

Section 319 Nonpoint Source Pollution Control Program Watershed Project Final Report

Hardwood Creek TMDL Implementation Project

By

The Rice Creek Watershed District



September 2014

This project was conducted in cooperation with the State of Minnesota and the United States Environmental Protection Agency, Region 5.

Grant # B42568

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Grant Project Summary

Project title: Hardwood Creek TMDL Implementation Project

Organization (Grantee): Rice Creek Watershed District

Project start date: 10/1/2009 Project end date: 8/29/2014 Report submittal date: 10/03/2014

Grantee contact name: Phil Belfiori Title: Administrator

Address: 4325 Pheasant Ridge Drive NE, Ste 611

City: Blaine State: MN Zip: 55449

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Basin (Red, Minnesota, St. Croix, etc.): Upper Mississippi - 07010206 County: Anoka, Washington

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: \$326,264.72 Final total project costs: 594,117.25

Matching funds: Final cash: \$256,552.53 Final in-kind: 11,300.00 Final Loan: \$

Contract number: B42568 MPCA project manager: Chris Zadak

For TMDL Development or TMDL Implementation Projects only

Impaired reach name(s): Hardwood Creek

AUID or DNR Lake ID(s): 07010206-596

Listed pollutant(s): Total Suspended Solids (TSS) and Biological Oxygen Demand (BOD)

303(d) List scheduled start date: _____ Scheduled completion date: _____

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

Executive Summary of Project (300 words or less)

This summary will help us prepare the Watershed Achievements Report to the Environmental Protection Agency. (Include any specific project history, purpose, and timeline.)

Hardwood Creek was listed on Minnesota's 303(d) List of Impaired Waters, as not supporting aquatic life. The Creek was listed for biota and low dissolved oxygen. The resulting Total Maximum Daily Load Study found the primary stressors on biota to be 1) loss of habitat due to sedimentation, and 2) low dissolved oxygen. To address loss of habitat due to sedimentation, the Hardwood Creek TMDL Implementation Plan recommended projects that reduced concentrations of total suspended solids (TSS) – mostly by reducing in-stream erosion. To address low dissolved oxygen, the Implementation Plan recommended livestock Best Management Practices (BMPs). The *Hardwood Creek TMDL Implementation Project* addressed both recommendations. To reduce TSS concentrations, field surveys and models identified the location and relative magnitude of in-stream erosion. On a site in Hugo, MN, eroding stream banks were stabilized by creating a floodplain bench (i.e. two-stage channel). By constructing a floodplain bench, flood flow energy was reduced, resulting in more stable stream banks. At a site in Lino Lakes, MN, a previously channelized stream reach was restored to a natural meandering pattern. Prior to restoration, this channelized section was actively widening, resulting in bank erosion and very poor in-stream habitat. Additionally, the channelization resulted in abandonment of adjacent floodplain wetlands, leaving no depositional areas for flood flow sediment. Following restoration, this reach is stable, connected to floodplain wetlands during flood flow, and has greatly improved in-stream habitat. To address low dissolved oxygen, we designed and installed livestock BMPs on a farm operating in the riparian area of Hardwood Creek. These BMPs include two stable stream crossings, a livestock fence, and “managed rotational” livestock grazing plan. Monitoring at all sites is ongoing. Preliminary results indicate a decrease in TSS and BOD.

Goals (Include three primary goals for this project.)

- 1st Goal: Reduce Average Annual Total Suspended Solids Concentrations to 19 mg/L or less
- 2nd Goal: Reduce Average Annual Biological Oxygen Demand Concentrations to 3.2 mg/L or less
- 3rd Goal: Improve in-stream habitat for fish and invertebrates

Results that count (Include the results from your established goals.)

- 1st Result: Average annual TSS concentrations are meeting goal (<19 mg/L)
- 2nd Result: Average annual BOD concentrations are meeting goal (<3.2 mg/L)
- 3rd Result: 950 feet of channel stabilized, 2150 feet of stream meander restoration; 5 livestock BMPs; 1 conservation easement with 1500 feet of buffer strip establishment

Picture (Attach at least one picture, do not imbed into this document.)

Description/location:

"Meander_Pre": This photo shows the condition of the channelized portion of Hardwood Creek prior to restoration. The straight pattern led to erosion (widening) and loss of habitat.

"Meander_Post": This is the channelized portion of the Creek after it was connected to its original, meandering pattern. The channel is stable, with greatly improved habitat.

"2stage_pre": Pre-project, this channel is incised, and laterally unstable. Much erosion.

"2stage_post": Post-project, this channel has a constructed floodplain bench, and is laterally stable. Habitat improved.

