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in cooperation with the Rice Creek Watershed District
for the Minnesota Pollution Control Agency

Hardwood Creek Impaired Biota (Fish) and Dissolved Oxygen TMDL Implementation Plan

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Cover Image
Hardwood Creek

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1.0. Problem Statement

1.1. Background

The Federal Clean Water Act requires states to adopt water quality standards to protect the nation's waters. These standards define how much of a pollutant can be in a surface or ground water while still allowing it to meet its designated uses, such as for drinking water, fishing, swimming, irrigation, or industrial purposes. Many of Minnesota's water resources cannot currently meet their designated uses because of pollution problems from a combination of point and non-point sources.

For each pollutant that causes a water body to fail to meet the state water quality standards, the Federal Clean Water Act requires that the Minnesota Pollution Control Agency (MPCA) conduct a total maximum daily load (TMDL) study. A TMDL study identifies both point and non-point sources of each pollutant that is causing a water quality impairment. Water quality sampling and computer modeling determine the pollutant reductions needed, for each pollutant source, to enable the water quality standard to be met. Water bodies may have several TMDLs, each one determining the limit for a different pollutant.

1.2. TMDL Listing

In 2002, Hardwood Creek was listed on Minnesota's 303(d) List of Impaired Waters, for biological impairment resulting from a low fish index of biotic integrity (IBI). In 2004, Hardwood Creek was again listed on Minnesota's 303(d) List of Impaired Waters, for biological impairment, this time due to low dissolved oxygen (Table 1). Due to the fact that both TMDLs are intrinsically linked, a TMDL study was conducted that encompassed both impairments.

Hardwood Creek has an approximate 15,500-acre watershed that includes a significant portion of rural and agricultural areas (Figure 1). The watershed includes portions of May Township and the cities of Hugo, Forest Lake, and Lino Lakes. The upper two-thirds of Hardwood Creek are also known as Washington County Judicial Ditch #2 and it originates south of Rice Lake. From Rice Lake, Hardwood Creek flows north to Corrie's Swamp, then turns and continues west until emptying into Peltier Lake, where it ends. The upper portion of the Hardwood Creek drainage way, from Rice Lake to Highway 61, is a broad, low-lying swale containing wetland communities of significant natural resource values. Downstream from Highway 61, the soils get sandier and the topography slightly increases.

The impairment on the lower reach of Hardwood Creek was characterized by a low fish index of biotic integrity (IBI) score. The IBI created by the MPCA uses fish composition data to measure the overall health and integrity of a stream. The IBI assesses stream health using twelve different fish metrics. These twelve metrics fall into three categories: species composition, trophic composition, and fish abundance and condition. Data are obtained for each of these metrics at a given site, and a number rating is assigned to each metric. The sum of the twelve ratings yields an overall site score, with scores ranging from 0 for exceptionally poor quality to 100 for sites of exceptionally high quality. The IBI integrates information from individual, population, community, and ecosystem levels into a single ecologically based index of water resource quality

(Karr 1981, Karr et al. 1986, IEPA 1989). Hardwood Creek (both the upstream and downstream reaches) is also listed for low dissolved oxygen.

The upper stretch of Hardwood Creek (from Rice Lake to Highway 61) has naturally occurring low dissolved oxygen due to the release of organics from underlying peat deposits and poorly oxygenated groundwater. Because dissolved oxygen levels in the upper portion of the creek can only be expected to meet natural background conditions and not support a fish community typical of this region, the MPCA de-listed the upper portion of the creek for the fish IBI. The MPCA does not have tools to properly assess a biological community that resides in an environment where DO levels are below 5 mg/L. However, the upper reach does need to meet the site-specific DO requirement of maintaining the natural background conditions.

Although biological assessments are useful for identifying biological impairments, they do not identify the cause of impairment. Linking biological effects with their causes is complex, particularly when multiple stressors impact a water body. Investigation procedures are needed that can successfully identify the stressor(s) and lead to appropriate corrective measures through habitat restoration and point/non-point source controls. The stressor identification (SI) process developed by U.S. EPA is a formal method for analyzing available evidence such as biological, physical, and chemical data, as well as land use and habitat data, and identifying the causes of biological impairment of aquatic systems through a step-by-step procedure (U.S. EPA 2000a). These steps include detecting biological impairment, assembling available data, listing candidate causes, analyzing the lines of evidence for each candidate cause, and characterizing the probable cause(s).

For Hardwood Creek, the primary stressors impacting the aquatic life in Hardwood Creek were determined to be sedimentation and low dissolved oxygen.

Table 1. TMDL Listing Information

Name	Description	River ID	Pollutant or Stressor	Affected Use	Year First Listed	Target Start/ Completion (reflects priority ranking)	CALM Category*
Hardwood Creek	Headwaters to Hwy 61	07010206-595	Oxygen, dissolved	Aquatic life	2004	2004/2008	5C
Hardwood Creek	Hwy 61 to Peltier Lk	07010206-596	Fish bioassessments	Aquatic life	2002	2003/2008	5A
Hardwood Creek	Hwy 61 to Peltier Lk	07010206-596	Oxygen, dissolved	Aquatic life	2004	2004/2008	5A

*5A: Impaired by multiple pollutants and no TMDL study plans are approved by EPA
5C: Impaired by one pollutant and no TMDL study plan is approved by EPA

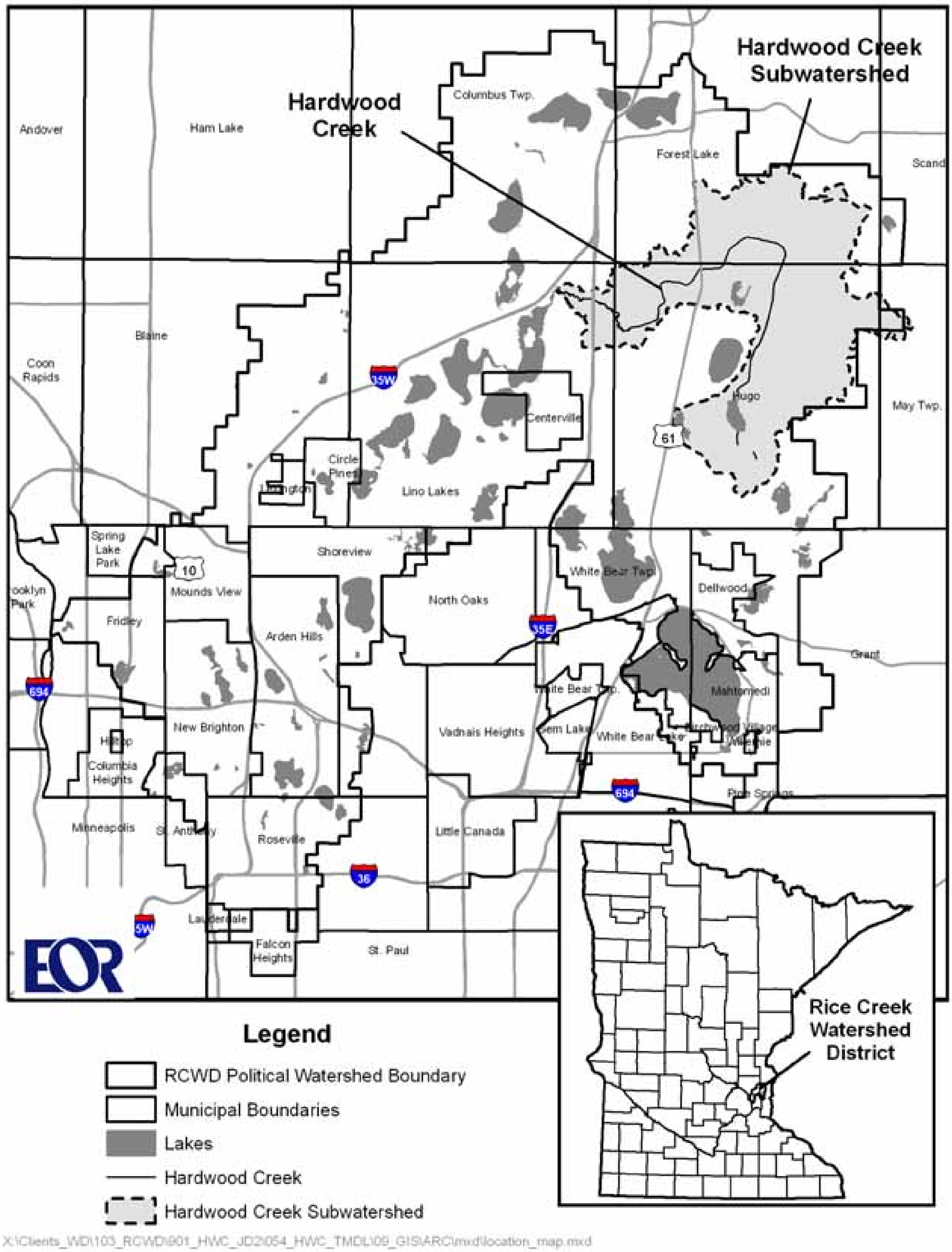

Figure 1. Location of the Hardwood Creek Watershed

2.0. TMDL Summary

2.1. Stressor Identification

Through the stressor identification process, the primary causes of the low IBI in Hardwood Creek were identified as sedimentation and low DO. The TMDL for the biological impairment is based on total suspended solids (TSS) loads, which address sedimentation. Various candidate mechanisms affecting DO were identified and ultimately may all play a role in DO levels to varying degrees. However, the low DO TMDL focuses on biochemical oxygen demand (BOD) loading, which was identified as a significant stressor during 2004. Therefore the TMDL for the low DO is based on BOD loads.

Altered habitat and altered hydrology were both found to be negatively impacting the biotic community.

