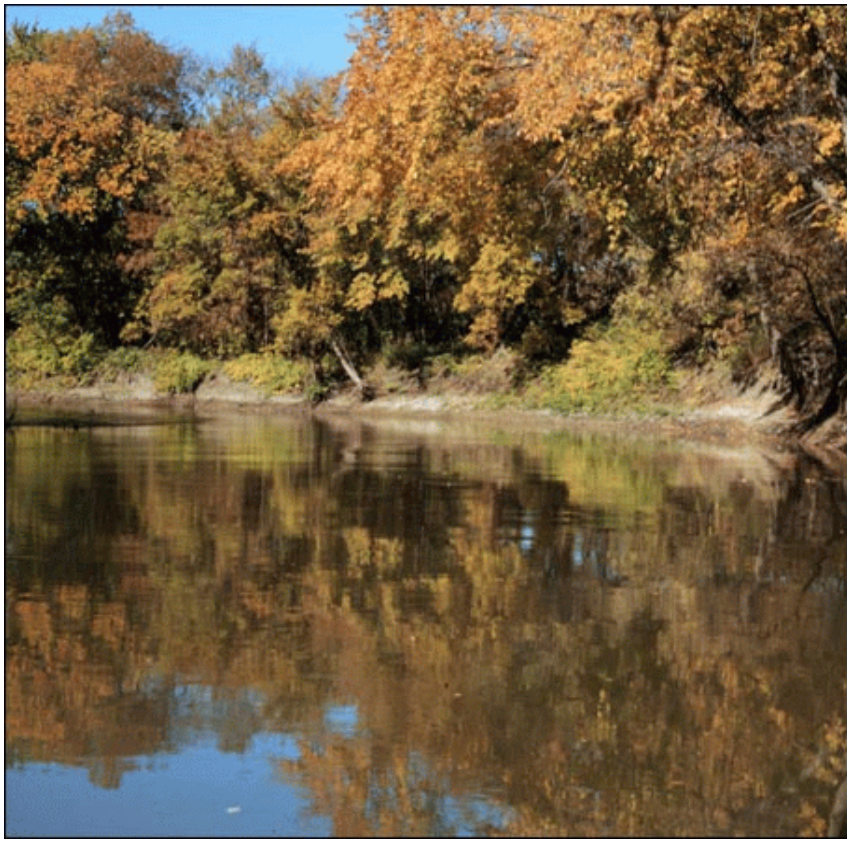
North Dakota Department of Health

Division of Water Quality
Surface Water Quality Management Program

North Dakota's Water Quality Monitoring Strategy for Surface Waters



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North Dakota's Water Quality Monitoring Strategy for Surface Waters

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I. INTRODUCTION

A. Background

The federal Clean Water Act provides the regulatory context and mandate for state water quality monitoring and assessment programs. The North Dakota Department of Health has been designated as the state water pollution control agency for purposes of the federal Clean Water Act and, as such, is authorized to take all actions necessary or appropriate to secure for the state all benefits of the Clean Water Act and similar federal acts (NDCC 61-28-04). State law establishes policy to protect, maintain and improve the quality of waters of state, while the overall goal of the federal Clean Water Act is to "restore and maintain the chemical, physical and biological integrity of the Nation's waters."

Various sections in the Clean Water Act require states to conduct specific activities to monitoring, assessment and protect their waters. These activities include:

- $ Developing and adopting water quality standards designed to protect designated beneficial uses (Section 303).
- $ Establishing monitoring programs to collect and analyze water quality data (Section 106).
- $ Reporting on the status of waters and the degree to which designated beneficial uses are supported (Section 305[b]).
- $ Identifying and prioritizing waters that are not meeting water quality standards (Section 303[d]).
- $ Assessing the status and trends of water quality in lakes and identifying and classifying lakes according to trophic condition (Section 314).
- $ Identifying waters impaired due to nonpoint sources of pollution as well as identifying those sources and causes of nonpoint source pollution (Section 319).

B. North Dakota's Surface Water Resources

The North Dakota Department of Health currently recognizes 247 lakes and reservoirs for water quality assessment purposes. Of this total, 139 are manmade reservoirs, and 108 are natural lakes. All lakes and reservoirs included in this assessment are considered significantly publicly owned. Based on the state's Assessment Database, the 139 reservoirs have an aerial surface of 543,156 acres. Reservoirs comprise about 71 percent of North Dakota's total lake/reservoir surface acres. Of these, 480,731 acres or 63 percent of the state's entire lake and reservoir acres are contained within the two mainstem Missouri River reservoirs (Lake Sakakawea and Lake Oahe). The remaining 137 reservoirs share 62,425 acres, with an average surface area of (312) 471 acres. The 108 natural lakes in North Dakota cover 218,518 acres, with approximately 117,697 acres or 54 percent attributed to Devils Lake. The remaining 107 lakes average 942 acres, with 40 percent being smaller than 200 acres.

There are 54,606 miles of rivers and streams in the state. Estimates of river stream miles in the state are based on the 1:100K National Hydrography Dataset (NHD) and include ephemeral, intermittent and perennial rivers and streams.

One of the most significant water resource types in the state are wetlands. There are an estimated 2.5 million acres of wetlands in the state. The majority of these wetlands are temporary, seasonal, semi-permanent and permanent depressional wetlands located in what is commonly called the Prairie Pothole Region.

C. Purpose and Scope

This document describes the North Dakota Department of Health's strategy to monitor and assess its surface water resources, including rivers and streams, lakes and reservoirs and wetlands. It does not address ground water monitoring and assessment or regulatory monitoring for National Discharge Pollution Elimination System (NDPES) permit compliance. For more information on ground water monitoring and assessment and NDPES compliance monitoring, the reader is referred to the Division Water Quality's Ground Water Protection and Permit Programs, respectively.

This strategy also fulfills requirements of Clean Water Act Section 106(e)(1) that requires the U.S. Environmental Protection Agency (EPA), prior to awarding a Section 106 grant to a state, to determine that the state is monitoring the quality of its waters, compiling and analyzing data on the quality of its waters and including those data in its Section 305(b) report. An EPA guidance document entitled *Elements of a State Water Monitoring and Assessment Program* (EPA, March 2003) outlines 10 key elements of a state monitoring program necessary to meet the prerequisites of CWA. The 10 key elements are:

- $ Monitoring Program Strategy.
- $ Monitoring Objectives.
- $ Monitoring Design.
- $ Core and Supplemental Water Quality Indicators.
- $ Quality Assurance.
- $ Data Management.
- $ Data Analysis/Assessment.
- $ Reporting.
- $ Programmatic Evaluation.
- $ General Support and Infrastructure Planning.

The purpose of this multi-year strategy is to describe the goals, objectives, scope and plan for surface water quality monitoring conducted by the North Dakota Department of Health. While the Department recognizes and benefits from numerous state, federal and local partners in the state that conduct monitoring and assessment activities, this document does not provide direction for monitoring efforts outside the responsibility of the Department.

II. TYPES OF MONITORING

Environmental monitoring data, including water quality monitoring data, can be categorized by the purpose for the monitoring and how the information is assessed and used. In general, the categories are: 1) condition monitoring, 2) problem investigation monitoring, 3) effectiveness monitoring and 4) special studies monitoring.

While there are similarities among the four monitoring types, these definitions are provided to help distinguish between the various purposes of monitoring programs and projects necessary to meet the goals and objectives of this strategy.

Condition monitoring is used to identify overall water quality status and trends by assessing the condition of individual waterbodies, populations of waterbodies or watersheds in terms of their ability to meet water quality standards or other established criteria (i.e., water quality index or biological indicators). The primary focus of condition monitoring is on understanding the status of the water resource, identifying changes in water quality over time and in identifying and defining problems at the watershed or ecosystem level. Examples of condition monitoring include ambient water quality or rotating basin monitoring for Section 305(b) reporting, lake water quality assessments and Section 303(d) Total Maximum Daily Load (TMDL) listing activities.

Problem investigation monitoring involves studying specific water quality problems or watershed restoration issues that results in the development of a management or remediation plan to protect or improve the resource. Problem investigation monitoring is used to determine the specific causes and sources of water quality impairments to rivers, streams, lakes, reservoirs or wetlands and to quantify pollutant loads. It is also used to determine the actions that are needed to return a waterbody to a condition that meets standards or other water quality goals. Examples of problem investigation monitoring include TMDL development projects, Section 319 Nonpoint Source (NPS) Pollution assessment projects and the investigation of specific water pollution issues (e.g., fish kills or pollution spills).

Effectiveness monitoring is used to assess the effectiveness and success of specific regulatory or voluntary management actions that have been implemented to improve or protect water quality. Effectiveness monitoring is not only used to evaluate the immediate success of management actions, but is used in an adaptive management framework to improve and refine management actions to meet the projects goals. Examples include monitoring for TMDL implementation projects or Section 319 NPS watershed restoration projects.

Special studies monitoring addresses monitoring activities that do not fit neatly into the other three categories. Typically, special studies monitoring would not directly result in an assessment of a specific lake, stream or wetland or in the implementation of management actions for specific waterbodies or watersheds. These studies would include those stream, lake and wetland studies that are more research-focused. Examples include monitoring for emerging issues such as pharmaceuticals, monitoring related to toxic pollutants such as mercury or pesticides, monitoring focused on specific geographic areas and studies focused on a specific problem, pollutant source, sampling method or to answer a specific question. These types of studies typically have a very specific purpose and are generally of relatively short duration.

III. MONITORING AND ASSESSMENT GUIDING PRINCIPLES

This strategy also incorporates six guiding principles considered by the Department to be essential for effective monitoring and necessary to meeting the goals and objectives.

Principle 1: Integrate and coordinate the use of scarce monitoring resources with those of other agencies and organizations.

The scarcity of funds and other resources necessary to adequately monitor and assess the state waters demands the Department work closely with other entities, both public and private, to ensure the broadest possible coverage of the state's surface water resources. The Department will seek opportunities to collaborate with other organizations to plan and implement monitoring programs and projects.

Principle 2: Maximize the use of local units of government and citizen volunteers to monitor surface water quality.

Local units of government such as soil conservation districts, water resource boards and cities have be important partners in conducting monitoring for nonpoint source assessments and for developing TMDLs. Citizen volunteers in the form of lake associations have conducted lake water quality monitoring. By using local governments and citizens in the monitoring, more waters can be assessed. When local governments and citizens volunteers are involved in collecting the data they are more likely to take the necessary steps to address water quality problems. Screening level monitoring by competent citizen volunteers will make more time for Department staff to address complex problems and issues.

Principle 3: Schedule field studies and other data acquisition activities to be consistent with the Department's rotating basin monitoring schedule.

North Dakota is a large state, and as a result, the expenditure of resources for travel and other logistics can be considerable. To the extent practical, monitoring programs and projects should be coordinated to occur within a basin at the same time. This would also facilitate the integration of data and reporting across water resource types.

Principle 4: Use a tiered monitoring approach consisting of rapid assessment of screening level assessments at numerous sites and intensive study designs at a smaller subset of pre-screened sites.

Whenever possible, the Department will use rapid assessments or screening level studies to initially evaluate the water quality condition of a waterbody. If the initial screening data suggests a potential problem exists, then more intensive monitoring will be performed by Department staff to verify the problem and to determine its specific cause and source. This tiered approach will result in the assessment of more waters each year and will allow the Department to focus limited resources on those waters with the most pressing needs.

Principle 5: Generate monitoring data that are scientifically defensible and relevant to the decision-making process.

All of the monitoring activities in this strategy are linked to specific goals and objectives and are established to be consistent with sound scientific and statistical concepts. Emphasis is given to quality assurance and quality control processes and procedures that will result in data that are of known precision and accuracy sufficient to support sound management decisions.

Principle 6: Manage and report water quality data in a way that is meaningful and understandable to the intended audience.

For monitoring data and information to be truly useful, it must be managed properly and reported to intended audiences in not only a meaningful way but in a timely manner. This strategy provides a commitment to data automation and the establishment of data management policies and procedures to ensure that water quality data are easily accessible and understandable to Department staff, other agencies and organizations and the public. Water quality monitoring and assessment programs, projects and studies should recognize that different levels of detail are needed for both data analysis and reporting depending on the audience.

IV. MONITORING AND ASSESSMENT GOAL AND OBJECTIVES

A. Monitoring and Assessment Goal

As stated earlier, the overall water quality goal of the state is "to protect, maintain and improve the quality of waters of the state," while the overall goal of the federal Clean Water Act is to "restore and maintain the chemical, physical and biological integrity of the Nation's waters." In support of these goals, this strategy and the Department have established a water quality monitoring goal ***"to develop and implement monitoring and assessment programs that will provide representative data of sufficient spatial coverage and of known precision and accuracy that will permit the assessment, restoration and protection of the quality of all the state's waters."*** In support of this goal and the water quality goals of the state and of the Clean Water Act, the Department has established 10 monitoring and assessment objectives. In order to fully meet these objectives, it will require additional time and resources to acquire and to develop the necessary database(s), indicators and staff expertise.

B. Monitoring and Assessment Objectives

The following general programmatic objectives have been established to meet the goals of this strategy. They are:

- $ Provide data to establish, review and revise water quality standards.
- $ Assess water quality status and trends.
- $ Determine beneficial use support status.
- $ Identify impaired waters.
- $ Identify causes and sources of water quality impairments.

- $ Provide support for the implementation of new water management programs and for the modification of existing programs.
- $ Identify and characterize existing and emerging problems.
- $ Evaluate program effectiveness.
- $ Respond to complaints and emergencies.
- $ Identify and characterize reference conditions.

In addition, a summary of the monitoring objectives for each program is provided in Table 1.

Table 1. Summary of Monitoring Program and Objectives for North Dakota.

Monitoring Program	Monitoring Objective(s)
Ambient Water Quality Monitoring Network for Rivers and Streams	1. To provide data for trend analysis, general water quality characterization and pollutant loading calculations. 2. To support the assessment of beneficial use attainment for Section 305(b) reporting and Section 303(d) listing 3. To identify water quality problems. 4. To evaluate the effectiveness of pollution control and abatement programs.
Biological Monitoring Program for Rivers and Streams	1. To assess aquatic life use attainment for Section 305(b) reporting and Section 303(d) listing purposes. 2. To identify water quality problems. 3. To evaluate the effectiveness of pollution control and abatement programs.
Ecoregion Reference Station Network	1. To develop biological indicators using fish, macroinvertebrates and/or periphyton and to use those indicators in biological condition assessment for the state's rivers and streams at varying spatial scales. 2. To develop/refine nutrient criteria for rivers and streams. 3. Refine existing sediment reference yields for rivers and streams.
Lake Water Quality Assessment Program	1. To describe the general physical and chemical condition of the state's lakes and reservoirs, including trophic status. 2. To assess beneficial use attainment for Section 305(b) reporting and Section 303(d) listing. 3. To identify water quality problems. 4. To evaluate the effectiveness of pollution control and pollution abatement programs (e.g., NDPDES, Section 319). 5. To refine fishery classifications described in the state water quality standards.

Table 1 (cont). Summary of Monitoring Program and Objectives for North Dakota.

Monitoring Program	Monitoring Objective(s)
Missouri River Mainstem Monitoring Program	1. Provide data for trend analysis, general chemical characterization and pollutant loading calculations. 2. Assess beneficial use attainment for Section 305(b) reporting and Section 303(d) listing. 3. Develop nutrient criteria. 4. Develop biological indicators for the mainstem Missouri River using fish, macroinvertebrates and/or periphyton and to use those indicators in biological condition assessment of the Missouri River. 5. Identify water quality problems.
Fish Tissue Contaminant Surveillance Program	1 To protect human health by monitoring and assessing the levels of commonly found toxic compounds in fish from the state's lakes, reservoirs and rivers. 2. To use these data to develop and issue fish consumption advisories. 3. To assess fish consumption use attainment for Section 305(b) reporting and Section 303(d) listing. 4. To identify water quality problems due to contaminants. 5. Monitor and assess human exposure of contaminated fish.
Wetland Monitoring and Assessment Program	1. To develop biological indicators and assessment methodologies for wetlands and to use those indicators and methods to monitor and assess wetland condition at varying spatial scales. 2. To refine and apply wetland assessment methods to evaluate the effectiveness of wetland mitigation and restoration programs and projects. 3. To support the development of water quality standards for wetlands.
TMDL Development Program	1. To assess the state's rivers, streams, lakes and reservoirs and to provide a list of waterbodies that are impaired. 2. To develop TMDLs for waterbodies on the state's Section 303(d) list that, when implemented, will restore the waterbody's impaired beneficial uses. 3. To develop scientifically defensible water quality targets that can be used in water quality assessment and in the development of TMDLs.
Nonpoint Source Pollution Management Program	1. To assess waterbodies with little or no water quality assessment information by identifying beneficial use impairments or threats to the waterbody and to determine the extent to which those threats or impairments are due to NPS pollution. 2. To evaluate the effectiveness of implemented BMPs in meeting the NPS pollutant reduction goals specified in NPS implementation projects.
Support Projects and Special Studies	1. To provide data or information to either answer a specific question or to provide program support.

Table 1 (cont). Summary of Monitoring Program and Objectives for North Dakota.

Monitoring Program	Monitoring Objective(s)
Complaint Investigation	1. The objectives of complaint investigation are to determine whether or not an environmental or public health threat exists and the need for corrective action where problems are found.
Fish Kill Investigations	1. The objectives of the fish kill investigation are to determine the extent of the fish kill and the possible cause(s) of the fish kill.

V. MONITORING PROGRAM DESIGNS

In order to meet the goals and objectives outlined above, the Department has taken an approach which integrates three basic monitoring designs. They are: 1) a fixed station approach; 2) a probabilistically based approach; and 3) an approach to address source identification and/or environmental response (e.g., complaints, spills or fish kills).

These three approaches can, in the interest of increased efficiency, to accommodate multiple purposes, or both, be combined when designing a monitoring program. The Department recognizes the need to integrate multiple designs in its monitoring programs and projects to meet the full range of information and assessment needs for decision makers. The Department also recognizes that each monitoring design may require a different number of samples, a different set of core indicators, exhibit a different sampling bias, and have a different basis for sample site selection. Accordingly, maximizing the applicability of the monitoring data requires that the monitoring design be matched to the monitoring objectives of the given program. Analysts and decision makers using data collected for one program or project's objectives to meet the objectives of another program (e.g., using statewide status and trends assessment data for validation of TMDLs) need to clearly understand the monitoring design used, including how the strengths and weaknesses of the specific monitoring design could affect the applicability of these data to a given water quality program. The sampling approaches and designs selected for each water quality monitoring program and project are described within each of the individual program/project write-ups.

A. Fixed Station Designs

Monitoring designed around fixed stations can be useful: 1) in targeting areas which are either subject to pollution or which are least impacted "reference" sites; 2) in targeting areas which are expected to exhibit either significant improvement due to point source controls or watershed restoration activities, or degradation; or 3) in order to detect trends in water quality. It should be noted that while fixed station designs are useful, there applicability to conduct statewide assessments is limited. The Department's ambient water quality monitoring program, which samples from fixed stations over long periods of time does so to provide to provide assessment information concerning both water quality status and trends.

B. Probabilistically Based Designs

An alternative approach to fixed stations is to select sites using a probability-based design. This type of design allows a statistically derived estimate of water quality or biological conditions in a select area even when all the waters within that area are not directly sampled. Based upon the natural variability of the water quality or biological indicators used and the level of sampled effort used, a level of confidence or uncertainty in the condition estimate can be determined. While fixed sites are often used to quantify temporal change at targeted locations, probabilistic sampling emphasizes spatial quantification of water quality or biological conditions.

C. Source Identification and Environmental Response

A different approach is needed when monitoring to identify pollution sources impacting a waterbody or to measure impacts or recovery of a waterbody to a spill event. This type of sampling is normally very intensive, both spatially and temporally in order to characterize the local impact of a short-term pollution event. Sampling stations are established based on existing knowledge of the pollution source (e.g., historical monitoring or from predictive modeling). In cases involving spills, often multiple sampling events are necessary to properly characterize the impact. Sampling designs can often be dynamic, adjusting to changing pollution conditions, environmental conditions, or simply being fined-tuned based on information obtained from prior sampling events.

VI. CORE AND SUPPLEMENTAL WATER QUALITY INDICATORS

Environmental indicators are direct or indirect measures of environmental quality used to assess the status and trends of environmental conditions. As such, indicators are critical components of the Department's ability to assess the overall water quality and biological conditions of the state's water resources and to identify sources and causes of pollution. A water quality or biological indicator's value is increased to the degree that it is based on representative, readily available, technically defensible data that are collected regularly and are sensitive to change (i.e., an indicator should not be so variable, naturally, that detection of trends over time cannot be measured).

The Department's water quality monitoring program uses a suite of indicators to assess beneficial use attainment and to determine causes and sources of stressors affecting water quality. The Department uses a tiered approach that combines core indicators selected for each beneficial use and water resource type combination, plus supplemental indicators selected according to site-specific or project-specific decision criteria. Core and supplemental indicators for each water resource type (i.e., lakes, reservoirs, rivers, streams and wetlands) include physical, chemical, habitat, biological and landscape variables and metrics. Tables 2, 3 and 4 provide a matrix of core and supplemental indicators used by the Department to assess beneficial use attainment for rivers and streams, lakes and reservoirs and wetlands, respectively. Specific indicators used with each monitoring program or project are discussed within each of the individual program/project write-ups.

VII. QUALITY ASSURANCE AND QUALITY CONTROL MEASURES

To ensure that all environmental and related data collected, compiled and/or generated for the Department are complete, accurate and of the type, quantity and quality required for their intended use, it is the policy of the Department that all environmental monitoring be in conformance with the *Quality Management Plan for the Environmental Health Section* (NDDoH/EHS Revision 6, August 2008) and with procedures described in project specific Quality Assurance Project Plans (QAPPs). All QAPPs are prepared according to guidance provided in the EPA document entitled *EPA Requirements for Quality Assurance Project Plans* (EPA, March 2001, reissued May 2006).

Overall organization for the Department's Environmental Health Section is detailed in the *Quality Management Plan for the Environmental Health Section* (NDDoH/EHS Revision 6, August 2008). The Environmental Health Section (EHS) is one of six sections in the Department. Within the EHS there are five divisions: Air Quality, Municipal Facilities, Waste Management, Water Quality and Chemistry. Dana Mount is the quality assurance coordinator for the EHS. The quality assurance coordinator is located in the EHS Chief's Office and reports directly to the Chief. The Chief's Office and the quality assurance coordinator are responsible for oversight of the EHS's quality system for quality assurance (QA) and quality control (QC) as delineated in the *Quality Management Plan for the Environmental Health Section* (NDDoH/EHS Revision 6, August 2008), including approving project QAPPs. It is the policy of the EHS that the primary responsibility for QA resides among program staff and designated project managers in each division; therefore, each program is responsible for the preparation, implementation, and assessment of its own project specific QAPPs.

Michael J. Ell is program manager for the Division of Water Quality's Surface Water Quality Management Program. As program manager he has the following QA/QC responsibilities:

- Reviewing and editing QAPPs;
- Providing oversight for study design, site selection, and adherence to design objectives;
- Reviewing and approving the final project work plans and other materials to support the project (e.g., standard operating procedures);
- Selecting appropriate project subcontractors, as needed; and
- Coordinating with contractors, reviewers and EPA to ensure technical quality and contract adherence.

Table 2. Core (C) and Supplemental (S) Indicators for Rivers and Streams.

Indicator	Beneficial Uses Designation			
	Aquatic Life	**Recreation**	**Drinking Water**	**Fish Consumption**
Chemical				
Dissolved Oxygen	C			
Ammonia	C			
pH	C			
Sulfate			C	
Chloride			C	
Trace Metals				
Water column	C		C	
Mercury in fish tissue				C
Pesticides	S		S	
Nutrients	C	C		
Physical				
Temperature	C			
Habitat	S			
Flow	C			
Suspended Sediment	S			
Taste and Odor			S	
Biological				
Pathogens				
Fecal coliform		C		
E. coli		S		
Enterococcus		S		
Macroinvertebrates	C			
Fish	C			
Algae				
Periphyton	S			
Phytoplankton	S			
Chlorophyll	S		S	
Landscape (e.g., percentage cover of land uses, road density, population density)	S	S	S	

The Surface Water Quality Management Program's program manager also assigns a designated project manager for each QAPP. These designated project managers are responsible for overall project coordination and supervision, including the reduction and analysis of project data and the preparation of the final report.

To ensure that the Department's QA/QC policies are adhered to, the SWQMP has instituted the following QA/QC activities and procedures:

- $ QAPPs and/or study plans must be submitted to the Department's QAC for review and approval prior to implementation;
- $ All data will be recorded on standardized reporting forms and should include a description of the sampling site(s), date and time of collection and collector identification;

$ Equipment used in sample collection will be cleaned, repaired and calibrated according to the manufacture's specifications, and a log will be maintained of all service and calibration activities;

$ Standard Operating Procedures (SOPs) will be developed and periodically reviewed for all field sampling procedures (these SOPs should describe in detail the field sampling and/or measurement procedures, meter calibration and maintenance procedures, sample chain-of-custody documentation, sample preservation, holding times and recommended sample container specifications, data recording form examples and data submission requirements);

Table 3. Core (C) and Supplemental (S) Indicators for Lakes and Reservoirs.

	Beneficial Uses Designation			
Indicator	**Aquatic Life**	**Recreation**	**Drinking Water**	**Fish Consumption**
Chemical				
Dissolved Oxygen	C			
Ammonia	C			
pH	C			
Sulfate			C	
Chloride			C	
Trace Metals				
Water column	C		C	
Mercury in fish tissue				C
Pesticides	S		S	
Nutrients (total and dissolved)	C	C	S	
Physical				
Temperature	C			
Sediment	S	S	S	
Taste and Odor			S	
Secchi disk transparency	C	C		
Biological				
Pathogens				
E. coli		C		
Enterococcus		S		
Fish	S			
Algae				
Phytoplankton	S			
Chlorophyll	S		S	
Eutrophic Condition				
TSI – Chlorophyll-*a*, Phosphorus, Secchi disk	C	C	S	
Landscape (e.g., percentage cover of land uses, road density, population density)	S	S	S	

Table 4. Core and Supplemental Indicators for Wetlands.