Acronyms (Name all project acronyms and their meanings.)

TMDL – Total Maximum Daily Load

TSS – Total Suspended Solids

BOD – Biochemical Oxygen Demand

DO – Dissolved Oxygen

IBI – Index of Biotic Integrity

RCWD – Rice Creek Watershed District

WCD – Washington Conservation District

BMP – Best Management Practice

MPCA – Minnesota Pollution Control Agency

EDA – Environmental Data Access system (MPCA)

Partnerships (Name all partners and indicate relationship to project)

Washington Conservation District – Assisted with livestock management site design

Work Plan Review

This section will list and report on each of the Objectives and Tasks outlined in the approved grant workplan. There were no changes to the original workplan, staff, or participating organizations.

Objective 1. Planning and Organization

The project implementation team consisted of RCWD Staff, WCD Staff, and consulting engineers. The engineers were chosen based on 1) technical expertise in the field of stream restoration, 2) past success in implementing stream restoration projects, and 3) cost. The consulting engineers were SRF, Inc. and Inter-Fluve, Inc.

To implement Objective 2, a contractor was selected following Minnesota Municipal Contracting Law. The contractor for the project was Sunram Construction, Inc.

Project Team Roles:

RCWD Staff – Manage all aspects of the project, work with landowners and secure access agreements / easements, monitoring and data collection (Objective 3), and livestock BMP design and installation

WCD Staff – Design for livestock BMPs

SRF Inc. – Prepare stream restoration plans and specifications, select and manage contractor

Inter-Fluve Inc. – Stream restoration design

Meetings were held at least quarterly to ensure adherence to the workplan, budget, and project goals.

Objective 2. BMP Implementation

Task 1. Streambank Stabilization and In-stream Improvements

As identified in the semi-annual grant reports, the number of sites at which streambank stabilization occurred decreased. However, the scale of the work at the sites increased dramatically. This change was based on recommendations from the design engineer, Inter-Fluve Inc.

The primary streambank stabilization activities occurred on a reach in Hugo, MN. This reach had become incised, and was vertically separated from the floodplain. Flood flows were contained within the channel. Stream banks were steep and eroding; the creek was actively widening - i.e. Stage 3 in the Channel Evolution Model (Schumm et al 1984) (Figure 1). To reduce erosion, and bring the channel in a stable state, a floodplain bench was excavated (Figure 2). The intent was to “push” the stream evolution forward to Stage 5 in the channel evolution. A floodplain bench was excavated at approximately at 1-year return flood elevation, and stabilized using native grasses, shrubs and trees (Figure 3). Two full years after construction, the streambank stabilization site remains stable, with no indication of in-stream erosion. **RESULT: 950 feet of channel were stabilized.**



Figure 1. Streambank stabilization site, prior to restoration



Figure 2. Streambank stabilization site immediately following construction



Figure 3. Streambank stabilization site 1.5 years after construction

A secondary streambank stabilization site was identified later during the grant timeline. This site is located in Hugo, MN, along a ditched portion of Hardwood Creek (Judicial Ditch 2). At this site, intensive row-crop agricultural activities were occurring within the riparian area. Edge-of-field erosion was carrying sediment directly to Hardwood Creek, while the lack of vegetation was resulting in bank erosion. A semi-permanent easement was purchased from the landowner, creating a 50-100 foot grass buffer between the field and the stream. **RESULT: The conservation easement created 1500 feet of buffer strip.**

The primary challenge with Task 1 was gaining landowner approval, and securing access rights. This obstacle was overcome with extra meetings, site reviews, and dropping the requirements for permanent easement.

Task 2. Monitoring and Repair of Stabilized Sites

Streambank stabilization sites were monitored during the course of the project. Following very high creek flows in the Spring of both 2013 and 2014, some minor repair and re-planting was necessary. However, this task ended up being less costly than originally estimated.

Task 3. Upper Hardwood Creek (JD2) Repairs

As part of ongoing annual ditch maintenance in the upper Hardwood Creek / Judicial Ditch 2 watershed, bank failures were identified and stabilized following guidance provided in Appendix D (Ditch Maintenance BMPs) of the Hardwood Creek TMDL report.

Task 4. Meander Restoration

As identified in the original workplan, meander restoration was the largest single component of the Hardwood Creek TMDL Implementation Project. This task was implemented as described in the original workplan, and as envisioned in the Hardwood Creek TMDL Implementation Plan.

