 ppm). The cooperatives have a slightly higher cutoff in terms of application: generally 40 ppm. The figure also shows though that the data is skewed by a few very high soil P areas.

Figure 3-13 shows soil phosphorus concentration, by field, over the study in lbs P in relation to the co-op cutoff for application (<40 ppm, the red line) and the University of Minnesota Extension cutoff for application (<25 ppm, the blue line).

Figure 3-13: Soil Phosphorus Concentration over Study



3.5 FERTILIZER APPLICATION

Soil testing was conducted on enrolled fields on a 2.2 acre grid to measure soil phosphorus concentrations and develop a recommended rate for application of di-ammonium phosphate (DAP) from year 2012 to 2016. Figures 3-14 through 3-20 show DAP application rates between 2012-2016. The DAP fertilizer is DAP-1846-0 and contains 46% phosphate and 18% nitrogen. This form of phosphate (P_2O_5) contains 43% phosphorus, which equals 20% phosphorus in DAP. Therefore, the recommended rate of 150 lbs DAPS/ac converts into 30 lbs P/ac.

Generally the cooperatives recommended rates for DAP application are zero lbs/ acre when soil concentrations are 40 ppm or greater. University of Minnesota Extension recommends zero application at soil concentrations of 25 ppm. The typical cooperative recommended DAP application rate is 150 lbs/ac.

Figure 3-14: DAP Application Rate Over Study

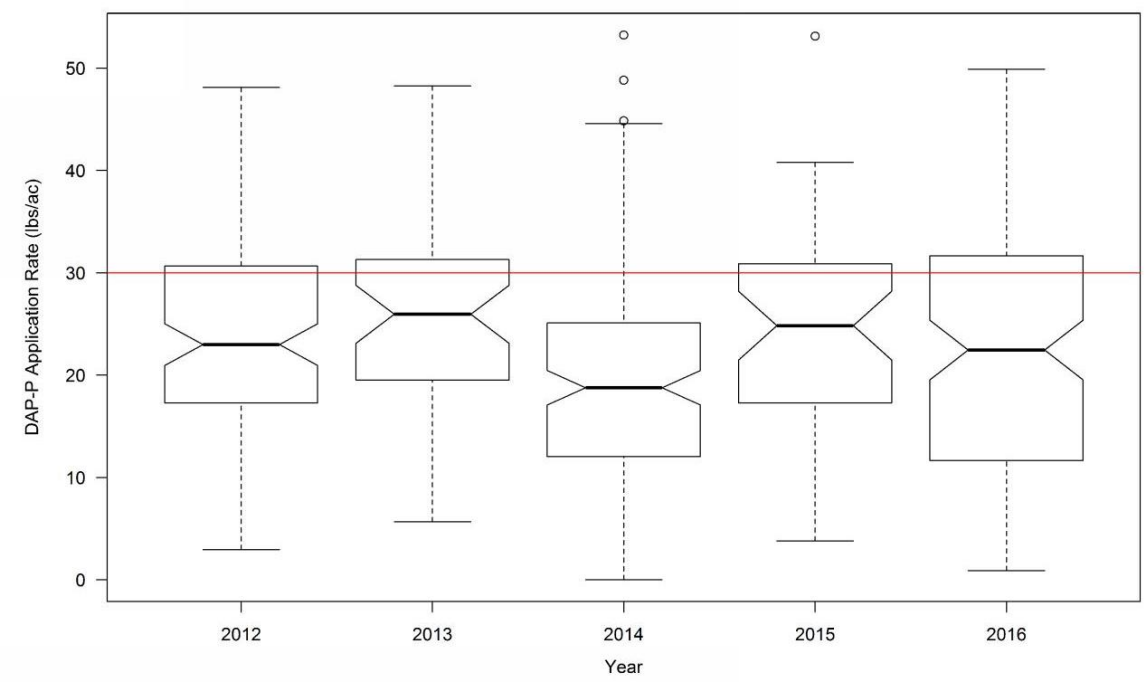
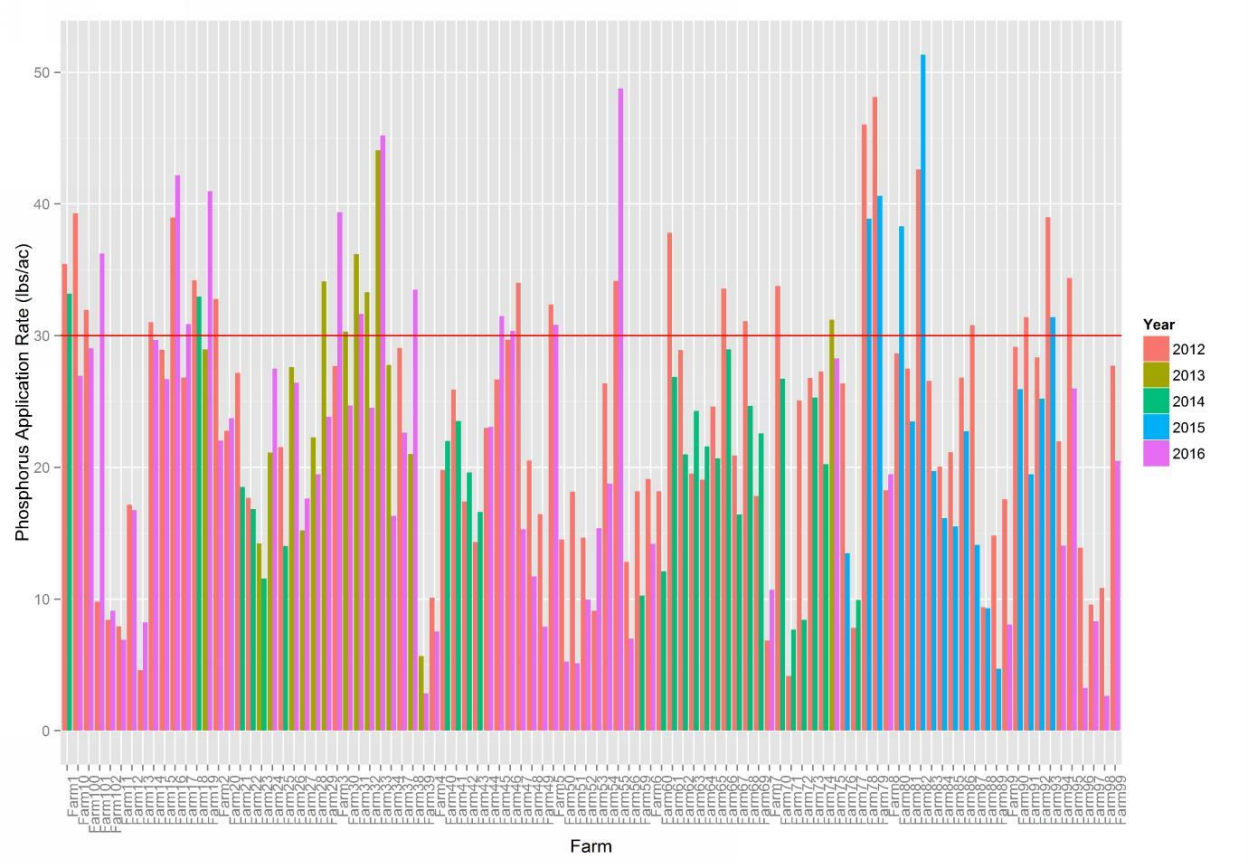


Figure 3-15: DAP Application Rate Over Study



It was not uncommon to see that when DAP recommended application rates decreased over the years, soil phosphorus concentration increased. To exclude natural processes that may increase soil phosphorus, a correlation analysis was done for soil organic matter content versus soil phosphorus concentration. When organic matter breaks down, it can release phosphorus into the soil. The test statistic (0.04) suggested no correlation between the two. Soil pH can affect the availability of soil phosphorus when it is greater than 7.3 or less than 5.5. The recorded soil pH was mostly in the range of 6 to 7 with only one year (2014) being higher (7.98). This high pH would drop the availability of phosphorus from high to medium, but would not be a significant change.

Soil phosphorus testing result and DAP application rate were only available for years of enrollment. Due to crop rotation, farms enrolled in multiple years did not enroll in consecutive years. Therefore, no information on DAP application rate in between enrollment years was available for the analysis. Though program participants were prohibited from additional spreading of manure, it is possible that manure spreading could have accounted for some increase. Either way, additional phosphorus would be added to the field to account for the soil phosphorus increase.

A map review of areas with the highest increases in soil phosphorus concentration showed that these areas are close to surface waterbodies, and downgradient from larger drainage areas. This points to soil erosion carrying phosphorus rich soils from upland to lowland areas.

Figure 3-16: DAP Application Rates Enrolled Fields, 2012

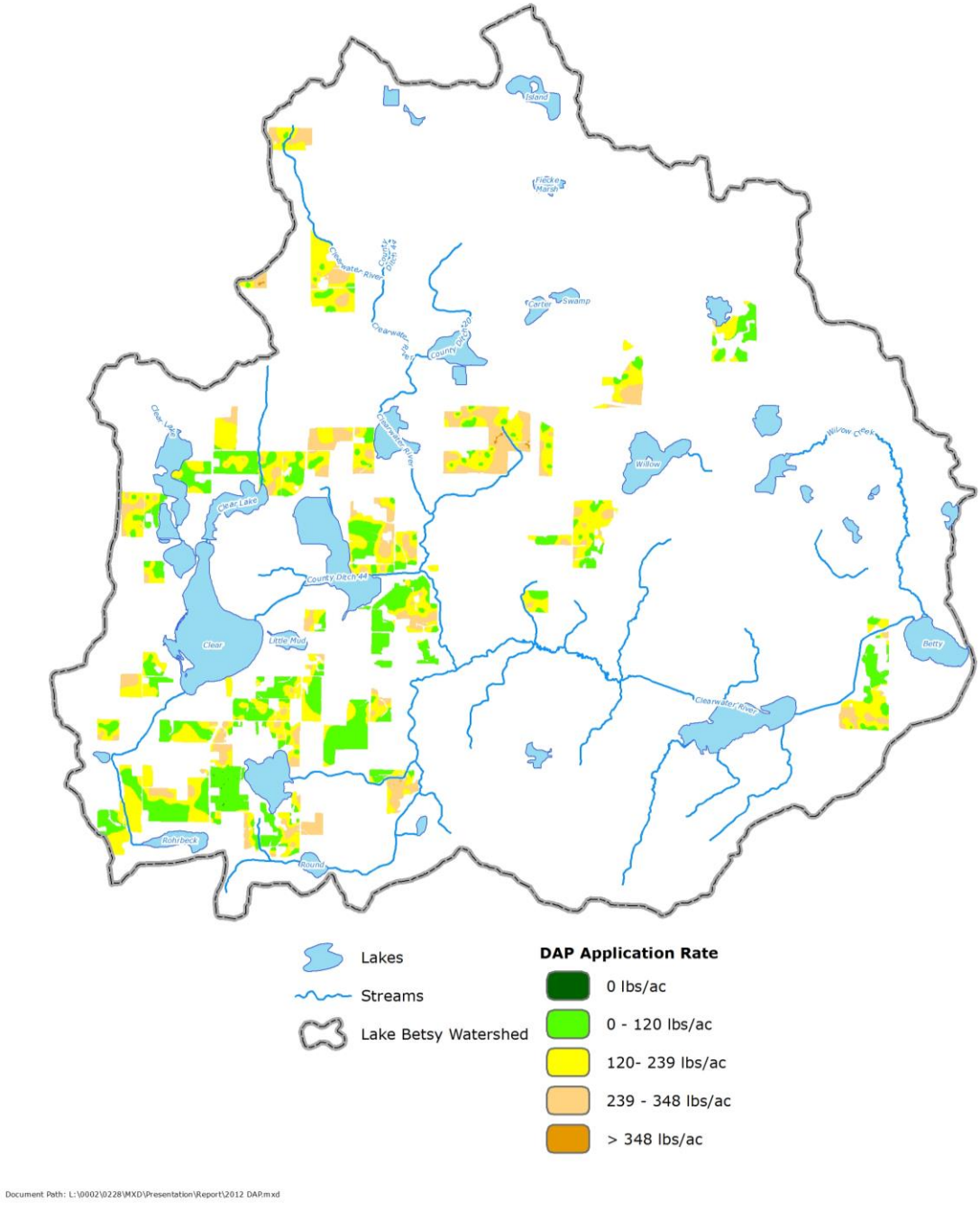


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Figure 3-17: DAP Application Rates Enrolled Fields, 2013