Indicator	Beneficial Uses Designation	
	Aquatic Life	**Recreation**
Chemical		
Trace Metals		
Water column	S	
Mercury in tissues	S	
Pesticides	S	
Nutrients (total and dissolved)	S	
Physical		
Temperature	S	
Sediment		
Biological		
Pathogens		
E. coli		C
Enterococcus		S
Macroinvertebrates	S	
Plants	C	
Algae		
Phytoplankton	S	
Chlorophyll	S	
Hydrogeomorphic	S	
Landscape (e.g., percentage cover of land uses, road density, population density)	S	S

- $ Staff within the Surface Water Quality Management Program will provide training, at least once each year, to field investigators in the measurement and collection of water quality samples;

- $ All samples collected for analysis will be submitted for analysis to the appropriate laboratory following standardized chain-of-custody procedures; and

- $ All data entered into the Department's data management system will be reviewed, checked and edited prior to final submission to STORET.

Additional information on program/project specific QA/QC requirements and procedures are provided within each of the individual program write-ups.

VIII. DATA MANAGEMENT

The Department is committed to recording and managing water quality monitoring data electronically and in a timely manner; integrating its data in a way that allows for efficient storage, retrieval, and evaluation; and reporting and sharing its data with EPA, other state and government agencies, regulated entities, and the general public.

A. Current Systems

Efficient data management is essential to an effective water quality monitoring and assessment program. Data management is necessary for assessment, reporting, tracking, sharing data and meeting data quality objectives. Electronic data management technology has greatly expanded the Department's ability to manage, present and share water quality information. Data management is organized around four main data management systems. The following describes of each of these database systems.

1. Sample Identification Database (SID)

Since 1993, the Department has maintained its own database management system. The Sample Identification Database (SID) is a Microsoft ACCESS database management system. All water column chemistry, fish tissue chemistry, sediment chemistry and field water quality data either collected by the Department's Surface Water Quality Management Program or for the program under contract or cooperative agreement are entered into SID. All samples results generated by the Department's Chemistry Division are electronically transmitted to the Surface Water Quality Management Program where they are incorporated into SID by the database management coordinator. Field data (e.g., temperature, pH, dissolved oxygen and conductivity measurements) and sample custody information (e.g., station description, date and time collected and depth) are recorded on standardized forms and entered into SID by program personnel.

2. Ecological Data and Application System (EDAS)

The Department uses a customized version of the Ecological Data and Application System (EDAS) database to store and manage all of its biological and habitat assessment data. EDAS is an Access database management and analysis tool that not only stores biological (e.g., fish and macroinvertebrate) and habitat assessment data, but also allows the user to calculate biological metrics using a set of predetermined queries and to export the results to Excel. Biological data and habitat assessment data entered into EDAS are downloaded to STORET.

3. STORET/Water Quality Exchange

All data entered into SID are transmitted electronically into EPA's STOrage and RETrieval database, termed STORET. STORET is a national database management system that was created by EPA as a repository for water quality, biological and physical data. STORET contains data collected beginning in 1999, along with older data that has been properly documented and migrated from the Legacy Data Center (LDC). Both systems contain raw biological, chemical and physical data on surface and ground water collected by federal, state and local agencies, Indian Tribes, volunteer groups, academics and others. All 50 states, territories and jurisdictions of the U.S. are represented in these systems.

Each sampling result in the LDC and in STORET is accompanied by information on where the sample was taken (i.e., latitude, longitude, state, county, Hydrologic

Unit Code and a brief site identification), when the sample was gathered, the medium sampled (e.g., water, sediment and fish tissue) and the name of the organization that sponsored the monitoring. In addition, STORET contains information on why the data were gathered; sampling and analytical methods used; the laboratory used to analyze the samples; the quality control checks used when sampling, handling the samples, and analyzing the data; and the personnel responsible for the data. All water quality data collected by the Department since 1993 are in STORET, while data collected prior to 1993 are in the LDC. Data are transmitted electronically from SID into STORET once each year, usually in February.

In 2009, the Department began migrating its data into STORET Data Warehouse via the Water Quality Exchange (WQX). The WQX is a new data management framework that makes it easier for States, Tribes and other organizations to share water quality monitoring data over the internet. While the STORET Data Warehouse will continue to be the repository for all modern STORET data submitted through the WQX, eventually WQX will replace the distributed STORET Database (including the STORET Data Entry Module, Reports Module, and the STORET Import Module or SIM) as the primary means for submitting water quality monitoring data to EPA.

4. Assessment Database (ADB)

With an estimated 54,609 miles of rivers and streams and 700,218 acres of lakes, it is impractical to adequately assess each and every mile of stream or every acre of lake. However, the Department believes it is important to (1) accurately assess those waters for which beneficial use assessment information is available and (2) account for those stream miles and lake acres that are not assessed or for which there is insufficient data to conduct an assessment. As a result, the Department has adopted the Assessment Database (ADB) to manage water quality assessment information for the state's rivers, streams, lakes and reservoirs.

Developed by EPA, the ADB is an Microsoft Access "accounting"/database management system that provides a standard format for water quality assessment information. It includes a software program for adding and editing assessment data and transferring assessment data between the personal computer and EPA. Assessment data, as compared to raw monitoring data, describes the overall health or condition of the waterbody by describing beneficial use impairment and, for those waterbodies where beneficial uses are impaired or threatened, the causes and sources of pollution affecting the beneficial use.

North Dakota's ADB contains 1,711 discreet assessment units (AUs) representing 54,609 miles of rivers and streams and 248 lakes and reservoirs. Within the ADB, designated uses are defined for each assessment unit (AU) (i.e., river or stream reach, lake, reservoir or wetland) based on the state's water quality standards. Each use is then assessed using available chemical, physical and/or biological data.

The ADB provides an efficient accounting and data management system. It also allows for the graphical presentation of water quality assessment information by linking assessments contained in the ADB to the National Hydrography Dataset (NHD) file through geographic information systems (GIS). In order to facilitate the GIS datalink, the Department has "reach-indexed" each AU in the ADB to the NHD file. The product of this process is a GIS coverage that can be used to graphically display water quality assessment data entered in the ADB.

Reports generated from the ADB are used as the basis for the state's biennial *Integrated Section 305(b) Water Quality Assessment Report and Section 303(d) List of Impaired Waters Needing TMDLs*.

5. Geospatial Data/GIS

Many of the Geographic Information System (GIS) geospatial data layers that the Department uses are available via the North Dakota GIS hub (http://www.nd.gov/gis/). Additional data layers (e.g., chemical and biological monitoring sites, USGS flow gauging sites, Section 303(d) Listed Impaired Waters, Section 319 Watershed Project Areas, etc.) not available on the GIS HUB are created and made available as ARC Map shape files by the SWQMP's Database Management Coordinator.

IX. DATA ANALYSIS, ASSESSMENT, AND REPORTING

North Dakota generates numerous reports dealing with findings associated with the Department's water quality monitoring programs and projects. Reports range from those required by the Clean Water Act to technical reports summarizing the results of specific monitoring activities.

A. Clean Water Act Assessment and Reporting

As part of its CWA reporting responsibilities, the Department prepares and submits the *Integrated Section 305(b) Water Quality Assessment Report and Section 303(d) List of Waters Needing Total Maximum Daily Loads.* This biennial report and accompanying Section 303(d) list **must** be submitted to EPA by April 1st of every even numbered year. As the title indicates, this report combines reporting requirements under Section 305(b) of the CWA and Section 303(d).

Water quality reporting requirements under Sections 305(b) and 303(d) of the CWA require states to assess the extent to which their lakes and reservoirs and rivers and streams are meeting water quality standards applicable to their waters, including beneficial uses as defined in their state water quality standards. In addition to beneficial uses, applicable water quality standards also include narrative and numeric standards and antidegradation policies and procedures. While Section 305(b) requires states and tribes to provide only a statewide water quality summary, Section 303(d) takes this reporting a step further by requiring states to identify and list the individual waterbodies that are not meeting applicable water quality standards and to develop TMDLs for those waters. Both Section 305(b) reporting and Section 303(d) listing accomplish this assessment by

determining whether the waterbody or AU is supporting its designated beneficial uses.

Beneficial uses are not arbitrarily assigned to AUs, but rather are assigned based on the *Standards of Quality for Waters of the State* (NDDoH 2006). These regulations define the protected beneficial uses of the state's rivers, streams, lakes and reservoirs. Six beneficial uses (aquatic life, recreation, drinking water, fish consumption, agriculture, industrial and fish consumption) were assessed for purposes of Section 305(b) reporting and Section 303(d) listing

Assessments are conducted based on methods and procedures described in the document entitled "Water Quality Assessment Methodology for North Dakota's Surface Waters" (NDDoH 2007). In general assessments are done by comparing all available and existing information for an assessment unit to applicable water quality criteria (narrative and numeric). This information, which is summarized by specific lake, reservoir, river reach or sub-watershed, is integrated as beneficial use assessments that are entered into a water quality assessment "accounting"/database management system developed by EPA. This system, which provides a standard format for water quality assessment and reporting, is termed the ADB (see Section VII, Data Management, for a complete description of the ADB).

For purposes of these "Integrated Reports", EPA has encouraged states to follow its integrated reporting guidance (EPA 2005). Key to integrated reporting is an assessment of all of the state's waters and placement of those waters into one of five categories. The categories represent varying levels of water quality standards attainment, ranging from Category 1, where all of a waterbody's designated uses are met, to Category 5, where a pollutant impairs a waterbody and a TMDL is required (Table 5). These category determinations are based on consideration of all existing and readily available data and information consistent with the state's assessment methodology. As part of the integrated Section 305(b) and Section 303(d) reporting to EPA, the state also provides a copy of the Assessment Database (ADB) with that year's assessment information.

B. General Reporting

In addition to reporting required under the CWA, the Department also produces a variety of annual, semi-annual and final reports for specific monitoring programs and projects. Regardless of the program or project, the goal of the Department is to produce a written summary of all monitoring activities as soon as the data become available. Examples of general reports prepared by the Department include:

- Lake assessment reports;
- TMDL development reports;
- NPS assessment reports;
- NPS watershed implementation project summary reports;
- Fish consumption advisories; and
- Index of Biological Integrity (IBI) development reports.

Table 5. Assessment Categories for the Integrated Report.

Assessment Category	Assessment Category Description
Category 1	All of the waterbody's designated uses have been assessed and are met.
Category 2	Some of the waterbody's designated uses are met, but there is insufficient data to determine if remaining designated uses are met.
Category 3	Insufficient data to determine whether any of the waterbody's designated uses are met.
Category 4	The waterbody is impaired or threatened, but a TMDL is not needed. This category has been further sub-categorized as: X 4A - waterbodies that are impaired or threatened, but TMDLs needed to restore beneficial uses have been approved or established by EPA. X 4B - waterbodies that are impaired or threatened, but do not require TMDLs because the state can demonstrate that "other pollution control requirements (e.g., BMPs) required by local, state or federal authority" (see 40 CFR 130.7[b][1][iii]) are expected to address all waterbody-pollutant combinations and attain all water quality standards in a reasonable period of time. X 4C - waterbodies that are impaired or threatened, but the impairment is not due to a pollutant.
Category 5	The waterbody is impaired or threatened for at least one designated use and a TMDL is needed.

X. MONITORING PROGRAM COORDINATION AND COLLABORATION

Currently, there is no formal mechanism for monitoring coordination or communication in the state. There are, however, a number of collaborative efforts that enhance surface water quality monitoring programs in the state. Some of these efforts are formed through USGS cooperative agreements, contracts between the Department and local soil conservations districts or water resource boards.

Monitoring communication is also facilitated through the Department's involvement with two international organizations. North Dakota has two rivers of international significance. The Souris River originates in the Canadian province of Saskatchewan, loops through North Dakota and returns to the province of Manitoba. The Red River of the North originates at the confluence of the Bois de Sioux and Ottertail Rivers at Wahpeton, North Dakota. The Red River flows north, forming the boundary between North Dakota and Minnesota before entering Manitoba. The Department participates in two cross-border cooperative efforts to jointly manage and protect these rivers.

To ensure an ecosystems approach to transboundary water issues and to achieve greater operational efficiencies in the conduct of the International Joint Commission (IJC) and its responsibilities, the IJC has combined the ongoing responsibilities of the International Souris River Board of Control and the Souris River aspects of the International Souris-

Red River Engineering Board into the International Souris River Board (ISRB). The ISRB operates under a directive from the IJC dated April 11, 2002. Part of the ISRB's mission is to assist the IJC in preventing and resolving disputes related to the transboundary waters of the Souris River basin.

The other international water quality effort in which the Department is involved is the International Red River Board. Created by the International Joint Commission (IJC), the board monitors Red River water quality. The board also informs the IJC of trends and exceedances of water quality objectives, documents discharges and control measures, establishes a spill contingency plan and identifies future water quality issues. Board activities are detailed in annual reports. Other members of the board include Environment Canada, Manitoba Water Stewardship, EPA, USGS, U.S. Bureau of Reclamation and the Minnesota Pollution Control Agency.

A. State Monitoring Council

As part of this strategy, the Department established a state monitoring council. The council is made up of agencies and organizations in the state with an interest in water quality monitoring. The primary purpose of the council is to review the state's monitoring strategy and to make recommendations for improving state monitoring and assessment programs. The council will also provide a forum and an opportunity for agencies and organizations to: (1) share monitoring ideas, data and results; (2) discuss monitoring program successes and failures; and (3) develop or expand partnerships among council member agencies and organizations.

As part of this council, it is hoped that the Department can facilitate the formation of a number of workgroups or committees focused on specific monitoring resource types or issues, including:

- Ambient Surface Water Monitoring Network;
- Biological Monitoring;
- Watershed Restoration and BMP Effectiveness Monitoring;
- Lake and Reservoirs Monitoring;
- Wetlands Monitoring; and
- Landscape Analysis.

The council also sponsored the first North Dakota Water Quality Monitoring Conference in February 2012 and plans to hold similar conferences every 2 years.

XI. PROGRAM EVALUATION

In May 2003, EPA conducted a review of North Dakota's Monitoring and Assessment Program. This program review was conducted by Jill Minter, Monitoring Coordinator, and Vern Berry, TMDL Project Officer, and was based on the 10 key elements of a monitoring program described in the *Elements of a State Monitoring and Assessment Program* guidance document (EPA, March 2003). Recommendations provided in this review have been summarized and, to the extent possible, included in this monitoring strategy. The Department will continue to refine its monitoring program through annual

internal and external reviews.

A. External Program Review

With the exception of the recently completed program review by EPA, there has never been any external review or input to the state's monitoring and assessment program. As part of this strategy, the Department proposes to establish a state monitoring council made up of agencies and organizations in the state with an interest in water quality monitoring. The primary purpose of the council will be to provide overall program evaluation and to review the state's monitoring strategy and to make recommendations for improving the Department's monitoring and assessment programs. The council will also provide a forum and an opportunity for agencies and organizations to: (1) share monitoring ideas, data and results; (2) discuss monitoring program successes and failures; and (3) develop or expand partnerships among council member agencies and organizations.

B. Internal Program Review

By virtue of its organization, it is relatively easy for the Department to carry out internal program evaluations and to implement adjustments as needed. To ensure the Department's monitoring goal and objectives are met, an evaluation process has been integrated into each monitoring program or project. This evaluation process is described for each program or project (see Section XII).

XII. GENERAL SUPPORT AND INFRASTRUCTURE PLANNING

A. Current Program Support and Infrastructure

The Monitoring and Assessment Program is located within the Division of Water Quality's Surface Water Quality Management Program (SWQMP) and, as such, is also responsible for implementing the Water Quality Standards, Monitoring and Assessment, TMDL, Nonpoint Source, Lake Water Quality, and Wetlands Programs.

For these multiple CWA programs, there are a total of 11.25 FTEs in the SWQMP, including: one Program Manager (1 FTE), one Database Coordinator (1 FTE), three Environmental Scientists/Water Quality Monitoring Specialists (3 FTEs), one NPS Coordinator (1 FTE), three TMDL/Watershed Liaisons (3 FTEs), one Watershed Planning and Education Coordinator (1 FTE), and a part-time GIS Coordinator (0.25 FTE). Duties are not as clearly divided as noted above. For example, monitoring staff also analyze data and develop indicators, and TMDL staff collect samples at Department fixed station network sites. The Surface Water Quality Management Program's main office is located in Bismarck, with three additional field offices located in Dickinson, Fargo, and Towner. Each field office is staffed by one full time equivalent (FTE).

One limitation to implementing an adequate monitoring and assessment program in North Dakota has been limited staff resources. Additional FTEs to support the Surface Water Quality Management Program would need to be authorized by the state legislature. The Department has requested and received authority to hire one or two summer temporary

employees each year, although requests are not always met in full.
In order to fill this resource gap, the Department uses other partners to help meet its needs for water quality data and information. The Department has been able to expand the amount of field work carried out to support its programs through cooperative agreements with the USGS North Dakota District Office, by contracting with local soil conservation districts and through the use of private consultants.

A bright spot in its water quality monitoring and assessment support and infrastructure are the expanded Departmental services available to conduct laboratory analysis samples. The Department's Laboratory Services Division, consisting of the Chemistry and Microbiology laboratories, has just completed laboratory expansions and upgrades. The two laboratories provide virtually unlimited analyses of all water column, sediment and fish tissue samples collected by the Department and its cooperating partners. The Chemistry laboratory provides analyses of major cations and anions, trace elements (including mercury), nutrients, total organic carbon, organic compounds (e.g., pesticides, VOCs, BTEX and PCBs), total suspended solids, biochemical oxygen demand and chlorophyll. The Microbiology laboratory provides analysis of samples for fecal coliform, E. coli and Enterococcus bacteria.

Funding to support current monitoring programs comes mainly from EPA via Section 106 block grants, Section 106 Supplemental Monitoring Initiative grants, Section 104(b)(3) Wetland Develop Program grants, Section 604(b) watershed management grants and Section 319 NPS grants. It is unlikely that increased state general funds will be made available to support expanded monitoring and assessment programs; therefore to meet the goals and objectives of this strategy EPA will have to significantly increase it's financial commitment to states for monitoring.

B. Resource Needs and Priorities

Where appropriate, each monitoring program and project described in Section XIII provides a description of its current support and infrastructure commitment as well as the identified need for additional resources to meet monitoring program gaps. These gaps are described as enhanced monitoring program or project activities/tasks, staffing, training and funding necessary to fulfill all of the goals and objectives of this strategy assuming unlimited financial and manpower resources are available. Within many program/project descriptions, the resource needs are broken down by 5 and 10-year increments, which detail operating, staffing, research, funding, and program improvements that are needed.

It should be recognized that the Department currently does not have the resources necessary to achieve all of the goals, objectives, programs and projects identified in this strategy, therefore the Department has prioritized its monitoring program enhancements. These enhancements, provided in Table 6, describe the prioritize in which program enhancements will be funded by additional funding sources, including but not limited to supplemental Section 106 grants.

Table 6. Water Quality Monitoring and Assessment Program Enhancement Priorities.

Water Quality Monitoring Program Enhancement	Priority
USGS ambient monitoring program evaluation	High
Revised ambient water quality monitoring program implementation	Medium
Maintain and/or establish flow gauging stations at revised ambient monitoring sites	Medium
Implement biological monitoring as part of the national river and streams survey	Medium
Develop targeted biological monitoring and assessment protocol	High
Implement target monitoring and assessment on all sub-category 5A TMDL listed rivers and streams	High
Implement reference site biological monitoring and indicator development	High
Implement targeted lake water quality monitoring and assessment project by sampling a minimum of 15 lakes per year for the next three years (2008-2010)	High
Implement targeted lake water quality monitoring and assessment by sampling a minimum of 15-20 lakes per year from 2011-2013	High
Implement a rotating schedule whereby priority lakes and reservoirs are sampled every 5-10 years	Medium
Implement water quality monitoring and assessment as part of the survey of nation's lakes	Medium
Implement ambient water quality monitoring on the mainstem Missouri River as part of the revised statewide ambient water quality monitoring program	Medium
Develop and implement mainstem Missouri River biological monitoring and assessment program	Low
Implement enhanced targeted fish tissue contaminant surveillance program for the state's lakes, reservoirs, rivers and streams by: 1) improving the Division of Laboratory Services capability to analyze mercury in fish tissues; and 2) increasing the laboratory's capability to analyze additional chemical contaminants.	High
Develop and implement a probabilistic fish tissue monitoring design for lakes, reservoirs, rivers and streams.	Medium
Assess mercury expose to human populations in the state through human biological monitoring.	Low
Identify and prioritize additional wetlands classes in the state for level III biological indicator development and develop indicators and level III wetland monitoring and assessment methods for priority wetland classes	High
Using a probabilistic sampling design, conduct level III regional and/or watershed scale wetland assessments and integrate into the Section 305(b) report	High
Refine existing level II rapid wetland assessment methods and level I landscape assessment methods and develop new methods, as needed.	Medium
Use level II rapid wetland assessment methods and level I landscape methods to assess wetland restoration and mitigation projects	Medium
Integrate level II rapid wetland assessment methods and level I landscape methods into regional wetland assessments and into watershed assessment and restoration projects.	High
Integrate results of regional level II and level I wetland assessments into Section 305(b) reports	High
Implement monitoring and assessment as part of the National Wetland Condition Assessment	High
Conduct an intensification study of the National Wetland Condition Assessment	High

XIII. NORTH DAKOTA MONITORING PROGRAMS, PROJECTS AND STUDIES

In order to meet the state's monitoring goal which is ***"to develop and implement monitoring and assessment programs that will provide representative data of sufficient spatial coverage and of known precision and accuracy that will permit the assessment, restoration and protection of the quality of all the state's waters",*** the Department has developed several monitoring programs, projects and studies. A summary of these programs, including the monitoring objectives for each program is provided in Table 1.

In the following sections, current monitoring activities are also summarized in the form of narrative descriptions. These summaries include the project or program purpose (objectives), monitoring design (selection of monitoring sites), selected parameters and the frequency of sample collection.

A. Ambient Water Quality Monitoring Network for Rivers and Streams

1. Monitoring Objectives

The Department's "Ambient Water Quality Monitoring Network for Rivers and Streams" was established in the 1960s. The primary objective of this network is to provide data for trend analysis, general water quality characterization and pollutant loading calculations. This network also supports the assessment of beneficial use attainment for Section 305(b) reporting and Section 303(d) listing purposes, the identification of water quality problems and is used to evaluate the effectiveness of pollution control and abatement programs (e.g., NDPDES, Section 319) (see Table 1).

2. Monitoring Design

Although the network has undergone several modifications since its inception, the network currently consists of 34 fixed-station ambient monitoring sites located on 19 rivers (Table 7). Sites are both wadable and non-wadable. Where practical, these sites are co-located with USGS flow-gauging stations. The objective of maintaining a network of stream flow stations co-located with water quality monitoring stations is to provide stream flow data that is necessary for the analysis and interpretation of water quality data.

Water quality samples are collected by USGS personnel (8 sites) and Department personnel (26 sites). Samples are collected every six weeks during the open-water period (generally from early April through November) and once during the winter under ice cover (generally in late January or early February). Samples are collected and analyzed for water chemistry and bacteria at each of these sites. Parameters include: major ions, trace elements, total suspended solids, total and dissolved nutrients (total phosphorus, total nitrogen, ammonia, nitrate-nitrite, Total Kjeldahl Nitrogen), total organic carbon, dissolved organic carbon, Enterococcus bacteria, fecal coliform bacteria and E. coli bacteria (Table 8). Field measurements are taken for dissolved oxygen, temperature, conductivity

and pH.

Table 7. Ambient Water Quality Monitoring Network Sites.

Station ID	River	Location
380161	Souris River	above Minot
380021	Des Lacs River	at Foxholm
380095	Souris River	at Verendrye
385055	Bois de Sioux	Near Doran, MN
380083	Red River	at Brushville, MN
380031	Wild Rice River	Near Abercrombie
385414	Red River	at Fargo *
385040	Red River	Near Harwood
380010	Sheyenne River	at Warwick
380009	Sheyenne River	3 mi E of Cooperstown
380153	Sheyenne River	below Baldhill Dam
380007	Sheyenne River	at Lisbon
385001	Sheyenne River	Near Kindred
384155	Maple River	at Mapleton
380156	Goose River	at Hillsboro *
384156	Red River	at Grand Forks *
380037	Turtle River	at Manvel *
380039	Forest River	at Minto *
380157	Park River	at Grafton *
380158	Pembina River	at Neche *
384157	Red River	at Pembina *
384130	James River	at Grace City
380013	James River	at Jamestown
380012	James River	at LaMoure
380022	Little Missouri River	at Medora
380059	Little Missouri River	S of Watford City on Hwy 85 bridge
384131	Knife River	near Golden Valley
380060	Spring Creek	at Zap
380087	Knife River	at Hazen
380160	Heart River	above Lake Tschida
380151	Heart River	near Mandan
380077	Cedar Creek	at Raleigh
380105	Cannonball River	near Raleigh
380067	Cannonball River	S of Breien

* Sampled by the USGS

Table 8. Ambient Water Quality Monitoring Parameters.

Field Measurements	Laboratory Analysis			
	General Chemistry	Trace Elements	Nutrients and Organic Carbon	Biological
Temperature	Sodium	Aluminum	Dissolved Ammonia	Fecal coliform
pH	Magnesium	Antimony	Dissolved Nitrate-nitrite	E. coli
Dissolved Oxygen	Potassium	Arsenic	Total Kjeldahl Nitrogen (dissolved)	Enterococcus sp.
Specific Conductance	Calcium	Barium	Total Nitrogen (dissovled)	
	Manganese	Beryllium	Total Phosphorus (dissolved)	
	Iron	Boron	Dissolved Organic Carbon	
	Chloride	Cadmium	Total Ammonia	
	Sulfate	Chromium	Total Nitrate-nitrite	
	Carbonate	Copper	Total Kjeldahl Nitrogen	
	Bicarbonate	Lead	Total Nitrogen	
	Hydroxide	Nickel	Total Phosphorus	
	Alkalinity	Silver	Total Organic Carbon	
	Hardness	Selenium		
	Total Dissolved Solids	Thallium		
	Total Suspended Solids	Zinc		

Through cooperative agreements with the USGS, two new components were added to the network. Equipment was installed at the USGS gauging station at Fargo (USGS site 05054000) in September 2003 and at Grand Forks (USGS site 05082500) in October 2006 that monitors field parameters continuously. Data are collected through the deployment of a continuous recording YSI Model 600 multi-probe sonde and data logger. Output from the sonde is transmitted via telemetry and the data posted "real-time" on the USGS North Dakota district web site. The USGS is also collecting water quality samples 10 times per year from these sites, and these are being analyzed for major cations and anions, total suspended sediment, total phosphorus, total nitrogen, ammonia, nitrate-nitrite and fecal coliform bacteria. As this data set increases, regression relationships will be developed for selected water quality variables (e.g., total suspended sediment, TDS, total phosphorus and total nitrogen) using the continuously recorded field parameters. The goal of this system will be to use these regression relationships to provide "real-time" concentration estimates of total suspended sediment, total phosphorus, total nitrogen and TDS and to post these data on the web.

