Appendix 1. QAPP for Wisconsin Great Lakes Beach Monitoring Program

Wisconsin Great Lakes Beach Monitoring Program Quality Assurance Project Plan

DNR PUB-WT-840

Wisconsin Department of Natural Resources
Bureau of Watershed Management

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Approval Sheet

Wisconsin Department of Natural Resources

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EXECUTIVE SUMMARY

Wisconsin recreational waters are vital to our individual well-being and our local and state economies. Lake Michigan and Lake Superior have afforded the state of Wisconsin valuable natural resources for aquatic recreational activities. There are important social and economic benefits to providing safe and healthy aquatic recreational activities to the public.

This is a Quality Assurance Project Plan for the Wisconsin Beach Program. Water Quality Standards staff, the local health departments and a BEACH Act Workgroup have developed a comprehensive beach monitoring program to monitor public beaches for *E.coli* along the Lake Michigan and Lake Superior coastlines. This program supports beach monitoring and notification for the following counties: Douglas, Bayfield, Ashland, Iron, Door, Brown, Kewaunee, Manitowoc, Sheboygan, Ozaukee, Milwaukee, Kenosha, and Racine. The coastal beach monitoring program was developed to meet requirements in the federal Beaches Environmental Assessment & Coastal Health (BEACH) Act of 2000. Since 2003, monitoring and notification processes have been carried out by participating local health departments. Wisconsin was the first state in the nation to fully implement a beach monitoring program in accordance with federal program criteria and has been held up by the U.S. Environmental Protection Agency as a model for other states.

A. PROGRAM ORGANIZATION

The Wisconsin Beach Monitoring Project is staffed by the following positions:

Beach Program Manager	Toni Glymph
Beach Program Coordinator	Nicole Richmond
Water Quality Standards Section Chief	Bob Masnado

Beach Act Workgroup:	
City of Racine Health Department	Julie Kinzelman
City of Milwaukee Health Department	Mary Ellen Bruesch
DNR Bureau of Parks	Bruce Chevis
Keep Our Beaches Open (KOBO)	David White
Kenosha County Division of Health	Dorene Leinenweber
Madison Public Health Department	Kirsti Sorsa
Milwaukee Metropolitan Sewerage District	Jeffrey MacDonald
Ozaukee County Land & Water Conservation	Andrew Struck
Ozaukee County Public Health Department	Dan Ziegler
UW Milwaukee Water Institute	Dr. Sandra McLellan
WI Department of Health & Family Services	Michelle Simone
WI State Laboratory of Hygiene	Jon Standridge

Water Quality Standards Section Chief, Bureau of Watershed Management serves as a Supervisor responsible for oversight and evaluation activities to ensure project implementation.

"Water Quality Standards Specialist" serves as Project Manager, responsible for project implementation, data evaluation, public notification and the overall supervision of the Beach Program Coordinator. She assures that the project proceeds in compliance with grant requirements. She is responsible for ensuring that technical and scheduling objectives as specified in the QAPP are achieved successfully and for maintaining the official, approved QA Project Plan.

“Beach Program Coordinator” supports the Project Manager and is as a liaison between the USEPA and the local public health departments. She is responsible for contractual agreements for funding, data evaluation, conducting social surveys, organizing meetings and assisting with report writing.

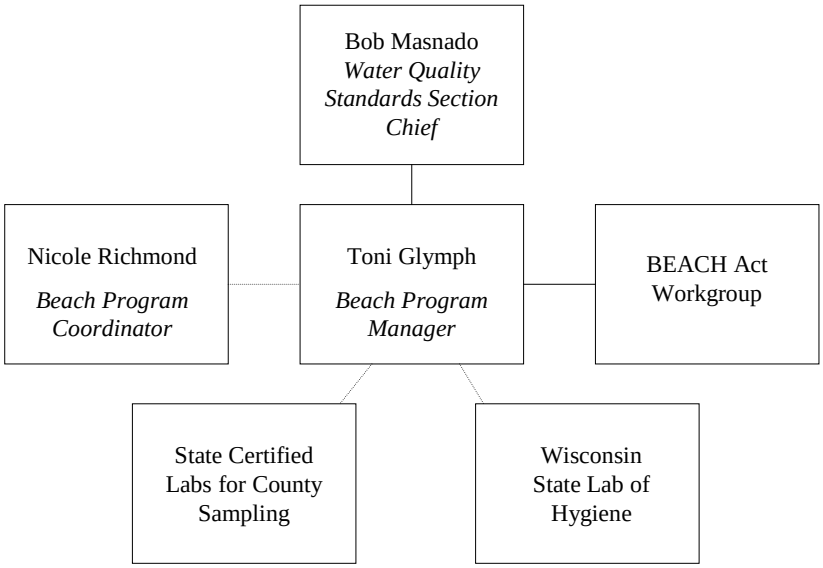
The "BEACH Act Workgroup" is composed of representatives of local and state public health departments located along the Great Lakes. This workgroup assisted in the development of a State-wide beach monitoring and public notification plan.