The meander restoration site was located in Lino Lakes, MN. The reach is immediately adjacent, and to the west of Interstate 35E. This reach was channelized during the construction of Interstate 35E, sometime during the 1970's. Figure 4 shows the creek pattern prior to, and after channelization.

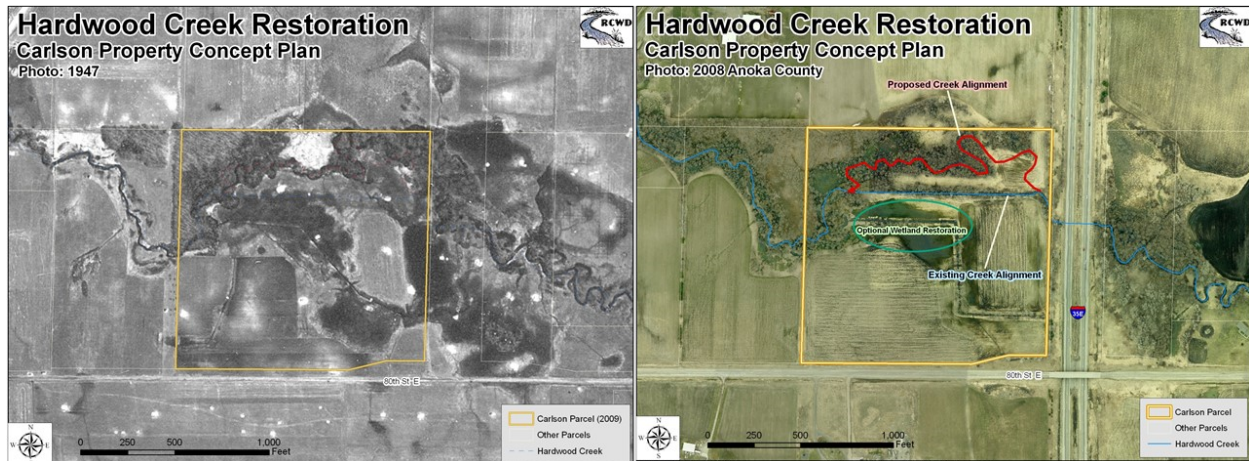


Figure 4. The meander restoration project site, prior to and after historic channelization

The channelization abandoned approximately 2000 feet of natural channel. The resulting ditch had an increase in sediment transport capacity, manifested in eroding and actively widening stream banks. Additionally, the stream no longer had access to the floodplain; ditch spoils were deposited on the banks, creating a dike effect.

To decrease sediment transport capacity, and reconnect the stream to the original floodplain, the Hardwood Creek TMDL Implementation Project reconnected this channelized reach to its original meandering pattern. This concept is shown in Figure 4, and a post-project photograph is shown in Figure 5.



Figure 5. Aerial view of the meander restoration site, showing the newly meandered channel, the old channelized section (filled during construction), and Interstate 35E.

The process for this task began with concept designs and modeling. Concepts were modeled with HEC-RAS to determine feasibility. The proposed pattern closely matched the historic pattern, and added

2150 feet of new channel. Once it was determined that the concepts were feasible, final plans were created. Construction occurred in two phases. During phase 1, the new meander pattern was excavated. Bank protection devices, such as root wads and live stakes, were installed. Native grasses, shrubs, and trees were planted. However, “plugs” were left at the up- and downstream end of the new pattern, keeping it offline while vegetation could establish. Phase 2 of construction occurred one year later. Plugs were removed, and water was allowed to flow through the new pattern. The old, channelized section was filled to the elevation of the surrounding landscape (floodplain wetland).

The newly meandered pattern has been online for one full season. The reach has remained stable, without any indication of bank or bed erosion, despite 2014 having some of the highest flows in nearly 10 years. **RESULT: 2150 feet of meandered and stabilized channel was added, which reestablished connection to adjacent floodplain wetlands.**

There were several problems encountered during Task 4. First, securing access from the landowner proved very difficult. Concerns about loss of “buildable / developable” land nearly derailed the project. This was overcome through *many* meetings with the landowner and their real estate representative. Ultimately, access was secured by purchasing a temporary easement. The overall Hardwood Creek TMDL Implementation Project was delayed by about 1 year due to extra work encountered in this task.

Task 5. Livestock Management

This task was implemented on a property in Hugo, MN. On this property, livestock (cattle) had direct access to the Hardwood Creek. Repeated crossings at low areas, along with patches of overgrazing, was resulting in streambank, bed, and overland erosion.

Livestock management activities that occurred during the Hardwood Creek TMDL Implementation project include the installation of two stable cattle crossings (following guidance from NRCS Conservation Practice Standard 578-1), a grazing management fence, and a “managed rotational” grazing plan. Additionally, a drain tile causing massive stream bank erosion was re-routed on this property. The new tile outlet provides a grass buffer for filtration.