3. Quality Assurance

A Quality Assurance Project Plan (QAPP) is developed and updated annually for the "Ambient Water Quality Monitoring Network." Components of the QAPP include: 1) a description of responsibilities; 2) detailed monitoring design, including sample variables; 3) standard operating procedures, including sample custody procedures; 4) procedures for annual field audits; 5) procedures for the collection and analysis of QA samples (e.g., trip blank samples, duplicate samples, laboratory split samples); 6) procedures for equipment inspection and maintenance; 7) procedures for program assessment and corrective actions; and 8) data review, validation and verification requirements.

4. Core and Supplemental Water Quality Indicators

Current core indicators include flow (obtained from collocated USGS gauging stations), field parameters (temperature, pH, dissolved oxygen, specific conductance), common ions, trace elements, nutrients, total suspended solids, and bacteria (Tables 8 and 9). It is anticipated that in addition to the current set of core indicators, clean sediment and pesticides will be sampled in the future.

Table 9. Current (C) and Future (F) Core Indicators Used By the Ambient Water Quality Monitoring Program.

Monitoring Program	Flow	Field Measurements	Water chemistry (ions and trace metals)	Water Chemistry (nutrients)	Pathogens	Clean sediment (suspended and bed)	Pesticides
Ambient Water Quality Monitoring Network for Rivers and Streams	**C, F**	**C, F**	**C, F**	**C, F**	**C, F**	**F**	**F**

5. Data Management

All sample results generated by the Department's Laboratory Services Division are electronically transmitted to the Surface Water Quality Management Program where they are incorporated into SID by the database management coordinator. Field data (e.g., temperature, pH, dissolved oxygen and conductivity measurements) and sample custody information (e.g., station description, date and time collected and depth) are recorded on standardized forms and entered into SID by program personnel. All data entered into SID are transmitted electronically into EPA's STORET database.

6. Data Analysis and Assessment

The data collected through this network are used in water quality assessments for the "North Dakota Integrated Section 305(b) Report and Section 303(d) List." Data are pooled across years and beneficial uses are assessed using the procedures described in the "Water Quality Assessment Methodology for North Dakota's Surface Waters" (NDDoH 2007).

7. Reporting

The data collected through this network are used in water quality assessments that are reported in the biennial "North Dakota Integrated Section 305(b) Report and Section 303(d) List." Data collected by the USGS are reported each water year (October 1 to September 30) in USGS annual reports. "Real-time" data collected by the USGS at the Red River at Fargo and Grand Forks sites are made available via the USGS's web site at http://nd.water.usgs.gov.

8. Program Evaluation

In addition to the Department's ambient monitoring network for rivers and streams, the USGS and the North Dakota State Water Commission (SWC) also operate a "high-low flow" water quality monitoring network consisting of approximately 81 sampling sites located throughout the state (thirty of which are collocated with the Department's ambient water quality monitoring network sites). Samples are collected twice per year, generally during spring runoff at high flow and during late summer during low flow. In addition to field measurements for temperature, pH, dissolved oxygen, and conductivity, samples are collected for common ions and selected trace elements. After 35-years of operation program goals, objectives and uses of these data have become ill defined (Robert Lundgren, personnel communication).

Independent of the SWC's cooperative "high-low flow" monitoring network, the USGS has had both short-term and long-term water quality monitoring programs with various federal agencies and local cooperators (e.g., cities, water resource boards). Currently, the USGS maintains several cooperative monitoring sites on the Souris and James Rivers.

The Department, USGS and SWC all recognize that the overlap and redundancy in these monitoring programs are inefficient resulting in wasted human and financial resources. To address this problem, the three agencies have entered into a cooperative study to review and evaluate each of these long-term sampling programs. The purposes of this study, which will be conducted by the USGS, are to: 1) evaluate spatial and temporal variability in the existing data; 2) tends and loading estimates developed from the historical "high-low flow" and ambient monitoring data; 3) quantify the benefits of the data that are currently being collected in relation to the data quality objectives of each sampling program; and 4) determine and make recommendations for an efficient state-wide sampling design for monitoring water quality conditions of rivers and streams.

9. Implementation Plans and Schedule

Results and recommendations from this evaluation are expected in 2009 with partial implementation beginning in 2010 and full implementation by 2013 (Table 10). Diminishing resources, both state and federal, have significantly reduced the number of long-term stream flow gauging stations. Efforts should be made to maintain the current network of stations and to add or re-establish historic stations that have been discontinued.

2008-2012 Plan

- Implement current state wide ambient water quality monitoring network;
- Complete cooperative study to evaluate state-wide water quality monitoring networks and make recommendations for improved network;
- Present results to Water Quality Monitoring Council/Ambient Monitoring Workgroup;
- Revise the QAPP for the Ambient Water Quality Monitoring Network to reflect interim revisions to the network design; and
- Initiate revisions to ambient monitoring network (e.g., flow and water quality monitoring sites, sampling frequency, sample parameters, sampling procedures).

2013-2019 Plan

- Revise the QAPP for the Ambient Water Quality Monitoring Network to reflect final revisions to the network design; and
- Fully implement revisions to ambient water quality monitoring network, including maintaining and/or flow gauging stations which are collocated with water quality monitoring sites.

Table 10. Implementation Schedule for the Ambient Water Quality Monitoring Program.

Implementation Element	Years											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Implement current state-wide network	■	■	■									
Complete cooperative evaluation study	■	■	■									
Present study results to monitoring council			■									
Revise QAPP for monitoring network			■									
Initiate revisions to monitoring network sampling			■	■	■							
Revise QAPP to reflect full implementation design					■							
Fully implement monitoring network revisions						■	■	■	■	■	■	■

10. General Support and Infrastructure Planning

Current Program Support and Infrastructure

Since sampling, analysis, data management, and reporting activities associated with the ambient monitoring program are currently allocated to multiple staff within the Department it is difficult to make precise estimates as to the total cost of this program. Current ambient monitoring and assessment program expenditures are estimated at $ 210,000 with 1.25 FTEs. This estimate does not include staffing and resources provided by the USGS for the operation of seven sites through cooperative agreement. Table 11 provides a summary of the estimated costs of the Department's current program as well as the costs associated with full implementation of a revised program.

Table 11. Current and Future Support and Infrastructure Costs for the Ambient Water Quality Monitoring Program.

Resource	Current FTE	Current Annual Cost	FTE w/ Program Improvement (2010)	Annual Cost w/ Program Improvement (2010)	FTE w/ Full Program Implementation Improvement	Annual Cost w/ Full Program Implementation Improvement
Staffing	0.75	$ 50,000	1.0	$ 70,000	1.5	$120,000
Operating		$ 30,000		$ 50,000		$ 60,000
Laboratory Staffing/Operating	0.5	$100,000	0.5	$150,000	0.5	$180,000
Contractor		$ 30,000		$ 75,000*		$ 60,000
TOTAL	1.25	$210,000	1.5	$345,000	2.0	$420,000

* Includes cost for cooperative monitoring program study

Resource Needs and Priorities

While it is difficult to provide current costs and staffing estimates for the ambient monitoring and assessment program, it is even more difficult to project future costs and staffing needs with a revised and enhanced program. Once the USGS has completed their evaluation, projecting future resource needs will be more tangible. For purposes of program planning, it is estimated that staffing and costs will double with an enhanced program.

While the program analysis and evaluation, provided by the USGS is considered a high priority monitoring enhancement the implementation of the evaluations recommendations are considered a medium priority in this strategy (Table 6).

B. Biological Monitoring and Assessment Program for Rivers and Streams

1. Monitoring Objectives

Since the biological monitoring and assessment program was first implemented its primary objective has been to provide biological data to assess aquatic life use attainment for Section 305(b) reporting and Section 303(d) listing purposes (Table 1). Biological monitoring data are also used to identify water quality problems and to evaluate the effectiveness of pollution control and abatement programs (e.g., NDPDES, Section 319) (see Table 1).

The monitoring objectives of this program are to develop biological indicators using fish, macroinvertebrates and/or periphyton and to use those indicators in biological condition assessment for the state's rivers and streams at varying spatial scales (e.g., stream reach, watershed, basin, state, ecoregion). Biological monitoring data are also used, to identify water quality problems and to evaluate the effectiveness of pollution control and abatement programs (e.g., NDPDES, Section 319).

2. Monitoring Design

Historic Program

The Department first conducted state wide biological monitoring of its rivers and streams from 1993 through 2000 using a **rotating basin approach with intensive targeted sampling sites.** The initial program, a cooperative effort with the Minnesota Pollution Control Agency and the USGS's Red River National Water Quality Assessment Program, was conducted in 1993 and 1994 and involved approximately 100 sites in the Red River Basin. The results of this initial program lead to the development of the index of biological integrity (IBI) for fish in the Red River Basin. The program continued in the Red River Basin in 1995 and 1996 by sampling an additional 100-plus biological monitoring sites.

The Souris River Basin was then targeted for sampling in 1997 followed by the James River Basin in 1998 and the Missouri River Basin in 1999 and 2000. While the program started with fish sampling in 1993, biological monitoring was expanded to include macroinvertebrate sampling in 1995. A habitat assessment also was conducted at each site following the Rapid Bioassessment Protocols published by EPA. The purpose of this biological monitoring program was to (1) develop an IBI for fish and macroinvertebrates and (2) provide an assessment of aquatic life use attainment for those stream reaches that were assessed.

EMAP Western Pilot Project

The rotating basin monitoring program was discontinued in 2001 while the department focused its resources in support of sampling for EPA's Environmental Monitoring and Assessment Program (EMAP) Western Pilot Project. The EMAP Western Pilot Project was the second regional pilot project within EMAP focusing on multiple resources. The first of these regional pilot projects focused on the mid-Atlantic region (Maryland, Delaware, Pennsylvania, Virginia and West Virginia). The EMAP Western Pilot Project was a five-year effort (2000-2004) targeted for the western conterminous United States. The pilot involved three EPA Regions (VIII, IX and X) and 12 states (North Dakota, South Dakota, Montana, Wyoming, Colorado, Utah, Arizona, Nevada, Idaho, California, Washington and Oregon). The purpose of the EMAP Western Pilot Project was to: (1) develop the monitoring tools (e.g., biological indicators, stream survey design methods and description[s] of reference condition) necessary to produce unbiased estimates of the ecological condition of rivers and streams that are applicable for the west; and (2) demonstrate those tools in assessments of ecological condition of rivers and streams across multiple geographic regions in the west. In addition to state- and regional-specific assessment questions, the goal of the EMAP Western Pilot's Surface Water Project is to provide answers to three general assessment questions: (1) What proportion of the perennial river and stream miles in the western United States are in acceptable (or poor) biological condition? (2) What is the relative importance of potential stressors (e.g., habitat modification, sedimentation, nutrients, temperature, toxic contaminants, grazing, urbanization) in rivers and streams across the west? (3) What are the stressors associated with the perennial rivers and streams in poor condition? In addition to answering these questions for the western 12-state region of the United States, the EMAP sampling design will allow these questions to be answered in each of the three EPA regions in the west, in each participating state and in several more spatially-intensive "focus areas" in each region. Within North Dakota, these areas are the Upper Missouri River Basin and the Northern Glaciated Plains Ecoregion.

Field sampling for the project began in 2000 and continued through 2003. Based on the EMAP study design, 64 probability-based sites (representing 4,278 perennial stream miles) were sampled within the state. Sites were chosen by EMAP staff based on a random site-selection process. By randomly selecting sites, results can be extrapolated to the entire resource population of concern (in this case, all perennial rivers and streams in the west, EPA Region VIII, North Dakota, the Missouri River Basin and the Northern Glaciated Plains Ecoregion). In addition to the 64 random sites, an additional 47 sites were chosen as targeted "reference" and "trashed" sites. Reference sites exemplify river and stream reaches that are considered "least impaired" with respect to anthropogenic (human) disturbance or stress, while "trashed" sites are believed to be impaired due to one or more anthropogenic stressors (e.g., nutrients, habitat, toxics).

Results of the EMAP Western Pilot Project for North Dakota, along with all of the other states in the region, have been summarized in a report that will be published by EPA Region 8. These results have also been summarized in the

2008 Integrated Report for North Dakota (NDDoH 2008).

Red River Basin Biological Monitoring and Assessment Project

Beginning in the spring of 2005 through 2007, the department conducted a biological monitoring and assessment project in the Red River Basin. This project was a joint effort with the Minnesota Pollution Control Agency which sampled the Minnesota side of the Red River Basin. The purposes of this project are to: (1) assess (using biological, physical and chemical data) the current biological condition of perennial, wadable rivers and streams in the North Dakota and Minnesota portions of the Red River basin; (2) assess the current status of aquatic life use attainment of the perennial, wadable streams of the Red River basin; (3) develop and refine indices of biological integrity for the fish and macroinvertebrate communities; and (4) investigate potential stressors to impaired aquatic life uses.

Sampling consisted of macroinvertebrates, fish, physical habitat and water chemistry. Sampling in 2005 was limited to the Lake Agassiz Plain ecoregion; however, due to above normal precipitation in June and July 2005, only nine sites (three reference and six probabilistic) were sampled for fish and physical habitat. A total of 41 sites (eight reference, nine trashed, eight duplicate Minnesota and 16 probabilistic) were sampled for macroinvertebrates in September 2005. Due, in part, to delays in securing the state FY05 supplemental grant carry-over funds and to staffing shortages caused by untimely employee resignations, sampling was again limited in 2006. Fish were not collected in 2006, and only 17 sites were sampled in the Northern Glaciated Plains ecoregion for macroinvertebrates. All sampling activities were completed in 2007. In the Lake Agassiz Plain ecoregion, a total of 24 random, 10 targeted reference and 10 targeted impaired sites were sampled for the fish indicator. A total of 25 random, 10 targeted reference and 10 targeted impaired sites were visited for the macroinvertebrate indicator in the Lake Agassiz Plain ecoregion. Within-year and among-year replicate samples were also collected as a measure of variability. In the Northern Glaciated Plains ecoregion, field sampling was conducted only for macroinvertebrates. A total of 25 random, 10 targeted reference and 10 targeted impaired sites were sampled for macroinvertebrates. Within-year and among-year samples were once again collected as a measure of variability. Fish were not sampled in this ecoregion.

National Rivers and Streams Assessment

In 2008 and 2009, the department will be participating in the EPA-sponsored National Rivers and Streams Assessment (NRSA). The NRSA is a probabilistic assessment of the condition of the nation's rivers and streams and is designed to:

- Assess the condition of the nation's rivers and streams.
- Establish a baseline to compare future rivers and streams surveys for trends assessments.
- Evaluate changes in condition from the 2004 Wadable Streams Assessment.

- Help build state and tribal capacity for monitoring and assessment and promote collaboration across jurisdictional boundaries.

The NRSA is one in a series of water assessments being conducted by states, tribes, the EPA and other partners. In addition to rivers and streams, the water assessments will also focus on coastal waters, lakes and wetlands in a 5-year revolving sequence. The purpose of these assessments is to generate statistically valid reports on the condition of our nation's water resources and identify key stressors to these systems.

The goal of the NRSA is to address two key questions about the quality of the nation's rivers and streams:

- What percent of the nation's rivers and streams are in good, fair and poor condition for key indicators of water quality, ecological health and recreation?
- What is the relative importance of key stressors such as nutrients and pathogens?

The NRSA is designed to be completed during the index period of late May through September. Field crews will collect a variety of measurements and samples from predetermined sampling reaches (located with an assigned set of coordinates) and from randomly selected stations along the sampling reach. The field crews will also document the physical habitat conditions along the sampling reach.

The NRSA design for 2008 and 2009 involves 61 randomly selected sites in North Dakota. The population of rivers and streams from which these sites were selected include both wadable and non-wadable perennial rivers and streams located throughout the state.

As part of its long-term biological monitoring and assessment program the Department will continue to support and participate in the rotating Survey of the Nation's Waters program. Following the 2008 and 2009 NRSA and based on the 5-year rotating cycle, rivers and streams will be sampled again in 2013 and 2014 and 2018 and 2019. In 2008 and 2009 there are a sufficient number of randomly selected sites (61) to ensure statewide condition estimates with 90 % confidence +/- 10 %. In subsequent surveys, the Department will ensure there are at least 50 sites selected and sampled within the state to achieve 90 % confidence +/- 10 %. For example, if the national survey in 2013 and 2014 only includes 30 randomly selected sites in North Dakota, the Department will select and sample an additional 20 sites.

3. Quality Assurance

Red River Basin Biological Monitoring and Assessment Program

A Quality Assurance Project Plan (QAPP) was developed for the "Red River

Biological Monitoring and Assessment Program". Components of the QAPP included: 1) a description of responsibilities; 2) detailed monitoring design, including sample variables; 3) standard operating procedures, including sample custody procedures; 4) procedures for annual field audits; 5) procedures for the collection and analysis of QA samples (e.g., independent lab verification, residue analysis); 6) procedures for equipment inspection and maintenance; 7) procedures for program assessment and corrective actions; and 8) data review, validation and verification requirements.

National Rivers and Streams Assessment

For the NRSA, the EPA has developed field operations manuals for both wadable and non-wadable rivers and streams. These manuals describe field protocols and daily operations for crews to use in the NRSA. In addition, field training is provided to all crews participating in the NRSA and a field audit is conducted by EPA personnel of each crew to ensure field sampling and reporting procedures are being followed.

4. Core and Supplemental Water Quality Indicators

Core indicators that have been used in the SWQMP's biological monitoring and assessment program, including the recently completed Red River Basin Biological Monitoring and Assessment Program, include field parameters (temperature, pH, dissolved oxygen, specific conductance), water chemistry (common ions, trace elements, nutrients, total suspended solids), macroinvertebrates, fish, and physical habitat measures (Table 12). For the NRSA, pathogens (i.e., Enterococcus), periphyton (wadable streams) and phytoplankton (non-wadable streams) are sampled in addition to field measurements, water chemistry, macroinvertebrates, fish and physical habitat. It is possible that in addition to the current set of core indicators, sediment and fish tissue contaminants will be sampled in the future.

5. Data Management

All water chemistry samples results generated by the Department's Chemistry Division are electronically transmitted to the Surface Water Quality Management Program where they are incorporated into SID by the database management coordinator. Field data (e.g., temperature, pH, dissolved oxygen and conductivity measurements) and sample custody information (e.g., station description, date and time collected and depth) are recorded on standardized forms and entered into SID by program personnel. All biological (macroinvertebrates and fish) and physical habitat data are entered into the SWQMP's Access based Ecological Data and Application System (EDAS). All data entered into SID and EDAS are transmitted electronically into EPA's STORET database.

Sample results generated from the NRSA project are managed by the EPA.

Table 12. Current (C) and Future (F) Core Indicators Used By the Biological Monitoring and Assessment Program for Rivers and Streams.

Monitoring Program	Field Measurements	Water chemistry (ions and trace metals)	Water chemistry (nutrients)	Pathogens	Chlorophyll-*a*	Macroinvertebrates	Periphyton	Phytoplankton	Fish	Fish Tissue	Sediment Contaminants	Physical Habitat/Stream Stability
Biological Monitoring and Assessment Program for Rivers and Streams	C,F	C, F	C, F	C,F	F	C, F	C, F	C, F	C, F	F	F	C, F

6. Data Analysis and Assessment

The department has adopted the "multi-metric" index approach to assess biological integrity or aquatic-life use support for rivers and streams. The multi-metric index approach assumes that various measures of the biological community (e.g., species richness, species composition, trophic structure, and individual health) respond to human-induced stressors (e.g., pollutant loadings or habitat alterations). Each measure of the biological community, termed a "metric," is evaluated and scored on either a 1-, 3-, 5-point scale (fish) or on a scale of 0-100 (macroinvertebrates). The higher the score, the better will be the biological condition and, presumably, the lower the pollutant or habitat impact. For each biological community (macroinvertebrates or fish) metrics which show a response to the human disturbance gradient are summed (in the case of the 1-, 3-, 5-point scale) or averaged (in the case of the 0-100 scale) into an Index of Biological Integrity (IBI).

To date, the Department has developed multi-metric IBIs for fish and macroinvertebrates in the Lake Agassiz Plain ecoregion and for macroinvertebrates in the Northern Glaciated Plains ecoregion. The Department continues to refine existing metrics and IBIs and to develop new IBIs for additional regions in the state (see Section XIII. C. Ecoregion Reference Site Network for more detail on IBI development).

To analyze and interpret data collected as part of the EMAP Western Pilot Project, EPA Region 8 developed periphyton, macroinvertebrate and fish IBIs based on two broad ecoregions. One of these ecoregions, termed the "Cultivated Plains" is an aggregation of the Lake Agassiz Plains and Northern Glaciated Plains ecoregion. The other broad ecoregion, termed the "Rangeland Plains", encompasses the western half of the state and is an aggregation of the Northwestern Glaciated Plains and Northwestern Great Plains ecoregions. Using IBIs developed for these two regions, IBI scores were calculated for samples collected in North Dakota as part of the EMAP Western Pilot Project. Regional assessments were made for North Dakota rivers and streams based the probabilistic sample design. For each broad ecoregion in the state (cultivated

plains and rangeland plains) and for each biological community (macroinvertebrates, periphyton, and fish), estimates were provided as to the extent of stream miles in each of three condition classes (i.e., least-disturbed, moderately-disturbed, and most-disturbed).

For the NRSA, the Department will work cooperatively with the EPA to develop and refine regionally representative reference-based IBIs and scoring thresholds for assessing biological condition. Once developed the Department will apply the IBI scores and condition assessments to probabilistic sites sampled in North Dakota. From these data statewide estimates of the percent and number of stream miles estimated to be in various condition classes will be assessed.

7. Reporting

Probability survey results based on basin, regional or statewide designs, like that of the EMAP Western Pilot Project, the Red River Basin Biological Monitoring and Assessment Project or the NRSA, are reported in project specific reports prepared by the Department and/or the EPA. These survey results are also summarized in the biennial "North Dakota Integrated Section 305(b) Report and Section 303(d) List." Summary results from these surveys are also entered into the ADB's Probability Survey Module.

8. Program Evaluation

Since the biological monitoring and assessment program for rivers and streams was first started in the early 1990's many lessons have been learned. The program, from 1993 through 2000, focused on targeted sampling sites with very little emphasis on "reference" site selection. The result was a series of IBIs developed with less than adequate scientific basis. The lack of an adequate number of reference sites also resulted in the inability to develop biological condition thresholds. Targeted sample sites also limited the Department to applying the results to only site specific or reach specific assessments.

Beginning with the implementation of the EMAP Western Pilot Project, through the Red River Basin Biological Monitoring and Assessment Project, and now with the Department's participation in the National River and Stream Survey, the Department has fully embraced the probabilistic sample design. Implementation of the probabilistic sample design, coupled with the Department's approach of developing and refining IBIs through the selection of "reference" sites (see the following section describing the Department's Ecoregion Reference Station Network), will result in scientifically defensible biological indicators which can be used to provide unbiased estimates of the biological condition of the state's rivers and streams.

While the primary focus of the biological monitoring and assessment program for rivers and streams will be condition and aquatic life use assessment through probabilistic sampling designs, the Department recognizes that targeted sampling is also a necessary component of its program. This includes targeted "reference

site" sampling for indicator development as well as targeted site selection and sampling to assess specific stream and river reaches for TMDL development, watershed assessment or for Section 305(b) assessment and Section 303(d) listing. There are currently 45 river and stream reaches listed on the "2008 Section 303(d) List of Impaired Waters Needing TMDLs" that are listed based on biological indicators (NDDoH 2008). Most, if not all, of these listings are based on limited biological assessment data and/or data that are of poor quality. It is the Department's goal to resample these river and stream reaches and to assess current aquatic life use support status.

9. Implementation Plans and Schedule

National River and Stream Survey

Beginning in 2008 and 2009, and every five years thereafter, the Department will participate in the National River and Stream Survey (Table 13). If needed, the Department will supplement the number of statewide probabilistic sites chosen by the EPA to achieve a minimum sample size of 50 for each survey cycle.

Biological Indicator Development

Each year the Department will select and sample a minimum of 20 targeted "reference" and trashed sites to be used for biological indicator development (Table 13). It is expected that these sites, and the biological data collected at them, will also serve to provide data for nutrient criteria development and for clean sediment criteria. Additional detail and information on implementation plans and schedules for biological indicator development is provided in Section VIII. C. which describes the Ecoregion Reference Network.

Targeted River and Stream Reach Assessment

An important component to the Department's biological monitoring and assessment program is targeted biological monitoring and assessment. The goal of targeted biological monitoring and assessment is to assess aquatic life use support status or the biological condition of specific river or stream reach or for a river or stream network with a watershed. The state's most recent 2008 Section 303(d) list of impaired waters needing Total Maximum Daily Loads lists 45 river and stream reaches which are assessed as impaired based on biological indicators. Most of these biological impairments are based on data collected in the early to mid-1990's and/or IBIs based on poorly defined reference sites. As part of the 2008 Section 303(d) list, the Department defined each of these waterbodies as assessment Subcategory 5A. This subcategory includes rivers, streams, lakes or reservoirs that were assessed and listed in previous Section 303(d) lists, including the 2006 list, but where the original basis for the assessment decision and associated cause of impairment is questionable. These Subcategory 5A waterbodies include rivers and streams segments which are listed for biological impairments based on: 1) only one sample for the entire segment; 2) samples collected more than 10 years ago; and/or 3) IBIs which were developed using

poorly defined reference sites and a limited number of reference sites. The Department has targeted these Subcategory 5A river and stream reaches for further monitoring in the next 2-4 years to verify their impairment status.

Targeted biological monitoring and assessment is also part of many nonpoint source watershed assessments and TMDL studies. Targeted monitoring may also be used to assess point source discharge impacts. These assessments are used to determine the extent to which aquatic life uses are fully supporting, fully supporting, but threatened, or not supported for rivers and streams in a watershed.