Local health departments use their own labs to conduct water testing. The labs are required to conduct testing based on current best practices, and have agreed to deliver results within 24 to 48 hours after sample submission.

Table 1 – Lab Analysis and Beaches Monitored

Lab To Analyze Samples	Beaches Monitored
Brown County Health Department	Bayshore Park, Communiversity Park, Longtail
Douglas County Department of Health	Allouez Bay, Amnicon River, Barker's Island Inner, Brule River State Forest, Middle River, Wisconsin Point
Kenosha County Division of Health	Eichelman, Simmons, Alford Park, Pennoyer, Southport
Manitowoc County Health Department	Hika Park Bay, Memorial Drive Wayside, Neshotah, Point Beach State Forest, Fischer Park, Red Arrow Park, YMCA
City of Milwaukee Health Department	Bradford, McKinley, South Shore, Watercraft
North Shore Health Department	Tietjen/Doctor's Park
Ozaukee County Health Department	Cedar Beach Road, County Road D Boat Launch, Harrington Beach State Park, Upper Lake Park
Racine Health Department	North, Zoo
Sheboygan Health and Human Services	Kohler Andrae State Park, Blue Harbor, Deland, King Park, Amsterdam, Foster, KK Road, Van Ess Road
South Milwaukee Health Department	Bayview Park, Bender, Grant Park
UW-Lab at Crossroads at Big Creek (UW-Oshkosh)	(Door County Beaches see below)
Door County	Baileys Harbor, Egg Harbor, Ellison Bay Town Park,Ephraim, Murphy Park, Newport Bay, Fish Creek, Nicolet Bay, Otumba Park, Sister Bay, Sunset, Whitefish Dunes, Anclam Park, Europe Bay Beach, Jackson Harbor Ridges, Lakeside Park, Percy Johnson, Portage Park, Sand Dune, Sandy Bay, School House, Sturgeon Bay Canal, Gislason, Haines Park, Rock Island State Park, Whitefish Bay Boat Launch
Kewaunee	City of Kewaunee, Crescent
UW-Lab at Northland College (UW-Oshkosh)	(Ashland, Bayfield, and Iron Beaches see below)
Ashland	Bayview Park, Big Bay State Park, Big Bay Town Park, Casper Road Kreher Park, LaPoint Memorial, Maslowski
Bayfield	Bark Bay, Bono Creek, Broad Street, Herbster, Memorial-Bayfield, Memorial Park-Washburn, Port Wing East, Port Wing West, Sioux River North, Sioux River South, Siskiwit Bay, Thompson West End Park, Washburn Marina, Wash Walking Trail/BAB, Washington Ave., Wikdal Memorial Boat Launch
Iron	Oronto Bay, Saxon Harbor East, Saxon Harbor West
Village of Shorewood Health Department	Atwater Park, Klode Park

Organizational Chart



Principal Data Users

- Wisconsin Department of Natural Resources
- Local Health Departments
- Beach Managers
- Bureau of Parks
- Administrator, USEPA
- Local Health Department Laboratories

1. Background

Wisconsin's Beach Program is a coastal beach water quality monitoring program. The program was developed to address health risks to beach users by the Wisconsin DNR, the BEACH Workgroup, and state and local health officials. The Lake Michigan and Lake Superior shorelines are lined with 192 public beaches. These beaches are visited by thousands of people each year. Much of the state's beach water is subject to contamination from sources such as storm sewers, wastewater treatment discharges, combined sewer overflows, agricultural runoff, wildlife wastes and adverse weather. This contaminated water is a potential cause of gastrointestinal illness and other diseases.

2. Program Objectives

The overall objective of this program is to maintain a comprehensive beach monitoring and public notification plan for beaches adjacent to Lake Michigan and Lake Superior.

In accordance with BEACH Act performance criteria, objectives include:

(1) A risk-based beach evaluation and classification process
(2) A sampling design and monitoring implementation plan
(3) A process for monitoring report submission and delegation
(4) Assessment methods and procedures
(5) Public notification and risk communication plans
(6) Measures to notify EPA and local governments of human health risks
(7) A process for notification report submission and delegation
(8) Surveys for public evaluation have been developed

3. Overall Program/Task Descriptions

Program Objective (1) - Risk-Based Beach Evaluation and Classification

According to the BEACH Act, "coastal recreation waters" are defined as the Great Lakes and marine coastal waters (including coastal estuaries) designated under CWA section 303(c) by a state for use for swimming, bathing, surfing, or similar water contact activities. "Coastal recreation waters" do not include either inland waters or waters upstream of the mouth of a river or stream that has an unimpaired natural connection with the open sea. Wisconsin Administrative Code, Chapter NR 104 designates Lake Michigan and Lake Superior for recreational use.

