APPENDIX D: LAKE & STREAM DIAGNOSTIC STUDIES

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Main Components

Diagnostic studies include three main components:

- Historic and current water quality trends,
- Identification of pollutant sources and loads, and
- Validation of or reassignment of numerical goals and quantification of pollutant reductions needed to meet State or District goals.

Lake Diagnostic

Historic and current water quality trends

Historic and current water quality trends in lakes are based on phosphorus, chlorophyll-a, and Secchi transparency depth data. In addition, the condition of lake sediments, aquatic plants and fish community also strongly influences water quality. Therefore, lake diagnostic studies usually include a survey of aquatic plants to identify presence of invasive or nuisance aquatic plants, analysis of lake-bottom sediments for phosphorus release estimates, and bathymetry (to determine lake depths and volume) when needed. In addition, plankton data may be collected to understand the biology of the lake and the impacts that the fishery may be having on water quality.

Identification of pollutant sources and loads

A Watershed Assessment Model (GIS tool) was developed for the District to estimate watershed pollutant loads to lakes and streams from nonpoint sources and characterize the sensitivity of resources within the watershed. This model includes the following five main components:

- Subwatershed Delineation – district-wide delineation down to every landlocked basin and branch of stream (1,062 subwatersheds).
- Landlocked Basin Analysis – spreadsheet runoff modeling and identification of all landlocked depressions greater than 1-acre (466 of the 1,062 subwatersheds are landlocked).
- Subwatershed Ecological Sensitivity Ranking – overall ranking of subwatersheds based on sensitivity criteria developed for all resources (lakes, streams and wetlands) plus additional criteria for landscape units and collaborative planning efforts.
- Phosphorus and Sediment Loading – Phosphorus Loading (via EPA Simple Methodology) and Soil Erosion Potential (via RUSLE) on a 10m x 10m grid across the entire watershed.
- Subwatershed Pollutant Potential – the outputs of the RUSLE analysis and the Simple Method analysis were combined in order to compare one subwatershed to another on a watershed wide basis.

Quantification of pollutant reductions needed to meet Goals

A basic lake response model will be developed in conjunction with the watershed-loading model and will be calibrated to the water quality monitoring data for the lake. The model will be used to predict the quality of the lake in the future (based on the findings of the future conditions watershed-loading model) and to determine the response of the lake to potential nutrient load reductions. The overall phosphorus load reduction needed to meet the goal scenario will be estimated. In addition, this lake model can be used to validate or reassign numeric goals.

Tasks and Estimated Budget

Diagnostic Study Task & Description	Lake Diagnostic Category					
	Deep Lake		Shallow Lake (bathymetry data not available)		Shallow Lake (bathymetry data available)	
	Hours	Cost	Hours	Cost	Hours	Cost
Historic and current water quality trends						
Data formatting	4	$472	4	$472	4	$472
Data analysis	4	$472	4	$472	4	$472
Identification of pollutant sources and loads						
Estimate septic system load from number of shoreline parcels	6	$708	6	$708	6	$708
Estimate feedlot load from number of feedlot animals	4	$472	4	$472	4	$472
Estimate internal load potential from sediment phosphorus concentration (deep lakes) or trophic state (shallow lakes)						
Sediment collection (deep lakes) or aquatic plant survey (shallow lakes)	8	$944	-	$3,000	-	$3,000
Sediment laboratory analysis (deep lakes)	-	$350	-	-	-	-
Mid-summer dissolved oxygen & temp.profile (deep lakes) or aquatic plant summary (shallow lakes)	2	$236	2	$236	2	$236
Bottom water total phosphorus trends (deep lakes) or fish community summary (shallow lakes)	2	$236	2	$236	2	$236
Estimate watershed load from Watershed Assessment Tool	8	$944	8	$944	8	$944
Quantification of pollutant reductions needed to meet Goals						
Quantify lake physical characteristics (surface area, volume, mean depth, max depth)	2	$236	2	$236	2	$236
Bathymetry data collection	-	-	8	$944	-	-
Bathymetry data digitization	8	$944	8	$944	8	$944
BATHTUB model set-up, calibration, and reduction scenarios	12	$1,416	12	$1,416	12	$1,416
20-page summary report						
Report maps	8	$944	8	$944	8	$944
Draft report	24	$2,832	24	$2,832	24	$2,832
Revisions	8	$944	8	$944	8	$944
Final report	8	$944	8	$944	8	$944
Two public input meetings: Goal Setting and Diagnostic Results						
Preparation	16	$1,888	16	$1,888	16	$1,888
Attendance	6	$708	6	$708	6	$708
Follow-up	6	$708	6	$708	6	$708
Project Coordination	8	$944	8	$944	8	$944
TOTAL	**144**	**$17,342**	**144**	**$19,992**	**136**	**$19,048**

Stream Diagnostic

A Stream Diagnostic Study will be conducted on streams that have not met State or District goals and have been categorized as an Impaired or Focused resource, according to the criteria in Section III of the District Watershed Management Plan (Plan). Implementation of this protocol will evaluate historic and current water quality trends, channel stability, condition of riparian corridor, sediment contributions and sources of impairment or degradation to habitat.