To accomplish the goals of targeted biological monitoring and assessment the Department must first develop an assessment protocol that defines the minimum number of sites needed to assure that samples are representative of current biological conditions for the stream reach or watershed, both in terms of spatial extent and temporal variability (Table 13). Multimetric IBIs and biological condition scoring thresholds developed through the Ecoregion Reference Network will then be applied to samples collected to determine overall aquatic life use support or biological condition (e.g., good, fair, poor).

10. General Support and Infrastructure Planning

Current Program Support and Infrastructure

Sampling, analysis, data management, and reporting activities associated with the biological monitoring and assessment program are currently allocated to multiple staff within the Department. Current costs are also dependent on whether or not the Department is in a National River and Stream Survey year. It is, therefore, difficult to make precise estimates as to the total annual cost of this program. Current biological monitoring and assessment program expenditures are estimated at $ 135,000 with 1.5 FTEs. Table 14 provides a summary of the estimated costs of the Department's current program as well as the costs associated with full implementation of a revised program.

Table 13. Implementation Schedule for the Biological Monitoring and Assessment Program for Rivers and Streams.

Implementation Element	Years											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
National River and Stream Survey												
River and stream monitoring	■	■				■	■				■	■
Data analysis and reporting			■	■				■	■			
Survey design					■					■		
Biological Indicator Development												
Sample 10 reference and 10 trashed sites in the Northwestern Glaciated Plains and Northwestern Great Plains ecoregions	■											
Sample 10 reference and 10 trashed sites in the Northern Glaciated Plains ecoregion		■										
Sample 15 reference and 15 trashed sites in the Northwestern Glaciated Plains and Northwestern Great Plains ecoregions		■										
Sample 10 reference and 10 trashed sites in the Lake Agassiz Plains ecoregion			■									
Sample 5 reference and 5 trashed sites in the Northern Glaciated Plains ecoregion			■									
Sample 10 reference and 10 trashed sites in the Lake Agassiz Plains ecoregion					■							
Sample 5 reference and 5 trashed sites in the Northern Glaciated Plains ecoregion					■							
Sample 10 reference and 10 trashed sites in the Northwestern Glaciated Plains and Northwestern Great Plains ecoregions						■						
Biological Indicator Development												
Develop and/or revise IBIs for ecoregions and develop biological condition scoring thresholds based on reference		■	■	■	■	■						
Resample 20 reference sites each year throughout the four level 3 ecoregions in the state							■	■	■	■	■	■
Targeted Biological Monitoring and Assessment												
Develop targeted monitoring and assessment protocol defining representative sample size and spatial extent		■										
Sample TMDL listed sub-category 5A river and stream reaches and reassess aquatic life use support using protocol		■	■	■	■							
Conduct targeted river and stream biological assessments and watershed assessments, as needed.		■	■	■	■	■	■	■	■	■	■	■

Table 14. Current and Future Support and Infrastructure Costs for the Biological Monitoring and Assessment Program.

Resource	Current FTE	Current Annual Cost	FTE w/ Program Improvement	Annual Cost w/ Program Improvement
Staffing	1.5	$ 75,000	2.5	$ 125,000
Operating		$ 30,000		$ 50,000
Contractor		$ 15,000*		$ 30,000*
TOTAL	1.5	$ 135,000	2.5	$ 205,000

* Includes cost for laboratory analysis of macroinvertebrate and periphyton samples.

Resource Needs and Priorities

It is anticipated that full implementation of the department's biological monitoring and assessment program, including the national river and streams survey, biological indicator development, and targeted biological monitoring and assessment, will require 2.5 FTEs and cost $205,000 each year (Table 14).

C. Ecoregion Reference Network Monitoring Program

1. Monitoring Objectives

The Ecoregion Reference Network Monitoring Program is used to support a variety of water quality management and biological monitoring and assessment activities by providing a network of biologically "least disturbed" reference sites within each of the states four major level 3 ecoregions (Lake Agassiz Plain, Northern Glaciated Plain, Northwestern Glaciated Plain, and Northwestern Great Plain) (Figure 1). Objectives of the Ecoregion Reference Network Monitoring Program include the development of biological indicators. Reference sites are also expected to support the development of nutrient criteria for rivers and streams and the refinement of existing clean sediment reference yields.

First introduced by the EPA in the 1980's, the ecoregion concept assumes that waterbodies reflect the character of the land they drain, and that where sites are physically comparable, chemical and biological conditions should also be comparable. As such, reference sites located within a given ecoregion can serve as benchmarks for all other sites within the same ecoregion. Reference sites, therefore, become powerful tools when assessing or comparing results from both chemical and biological monitoring stations.

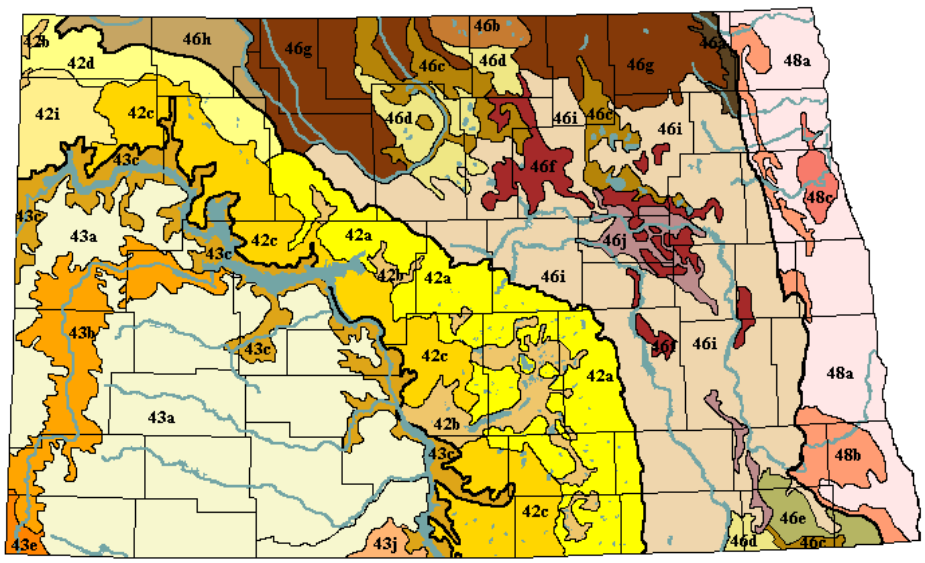

Figure 1. Map Depicting Ecoregions in North Dakota (Lake Agassiz Plain [48], Northern Glaciated Plain [46], Northwestern Glaciated Plain [42], Northwestern Great Plain [43]).

2. Monitoring Design

The goal of the Ecoregion Reference Network Monitoring Program is to establish a minimum set of 30 "reference sites" within each of the following level 3 ecoregions or ecoregion combinations: Lake Agassiz Plain (48), Northern Glaciated Plains (46), and combination Northwestern Glaciated Plains/Northwestern Great Plains (42/43). In addition to the 30 "reference sites" per ecoregion/ecoregion combination, the department will also select and sample 30 companion "highly disturbed" or "trashed" sites. These sites will be used as a basis of comparison when selecting and calibrating metrics used in IBIs.

Reference sites and companion "trashed" sites are selected through a three step process, including: 1) landscape metric analysis using GIS; 2) site reconnaissance using digital orthoquads and aerial photos via GIS; and 3) site inspection and ground truthing.

During 2005, 2006, and 2007, as part of the Red River Biological Monitoring and Assessment Project, the Department sampled 10 reference and 10 trashed sites in the Lake Agassiz Plain ecoregion and 10 reference and 10 trashed sites in the Red River basin portion of the Northern Glaciated Plains ecoregion. In 2008, another 10 reference and 10 trashed sites were sampled in the remaining portions of the Northern Glaciated Plains ecoregion. Reference site sampling will continue in 2009 with 20 reference and 20 trashed sites sampled in the combined Northwestern Glaciated Plains/Northwestern Great Plains ecoregions and 5 reference and 5 trashed sites sampled in the Northern Glaciated Plains ecoregion. In 2010 and again in 2011, 10 reference and 10 trashed sites will be sampled each year in the Lake Agassiz Plain and 5 reference and 5 trashed sites will be sampled each year in the Northern Glaciated Plains ecoregion. The department's first round of reference site sampling will conclude in 2012 with the sampling of 10 reference and 10 trashed sites sampled in the combined Northwestern Glaciated Plains/Northwestern Great Plains ecoregions (Table 15).

In the Lake Agassiz Plains ecoregion, sites will be sampled for fish, macroinvertebrates, and periphyton. In the remaining ecoregions sites will be sampled for macroinvertebrates and periphyton. Sites in all ecoregions will also be sampled for water chemistry and physical habitat.

Specific monitoring design details for the Ecoregion Reference Network Monitoring Program, including standard operating procedures for site selection, reconnaissance, and ground truthing, as well as field sampling procedures are provided in the "Quality Assurance Project Plan for Ecoregion Reference Network Monitoring Program" (draft January 2009).

3. Quality Assurance

A draft Quality Assurance Project Plan (QAPP) was developed for the "Ecoregion Reference Network Monitoring Program." Components of the QAPP included: 1) a description of responsibilities; 2) detailed monitoring design, including sample

variables; 3) standard operating procedures, including sample custody procedures; 4) procedures for annual field audits; 5) procedures for the collection and analysis of QA samples (e.g., independent lab verification, residue analysis); 6) procedures for equipment inspection and maintenance; 7) procedures for program assessment and corrective actions; and 8) data review, validation and verification requirements.

4. Core and Supplemental Water Quality Indicators

Core indicators used in the SWQMP's biological monitoring and assessment program, including the Ecoregion Reference Network Monitoring Program, include field parameters (temperature, pH, dissolved oxygen, specific conductance), water chemistry (common ions, trace elements, nutrients, total suspended solids), macroinvertebrates, periphyton, fish, and physical habitat measures (Table 15).

Table 15. Current (C) Core Indicators Used By the Ecoregion Reference Network Monitoring Program.

Monitoring Program	Field Measurements	Water chemistry (ions and trace metals)	Water chemistry (nutrients)	Macroinvertebrates	Periphyton	Fish	Physical Habitat/Stream Stability
Reference Site Monitoring	C	C	C	C	C	C	C

5. Data Management

All water chemistry samples results generated by the Department's Chemistry Division are electronically transmitted to the Surface Water Quality Management Program where they are incorporated into SID by the database management coordinator. Field data (e.g., temperature, pH, dissolved oxygen and conductivity measurements) and sample custody information (e.g., station description, date and time collected and depth) are recorded on standardized forms and entered into SID by program personnel. All biological (macroinvertebrates, periphyton, and fish) and physical habitat data are entered into the SWQMP's Access based Ecological Data and Application System (EDAS). All data entered into SID and EDAS are transmitted electronically into EPA's STORET database.

6. Data Analysis and Assessment

The department has adopted the "multi-metric" index approach to assess biological integrity or aquatic-life use support for rivers and streams. The multi-metric index approach assumes that various measures of the biological community (e.g., species richness, species composition, trophic structure, and

individual health) respond to human-induced stressors (e.g., pollutant loadings or habitat alterations). Each measure of the biological community, termed a "metric," is evaluated and scored on either a 1-, 3-, 5-point scale (fish) or on a scale of 0-100 (macroinvertebrates and periphyton). The higher the score, the better will be the biological condition and, presumably, the lower the pollutant or habitat impact. For each biological community (macroinvertebrates or fish) metrics which show a response to the human disturbance gradient are summed (in the case of the 1-, 3-, 5-point scale) or averaged (in the case of the 0-100 scale) into an Index of Biological Integrity (IBI).

To date, the Department has developed multi-metric IBIs for fish in the Lake Agassiz Plain ecoregion and for fish and macroinvertebrates in the Northern Glaciated Plains ecoregion. Fish, macroinvertebrate, and periphyton data collected as part of the Ecoregion Reference Network Monitoring Program will be used to refine existing metrics and IBIs and to develop new IBIs for additional ecoregions in the state. Metrics used in IBIs are selected through a six step process (Figure 2) and combined into an overall IBI. Biological condition scoring thresholds of good, fair, and poor (fully supporting, fully supporting, but threatened, and not supporting) are based on the frequency distribution of reference sites scores for the ecoregion.

7. Reporting

As reference sites are sampled in each ecoregion and the results are analyzed, reports will be prepared describing each multi-metric IBI developed based on each ecoregion and biological assemblage. These reports will also include a description of the biological condition scoring thresholds for each ecoregion/biological assemblage combination.

8. Program Evaluation

Since the biological monitoring and assessment program for rivers and streams was first started in the early 1990's many lessons have been learned. The program, from 1993 through 2000, focused on targeted sampling sites with very little emphasis on "reference" site selection. The result was a series of IBIs developed with less than adequate scientific basis. The lack of an adequate number of reference sites also resulted in the inability to develop biological condition thresholds. Implementation of Ecoregion Reference Station Network will result in scientifically defensible biological indicators necessary to accurately assess aquatic life use support and to provide unbiased estimates of biological condition through probability surveys. Reference sites selected for biological indicator development and the results generated from these sites are also expected to support other program activities, such as nutrient criteria development and sediment criteria.

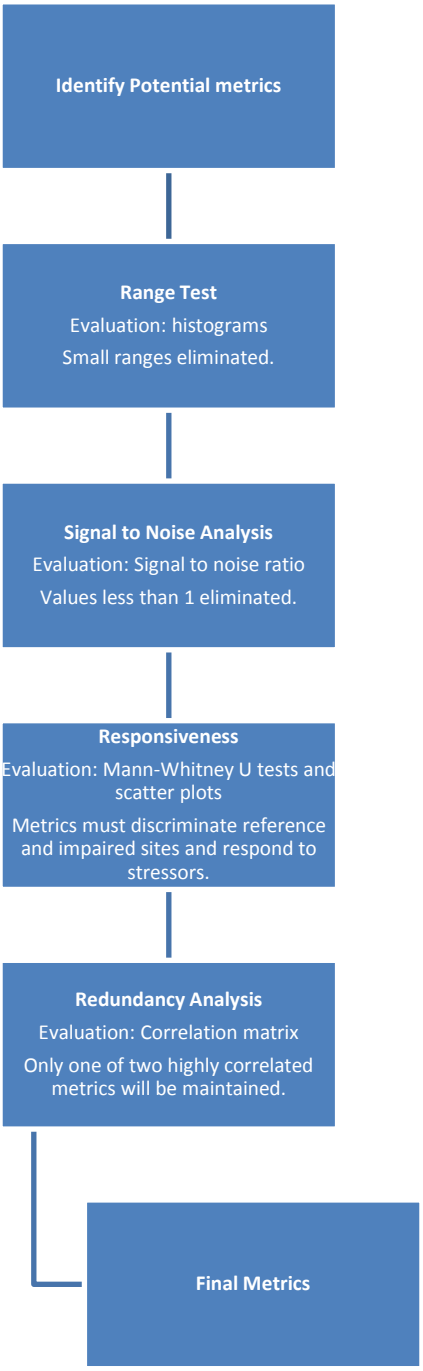

Figure 2. Multi-metric Screening and Evaluation Process.

9. Implementation Plans and Schedule

Each year the Department will select and sample a minimum of 30 targeted "reference" and trashed sites to be used for biological indicator development (Table 16). It is expected that these sites, and the biological data collected at them, will also serve to provide data for nutrient criteria development and for clean sediment criteria.

Table 16. Implementation Schedule for the Ecoregion Reference Network.

Implementation Element	Years											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Ecoregion Reference Site Monitoring												
Sample 10 reference and 10 trashed sites in the Northwestern Glaciated Plains and Northwestern Great Plains ecoregions	■											
Sample 10 reference and 10 trashed sites in the Northern Glaciated Plains ecoregion		■										
Sample 10 reference and 10 trashed sites in the Northwestern Glaciated Plains and Northwestern Great Plains ecoregions		■										
Sample 10 reference and 10 trashed sites in the Lake Agassiz Plains ecoregions			■									
Sample 5 reference and 5 trashed sites in the Northern Glaciated Plains ecoregion			■									
Sample 10 reference and 10 trashed sites in the Lake Agassiz Plains ecoregions				■								
Sample 5 reference and 5 trashed sites in the Northern Glaciated Plains ecoregion				■								
Sample 10 reference and 10 trashed sites in the Northwestern Glaciated Plains and Northwestern Great Plains ecoregions					■							
Resample 20 reference sites each year throughout the four level 3 ecoregions in the state					■	■	■	■	■	■	■	■

10. General Support and Infrastructure Planning

Current Program Support and Infrastructure

Current sampling, analysis, data management, and reporting activities and cost associated with the Ecoregion Reference Network Monitoring Program are included with overall biological monitoring and assessment program (see Section XIII. B. Biological Monitoring and Assessment Program), therefore, it is difficult to make precise estimates as to the total annual cost of this program. Current biological monitoring and assessment program expenditures are estimated at $ 135,000 with 1.5 FTEs (Table 14). Table 17 provides a summary of the estimated current annual costs as well as the cost necessary to fully implement the Ecoregion Reference Network Monitoring Program.

Table 17. Current and Future Support and Infrastructure Costs for the Ecoregion Reference Network Monitoring Program.

Resource	Future FTE	Current Annual Cost	FTE w/ Program Improvement	Annual Cost w/ Program Improvement
Staffing	0.25	$ 15,000	1.5	$ 125,000
Operating		$ 10,000		$ 50,000
Contractor		$ 50,000*		$ 25,000**
TOTAL	0.25	$ 75,000	1.5	$ 200,000

* Includes cost for cooperative USGS monitoring program and laboratory analysis of macroinvertebrate and periphyton samples.
** Includes costs for laboratory analysis of macroinvertebrate and periphyton samples.

Resource Needs and Priorities

It is anticipated that full implementation of the Department's Ecoregion Reference Network Monitoring Program, will require 1.5 FTEs and cost $200,000 each year (Table 17).

D. Lake Water Quality Assessment Program

1. Monitoring Objectives

Monitoring objectives of the Lake Water Quality Assessment Program are to: 1) describe the general physical and chemical condition of the state's lakes and reservoirs, including trophic status; 2) assess beneficial use attainment for Section 305(b) reporting and Section 303(d) listing; 3) identify water quality problems; 4) evaluate the effectiveness of pollution control and abatement programs (e.g., NDPDES, Section 319); and 5) refine fishery classifications described in the state water quality standards.

2. Monitoring Design

Historic Program

The Department currently recognizes 249 lakes and reservoirs for water quality assessment purposes. Of this total, 139 are manmade reservoirs and 110 are natural lakes. Reservoirs are defined as waterbodies formed as a result of dams or dugouts constructed on natural or manmade drainages. Natural lakes are waterbodies having natural lake basins. A natural lake can be enhanced with outlet control structures, diversions or dredging.

From 1991 through 1996, through a grant from the EPA Clean Lakes Program, the Department initiated a Lake Water Quality Assessment (LWQA) Program. During that time, the Department has completed sampling and analysis for 111 lakes and reservoirs in the state. The lakes and reservoirs targeted for assessment were chosen in conjunction with the North Dakota Game and Fish Department.

Criteria used during the selection process were geographic distribution, local and regional significance, fishing and recreational potential and relative trophic condition. Lakes without much historical monitoring information were given the highest priority.

The results from this LWQA Program were prepared in a functional atlas-type format. Each lake report discussed the general description of the waterbody, general water quality characteristics, plant and phytoplankton diversity, trophic status estimates and watershed condition.

Beginning in 1997, LWQA Program activities were integrated into the Department's rotating basin monitoring strategy. Lake Darling and the Upper Des Lacs Reservoir were sampled as the Department focused its monitoring activities in the Souris River Basin in 1997. Pipestem Dam and Jamestown Reservoir were sampled in 1998; Lake Sakakawea was sampled in 1999; and Bowman-Haley Reservoir, Patterson Lake and Lake Tschida were sampled in 2000.

In addition to their inclusion in the annual LWQA Program, Devils Lake and Lake Sakakawea have received special attention. Devils Lake has increased in elevation 26 feet since 1993. In response to questions regarding water quality changes resulting from these water level increases, the Department initiated a comprehensive water quality monitoring program in 1993 for Devils Lake

While Devils Lake has increased in elevation over the last 10 years, Lake Sakakawea's lake level has dropped significantly since 2002. This drop has been due to drought conditions in the upper Missouri River Basin of Montana resulting in reduced runoff and by the U.S. Army Corps of Engineers' operating policies, which favor downstream navigation interests over the health and condition of the upper Missouri River reservoirs. Of particular concern in North Dakota is the quality of Lake Sakakawea's cold water fishery. Since 2002, the Department and the North Dakota Game and Fish Department have cooperated in a project to monitor the condition of the lake. Sampling consists of weekly dissolved oxygen (DO)/temperature profiles and water quality samples collected once each month at seven locations.

With exception of Devils Lake and Lake Sakakawea sampling, lake water quality monitoring and assessment was limited from 2001 through 2004. Beginning in 2005, through 2006 and 2007, the Department initiated a cooperative lake water quality assessment program with the North Dakota Game and Fish Department's Fisheries Division. Through this program, 60 lakes and reservoirs were sampled in 2005, ten in 2006 and six in 2007. Samples were collected at least twice during the summer (May/June, July/August or September/October) and once during the winter. The purposes of this project were to: (1) characterize general water quality conditions; (2) assess trophic conditions; (3) determine trends; and (4) assess whether beneficial uses are being met. The results from this project were summarized in short reports for each lake or reservoir.

Current and Future Program

As was stated previously the Department recognizes 249 public lakes and reservoirs for assessment purposes. Of this total, 121 have no monitoring data, or so little monitoring data, that water quality can not be assessed. These remaining lakes and reservoirs will be the target of monitoring and assessment. After that the Department will develop a prioritization and schedule whereby lakes and reservoirs will be monitored and assessed on a 5-10 year schedule. Beginning in 2008 and extending through 2010, the Department will sample approximately 15 lakes or reservoirs in the state. Through this "Targeted Lake Water Quality Assessment Project", lakes will be sampled 3 times per year, twice during the summer and once during the winter. Classified lakes and reservoirs in the state with little or no monitoring data will be targeted for monitoring and assessment under this project. This initial 3-year project will result in water quality and trophic status assessments for a minimum of 45 lakes in the state. Information from these assessments will be published in a lake atlas format and posted on the department's web site. These assessments will also be used to assess beneficial use attainment status for Section 305(b) reporting and Section 303(d) listing. Assuming continued funding can be secured, the Department plans to continue or expand this program beyond 2010.

Given their statewide significance, Devils Lake and Lake Sakakawea will continue to be targeted for monitoring by the Department. Even with the cooperation and assistance provided by the North Dakota Game and Fish Department, sampling Lake Sakakawea requires a significant manpower commitment. The Department will be looking for other partners (e.g., U.S Army Corps of Engineers and USGS) to help with this effort.

Survey of the Nation's Lakes

In 2007, the U.S. EPA, in partnership with the Department and other state agencies, initiated the Survey of the Nation's Lakes to answer key environmental questions about the quality of the nation's lakes. The survey will provide a snapshot of the condition of our nation's lake resource on a broad geographic scale. Results from this assessment will allow water quality managers, the public, state agencies and others to say, with known statistical confidence, what proportion of the nation's lakes are in poor biological condition and identify key stressors affecting this resource. Data collected from the lakes will be analyzed on both a regional and national scale. The information generated from this survey fills an important gap in meeting the requirements of the Clean Water Act. The goals of the lakes survey are to:

- Provide regional and national estimates of the condition of lakes in good, fair and poor condition.
- Explore the relative importance of key stressors such as nutrients and pathogens and their extent across the population.
- Establish a baseline to compare future surveys for trends assessment and to evaluate trends since the 1970's National Eutrophication Study.

- Help build state and tribal capacity for monitoring and assessment.

To answer these questions and to achieve the goals of the program, the lakes survey focused on identifying and measuring relevant lake quality indicators in three basic categories: ecological integrity, trophic status and recreational condition. Data collected on stressors will be analyzed to explore associations between stressors and ecological condition.

For the purposes of this survey, lakes are defined as natural or manmade freshwater lakes, ponds and reservoirs in the conterminous U.S. Additional criteria included lake size greater than 10 acres (4 hectares), lake depth greater than 1 meter, and lake area greater than 1000 square meters of open water. Water bodies that were excluded include the Great Lakes (surveyed as part of the National Coastal Condition Assessment), the Great Salt Lake and other naturally saline systems, and water treatment or disposal ponds.

The lake sampling locations were selected using a modern probabilistic survey design approach. In North Dakota, the department, working in cooperation with the USGS, conducted lake sampling at 38 lakes.

As is the case with the National river and Streams Survey (NRSA), the Survey of the Nations Lakes is based on a 5-year rotating cycle where lakes and reservoirs will again be sampled through the probabilistic design in 2012, 2017, etc. While only 38 lakes and reservoirs were sampled in 2007, in subsequent surveys the Department will ensure there are at least 50 lakes sampled to achieve 90 % confidence +/- 10%.

Volunteer Lake Monitoring

While not a significant component of the state's lake assessment program, the Department also cooperates and assists lake associations and citizen groups with volunteer lake monitoring and assessment projects. When a group or association requests assistance Department staff will meet with the group to define the overall goals and objectives of the project. Based on these goals and objectives, the Department will prepare a sampling plan and provide training in sampling methods. The group is responsible for day-to-day monitoring activities, and the Department provides laboratory analysis of all samples collected.

3. Quality Assurance

Specific Quality Assurance Project Plans (QAPP) have been developed for the "Targeted Lake Water Quality Assessment Project", Lake Sakakawea, and Devils Lake. Components of these QAPPs included: 1) a description of responsibilities; 2) detailed monitoring design, including sample variables; 3) standard operating procedures, including sample custody procedures; 4) procedures for annual field audits; 5) procedures for the collection and analysis of QA samples (e.g., independent lab verification, residue analysis); 6) procedures for equipment inspection and maintenance; 7) procedures for program assessment and

corrective actions; and 8) data review, validation and verification requirements. Each year these QAPP will be revised based on new lakes targeted for sampling, and/or revisions site locations, sample frequency, or sample parameters.
For the Survey of the Nation's Lakes (SNL), the EPA has developed the "Survey of the Nations Lakes Field Operations Manual" (EPA 2007). This manual describes field protocols and daily operations for crews to use in the SNL. In addition, field training is provided to all crews participating in the SNL and a field audit is conducted by EPA personnel of each crew to ensure field sampling and reporting procedures are being followed.

4. Core and Supplemental Water Quality Indicators

Core indicators that are currently being used in the Department's Targeted Lake Water Quality Assessment Project, include field parameters (temperature, pH, dissolved oxygen, specific conductance), water chemistry (common ions, trace elements, nutrients), and chlorophyll-a (Table 18). It is possible that in addition to the current set of core indicators, phytoplankton, sediment and fish tissue contaminants will be sampled in the future.