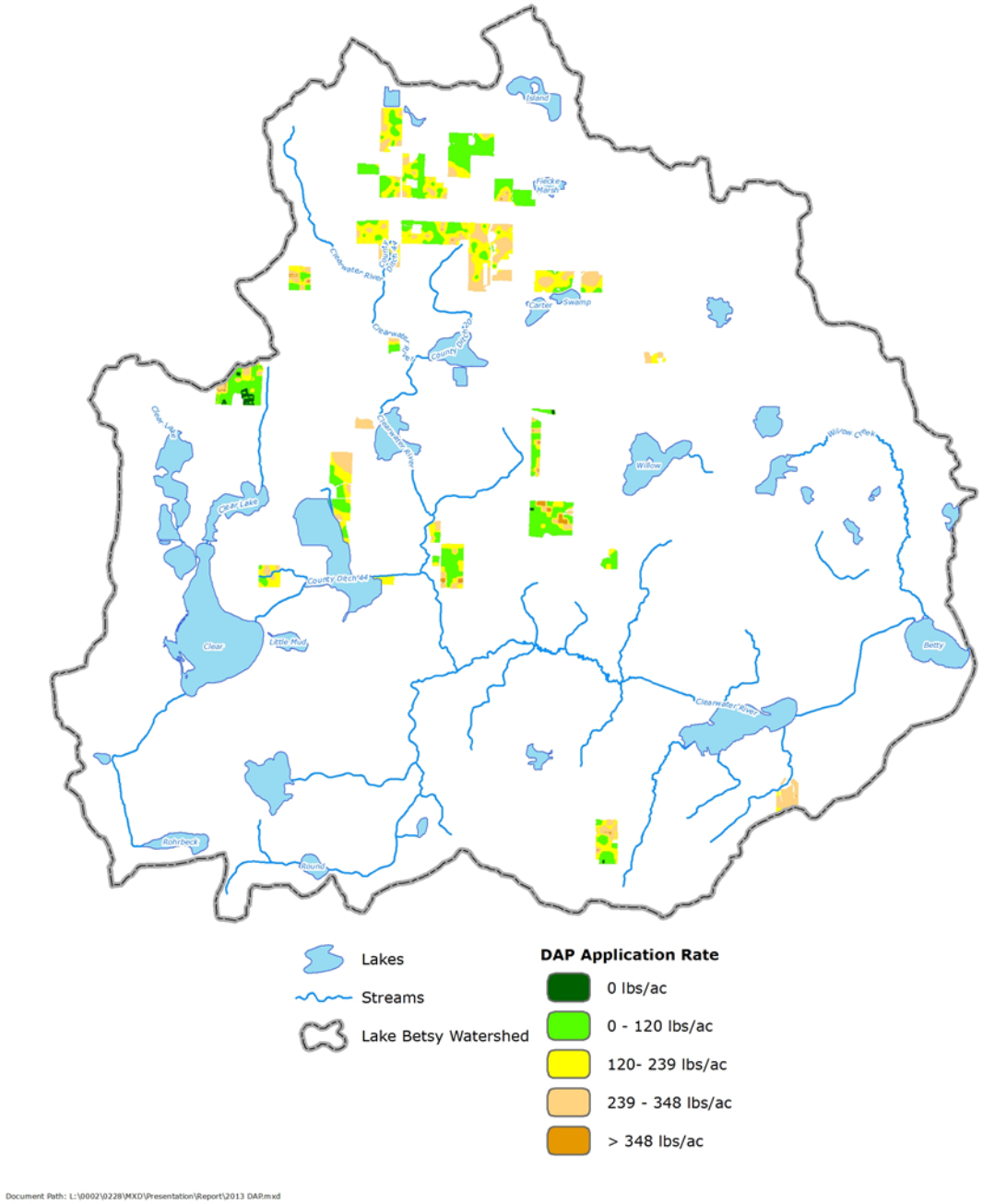


Figure 3-18: DAP Application Rates Enrolled Fields, 2014

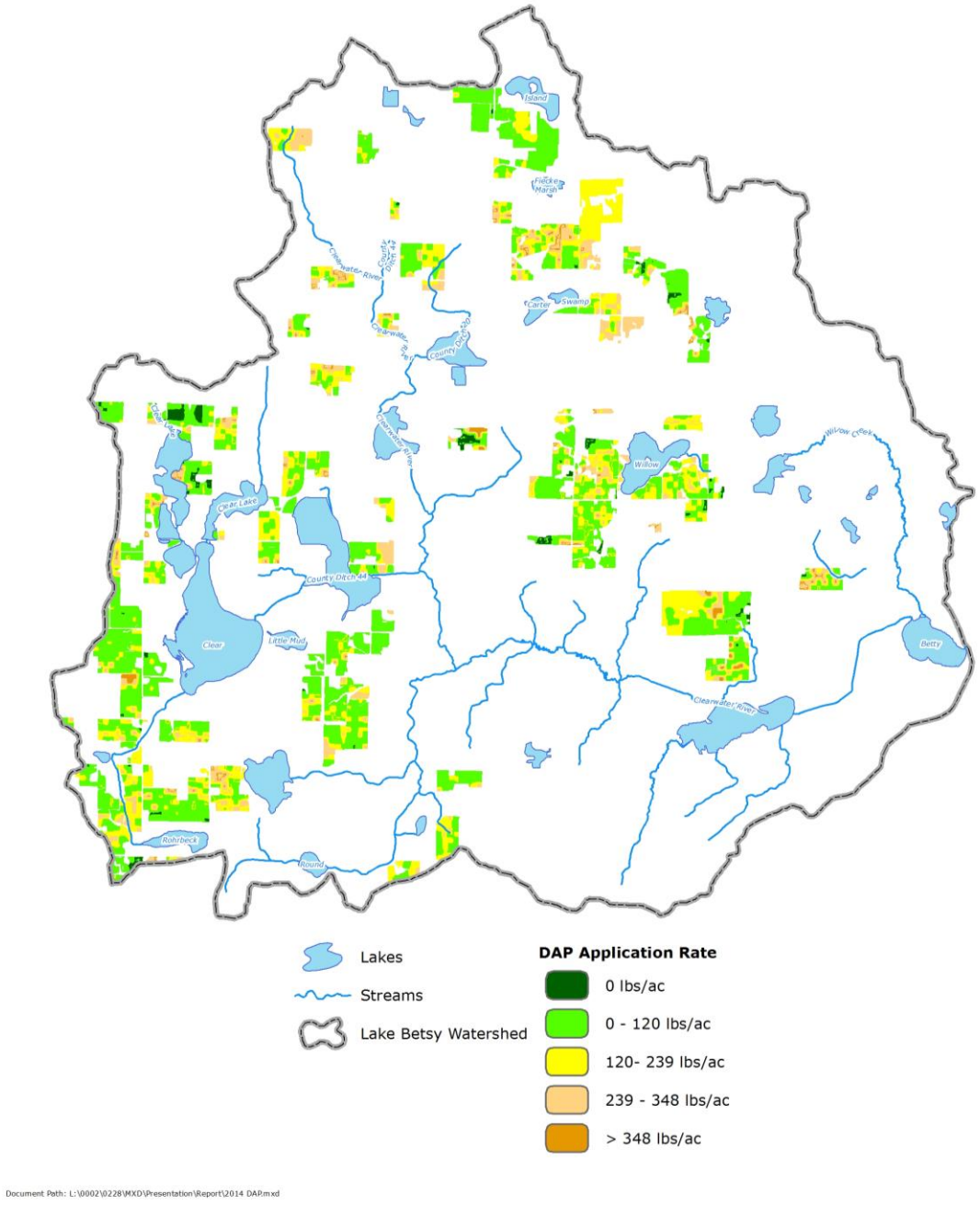


Figure 3-19: DAP Application Rates Enrolled Fields, 2015

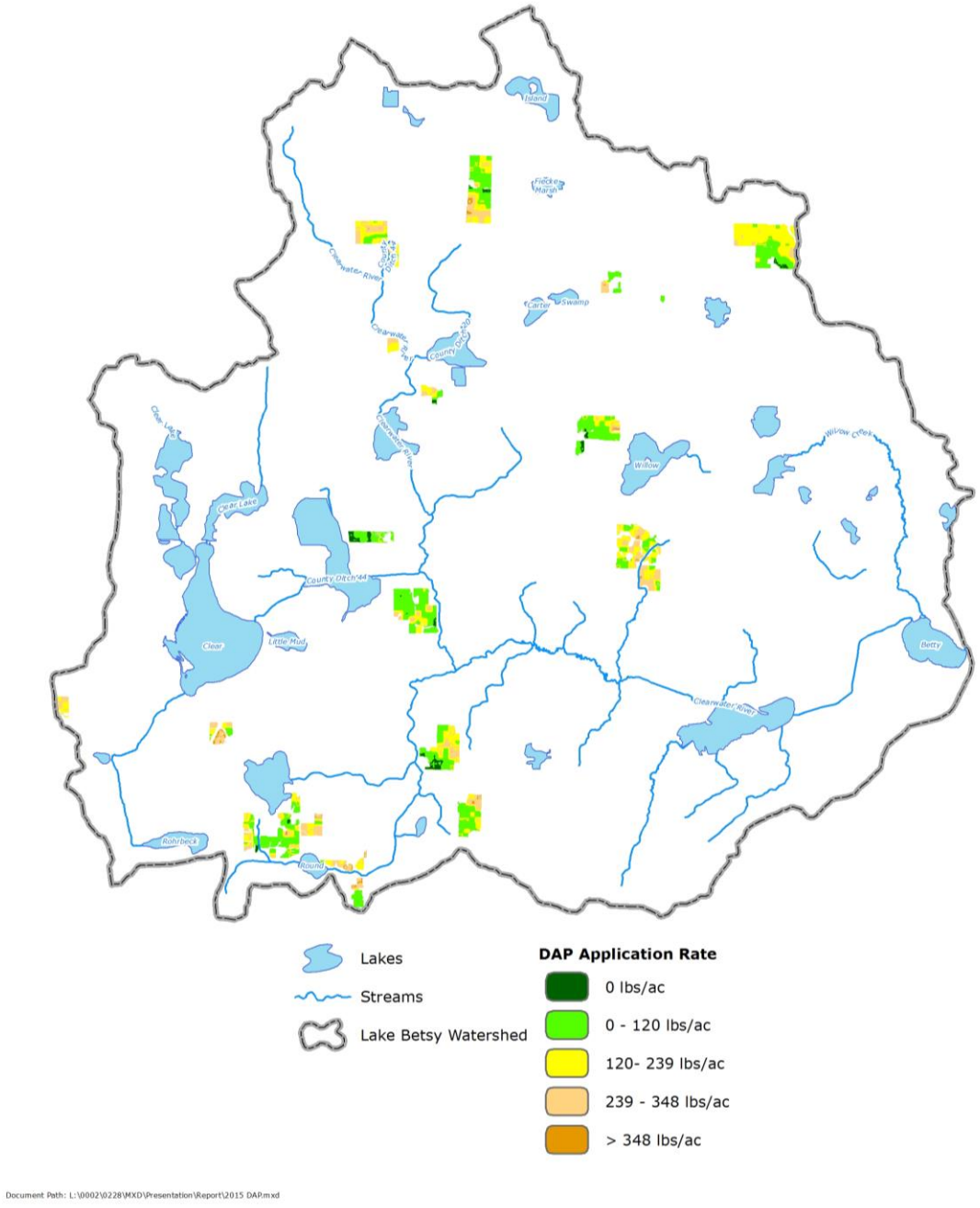
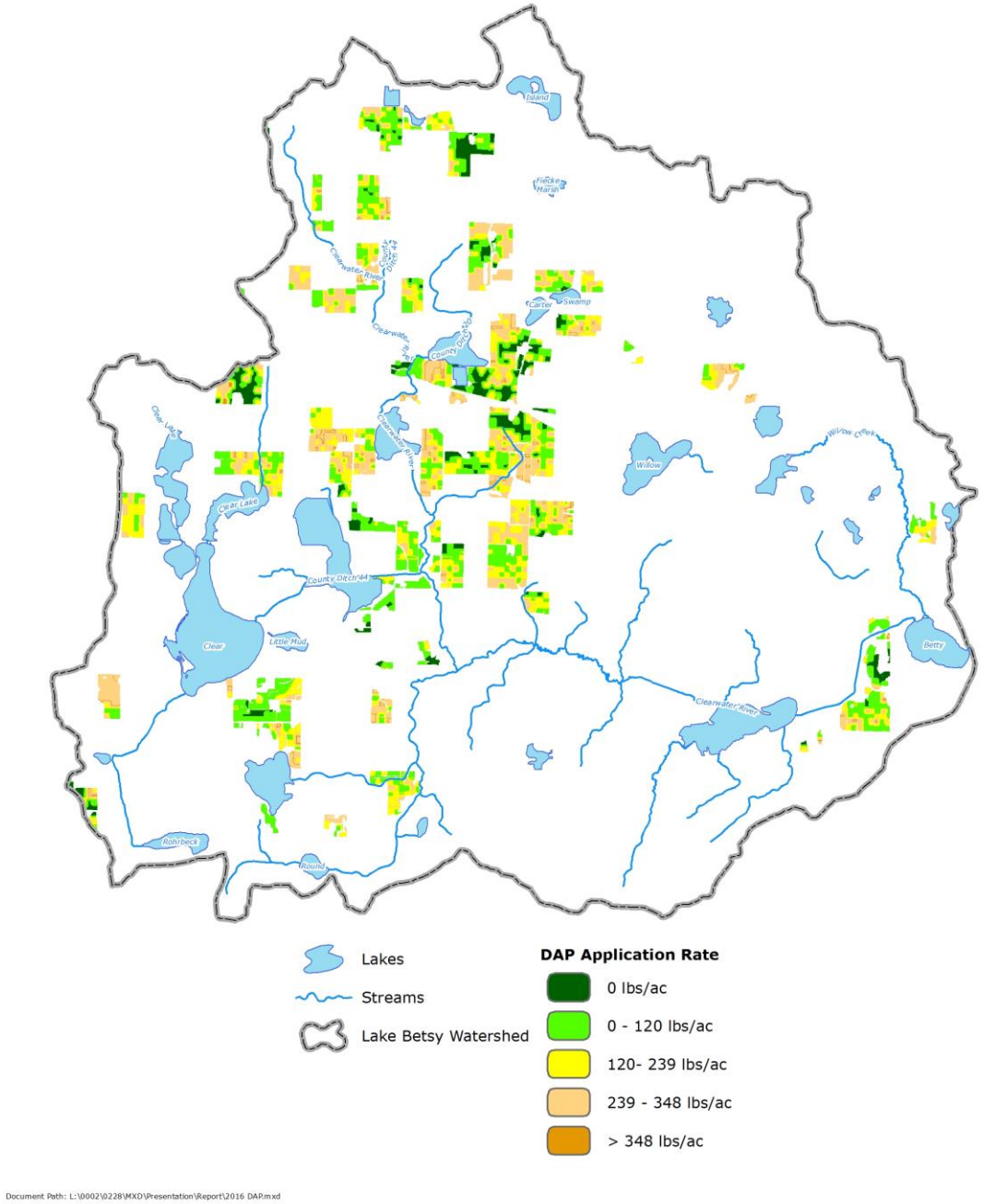