Watershed (GIS) Assessment

To assess the watershed conditions, previous work within the watershed will be evaluated including MLCCS data, wetland management plan data (including protection needs), and hydrologic/hydraulic studies. This includes a review of planned state assessments when TALU is implemented in the Watershed. Existing phosphorus sources will be inventoried including animal agriculture, feedlot and grazing practices, point sources such as industrial activities, and wastewater facilities. Land ownership will be inventoried in GIS format to allow simple access to contact information. Other watershed scale factors will be investigated including groundwater inputs when applicable.

A Watershed Assessment GIS Tool was developed for the District, which included the following five main components:

Subwatershed Delineation
District-wide delineation down to every landlocked basin and branch of stream (1,062 subwatersheds).

Subwatershed Ecological Sensitivity Ranking
Overall ranking of subwatersheds based on sensitivity criteria developed for all resources (lakes, streams and wetlands) plus additional criteria for landscape units and collaborative planning efforts.

Phosphorus and Sediment Loading
Phosphorus Loading (via EPA Simple Methodology) and Soil Erosion Potential (via RUSLE) on a 10m x 10m grid across the entire watershed.

Subwatershed Pollutant Potential
The outputs of the RUSLE analysis and the Simple Method analysis were combined in order to compare one subwatershed to another on a watershed wide basis.

Data Collection

In addition to the routine monitoring program necessary for all streams in the District, a series of data collection surveys will be conducted. The general location of each data collection survey will be determined through the Watershed GIS Assessment outlined above. It is assumed survey locations will be representative of overall channel type and be downstream of suspected risks or sources of impairment. Stream data collection surveys will be delineated with GPS coordinates at the upstream and downstream limits, and have a reach length no greater than 20 times the bankfull width and no less than 500 feet.

This program will minimally consist of flow measurements, water quality sampling, and thermal monitoring. More parameters will be measured as it relates to the specific impairment and/or type of degradation, such as cross-sectional profiles, substrate assessments, canopy cover estimates, and etc. Stream discharge will be calculated, through a series of flow measurements, a minimum of four times per year, in order to determine baseflow and bankfull flow. To allow for comparable data, the District will aim to record annual flow data on the same date as the prior year and quarterly flow data so that each stream is not more than one day apart. Water quality sampling and thermal monitoring will accompany the stream flow data collection. In some cases, the stream implementation plan may require more regular thermal or water quality sampling data. In addition to the water chemistry parameters outlined in Section IV of the Plan, other parameters will be collected according to the impairment or type of degradation. This will vary depending on the causal factors influencing stream quality. For example, if bank erosion is identified as a significant issue related to declining water quality, stream bank surveys may be necessary to track implementation efforts.

Benthic Macroinvertebrate sampling is assumed to be repeated *three* times per year at *three* specific locations representative of the overall stream. These locations may be in or outside the data collection survey reach length. General vicinity of macroinvertebrate sampling locations will be recorded by a handheld GPS. The macroinvertebrate organisms will be identified to genus. Indices of biotic integrity for small streams will be calculated based on the macroinvertebrate data, which will allow for comparisons to historic monitoring data and other streams within the watershed. Table D-1 identifies the key macroinvertebrate measures, Table D-2 identifies water quality ranking based solely on Hilsenhoff's biotic index (HBI).

The District will use a level-1 Rosgen Classification and a Pfankuck (1975) stream channel stability rating procedure, as modified by Rosgen (1996, 2001b). This information on existing stream type, potential stream type, and channel stability rating informs the management recommendations of each stream. As channel geomorphology is typically less variable than biotic components, this in-stream assessment will be conducted as deemed necessary after the initial diagnostic is complete.

Stakeholder Involvement

During the watershed and in-stream assessments, landowners will be contacted for input and data. From this outreach effort, a stakeholder group will be formed. Additional stakeholders will include the CMSCWD, County, Conservation District, MNDNR, local governments, and agency representatives, as appropriate. A minimum of two meetings will be held with this stakeholder group. Stakeholder involvement is intended to meet public involvement requirements for plan amendments.

Goal Setting

The State established total suspended solid and eutrophication goals for rivers and streams in the summer of 2014. Goal setting for all impaired streams will be based on current State standards and benchmarks will be set and scheduled in coordination with State efforts. Based on considerations of best usage and the need for water quality protection in the interest of the public, and in conformance with the requirements of Minnesota Statutes, section 115.44, the waters of the state are grouped into one or more aquatic life use classifications. The classifications are listed in MN Rule Chapter 7050 (parts 7050.0400 to 7050.0470) and will be modified when TALU is adopted. All streams and creeks within the District where there is current State Use Class data are considered Class 2A (cold water streams) or Class 2B (warm water streams) for the purposes of this assessment. Swedish Flag and Carnelian are Class 2B streams that are listed as impaired according to State standards. Gilbertson's is the only class 2A stream listed as impaired according to current State standards.