For the Survey of the Nation's Lakes, core indicators include: pathogens (i.e., Enterococcus), phytoplankton (diatoms and soft algae), zooplankton, paleo diatom cores, macroinvertebrates, physical habitat, field measurements, and water chemistry (Table 18).

Table 18. Current (C) and Future (F) Core Indicators Used By the Lake Water Quality Assessment Program.

Monitoring Program	Field Measurements	Water chemistry (ions and trace metals)	Water chemistry (nutrients)	Pathogens	Chlorophyll-*a*	Macroinvertebrates	Phytoplankton	Fish Tissue	Sediment Contaminants	Physical Habitat/Stream Stability
Targeted Lake Water Quality Assessment Project	C	C	C		C		F	F	F	
Survey of the Nations Lakes	C	C	C	C	C	C	C			C

5. Data Management

All water chemistry samples results generated by the Department's Chemistry Division are electronically transmitted to the Surface Water Quality Management Program where they are incorporated into SID by the database management coordinator. Field data (e.g., temperature, pH, dissolved oxygen and conductivity measurements) and sample custody information (e.g., station description, date and time collected and depth) are recorded on standardized forms and entered into SID by program personnel. All data entered into SID are transmitted electronically into EPA's STORET database.

Sample results generated from the Survey of the Nation's Lakes project are managed by the EPA.

6. Data Analysis and Assessment

The data collected through the Targeted Lake Water Quality Assessment Project are summarized through the use of general descriptive statistics (i.e., mean, minimum, maximum) with comparisons made with regionally similar lakes or reservoirs. Trophic status is assessed using total phosphorus, chlorophyll-a, Secchi Disk Transparency. Temperature and dissolved oxygen data are presented graphically by plotting measurements vs. depth. Where historic data are available for a lake or reservoir, water quality trends are assessed by plotting concentrations over time.

Due to their statewide significance, data for Lake Sakakawea and Devils Lake are reduced and analyzed each year. For Lake Sakakawea, temperature and dissolved oxygen profile data are analyzed and reduced using an Excel based "Cold-water Habitat" tool. The tool examines temperature and dissolved oxygen profile data, determines the depths of the epilimnion, metalimnion, and hypolimnion, then calculates the area of cold-water habitat that exists for the lake. For purposes of this analysis, cold-water habitat is defined as areas in the lake where the dissolved oxygen concentration in the lake is equal to or greater than 5 mg/L and the temperature is less than or equal to 15º C. This criterion has been set for the protection of cold-water fish species like rainbow smelt, rainbow trout, brown trout and Chinook salmon.

For the Survey of the Nation's Lakes study that was conducted in 2007, the Department is working with EPA in the analysis and assessment of data collected in North Dakota. The Department is also working cooperatively with the states of Montana, Minnesota, South Dakota and Iowa in the analysis of data for natural lakes in the Prairie Pothole Region of the central plains.

7. Reporting

Results from each year's targeted lake monitoring will be reported in the form of a lake atlas report. In addition to introductory information, such as the project's purpose and sampling methods, the report will include a short summary report for

each lake sampled. Information presented in the individual lake summary reports includes: 1) background information on the lake or reservoir (e.g., location, physiographic/ecological setting, recreational facilities, water quality standards classification, historic and current fishery, and water quality monitoring history); 2) temperature and dissolved oxygen profile results, 3) general water quality results, including a discussion of limiting nutrients; 4) trophic status assessment; and 5) water quality and trophic status trends, if historic data exist.

Each year the Department prepares a report summarizing the monitoring results for Devil Lake. In addition to providing a summary of water quality conditions for the lake for the previous year the report provides a summary of water quality trends since the Department first started monitoring in 1995. The report provide results for conductivity, chloride, sulfate, total dissolved solids, nutrients, chlorophyll-a, Secchi Disk Transparency, dissolved oxygen, and temperature.

Other than providing informal summary reports to management, no formal, peer reviewed, report is prepared by the Department that summarizes annual monitoring results for Lake Sakakawea. If resources are available it is the Department's goal to prepare a comprehensive report describing current water quality conditions as well as trends in water quality.

8. Program Evaluation

While the primary focus of the Lake Water Quality Assessment Program has, and will continue to be, targeted lake and reservoir water quality monitoring and assessment, the Department recognizes that statewide probabilistic sampling and condition assessment is also a necessary component of its program. Targeted sampling is necessary to support Section 305(b) assessment and reporting, Section 303(d) listing and de-listing decisions, water quality standards development (e.g., nutrient criteria and lake classification), and fisheries management. As was stated previously the Department recognizes 249 public lakes and reservoirs for assessment purposes. Of this total, 121 have no monitoring data, or so little monitoring data, that water quality cannot be assessed. These remaining lakes and reservoirs will be the target of monitoring and assessment activities in the next 5-6 years. After that, the Department will develop a prioritization and schedule whereby lakes and reservoirs will be monitored and assessed on a 5-10 year schedule.

9. Implementation Plans and Schedule

Targeted Lake Water Quality Assessment Project

As was stated previously the Department recognizes 249 public lakes and reservoirs for assessment purposes. Of this total, 121 have no monitoring data, or so little monitoring data, that water quality cannot be assessed. These remaining lakes and reservoirs will be the target of monitoring and assessment activities in the next 5-6 years. Immediate plans include targeted monitoring and assessment of a minimum of 15 lakes and reservoirs per year for the next three years (2008-

2010) (Table 19). Depending on available resources, additional lakes and reservoirs will be sampled beyond 2010, until most if not all the state's lakes and reservoirs have been sampled at least once (Table 19). After that the Department will develop a prioritization and schedule whereby lakes and reservoirs will be monitored and assessed on a 5-10 year schedule.

With ongoing concerns regarding their management and with their statewide significance, it is anticipated that Lake Sakakawea and Devils Lake will continue to be monitored each year. To ensure that each lake's QAPP are meeting contemporary monitoring and assessment needs of the public and management, sampling sites, methods, frequency, and parameters will be reviewed each year.

Survey of the Nation's Lakes

The Department participated in the first Survey of the Nation's Lakes in 2007. Based in the EPA's schedule, this probabilistically based survey will be repeated every 5-years (Table 19). The Department plans to participate in subsequent surveys and, if necessary, supplement the number of probabilistic lake sites chosen by the EPA to achieve and minimum sample size of 50 lakes for each survey cycle.

Table 19. Implementation Schedule for the Lake Water Quality Assessment Program.

Implementation Element	Years												
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Targeted Lake Water Quality Monitoring Project													
Monitor and assess a minimum of 15 lakes and reservoirs each year for 3-years		■	■	■									
Depending on available resources, conduct monitoring and assessment on an additional 15-20 lakes each year					■	■	■						
Implement a rotating schedule whereby priority lakes and reservoirs are sampled every 5-10 years								■	■	■	■	■	■
Conduct monitoring and assessment of Devils Lake and Lake Sakakawea each year	■	■	■	■	■	■	■	■	■	■	■	■	■
Survey of the Nation's Lakes													
Lake sampling	■					■					■		
Data analysis and reporting		■	■				■	■				■	■
Survey design					■					■			

10. General Support and Infrastructure Planning

Current Program Support and Infrastructure

Current program support and infrastructure includes costs and resources to monitor, assess and prepare reports for 15 targeted lakes per year for the next three years as well as costs to sample Devils Lake and Lake Sakakawea. Current program costs are estimated to be $85,000 with 1 FTE for field sampling, data analysis and reporting and 0.25 FTE for laboratory analysis (Table 20).

Resource Needs and Support

It is anticipated that full implementation of the Lake Water Quality Assessment Program will include the development and implementation of targeted lake monitoring and assessment of priority lakes and reservoirs on a 5-10 year schedule, annual monitoring and assessment of Lake Sakakawea and Devils Lake, and probabilistic sampling of a minimum of 50 lakes and reservoirs every 5-years as part of the Survey of the Nations Lakes study. Cost and resource needs for this program are estimated to be $270,000 and require 2.5 FTEs (Table 20).

Table 20. Current and Future Support and Infrastructure Costs for the Lake Water Quality Assessment Program.

Resource	Current FTE	Current Annual Cost	FTE w/ Program Improvement (2011)	Annual Cost w/ Program Improvement (2011)	FTE w/ Full Program Implementation Improvement, including National Survey	Annual Cost w/ Full Program Implementation Improvement, including National Survey
Staffing	1.0	$ 50,000	1.5	$ 85,000	2.0	$ 85,000
Operating		$ 20,000		$ 50,000		$ 75,000
Laboratory Staffing/Operating	0.25	$ 15,000	0.5	$ 50,000	0.5	$ 50,000
Contractor						$ 60,000*
TOTAL	1.25	$ 85,000	2.0	$185,000	2.5	$270,000

* Contractor costs are for USGS assistance in implementing the Survey of the Nation's Lakes sampling.

E. Missouri River Mainstem Monitoring Program

1. Monitoring Objectives

Monitoring objectives of the Missouri River Mainstem Monitoring Program are to: 1) provide data for trend analysis, general chemical characterization and pollutant loading calculations; 2) assess beneficial use attainment for Section 305(b) reporting and Section 303(d) listing; 3) develop nutrient criteria; 4) develop biological indicators for the mainstem Missouri River using fish, macroinvertebrate and/or periphyton and to use those indicators in biological condition assessment of the Missouri River; and 5) identify water quality problems.

2. Monitoring Design

Current and Historic Program

The mainstem Missouri River in North Dakota consists of two reaches. One reach is from the Montana-North Dakota boarder downstream to Lake Sakakawea. This reach extends upstream to Ft. Peck Dam in Montana and includes the Yellowstone River confluence in North Dakota. The second reach extends approximately 89-miles from Garrison Dam downstream to the upper end of Lake Oahe just south of Bismarck, North Dakota. With an annual mean daily flow of 22,800 cubic feet per second (period of record 1912-2003) the Missouri River is the largest river in the state. Due to its size, the mainstem Missouri River presents unique monitoring and assessment challenges.

Historically, monitoring on the mainstem Missouri River has been limited to flow and chemical monitoring conducted by the US Geological Survey. Flow gauging sites are currently located on the Missouri River at Culbertson, MT (06185500) and at Bismarck (06342500). In addition there are stage only stations on the Missouri River at Buford (06329640), near Buford (06329650), near Williston (06330000), above Stanton (06339010), near Stanton (06340700), near Hensler (06340900), at Washburn (06341000), at Price (06342020), and near Schmidt (06349700). Currently there is only one water quality monitoring station on the Missouri River. The USGS's North Dakota Water Resource Center conducts water quality monitoring at the Bismarck site twice per year. In addition to taking field measurements for temperature, dissolved oxygen, ph and conductivity, samples are collected and analyzed for general chemistry and trace metals.

From 2000 through 2003, EPA scientist from the Mid-Continent Ecology Division Laboratory in Duluth, MN conducted research on the Garrison reach of the Missouri River. The primary purpose of this project, termed the Upper Missouri River Pilot Project, was to research methods and protocols which would be used to assess water quality conditions of the nation's Great Rivers Ecosystem. Resource populations targeted for methods development included river shorelines, river open water, river backwaters, in-channel riparian habitat, terrace forest stands, and the upper Missouri River landscape. Indicators targeted for methods development included benthic macroinvertebrates, fish, habitat, water chemistry, and landscape variables.

Based on the lessons learned and the methods developed during the Upper Missouri River Pilot Project, in 2004 and 2005, EPA's Office of Research and Development launched the Environmental Monitoring and Assessment Program-Great Rivers Ecosystem Project (EMAP-GRE). The purposes of this project were to: 1) estimate what proportion of the GRE, expressed in river miles, are in good, fair, and poor condition; 2) estimate the extent of aquatic, floodplain, and riparian habitat in the GRE; and 3) estimate the relative importance of potential stressors (e.g., flow modification, bank stabilization, nutrients, metals, invasive species). Included in the EMAP-GRE project was the Missouri River. The focus of the EMAP-GRE project in North Dakota were the reaches from Garrison Dam

downstream to Lake Oahe and upstream from Lake Sakakawea to the North Dakota-Montana border. Monitoring activities for EMAP-GRE in North Dakota and Montana were contracted to the USGS North Dakota District. In 2004 and 2005 staff with the Department assisted with field sampling. A total of 22 sites were randomly selected and sampled on the Missouri River in North Dakota. Eight (8) were on the reach from the ND/MT boarder to Lake Sakakawea and 14 on the reach from Garrison Dam to Lake Oahe.

Most recently, the department has been participating in the EPA-sponsored National Rivers and Streams Assessment (NRSA). As stated earlier (see section XIII. B. "Biological Monitoring and Assessment Program for Rivers and Streams" for a complete description), the NRSA is a probabilistic assessment of the condition of the nation's rivers and streams.

The NRSA design for 2008 and 2009 involves 61 randomly selected sites in North Dakota, two were on the Missouri River.

3. Quality Assurance

Specific quality assurance procedures and plans are part of the USGS's flow gauging and water quality sampling programs. For the Upper Missouri River Pilot Project, the Great River Ecosystem Survey, and the National River and Streams Survey, the EPA has developed the field operations manuals. These manuals described the field protocols and daily operations for crews to be used in these projects. In addition, field training was provided to all crews participating in these projects and a field audit was conducted by EPA personnel for each crew participating in the Great River Ecosystem Survey and the National River and Streams Survey, to ensure field sampling and reporting procedures were being followed.

4. Core and Supplemental Water Quality Indicators

The core indicator that is currently being used by the USGS at most of the mainstem Missouri River sites is river stage height. At the Missouri River at Bismarck site, core indicators include stream stage and discharge, field parameters (temperature, pH, dissolved oxygen, specific conductance) and water chemistry (common ions, trace elements, nutrients), and chlorophyll-a (Table 21).

For the Upper Missouri River Pilot Project, the Great Rivers Ecosystem Survey, and the National River and Streams Survey, core indicators include: phytoplankton (diatoms and soft algae), zooplankton, macroinvertebrates, fish, physical habitat, field measurements, and water chemistry (Table 22).

Table 21. Current (C) Core Indicators Used by the USGS for Missouri River Monitoring.

Monitoring Program	Stage/Discharge	Field Measurements	Water chemistry (ions and trace metals)
Missouri River Mainstem Monitoring Program	C	C	C

Table 22. Current (C) Core Indicators Used by the EPA for the Upper Missouri River Pilot Project, the Great River Ecosystem Survey, and the National River and Streams Survey.

Monitoring Program	Field Measurements	Water chemistry (ions and trace metals)	Water chemistry (nutrients)	Pathogens	Chlorophyll-*a*	Macroinvertebrates	Periphyton	Phytoplankton	Fish	Physical Habitat/Stream Stability
Missouri River Related Biological Monitoring and Assessment Programs	C	C	C	C	C	C	C	C	C	C

5. Data Management

All stage and flow data and water chemistry sample results generated by the USGS North Dakota Water Resource Center are managed by the USGS and are available through their National Water Information System (NWIS) web interface at http://nd.water.usgs.gov/.

Sample results generated by the EPA for Upper Missouri River Pilot Project, the Great Rivers Ecosystem Survey, and the National River and Streams Survey are managed by the EPA's Mid-Continent Ecology Division Laboratory in Duluth, MN.

6. Data Analysis and Assessment

Data generated by the USGS are made available to the public through their NWIS web interface. Users, including the NDDoH, can download the data in a variety of formats. Although limited, the water chemistry data collected by the USGS are used in water quality assessments that are reported in the biennial "North Dakota Integrated Section 305(b) Report and Section 303(d) List."

Results generated by the EPA for Upper Missouri River Pilot Project and the Great Rivers Ecosystem Survey are being analyzed by the EPA's Mid-Continent

Ecology Division Laboratory in Duluth, MN.

7. Reporting

As stated previously, Missouri River data generated by the USGS North Dakota Water Resource Center are made available through the USGS's NWIS web interface. These data are also published by the USGS each year as part of the annual "Water-Data Report."
Results and analysis generated by the EPA for Upper Missouri River Pilot Project and the Great Rivers Ecosystem Survey will be published and reported by the EPA's Mid-Continent Ecology Division Laboratory in Duluth, MN.

8. Program Evaluation

Chemical Monitoring

Current USGS monitoring activities are considered part of the "Ambient Water Quality Monitoring Network for Rivers and Streams" (see Section XIII.A. for additional detail) and are considered inadequate for assessment of the mainstem Missouri River. Monitoring on the Missouri River in North Dakota consists of nine stage only sites, two flow sites (one which is actually near the border in Montana), and only one water quality site, located at Bismarck. Not only is the spatial representation of monitoring inadequate for the Missouri River, but the temporal representation of monitoring at the Bismarck site, based on two samples per year, is also inadequate.

To address inadequacies in mainstem Missouri River monitoring as well with the current "Ambient Water Quality Monitoring and Assessment Program", the USGS, the North Dakota State Water Commission, and the Department have entered into a cooperative study to review and evaluate each of their long-term water quality sampling programs. The purposes of this study, which will be conducted by the USGS, are to: 1) evaluate spatial and temporal variability in the existing data; 2) tends and loading estimates developed from the historical "high-low flow" and ambient monitoring data; 3) quantify the benefits of the data that are currently being collected in relation to the data quality objectives of each sampling program; and 4) determine and make recommendations for an efficient state-wide sampling design for monitoring water quality conditions of rivers and streams, including the mainstem Missouri River.

Biological Condition Monitoring and Assessment

The EPA has accomplished much in the way of developing methods and indicators for assessing the biological condition of the nation's "Great Rivers", including the Missouri River. What remains, is the development and implementation of a monitoring design to assess the biological condition and aquatic life uses of the Missouri River in North Dakota. Given the limited reach extent of mainstem Missouri River in the state, a survey design which sets a predetermined number of sites and selects sample sites based on a predetermined

distance will likely be the most efficient use of the Department's monitoring resources. For example, if it is assumed that there are approximately 125 miles of Missouri River in North Dakota, a sample site allocation of 25 sites would result in a site every 5 miles of river length. Depending on available resources, all 25 sites could be sampled in the same year, or sampling could be allocated among multiple years. To be consistent with indicators developed, or under development by the EPA, sites will be sampled for all of the core indicators used by the Upper Missouri River Pilot Project and the Great Rivers Ecosystem Survey (Table 22).

9. Implementation Plans and Schedule

Chemical Monitoring

The implementation plan and schedule for chemical monitoring on the mainstem Missouri River are reflected in the "Implementation Plan and Schedule" for the "Ambient Water Quality Monitoring Network for Rivers and Streams" (see Section XIII.A. for additional detail). Based on this implementation plan and schedule, revisions to the state's ambient water quality monitoring program are planned in two phases. Due to the complexities associated with sampling the Missouri River, it is unlikely that enhanced monitoring on the Missouri River will occur until the revised program is fully implemented. Assuming adequate resources are available, this is scheduled to occur sometime between 2013 and 2018.

Biological Condition Monitoring and Assessment

To accomplish the biological monitoring and assessment objectives of the "Missouri River Mainstem Monitoring Program", the Department must first adapt and refine sampling methods and protocols developed by the EPA for the Great Rivers, including the Missouri River. The Department will also need to develop a monitoring design that defines the minimum number of sites needed to assure that samples are representative of current biological conditions for the mainstem Missouri River in North Dakota, both in terms of spatial extent and temporal variability. Multimetric IBIs and biological condition scoring thresholds developed through the EPA Great Rivers Survey and/or National River and Streams Survey will then be applied to samples collected to determine overall aquatic life use support or biological condition (e.g., good, fair, poor). As stated earlier, full implementation of a biological condition monitoring and assessment program for the Missouri River is not expected until 2013, at the earliest (Table 23).

10. General Support and Infrastructure Planning

Current Program Support and Infrastructure

Since there are currently no monitoring efforts with respect to the Missouri River conducted by the Department, there no current costs associated with sampling, analysis, data management, and reporting activities associated with the biological monitoring and assessment program currently allocated to staff within the Department (Table 24).

Table 23. Implementation Schedule for the Missouri River Mainstem Biological Monitoring and Assessment Program.

Implementation Element	Years											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Biological Monitoring and Assessment												
Adapt and refine existing monitoring and assessment methods and protocols developed by the EPA for the Great Rivers Survey and/or National River and Streams Survey					■	■						
Develop sample design and final implementation schedule						■	■					
Conduct mainstem Missouri River biological monitoring and assessment.								■	■	■	■	■

Table 24. Current and Future Support and Infrastructure Costs for the Missouri River Mainstem Monitoring and Assessment Program.

Resource	Current FTE	Current Annual Cost	FTE w/ Program Improvement	Annual Cost w/ Program Improvement
Staffing	0	$ 0	0.5	$ 25,000
Operating		$ 0		$ 50,000
Contractor		$ 0		$ 30,000*
TOTAL	0	$ 0	0.5	$ 105,000

* Includes cost for laboratory analysis of macroinvertebrate and periphyton samples.

Resource Needs and Priorities

Chemical Monitoring

It is expected that costs associated with full implement of the Department's Ambient Water Quality Monitoring Program will include sites on the mainstem Missouri River and that the costs associated with operating these sites will be reflected in future support and infrastructure needs for the "Ambient Water Quality Monitoring Network for Rivers and Streams" (see Section XIII.A. for additional detail).

Biological Condition Monitoring and Assessment

It is anticipated that full implementation of the Department's mainstem Missouri River biological condition monitoring and assessment program will require 0.5 FTEs and cost $105,000 each year (Table 24). It is possible that costs and personnel associated with this program could be included with the Department's other biological monitoring and assessment programs (see Section XIII.B. for additional detail). However, due to its size and the unique challenges sampling the Missouri River poses, it is anticipated that additional resources will be needed to meet program objectives.

F. Fish Tissue Contaminant Surveillance Program

1. Monitoring Objectives

The primary objectives of the Fish Tissue Contaminant Surveillance Program are to: 1) protect human health by monitoring and assessing the status and trends of commonly found toxic compounds in fish from the state's lakes, reservoirs, rivers, and streams; 3) use these data to develop and issue fish consumption advisories; 4) assess fish consumption use attainment for Section 305(b) reporting and Section 303(d) listing; and 5) identify water quality problems due to the toxic effects of contaminants on the ecological health of the state's aquatic resources.

While not specifically a part of the Fish Tissue Contaminant Surveillance Program, a secondary objective is to monitor and assess human exposure of contaminated fish. For example, methylmercury is known a neurotoxin at elevated doses and polychlorinated biphenyls (PCBs) are considered carcinogenic to humans. In addition, there is recent evidence that diets rich in selenium may mitigate the toxicological effect of methylmercury (Ralston 2008 and Peterson, et al. 2009).

2. Monitoring Design

Historic Program

The Department has maintained an active fish tissue monitoring and contaminant surveillance program since 1990. As part of this program, individual fish tissue samples were collected from selected lakes, reservoirs and rivers throughout the state and analyzed for methyl-mercury. For example, in 2004, the Department cooperated with the North Dakota Game and Fish Department Fisheries Division in the collection and analysis of 700 fish tissue plug samples from 24 lakes and reservoirs, including Devils Lake and Lake Sakakawea.

The Department has also participated in sampling for the National Fish Tissue in Lakes Survey. Eight lakes were selected in North Dakota as part of the national probability survey of 500 lakes and reservoirs. Sampling took place from 2000 through 2003.

Current and Future Program

The current and future monitoring program described here build upon the Department's highly successful historic monitoring program. The program will continue to focus on those specific waterbodies and fish species currently under fish consumption advisories for methylmercury, especially targeted game fish species (e.g., walleye, northern pike, white bass, yellow perch, channel catfish) in Devils Lake, Lake Sakakawea, Lake Oahe, the Missouri River and the Red River. These data will provide a tool to assess the status and trends in methylmercury contamination in fish in these important state fisheries. The goal will be to collect a representative sample of fish (3-5 individuals per species per size class) from each waterbody once every five years. Total mercury will be analyzed from all fish collected from these waters. In addition, a subsample of fish collected will also be analyzed for trace elements (including selenium), PCBs, and selected pesticides (e.g., chlordane, DDT, DDD, DDE, etc.). Emerging contaminants of concern (e.g., polybrominated diphenyl ethers [PBDEs]) will be added to the list when analytical capability by the Department's Laboratory Services Division becomes available.

In addition to fish contaminant sampling of the state's significant waterbodies, the Department will continue to monitoring the state's remaining lakes, reservoirs, rivers and streams through a combination of targeted sampling and probabilistic sampling. The Department will continue to opportunistically collect fish from lakes and reservoirs as part of North Dakota Game and Fish Department (NDGF) routine fish survey work. The Department works closely with the NDGF's six district fisheries biologists in the selection and collection of fish from a number of small to mid-sized lakes and reservoirs each year. Once again, total mercury will be analyzed from all fish collected from these waters with a subsample of fish analyzed for trace elements, PCBs, and selected pesticides. Emerging contaminants of concern (e.g., PBDEs) will be added to the list of analytes for these waterbodies in the future.

Eventually, the Department would like to implement a probabilistic sampling design as part of its fish tissue contaminants surveillance program. This program will likely focus lakes and reservoirs first, then on perennial rivers as a separate assessment population. In order to provide unbiased estimates of contaminant levels in fish across the state it is also likely that 30-50 lakes or reservoirs will be randomly selected and sampled across the state. Based on available resources, all 30-50 lakes and reservoirs may be sampled during the same year or may be sampled during multiple years. Sampling may also be limited to one size class and fish species or include multiple size classes and fish species. Since this program is intended as a statewide survey, fish tissue analysis will consist of as many contaminants as possible, including total mercury, trace elements, PCBs, and selected pesticides.

3. Quality Assurance

A Quality Assurance Project Plan (QAPP) is developed and updated annually for the "Fish Tissue Contaminant Surveillance Program." Components of the QAPP include: 1) a description of responsibilities; 2) detailed monitoring design, 3) standard operating procedures, including sample custody procedures; 4) procedures for annual field audits; 5) procedures for the collection and analysis of QA samples (e.g., duplicate samples, laboratory split samples); 6) procedures for equipment inspection and maintenance; 7) procedures for program assessment and corrective actions; and 8) data review, validation and verification requirements. Components of the monitoring design will include: the waterbodies, fish species, and size classes targeted for sampling; 2) the number of samples collected per waterbody, fish species and size class; 3) sampling personnel and gear; and 3) the contaminants analyzed.