Altered Habitat and Altered Hydrology Linked to Excessive Sedimentation

Excessive sediment has resulted in poor habitat quality in Hardwood Creek, through the covering and filling of cobbles and gravel substrate and interstitial spaces, decreasing pool depth, and the potential burial of larger coarse woody debris. In addition, excessive sediments can affect stream aquatic use conditions by eliminating stable, coarse substrates that provide shelter during high flow events, thereby potentially affecting fry, smaller fish, and the macroinvertebrate communities.

The upper two-thirds of Hardwood Creek (~10 miles) are channelized, or ditched. Ditching can produce more frequent and higher peak flows downstream leading to bank instability, which can increase suspended sediments and ultimately decrease habitat quality. These phenomena have all been observed in Hardwood Creek. The complex suite of stressors also includes decreased woody debris, which reduces available substrate and changes the energy source for consumers; decreased sinuosity, which changes flow characteristics; erosional patterns and substrates; increased channel depth; loss of pools that act as refugia; and loss of riffles that oxygenate water and transport sediment.

Low Dissolved Oxygen

At the downstream monitoring site, the DO daily minimum drops below 5 mg/L during dry conditions and low flows. Low DO under low flows could be largely driven by the low DO in baseflow coming from the upstream reach, or by stagnant water conditions at the monitoring site itself. These data are from continuous monitoring that was completed in 2004. There are also instantaneous DO measurements at the downstream site from previous years; these data show that there are times when DO drops below the standard during almost all flow regimes. Low DO during high flows could be driven by high BOD loading from the watershed or from in-stream erosion of organic matter.

There are substantial diurnal DO fluctuations in the upper reach of Hardwood Creek. The monthly average of daily DO ranges is highest in July and August on the upstream reach (site H1.3). The range is the lowest at the downstream site (H2), where it ranges from 0.7 to 2.5 mg/L. These high swings in DO over the course of a day are commonly due to high in-stream primary production from either algae or macrophytes, which are both common in Hardwood Creek and the adjoining wetlands.

2.2. Peltier Lake TMDL

Hardwood Creek flows into Peltier Lake, which is on the 303(d) list of impaired water bodies due to excessive nutrients. The TMDL allocations (currently under review) require substantial phosphorus reductions from the watershed. Since phosphorus is often bound to suspended sediment and/or incorporated into organic matter, the BMPs implemented to address the Peltier Lake TMDL will also reduce sediment and BOD loading to Hardwood Creek.

2.3. Water Quality Goals

Fish IBI

Attainment of aquatic life uses is determined by directly measuring fish and aquatic macroinvertebrate populations to see how they compare to reference areas. The MPCA has been using fish community data to assess water resource quality for the last decade. Minnesota uses a regional reference site approach based on a major river basin framework. Attainment benchmarks are established for each subbasin in the form of biocriteria (indices of biological integrities, or IBIs). For the Upper Mississippi Watershed, a separate IBI was developed for four stream size classes based on drainage area (Table 2). Hardwood Creek has a drainage area of approximately 27 square miles and therefore the applicable criterion is 46.

Table 2. Upper Mississippi Fish Index of Biological Integrity Criteria

Drainage Area	Full Support -- Not Listed	Non- Supporting -- Listed
$5mi^2$ - $35mi^2$	IBI > 46	IBI < 46
$35mi^2$ - $200mi^2$	IBI > 46	IBI < 46
$>200mi^2$	IBI > 61	IBI < 61

Total Suspended Solids Goal

TSS was selected as a surrogate to represent sedimentation and habitat quality in streams, and an in-stream TSS concentration goal was used to calculate the TMDL. Minnesota does not have numeric sediment criteria developed for rivers and streams in the state. Therefore, a numeric TSS goal was developed with the aim of improving and protecting in-stream habitat. The effects of recent stream restoration projects in Hardwood Creek were used to determine the in-stream TSS concentration as a result of these activities, and this concentration was used as the TSS goal. The restored habitat results in less erosion and a lower contribution of sediment.

The goal was developed by using an in-stream sediment transport model, CONCEPTS, to predict the in-stream TSS concentration under different scenarios. CONCEPTS (CONservational Channel Evolution and Pollutant Transport System) is a computer model that simulates open channel hydraulics, sediment transport, channel morphology, and geotechnical processes of bank failure by tracking bed changes and channel widening. The restored channel modeled scenario represents the effects of the in-stream stabilization practices implemented in lower Hardwood Creek.

The existing conditions modeled scenario (i.e., pre-restoration condition in 2002) predicts an average annual in-stream TSS concentration of 22 mg/L, and the restored channel scenario predicts an average annual in-stream TSS concentration of 19 mg/L. 19 mg/L TSS was used as the in-stream TSS goal for the Hardwood Creek TMDL.

Biochemical Oxygen Demand Goal

BOD was used as the target parameter to address the DO TMDL. Minnesota does not have numeric BOD criteria developed for rivers and streams in the state. However, the state has data summaries by ecoregion in a technical report entitled “Selected Water Quality Characteristics of Minimally Impacted Streams from Minnesota’s Seven Ecoregions” (McCollor and Heiskary 1993). The technical team for this TMDL considered these data and decided to set the BOD goal for the Hardwood Creek TMDL at the 75th percentile of the minimally impacted streams in the North Central Hardwood Forests ecoregion, which is 3.2 mg/L BOD. In the absence of more watershed-specific data, using historical ecoregion data with emphasis on the 75th percentile levels is an appropriate approach and is among the options recommended by EPA for water quality criteria (e.g., see USEPA, 2000 for nutrient criteria in rivers and streams) and was used recently by the MPCA for development of the state’s lake eutrophication standards.

2.4. TMDL Allocations

This study used a variety of methods to evaluate the current loading, contributions by the various pollutant sources, as well as the allowable pollutant loading capacity of the creek. These methods included the load duration curve approach, which takes into account that loading capacity varies by stream flow. The average TSS concentration will need to be decreased 14% from approximately 22 mg/L to 19 mg/L. The average BOD concentration will need to be decreased 30% from approximately 4.6 mg/L to 3.2 mg/L.

The sources of sediment and BOD include regulated MS4 stormwater, unregulated stormwater, and in-stream bed and bank erosion (Table 3). The regulated MS4 stormwater falls under the TMDL’s wasteload allocation (WLA), and the unregulated sources (unregulated stormwater and in-stream erosion) fall under the TMDL’s load allocation (LA).

Table 3. Source Categories for WLAs and LAs

Source	TSS	BOD
MS4 stormwater	WLA	WLA
Non-MS4 stormwater	LA	LA
In-stream bed and bank erosion	LA	--

The TSS loading capacity represents the average daily load, averaged over the course of a year under the identified flow condition, that the stream can assimilate. Since it is the cumulative impact of TSS on habitat that is relevant to the biota, the long term loading is relevant. The BOD loading capacity represents the maximum daily load, under the identified flow condition, that the stream can assimilate. Since BOD affects DO concentrations in the short term, it is the daily maximum that is relevant.

The percent distribution and needed percent reductions of each TSS source were estimated using annual average data (Table 4). The baseline load from bed and bank erosion is based on the 2002 CONCEPTS model scenario; the TMDL bed and bank load is based on the restored channel scenario (see Appendix C of the TMDL report). This baseline load from the bed and bank accounts for much of what would be considered the natural background load in the TMDL.

Since the total instream load in Hardwood Creek was based on monitoring data, the watershed load was calculated by subtracting the bed and bank erosion load from the total load in the stream.

TMDL allocations are presented under five different flow regimes (Table 5 and Table 6). Categorical WLAs were provided for all permitted stormwater sources: MS4, construction, and industrial stormwater. The sources will collectively need to meet the WLA.

Table 4. TSS Percent Reductions

Source		Percent of TMDL	Baseline (2002) (lbs/year)	TMDL (lbs/yr)	% Reduction
LA - Total		**86%**	**1.12E+06**	**9.20E+05**	**18%**
LA - Instream		29%	4.40E+05	3.10E+05	30%
LA - Non-permitted stormwater * (93% of watershed total)		57%	6.75E+05	6.10E+05	10%
WLA – Permitted stormwater (7% of watershed total)**		**4%**	**5.08E+04**	**4.28E+04**	**16%**
MS4 or other source	Permit #				
City of Hugo	MS400094				
City of Lino Lakes	MS400100				
RCWD	MS400193				
Anoka County	MS400001				
Washington County	MS400160				
Mn/DOT Metro District	MS400170				
Construction stormwater	Various				
Industrial stormwater	No current permitted sources				
MOS		**10%**		**1.07E+05**	**--**
Total		**100%**	**1.17E+06**	**1.07E+06**	**9%**

Table 5. TSS TMDL: LA, WLA, MOS

Source		% Allocation	TMDL (average lbs/day)				
			High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
			183.7 - 65.0 cfs	65.0 - 15.3 cfs	15.3 - 6.4 cfs	6.4 - 1.9 cfs	1.9 - 0.0 cfs
LA		86%	8,874	2,153	821	372	122
WLA – Permitted stormwater		4%	413	100	38	17	6
MS4 or other source	Permit #						
City of Hugo	MS400094						
City of Lino Lakes	MS400100						
RCWD	MS400193						
Anoka County	MS400001						
Washington County	MS400160						
Mn/DOT Metro District	MS400170						
Construction stormwater	Various						
Industrial stormwater	No current permitted sources						
MOS		10%	1,032	250	95	43	14
Total		**100%**	**10,319**	**2,503**	**954**	**432**	**142**

Table 6. BOD TMDL: LA, WLA, MOS

Source		% Allocation	TMDL (lbs/day)				
			High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
			183.7 - 65.0 cfs	65.0 - 15.3 cfs	15.3 - 6.4 cfs	6.4 - 1.9 cfs	1.9 - 0.0 cfs
LA		84%	1,460	354	135	61	20
WLA – Permitted stormwater		6%	104	25	10	5	2
MS4 or other source	Permit #						
City of Hugo	MS400094						
City of Lino Lakes	MS400100						
RCWD	MS400193						
Anoka County	MS400001						
Washington County	MS400160						
Mn/DOT Metro District	MS400170						
Construction stormwater	Various						
Industrial stormwater	No current permitted sources						
MOS		10%	174	42	16	7	2
Total		**100%**	**1,738**	**421**	**161**	**73**	**24**

3.0. Implementation Partners and Planning

To improve the biological community in Hardwood Creek and meet the goals of the TMDL, the average TSS concentration will need to be decreased 14% from approximately 22 mg/L to 19 mg/L. The average BOD concentration will need to be decreased 30% from approximately 4.6 mg/L to 3.2 mg/L. To achieve these goals, a variety of measures will be implemented across the watershed in the upcoming four years. Multiple partners will be involved in this implementation process, and a coordinated effort will be needed to successfully carry out the implementation plan.