Approximately 55 miles of public beach miles and a total of 192 coastal beaches have been identified along Lake Michigan and Superior. The definition of "beach" for the purpose of Wisconsin BEACH Act implementation is:

"A publicly owned shoreline or land area, not contained in a man-made structure, located on the shore of Lake Michigan or Lake Superior, that is used for swimming, recreational bathing or other water contact recreational activity."

The coastal beaches were geo-located using GPS technologies and maps were created for each county identifying all beaches. Each beach was evaluated using the Beach Evaluation and Classification Checklist (Appendix A). Additional GPS data layers were added to include the location of all wastewater treatment outfalls along with their proximity to the beaches. Additional information was collected for each beach for evaluation: the potential for impacts from storm water runoff, bather and waterfowl loads, and the location of outfalls and farms. This information was used to rank and classify beaches as "high," "medium," or "low" priority.

Program Objective (2) - Sampling Design and Monitoring Implementation Plan

The overall purpose in monitoring beaches is to collect data that can be used in decision-making processes that protect the health of swimmers. The intent of the Wisconsin program is to require enough monitoring to make good decision without burdening the beach facilities responsible for beach monitoring with unnecessary cost and effort.

The tiered monitoring plan describes the monitoring requirements for *High*, *Medium* and *Low* priority beaches. It also addresses when basic sampling should be conducted, when additional samples should be collected and where and how to collect samples.

Table 2 - Priority Beaches and Sampling Requirements

High Priority Beaches

Basic Sampling	***Additional Sampling***	***Where to Sample***	***Depth to Sample***
Begin sampling at least one week prior to the swimming season Sample at least ***4 times*** per week during the swimming season	After heavy rainfall (generally ¼ to ½ inch- depending on local conditions) After a major pollution event where potential exists that indicator levels may be expected to exceed standard (sewage leak, spill) Immediately following the exceedance of the water quality standards	*Depends on characteristics of the beach* Middle of typical bathing area For longer beaches, one sample for every 500m of beach	Knee depth Where 24-30 inch depth is first encountered, take sample 6-12 inches below surface of water Other as you feel is necessary for your beach *(e.g., surface of water, waist depth, sediment)*

Medium Priority Beaches

Basic Sampling	***Additional Sampling***	***Where to Sample***	***Depth to Sample***
Begin sampling at least one week prior to the swimming season Sample at least ***2 times*** per week during the swimming season	After heavy rainfall (generally ¼ to ½ inch- depending on local conditions) After a major pollution event where potential exists that indicator levels may be expected to exceed standard (sewage leak, spill) Immediately following the exceedance of the water quality standards	*Depends on characteristics of your beach* Middle of typical bathing area For longer beaches, one sample for every 500m of beach	Knee depth Where 24-30 inch depth is first encountered, take sample 6-12 inches below surface of water

Low Priority Beaches

Basic Sampling	***Additional Sampling***	***Where to Sample***	***Depth to Sample***
Begin sampling at least one week prior to the swimming season Sampling frequency at low priority beaches should be determined by state and local authorities, taking into account resource constraints and evaluation of risk factors at individual beaches.	After a major pollution event where potential exists that indicator levels may be expected to exceed standard (sewage leak, spill) Immediately following the exceedance of the water quality standards	*Depends on characteristics of your beach* Middle of typical bathing area	Knee depth Where 24-30 inch depth is first encountered, take sample 6-12 inches below surface of water.

Program Objective (3) - Monitoring Report Submission & Delegation

A process is developed to compile and report beach water quality data in timely reports that describe any delegation of monitoring and notification responsibilities that may be made to local governments.

a) Delegation
The WDNR coordinates with local governments and delegates, as appropriate, responsibilities for monitoring programs to local governments. Local citizens and officials are more familiar with local problems, needs, and are in a better position to address local issues and formulate solutions.

b) Report Submission
Monitoring data will be updated to the public, EPA, and other agencies in a timely manner along with the actions taken to notify the public when water quality standards are exceeded.

Program Objective (4) - Methods Assessment & Procedures

To assure consistency in collecting samples for analysis, the following procedures will be used:

1) Specific sites will be designated for collecting samples during the bathing season. Samples will be collected exclusively at these sites for the duration of the sampling period.
2) Sample bottles will be prepared and provided by the laboratories charged with conducting bacteria analyses.

See Appendix E for Wisconsin's Beach Monitoring Sampling Protocol.