Goal setting for streams categorized as Focused will typically be accomplished in one public/stakeholder involvement meeting and a number of District Board of Manager meetings. Routine stream goals are based on maintaining their 2003 stream health grade and reducing susceptibility to overall degradation of the stream. Specific benchmarks will be set for each stream and will be based on the specific risks and degradation that have caused the deviation from District goals.

Watershed Modeling

If the stressor identification process identifies sediment or nutrient loading as a significant issue in the stream, a watershed water quality model will be developed. Suggested modeling techniques include the P8 Urban Catchment Model or the Soil and Water Assessment Tool (SWAT) for simulating watershed runoff and water quality. These models can be used to estimate sediment and nutrient loads off the landscape. A future conditions scenario, based on projected land use, will be run to identify potential future impacts to the stream.

Implementation Plan

An implementation plan that identifies the activities needed to achieve stream health goals will be developed. Implementation activities for each stream will be prioritized according to cost effectiveness and potential for greatest improvements. Each activity will have a description, suggested location, assumed pollutant removal when applicable, and cost estimate. Stakeholders will provide input on the implementation plan through public involvement meetings.

Monitoring Plan

As a component to the diagnostic study, a Monitoring Plan will be developed as a means of tracking the progress of specific management activities. This plan will be geared towards the set benchmarks.

Estimated Budget

A conservative, preliminary estimate of probable cost range for a stream diagnostic is provided below for reference. Actual costs may vary significantly depending on the causal factors influencing stream quality and the magnitude of data previously collected.

Stream Diagnostic Study Task & Description	Hours	Cost
Watershed Assessment		
Estimate septic system load from number of parcels	6	$708
Estimate feedlot load from number of feedlot animals	4	$472
Estimate watershed load from Watershed Assessment Tool	8	$944
Estimate Survey Location through land use and perceived risk assessment	4	$472
Data Collection Survey		
Quantify stream physical characteristics (surface area, discharge, length, profile, max depth)	28	$3,680
Conduct geomorphology assessment	20	$2,620
Macroinvertebrate collection (3 locations, 3x/yr for 3 years)	24	$2,382
Submit Macroinvertebrate samples for processing	-	$2,250
Physical, Chemical & Hydrologic In-Stream Monitoring (3 yrs)	-	N/A*
Summary Report & Plan Development		
Report maps	8	$944
Draft report	24	$2,832
Revisions	10	$944
Final report	8	$944
Two Public Input Meetings: Goal Setting and Diagnostic Results		
Preparation	16	$1,888
Attendance	6	$708
Follow-up	6	$708
Project Coordination	8	$944
TOTAL	**180**	**$23,440**

* *In-Stream Monitoring assumed to be previously collected or funding through District Monitoring Program, otherwise estimate an additional $9,000/yr.*

Table D-1. Key macroinvertebrate measures.

Metric	Explanation
Chironomidae Species Richness	The number of midge species (small flies). Some of these species indicate healthy waters (pollution intolerant) and others indicate bad water quality (pollution tolerant). In general, a high proportion of chironomids indicates sandy or loose substrate and poorer trout habitat. Individual species analysis is highly informative.
Invertebrate Taxa Richness	Overall diversity. More diverse systems indicate more diverse habitat and a functioning food web. Sites with taxa richness less than 15 are considered impaired. Sites with taxa richness greater than 25 are considered to be excellent.
HBI	Hilsenhoff's biotic index is a very robust and reliable measure of water quality with respect to organic pollution only. The lower the number, the better the water quality is, on a scale of 0 to 10. See Table D-2 for water quality ranking based solely on HBI.
% EPT	The number of Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) families in the sample. More of these groups indicate better habitat (riffles), trout conditions, and water quality because these families are sensitive to a variety of disturbances and pollutants. A higher EPT reflects better water quality than a lower one.
% Dominance	The percent of the population that is made up of the one most dominant taxa. In general, if a single kind of organism dominates a system it is the result of disturbance. This measure is very informative if, for instance, there is a high diversity but also a high dominance of a pollution tolerant group.
Most Common Families	The three most common families of macroinvertebrates found at each sample site. This is an important measure of which groups are doing best in the system. Different families have different tolerances to habitat change and pollution.

Table D-2. Evaluation of water quality using Hilsenhoff's Family Level Biotic Index.

Family Biotic Index	Water Quality	Degree of Organic Pollution
0.00-3.75	Excellent	Organic pollution unlikely
3.76-4.25	Very good	Possible slight organic pollution
4.26-5.00	Good	Some organic pollution probable
5.01-5.75	Fair	Fairly substantial pollution likely
5.76-6.50	Fairly poor	Substantial pollution likely
6.51-7.25	Poor	Very substantial pollution likely
7.26-10.0	Very poor	Severe organic pollution likely