3.1 Implementation Partners

The Rice Creek Watershed District (RCWD) will lead the coordinated effort to improve the biological integrity of Hardwood Creek. The RCWD will work closely with a core group of partners on data collection and project implementation. These core partners include:

Core Implementation Partners:
- Anoka Conservation District (ACD)
- Board of Water and Soil Resources (BWSR)
- Cities of Hugo, Forest Lake & Lino Lakes
- Minnesota Department of Natural Resources (DNR)
- Minnesota Pollution Control Agency (MPCA)
- Washington Conservation District (WCD)

Multiple partners, listed below, will provide guidance, as appropriate, regarding the actions outlined in this implementation plan. The RCWD will coordinate and lead meetings with implementation partners.

Potential Implementation Partners:
- Anoka County
- Minnesota Department of Agriculture (MDA)
- Minnesota Department of Transportation (Mn/DOT)
- Natural Resources Conservation Service (NRCS)
- University of Minnesota
- United States Fish and Wildlife Service (USFWS – Partners for Wildlife)
- Washington County

Time frame: 2009 – 2013, Cost: $5,000 In-Kind

3.2. Funding Opportunities

A combination of grants, in-kind staff time, and cash matches will be used to fund the implementation activities described in this plan.

<u>Clean Water Act Section 319 Programs</u> – Financial assistance is provided to address non-point source water pollution, including the study of water bodies with pollution problems, development of action plans, and implementation of the action plans.

Minnesota Clean Water Legacy Program – Passage of the Clean Water, Land and Legacy Amendment in 2008 made funding available for TMDL implementation activities. Four state agencies are involved in distributing the funds: the Board of Water and Soil Resources, the Minnesota Pollution Control Agency, the Minnesota Department of Agriculture, and the Minnesota Department of Natural Resources.

State Cost-Share – State Cost-Share is a program of the Minnesota Board of Water and Soil Resources. It is administered through local SWCDs and is designed to provide base grants of up to 75% of a project cost in order to help local landowners/occupiers with projects that protect and improve water quality, such as controlling soil erosion and reducing sedimentation. By reducing soil loss there should be commensurate reduction in phosphorus (that is attached to the soil) delivered to surface water.

Environmental Quality Incentives Program (EQIP) – EQIP is a program of the Natural Resources Conservation Service whose funds are provided through the Federal Farm Bill. It is designed to help private landowners with technical assistance and a cost-share of up to 50% in order to protect local soil and water resources. They fund such things as nutrient management plans, designs for animal waste structures, wetland restoration, rotational grazing management plans and conservation tillage

Agriculture Best Management Practices Loan Program (AgBMP Loan Program) – AgBMP Loan Program is a program of the Minnesota Department of Agriculture. It is administered through local SWCDs, and offers low interest loans (currently 3%) for implementation of best management practices to improve water quality problems that are caused by agricultural activities or failing septic systems.

Conservation Reserve Program – USDA program which shares the cost of establishing riparian buffers with the landowner, and provides landowner land rental payments for a minimum of 10 year. Landowner must enter in to a contractual agreement with the USDA, and is required to meet minimum federal standards. Contact the USDA-NRCS office for details.

Partners for Wildlife Program – USF&WS financial assistance program to establish wildlife habitat project such as wetland rehabilitations and riparian rehabilitations. Contact USF&WS for more details.

State Conservation Easement Programs – BWSR program locally administered by SWCD, which purchases conservation easements and provides funding for establishment of BMPs. Easements, are perpetual, between the State of MN and the landowner. Contact WCD office for more details.

In-Kind Contributions – Many of the actions will be implemented by Rice Creek Watershed District, Washington Conservation District, Washington County, and the City of Hugo using in-kind funding.

Landowners – For actions aimed at decreasing the total sediment and phosphorus load from individual landowner sites, landowners will, on a voluntary basis, provide a percentage of the cost of the installation of the management practice. The RCWD has, and will continue to work directly with landowners on specific improvements.

4.0. Implementation Actions

This section contains descriptions of the management measures, estimates of load reductions, costs, schedule, and interim measurable milestones. The estimated pollutant reductions presented in this section are based on best professional judgment and are intended to provide only rough estimates of load reductions. Also, for BMPs involving specific reaches (e.g., streambank stabilization) those reduction percentages are specific to the loading generated within the subject reach(es) (rather than loading reduction for all of Hardwood Creek) compared to current loading levels. It is important to point out that many of the proposed actions not only reduce pollutant loading, but also will greatly enhance the habitat for both aquatic and terrestrial organisms. Therefore, these actions will improve fish IBI scores through multiple means.

A summary of the actions outlined in this implementation plan is presented in Figure 2. The listed actions represent implementation options. Landowner cooperation will be needed to implement many of the identified projects. With some actions, feasibility studies may also be warranted.

Stream and Streambank Restoration

Streambank Stabilization & In-Stream Improvements

- Bio-engineering techniques
- Habitat modifications
- Education

Meander Restoration

- Bio-engineering techniques
- Habitat modifications
- Education

Riparian Buffers

- Conservation Easements
- Establish Riparian Buffer
- Buffer Ordinance

Stormwater Management

- Stormwater management ordinances in City of Hugo, City of Forest Lake, and the City of Lino Lakes
- Rice Creek Watershed District Rules
- Education

Livestock Management

Livestock Facilities

- Waste storage facilities
- Vegetated filter strips
- Move fences
- Improved lot cleaning
- Education

Livestock Grazing

- Livestock exclusion
- Rotational grazing
- Education

Surface-Applied Manure Management

- Manure application setbacks
- Certified nutrient management plans
- Education

Figure 2. Implementation Action Summary

4.1. Streambank Stabilization & In-Stream Improvements

In 2006 and 2007 the RCWD implemented several streambank stabilization projects along HWC using bioengineering techniques along with in-stream habitat restoration practices. Completed projects are itemized in the *Hardwood Creek Basis of Design Report* (Wenck, June 2008). While substantive work has been completed, there are still several areas along HWC that have severely eroded banks. These areas are affected by either variable flows or livestock grazing and could be stabilized by promoting streamside reforestation, livestock exclusion, and streambank stabilization using bioengineering techniques.

Table 7. Streambank Stabilization Summary

Implementation partners:	Rice Creek Watershed District
Estimated cost:	$178,600
Time frame:	2009 – 2013
Estimated load reduction:	10 - 20% of total sediment load; 15% of total phosphorus load
Interim milestones:	Landowner approval

4.1.1. Planned Streambank Stabilization Sites

Previously identified streambank stabilization areas are detailed in the *Hardwood Creek Basis of Design Report* and also summarized below. For each of the areas, several specific stabilization sites have been identified with varying stabilization techniques including, but not limited to rock vanes, riffles, coir blocks, live stakes, rood wads, bank armoring, and vegetative restoration. Figure 3 identifies stabilization area locations. Livestock exclusion (especially in the area identified in Section 4.5.1) should be a prerequisite for streambank stabilization.

Table 8. Identified Streambank Stabilization Sites

Area	Number of Stabilization Sites	Estimated Cost[1] (Wenck, June 2008)
Area 5.1	10	$21,000
Area 5.2	17	$26,800
Area 5.3	14	$16,600
Area 5.4	4	$8,700
Area 5.5	12	$31,900
Area 5.6	21	$53,600
Total	**78**	**$158,600**

[1] Estimated cost does not include cost, if any, of securing easements.

4.1.2. Monitoring and Repair of Stabilized Sites

For all streambank stabilization work, a maintenance and inspection plan should be developed. It is recommended the RCWD monitor all past and future projects to ensure that implementation activities are successful and if not, develop a plan of action to supplement or repair previous efforts. A conservative estimate for supplementing previously repaired efforts is approximately $20,000.

4.1.3. Upper Hardwood Creek (JD2) Repairs

Identification and stabilization of bank failures along Upper Hardwood Creek (JD2) should occur with the annual inspection and maintenance activities by the City of Hugo/RCWD for the judicial ditch system.