During the development of the grant application and workplan, it was assumed that an exclusion livestock fence would be constructed – that is, a fence that would completely exclude cattle from the stream. Thus, the cost estimate for this activity included many dollars for fence materials and installation. Ultimately, the land owner was firmly against a long, and complex exclusion fence. The short section of fence that was constructed provides for managed rotational grazing, but does not exclude cattle from the stream. While not ideal, this represents a major improvement from the pre-project condition. This change in project design resulted in lower than anticipated costs (approx. \$18,000 less).

This task is summarized in Figure 6. **RESULT: 5 livestock management BMPs were installed, including the grazing management plan.**

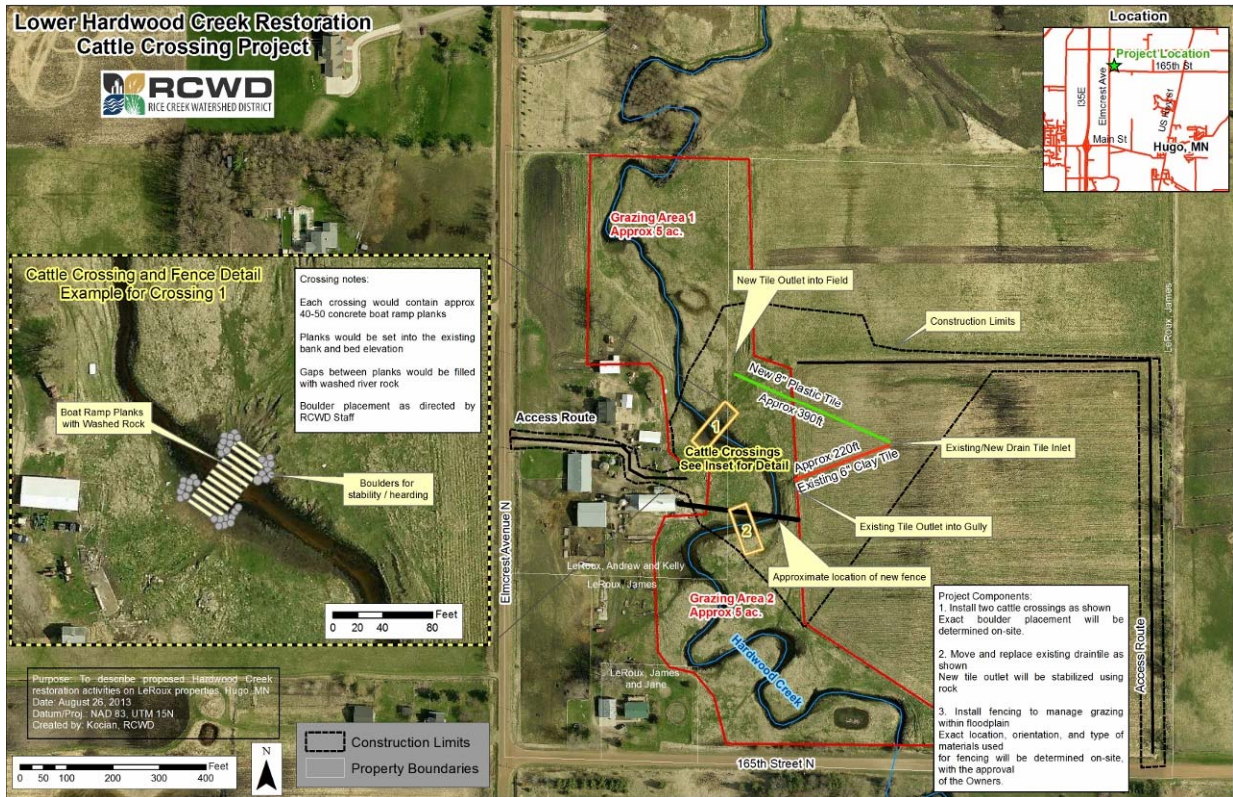


Figure 6. Livestock management concept (constructed as shown)

Task 6. Easements

A temporary easement was secured on the meander restoration site for the purposed of construction. A semi-permanent easement was secured at another site to create a grass buffer. All project sites contain sufficient existing regulatory protections (e.g. DNR Public Waters jurisdiction, Wetland Conservation Act, RCWD floodplain protection, etc.) to ensure long-term viability of this project.