The data will be verified through a systematic process to determine if the data has been collected in accordance with the specification with respect to compliance with established standards and the QAPP, precision, accuracy, consistency, and completeness. We will assess whether the data quality objectives of this project have been met. Once the data have been confirmed to meet the standards, they are systematically examined to determine their technical usability with respect to the planned objectives. The data is assessed to determine whether they are of the right type, quality, and quantity to support the intended use.

Program Objective (5) - Public Notification and Risk Communication

A public notification and risk communication plan was developed and standard advisory signs were designed based on feedback from a beach user survey in 2002 and public meetings held around the state. The Beach Health Website formerly designed and used by the Southeast Taskforce for beaches in Milwaukee, Racine and Kenosha was expanded to include all public beaches monitored under the BEACH Act program. The website and data management is contracted through the United States Geological Survey (USGS). Local citizens can log onto the website www.wibeaches.us to look at current conditions of their beach. In addition, they may get emails of updated the beach status of their choice. Beach surveys have been conducted in 2002 and 2005 to receive public perceptions and input for the Beach monitoring program in Wisconsin (Appendices B and C).

Program Objectives (6) & (7) - Measures to Notify EPA and Local Governments

Wisconsin has measures for prompt communication of any occurrence, nature, location, pollutants involved, and the extent of any exceeding of, likelihood of exceeding, applicable water quality standards for pathogens and pathogen indications. Communication openly exists between state officials, the EPA and to a designated official of the local health departments having jurisdiction over the beach.

Program Objective (8) – Process for Public Evaluation

Social surveys were developed in 2002 to interview the public at beaches to gather input for the BEACH program (see Appendix B). In 2005, a similar survey was conducted at beaches throughout Wisconsin to see the

effectiveness of Wisconsin's Beach Programs (see Appendix C). Social surveys and public meetings will be held in the future to give the public the opportunity to provide feedback for Wisconsin's Beach Monitoring Program.

4. Schedule

The official beach season is defined for Wisconsin coastal beaches as Memorial Day Weekend through Labor Day Weekend. At some coastal beaches in Wisconsin, swimming may not begin until mid-June due to colder water temperatures. Where weather and swimming history indicate this to be the case, initial sampling associated with this program was reduced or delayed to occur when swimming occurs, but began no later than June 15. Frequency of sampling is dependant on the ranked priority of each beach (See Table on previous page).

5. Personnel, Special Equipment or Supplies

Personnel: BEACH Act Coordinator supports the Project Manager and is as a liaison between the USEPA and the local public health departments. She is responsible for contractual agreements for funding, data evaluation, conducting social surveys, organizing meetings and assisting with report writing.

6. Special Training Requirements or Certifications

Samples will be collected by State Registered Sanitarians, Public Health Nurses, and Interns under the direction of Sanitarians and/or City Parks personnel trained on proper field sampling technique

Sample analyses will be performed by certified laboratory personnel, trained and experienced in current laboratory procedures for bacteria analysis. Laboratories certified by the Wisconsin Department of Agriculture Trade and Consumer Protection will perform all testing.

Sample result evaluation and analysis, notification of results to project participants and the public, as well as any accompanying recommendations, are under the direct supervision of the Project Manager.

7. Documentation and Records

Records generated during the project include:

- Documentation regarding agreements, negotiations, and expectations.
- An annual comprehensive report will be prepared for submission to the Water Division Administrator, the Director of the Bureau of Watershed Management and the USEPA Administrator.

a) Field Records

A Beach Evaluation & Classification Checklist – was completed by field staff evaluating available information, pollution threats, sanitary surveys, and exposure considerations. All field information was recorded on individual checklist forms for each beach (Appendix A). All beaches were geo-located and mapped. Maps are now available online at www.dnr.wi.gov. and www.wibeaches.us . Hard copies of each file and other relevant field data, including notebooks, maps, drawings, photographs, and communication records are stored at the office.

b) Laboratory Records

Laboratory data form are to be completed initially by the sample collector at the time the sample is collected; followed by the laboratory sample receipt person and analyst when the sample is received, tested, and results are determined. The laboratory data form allows collection of information including, but not limited to, the name of beach, body of water, sampling point, date/time of collection, water and weather conditions, as well as name of laboratory, dates and times of testing, and final results. The laboratory data form serves as a Chain-of-Custody record for each sample collected and analyzed. The laboratory maintains control of other relevant laboratory records including logs, bench sheets, and raw analytical and QA/QC data. All data that is collected is entered into the database and historical data can be found at www.wibeaches.us.

c) Standard Operating Procedures

A Sampling Protocol Requirements Page has been created to accompany all local health department grants (See Appendix E). Health departments are required to comply with sampling requirements in order to receive funding for beach monitoring.

d) Staffing and Training
The personnel responsible for sample collection and environmental measurements at the beaches, as well as those performing the bacterial indicator analyses, are trained for those activities. Training is ongoing and documented.