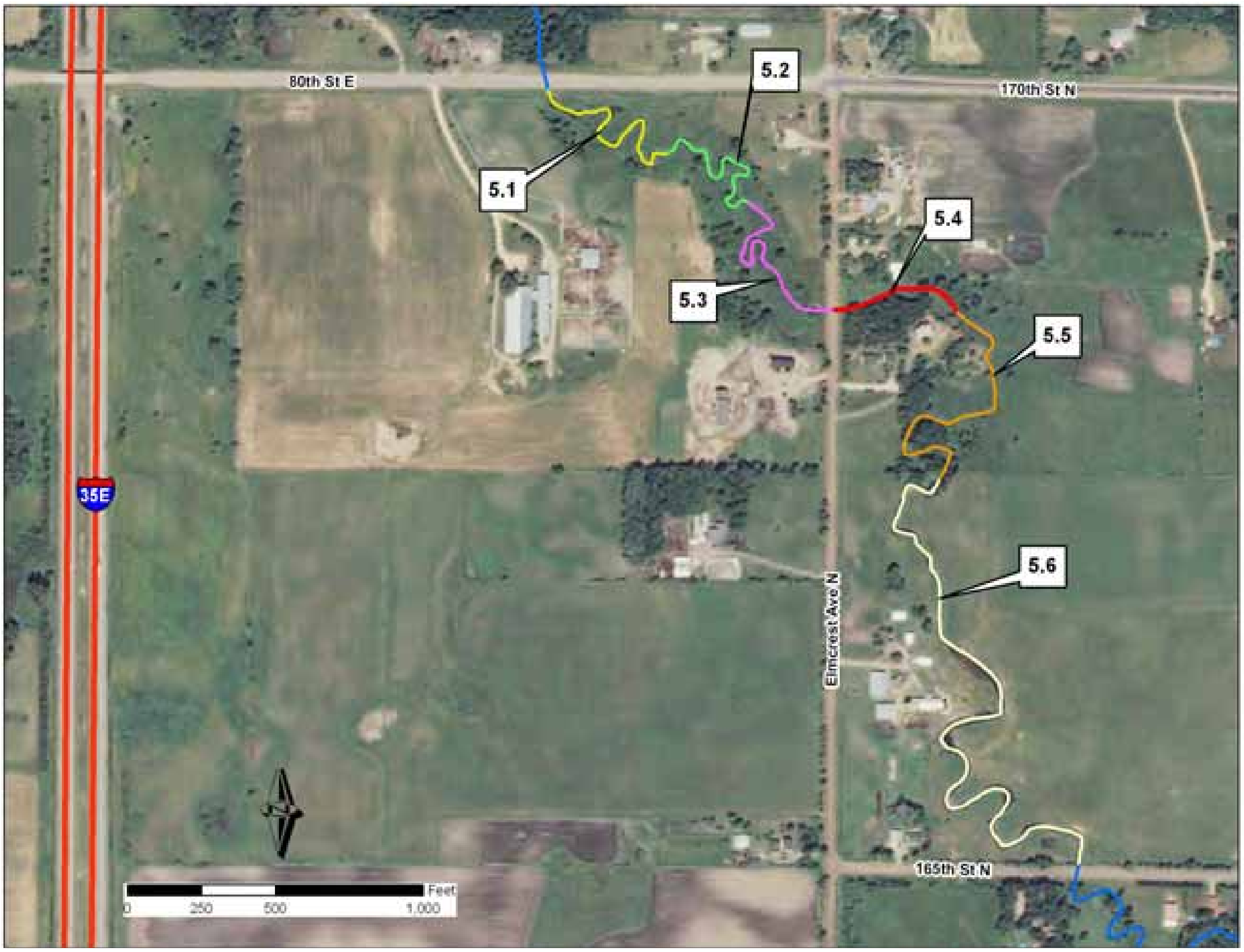

Figure 3. Streambank Stabilization Sites

4.2. Meander Restoration

Due to hydrologic and morphologic alterations of the system, reestablishment of meanders within HWC/JD2 is recommended to stack benefits that the corridor could provide rather than focusing singularly on the system as stormwater conveyance. Reestablishment of meanders would provide for channel capacity to carry the current hydrology of the system as well as reconnect the channel to its floodplain allowing for sediment deposition and nutrient storage.

While the RCWD Board opted for Minor Maintenance as opposed to the Stable Stream Design for management of JD2, three segments of HWC/JD2 are still considered prime candidates for remeandering. These segments include:

1. Meander Restoration Site 1 – straightened section of HWC immediately downstream of I-35E
2. Meander Restoration Site 2 – JD2/HWC through the wetland immediately downstream of Highway 61
3. Meander Restoration Site 3 – JD2/HWC from 170th St. N. downstream to 165th St. N.

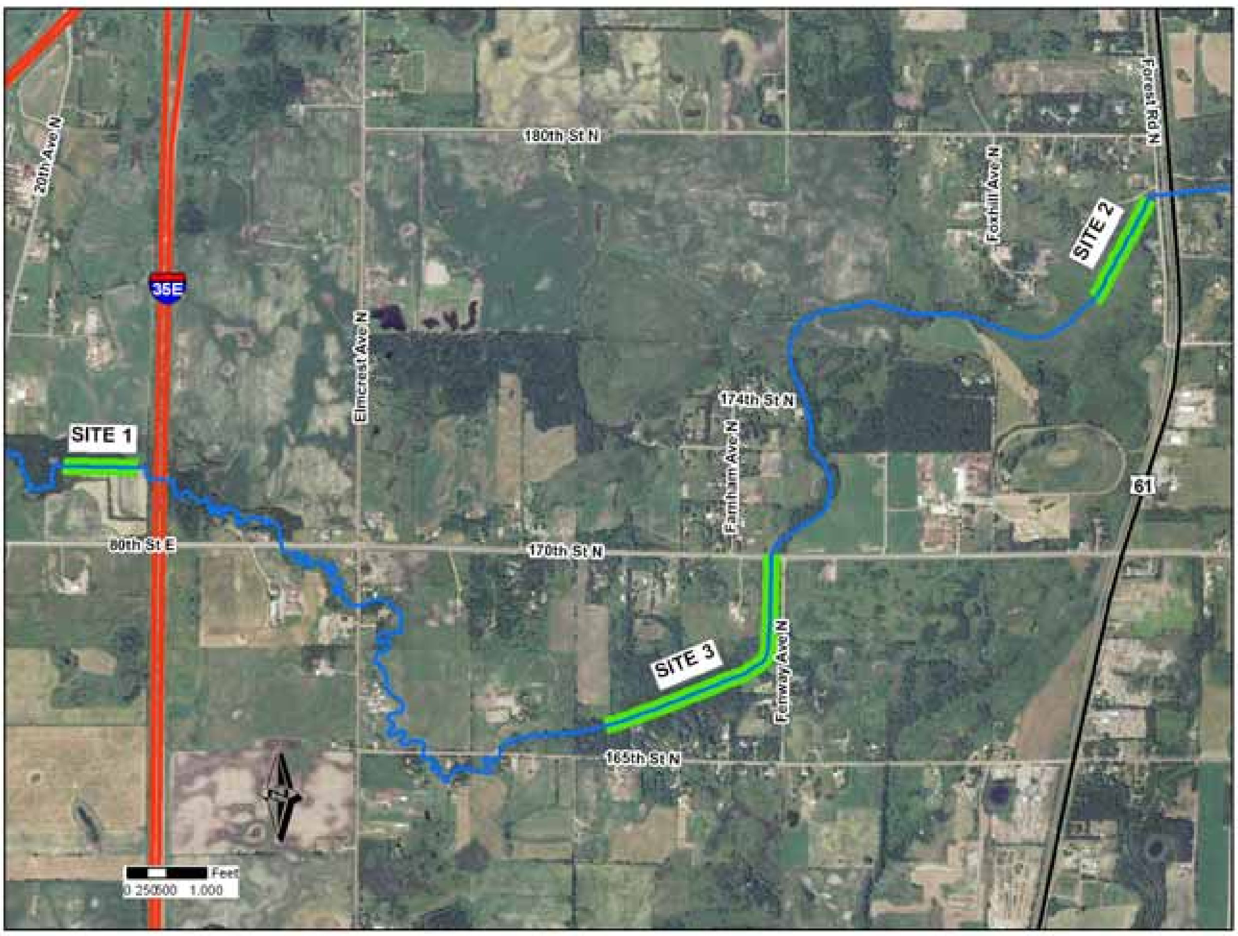

Figure 4. Meander Restoration Sites

4.2.1. Meander Restoration/Design

Concept design would create a properly sized meandered base channel lower than the existing channel, a connected and properly sized floodplain also lower than the existing floodplain, and a stable meander pattern. Figure 5 shows a cross-section of this concept design.

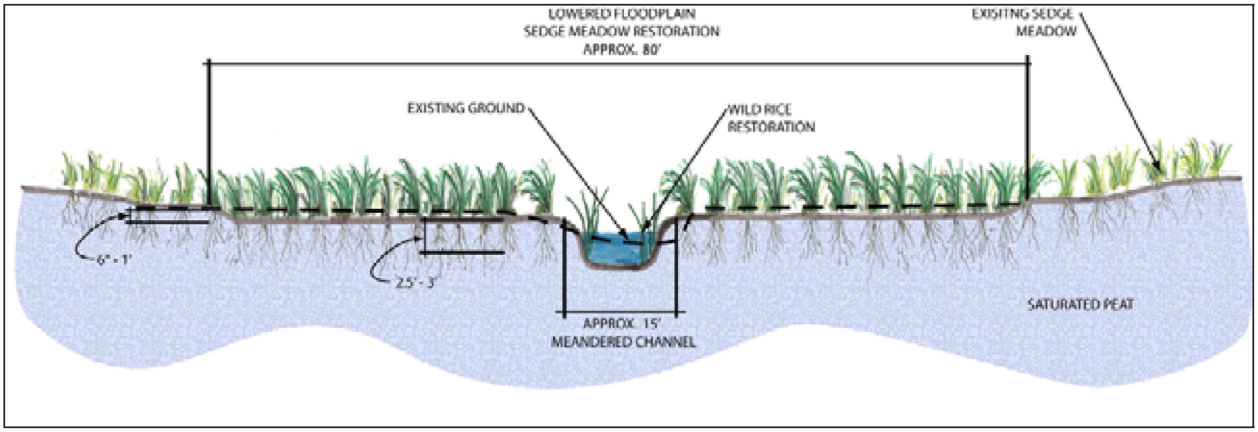

Figure 5. Typical Re-meandered Cross Section

This concept design is based on stream morphology principles in order to establish equilibrium between the stream channel and the external forces shaping the channel, leading to a stable channel configuration. Final designs would be based on the stream morphology analysis conducted by the District (and its consultants) from 2003-2005. Further analysis of this data would allow determination of the appropriate channel dimension, pattern, and profile for each reach.