4. Core and Supplemental Water Quality Indicators

Current core indicators sampled and analyzed in fish tissues include methyl-mercury, trace elements, select organochlorine pesticides, and PCBs (Table 25). It is anticipated that in addition to the current set of core indicators, PBDEs, pharmaceuticals and personnel care products (PPCs), and dioxins will be sampled in the future.

Table 25. Current (C) and Future (F) Core Indicators Used By the Fish Tissue Contaminant Surveillance Program.

Monitoring Program	Methyl-mercury	Trace metals	Organochlorine Pesticides	PCBs	PBDEs	Pharmaceuticals and personnel care products	Dioxins
Fish Tissue Contaminant Surveillance Program	**C, F**	**C, F**	**C, F**	**C, F**	**F**	**F**	**F**

5. Data Management

All sample results generated by the Department's Laboratory Services Division, including fish tissue contaminant results, are electronically transmitted to the Surface Water Quality Management Program where they are incorporated into SID by the database management coordinator. Sample custody information (e.g., waterbody description, date and time collected, collection method, tissue type, species, length and weight) are recorded on standardized forms and entered into SID by program personnel. All data entered into SID are transmitted electronically into EPA's STORET/WQX database.

6. Data Analysis and Assessment

Data generated through current and future fish tissue surveillance monitoring projects will be utilized to identify the status and trends of contaminants in fish. Data will be statistically analyzed to determine trends and average concentrations of contaminants in fish tissue on a statewide, regional, and/or waterbody specific basis.

Methyl-mercury data are also used to issue, on an as needed basis, species-specific fish advisories for the state's rivers, streams, lakes and reservoirs based on risk-based consumption levels. The approach compares the estimated average daily exposure dose for specific waterbodies and species to EPA's recommended reference dose (RfD) for methyl-mercury. Using these relationships, fish tissue data are interpreted by determining the consumption rate (e.g., two meals per week, one meal per week or one meal per month) that would likely pose a health threat to the general population and to sensitive populations (i.e., children or pregnant or breast-feeding women). In addition to the current mercury advisory, the Department expects to use risk-based values for other contaminants (e.g., PCBs, chlordane, DDT) in the future.

Currently, only methyl-mercury data are used in water quality assessments for the "North Dakota Integrated Section 305(b) Report and Section 303(d) List." Fish consumption use, based only on methyl-mercury data, is assessed for the state's rivers, streams, lakes, and reservoirs. Fish consumption use is assessed using the procedures described in the "Water Quality Assessment Methodology for Surface Waters" (NDDoH 2008).

7. Reporting

The methyl-mercury data collected through this program are used in water quality assessments that are reported in the biennial "North Dakota Integrated Section 305(b) Report and Section 303(d) List."

Currently, the Department's fish consumption advisory is updated on an as needed basis and is published on the Department's web site at http://www.ndhealth.gov/WQ/SW/Z7_Publications/ . Public health outreach and risk information will also be developed with fish consumption advisory messages matched to specific populations within advisory areas. These risk reduction strategies will take into account ethnic difference in information source, perception about safety and health risks, and consumption patterns. Information will be developed and distributed regarding how to reduce risk by eating or avoiding certain kinds of fish and by eating smaller fish. The goal of this information is to help people understand that they can reduce their risk of eating contaminated fish while not necessarily decreasing the amount of fish eaten.

8. Program Evaluation

The Fish Tissue Contaminant Surveillance Program's monitoring goals and objects are articulated through the program's Quality Assurance Project Plan (QAPP). Each year the program is evaluated and the QAPP/workplan is revised, as needed, to reflect current and anticipated program needs. Health Department managers and staff, including epidemiologists and women and children health professionals, review the QAPP/workplan and provide feedback on data needs for advisory purposes and program evaluation. Other agencies (i.e., US Fish and Wildlife Service and North Dakota Game and Fish Department) are also asked to review the workplan.

Currently, fish tissue sampling is limited to lakes and reservoirs throughout the state that are sampled by the North Dakota Game and Fish Department Fisheries Division as part of its routine fisheries management activities (e.g., population surveys). And with the exception of a few special investigations, samples are only analyzed for methyl-mercury. The goals and objectives of an enhanced fish tissue surveillance program would be to achieve statewide coverage of fish tissue sampling, including rivers and streams, and would include analysis of additional contaminants such as heavy metals, pesticides and other organic compounds (e.g., PCBs, PBDEs, pharmaceuticals and personal care products, and dioxin). To achieve this goal, the Department will need to implement a combination of target sampling, focusing on specific waterbodies and contaminants, as well as a probabilistic sampling design.

Current gaps in the program involve a lack of adequate resource for monitoring (i.e., personnel, travel, equipment, and supplies), sample analysis, and data analysis and reporting.

9. Implementation Plans and Schedule

Targeted Fish Tissue Lake, Reservoir, River and Stream Monitoring

The program will continue to focus on those specific waterbodies and fish species currently under fish consumption advisories for methylmercury, especially targeted game fish species (e.g., walleye, northern pike, white bass, yellow perch, channel catfish) in Devils Lake, Lake Sakakawea, Lake Oahe, the Missouri River and the Red River (Table 26). These data will provide a tool to assess the status and trends in methylmercury contamination in fish in these important state fisheries. The goal will be to collect a representative sample of fish (3-5 individuals per species per size class) from each waterbodies once every five years. Total mercury will be analyzed from all fish collected from these waters. In addition, a subsample of fish collected will also be analyzed for trace elements (including selenium), PCBs, and selected pesticides (e.g., chlordane, DDT, DDD, DDE, etc.). Emerging contaminants of concern (e.g., PBDEs) will be added to the list when analytical capability by the Department's Laboratory Services Division becomes available.

In addition to fish contaminant sampling of the state's significant waterbodies, the Department will continue targeted monitoring of the state's remaining lakes, reservoirs, rivers and streams. As necessary, the Department will continue to opportunistically collect fish from lakes and reservoirs as part of North Dakota Game and Fish Department (NDGF) routine fish survey work. The Department works closely with the NDGF's six district fisheries biologists in the selection and collection of fish from a number of small to mid-sized lakes and reservoirs each year. Once again, total mercury will be analyzed from all fish collected from these waters with a subsample of fish analyzed for trace elements, PCBs, and selected pesticides. Emerging contaminants of concern (e.g., PBDEs) will be added to the list of analytes for these waterbodies in the future.

Table 26. Implementation Schedule for the Fish Tissue Contaminant Surveillance Program.

Implementation Element	Years											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Targeted Fish Tissue Monitoring Project												
Conduct targeted fish tissue monitoring for methylmercury from the state's important fisheries (e.g., Devils Lake, Lake Sakakawea, Lake Oahe, Missouri River, and the Red River) once every five years.			■	■				■	■			
Conduct targeted fish tissue monitoring for additional contaminants from the state's important fisheries.								■	■			
Conduct targeted fish tissue monitoring for methylmercury and other contaminants from additional priority lakes, reservoirs, rivers and streams as needed.			■	■	■	■	■	■	■	■	■	■
Based on results of targeted methylmercury monitoring, update state fish consumption advisory.			■	■	■	■	■	■	■	■	■	■
Probabilistic Fish Tissue Monitoring Project												
Develop probabilistic sampling design for fish tissue contaminants for the lakes and reservoirs across the state.					■							
Implement probabilistic sampling design for fish tissue contaminants for the lakes and reservoirs across the state.						■					■	
Update statewide fish consumption advisory for lakes and reservoirs.							■					■
Develop probabilistic sampling design for fish tissue contaminants for the rivers and streams across the state.					■							
Implement probabilistic sampling design for fish tissue contaminants for the rivers and streams across the state.							■					■
Update statewide fish consumption advisory for rivers and streams.								■				
Human Exposure Assessment												
Develop sampling design to assess human risk to exposure to mercury in sport and commercial fish.							■					
Implement human mercury exposure risk assessment monitoring.								■				
Based on results of human risk assessment monitoring, adjust fish consumption advisory for sport caught fish in North Dakota.									■			

Probability-Based Fish Tissue Lake, Reservoir, River and Stream Monitoring

In the future, the Department plans to implement a probabilistic sampling design as part of its fish tissue contaminants surveillance program (Table 26). This program will likely focus lakes and reservoirs first, then on perennial rivers as a separate assessment population. In order to provide unbiased estimates of contaminant levels in fish across the state it is also likely that 30-50 lakes or reservoirs will be randomly selected and sampled across the state. Based on available resources, all 30-50 lakes and reservoirs may be sampled during the same year or may be sampled during multiple years. Sampling may also be limited to one size class and fish species or include multiple size classes and fish species. Since this program is intended as a statewide survey, fish tissue analysis will consist of as many contaminants as possible, including total mercury, trace elements, PCBs, and selected pesticides.

Human Exposure Assessment

While not specifically a part of the Fish Tissue Contaminant Surveillance Program, a secondary objective of the program is to monitor and assess human exposure of contaminated fish (Table 26). For example, methylmercury is known a neurotoxin at elevated doses and PCBs are considered carcinogenic to humans. In addition, there is recent evidence that diets rich in selenium may mitigate the toxicological effect of methylmercury (Ralston 2008 and Peterson, et al. 2009).

10. General Support and Infrastructure Planning

Current Program Support and Infrastructure

Since sampling, analysis, data management, and reporting activities associated with the fish tissue contaminant surveillance program are currently allocated to multiple staff within the Department it is difficult to make precise estimates as to the total cost of this program. Current ambient monitoring and assessment program expenditures are estimated at $ 31,000 with 0.35 FTEs. This estimate does not include staffing and resources provided by the North Dakota Game and Fish Department for the collection of fish. Table 27 provides a summary of the estimated costs of the Department's current program as well as the costs associated with full implementation of a revised program.

Resource Needs and Priorities

It is anticipated that full implementation of the Department's fish tissue surveillance program will require 2.0 FTEs and cost $230,000 each year of its operation (Table 27). It is possible that costs and personnel associated with the human exposure assessment could be included with the Department's other human health assessment programs, however, due to the unique challenges, laws, and regulations associated with human exposure assessment, it is anticipated that additional resources will be needed to meet all of the program's goals and objectives.

While improving the efficiency and analytical capability of the Division of Laboratory Services to conduct fish tissue analysis is a high priority, developing a probabilistic sampling design for fish tissue monitoring across the state is a medium priority and human exposure assessment is a low priority (Table 6).

Table 27. Current and Future Support and Infrastructure Costs for the Fish Tissue Contaminant Surveillance Program.

Resource	Current FTE	Current Annual Cost	FTE w/ Program Improvement (Probabilistic Design and Enhanced Lab Capability)	Annual Cost w/ Program Improvement (Probabilistic Design and Enhanced Lab Capability)	FTE w/ Full Program Implementation Improvement, including Human Exposure Assessment	Annual Cost w/ Full Program Implementation Improvement, including Human Exposure Assessment
Staffing	0.10	$ 6,000	1.0	$ 60,000	2.0	$120,000
Operating		$ 10,000		$ 30,000		$ 50,000
Laboratory Staffing/Operating	0.25	$ 15,000	0.5	$ 30,000	1.0	$ 60,000
TOTAL	0.35	$ 31,000	1.5	$120,000	3.0	$230,000

G. Wetland Monitoring and Assessment Program

1. Monitoring Objectives

Wetlands are often ignored in state water quality monitoring and assessment programs. However, with more than 2.5 million acres of wetlands in the state, the Department believes wetland monitoring and assessment should be an important component of its overall water quality monitoring and assessment strategy. The primary objectives of the Wetland Monitoring and Assessment Program are to: 1) develop biological indicators and assessment methodologies for wetlands and to use those indicators and methods to monitor and assess wetland condition at varying spatial scales (e.g.,. individual wetland, wetland complex, watershed, ecoregion); and 2) develop spatial analysis methods and tools which can be used to identify potential wetland restoration and creation sites and to apply these methods in a watershed planning and restoration context. Secondary objectives of the Wetland Monitoring and Assessment Program are to: 1) refine and apply these methods to evaluate the effectiveness of wetland mitigation and restoration programs and projects; and 2) support the development of water quality standards for wetlands.

2. Monitoring Design

EPA recommends wetland assessment projects use the three tiered approach in the form of landscape assessment (level I), rapid assessment (level II), and intense assessment (level III) (U.S. EPA 2006, Kentula 2007). Recent studies have successfully used this methodology to determine wetland health (Brooks et al. 2004, Wardrop et al. 2007). Each level of assessment provides the resource manager with wetland condition information with varying levels of accuracy. Since most level I assessment methods are larger scale landscape assessments based on remote sensing data (Phillips et al. 2005, Mita et al. 2007, Wardrop et al.

2007), they are considered the least accurate. They also require fewer resources and are generally less costly to implement. Once developed, level I assessments, using remote sensing, require no field work and can be done from an office. These assessments are typically general assessments, intending to give the surveyor a first glimpse into the landscape condition of wetlands in an area.

Level III assessment methods, on the other hand, are considered the most accurate since they require field data collection at the wetland scale. Level III assessment methods are also resource intensive and quite costly to implement.

Recent efforts to establish level II wetland assessment methods have come in the form of rapid assessments (Mack et al. 2001, Collins et al. 2008). Rapid assessment methods are less time and financially intensive than level III methods utilizing IBI's; however, the information is less detailed. Rapid assessments can be used where level III surveys are not possible or too expensive to conduct. Rapid assessments are meant to give a rapid on the ground assessment of wetland condition, and identify possible stressors to the biotic communities.

Since the early 1990's the Department has been active in the development of wetland monitoring methods and sampling designs to assess the quality (i.e., biological integrity) wetland resources across the state. In particular, the Department has developed an active research program in collaboration with academic partners at North Dakota State University and the University of North Dakota to monitor and assess wetlands.

Working in collaboration with its academic partners, the Department now has available assessment methods for each level of wetland assessment. The following is a brief description of methods which have been developed for each level of wetland assessment.

Level III

Since it's beginning, the key to the development of the Department's Wetland Monitoring and Assessment Program has been the development of biological indicators which can be used as a level III wetland assessment tool for assessing the ecological condition of wetlands. While the development of widely applicable and robust indicators for macroinvertebrates has met with limited success, the development of an index of biological integrity (IBI) for wetland plants has been extremely successful.

DeKeyser et al. (2003) developed an IBI for seasonal wetlands in the Prairie Pothole Region (PPR) that is termed the Index of Plant Community Integrity (IPCI). An IPCI was also developed to quantitatively assess the condition of temporary and semi-permanent wetlands of the Northwestern Glaciated Plains (NWGP) ecoregion of North Dakota (DeKeyser 2000, Kirby and DeKeyser 2003).

The IPCI for temporary, seasonal, and semi-permanent wetlands was further

evaluated over a wider variety of disturbances and a larger geographic area including sites in the Northern Glaciated Plains (NGP) and sites in other sub-ecoregions of the NWGP in northeastern Montana and North and South Dakota (Hargiss 2005, Hargiss et al. 2008). These IBIs can now be applied in level III assessments throughout the Northern Glaciated Plains and Northwestern Glaciated Plains ecoregions of North Dakota, South Dakota, and Montana.

Level II

The level II, North Dakota Rapid Assessment Method (NDRAM), was developed by researchers at North Dakota State University for the Missouri River Coteau Regional Wetland Assessment Pilot Project (see below) (Hargiss 2009). The NDRAM incorporates metrics from other rapid assessment methods for wetlands currently being used around the nation, as well as characteristics specific to the Prairie Pothole Region (Mack 2001, Collins et al. 2008). The NDRAM assesses the three factors needed for a site to be considered a wetland: hydrology; hydric soils; and hydric vegetation (Tiner 1999). It takes into account physical and biological characteristics of a site, as well as stressors affecting the site.

The NDRAM can be used to predict wetland condition using a rapid process for temporary, seasonal, or semi-permanent wetlands and is completed with a general walking survey. The NDRAM is conducted by walking around the wetland observing the vegetation, land use, management, and hydrologic features. This information is then used to complete the NDRAM field form.

The first step to completing the NDRAM involves filling out a general site description, land owner and land use information, amount and type of cover, and filling out a site map. This information may be useful during return visits to the site to determine trends and changes at the site. The portion of the NDRAM used to determine the final score utilizes a three metrics system. The three metrics used are: 1) buffers and surrounding land use; 2) hydrology, habitat alteration, and development; and 3) vegetation. Metric 1 is worth 20 points and includes two parts: 1a) average buffer width; and 1b) intensity of surrounding land use. Metric 1a calculates the average buffer on a scale from 0 to 10 points ranging from very narrow (<10 meters wide around the wetland) to wide (50 meters or more). Metric 1b assesses the intensity of surrounding land use on a scale from 0 to 10 points ranging from high (urban area or row crop) or very low (native prairie and/or light to moderate grazing).

Metric 2, which assesses hydrology, habitat alteration, and development, is worth a total of 57 points, and includes 6 sections: 2a) substrate/soil disturbance; 2b) plant community and habitat development; 2c) habitat alteration and recovery from current and past disturbance; 2d) management; 2e) modifications to natural hydrologic regime; and 2f) potential of wetland to reach reference (native) condition for the area. Metric 2a is worth a potential 7 points and asks the rater to assess the soil/substrate disturbance on a scale from undisturbed to recent or no recovery. Metric 2b is potentially worth 12 points and assesses the plant community and habitat development on a scale from poor to excellent. Metric 2c

assesses habitat alteration and recovery on a scale from most suitable to recent or no recovery and is worth a potential 10 points. Metric 2d assesses the management techniques used at a site and is worth 4 points. Management techniques are rated on a gradient starting with cropped sites as the 0 points valued, restored, CRP, idle, or hayed areas at the 2 point level and burned or moderately grazed areas at the 4 point level. Metric 2e assesses modifications that have occurred within the wetland basin. It is worth a potential 12 points and rates sites on a scale from no modifications to recent or no recovery. Metric 2f assesses the potential of a wetland for a potential 12 points on a scale from no potential to excellent potential.

Metric 3 assesses the vegetation of a site, is worth a potential 23 points and encompasses two parts: 3a) invasive species; and 3b) overall condition. Metric 3a has a potential three points possible for a site absent of invasive species, but it is possible for a site to lose 3 points if invasives are extensive (covering >75% aerial cover). Metric 3b is worth a potential 20 points and rates sites on a condition gradient from very poor to very good.

Scores for each metric are added to produce a total score between 0 and 100. A score of 0 is indicative of a site in very poor condition, while a score of 100 indicates a native condition reference site.

Level I

While an IBI approach to wetland assessment using the IPCI can provide very precise information on the biological condition of individual wetlands or populations of wetlands within regions (e.g., watersheds or ecoregions), it does require the use of personnel skilled in wetland plant identification and can be costly to implement, especially on large regional scales. In order to find a wetland assessment method that is less costly to implement, the Department has also collaborated with NDSU's Soil Sciences Department to develop a regional-scale wetland assessment methodology using satellite remotely sensed data and GIS tools. This approach was developed by assembling calibration and verification IPCI data from wetlands sampled previously and by using multi-spectral Landsat Thematic Mapper ™ and Enhanced Thematic Mapper (ETM+) satellite data. The result, termed the Landscape Wetland Condition Assessment Model (LWCAM) is used to predict wetland condition through the use of GIS software (Mita et al. 2007).

The LWCAM uses LANDSAT TM and ETM+ satellite data as a means of classifying, mapping, and quantifying landscape land cover components. Wetlands are assessed as a data point representing a single landscape. A 0.283 km^2 (300m radius extent) buffer is delineated from the center of each wetland (Figure 3). Landscape characteristics (i.e., metrics) are then analyzed within this buffer. A three-year temporal-scale analysis (e.g., 2002, 2003, 2004 map years) is generally selected to allow for the comparison of different wetland landscapes or the same landscape model at different times. Landscape pattern metrics are derived from land cover components within the landscape extent using the

ArcView-for-FRAGSTAT program.

LWCAM data are analyzed according to the system used by Mita et al. (2007). The landscape metrics are quantified in terms of the individual patches, classes (specific land cover), and the landscape unit as a whole. Metric values at the class level are computed by summing and averaging over all patches of the same type, while landscape level metrics are summarized from class level information. A list of metrics for the LWCAM can be found in Table 28. Based on the metrics, wetlands were grouped according to condition of Good, Intermediate, and Poor (Figure 4). Intermediate wetlands are further separated into trending towards Good or trending towards Poor based on habitat fragmentation characteristics.

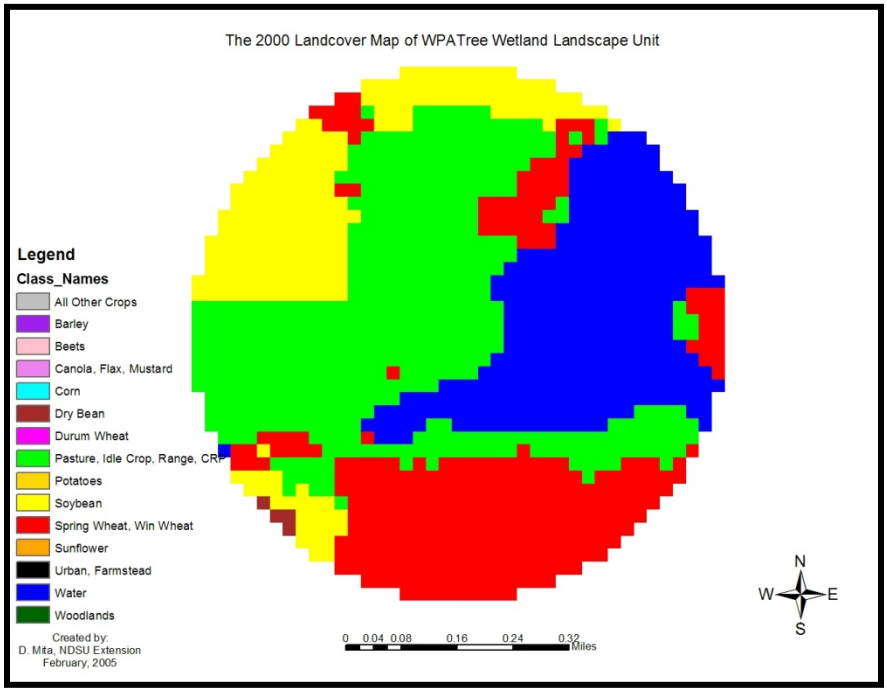

Figure 3. 300-meter Buffer of Land Use for a Sample Wetland Delineated for the LWCAM.

Table 28. Metrics Used for the LWCAM.

Metric	Definition	Description
LPI	Largest patch index	% of landscape that the largest patch comprises
C%LAND	Core area percent of landscape	Core area in each patch type (land cover) as a % of total landscape area
NPA	Number of patches per area	Number of patches per unit area of the landscape

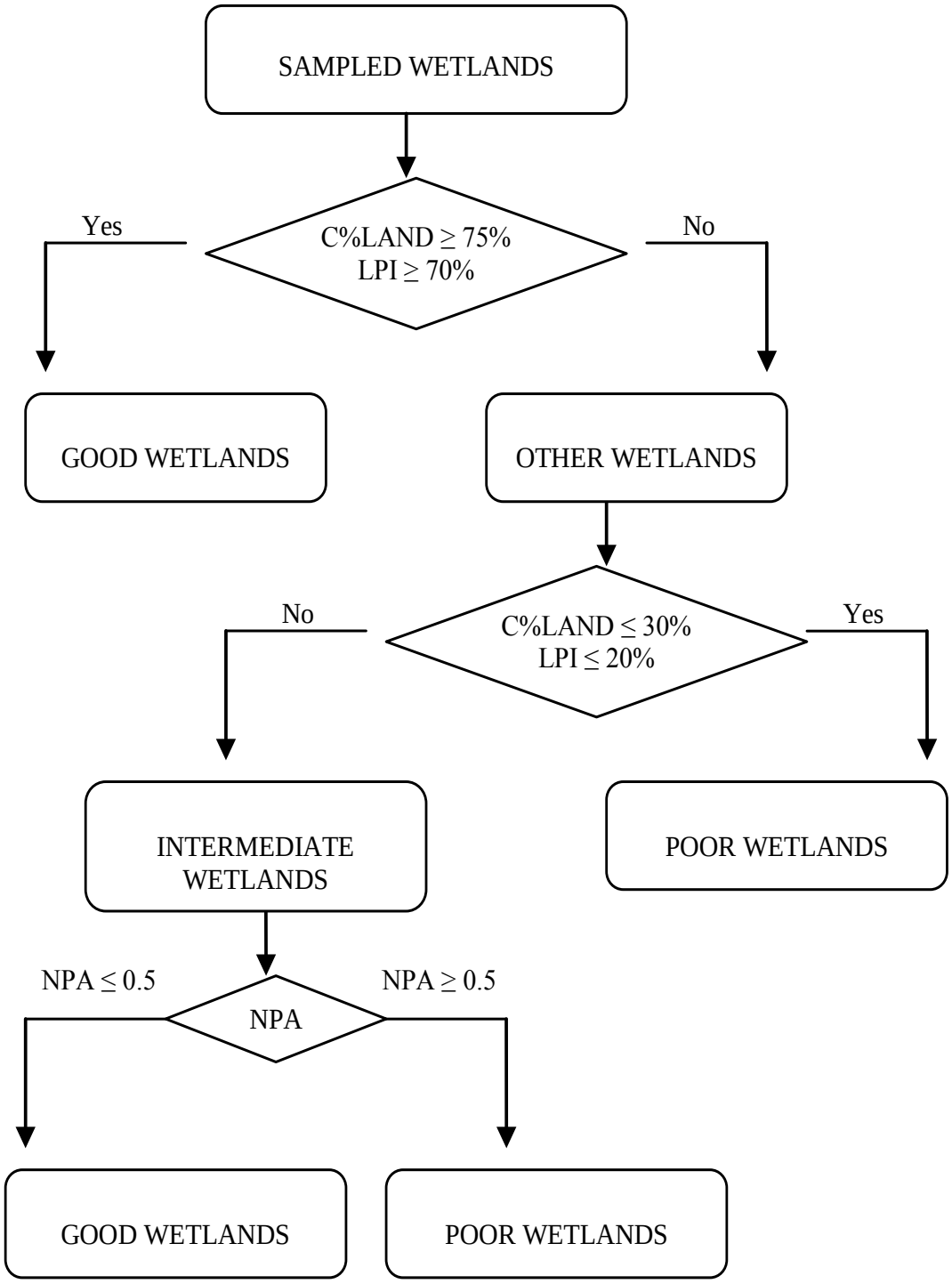

Figure 4. Diagram of Good, Intermediate, and Poor Designations According to the LWCAM Model (Mita et al. 2007).