Storage, access to, and final disposition of all records are subject to the requirements of the State of Wisconsin.

B. DATA QUALITY OBJECTIVES

1. The Decision

a) Determine when and if recreational use of a swimming area poses a health risk to users.
b) Determine the most efficient methods of communication risks to users.

2. Inputs to the Decisions

The following informational inputs resolve the decision statements presented in B1 and B2:

a) Conditions under which elevated levels of bacteria occur - This data is gathered by sampling beach water, assessing potential sources of fecal contamination and reviewing bacteria levels during significant storm events and pollution discharge events.

b) Frequency and Type of Recreational Use - Field staff determined bather load and types of use by visiting beaches, taking actual counts and observing activities. They solicited information from beach staff on average bather loads, and peak periods of use.

c) Potential Sources of Contamination – Field staff reviewed available information about each beach and conducted site visits to identify potential sources of contamination.

d) Evaluation of Current Methods of Risk Communication – This information was collected via a random survey of beach users to assess the effectiveness of current communication methods. In addition, field staff investigated how other states and beach communities inform the public of the risks of exposure to pathogenic bacteria.

e) Assessment of Population Demographics - Data describing the demographics of beach visitors was gathered using several different sources through a sociological process known as "triangulation." By obtaining data from several sources, accuracy can be improved by comparing reports from one source against another.

- Data was collected directly through a social survey of beach visitors. This provided information about the characteristics of the visitors (See Appendix B for a sample survey).

- Field staff contacted local community representatives to learn more about the ethnicity of the area. Such interviews helped show what groups are present, and if/how they use the beaches. Similarly, the administrative authority for each beach was contacted to obtain information on what people groups use the beach.

- Staff viewed census data from the US Census for information about the characteristics of the community in which the beach is located.

All three of these methods -- on-beach surveys, interviews with community representatives and beach administrators, and the use of census data -- bring perspectives on who uses the beaches and why. In particular, the on-beach surveys added the most important information. The community leaders and census data describe only the demographics of the local beach visitors, while on-beach surveys provide more information about tourists who come from outside the community.

f) The Effectiveness of Current Notification Procedures - Field staff interviewed beach users to determine the effectiveness of current beach warning and posting procedures and obtained suggestions for improving risk notification to beach users.

g) Regulatory Standards - If fecal contamination indicators exceed the acceptable levels as determined by statistical analysis, an advisory (Appendix D) against recreational use of the beach will be posted. Acceptable levels are as follows in Table 3:

Table 3 – Regulatory Standards

Pathogen Indicator	Geometric Mean cfu/100mL	Single Sample Maximum cfu/100mL	Beach Closure cfu/100mL
E.coli	**126**	**235**	**>1000**

3. Study Boundaries

All beach water sampling evaluations and assessments were conducted on public coastal beaches located along Lake Michigan and Lake Superior. Data is collected from the specific beaches during the beach season, which runs for approximately 14 weeks from Memorial Day to Labor Day. The test of choice for determining fecal contamination is *E. coli*.

4. Decision Rules

a) The single sample maximum shall not exceed 235 cfu/100mL for *E. col.*

b) The geometric mean of 5 most recent samples collected during a 30-day period shall not exceed 126 cfu/100mL for *E. coli*.

c) Beach closures will result when single sample results exceed 1000 cfu/100mL for *E.coli.*

d) Beach advisory signs will be posted and removed based on indicator data and the output of the predictive model selected.

5. Limits on Decision Errors

The geometric mean value specified in Table 3 is based on specific levels of risk of acute gastrointestinal illness of no more than 8 illnesses per 1000 swimmers. EPA has determined that when this water quality criterion is implemented in a conservative manner, it is protective for the prevention of a gastrointestinal illness resulting from primary contact recreation. Only clear, accurate, results will be used to calculate the geometric mean. Uncertain results, missing results due, for example, to collector or laboratory accident will not be used in the calculation.

The use of the single sample maximum is important because it is assumed that environmental conditions such as rainfall, wind, currents and temperature, vary temporally and spatially. The single sample maximum, also specified in Table 3, is based on specific levels of risk of acute gastrointestinal illness of no more than 8 illnesses per 1,000 swimmers. If a sample result exceeds the established maximum (235 cfu/100mL), an advisory against recreational use will be posted at points of access at the beach. If a sample result exceeds the closure level (>1000cfu/100mL), a closure sign will be posted at points of access at the

beach. Sampling is required within 24 hours of an exceedance. Advisories and closures can be removed when bacteria counts return to acceptable levels.