In addition, Dr. Sandy Verry, a peatland drainage and stream restoration expert, was previously contacted to provide design input. Dr. Verry's recommendations would be incorporated into final designs. Of note, Dr. Verry recommended that a new channel be created off of the existing ditch and allowed to stabilize for one growing season before ditch flows are diverted. The reasons for this are:

- Reduced risk of channel block failures
- More stable peat for construction as verified through the von Post analysis
- Easier constructability without active ditch flows
- Significantly less water quality impact both during construction and long-term

4.2.2. Water Quality Benefits

This design will increase the interaction of the in-stream flow with the floodplain and will allow settling, storage, and recycling of in-stream nutrients in channel and on the floodplain. Additionally, the meandered channel will have more benthic, or stream bottom, surface area, which will improve in-stream water quality. Dissolved nutrients are primarily removed by sorption, or attachment, onto bottom sediments or through uptake by microbial communities on the stream bottom (Mulholland et al. 1985), and in-stream processes are important determinants of stream water nutrient concentrations (Mulholland and Hill 1997). A greater surface area provides more substrate for microbial communities in addition to more attachment sites, and phosphorus retention has been related to stream bottom area (Doyle et al. 2003).

Reestablishment of meanders should also result in decreased bank erosion and sediment transport through the meandered sections. Bank erosion will be reduced by incorporating stabilization techniques identified in 4.1.1 (cross-vanes, root wads, etc.). Bank erosion will also be reduced as a result of decreased stream velocity through meandered sections. Velocity will decrease as a result of 1) increased roughness in the channel (root wads, willow plantings, etc.) and 2) decreased stream slope due to the increase in stream length. In summary, establishing meanders will reduce the capacity for the creek to entrain and transport sediment.

4.2.3. Cost

The estimated cost for reestablishment of meanders immediately downstream of I-35E is $250,000. The estimated cost of meander reestablishment for the Hwy 61 wetland area is approximately $200,000. Reestablishment of meanders from 170th St. N to 165th St. N is estimated at approximately $450,000.

Table 9. Meander Restoration Summary

Implementation partners:	Rice Creek Watershed District
Estimated cost:	$900,000
Time frame:	2009 – 2013
Estimated load reduction:	10 - 20% of total sediment load; 10% of total phosphorus load
Interim milestones:	Landowner approval

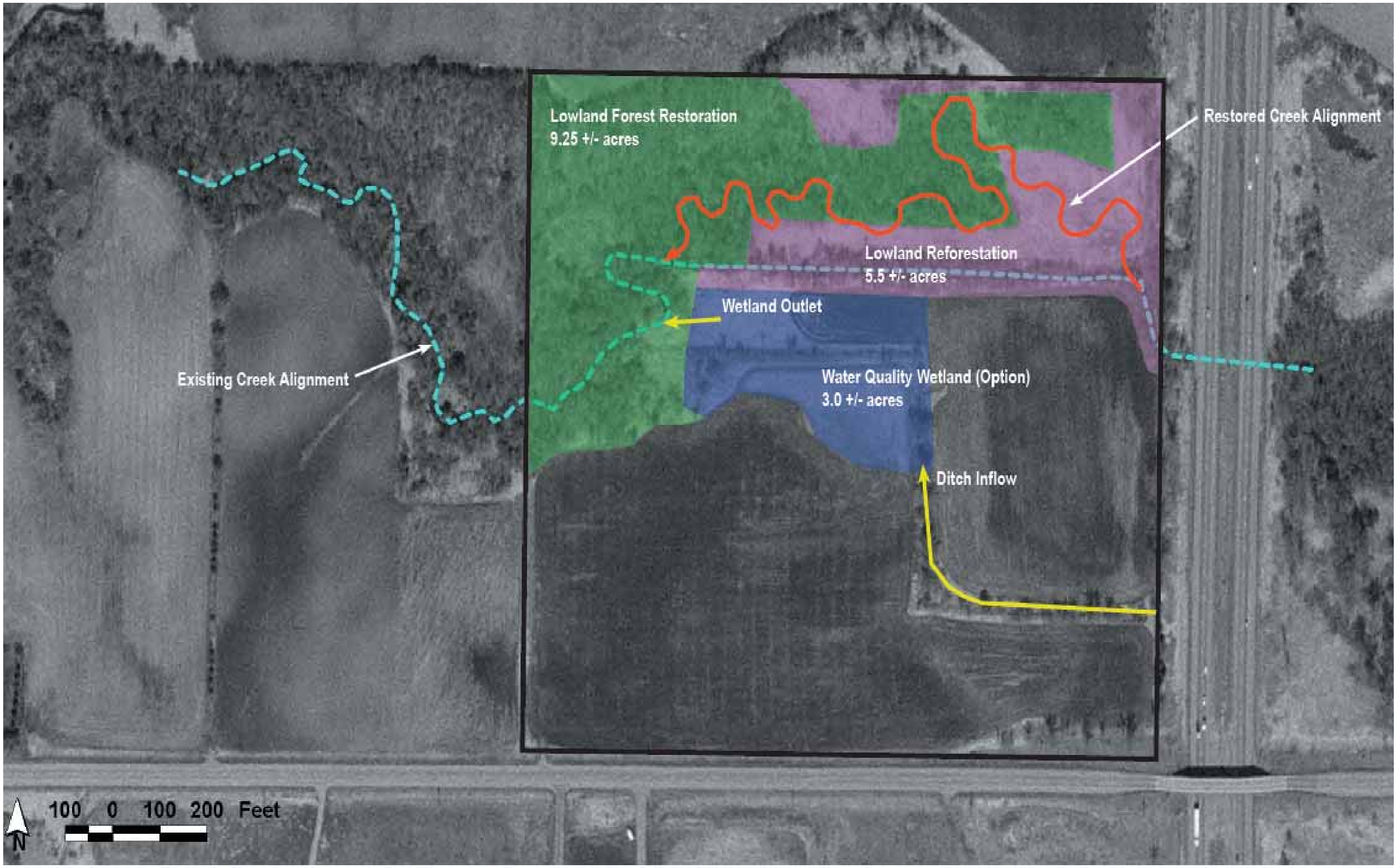

Figure 6. Meander Restoration Site 1 – Concept Plan

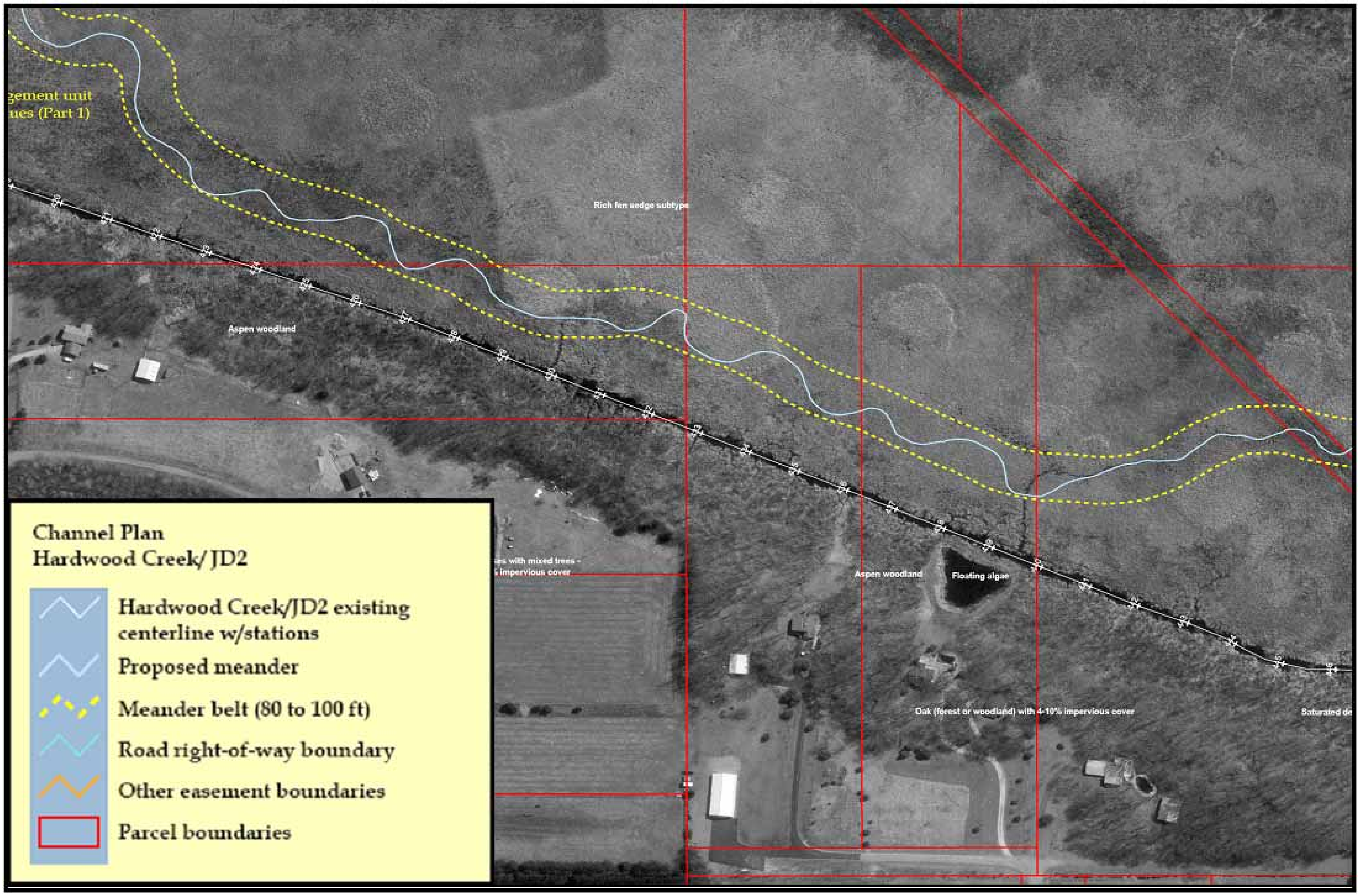

Figure 7. Meander Restoration Sites 2 & 3 – Representative Concept

4.3. Stormwater Management

Due to historic channelization and changes in land use over time, the hydrology of Hardwood Creek has been altered. This change in hydrology has had a profound effect on sediment, nutrients, oxygen, and in-stream habitat. Any additional changes in hydrology will only exacerbate the current problems. Therefore, in order to protect the geomorphological and ecological integrity of Hardwood Creek and limit impacts to Peltier Lake, stormwater discharge or hydrologic modifications that increase runoff rates or volumes into the creek for the 2-year storm should be limited. The RCWD has rules established to minimize the effect that stormwater has on receiving waterbodies.