Objective 3. Monitoring and Data Collection

Task 1. Flow and water quality monitoring

Flow and water quality data were collected as described in the workplan. This includes continuous flow data, and bi-monthly water samples that were analyzed for phosphorus (both total and dissolved), TSS, and nitrogen (both nitrate/nitrite and total). Additionally, samples were analyzed for Biochemical Oxygen Demand (BOD). Data were collected at sites H2 (EQuIS ID S003-032) and H1.3 (S003-047). All data are submitted to EQuIS annually.

Task 2. Biological monitoring data

RCWD staff have coordinated with MPCA staff to have sites evaluated for both fish and invertebrates. Existing Hardwood Creek biological monitoring sites have been visited most recently in 2010. Although planned, high flows prevented sampling in 2014. RCWD will work with MPCA to ensure re-sampling in 2015.

Task 3. Stability and geomorphic assessments

Permanent longitudinal and cross-section survey sites have been created at multiple restoration sites. Stability surveys, such as the Pfankuch and BEHI, have been conducted.

Objective 4. Reporting, Fiscal Management, and Administration

Task 1. Reporting

All necessary reporting, including semi-annual grant reports and E-Link, has been done.

Task 2. Fiscal Management

Spreadsheets and timesheets were used as a local match tracking system. Semi-annual fiscal reports were completed and submitted with semi-annual grant reports.

Grant Results

Measurements

This project is being evaluated in a number of ways. **First**, project goals are being assessed directly by measuring the concentrations of Total Suspended Solids and Biochemical Oxygen Demand. **Second**, a number of surrogate measurements to specifically assess stream restoration and habitat quality are being collected. **Finally**, direct assessments of the numeric aquatic life standard will be conducted by MPCA.

DIRECT ASSESSMENT OF PROJECT GOALS

Total Suspended Solids (TSS)

The project workplan established goals for TSS; average annual concentrations should be 19 mg/L or less. Between May of 2010 (the start of this grant project) and July of 2014 (most recently available data at time of report), 50 water samples were collected at the H2 monitoring site on Hardwood Creek and analyzed for TSS. Samples were collected across the full range of flows observed at the site, between March and November of each year. Samples were collected following standard industry procedures, outlined in the Rice Creek Watershed District Monitoring Plan. Samples were analyzed by a Minnesota Department of Health accredited lab. The results of this monitoring are presented in Figure 7.

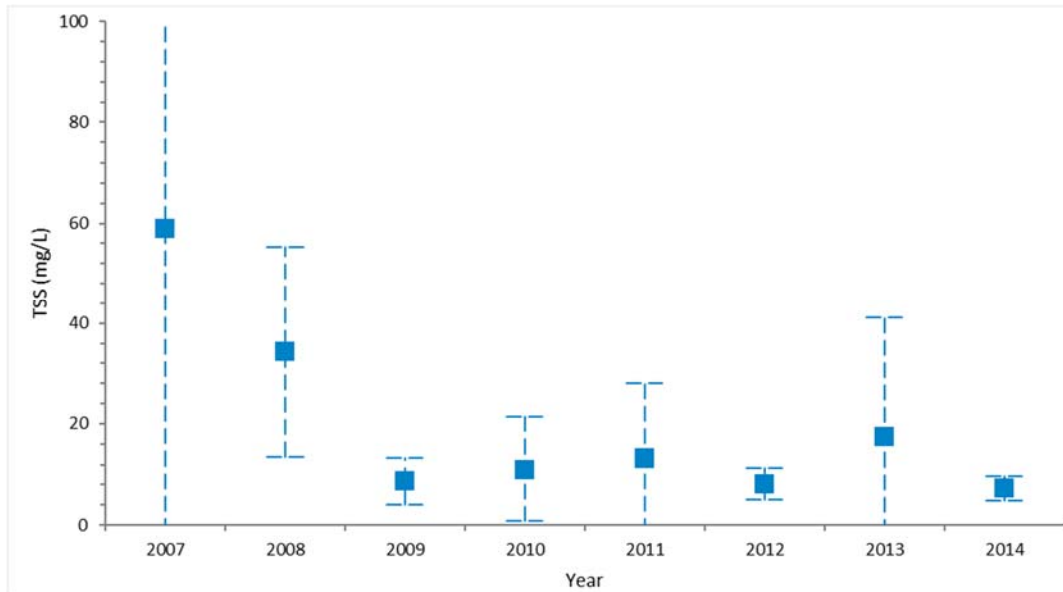


Figure 7. Mean and 1 SD of TSS concentrations at the H2 (S003-032) monitoring site on Hardwood Creek, by year.