Regional Scale Wetland Assessment Pilot Project

The current trend in wetland assessment is in using a probabilistic sampling design coupled with multi level assessment (level I, II, and III) to evaluate the condition of wetlands within an area (Hychka et al. 2007, Stevens and Jensen 2007, Wardrop et al. 2007). This approach was implemented in North Dakota through a regional-scale wetland assessment pilot project (Hargiss 2009). The purposes of this project were to: 1) assess the biological condition of wetlands on a large geographic scale using a probabilistic study design to select and sample wetlands; and 2) apply the plant IPCI (level III), NDRAM (level II), and LWCAM (level I) assessment methods to independently assess wetland condition. Due to the high density of wetlands within this area, the study area for this pilot project was a 2,500 km^2 region within the Missouri Coteau level IV ecoregions of North Dakota (Figure 5). Results of this regional assessment will be used to evaluate the probabilistic sample design as well as the pros and cons of each assessment method.

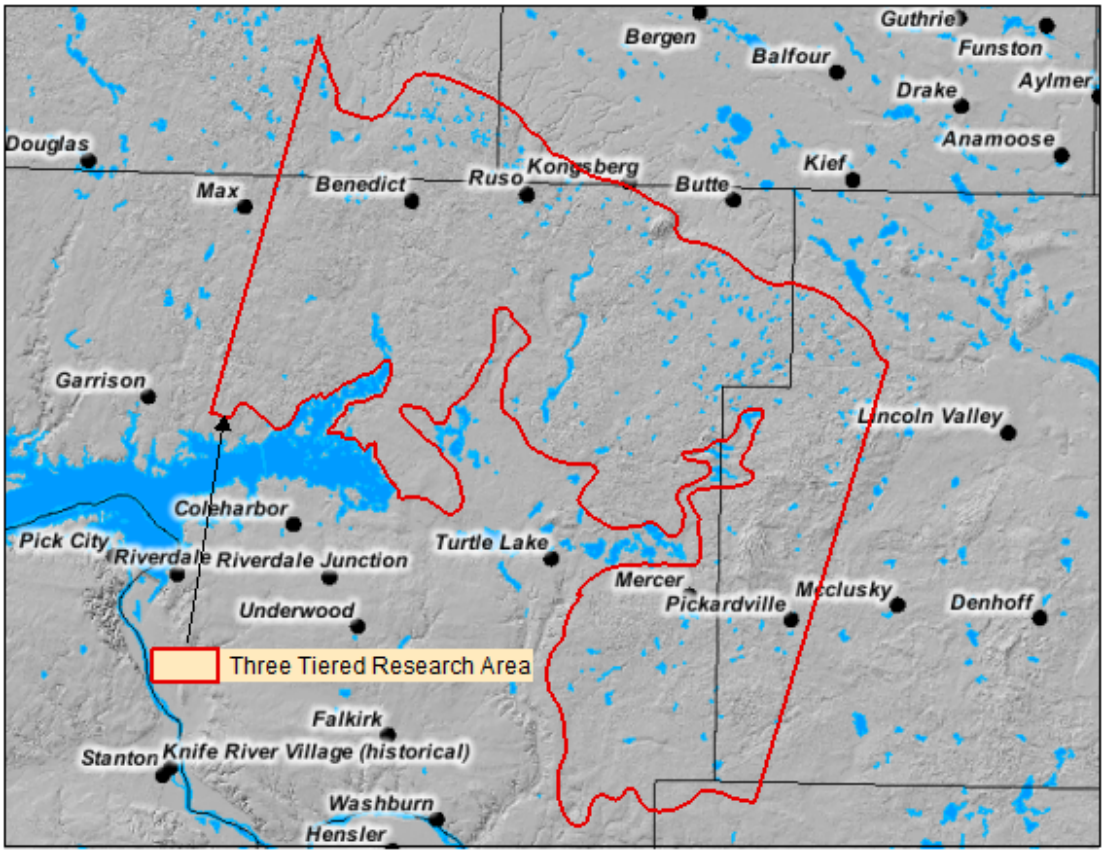

Figure 5. Regional Wetland Assessment Pilot Project Study Area (outlined in red) Within the Missouri Coteau Ecoregion of North Dakota.

National Survey of the Nation's Wetlands

In 2011, the department participated in the EPA-sponsored National Wetland Condition Assessment (NWCA). The NWCA is a probabilistic assessment of the condition of the nation's wetlands and is designed to:

- Determine regional and national ecological integrity of wetlands;
- Help build state and tribal capacity for monitoring and assessment and promote collaboration across jurisdictional boundaries;
- Achieve a robust, statistically-valid set of wetland data; and
- Develop baseline information to evaluate progress made with wetland protection and restoration programs.

The NWCA is one in a series of water assessments being conducted by states, tribes, the EPA and other partners. In addition to wetlands, the water assessments will also focus on coastal waters, lakes and rivers and streams in a 5-year revolving sequence. The purpose of these assessments is to generate statistically valid reports on the condition of our nation's water resources and identify key stressors to these systems.

Working in collaboration with States and Tribes, EPA has identified three main objectives of the NWCA:

- To produce a national report that describes the quality of the nation's wetlands;
- To assist states and tribes implement wetland monitoring and assessment programs that will be used to guide wetland management policies and project decision-making; and
- To advance the science of wetlands monitoring and assessment.

The sampling design for the NWCA is a probability-based network of wetlands sampling sites that will provide statistically valid estimates of condition for a population of wetlands with known confidence. The NWCA is designed using modern survey techniques and all sample sites are selected at random to represent the condition of wetlands across the country.

The NWCA is intended to be a compliment to the US Fish and Wildlife Service's Status and Trends Report. Every five years the US Fish and Wildlife Service publishes a Status and Trends Report that documents trends in the acreage of the nations's wetlands. The NWCA will establish a baseline assessment of condition for some wetlands types. Taken together, these two efforts will provide decision makers with scientifically-defensible information documenting the current status of both wetland quantity and quality in the US.

As part of its long-term biological monitoring and assessment program the Department will continue to support and participate in the rotating Survey of the

Nation's Waters program. Following the 2011 NWCA and based on the 5-year rotating cycle, wetlands will be sampled again in 2016 and 2021.

Prairie Pothole NWCA Intensification Project

As a compliment to the 2011 National Wetland Condition Assessment (NWCA), the Department received Region 8 Wetland Program Development Grant funding to conduct and intensification study within the state as well as within the Prairie Pothole Region (PPR) of North Dakota. Working in collaboration with researchers at North Dakota state university the purpose of this project is to intensify the methods, analysis, and results of the NWCA within North Dakota and the PPR of North Dakota. This was accomplished by: 1) selecting and sampling 53 wetland sites in North Dakota (11 NWCA sites and 43 intensification sites) using the NWCA methods; and 2) sampling the assessing the NWCA wetlands selected with three tiered regional specific assessment methods developed by the Department and NDSU. When the project is completed, the data collected and the analysis will result in models relating existing wetland assessment data from regional studies to ecosystem services and a comparison of the NWCA data/results to the regional specific methods data/results.

EPA Region 8 Wetland Program Development Grant Funded Projects

Through funding provided by EPA Region 8 Wetland Development Grants the Department collaborated with NDSU and UND in the completion of several wetland monitoring and assessment related projects. The following is a summary of these projects.

Remote Integrated Assessment and Monitoring for North Dakota Agricultural Wetlands (Smith et al. 2008) – The purpose of this project was to develop and test methods to assess wetlands in a watershed context. Using the National Wetland Inventory and GIS data (elevation, geology, hydrology, and vegetation) a model was developed which can be used to evaluate wetland profiles at the watershed scale. Results of the project also demonstrated a method for wetland restoration targeting and the evaluation of functional attributes of prairie pothole wetlands and their potential impact to navigable waters in a watershed.

Assessment of Wetland Plant Communities Located on Restored Prairie (Paradeis 2008) - The goal of this study was to evaluate species composition and the physical characteristics of wetlands in restored native prairie areas and to incorporate the data obtained into a model that will predict wetland species composition based on environmental variables. Plant communities within the wetlands in the study area were evaluated using an Index of Plant Community Integrity (IPCI) approach. The Hydrogeomorphic model (HGM) was used to assess physical characteristics and to evaluate wetland functions. Data was analyzed using a Non-metric Multidimensional Scaling (NMS) ordination and a Structural Equation Model predicting vegetative states in relation to environmental gradients. The results of this study may be used to identify the potential composition of wetland plant communities in restored native prairie

areas and to evaluate the success of restoration techniques in the Prairie Pothole Region.

Defining and Locating Reference Condition Wetlands in Unique Ecosystems of North Dakota (Dekeyser et al. 2008) – To date, wetland monitoring and assessment efforts in North Dakota have focused on temporary, seasonal, and semi-permanent depressional wetlands located in the Prairie Pothole Region (PPR). Within the PPR there has been a large amount of habitat fragmentation and draining of wetlands (Galatowitch et al. 2000). There are, however, unique areas in the state where we have obtained limited or no data data relating to wetland biological condition. These areas include the Red River Valley (Glacial Lake Agassiz Basin ecoregion), Turtle Mountains (Turtle Mountains ecoregion), Pembina Gorge (Pembina Escarpment ecoregion), and the southwest North Dakota (ND) slope wetlands area (Missouri Plateau ecoregion). Wetlands within these areas are unique based on topography, vegetation, and connectivity to other areas. It is important to find reference condition sites within these areas not only to investigate the overall condition of wetlands within the state of North Dakota, but also to prepare for the 2011 National Wetland Condition Assessment in which reference areas for wetlands all over ND will need to be located. Locating reference wetlands within these areas is also the first step in developing biological indices for studying these unique habitats (Karr and Chu 1997, Gilbert et al. 2006) and will provide a vegetative database on reference condition wetlands for the entire state beyond just the PPR. The IPCI developed for temporary, seasonal, and semi-permanent wetlands of the PPR (DeKeyser 2000, DeKeyser et al. 2003ab, Kirby and Dekeyser 2003, Hargiss 2005, Hargiss et al. 2008) is a well developed tool for determining wetland plant community condition, and for assessing wetland condition in the region. Combining the use of remote sensing to find sites, the IPCI, the Hydrogeomorphic (HGM) Model, and the US and ND Rapid Assessment Models (USRAM/NDRAM) to assess wetlands will aid in the Department's goal of defining wetland reference conditions in the state.

The study area is located in the Northwestern Great Plains (NWGP) in southwest ND; the Lake Agassiz Plain (LAP) along the eastern corridor of ND; and the Northern Great Plains (NGP) of north and east central ND (Figure 1). The Turtle Mountains and Pembina Escarpment are relatively small ecoregions with unique topography and vegetation types not commonly found in ND. The Turtle Mountains ecoregion has abundant wetland resources, with higher precipitation rates that support a forest canopy over the area. Therefore, there is very little farming in this area, but there is some pastureland (Bryce et al. 1998). The Pembina Escarpment ecoregion is a rugged, forested area formed by glacial scouring. The Glacial Lakes Agassiz Basin is unique because it is the bottom of what was once Lake Agassiz that was formed by glaciers. This area is extremely flat land used for cultivation farming, the area is prone to flooding and soils are extremely productive. The Missouri Plateau ecoregion is unique as it consists of slope wetlands draining to tributaries of the Missouri River. This area has topography mostly unaffected by glaciations. Typical land uses are spring wheat, alfalfa, and grazing land. Of the wetlands within the state, temporary and seasonal wetlands are the most represented classes, by number, of wetlands when

compared to semi-permanent wetlands. For this reason, temporary and seasonal wetlands and the most predominant hydrologic type of slope wetlands will be the focus sample population for the ground survey using the IPCI, HGM Model, and USRAM.

3. Quality Assurance

EPA Wetland Program Development Grant Projects

A Quality Assurance Project Plan (QAPP) is developed and approved for each project funded and implemented through EPA Region 8's Wetland Program Development Grants. Components of each project QAPP includes: 1) a description of responsibilities; 2) detailed monitoring design, including sample variables; 3) standard operating procedures, including sample custody procedures; 4) procedures for annual field audits; 5) procedures for the collection and analysis of QA samples (e.g., independent lab verification, residue analysis); 6) procedures for equipment inspection and maintenance; 7) procedures for program assessment and corrective actions; and 8) data review, validation and verification requirements.

National Wetland Condition Assessment

For the NWCA, the EPA will be developing a Field Operations Manual. This manual will describe field protocols and daily operations for crews to use in the NWCA. In addition, field training will be provided to all crews participating in the NWCA and a field audit will be conducted by EPA personnel of each crew to ensure field sampling and reporting procedures are being followed.

4. Core and Supplemental Water Quality Indicators

Core indicators that are currently being used in projects funded through EPA Region 8 Wetland Program Development Grants, include plants, and hydrogeomorphic and landscape attributes (Table 29). It is possible that in addition to the current set of core indicators field parameters (temperature, pH, specific conductance), water chemistry (common ions, trace elements, nutrients), macroinvertebrates, chlorophyll-a, phytoplankton, and sediment contaminants will be sampled in the future.

For the NWCA, core indicators will likely include: pathogens (i.e., Enterococcus), field measurements, water chemistry, plants, sediment contaminants, and hydrogeomorphic and landscape attributes (Table 29).

Table 29. Current (C) and Future (F) Core Indicators Used By the Wetland Monitoring and Assessment Program.

Monitoring Program	Field Measurements	Water chemistry (ions and trace metals)	Water chemistry (nutrients)	Pathogens	Chlorophyll-*a*	Plants	Macroinvertebrates	Phytoplankton	Sediment Contaminants	Hydrogeomorphic	Landscape
EPA Region 8 WPDG Projects	F	F	F	F	F	C	F	F	F	C	C
National Wetland Condition Assessment	C	C	C	C		C				C	C

5. Data Management

All water chemistry sample results generated by the Department's Laboratory Service's Division are electronically transmitted to the Surface Water Quality Management Program where they are incorporated into SID by the database management coordinator. Field data (e.g., temperature, pH, dissolved oxygen and conductivity measurements) and sample custody information (e.g., station description, date and time collected and depth) are recorded on standardized forms and entered into SID by program personnel. All biological (macroinvertebrates and fish) and physical habitat data are entered into the SWQMP's Access based Ecological Data and Application System (EDAS). All data entered into SID and EDAS are transmitted electronically into EPA's STORET database.

Currently, there is no mechanism to store, manage or retrieve wetland plant data or hydrogeomorphic data in either EDAS or SID. These data, which are primarily collected by NDSU are stored at NDSU's Soil Sciences Department.

Sample results generated from the NWCA project will be managed by the EPA.

6. Data Analysis and Assessment

The data collected through the various projects funded through the EPA Region Wetland Program Development Grants are generally analyzed and reported by the Department's various academic partners at NDSU and UND. Data are analyzed through the use of descriptive parametric statistics, multivariate statistical methods, and non-parametric methods. Where the Index of Plant Community Integrity is used, NDSU and the Department have adopted the "multi-metric: index approach to assess the biological condition of wetlands in the state (DeKeyser 2000, Kirby and DeKeyser 2003).

For the NWCA that will be conducted in 2011, the Department will be working with EPA and researchers at NDSU in the analysis and assessment of data collected in North Dakota.

7. Reporting

Semi-annual, annual and final reports are submitted to the EPA Region 8 project officer for each project funded through the Wetland Program Development Grants. In addition, several presentations and posters have been prepared and presented to meetings, workshops and conferences throughout the county, including Region 8 Wetland Workgroup workshops. Academics from NDSU and UND have also published several peer reviewed journal articles.

8. Program Evaluation

The Department first articulated goals for a wetlands monitoring and assessment program in the early 1990's in a report entitled "Strategy and Workplan for Water Quality Standards Development in North Dakota" (NDDoH 1993). While this strategy's main focus was on water quality standards development for wetlands, the strategy emphasized the use of biological data and a reference condition approach. While water quality standards development remains an objective of the program, condition assessment is now the main focus of the wetland monitoring and assessment program.

The key to the development of the Department's Wetland Monitoring and Assessment Program has been and will continue to be the development of biological indicators which can be used as a level III wetland assessment tool for assessing the ecological condition of wetlands. While the development of widely applicable and robust indicators for macroinvertebrates has met with limited success, the development of an index of biological integrity for wetland plants, the IPCI, has been extremely successful. The Department's support for level III wetland monitoring and assessment methods will continue with the development of additional biological indicators (e.g., macroinvertebrates, algae), refinement of reference site selection methods, and the development of level III monitoring and assessment methods for additional wetland classes (e.g., slope wetlands, fens) and regions in the state. The Department will also continue to refine level II rapid assessment methods, appropriately calibrated to level III data, which can be used as tools to evaluate wetland restoration and mitigation efforts or as a tool to assess wetlands in a watershed context. Lastly, the Department will continue to evaluate and support level I landscape scale wetlands assessment methods which can be used to assess wetlands at various regional scales.

The Department will also work to better integrate wetland monitoring and assessment into watershed assessment and restoration planning efforts. Included in these watershed assessment and planning efforts should be efforts to: 1) complete and harmonize wetland inventory data in watersheds in the state; 2) identify wetland losses/gains (i.e., change analysis) in watersheds in the state; 3) determine relationships between water quality and landscape scale wetland

metrics (e.g., wetlands intact, wetlands lost, wetland storage intact, and wetland storage lost) in watersheds in the state; and 4) develop methods to identify and target wetland protection and restoration efforts in watersheds which will benefit water quality (i.e., reduce nutrients).

9. Implementation Plans and Schedule

Level III Wetland Monitoring and Assessment

It is the Department's intent to continue to work with its academic partners and local, state and federal resource management agencies to identify and prioritize additional wetland classes in the state for level III biological indicator development (Table 30). Once these priority wetlands classes are identified, then reference sites will be selected and appropriate indicators (e.g., plant, macroinvertebrate, algae) monitored and tested.

As current level III wetland indicators and methods are refined and as new wetland indicators are tested and become available, regional and watershed wetland assessments will be conducted and the results integrated into the biennial Section 305(b) water quality assessment report (Table 30).

Level II Wetland Monitoring and Assessment

The basis for level II rapid wetland assessment methods are the more intensive level III data and methods. As level III wetland assessment methods are developed for additional wetland classes, then additional level II rapid assessment methods will be developed and tested (Table 30). The Department will communicate these methods to other state and federal agencies and will work to integrate these methods as a means to monitor and assess wetland mitigation and restoration efforts. The Department will also work with local, state and federal resource agencies to integrate and use these rapid assessment methods in watershed and other regional assessment methods. Results of these regional and watershed assessments will also be integrated into the state Section 305(b) report (Table 30).

Level I Wetland Monitoring and Assessment

As new landscape scale GIS data become available and/or as existing data are refined, the Department will work with its academic partners in the development of new level I landscape scale wetland assessment methods or in the refinement of existing methods (Table 30). The Department will communicate these methods to other state and federal agencies and will work to integrate these methods as a means to monitor and assess wetland mitigation and restoration efforts. The Department will also work with local, state and federal resource agencies to integrate and use these rapid assessment methods in watershed and other regional assessment methods. Results of these regional and watershed assessments will also be integrated into the state Section 305(b) report (Table 30).

National Wetland Condition Assessment

Monitoring for the initial National Wetland Condition Assessment was completed in 2011. Based in the EPA's schedule, this probabilistically based survey will be repeated every 5-years (Table 30). The Department plans to participate in subsequent surveys and, if necessary, supplement the number of probabilistic wetland sites chosen by the EPA to achieve and minimum sample size of 50 wetlands each survey cycle.

Integration of Wetland Monitoring and Assessment Into Watershed Assessment, Planning and Restoration

Currently, wetland monitoring, assessment and restoration programs are not well integrated into state watershed assessment, planning and restoration projects. Most agencies and organizations in the state who work to protect and restore wetlands do so to enhance wildlife functions or to reduce flooding. Generally, there is little or no regard to the potential improvement wetland restoration can provide to water quality.

It is the Department's goal to better integrate its wetland monitoring, assessment and restoration programs and activities in its watershed programs. To accomplish this goal the Department will seek EPA Wetland Program Develop grant funding to develop a pilot project in which wetland inventory, monitoring and assessment will be integrated into watershed assessment, planning and restoration. Specific objectives of the project will be to: 1) complete and harmonize a wetland inventory for the watershed; 2) conduct a change detection analysis in select sub-watersheds of the watershed; 3) determine the relationship between current water quality and landscape wetland metric such as wetland area intact, wetland area lost, wetland storage intact, and wetland storage lost; and 4) develop a methodology to target wetland conservation and restoration efforts to maximize water quality benefits.

10. General Support and Infrastructure Planning

Current Support and Infrastructure

Current wetland monitoring and assessment program support is estimated at $105,000 with most of the costs going to contract support provided by North Dakota State University (Table 31). The Department's support costs are minimal. Support is limited to approximately 0.1 FTE which is devoted mainly to contract management and reporting. Funding for current wetland monitoring and assessment program activities is provided through EPA Region 8 Wetland Program Development Grants.

Table 30. Implementation Schedule for the Wetland Monitoring and Assessment Program.

Implementation Element	Years												
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Level III Monitoring and Assessment													
Identify and prioritize additional wetland classes in the state for biological indicator development.			■	■									
Indentify reference sites and develop biological indicators for priority wetland classes.			■	■	■								
Using a probabilistic sampling design conduct regional wetland assessments for priority wetland classes in the state					■	■	■	■	■	■	■	■	■
Integrate results of regional wetland assessments into Section 305(b) reports						■		■		■		■	
Level II Monitoring and Assessment													
Using level III intensive wetland indicator methods, refine existing rapid assessment methods and develop new methods as needed					■	■	■	■	■	■	■	■	■
Coordinate with other state and federal agencies in the development and use of rapid assessment methods to monitor and assess wetland mitigation and restoration projects				■	■	■	■	■	■	■	■	■	■
Work with local, state and federal resource managers to integrate level II rapid assessment monitoring and assessment methods into regional wetland assessments and into watershed assessment and restoration projects				■	■	■	■	■	■	■	■	■	■
Integrate results of regional wetland assessments into Section 305(b) reports						■		■		■		■	
Level I Monitoring and Assessment													
Using level II rapid assessment methods and level III intensive wetland indicator methods continue to refine and develop new GIS based landscape level assessment methods					■	■	■	■	■	■	■	■	■
Work with local, state and federal resource managers to integrate level I landscape level assessment monitoring and assessment methods into regional wetland assessments and into watershed assessment and restoration projects				■	■	■	■	■	■	■	■	■	■
Integrate results of regional wetland assessments into Section 305(b) reports						■		■		■		■	
National Wetland Condition Assessment													
Survey design			■	■				■	■				■
Wetland sampling					■					■			
Data analysis and reporting						■	■				■	■	
Conduct regional or statewide intensification studies as a companion to the National Wetland Condition Survey					■	■	■			■	■	■	
Watershed and Wetland Monitoring and Assessment Integration													
Indentify pilot project and project partners								■					
Harmonize wetland inventory data in pilot watershed								■	■				
Identify sub-watershed and conduct change analysis to determine the extent of wetland loss or gains								■	■				
Develop watershed scale wetland metrics and identify relationships between water quality and wetland metrics.								■	■				
Develop landscape scale GIS based methods to identify and target wetland restoration and conservation efforts that will maximize water quality benefits (e.g., nutrient reduction)								■	■				
Implement wetland monitoring, assessment and restoration tools in a pilot watershed assessment and planning project.									■	■	■		

Resource Needs and Support

It is anticipated that full implementation of the wetland monitoring and assessment program will require a significant FTE investment by the Department going from 0.1 FTE to 2.0 FTE. At a minimum it is expected that 1.5 FTE will be needed, long term, for implementation of the National Wetland Condition Assessment (Table 31). Program improvement and full implementation will also require continued support from the Department's academic partners (e.g., NDSU, UND) and through various state and local agencies (e.g., ND Game and Fish Department, ND State Water Commission, ND Department of Transportation, soil conservations districts, water resource boards) and organizations (e.g., ND Natural Resources Trust, Ducks Unlimited), through contracts administered by the Department. While some program funding can be expected through the supplemental Section 106 grant program, it is anticipated that the EPA Region 8 Wetland Program Development Grant will remain a source of future program support.

Table 31. Current and Future Support and Infrastructure Costs for the Wetland Monitoring and Assessment Program.

Resource	Current FTE	Current Annual Cost	FTE w/ Program Improvement, including National Survey (2011)	Annual Cost w/ Program Improvement, including National Survey (2011)	FTE w/ Full Program Implementation Improvement, including National Survey	Annual Cost w/ Full Program Implementation Improvement, including National Survey
Staffing	0.1	$ 5,000	1.5	$ 75,000	2.0	$100,000
Operating				$ 50,000		$ 75,000
Laboratory Staffing/Operating	0.0		0.25	$ 15,000	0.5	$ 50,000
Contractor*		$100,000		$150,000		$150,000
TOTAL	0.1	$105,000	2.25	$290,000	2.5	$375,000

* Contractor costs are for assistance from NDSU in implementing program development and implementation, including National Wetland Condition Assessment sampling.

H. Impaired Waterbody Monitoring, Assessment and TMDL Development Program

The following is a brief summary of the monitoring and assessment program elements for the Impaired Waterbody Monitoring, Assessment and TMDL Development Program. A detailed description of the program elements is provided in the document entitled "Impaired Waterbody Monitoring, Assessment, and TMDL Development Strategy for North Dakota" (NDDoH 2009).

1. Monitoring Objectives

The Department is committed to the restoration of impaired lakes, reservoirs, rivers, and streams through the development of Total Maximum Daily Loads and by their implementation through NDPDES permits and Section 319 nonpoint source watershed restoration projects.

The objectives of the Impaired Waterbody Monitoring and Assessment and TMDL Development Program are: 1) to assess the state's rivers, streams, lakes and reservoirs and to provide a list waterbodies that are impaired; 2) to develop TMDLs for waterbodies on the state's Section 303(d) list that, when implemented, will restore the waterbody's impaired beneficial uses; and 3) to develop scientifically defensible water quality targets that can be used in water quality assessment and in the development of TMDLs.