Table 10. Stormwater Management Summary

Implementation Partners:	RCWD MPCA Ramsey County
Estimated cost:	$1,250,000
Timeline:	2009 – 2013
Estimated load reduction:	15% of total phosphorus load; 15% of total sediment load
Interim milestones:	NA

<u>Local Authorities</u>
The local authorities that exist within the Hardwood Creek watershed will play important roles in the implementation of loading reductions recommended in this TMDL. The Cities of Hugo, Forest Lake, Lino Lakes, and the RCWD, through zoning, planning or permitting have the ability to reduce nutrient and sediment loading, reduce stormwater rates and volumes, preserve wetlands and make riparian corridors a preferential land use in those areas.

<u>General Permits for Construction Site Stormwater</u>
One way to control stormwater is through the issuance of general permits for construction stormwater under the NPDES program. The current construction stormwater general permit contains provisions for discharges that occur within one mile of an impaired water.

For construction permits that apply to ditch maintenance activities, the permit holder will follow a list of BMPs developed specifically for ditch maintenance (Appendix D of the TMDL: Ditch Maintenance BMPs). By using these BMPs, the stream will be protected from excessive sedimentation during and after the maintenance activities.

<u>Phase II MS4 Permits for Local Jurisdictions</u>
Federal storm water regulations call for the issuance of Phase II NPDES (MS4) stormwater permits to specific smaller municipalities. Within 18 months of EPA approval of the TMDL, the MS4 communities must review their SWPPP for compliance with the WLA and update their SWPPP if necessary. Implementation actions in the regulated MS4s' SWPPPs that address phosphorus reductions for the Peltier Lake TMDL very likely will also address required sediment and BOD reductions for the Hardwood Creek TMDL.

The regulated MS4 communities (municipalities, road authorities, and RCWD) will together need to meet wasteload allocations for regulated stormwater runoff (for TSS this equates to an estimated 16% reduction in loads; Table 4). RCWD's rules will mitigate the impact that future development has on receiving waterbodies. To achieve the load reduction needed relative to existing conditions, the following general actions will need to be completed:

- If not already completed through the local planning process, identify untreated areas that discharge to Hardwood Creek.
- Implement stormwater management retrofits for better pollutant, volume, rate, and erosion, focusing on the untreated areas.

Given the pending completion of the Peltier Lake TMDL and Implementation Plan and the obvious overlap with the Hardwood Creek TMDL it makes sense to defer the specifics of stormwater implementation actions for Hardwood Creek until that effort is completed. If that TMDL gets unduly delayed, however, this implementation plan will be revised or amended to more specifically outline implementation measures for Hardwood Creek.

4.3.1. Highway 61 Wetland – Low Flow Restriction

In the area extending between approximately 1,200 and 3,000 feet downstream of U.S. Highway 61, there is the potential for water quality treatment without major disruption to the system (Concept Plan). While further hydraulic modeling would be necessary before making a definite proposal, initial investigations indicate that placement of a flow constriction just downstream of this wetland area would cause more frequent channel bank overtopping and natural filtering, without affecting the 100-year water surface elevation.

The flow constriction would be placed in the area where the landscape narrows, approximately 3,200 feet downstream of U.S. Highway 61 area. It would be designed such that the lowest overflow point is at the same elevation as the maintained ditch bottom. Baseflow and very low flows would thus flow essentially unrestricted through the channel, and normal water levels in the system would not be affected. However, the bottom opening of the structure would be narrower than existing conditions, while the upper portion of the structure would have an opening as wide as or wider than existing conditions. With the appropriate dimensions, such a structure would restrict flow from runoff events of a moderate magnitude, such as the two-year storm flow, and in the area just upstream of the structure, water would be forced out onto the floodplain, where it would undergo natural treatment and filtration. At the same time, because the upper portion of the channel and floodplain (the area accessed by very high flows) would not be restricted, the 100-year runoff event would not be significantly restricted, and the corresponding water surface elevations would not be increased.

Water Quality Benefit

The water quality benefit of the flow constriction would result in a reduction of both TP and TSS. Using PondNet, it was estimated that this system would provide a 5% reduction in TP loads.

Cost
A preliminary cost estimate for the low flow restriction structure is $50,000. This estimate assumes good mineral soils at to location of the structure and an approximate width of 50-feet. Additional surveying, modeling and design would be required to determine a more precise cost estimate. It would also be necessary to verify that the design of this restriction does not adversely affect the wetland community.

4.3.2. 20th Avenue Impoundment

In 2002, the District completed a study on Hardwood Creek titled the Hardwood Creek Treatment Option Analysis. The purpose of this study was to evaluate the biological, physical and chemical treatment methods that could be designed and constructed near the outlet of Hardwood Creek. Each treatment option was evaluated in detail in terms of performance, multifunctional benefits, and preliminary cost. The recommended design was a three-celled hybrid constructed wetland. However, it was recommended that the District further investigate the system upstream to identifying sources of pollution coming into the system.

4.3.3. Lateral Channel Treatment Basins

Five existing or drained (Type I and II) wetland areas have been identified along the corridor of HWC/JD2 downstream of Highway 61 that provide the enhancement opportunity for purposes of treating local sources of nutrient and sediment from Branch 4 of HWC/JD2 and other private laterals (Concept Plan). The concept design entails enhancement of the existing wetlands through impoundment and/or excavation to increase the water quality treatment volume. (Actual final proposals for such plans will be subject to review by appropriate state and/or federal authorities for compliance with relevant wetland regulations.)

In concept, these existing wetlands would be excavated to depths ranging between 3 and 5 feet. The excavated area will allow runoff from the branch/laterals of HWC/JD2 to move through the enhanced wetland at a much slower rate, thereby allowing sediment to settle out and nutrient uptake by wetland plant communities. The shallow edges of the enhanced wetland would be planted with native wetland plants. These forbs and grasses will provide wildlife habitat as well as improve the aesthetics of the area.

The sizing of these concept wetland treatment basins was based on the runoff volume from the 2.5-inch rainfall event over the contributing drainage area under future land use conditions. Future land use conditions were based on the Hugo Comprehensive Stormwater Management Plan which identifies tributary areas as Urban Reserve (2-3 units/acre).

The following table below summarizes the tributary drainage area, water quality treatment volume, surface area, estimated cost, and estimated TP removal for each basin. Associated sediment and BOD reductions were not estimated when these projects were originally planned, but are expected to occur for these pollutants to a significant degree as well.

Table 11. Later Channel Treatment Basin Summary

Basin ID	Description	Tributary Area (acres)	Volume (acre-feet)	Area (acres)	Estimated Cost*	% TP Removal**
A	Horse Stable	130	6.0	2.0	$140,000	33%
B	180th Lateral	210	9.5	9.0	$235,000	40%
C	Branch 4 Secondary	50	2.25	4.0	$70,000	42%
D	Branch 4 Primary	570	25.0	23.5	$550,000	44%
E	165th Lateral	55	2.5	3.25	$75,000	43%

* Volume is achieved via excavation. Does not include easement cost associated with implementation.
** It should be noted that these improvements are for nutrients from local tributary areas, not the mainstem of HWC/JD2 DS 61.

4.4. Vegetated Riparian Buffers

Riparian buffer zones play an important role in stream ecosystems and provide numerous benefits. Recent literature reviews on riparian buffers suggest applying different riparian buffer widths to meet different riparian goals. In the case of HWC/JD2, the primary goal for reestablishing buffers would be to filter sediment and pollutants, reduce the impact of floods, stabilize stream banks, and improve in-stream habitat.

Table 12. Buffer Implementation Summary

Implementation Partners:	RCWD MPCA Anoka County
Estimated cost:	$125,000
Timeline:	2009 – 2013
Estimated load reduction:	10% reduction in total sediment load, 25% of total phosphorus load
Interim milestones:	NA

A 100-foot buffer would be adequate for water quality and native aquatic organisms. However, a 50-foot buffer is more feasible and should, under most conditions, provide good protection to the stream morphology and habitat preservation. The risk is that heavy rain, floods, or poor management of contaminant sources could more easily overwhelm a narrower buffer.

Two recommendations are presented here. First, site-specific conditions should be further investigated for the purpose of targeting easement corridor vegetation management for pollution prevention. In concert with this will be the preservation of existing native vegetation and a determination as to whether it is worth salvaging existing native plants within the buffer zone, or whether wholesale reestablishment would be more effective. The District's NRI/MLCCS database will begin to determine this followed by individual site investigations.

Second, it is recommended that a minimum 100-ft buffer width be targeted as a long-term goal and a 50-foot buffer be targeted as the short-term goal. A two or three-tiered buffer is recommended. This approach would establish a permanent buffer immediately adjacent to the stream (1st tier) and allow land owners limited access and management opportunities in the outer buffer area (2nd and/or 3rd tier). This zone would be analyzed in the context of various features that could allow for the development of a flexible buffer width. Priority should be given first to those areas that do not currently have any riparian buffer followed by areas that currently have a marginal buffer (<50 feet).

Costs

Reestablishment of a riparian buffer zone along HWC/JD2 would entail landowner negotiation and the acquisition of conservation easements. Direct costs for vegetation are divided into native plant cover establishment for herbaceous only and with additional woody cover. For moderately diverse native herbaceous cover the costs for plant material without and with contract installation are approximately $1,600 and $4,700 per acre, respectively. Contracted annual maintenance is added on top of this at approximately $750 per acre. Additional tree cover costs for plant material vary depending on the type of material installed. For larger-scale riparian plantings it is recommended to use younger bare-root material planted at a high initial density, up to 500 seedlings per acre. Tree seedlings are approximately $25 for 25 seedling trees. Thus, at a minimum for plant material the price is $500 per acre. A cost of $4,500 per acre (26 acres total) estimated for establishing a 50-foot buffer.