Selection of the appropriate predictive model is critical to the beach-monitoring program. The decision errors for the model will drive the model selection. Once the appropriate model is selected, beach advisories will be based on the output of the predictive model because correlation with bacteria data will not be known until 24 to 48 hours after the water sample has been collected.

6. Design Optimization

a) The use of the Beach Evaluation and Classification Checklist to classify and rank beaches for establishing a monitoring frequency resulted in an adequate level of testing to protect the public.

b) The evaluation of data from other past and present monitoring efforts that have similar sampling and analytical protocols have assisted in our effort to assess short-term trends due to storm events.

C. MEASUREMENT/DATA ACQUISITION

1. Process Design

Objective (a) – Identification of public bathing beaches adjacent to Lake Michigan and Lake Superior

The first step in the beach evaluation and classification process was to identify and locate the beaches along Lakes Michigan and Superior. Once the beaches were identified and evaluated, the information was used to classify each beach into a priority category of High, Medium, or Low. This classification was used to direct resources toward monitoring and notification programs at the beach.

a) Geo-locational data - All currently used public beaches along Lakes Michigan and Superior was identified, and located via the use of GPS and GIS technologies. All available Digital OrthoPhotos and Digital Raster Graphics were viewed to see if a beach showed up clearly and could be digitized on screen using ArcView 3.2. If the beach could not be delineated on screen then a site visit was made and coordinates were collected using a Trimble ProXR GPS unit. The Trimble ProXR GPS unit collected locational data in the Wisconsin Transverse Mercator (WTM) format with sub-meter accuracy. The data was stored in the datalogger and downloaded into the computer using the Pathfinder software. Once a beach polygon layer had been created, it was used to create a second layer by converting the polygons to polylines. The line layer was edited so that a single line represented the length of each beach. Attributes such as beach name and measured length were tied to each line feature. A map of each monitored beach was developed indicating the adjacent coastal recreation waters, points of access by the public, length of beach, as well as any known potential sources of pollution.

Quality Control

The TSC1 datalogger acts as the controlling software by communicating with the GPS receiver to set specific GPS parameters required for optimal accuracy. Data validity is determined by the number of satellites. If there are too few satellites, a warning tone sounds to identify the data. The same validity checks are built into the Pathfinder software. Any data collected by too few satellites was identified and eliminated through this software.

Objective (b) - Beach Evaluation and Classification Plan

Each beach was evaluated using a Beach Evaluation Checklist (Appendix A). The checklist provided a list of factors that were used to rank and classify the beaches. The list included: available information, pollution threats, sanitary surveys, exposure considerations and monitoring data. Along with geo-locational

data, field staff collected beach characteristic data, environmental condition data and beach informational data.

a) Beach Characteristic Data – The following characteristics of each beach were visually observed and recorded on the Beach Assessment Checklist by the field staff:

- Type of terrain within 5 miles of the beach
- Number of point source discharges (outfalls, drainage pipes etc.)
- Any known point and non-point sources of pollution (CSOs, SSOs, etc.) near sample locations were indicated on laboratory sample data forms and beach maps
- Land use (farms, animals, houses, marinas, industry, restrooms, parking lots)
- Beach populations (bathers in/out of water, waterfowl, sand sports, water sports

b) Environmental Conditions - The following WEB sites were used to view real-time and historical weather conditions, wind speed & direction, water temperature and wave height:

- http://www.aos.wisc.edu/~sco/
- http://www.coastwatch.msu.edu/twomichigans.html
- http://www.ndbc.noaa.gov\station_page.phtml?station=45007

c) Beach Informational Data - Part of the process of evaluating potential health risks related to pathogen exposure during bathing or swimming activities was to compile available information about each beach, including historical knowledge of the beach, designated used, and possible sources of fecal contamination. Table 4 below lists the following sources that were used to help classify and rank our beaches.

Table 4 - Beach Information Sources

Information Source	***Type of Information***	***Purpose***
State Water Quality Report (CWA Section 305(b))	• Known problems with the recreational water • Known or suspected causes • Proposed corrective actions	Review reports on the quality of the recreational waters
Swimmer Reports or Hospital Records	• The number of swimmer complaints • Documented reports of illness • Epidemiological studies conducted • Other agency described health problems	Determine the history of risks to swimmers
Advisory Reports and Closings	• Closings caused by rain events • Frequency of closings during season • Causes of closures • Number of swimmers affected by the closing.	Determine the likelihood of risks to swimmers
Development Planning Reports	• Location of sewer lines • Outfalls • Trash areas • Septic systems • Leaking sewer lines • runoff	Identify potential sources of fecal contamination
Point Source Discharge Data	• Combined Sewer Overflows (CSOs) • Concentrated Animal Feeding Operations (CAFOs) • Public Owned Treatment Works (POTWs)	Identify potential sources of fecal contamination
Nonpoint Source Reports (CWA Section 319)	• Reductions in nonpoint source pollution • Improvement in water quality	Determine the extent of nonpoint source pollution
Environmental Group Reports	• *Surfrider* - National beach water quality testing, monitoring and notification program http://www.surfrider.org. • *Heal the Bay* - Local beach closure protocol http://www.healthebay.org • *Natural Resources Defense Council* - Beach closings and monitoring and notification program. http://www.nrdc.org	Review conducted studies and published reports
Chamber of Commerce Reports	• Number of tourist • Tourist spending	Investigate how beaches and recreational waters contribute to the local economy
Sanitary Surveys	• Source controls • Source identification • Persistent problems • Magnitude of pollution • Management actions	Identify potential sources of pollution