To meet these objectives the TMDL Development Program has three components. The first component involves the listing of rivers, streams, lakes and reservoirs which are known to be impaired for one or more beneficial uses. If necessary, this component may also include follow up monitoring of Section 303(d) listed waterbodies to ensure they are still not meeting water quality standards. This may occur if water quality standards are changed or if the basis for the original listing is based on best professional judgment or questionable data. Second is the collection of data and the development of TMDLs for priority TMDL listed waterbodies. The third component involves the development of appropriate, scientifically defensible water quality targets or criteria that are linked to beneficial use attainment and that can be used in the development of TMDLs or for the assessment of waterbodies for TMDL listing.

2. Monitoring Design

Because each TMDL development project or impaired waterbody assessment is waterbody and pollutant specific, the design of each monitoring project depends on the issue or question to be answered. Categories of monitoring projects with the Impaired Waterbody Monitoring, Assessment and TMDL Development Program include:

- Confirm impairment – For some waterbody/pollutant combinations listed on the Section 303(d) list it may be necessary to confirm that an impairment does or does not exist. For example, some waterbodies may have been originally listed based on best professional judgement which is based on land use conditions in the waterbody's watershed, or the listing may be based on data that is now quite dated. As a result, it may be appropriate to conduct additional monitoring to confirm that an impairment still exists. In this situation monitoring should be consistent with the Department's Beneficial Use Assessment Methodology (NDDoH 2008).

- Water Quality Targets - Water quality targets are quantified endpoints or criteria that can be used to measure or assess achievement of applicable water quality standards. In many cases the TMDL is based on a pollutant with specific numeric limits defined in state water quality standards, however, for pollutants that are based on narrative standards (e.g., sediment, nutrients, biological assessments), the narrative standard must be translated to a measurable value. Current activities that involve the development of water quality targets include: 1) the development of

nutrient criteria for lakes, reservoirs, rivers, and streams; and 2) the development of suspended sediment targets for rivers and streams.

- Source identification – Monitoring to identify the source or sources of the pollutant causing an impairment is generally required for TMDL development. In addition to identifying the spatial extent of pollutant sources, the relative contribution from multiple sources is necessary for source allocation once the TMDL has been established.

- Modeling – For many TMDL development projects, modeling is employed. Models vary in complexity and in their application. Some models (e.g., SWIMM, AnnAGNPS, SWAT) are used to identify pollutant sources in a watershed. Other models are used to assess water quality response (e.g., trophic status or dissolved oxygen concentration) due to various pollutant reduction (e.g., nutrient or BOD load reduction) scenarios.

- Effectiveness monitoring – Once a TMDL is implemented, the effectiveness of the best management practices or other measures used to reduce the pollutant(s) must be determined. This monitoring design is used to determine if the water quality impairment has been addressed or may be used in an adaptive management context to trigger additional management actions to address the remaining sources.

3. Quality Assurance

Specific Quality Assurance Project Plans (QAPP) are developed for each activity or project within the Impaired Waterbody Monitoring, Assessment and TMDL Development Program in which environmental data are collected. Components of these QAPPs included: 1) a description of responsibilities; 2) detailed monitoring design, including sample variables; 3) standard operating procedures, including sample custody procedures; 4) procedures for annual field audits; 5) procedures for the collection and analysis of QA samples (e.g., independent lab verification, residue analysis); 6) procedures for equipment inspection and maintenance; 7) procedures for program assessment and corrective actions; and 8) data review, validation and verification requirements.

4. Core and Supplemental Indicators

As described earlier, the pollutant, water quality variable, and/or indicator selected for a monitoring project depends on the issue or question to be answered. For a lake or reservoir TMDL, the issue may be phosphorus loading and its response on chlorophyll-a concentration. For a river or stream, the issue may be the identification of bacteria sources impacting recreational use.

5. Data Management

All data generated by the Department for targeted monitoring, assessment or TMDL development projects are transmitted in hard copy or electronically to the Surface Water Quality Management Program where they are incorporated into SID by the database management coordinator. Field data (e.g., temperature, pH, dissolved oxygen and conductivity measurements) and sample custody information (e.g., station description, date and time collected and depth) are recorded on standardized forms and entered into SID by program personnel. All data entered into SID are transmitted electronically into EPA's STORET database.
All biological (i.e., macroinvertebrates, periphyton, and fish) and physical habitat data are entered into the SWQMP's Access based Ecological Data and Application System (EDAS). All data entered into SID and EDAS are transmitted electronically into EPA's STORET database.

6. Data Analysis and Assessment

Data collected for each monitoring activity or project are analyzed based on the data quality objectives described on each project specific QAPP. Data collected to confirm an impairment or to assess the effectiveness of TMDL implementation will be assessed based on the state's beneficial use assessment methodology (NDDoH 2008). Other data may be used to calibrate or validate a water quality model. In this case, the data must be analyzed in a manner that is consistent with the models output (e.g., average annual concentration or daily average concentration).

7. Reporting

Reports are prepared of each TMDL development project. These reports are sent out for public comment and are approved by EPA Region 8. Waterbody assessments to confirm an impairment or to evaluate the effectiveness of a TMDL implementation project are used to update the Assessment Database (ADB) and are reported through the biennial Section 303(d) list and Section 305(b) report.

8. Program Evaluation

Ultimately, the development and implementation of TMDLs consistent with the EPA's pace requirement will be the program's best measure of success. Targeted monitoring used to evaluate the effectiveness of TMDL implementation will also be a key means to evaluate the program.

9. Implementation Plan and Schedule

Impaired Waterbody Monitoring, Assessment, and TMDL Development Program monitoring activities can be categorized into four main areas, including:

- Impaired waterbody monitoring and assessment/impairment confirmation;
- TMDL indicator development;
- TMDL development; and
- TMDL implementation project effectiveness monitoring.

Implementation plans and schedules for each of these categories are detailed in the document entitled "Impaired Waterbody Monitoring, Assessment, and TMDL Development Strategy for North Dakota" (NDDoH 2009).

10. General Support and Infrastructure Planning

The responsibility for TMDL development in North Dakota lies primarily with the Department's Surface Water Quality Management Program. TMDL development staff are located in two regional field offices located in Fargo and Towner, North Dakota and in Bismarck. Additional technical support for TMDL development projects and overall program coordination are provided by Surface Water Quality Management Program staff located in Bismarck, North Dakota.

Historically, the technical and financial resources necessary to complete the state's TMDL development priorities have hampered the pace of TMDL development in the state. Recently, however, the state's TMDL program has seen an improvement in the financial resources available for TMDL development projects. While still significantly short of the funding necessary to meet the state's TMDL development schedule, the Department has identified additional grants and funding to complete TMDLs. These include Section 604(b) grants, Section 106 block grant funds, and Section 319 Nonpoint Source Pollution Management Program grants. Current program support and infrastructure as well as future program resource needs and priorities are provided in the in the document entitled "Impaired Waterbody Monitoring, Assessment, and TMDL Development Strategy for North Dakota" (NDDoH 2009).

I. Nonpoint Source Pollution Management Program Monitoring

The following is a brief summary of the monitoring and assessment program elements for Nonpoint Source Pollution Management Program Monitoring. A detailed description of the program elements is provided in the draft "North Dakota Nonpoint Source Pollution Management Program Plan" (NDDoH 2009).

1. Monitoring Objectives

Monitoring activities supported through the NPS Program can be segregated into one of two general categories: NPS Pollution Assessment or NPS Project Evaluation. Data collected through NPS pollution assessment activities provide the foundation to: 1) define watershed management needs; 2) set beneficial use

improvement goals; and 3) quantify pollutant reduction goals for the waterbody. This same assessment data is also used to update the Integrated Reports and/or develop TMDLs for 303(d) listed waterbodies within the assessed watershed.

Specific monitoring objectives for the NPS Program are as follows:

- To assess waterbodies with little or no water quality assessment information by identifying beneficial use impairments or threats to the waterbody and to determine the extent to which those threats or impairments are due to NPS pollution.

- To evaluate the effectiveness of implemented BMPs in meeting the NPS pollutant reduction goals specified in NPS implementation projects.

2. Monitoring Design

The design of all NPS Program monitoring efforts will be dependent on a number of factors including 1) watershed size; 2) waterbody type; 3) type of impaired beneficial uses; 4) NPS pollution sources and causes; 5) seasonal weather patterns; and 6) local land use practices. These same variables will also influence monitoring design considerations such as monitoring site locations, sampling frequencies, targeted parameters, and sampling methods. Given the diversity between watersheds, it is not feasible to have a set monitoring design for all NPS Program monitoring efforts. Instead, all factors that may influence a monitoring design are evaluated and addressed during the development of the site-specific quality assurance project plan (QAPP). The QAPP will describe the specific monitoring design and methods that will be used to ensure all data are representative of existing conditions within the targeted waterbody and its watershed.

3. Quality Assurance

A specific Quality Assurance Project Plan (QAPP) is developed for each activity or project within the NPS Pollution Management Program in which environmental data are collected. Components of these QAPPs included: 1) a description of responsibilities; 2) detailed monitoring design, including sample variables; 3) standard operating procedures, including sample custody procedures; 4) procedures for annual field audits; 5) procedures for the collection and analysis of QA samples (e.g., independent lab verification, residue analysis); 6) procedures for equipment inspection and maintenance; 7) procedures for program assessment and corrective actions; and 8) data review, validation and verification requirements.

4. Core and Supplemental Indicators

All NPS Program monitoring efforts are focused on the collection of data to determine existing beneficial use conditions as well as to identify the sources and causes of any pollutants impairing those uses. The QAPPs for these projects will

differ somewhat to account for variations in each watershed, however, in most cases, all QAPPs share the same basic core indicators (Table 32). In addition to the basic water quality parameters (e.g., nutrients, suspended sediment and field measurements for temperature and dissolved oxygen, most watershed assessment and implementation projects include stream macroinvertebrate sampling, a riparian/stream stability assessment, and the collection of landuse use variables. Mean daily flow is also collected at water quality sites so estimates of pollutant load or yield can be computed.

Table 32. Current (C) Core and Supplemental (S) Indicators Used in NPS Watershed Assessment and Implementation Projects in North Dakota.

Monitoring Program	Field Measurements	Water chemistry (ions and trace metals)	Water chemistry (nutrients)	Suspended Sediment	Pathogens	Chlorophyll-*a*	Macroinvertebrates	Periphyton	Phytoplankton	Fish	Landscape Characteristics	Physical Habitat/Stream Stability	Flow
NPS Pollution Management Program Monitoring Projects	S	S	C	C	C	C	C	S	S	S	C	C	C

5. Data Management

All data generated by the Department through monitoring conducted as part of the NPS Pollution Management Program are transmitted in hard copy or electronically to the Surface Water Quality Management Program where they are incorporated into SID by the database management coordinator. Field data (e.g., temperature, pH, dissolved oxygen and conductivity measurements) and sample custody information (e.g., station description, date and time collected and depth) are recorded on standardized forms and entered into SID by program personnel. All data entered into SID are transmitted electronically into the EPA's WQX/STORET data warehouse.

All biological (i.e., macroinvertebrates, periphyton, and fish) and physical habitat data are entered into the SWQMP's Access based Ecological Data and Application System (EDAS). All data entered into SID and EDAS are transmitted electronically into the EPA's WQX/STORET data warehouse.

6. Data Analysis and Assessment

Data interpretation is completed at the end of the projects and accomplished by Surface Water Quality Management Program staff. The specific methods used to interpret data will vary between projects and will be described in each QAPP. Some methods that may be used include descriptive statistics, Seasonal Kendall test, BATHTUB model, and FLUX model. Data collected to confirm an impairment or to assess the effectiveness of BMP implementation will be assessed

based on the state's beneficial use assessment methodology (NDDoH 2008).

The direct measurement of water quality trends and beneficial use improvements can be very challenging due to variables such as annual weather patterns and delayed responses to applied practices. This is particularly true for the first 5-7 years of a watershed project. For this period and for annual reporting purposes, several supplemental methods may also be used to estimate water quality and/or beneficial use improvements. Some of the supplemental data analysis and assessment methods or tools that may be employed include: 1) STEPL or AnnAGNPS models; 2) Animal Feedlot Runoff Risk Index Worksheet; 3) tracking the location and amount of applied BMP; and 4) photo monitoring. The specific data analysis and assessment approach will vary between projects and is dependent on the specific goals and objectives of the project.

7. Reporting

A minimum of two reports will be developed during the course of a local watershed project. The first report will be developed at the conclusion of the assessment phase and the second report will be completed upon conclusion of the implementation phase. Data collected during an assessment project will be summarized in a watershed-specific NPS Pollution Assessment Report. In addition, if there are 303(d) listed reaches within the project area, the assessment data will also be used to develop the appropriate TMDLs. Both reports will include the data interpretations needed to assist with the development of a watershed management plan that will address NPS pollutants impairing the beneficial uses of the assessed waterbody.

For implementation phase watershed projects, an end-of-project report will be developed to summarize all data collected during the project period. These final data summary reports will provide a comparative analysis of pre and post project conditions. The reports will focus on the relationship between water quality/beneficial use trends and documented land use changes in the watershed. The degree to which the project achieved its goals for beneficial use improvement and/or pollutant load reductions will also be discussed in the end-of-project report. The data summaries will be included in the comprehensive final project report entered in the Grants Reporting and Tracking System (GRTS).

8. Program Evaluation

Given the "local" focus of the NPS Program's monitoring strategy, the effectiveness of the Program's monitoring efforts will essentially be measured by the number of successful monitoring projects supported by the NPS Program. Success will be defined by the completion of all components of the local monitoring initiatives and development of the final data summary reports. Feedback from local project sponsors and staff will also provide a means for evaluating the effectiveness of the NPS Program's delivery system for technical and financial assistance. Monitoring associated with all locally sponsored NPS projects are evaluated on a yearly basis through the required annual project

reports.

In addition, the NPS Task Force reviews the NPS Pollution Management Program Plan, including its monitoring components every five years. These reviews focus on the monitoring outputs associated with the various goals and objectives identified in the current Management Plan. Feedback from this part of the review process is used to determine if the NPS Management Program Plan needs to be revised to address potential NPS pollution threats associated with new or changing resource management practices. While it is difficult to predict exactly what new NPS pollution threats or resource management issues may arise, it is very likely a majority of the state's future NPS pollution management efforts, including monitoring, will continue to be focused on agriculture. Current trends in the agricultural industry indicate future agricultural NPS pollution threats may be associated with larger farming operations, new crop rotations and types, tile drainage, expiration of CRP contracts, and/or concentrated livestock feeding areas. Non-agricultural resource concerns that may also be recognized as localized priorities include: 1) energy development; 2) management of small ranchettes; 3) saline soils; and 4) affects of the green ash borer on riparian forests. These issues will all require some form of monitoring to assess their impacts and/or to evaluate efforts to minimize their impacts.

9. Implementation Plans and Schedule

Support from local project sponsors (i.e., soil conservation districts and water resource boards) is the primary means through which NPS watershed projects (assessment and implementation) are implemented. Priority is given to Section 303(d) TMDL listed waterbodies. Each year 3-5 new watershed assessment projects are initiated. These projects are 2-3 years in length, therefore each year the Department is managing between 6 and 10 NPS monitoring and assessment projects.

In addition to watershed assessment monitoring projects, the Department also provides Section 319 funding to 4-5 watershed implementation/restoration projects each year. Each of these projects has a monitoring component. These projects are between 5 and 7 years in length, therefore during any given year the Department may be managing monitoring activities for over 20 projects.

Since the number of projects initiated and funded each year is largely limited by available Section 319 grant funds and access to local match, it is not expected that the number of projects will increase unless Section 319 program funding is increased.

10. General Support and Infrastructure Planning

The annual NPS Program Staffing and Support Workplan which is submitted to EPA Region 8 describes the roles and responsibilities of Department staff involved in the NPS Program. Under the workplan, approximately 4 FTE are dedicated to monitoring and assessment activities supported by the NPS Program.

Based on anticipated Section 319 NPS program funding, it is not expected that there will be any additional NPS Program monitoring and assessment workload in the future.

J. Other Monitoring and Assessment Related Activities

1. Support Projects and Special Studies

Support projects and special studies are activities that are conducted on an as-needed basis to provide data or information to either answer a specific question or to provide program support.

Special studies provide immediate and in-depth investigations of specific water quality problems or emerging issues and usually involve practical research. In conducting practical research, the Surface Water Quality Management Program may rely on its own staff or may contract with the USGS, academia or private consultants. Examples of special studies projects conducted by the Department include:

- $ Studies to develop nutrient criteria for streams and lakes.
- $ Time of travel studies, dispersion and reareation studies in support of water quality model development.
- $ The Lostwood National Wildlife Refuge wetland mercury assessment project.

Support projects are activities conducted or supported by the Department that result in products or tools that enhance overall program efficiency or lead to new assessment methods. Examples of support projects conducted or supported by the Department include:

- $ Studies to evaluate or compare monitoring methods.
- $ The watershed and sub-watershed delineation and digitization project.

2. Complaint Investigations

The primary objectives for the investigation of complaints are to determine: (1) whether or not an environmental or public health threat exists; and (2) the need for corrective action where problems are found. Since customer service is a primary focus of the Department, complaint response is a very high priority. When complaints are received by the Department, they may be handled by Department staff, including staff in other divisions of the Environmental Health Section, or forwarded to one of the local health districts located across the state. Once the complaint is routed to the appropriate state or local health district staff person, a field investigation is usually conducted. When problems are identified, voluntary correction is obtained in most cases, but necessary enforcement action can be take under the state water pollution laws (NDCC 61-28) and regulations or under other applicable state or federal laws.

3. Fish Kill Investigations

Fish mortalities can results from a variety of causes and sources, some natural in origin and some induced by man. It is recognized that speed is all-important in the initial phases of a fish kill investigation. Therefore, persons reporting a fish kill are encouraged to contact the Health Department or the North Dakota Game and Fish Department during normal working hours or Emergency Response through state radio. Once a fish kill is reported, staff from the Department's Surface Water Quality Management Program and/or North Dakota Game and Fish Department are dispatched to investigate. The objectives of the fish kill investigation are to: 1) determine the extent of the fish kill; and 2) the possible cause(s) of the fish kill. The extent of the investigation of a fish kill is dependent on the extent of the kill, the numbers and kinds of fish involved and the resources available at the time for the investigation. Following a decision to investigate, the investigation should continue until a cause is determined or until all known potential causes have been ruled out.

BIBLIOGRAPHY

Brooks, R.P., D.H. Wardrop, and J.A. Bishop. 2004. *Assessing Wetland Condition on a Watershed Basis in the Mid-Atlantic Region Using Synoptic Land-Cover Maps*. Environmental Monitoring and Assessment 94: 9-22.

Carlson, R.E. 1997. *A Trophic Status Index for Lakes.* Limnology and Oceanography, Vol. 22 (Issue 2), pp. 361-364.

Collins, J.N., E.D. Stein, M. Sutula, R. Clark, A.E. Fetscher, L. Grenier, C. Grosso, and A. Wiskind. 2008. *California Rapid Assessment Method (CRAM) for Wetlands*. Version 5.0.2. 151 pp.

DeKeyser, E.S. 2000. *A Vegetative Classification of Seasonal and Temporary Wetlands Across a Disturbance Gradient Using a Multimetric Approach*. Ph.D. Dissertation. North Dakota State University, Fargo, ND.

DeKeyser, E.S., D.R. Kirby, and M.J. Ell. 2003. *An Index of Plant Community Integrity: Development of the Methodology for Assessing Prairie Wetland Plant Communities.* Ecological Indicators 3:119-133.

Dekeyser, E.S., C. Hargiss, and M.J. Ell. 2008. *Quality Assurance Project Plan for Defining and Locating Reference Condition Wetlands in Unique Ecosystems of North Dakota.* North Dakota Department of Health, Bismarck, North Dakota

Gilbert, M.C., P.M. Whited, E.J. Clairain, Jr., and R.D. Smith. 2006. *A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Prairie Potholes*. US Army Corps of Engineers. Omaha, NE. 114 pp. + app.

Karr, J.R., and E.W. Chu. 1997. *Biological Monitoring and Assessment: Using Multimetric Indexes Effectively.* EPA 235-R97-001. University of Washington, Seattle.

Kirby, D.R. and E.S. DeKeyser. 2003. *Index of Wetland Biological Integrity Development and Assessment of Semi-Permanent Wetlands in the Missouri Coteau Region of North Dakota.* Final Report for the North Dakota Department of Health. Section 104[b](3) Wetland Grant funds. North Dakota State University, Department of Soil Sciences, Fargo, North Dakota.

EPA. March 2001, Reissue May 2006. *EPA Requirements for Quality Assurance Project Plans* (QA/R5). EPA/240/B-01/003. U.S. Environmental Protection Agency, Office of Environmental Information Quality, Washington, D.C.

EPA. March 2003. *Elements of a State Water Monitoring and Assessment Program.* EPA 841-B-03-003. Assessment and Watershed Protection Division, Office of Wetlands, Oceans and Watersheds, Washington, D.C.

EPA. 2005. *Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act*, July 29, 2005. Watershed Branch, Assessment and Watershed Protection Division, Office of Wetlands, Oceans, and Watersheds, Office of Water, United States Environmental Protection Agency, Washington, D.C.

EPA. 2006. *Application of Elements of a State Water Monitoring and Assessment Program for Wetlands.* U.S. EPA Wetlands Division. Office of Wetlands, Oceans and Watersheds. URL http://www.epa.gov/owow/wetlands/monitor/.

EPA. 2007. *Survey of the Nation's Lakes. Field Operations Manual*. EPA 841-B-07-004. U.S. Environmental Protection Agency, Washington, DC.

Galatowitsch, S.M., D.C. Whited, R. Lehtenin, J. Husveth, and K. Schik. 2000. *The Vegetation of Wet Meadows in Relation to Their Land-Use.* Environmental Monitoring and Assessment 60:121–144.

Hargiss, C.L.M. 2005. *An IPCI for Wetland Plant Communities*. Masters of Science Thesis. North Dakota State University, Fargo, ND.

Hargiss, C.L.M. 2009. *Estimating Wetland Quality for the Missouri Coteau Ecoregion in North Dakota.* Doctor of Philosophy Dissertation. North Dakota State University, Fargo, ND.

Hargiss, C.L.M., E.S. DeKeyser, D.R. Kirby, and M.J. Ell. 2008. *Regional Assessment of Wetland Plant Communities Using the Index of Plant Community Integrity*. Ecological Indicators 8:303-307.

Hayashi, M., G. van der Kamp, D.L. Rudolph. 1998. *Water and Solute Transfer Between a Prairie Wetland and Adjacent Uplands: Water Balance*. Journal of Hydrology 207(1-2):42-55.

Kentula, M. 2007. *Monitoring Wetlands at the Watershed Scale*. Wetlands 27:312-413.

Mack, J.J. 2001. *Ohio Rapid Assessment Method for Wetlands Manual*. Ohio EPA Technical Bulletin Wetland/2001-1-1. Ohio Environmental Protection Agency, Division of Surface Water, 401 Wetland Ecology Unit, Columbus, Ohio.

Mita, D., D. Kirby and E.S. DeKeyser. 2007. *Developing a Wetland Condition Prediction Model Using Landscape Structure Variability*. Wetlands 27:1124-1133.

NDCC 61-28-04. North Dakota Century Code, Chapter 61-28, Control, Prevention, and Abatement of Pollution of Surface Waters.

NDDoH. 1993. *Strategy and Workplan for Water Quality Standards Development in North Dakota*. North Dakota Department of Health, Division of Water Quality, Bismarck, N.D.

NDDoH. 2004. *North Dakota 2004 Integrated Section 305(b) Water Quality Assessment Report and Section 303(d) List of Waters Needing Total Maximum Daily Loads.* North Dakota Department of Health, Division of Water Quality, Bismarck, N.D.

NDDoH. 2006. *Standards of Quality for Waters of the State.* North Dakota Century Code 33-16-02.1. North Dakota Department of Health, Bismarck, ND.

NDDoH. 2007. *Water Quality Assessment Methodology for North Dakota's Surface Waters.* North Dakota Department of Health, Bismarck, ND.

NDDoH. 2008. *North Dakota 2008 Integrated Section 305(b) Water Quality Assessment Report and Section 303(d) List of Waters Needing Total Maximum Daily Loads.* North Dakota Department of Health, Division of Water Quality, Bismarck, North Dakota.

NDDoH. 2009. *Quality Assurance Project Plan for the Ecoregion Reference Network Monitoring Program* (draft). North Dakota Department of Health, Division of Water Quality, Bismarck, North Dakota.

NDDoH. 2009. *Impaired Waterbody Monitoring, Assessment, and TMDL Development Strategy for North Dakota (draft outline).* North Dakota Department of Health, Division of Water Quality, Bismarck, N.D..

NDDoH/EHS. August 2008, *Quality Management Plan for the Environmental Health Section (*Revision 6). Environmental Health Section, North Dakota Department of Health, Bismarck, N.D.

Paradeis, B. 2008. *Plant Community Composition of Wetlands Located on Restored and Native Prairie.* Masters Thesis, North Dakota State University.

Peterson, S.A., N.V.C. Ralston, D.V. Peck, J. Van Sickle, J.D. Robertson, V.L. Spate, and J. S. Morris. 2009. *How Might Selenium Moderate the Toxic Effect of Mercury in Stream Fish of the Western U.S.?* Environmental Science and Technology, Vol. 43, No. 10, pp. 3919-3925.

Phillips, R.L., O. Beeri, and E.S. DeKeyser. 2005. *Remote Wetland Assessment for Missouri Coteau Prairie Glacial Basins.* Wetlands 25:335-339.

Ralston, N.V.C. 2008. *Selenium Health Benefit Values as Seafood Safety Criteria.* EcoHealth, 5, pp.442-455.

Smith, B., R.L. Phillips, and O. Beeri. 2008. *Remote Integrated Assessment and Monitoring for North Dakota Agricultural Wetlands.* Final Report for the North Dakota Department of Health. Section 104[b](3) Wetland Grant funds. University of North Dakota John D. Odegard School of Aerospace Sciences, Grand Forks, North Dakota.

Stevens, D.L and S.F. Jensen. 2007. *Sample Design, Execution, and Analysis for Wetland Assessment.* Wetlands 27:515-523.

Tiner, R. W. 1999. *Wetland Indicators: A Guide to Wetland Identification, Delineation, Classification, and Mapping.* Lewis Publishers, CRC Press, Boca Raton, FL.

Wardrop, D.H., M.E. Kentula, S.F. Jensen, D.L. Stevens, Jr., K.C. Hychka, and R.P. Brooks. 2007. *Assessment of Wetlands in the Upper Juniata Watershed in Pennsylvania, USA, Using the HydrogeomorphicAapproach.* Wetlands 27:432-445.