Figure 3-20: DAP Application Rates Enrolled Fields, 2016



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3.6 OUTCOMES

3.6.1 Recruitment

CRWD achieved the grant recruitment goal of 16,000 acres as discussed in Section 3.1.

3.6.2 Changes in P Application

The changes over the entire area were difficult to draw specific conclusions from. However, the biggest conclusion would be continuation of the practice is warranted due to the wide variation in soil P and resulting DAP recommendations. Doing so is expected to optimize production and to minimize water quality impacts.

Changes in P application were assumed to be relative to the cooperatives typical recommended uniform rate of DAP application, 150 lbs/ac. The biggest change in application comes from looking at what we assume would have been applied to areas nearest to receiving waters (i.e. sensitive areas) based on the standard rate compared with what gridded soil tests show was actually needed. The table below shows these results:

Table 3-4: Standard Uniform DAP Application vs Variable Rate in Sensitive Areas

Year	Area (acres)	DAP - Coop Recommended Application lbs	DAP-Standard Rate Application Rate of 150 lbs/ac (lbs)	Potential Reduction in DAP Application (lbs)	Potential P Load Reduction (lbs P)
2012	467	50,062	70,101	20,039	4,008
2013	106	11,183	15,857	4,674	935
2014	515	38,692	77,024	38,332	7,666
2015	64	4,195	9,651	5,456	1,091
2016	325	22,688	48,771	26,083	5,217

The difference ranged from 4,700 to 38,000 lbs of DAP less applied in riparian areas per year, which translates into between 900 and 7,700 lbs less of soluble P applied adjacent to streams.. There isn't enough information to determine how much of the P not applied might have migrated into adjacent waters, but the reduction, on an annual basis could be significant. In terms of the target load reductions in this watershed, Lake Betsy requires a 4,100 lb reduction from the upstream watershed to meet state water quality goals. This program may provide 10-30% of the required upstream watershed load reduction assuming only a small percentage of the not-applied phosphorus would have migrated downstream.

3.6.3 Water Quality Monitoring

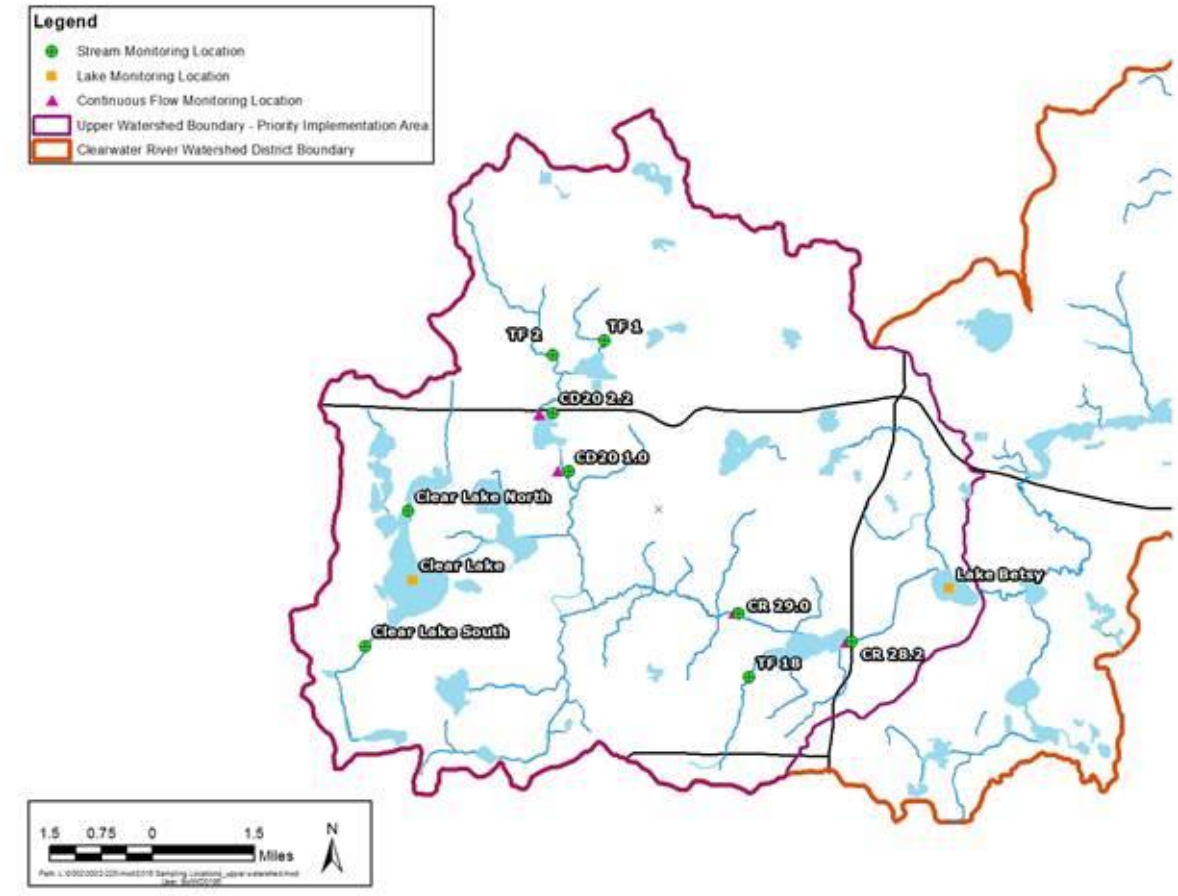
CRWD monitored upstream water quality at 11 locations shown in Figure 3-21. Water quality monitoring was conducted at the following sentinel lake and river locations with long term records in the priority implementation areas: Clearwater River at River Mile 29 and 28.2 (CR 29.0 and CR28.2), Clear Lake and Lake Betsy. Other stream monitoring locations, including two locations along Meeker County Ditch 20 North (CD 20-2.2 and CD 20-1.0), were monitored to provide additional watershed data (TF 1, TF 2, TF 18, Clear Lake North, Clear Lake South).

In addition to these sites, the CRWD conducted multiple tile outlet sampling at several locations in the watershed. Per agreements with property owners, the spatial locations of these sites are not displayed. The three sites with the most robust datasets (TF 5, TF 8 and TF 15) are reference below in subsequent analyses.

Though the original project contemplated additional tile outlet monitoring, in practice there were not enough suitable sites to implement this. Landowners were reluctant to allow access to have tiles from their individual fields sampled. Where we did gain access, the watersheds were small and runoff was extremely flashy and difficult to capture even with automated sampling. To achieve a meaningful dataset, staff opted to move further down the watershed to capture slightly larger drainage areas.

Figures 1-3 and 1-4 (Section 1) show water quality in Lake Betsy and the Clearwater River directly downstream of the implementation areas. Precipitation and runoff play a large role in water quality, and its impact can't be teased out so the CRWD looks more closely at longer term trends.

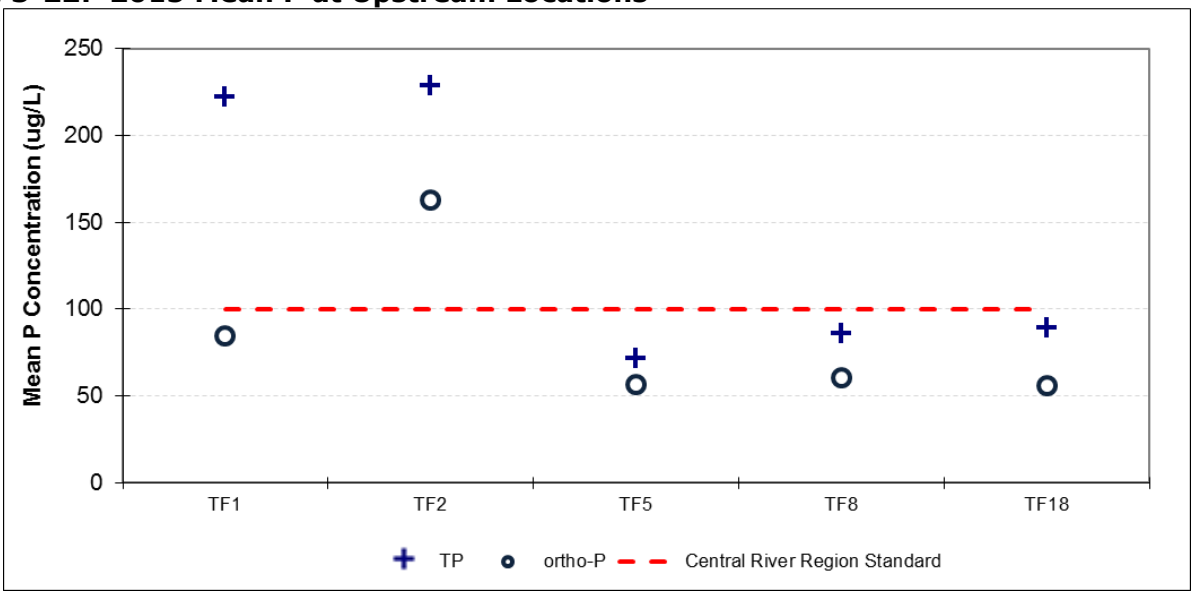
Figure 3-21: Monitoring Stations in the upper watershed



Monitoring at the sites show that phosphorus at the upstream sites was slightly lower than many of the main long-term stream monitoring sites, however the partitioning is different:

most of the phosphorus is in dissolved form (ortho-P) which is more available for uptake by algae and aquatic plants.

Figure 3-22: 2015 Mean P at Upstream Locations



3.7 SUMMARY & RECOMENDATIONS

The practice was popular with farmers enrolled in the program, and because the cooperatives had invested in the technology they pushed the practice outside the grant area (though no funding from this grant was provided). As such, the total impact of the project was not known. It seems likely the practice will continue (see section 4.2 below).

Soil P in specific fields varied significantly spatially and temporally during the study, pointing to the need to continue gridded soil testing every other year to optimize DAP application.

While the practice did not yield overall reductions in total amount of DAP applied, there were significant reductions in DAP application to sensitive areas near water bodies with high soil P.

Yields vary significantly from year to year for several reasons- fertilizer application is only one element. Separating out the impact of fertilizer application specifically is not possibly and farmers are typically reluctant to share yield data. Providing farmers with an independent farm management tool that tracks all farm inputs and outputs may help individual farmers track yield changes and make decisions based on cost/ benefit.