TSS concentrations are currently meeting the goals set in the workplan. Average annual TSS concentrations have been below 19 mg/L since 2009. This may be the result of cumulative restoration projects on Hardwood Creek; several restoration projects have occurred previously, including one in 2007. The most recent average, 7.3 mg/L, is the lowest on record. TSS samples will be collected and analyzed for the foreseeable future as part of the regular RCWD monitoring program. All future data will be submitted to EQUIS.

Reporting changes in TSS loads is difficult, given the variability in the flow and concentration data. However, using the TMDL reported volume and concentrations (Hardwood Creek TMDL, Tables 12 and 13), and using the same volume reported in the TMDL for comparison, the most recent TSS average concentration (2013/2014) indicate a reduction of approximately 430,000 lbs. This is a reduction of approximately 53% from the TMDL condition (2004). As previously mentioned, this reduction is likely the result of the cumulative impact of several restoration projects, including the Hardwood Creek TMDL Implementation Project.

Biochemical Oxygen Demand (BOD)

The project workplan established goals for BOD; average annual BOD concentrations should be 3.2 mg/L or less. Between May of 2010 (the start of this grant project) and July of 2014 (most recently available data at time of report), 16 samples water samples were collected at the H2 monitoring site on Hardwood Creek and analyzed for BOD. Samples were collected across the full range of flows observed at the site, between March and November of each year. Samples were collected following standard industry procedures, outlined in the Rice Creek Watershed District Monitoring Plan. Samples were analyzed by a Minnesota Department of Health accredited lab. The results of this monitoring are presented in Figure 8.

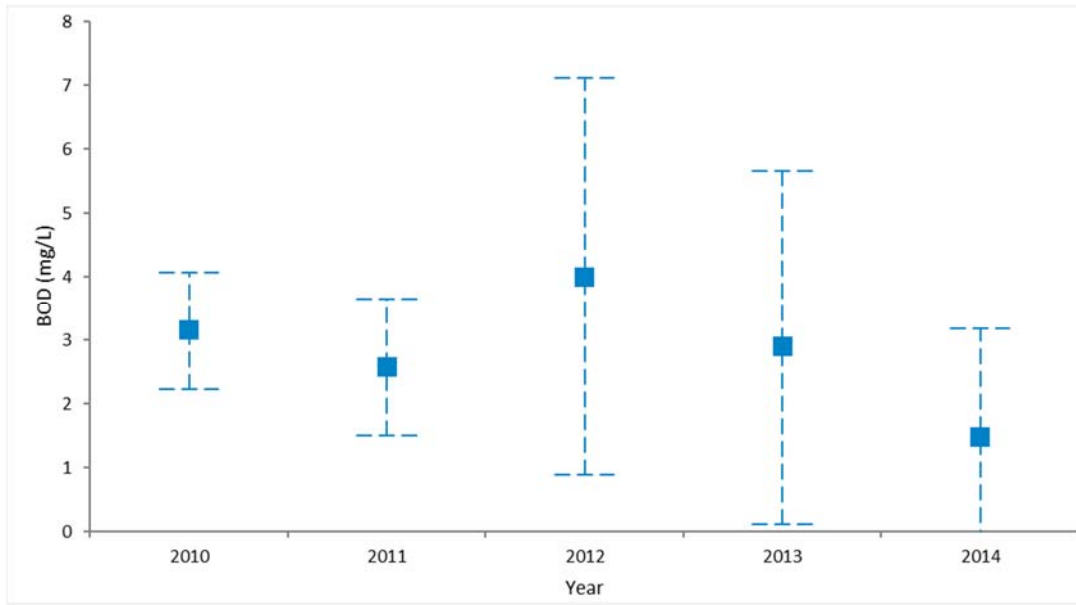


Figure 8. Mean and 1 SD of BOD concentrations at the H2 (S003-032) on Hardwood Creek, by year

BOD concentrations are currently meeting workplan goals. The most recent average, 1.5 mg/L, is the lowest on record. BOD samples will be collected and analyzed for the foreseeable future as part of the regular RCWD monitoring program. All future data will be submitted to EQUIS.

Reporting changes in BOD loads is difficult, given the variability in the flow and concentration data. However, using the TMDL reported volume and concentrations (Hardwood Creek TMDL, Tables 12 and 13), and using the same volume reported in the TMDL for comparison, the most recent BOD average concentration (2013/2014) indicate a reduction of approximately 740,000 lbs. This is a reduction of approximately 91% from the TMDL condition (2004). As previously mentioned, this reduction is likely the result of the cumulative impact of several restoration projects, including the Hardwood Creek TMDL Implementation Project.