4.5. Livestock Management

Management of livestock in riparian areas of HWC/JD2 would provide several benefits. First, controlling direct point source inputs of nutrients (manure) should reduce phosphorus loading and BOD (Line 2000). Second, allowing native grasses to reestablish on stream banks will provide a buffer for sediment runoff (Ownes et al. 1996), and provide better habitat for fish and bugs. Limiting livestock access to streams has been shown to be the most cost effective way of improving fish habitat (Thorn 1988). Recommended agricultural management BMPs are discussed below by stream reach.

Table 13. Livestock Management Implementation Summary

Implementation Partners:	RCWD MPCA Ramsey County
Estimated cost:	$75,000
Timeline:	2009 – 2013
Estimated load reduction:	30% of total phosphorus load; 20% of total sediment load
Interim milestones:	NA

4.5.1. HWC DS Reach: 165th to Elmcrest Avenue

This area has the greatest need for BMPs for the protection of HWC/JD2, while providing the landowner adequate resources to operate a farm. Site limitations include the close proximity of the barn and feedlot to HWC/JD2, steep slopes and erosive soils adjacent to the creek, and lack of adequate pasture area for the number of cattle. A combination of agricultural BMPs is recommended to address and attempt to overcome these obstacles. Potential BMPs are discussed below.

Livestock exclusion fencing. Livestock can impact stream systems by removing vegetation and compacting soils, resulting in soil erosion and excessive runoff. In addition, the removal of streambank vegetation increases water temperature and changes stream channel morphology. Installation of livestock exclusion fencing will restrict livestock from the stream riparian area and allow for subsequent vegetation and soil restoration.

Fencing the riparian buffer area could be done to accommodate farming activities while providing environmental protection. Locating livestock exclusion fencing to maximize the inclusion of steep slopes and concentrated flow areas within the buffer area is recommended.

Livestock crossings and pathways. Livestock fencing limits available pasture land, and an alternate location for pasturing must be found. The closest site with equal area is across the creek to the east. Installation of a livestock crossing across HWC/JD2 and pathways would need to be installed to access this area. The creek crossing could be accomplished by installation of a rock or concrete ford, earthen fill with designed culvert, or bridge. Additional study would be needed to determine which alternative is best, considering stream hydrology, cattle safety, and resource protection. The concept crossing should be located based on the shortest crossing distance to tie into equal elevation. Cattle pathways would be installed along the contour as practical. Installation of pathways should not result in creation of concentrated flows along the pathways. Pathway should be constructed with hard surface, and fencing would need to be installed to direct cattle traffic.

Pasture Management – Rotational Grazing. Once the cattle have reached the other side of the creek, adequate forage would need to be provided. It is recommended that a rotational grazing system be established. This alternative would provide adequate forage while limiting inputs into the creek.

Stockwater ponds. An alternate watering source may be needed to replace the discontinued access to HWC/JD2. Additional investigation would be needed to determine whether areas exist where soils are capable of retaining water and whether a well and/or pump would be needed. Since this site would concentrate cattle use, the stockwater pond must be carefully placed as to not result in runoff into HWC/JD2.

Diversions. Areas with steep slopes and concentrated flows that are within a practical fence line may have inadequate runoff treatment. In these cases an earthen diversion is recommended. This diversion would direct runoff away from these sensitive areas and release it in a location where adequate treatment could be provided.

Feedlot runoff control. To address water runoff from the feedlot area, clean water diversions and guttering is recommended. These BMPs are an attempt to remove water from ‘flushing’ the feedlot runoff into HWC/JD2. It is likely that this would address some of the feedlot runoff concern. However, additional analysis using MPCA FLEVAL model is recommended to determine how to adequately address feedlot runoff issues.

4.5.2. HWC DS Reach: 170th to 165th

The current land use riparian to HWC/JD2 is grassland, horse pasture, and (with aerial photo evidence) manure spreading. A significant resource protection issue appears to be the spreading of manure adjacent to HWC/JD2.

Manure Management. It is not uncommon for horse stables to have excess manure production with inadequate area for disposal. A manure management plan could be developed with the landowner to address manure utilization and prevent manure runoff into HWC/JD2. It is suspected that the landowner does not have adequate area for manure utilization, so assistance could be provided to find locations where the manure could be used as a resource. This should be addressed based on manure as a soil amendment and nutrient source instead of a waste product.

If horses are to be pastured in this area, livestock exclusion fencing should be installed to keep them out of the riparian buffer area.

4.5.3. HWC DS Reach: 165th to 165th

It appears that areas within this reach may be pastured with llamas and cattle.

The llama pasture area adjacent to HWC/JD2 is not as steep or heavily used as other parcels so a narrower buffer area would provide adequate protection to HWC/JD2 and pastureland for the landowner. Livestock exclusion fencing is recommended. Due to site constraints, the cattle area could be incorporated into a pasture management - rotational grazing system as discussed above.

Water Quality Benefit

Removing livestock from HWC/JD2 and its adjacent riparian area would eliminate the direct deposition of waste into the creek. This would effectively reduce nutrients into the stream. In addition, sediment would also be reduced. A conservative estimate of 20-60% removal of total phosphorus (TP) and 30%-70% removal of total suspended solids (TSS) is assumed for these direct discharge points.

4.6. Outreach

RCWD's educational program works to reduce stormwater runoff across the watershed and meet water quality goals, with the Blue Thumb program focusing on individual lots.

RCWD staff will meet with individual landowners to implement the specific projects identified in this implementation plan.

5.0. Monitoring

An important component of the TMDL process is follow-up monitoring. This monitoring will help determine whether the implementation actions have improved water quality. In addition, monitoring will help determine the effectiveness of various BMPs on habitat conditions and indicate when adaptive management should be initiated.

Sampling locations will remain the same as the historic stations established along Hardwood Creek and will at a minimum consist of H1.3 and H2 (Figure 8). Monitoring will occur annually at these sites after approval of the implementation plan. Monitoring will consist of three aspects:

1. Flow and water quality monitoring
2. Biological monitoring
3. Stability assessments
4. Geomorphic assessments

The goal of the monitoring plan is to assess the effectiveness of source reduction strategies for attaining water quality standards and designated uses. Hardwood Creek will remain listed until IBI standards for fish are met. RCWD staff will collect the samples.

Table 14. Water Quality Monitoring Summary

Implementation Partners:	RCWD, MPCA
Estimated cost:	$125,000
Timeline:	2009 – 2013
Estimated load reduction:	NA
Interim milestones:	NA

5.1. Flow and water quality monitoring

From snowmelt to freeze up, water quality and continuous flow will be monitored at sites H2 and H1.3. Samples will be collected and analyzed for total phosphorus (TP), soluble reactive phosphorus (SRP), total suspended sediment (TSS), volatile suspended sediment (VSS), nitrate/nitrite (NOx), and total Kjeldahl nitrogen (TKN). Field parameters will include DO. This monitoring will be a component of RCWD's annual monitoring program with the objective of long-term condition assessment.

Time frame: 2009 – 2013. Cost: $55,000(RCWD in-kind)

5.2. Biological monitoring

As part of the MPCA's newly developed *Watershed Approach* to water quality monitoring, Hardwood Creek will be monitored during 2010 and then again in 2020 as part of a ten-year monitoring cycle. One site (H2, also referred to as site 99UM103 by the MPCA) will be sampled once during the summer for both fish and invertebrate communities.

If possible, site H1.2 should also be monitored to track the effectiveness of a stream restoration project that has already been implemented.

5.3. Stability assessments

Tools such as the Pfankuch Stability Index, the Bank Erosion Hazard Index (BEHI), and the Qualitative Habitat Evaluation Index (QHEI) will be used by RCWD to assess the stability of Hardwood Creek in general, and more specifically of restoration projects. “Pre” data are available for both the Pfankuch and QHEI assessments, and continued data collection will allow assessment of completed restoration projects, providing the basis for adaptive management.

Habitat quality will also be assessed by MPCA as part of their 10-year watershed monitoring rotation.

5.4. Geomorphic assessments

Monitoring outlined in the River Stability Field Guide (Rosgen 2008) will be conducted by the RCWD. Specifically, aspects of Level IV (“Validation Level”) will be used, including, but not limited to, annual cross-section and longitudinal profiles, bank profiles, bank pins, and bed chains. Collection of these data will provide for the objective assessment of restoration actions, i.e. calculating sediment loss, aggradation, and degradation.