The delivery mechanism for this project was unique in that instead of the local government unit approaching and recruiting participants, the local cooperatives leveraged their existing connections to enroll farmers. The result was a higher than average uptake of the practice.

Since the grant application was written, the practice has increased. Areas not currently using variable rate fertilizer application with gridded soil testing may benefit from some seed capital to establish the practice.

4.0 Public Outreach and Education

The District integrates education and outreach, or civic engagement, in each project and program to leverage each dollar spent to protect and improve the water and natural resources in the District.

CRWD regular civic engagement involves hosting a bi-annual watershed tour, as well as giving presentations at board meetings, lake associations, local conferences and expos. The District also has a website and social media outlets. This project was featured at each of these outlets. Informal discussions with targeted audiences indicates engagement efforts were successful in educating audiences on purposes and results of the project, as well as increasing knowledge of watershed concepts.

4.1 EDUCATION & OUTREACH

Activities specific to this project included:

- April 2011 Brochure - Fertilizer Field Trial Results
- October 2012 Targeted Fertilizer Brochure - Program Enrollment
- June 2014 - A Rare Win for Lake, Streams and Farmers: Clearwater River Watershed District Honored at Environmental Initiative Award Ceremony for Targeted Fertilizer Project
- September 2014 Presentation to enrolled farmers and potential enrollees at a breakfast in Kimball
- December 2014 Presentation at Minnesota Association of Watershed Districts
- December 2014 - Farmers and Water Quality Win: Clearwater River Watershed District Receives Minnesota Association of Watershed Districts' Program of the Year Award
- January 2015 Presentation to Minnesota Division of the Izaak Walton League of America- "Targeted Fertilizer Application Reduction Program: A Unique Partnership Benefitting Water Quality & Agricultural Production"
- February 2015 Presentation to the Hennepin County Bar Association February 2015
- October 2015 Presentation at Minnesota Water Resources Conference October 2015
- March 2016 Presentation at the Iowa Water Resources Conference
- June 2016 Survey of enrollees and co-op participants (results in section 4.2)
- September 2016 Mailing to enrollees summarizing results

4.2 SURVEY RESULTS

Both the program enrollees and the cooperative staff were surveyed regarding their experiences with this program. The results of the enrollee survey are summarized in Appendix B which contains the survey sent out and the summary of results.

In general the cooperative staff was reluctant to comment, but their general feedback was:

- Program brought in other business, increased interest in other services/ products and increased profitability
- Program had an effect of overall operational effectiveness due to increased workload
- Program was a good fit to overall operations
- Some producers were reluctant to conduct business due to government involvement. However, overall participants had a good opinion of the program

5.0 Final Expenditures

PROJECT TITLE: Targeted Fertilizer Application Reduction Project
PROJECT SPONSOR: Clearwater River Watershed District
PROJECT ID#: PRJ07899

Project Budget Cost Category	Unit Cost (per hour, per mile, etc)	Unit	# 0f Units (hours, mileage, etc.)	Total Cost	Revenue Source Grant Cash	Cash Match	In-Kind Match	Total Budget	Expenditures To Date Grant Expenditures	Cash Match Expenditures	In-Kind Expenditures	Balances Total Expenditures	Balances Grant	Cash Match	In-Kind Match	Total Balance Remaining
OBJECTIVE 1: Project Coordination																
Task 1: Recruit Participants						**$ -**	**$ 7,679.30**	**$ 7,679.30**								
Professional Services/ Staff Time	50.00	$/ hr	150.00	$ 7,500.00		$0.00	$7,500.00	$ 7,500.00			$ 3,119.79	$ 3,119.79	$ -	$ -	$4,380.21	$ 4,380.21
Mileage	0.55	$/ mi	326.00	$ 179.30			$179.30	$ 179.30			$ 180.64	$ 180.64	$ -	$ -	$ (1.34)	$ (1.34)
Task 2: Coordinate with Partners							**$ 7,173.65**	**$ 7,173.65**								
Professional Services/ Staff Time	50.00	$/ hr	143.47	$ 7,173.65			$7,173.65	$ 7,173.65			$ 5,311.47	$ 5,311.47	$ -	$ -	$ 1,862.18	$ 1,862.18
Mileage	0.55	$/ mi	0.00	0.00			$0.00	$ -				$ -	$ -	$ -	$ -	$ -
Task 3: Education and Outreach					**$30,000.00**		**$ 192.50**	**$ 30,192.50**								
Professional Services/ Staff Time	50.00	$/ hr	600.00	$ 30,000.00	$30,000.00		$0.00	$ 30,000.00	$ 25,838.09			$ 25,838.09	$ 4,161.91	$ -	$ -	$ 4,161.91
Mileage	0.55	$/ mi	350.00	$ 192.50			$192.50	$ 192.50			$ 192.50	$ 192.50	$ -	$ -	$ -	$ -
Objective 1 Subtotal					$30,000.00	$0.00	$15,045.45	**$ 45,045.45**	$ 25,838.09	$ -	$ 8,804.40	$ 34,642.49	$ 4,161.91	$ -	$ 6,241.05	$ 10,402.96
OBJECTIVE 2: Project Implementation																
Task 1: Gridded Soil Testing	14.06	$/ acre	16,000.00	$ 225,000.00	$ 135,000.00	$ 90,000.00	$ -	$ 225,000.00	$ 135,000.00	$ 76,839.45		$ 211,839.45	$ -	$ 13,160.55	$ -	$ 13,160.55
Task 2: GPS-Aided Fertilizer Application	2.50	$/ acre	10,400.00	$ 26,000.00	$ 15,000.00	$ 11,000.00	$ -	$ 26,000.00	$ 15,000.00	$ 3,164.21		$ 18,164.21	$ -	$ 7,835.79	$ -	$ 7,835.79
Objective 2 Subtotal					$ 150,000.00	$ 101,000.00	$ -	**$ 251,000.00**	$ 150,000.00	$ 80,003.66	$ -	$ 230,003.66	$ -	$ 20,996.34	$ -	$ 20,996.34
OBJECTIVE 3: Demonstrate Results																
Task 1: Monitoring					**$35,000.00**	**$ 16,000.00**	**$ 32,000.00**	**$ 83,000.00**								
Professional Services/ Staff Time	50.00	$/ hr	1,100.00	$ 55,000.00	$25,000.00		$ 30,000.00	$ 55,000.00	$ 25,000.00		$ 27,394.71	$ 52,394.71	$ -	$ -	$ 2,605.29	$ 2,605.29
Milleage	0.55	$/ mi	3,636	$ 2,000.00			$ 2,000.00	$ 2,000.00			$ 1,951.60	$ 1,951.60	$ -	$ -	$ 48.40	$ 48.40
Samples	45.00	$/sample	578	$ 26,000.00	$10,000.00	$ 16,000.00		$ 26,000.00	$ 10,000.00	$ 13,965.14		$ 23,965.14	$ -	$ 2,034.86	$ -	$ 2,034.86
Task 2: Reporting					**$30,000.00**	**$ 40,000.00**		**$ 70,000.00**								
Professional Services/ Staff Time	125.00	$/ hr	560.00	$ 70,000.00	$30,000.00	$ 40,000.00		$ 70,000.00	$ 9,869.95	$ 54,093.22		$ 63,963.17	$ 20,130.05	$ (14,093.22)	$ -	$ 6,036.83
Mileage	0.55	$/ mi	0.00	$ -								$ -	$ -	$ -	$ -	$ -
Objective 3 Subtotal					$65,000.00	$56,000.00	$32,000.00	**$153,000.00**	$ 44,869.95	$ 68,058.36	$ 29,346.31	$ 142,274.62	$ 20,130.05	$ (12,058.36)	$ 2,653.69	$ 10,725.38
OBJECTIVE 4: Administration																
Task 1: Fiscal Management & Administration					**$10,000.00**			**$ 10,000.00**								
Professional Services/ Staff Time	50.00	$/ hr	200	$ 10,000.00	$10,000.00				$ 6,899.32			$ 6,899.32	$ 3,100.68	$ -	$ -	$3,100.68
Mileage	0.55	$/ mi	0.00	$ -								$ -				
Objective 4 Subtotal					$10,000.00	$0.00	$0.00	**$ 10,000.00**	$ 6,899.32	$ -	$ -	$ 6,899.32	$3,100.68	$0.00	$0.00	$3,100.68
GRAND TOTALS				$ 459,045.45	$255,000.00	$ 157,000.00	$47,045.45	$ 459,045.45	$227,607.36	$ 148,062.02	$38,150.71	$ 413,820.09	$27,392.64	$ 8,937.98	$8,894.74	$ 45,225.36

ITEMIZED BUDGET

	Budget	Actual
OBJECTIVE 1 - TOTAL	$ 45,045.45	$ 34,642.49
OBJECTIVE 2 - TOTAL	$ 251,000.00	$ 230,003.66
OBJECTIVE 3 - TOTAL	$ 153,000.00	$ 142,274.62
OBJECTIVE 4 - TOTAL	$ 10,000.00	$ 6,899.32
Grand Total	**$ 459,045.45**	**$ 413,820.09**

Original Project	
Original Grant Amount	$ 300,000.00
Original Local Match Share	$ 570,959.80
Original Project Cost	$ 870,959.80
Amended Project	
Amended Grant Amount	$ 255,000.00
Amended Local Match Share	$ 204,045.45
Amended Project Cost	$ 459,045.45

Grant Agreement %	
55.00%	45.00%
Grant	Local Match

Project Expenditures %	
55.00%	45.00%
Grant	Local Match

Appendix A

Project Work Plan

Revised Attachment A
Project Work Plan

2011 EPA Section 319(h) TMDL Implementation Grant Workplan
Targeted Fertilizer Application Reduction Project
Clearwater River Watershed District

Table of Contents

Revised Attachment A
Project Work Plan

1.0 Grant Project Summary

Organization (Grantee): Clearwater River Watershed District (CRWD)

Project Start Date: October 1, 2012
Project End Date: ~~August 31~~ September 30, 2016

Grantee Contact Name Dennis Loewen
Title: Assistant Administrator
Address: Box 481, Annandale, MN 55302
Phone #: (320)274-3935
E-mail: ~~loewen.dennis@yahoo.com~~ cole.loewen@crwd.org

Watershed: Clearwater River Watershed
Lake or Water Body: 11 Lake nutrient impairments, a stream DO and bacteria impairment (Clear Lake, Lake Betsy, Union Lake, Scott Lake, Lake Marie, Lake Louisa, Lake Caroline, Lake Augusta, Swartout Lake, Henshaw Lake, Lake Albion and the Clearwater River)
Latitude/Longitude for Center of Project Area: 45º 15' 48.30"/94º19' 21.53"
County: Meeker, Wright, Stearns

Project Type (check one): X_TMDL Implementation __319 DERA

Grant Amount: ~~$300,000~~ $255,000
Cash Match Funds: ~~$440,960~~ $157,000
In-kind Match Funds: ~~$129,999.80~~ $47,045.45
Total Project Costs: ~~$870,959.80~~ $459,045.45

Project Partners

- **Clearwater River Watershed District**
- **Farmers participating in the study**
- **MN Pollution Control Agency**
- **Local Fertilizer Co-ops**
- **Meeker County (County and SWCD)**
- **Stearns County (County and SWCD)**
- **Wright County (County and SWCD)**

2.0 Statement of Problems and Existing Conditions

Nutrient TMDLs completed for 11 impaired lakes in the Clearwater River Watershed District (CRWD) identified the need to reduce phosphorus load from agricultural sources by 80% to meet state standards. The approved TMDL Implementation Plan identified that aggressive agricultural BMPs are necessary to achieve in-lake water quality standards, and will require widespread farmer participation.

This project targets a sustained 10% annual reduction in fertilizer application rates from 16,000 acres of priority crop land resulting in a 3,200 lb/ annual phosphorus load reduction. This will constitute 13% of the non-point source load reduction required for Lake Betsy as identified in the TMDL and approved

TMDL Implementation Plan, as well as provide additional nutrient load reduction in eight (8) other nutrient impaired downstream lakes and the Clearwater River, which is impaired for low dissolved oxygen and bacteria. Improved water quality in these lakes will also benefit Clearwater Lake, a 3,158 acre high-value recreational lake.

The Clearwater River Watershed is comprised of a chain of lakes on the Clearwater River. The flow-through nature of this system means that load reductions in the upper watershed will have the greatest impact downstream. That is to say, water quality in the lakes upstream is the greatest predictor of water quality in downstream lakes. Therefore, the watershed-wide approved TMDL Implementation Plan identified that early phases of implementation will focus on the upper watershed, the headwaters of the CRWD.