SURROGATE MEASUREMENTS

Dissolved Oxygen (DO)

Dissolved oxygen is regularly measured by the RCWD at the H2 (S003-032) site on Hardwood Creek. Although not specifically identified in the workplan, maintaining DO levels above 5.0 mg/L (MN State Standard) is identified as a critical goal in the Hardwood Creek TMDL Implementation Plan. RCWD staff measure DO throughout the open-water season, using a YSI model 600XML-V2 multi-probe with optical DO sensor. The DO sensor is calibrated regularly, following manufacturer recommendations. Figure 9 shows the results of DO measurements.

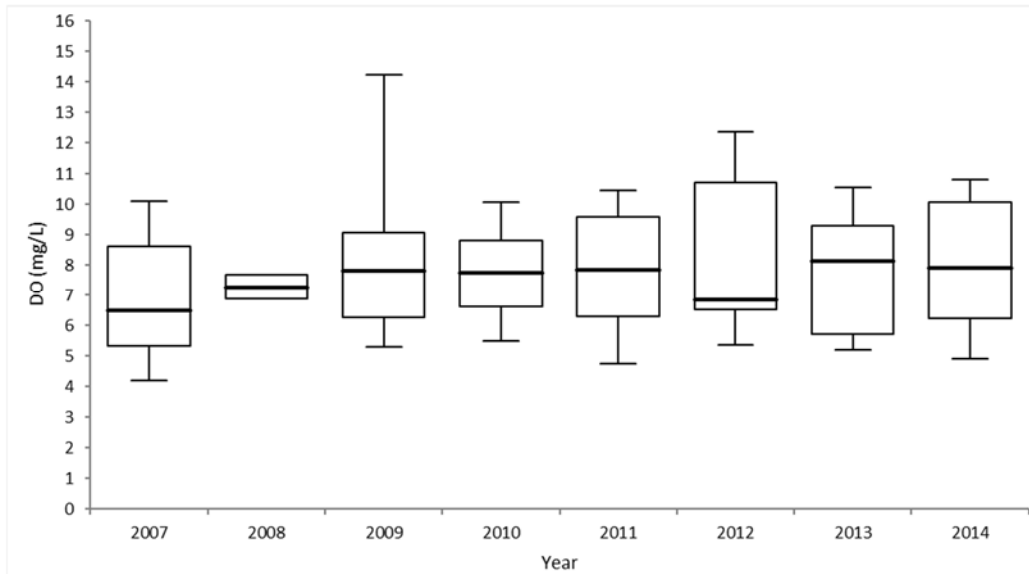


Figure 9. Mean, quartile, and range of DO measurements at H2 (S003-032) on Hardwood Creek, by year

Mean DO concentrations have remained stable since 2007. DO will be measured in Hardwood Creek for the foreseeable future as part of the regular RCWD monitoring program. All future data will be submitted to EQUIS.

Stream Stability / Fluvial Geomorphology

RCWD staff are using several tools to measure stream stability and physical features post pre- and post-project. Tools to assess stability include the Pfankuch stability survey and the Bank Erosion Hazard Index (BEHI – modified from Rosgen, 2001). The changing shape of the stream will be monitored by surveying cross sections and longitudinal profiles at regular intervals. Lastly, pebble counts will be conducted to monitor any changes in sediment size. Some of these data have already been collected – e.g. pre-project stability surveys, cross-sections, and longitudinal profiles. However, data are still being collected and analyzed, and additional data will be collected in the fall of 2014. Findings are not currently available.

AQUATIC LIFE ASSESSMENTS

RCWD is working with MPCA staff to conduct aquatic life assessments on Hardwood Creek following the restoration. It is anticipated that both fish and invertebrate surveys will be conducted, and those data will be used to calculate IBI scores and assess support of aquatic life standards. MPCA habitat assessments will also be collected as part of these surveys. RCWD staff will work with MPCA staff to conduct these surveys in 2015.

Products

Data Products

Water quality monitoring data (including goal-specific parameters like TSS and BOD) collected as part of this project have been submitted to EQUIS, and are available online via the MPCA's Environmental Data Access (EDA) system. Data were collected at two sites: H2 (EQUIS ID S003-032) and H1.3 (S003-047). Summaries for each site, extracted from the EDA system, are provided below.