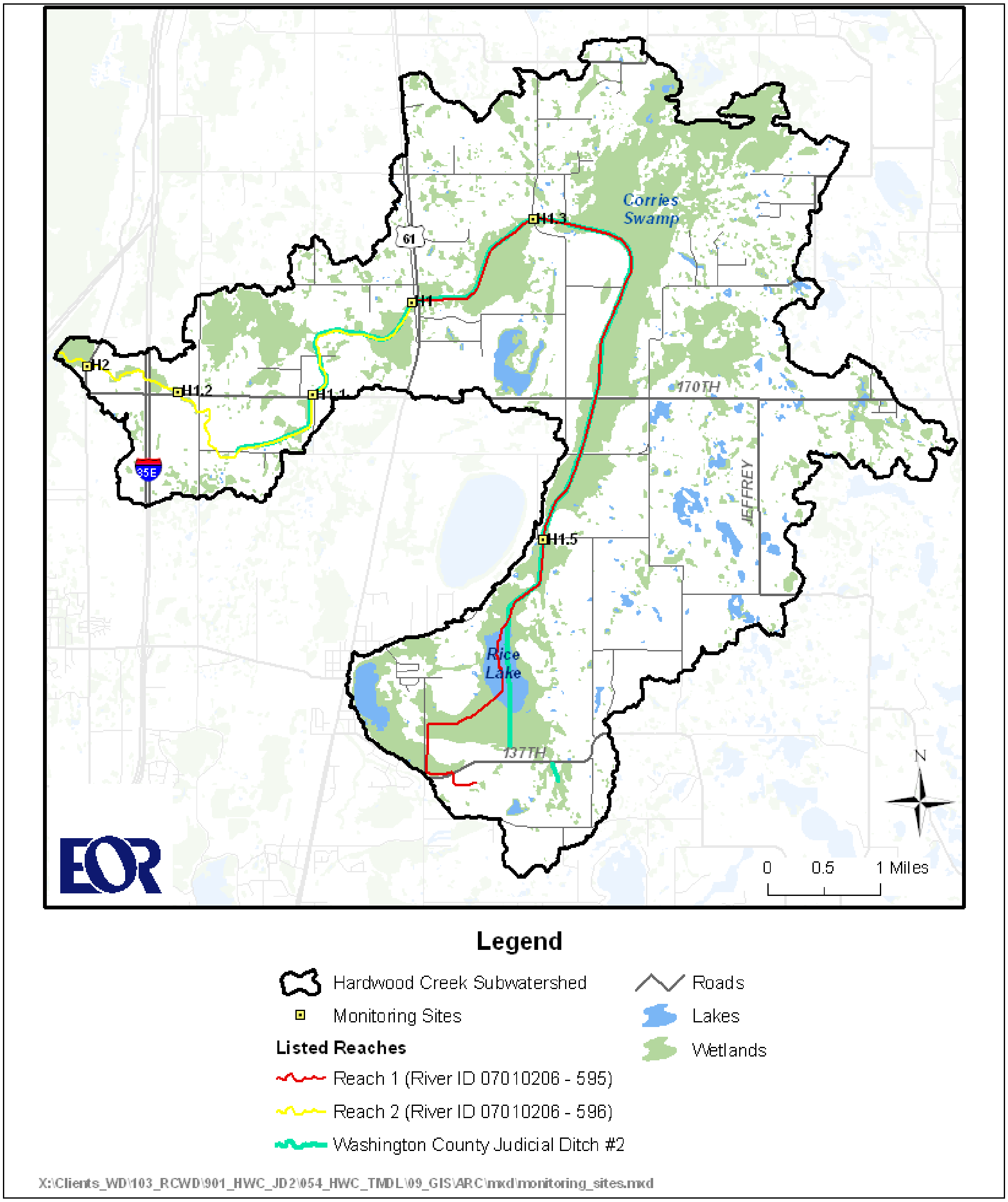

Figure 8. HWC Monitoring Sites

6.0. Adaptive Management Process

The implementation actions outlined in this management plan are intended to decrease the sediment and biological oxygen demand loading to Hardwood Creek and improve the biological integrity of the creek. However, at this stage of plan development it is not known to what extent the recommended implementation activities will be pursued nor the magnitude and scope to which the recommended activities will be realized. Since the cumulative effect on water quality therefore is also unknown, an ongoing assessment process will be implemented to evaluate the impact (effectiveness) of implementation activities on in-stream water quality and then tailor future implementation actions.

In other words, there will be ongoing assessment of the efficacy and costs of implementation actions, modeling revisions based on the actions implemented and monitoring data collected, and revisions then made to the implementation plan based on this new assessment. This process is referred to as adaptive management and is illustrated in the circular flow path of the lower right-hand portion of Figure 9.

As practices are being implemented in the watershed, in-stream water quality will be monitored to evaluate the impact that the implementation actions have on the fish communities and the sediment and oxygen concentrations in Hardwood Creek. If the biological community improves and water quality is improving, this suggests that the current approach is working and the same course will be followed. If water quality is not improving or there is no response to the biological community, this suggests that the approach being taken is not sufficient, or is targeted to the wrong sources. In this case, the approach will be evaluated and adjusted so that tangible in-stream water quality improvements can be realized.

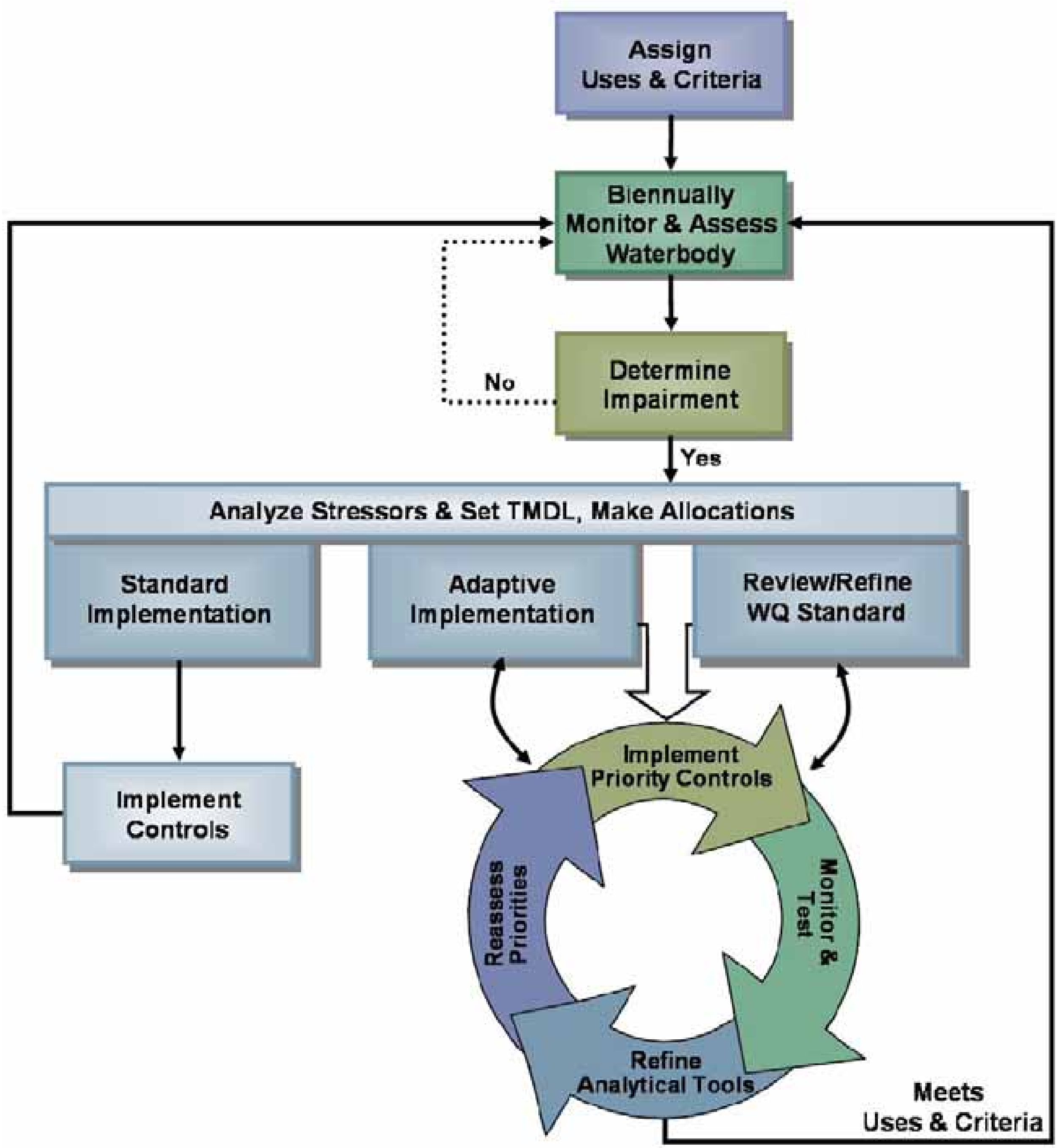

Figure 9. Alternative Implementation Processes

(Source: *Adaptive Implementation of Water Quality Improvement Plans: Opportunities and Challenges*, Nicholas School of the Environment and Earth Sciences, Nicholas Institute, Duke University, September, 2007)

7.0. Evaluation Plan

7.1. Measures for Success

- Increase in fish and macroinvertebrate IBI scores
- Sustained dissolved oxygen levels above 5 mg/L
- Number of landowners who install riparian buffers on land
- Number of acres of land enrolled in conservation programs
- Number of farmers implementing feedlot BMPs
- Number of manure management plans developed and implemented
- Comprehensive data set of water quality monitoring results
- Stream miles restored or stabilized
- Number of residents and officials who receive information on conservation practices available to landowners

Interim milestones include 1) implementation of all of the specific projects identified in this implementation plan, planned to be completed within two to three years, and 2) the evaluation of pollutant loads in Hardwood Creek every other year to determine if loads have decreased as a result of the implemented projects.

7.2. Desired environmental outcomes

By addressing the sources of sediment and BOD, this project will contribute to overall water quality improvements by reducing surface runoff into waters of Hardwood Creek. This will decrease the amounts of suspended solids and other pollutants entering our waters. This project will result in a reduction of sediment in Hardwood Creek, an increase in fish and macroinvertebrate IBI scores, and an improvement in dissolved oxygen concentrations.

7.3. Facilitation of the adoption of BMPs by the community in the project area

A highly individualized and focused approach to landowners will emphasize how individual practices have a beneficial impact on waterways. Using continuous, creative, and focused outreach in the community, a better understanding of the need for adopting BMPs will be recognized by the community and individual landowners. Extensive use of maps and aerial photographs will provide a meaningful context for landowners to make conservation decisions about their land. Extensive public outreach will educate landowners of the advantages and opportunities for technical and financial assistance to assist in establishing riparian buffers or updating their farming operations.

7.4. Coordination/ cooperation of federal, state, and local agencies and units of government

The RCWD will work closely with ACD, DNR, MPCA, NRCS, USFWS, WCD, and the Cities of Hugo, Lino Lakes, and Forest Lake. Outreach in all of the cities within the watershed will occur and support from city officials will be enlisted. Comprehensive strategies are being implemented by these groups to water quality issues, and together the collaborating agencies and organizations will share data and other information.

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