This project focuses on the two headwater lakes of the Clearwater River (Clear Lake and Lake Betsy) and their tributary watersheds. Reducing the non-point source phosphorus loads to these lakes will also benefit the Clearwater River and downstream impaired lakes, which receive large loads of phosphorus from the upstream lakes.

Soil fertilizers are used throughout the watershed and are usually applied to fields at a standard rate, even though soil nutrient levels, soil type, and pH may vary significantly across the field. This project entails systematic gridded soil testing and variable rate GPS-aided application to reduce fertilizer application and thus phosphorus load in agricultural runoff. This approach can be applied throughout the agricultural areas of the state to cut down on fertilizer costs and reduce runoff of nutrients into adjacent water bodies.

Soil tests will be taken on a 2.2 acre grid across up to 16,000 acres of critical cropland to determine the proper amount of fertilizer to be applied to each section of the field. The applicator will use the results of the soil tests and GPS technology to apply the precise amount of fertilizer in each grid of the fields. A 10% average reduction in fertilizer application rates was obtained on test plots in the area as part of a successful small-scale pilot program started in 2009.

The ideal range of phosphorus for crop uptake in agricultural fields is 25-30 ppm. Past soil testing has shown that phosphorus concentrations in soils in the watershed often are in the 35-45 ppm range, and in some cases may be as high as 200 ppm in soils that are over fertilized.

By using site specific fertilizer application, phosphorus concentrations could be maintained closer to the ideal range of 25-30 ppm, which would reduce the excess phosphorus available for runoff.

Priority crop land are those fields located in the upper watershed that drains to Clear Lake and Lake Betsy, which exports a significant phosphorus load to downstream lakes and those in sensitive areas for agricultural runoff, based on proximity to water bodies, slope, and soil type. These criteria are specifically in line with the CRWDs approved TMDL Implementation Plan.

Water quality monitoring will be conducted at drain tile outlets from selected fields. Samples will also be collected from tile outlets in fields that are not a part of the implementation area to be used as

background data for comparison. Crop yields and application rates will also be monitored. The CRWD will also monitor in-lake water quality and watershed loads in the Clearwater River.

This program, developed by an area farmer, has the support of local farmers and local co-ops. The CRWD will manage this program. The SWCDs from Meeker, Stearns and Wright Counties, local farmers, local co-ops and the CRWD will partner to map soil phosphorus on participating farm fields and perform the GPS targeted fertilizer application. The CRWD will recruit participants, monitor and report water quality and crop yields working with its District Engineer. Participating land owners will pay for fertilizer and a $2.50/acre program application fee. Grant funds are requested for soil testing and GPS-aided application. The CRWD, SWCDs and agricultural co-ops will provide education and outreach both in the selection of fields and in the dissemination of information. The CRWD and its engineer will collaborate to perform monitoring, document results and prepare education and outreach materials.

The project will begin when the contract is signed for the grant, and proceed until 16,000 acres have been enrolled in the program. Water quality monitoring will be conducted annually the first four years. The project will be complete in 2016. Interim milestones are results reporting in the CRWDs Annual Monitoring and TMDL Implementation Status Report. Results will also be reported in the Districts newsletter and quarterly reports to land owners. The project materials produced in this project (documented results and education and outreach materials) are intended to be used by other watersheds in the area to support similar projects and successful outreach to clients.

Project success will be gauged by farmer participation in enrolling 16,000 acres in the project. Other successes will include documented reduction in fertilizer application rates, and measured pound per acre load reductions in nitrogen and phosphorus between tile outlets monitored for fields in the program and fields not enrolled.

The relationships the CRWD will forge with farmers through the targeted civic engagement program will be invaluable as future voluntarily load reductions are sought from non-point agricultural sources. The dominant source to impaired waters in this watershed is private agricultural land. Significant load reductions from this source require targeted outreach to area land owners to gain buy-in and participation. This program provides an opportunity to build trust between those charged with water resource protection and the farmers who will need to make changes in their practices to achieve required load reductions to meet state water quality standards.

3.0 Project Goals and Objectives

GOAL: Reduce nutrient loads to CRWD water resources from agricultural lands by reducing fertilizer application through outreach, education, and recruitment of farmers into a program to perform gridded soil tests and GPS-aided fertilizer application of fertilizers. Achieving this goal will provide measurable progress towards water quality goals for several of the Districts impaired waters.

OBJECTIVE 1: Project Coordination

Revised Attachment A
Project Work Plan

Task 1.1 Recruit Participants
Identify and recruit program participants through county parcel and land use data and customer information provided by the co-ops. Applicants to the program will be prioritized based on their location within the watershed and proximity to receiving waters.

Task 1.2 Coordinate with Partners
This task entails coordination with the project partners which include area farmers, co-ops and counties to communicate project goals and objectives, get buy in, and facilitate implementation of the project in the target areas.

Task 1.3 Education and Outreach
This task entails preparation, distribution and presentation of materials for education and outreach to facilitate recruitment of program participants and provide the education about the project goal.

OBJECTIVE 1 Timeline: (2012) August-October, (2013-2015) April- September, (2016) April- September
Responsible Parties: CRWD Board of Managers, CRWD Staff, CRWD Farmers
Estimated Cost: Grant Cash-~~$0~~ $30,000.00 Match-~~$73,999.80~~ $15,045.45 Total-~~$73,999.80~~ $45,045.45

OBJECTIVE 2: Project Implementation
Task 2.1 Gridded Soil Testing
Collect soil samples from participant's fields on a 2.2 acre grid across up to 16,000 acres of critical crop land to determine the fertilizer needs for each field.
Task 2.1 Timeline: (2012) October-November, (2013-2015) September- November, (2016) March-June

Task 2.2 GPS- Aided Fertilizer Application
Use GPS-aided fertilizer application technology to apply fertilizer at variable rates consistent with needs identified in Task 2.1 (gridded soil testing). Fertilizer application will avoid tile intakes, providing a 50 lineal foot buffer where no fertilizer is applied.
Task 2.2 Timeline: (2013-2016) March-~~April~~ June

Responsible Parties: CRWD Staff, CO-OPs, CRWD Farmers
Estimated Cost: Grant Cash-~~$300,000~~ $150,000.00 Match-~~$344,960.00,~~ $101,000.00
Total-~~$644,960.00~~ $251,000.00

OBJECTIVE 3: Demonstrate Results
Task 3.1 Water Quality Monitoring
Water quality monitoring will be conducted at drain tile outlets from selected fields including both farms that are and are not participating in the program. Flow will be monitored as well as total and soluble phosphorus, nitrogen series, total suspended solids and field parameters. In addition to testing loads from individual fields, receiving water quality will also be tracked. Stream flow and water quality will be measured at 3 to 5 locations in the upper watershed to track changes in nutrient loads and concentrations resulting from implementation of the program. Flow, total phosphorus, soluble phosphorus, total suspended solids, nitrogen series and field parameters will be measured. Annual average lake water quality will also be tracked by measuring total phosphorus,

chlorophyll-*a*, Secchi depth and field parameters. The lab used for follow-up monitoring will be Water Laboratories Inc. in Elk River, and/ or MVTL for any work that cannot be done by Water Laboratories Inc.

Task 3.2 Report Results
Results will be reported annually for each year of the program in the CRWD's Annual Monitoring Report, and in an annual update brochure. The report will detail not only the extent of program application and reductions in fertilizer application over standard practice, but also corresponding water quality results. The evaluation and reporting will also entail recommendations as to any course corrections needed to optimize the program implementation and achieve the maximum load reduction possible. A major element of reporting the results will be to include a section on cost savings for farmers in terms of using this method of fertilizer application versus the standard. The goal of reporting and widely distributing these data is to make this type of nutrient management the normative behavior among agricultural producers in the area without supplying additional funding. Simply put, the goal of the project is to demonstrate the benefits so that that this practice is self sustaining.

Objective 3 Timeline: (2013-2016) March-~~April~~ September
Responsible Parties: CRWD Staff, CRWD Farmers, CRWD Engineer, CRWD Lab
Estimated Cost: Grant Cash-$~~0~~ $30,000.00 Match-$~~136,000.00~~ $40,000.00
Total-$~~136,000.00~~ $70,000.00

OBJECTIVE 4: Fiscal Management and Administration
Task 4.1 Fiscal Management
Track, manage, and report on project finances as necessary and required.
Task 4.1 Timeline: (2012) November-December, (2013-2015) January- February & November-December, (2016) January-September

Task 4.2 Administration
Track, manage, and report on administrative project elements as necessary and required.
Task 4.2 Timeline: August 2012 – September 2016

Responsible Parties: CRWD Board of Managers, CRWD Staff
Estimated Cost: Grant Cash-$~~0~~ 10,000.00 Match $~~16,000.00~~ $0.00
Total-$~~16,000.00~~ $10,000.00

4.0 Roles and Responsibilities

Table 1 identifies the roles and responsibilities for the Project.

5.0 Identification and Summary of Project Elements

The project entails four (4) elements, which correspond with the project objectives. They are listed and described below.

1. Project Coordination: This project element includes recruiting project participants and coordinating with project partners and preparing and delivering materials to education both participants and project partners.

2. Implement the Project: This project element includes gridded soil testing and GPS aided application of fertilizer on the targeted areas.
3. Demonstrate Results: This project element includes hydrologic, hydraulic, water quality monitoring to document the impact of the project and communicate results.
4. Fiscal Management and Administration: Secure necessary project permitting with appropriate agencies. Track, manage, and report on project finances and administrative project elements as necessary and required.

6.0 Milestone Schedule

See ~~figure 3~~Revised Attachment A – Gantt chart, the Gantt chart for the project.

7.0 Implementation Monitoring and Evaluation

To evaluate the efficacy of the program, data collected in advance of program implementation, will be compared to data collected during implementation. Annual data collection will include the following:

1. Flow will be measured at three to five upper watershed locations during the flow season (generally April- October). Discrete flow measurements will be used to develop the flow record. Measurements will be collected up to daily in the spring and at high flows, and weekly during low-flows that occur during the summer.
2. Water quality will be measured at the same stations concurrently with discrete flow measurements. Parameters may include total and soluble phosphorus, total suspended solids, nitrogen series, TSS, chlorophyll-*a,* and field parameters. Data will be collected to track changes in nutrient loads in the receiving waters.
3. Flow and water quality will also be measured at drain tile outlets for 4 fields, two which are participating in the program, and two that are not participating. Parameters may include total and soluble phosphorus, total suspended solids, nitrogen series, TSS, chlorophyll-*a*, and field parameters.
4. Lake water quality will also be measured. Total and soluble phosphorus, chlorophyll-*a*, Secchi depth and field parameters will be measured monthly May to September.

8.0 Watershed Assessment

A thorough assessment of the watershed was conducted as part of the watershed-wide TMDL studies and Implementation Plan done for the CRWD. These assessments can be found in the following reports:

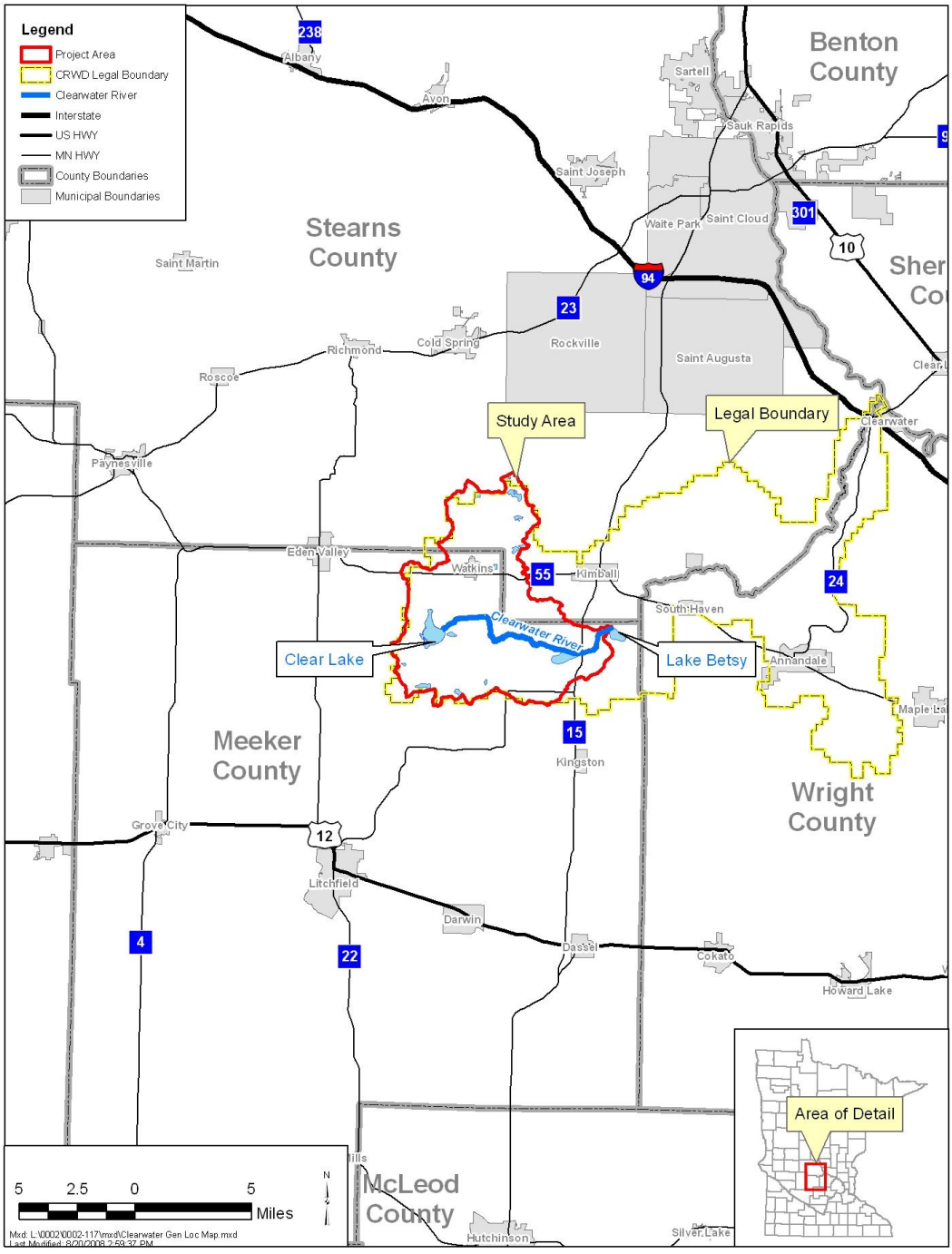
- Upper Watershed TMDL Studies for the Clearwater River Watershed District (EPA Approved May 2010)
- Dissolved Oxygen TMDL for the Clearwater River: Clear Lake to Lake Betsy (May 2010)
- Five Lakes Nutrient TMDL for: Lake Caroline, Lake Augusta, Albion Lake, Henshaw Lake and Swartout Lake (May 2010)
- Clearwater River Watershed District Watershed Protection and Improvement Plan (TMDL Implementation Plan) (May 2010)

9.0 Maps

Figures 1 and 2 show~~s~~ the location of the CRWD, the location of impaired waters, and the project location.

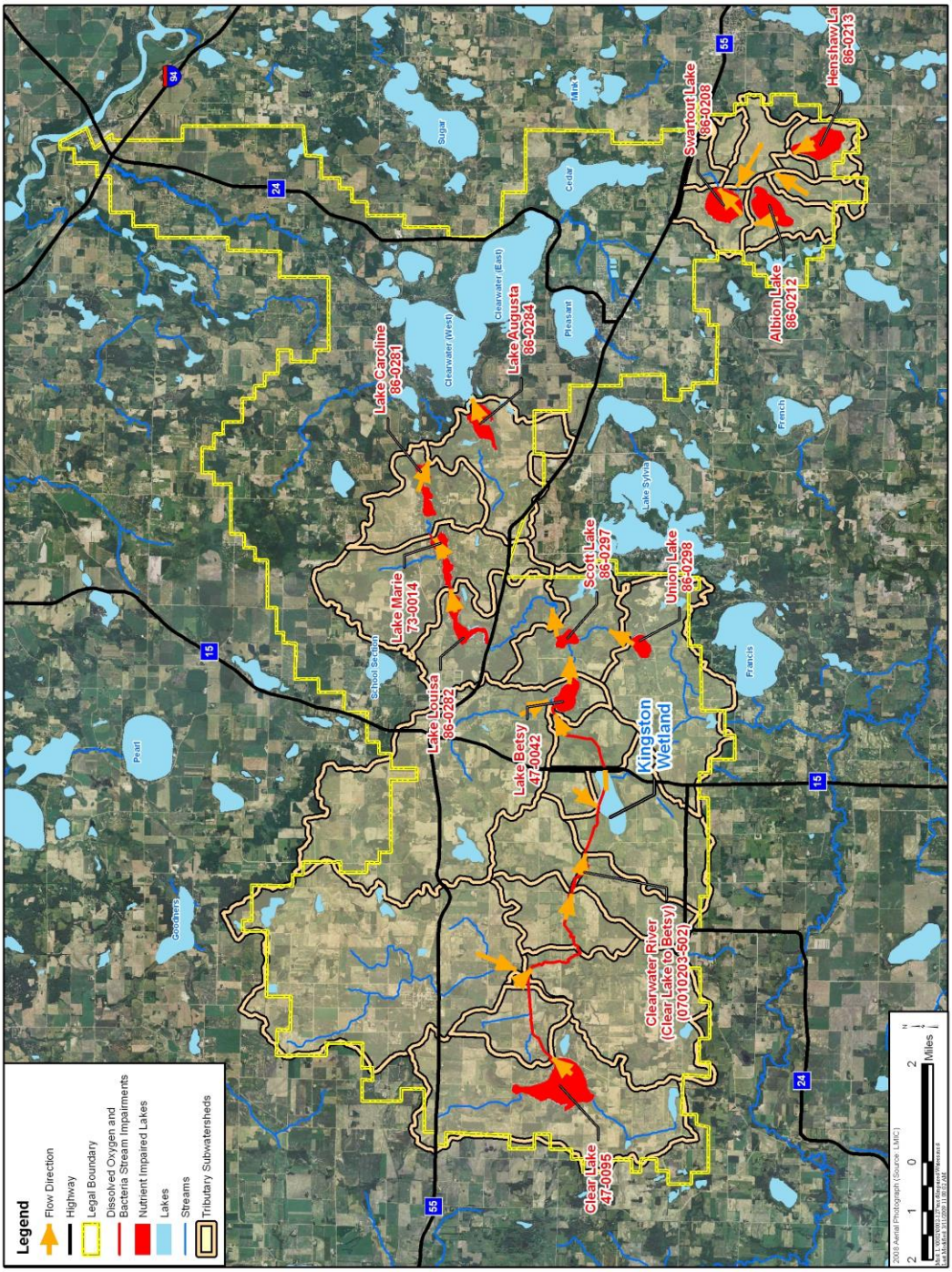
<u>Revised</u> Attachment A
Project Work Plan

Figure 1. Watershed Location



<u>Revised</u> Attachment A
Project Work Plan

Figure 2. Impaired Waters in CRWD/ Project Location



*** Shaded areas are tributary to impaired waters and will be priority implementation zones.**

10.0 Quality Assurance and Quality Control Procedures

The CRWD will work with the MPCA to develop an approved Quality Assurance Project Plan to meet the requirements specific to this project.

11.0 Clear and Measurable Outcomes

The project will be considered successful if the following specific targeted outcomes are achieved:

- Recruit farmers on up to 16,000 acres of agricultural lands in targeted areas into program.
- Implement program on up to 16,000 acres of agricultural lands for the duration of the program.
- Annual monitoring is conducted to track results.
- Measureable results are documented in annual monitoring report for the duration of program and annual program brochure.
- Local partners are engaged to cooperate in the project, measured by participation in program.

Appendix B

Producer Survey Results- Targeted Fertilizer Project

Clearwater River
WATERSHED DISTRICT
Promote | Protect |

CLEARWATER RIVER WATERSHED DISTRICT
75 Elm Street East, P.O.BOX 481
Annandale, MN 55302
(320) 274-3935 **|** www.crwd.org

OFFICE MEMORANDUM

TO: BOARD OF MANAGERS

FROM: Administrator Loewen

DATE: 4/8/2016

SUBJECT: Producer Survey Results- Targeted Fertilizer Project

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Summary
As part of the Targeted Fertilizer Project, a survey was mailed to all producers participating in the program. Of the 74 surveys mailed, 23 responses were received (response rate 31.08%). Respondents were given the option to submit responses via a web-based survey; no respondent took advantage of this option.

Some noteworthy highlights:

- No respondent indicate a decrease in yields due to the program
- All respondents indicate they are likely to continue targeted fertilizer practices
- 70% of respondents indicate reduced fertilizer costs | 57% of respondents indicate increased yields | 61% of respondents indicate increased profitability
- 39% of respondents indicate increase in fertilizer costs | 26% decrease in said costs
- 70-78% of respondents likely to recommend program to others

Estimated cost to complete this survey was $730.00. Cost breakdown is as follows:

- $112.50 for 74 mailers. Per mailer cost is $1.52, cost includes stamps, envelopes (including return envelopes), ink, paper
- $617.50 for staff time to create survey, handle mailing, process returns and generate summary report (19 hours total)

Staff recommends the Board consider making such exit surveys a standard practice for future CRWD programs, as the data collected provides useful socio-economic insights into the effectiveness of said program, as a relatedly low cost.

Summary of responses to individual questions
Figures 1-11 below summarize answers to each of the eight questions in the survey. Written responses are summarized in table 1-6.