Objective (c) - Assessment procedures to identify short-term increases in pathogens.

An important objective was to minimize beachgoers' health risk associated with infectious diseases caused by exposure to microorganisms. Notification of elevated levels of indicator bacteria is usually based on monitoring of beach waters. Under this system, however, users of recreational waters can be exposed to waterborne pathogens because of delayed notification. The laboratory methods used take 24 to 48 hours.

To reduce exposure to pathogens, we need tools that can provide a quick, reliable indication of the water quality conditions.

Assessment Procedures for Identifying Short-term Increases
Frequent, regular sampling is required to identify short-term increases in pathogens and increases due to weather events. Beach monitoring efforts are currently underway. We will continue to evaluate existing monitoring data along with new data, as it becomes available.

The following additional information is collected and utilized along with the monitoring data to aid in identifying short-term pathogen increases and increases due to storm events:

- Rainfall
- Wind speed and direction
- Air temperature
- Wave height
- Water temperature
- Turbidity
- Conductance

The usefulness of the data on beach conditions, beach uses, and environmental conditions that drive beach process must be evaluated to find significant or logical relationships of the driving mechanisms. Hopefully, parameter relationships will become apparent from the statistical analysis of the data. These relationships will help define the significant processes that will drive developing models to simulate the beach conditions described by the data. Model development and calibrations provide feedback for improved monitoring regimes. This circular processes of sampling, statistical analysis and modeling beach conditions will hopefully improve our understanding of pathogen exposure at beaches and lead to a predictive model(s) that forewarns of impending health hazards.

Using the above described model strategy, a generalized modeling approach is put forward to develop expertise in beach dynamics and modeling while the sampling process is on-going. Using existing data and new data, as it becomes available, statistical analysis can be used to identify parameter relationships. Selected models are being developed and applied to the data to find the best-suited model(s) and specific model needs. If the observations warrant, the sampling protocol or strategy can be assessed and modified to strengthen observed relationships or to identify other useful relationships, and better support modeling needs.

The calibration and predictive capabilities of the beach model(s) will be improved as more samples are collected. Multiple models will be considered with the long-term objective of having a simple and readily useable model(s) and possibly having a more complex computer model. This iterative model development process will continue throughout the program.

Modeling

Modeling will consist of two basic phases, calibration and predictions. Calibration will consist of taking the selected model(s) and adapting it to the beach conditions and the monitoring data. Since different beaches will have different conditions it may be necessary to have individual beach models but the goal will be to develop a model(s) that have universal application.

The prediction part of the modeling will be to use the model to estimate pathogen threats based on known conditions and then compare the model results with the sample observations. This process will include different ways to interpret the model predictions and developing useable indeces for stating pathogen threats at the beach. Statistical probability and/or reliability of the model will be a part of defining levels of hazards.

Model calibration will be done at logical stages and/or continuously through out the study. Logical steps at or near the 25%, 50% and 75% points in the project will be used to complete the entire modeling and prediction process for the purpose of developing an interim report as described below.

Adjustments to Monitoring and Modeling

The process of developing and improving the modeling and monitoring plan will be continuous. At a minimum of 25%, 50% and 75% of the way through the study, the process of adjusting the monitoring and the modeling effort will be formalized.

Interim Reports

Three interim reports are planned including a report on the ability of the model to predict beach hazards during this project. The interim reporting will serve several purposes beyond formalizing the process. It will provide for a comprehensive check of the project progress that will enable others to review and comment on the process. The report document will serve as means to communicate with other researchers conducting similar studies, see below. Formal reporting will be for these three milestones. Other documentation will be maintained through out the study.

Collaboration and Exchange of Information

The challenge at hand demands a collective effort and through this effort a collective solution. The modeling effort will include communicating and sharing of information with universities, colleges, EPA, USGS, other states, regional planning groups, counties, cities and other municipalities and interest groups. This will be done through individual contact, conferences and special meetings and/or site visits.