Stream Station Information

Station Name:	HARDWOOD CK AT 20TH AVE (CR-21) IN LINO LAKES
Waterbody Name:	
Data Steward Org:	MPCA
Station ID:	S003-032
Hydrologic Unit Code (HUC):	07010206
Assessment Unit:	
Period of Record:	1973 through 2012
Lat/Lon	45.2001,-93.0404

Projects that are associated with this station are as follows

Project	Purpose
Rice Creek Watershed District	Lakes and river/stream condition monitoring. Includes Hardwood Creek Biotic/Dissolved Oxygen TMDL monitoring data. 1/14/08: Matthew Kocian has replaced Chuck Johnson as project manager. Hardwood Ck TMDL was removed as part of the Name of this project
Hardwood Creek TMDL Implementation Project	319 Grant Project Funded Through MPCA. Sample Collection Method: Sample bottle. Field Measurements: pH, Spec Cond, temp, and DO with YSI; transparency with t-tube. Probe: YSI 600XLM V2
Rice Creek WD Background Water Quality Monitoring Program	DOCUMENT BACKGROUND WQ CONDITIONS IN THE RICE CREEK WATERSHED DISTRICT

Stream Station Information

Station Name: HARDWOOD CK AT HARROW AVE IN FOREST LK TWP
Waterbody Name:
Data Steward Org: MPCA
Station ID: S003-047
Hydrologic Unit Code (HUC): 07010206
Assessment Unit:
Period of Record: 1973 through 2012
Lat/Lon 45.2191,-92.9589

Projects that are associated with this station are as follows

Project	Purpose
Rice Creek Watershed District	Lakes and river/stream condition monitoring. Includes Hardwood Creek Biotic/Dissolved Oxygen TMDL monitoring data. 1/14/08: Matthew Kocian has replaced Chuck Johnson as project manager. Hardwood Ck TMDL was removed as part of the Name of this project
Hardwood Creek TMDL Implementation Project	319 Grant Project Funded Through MPCA. Sample Collection Method: Sample bottle. Field Measurements: pH, Spec Cond, temp, and DO with YSI; transparency with t-tube. Probe: YSI 600XLM V2
Rice Creek WD Background Water Quality Monitoring Program	DOCUMENT BACKGROUND WQ CONDITIONS IN THE RICE CREEK WATERSHED DISTRICT

Other Products

Engineering concept and final plans and specifications were produced as part of the project, and are available upon request from the RCWD.

A grazing management plan was produced for the landowner for whom the livestock fence and crossing was constructed. The plan was produced following guidance from the Minnesota Department of Agriculture (Moeching, H., *Managing Grazing in Stream Corridors*, 2007). This plan is available upon request from the RCWD.

Several hundred photographs were taken before, during, and after the project. Several photos are included in this report, and have been transmitted to MPCA via email. Additional photos are available upon request from the RCWD.

Long-term Results

The Hardwood Creek TMDL Implementation Project will produce long-term positive outcomes, both in Hardwood Creek, and in downstream Peltier Lake (impaired for nutrients).

BMP Implementation (i.e. stream bank stabilization and restoration) was specifically designed for long-term improvements to water quality and in-stream habitat. By considering the past and current geomorphic processes that were causing stream instability, and adjusting the stream pattern and profile, a more natural and stable channel has been constructed. In this new, stable state, lower TSS values are expected.

By working directly with local landowners, and implanting projects that both meet project goals *and* provide value to the landowners, effective partnerships have been created. Prior to the implementation of this project, relationships between landowners in the Hardwood Creek Watershed and the RCWD were strained. Building trust-based relationships between landowners and RCWD staff, while implementing effective projects, has opened the door for future restoration work and BMPs. For example, the “livestock management” landowner was initially unwilling to implement livestock BMPs. By listening to his concerns, and modifying the plans to address those concerns, we were able to implement a project that achieved workplan goals, while also providing benefit to the landowner, and improving local landowner rapport.

The stream restoration work – particularly the meander restoration – provide many lessons for both design and construction that will result in improved future stream restoration projects. For example, the Targeted Watershed Demonstration grant that was recently awarded to the RCWD from the MN Board of Water and Soil Resources includes a major meander restoration project on Middle Rice Creek. The lessons learned in the Hardwood Creek project will result in a better design and construction process.

All project components – streambank stabilization, meander restoration, livestock BMPs, and grass buffers – will provide a benefit to downstream **Peltier Lake**, by decreasing phosphorus loading. Peltier Lake is listed as impaired by nutrients. The Peltier Lake TMDL calls for significant reductions in phosphorus loading from the Hardwood Creek watershed. This project makes substantial progress in meeting the TMDL goals.

Monitoring of Hardwood Creek – both water quality, and stream stability – will continue for the foreseeable future as part of the RCWD’s monitoring program. Results from this monitoring will provide a basis for assessing long-term improvement resulting from stream restoration.