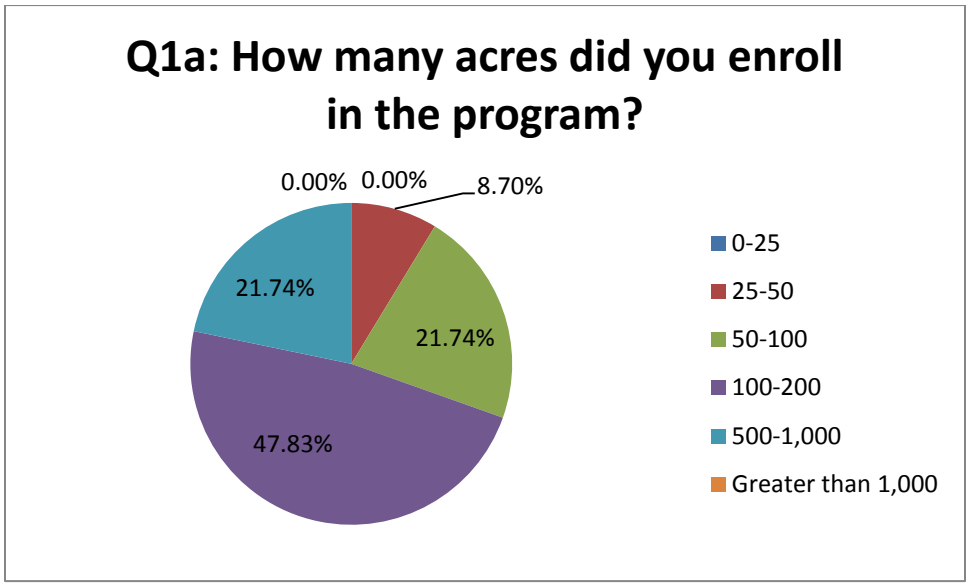

Figure 5: Question one, part "A" responses

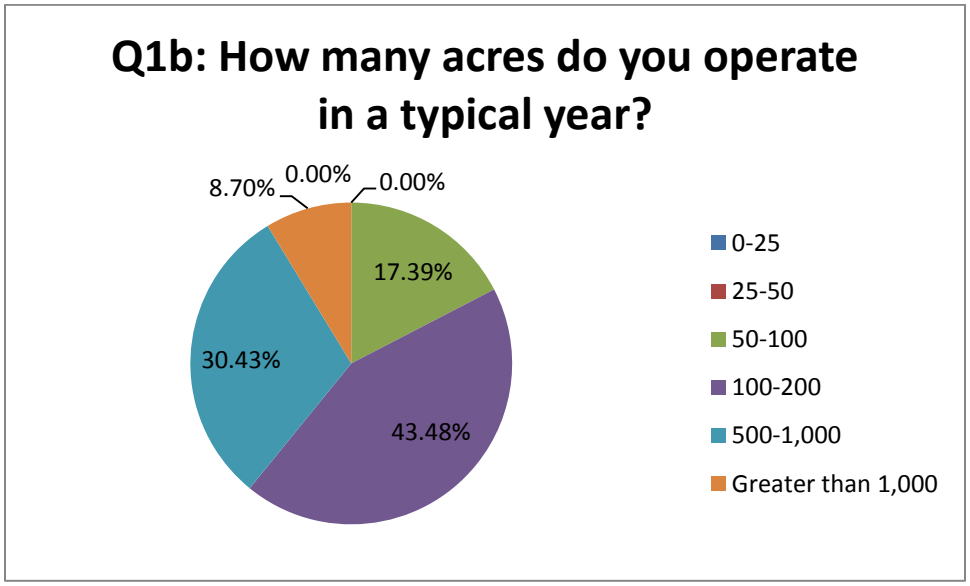

Figure 6: Question one, part "B" responses

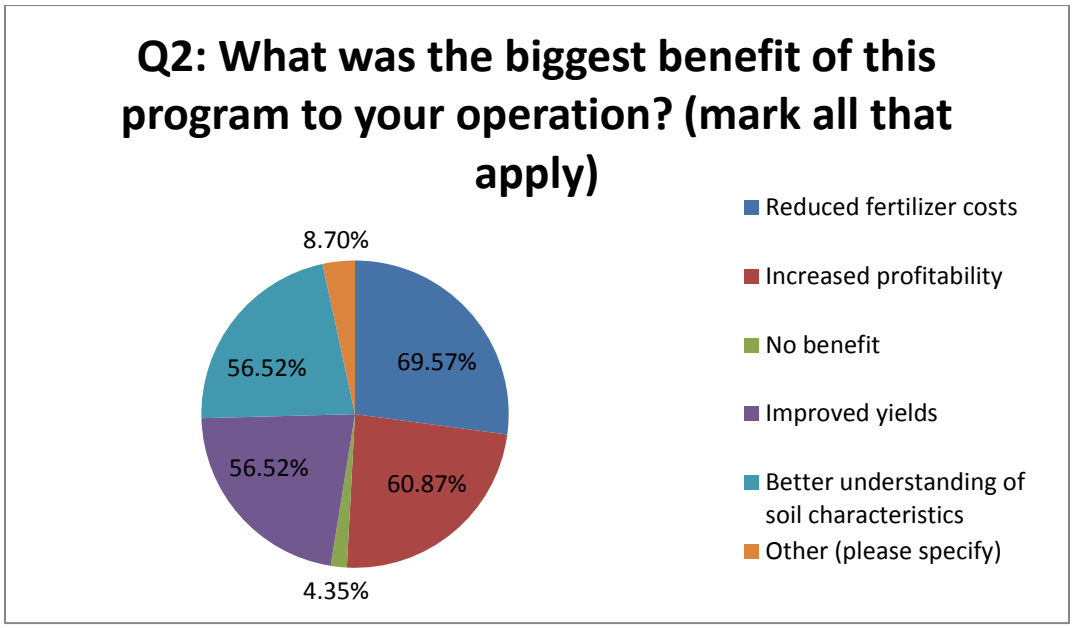

Figure 7: Question two responses

Table 1: Responses to question two's "other" category

#	"Other" responses
1	How some farms needed very little fertilizer and some needed more than I would have guessed.
2	The only benefit I could see was not to over fertilizer certain areas of the field. Overall yield had no noticeable change.
3	Put the fertilizer and lime where it was needed most by grid sampling.

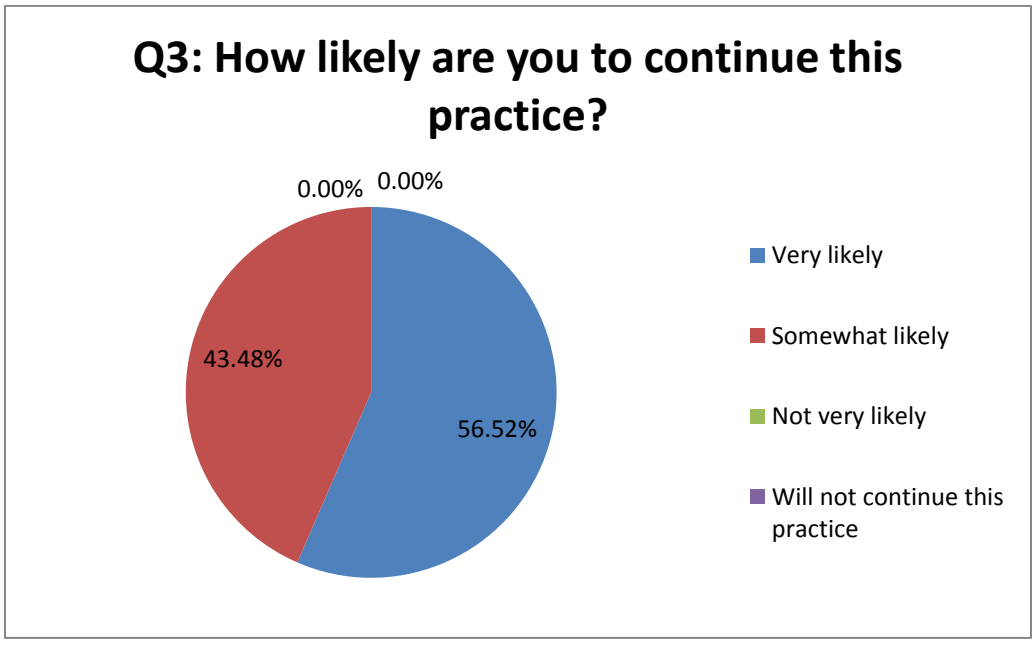

Figure 8: Question three responses

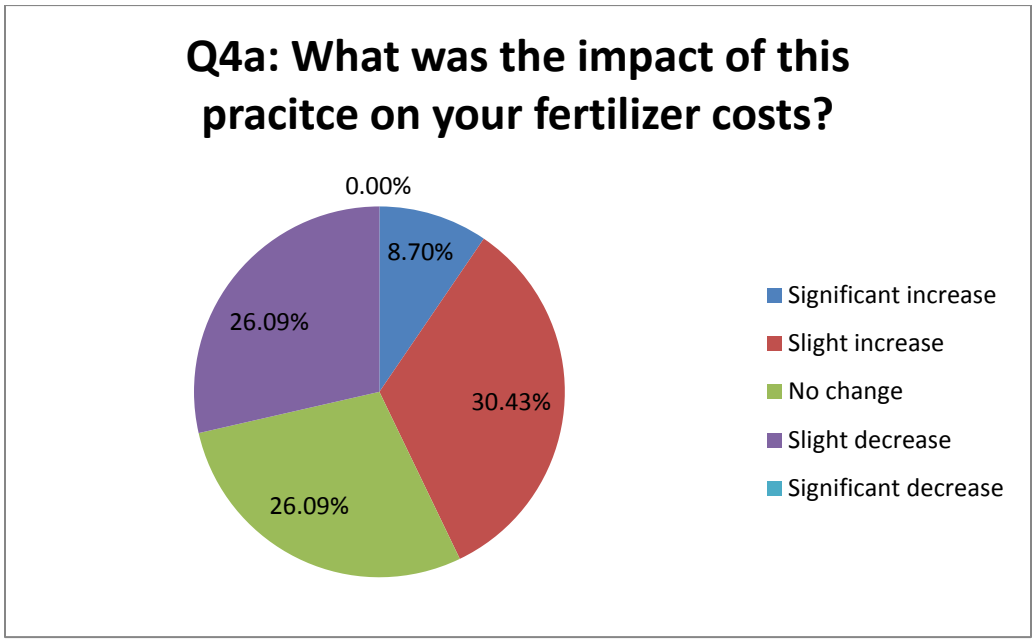

Figure 9: Question four, part "A" responses

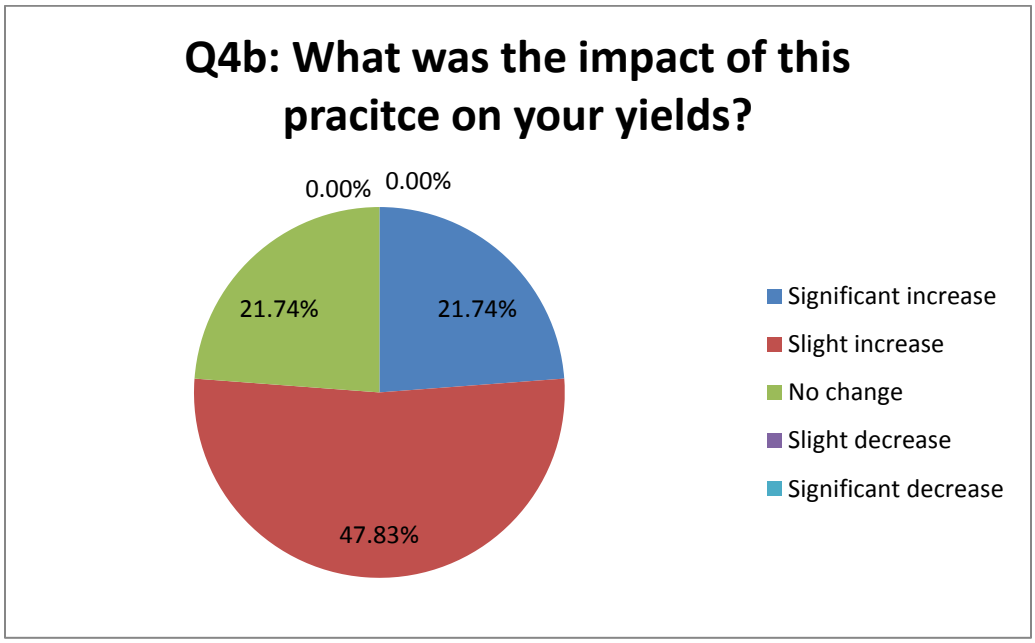

Figure 10: Question four, part "B" responses

Table 2: Question four's reasons for answers

#	Reason for answers
1	Less fertilizer used but more lime, corn yields up 5 bushels per acre.
2	Some farms we spent a lot more & some very little. Lots of lime which I have never done before. Yields have been very good but this year everyone's yields were.
3	It was a very good year for crops.
4	It helped us to know what our soil nutrients were so we did not over-fertilize.
5	Need to put done more lime. Held back on high price fertilizer in previous years. The best yields ever were last year, as fertilizer was placed where it was needed.
6	Going back over a ten year history on my fields saw no changes.

#	Reason for answers
7	Moved fertilizer to areas that needed it.
8	Don't know impact.
9	I have only been fertilizing on year 2015 and for the first time applied lime. I do expect to have yields increase this second year because of better placement of fertilizer, when put on by the fertilizer plant's equipment.
10	I have not harvested a crop yet. I have been on a build program making my fields more productive. Grid sampling will help me manage that when I reach the goals I am after.

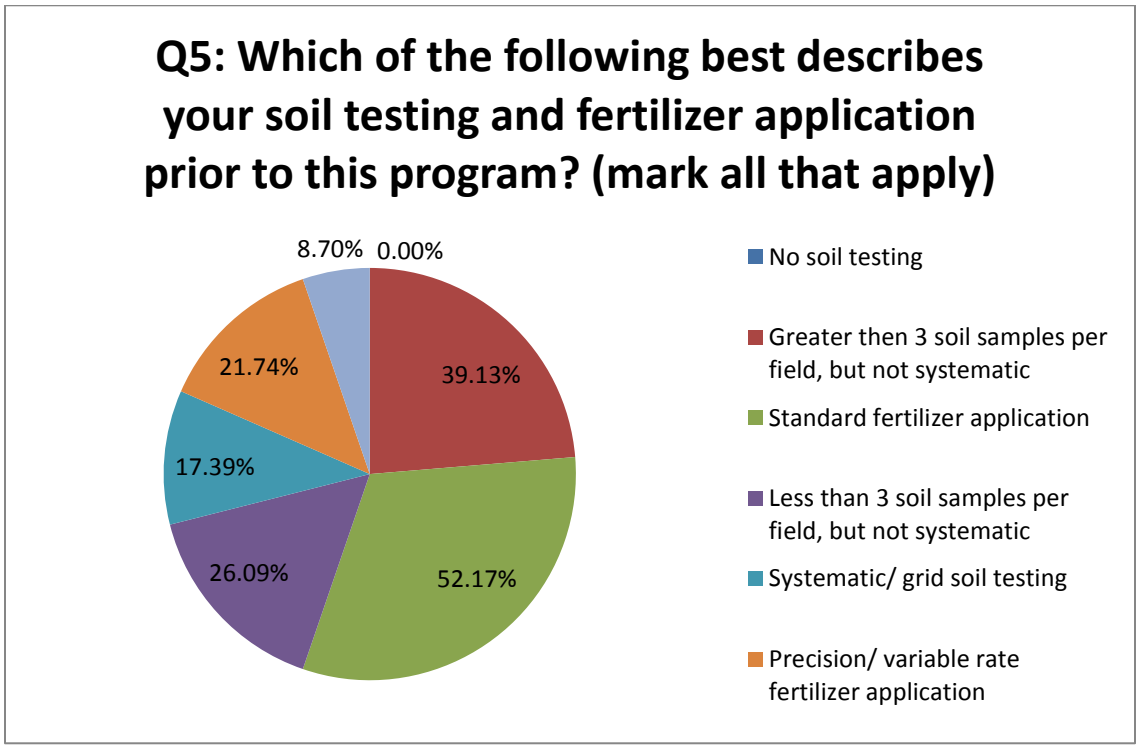

Figure 11: Question five responses

Table 3: Responses to question five's "other" category

#	"Other" responses
1	Soil samples taken once every 4-5 years.
2	Four tests per field.

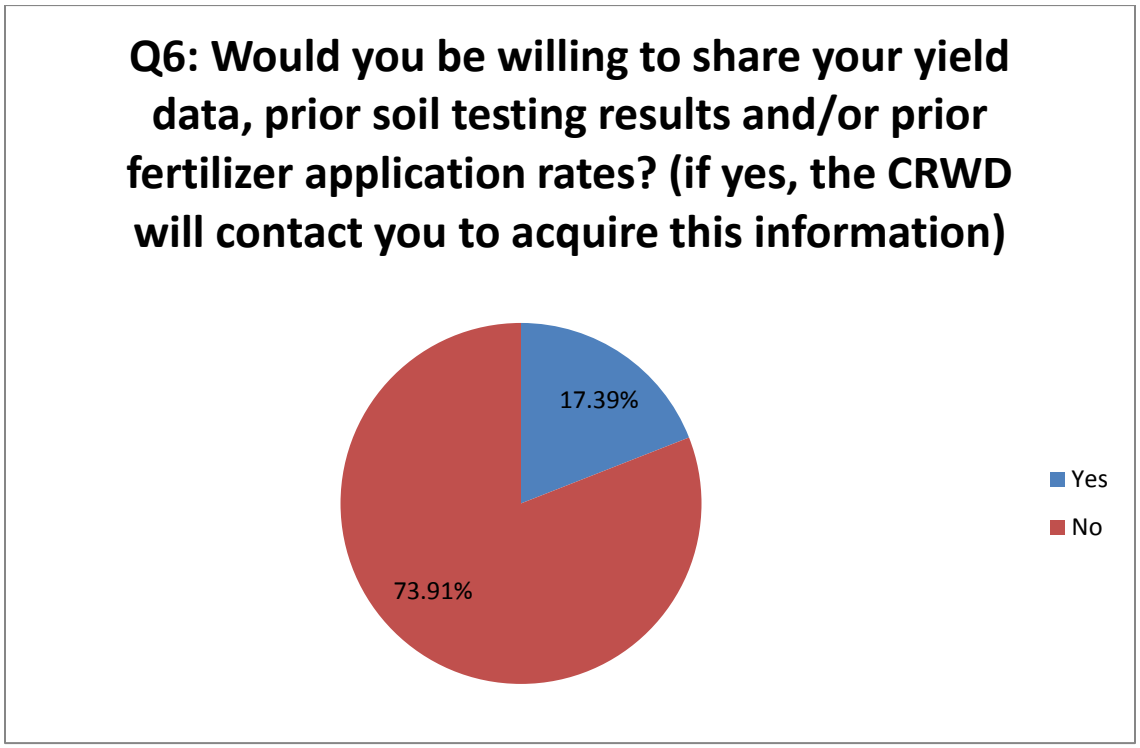

Figure 12: Question six responses

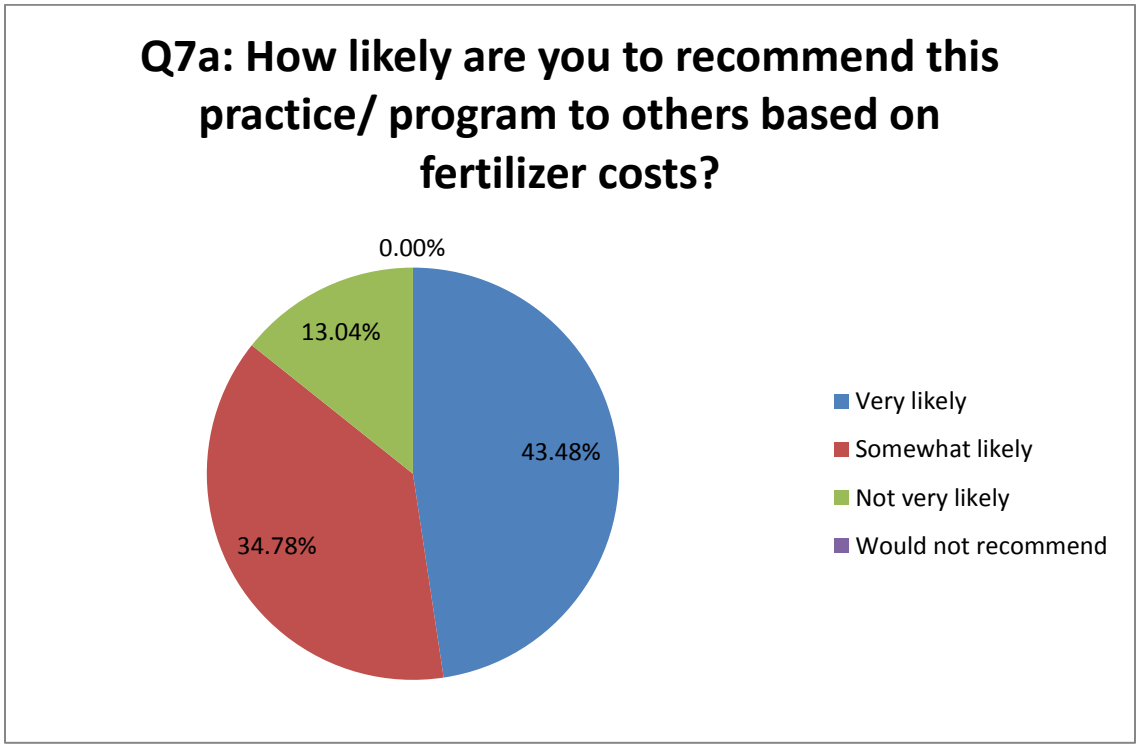

Figure 13: Question seven, part "A" responses

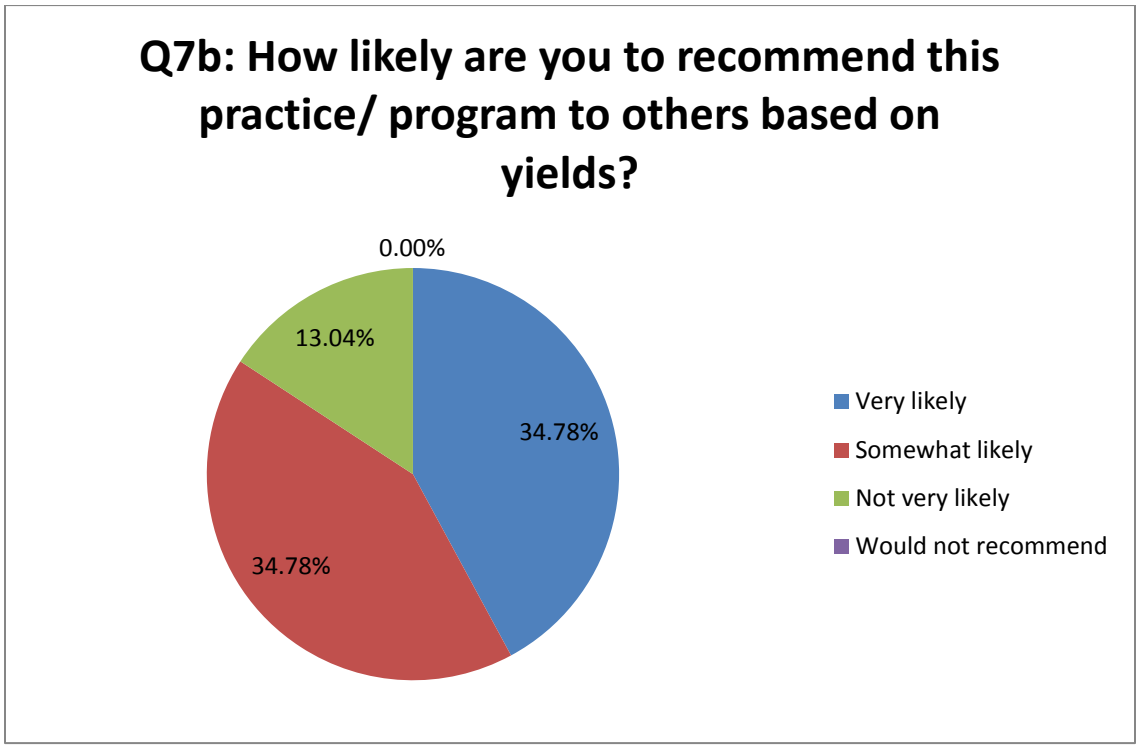

Figure 14: Question seven, part "B" responses

Table 4: Question seven's reasons for answers

#	Reason for answers
1	On the fertilizer you can save a lot on some fields, with the current pH you can also make better use of the fertilizer that is there. You can see that manure can be used better on the poorer fertilizer farms, which has goo yield impact.
2	To show them you don't have to over-fertilize to get good yields.
3	A win-win for keeping costs down, but most of all keep the lakes & river clean and groundwater safe.
4	No significant change in cost or yield.
5	It can be a hassle.
6	Targeted application will reduce total fertilizer use.
7	Not sure I understand what you are asking.
8	Understanding the volatility of the fertilizer is very important to taking care of our water quality.

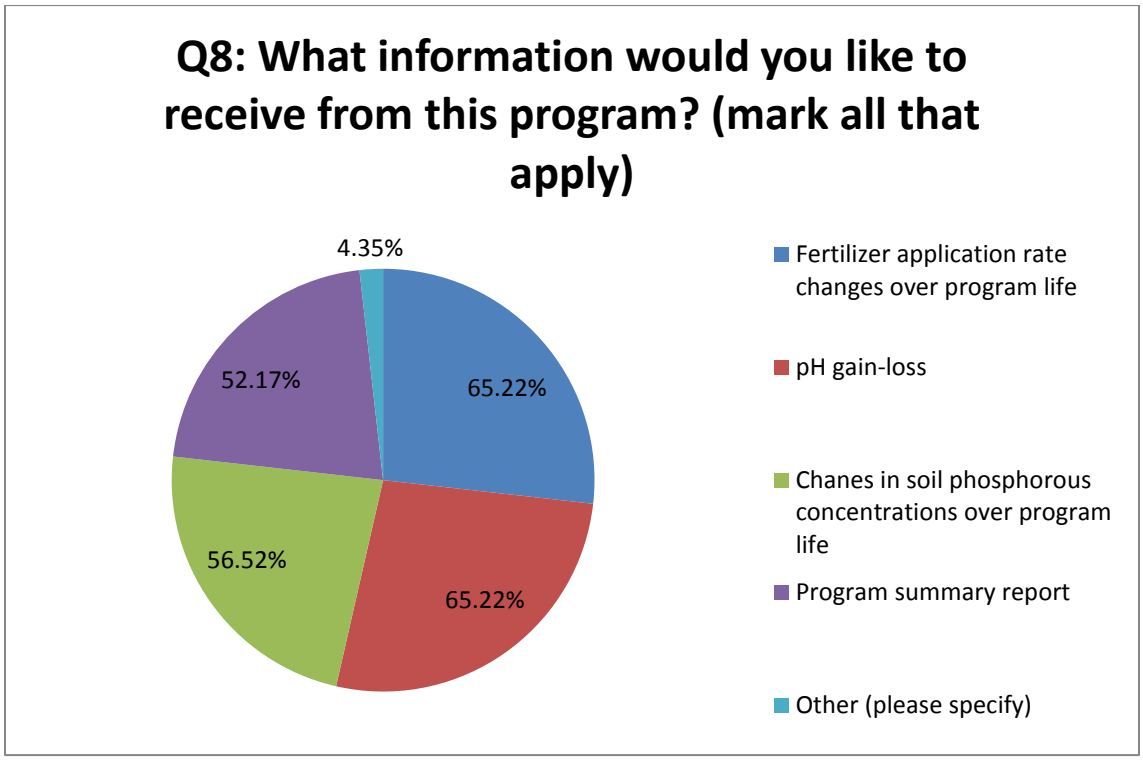

Figure 15: Question eight responses

Table 5: Responses to question eight's "other" category

#	"Other" responses
1	How little fertilizer we can get by with and use of cover crops to save soil. No till would be the best.

Table 6: Question nine: any additional comments on the program?

#	Additional comments
1	It worked to our benefit as well as lowering phosphorus level overall (I hope)!!
2	I really believe in grid, as I started in 1995 but was put on hold until this program started.
3	Soil sampling was great but I would have done that on my own. I would like to see your results.
4	This program was fine but the fertilizer plants had no applicators to put on the right amount.

Responsive partner.
Exceptional outcomes.

Toll Free: 800-472-2232 **Email: wenckmp@wenck.com** **Web: wenck.com**

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Windom
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Woodbury
651-294-4580

COLORADO
Denver
800-472-2232
Fort Collins
970-223-4705

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678-987-5840

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800-472-2232

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