Final Report

This will include a final report and the attendance of special meetings and conferences to share the results of the study. The final report will include model documentation, calibration and prediction. Application of model prediction to assessing pathogen hazards will be proposed, as will any other suggestions on monitoring for hazards and minimizing pathogen exposure to beachgoers.

Objective (d) - Public Notification and Risk Communication

One of the tasks of this objective was to assess problems with public notification and risk communication when ever the water quality criteria for bacteria has been exceeded, and to identify the audience. A survey was designed to assess the effectiveness of current notification procedures (see Appendix B). Field staff visited several beaches along the Great Lakes and conduct a random survey of beach users on the following information:

- Age of the user
- Gender
- Primary language
- Distance they live from the beach
- Type of contact with the water
- Recognition of Beach Advisory Sign
- Overall reaction to Advisory Sign
- Usefulness of Advisory Sign information
- Recommendations for changing the sign
- Familiarity with Beach Advisory content
- Illness related to beach activities
- Children on beach
- What source is used to obtain beach water quality information
- Desired methods of communication

Field staff will recorded beach location, date and time of interview on survey forms. Staff were careful to include diversity in gender, age and racial/ethnic background. The information was compiled and summarized in a report to the Beach Act Workgroup for final recommendations.

A follow-up beach social survey was conducted in the summer of 2005 (Appendix C). This survey included similar questions as the previous survey to evaluate the effectiveness of our notification program.

2. Sampling Method Requirements

All sampling is required to follow these general rules:

a. Samples will be collected in containers approved by the Wisconsin Department of Agriculture Trade and Consumer Protection (WDATCP) laboratory certification program.

b. Extreme care needs to be taken to avoid contaminating the sample and sample container.

- Do not remove bottle covering and closure until just prior to obtaining each sample.
- Do not touch the inside of the sample container.
- Do not rinse the sample container.
- Do not put caps on the ground while sampling.
- Do not transport the samples with other environmental samples.

c. Adhering to sample preservation and holding time limits is critical to the production of valid data.

- Samples should be labeled, iced or refrigerated at 1 - 4 degrees C immediately after collection and during transit to the lab. Samples will be immediately placed on wet ice and placed in a cooler for transport to the laboratory.

- Care should be taken to ensure that sample bottles are not totally immersed in water from melted ice during transit or storage.

- Samples should arrive in the laboratory no later than 24 hours after collection. Whenever possible samples should arrive at the lab on the day of collection, preferably before 2 p.m.

d. The sampler will complete the laboratory data form noting time, date, and location of sample collection.

e. Samples will be analyzed on the day of collection whenever possible and holding times may not exceed 24 hours.

3. Sample Handling and Custody Requirements

The laboratory data form will serve as a Chain-of-Custody record for each sample collected and analyzed. In keeping with laboratory requirements (Standard Methods), all samples must be sealed, chilled, and transported from the sample point to the laboratory for analysis within twenty-four hours after sampling. Sample collectors will have exclusive custody of any sample from the time of collection until the sample is deposited with the laboratory. The laboratory will assume custody of each sample it receives and is responsible for forwarding all sample analysis results to the Project Manager within twenty-four hours to forty-eight hours of receiving the sample.

4. Analytical Requirements

All analyses shall be performed in laboratories certified by the Wisconsin Department of Agriculture and Consumer Protection for microbiological analysis of *E.coli* in water. Table 5 lists all the current EPA approved analytical methods or microbiological analysis of E. coli.

Table 5 - EPA Approved Analytical Methods

Indicator	*Type of Analyses Performed*	*Method Number*
E. coli	❑ Membrane Filter Fecal Coliform Test (MFFCC) with Nutrient Agar ❑ Membrane Filter (MF) ❑ MPN - Enzyme Substrate Test - Colilert™	Standard Methods 9222(D) and Standard Methods 9222(G) Standard Methods 9213(B) Standard Methods 9223(B)

5. Quality Control Requirements

A number of quality control checks are required to ensure the quality of the generated data. All laboratory staff will adhere to current and generally accepted practices for safe handling, testing of samples, and chain of custody measures.

(a) Precision

Precision is a measure of the degree to which two or more measurements are in agreement. Field precision is estimated through the collection and measurement of two samples at the same sampling site at approximately 10 percent of the sites. The precision of laboratory analyses is estimated by analyzing two or more aliquots of the same water sample. This data quality indicator is obtained from two duplicate samples by calculating the relative percent difference (RPD) as follows:

$$RPD = \frac{|C_1 - C_2|}{(C_1 - C_2)/2} \times 100$$

Where C_1 is the first of the two values and C_2 is the second value. Because of the heterogeneity of populations of bacteria in surface waters, an RPD of less than or equal to 50 percent between field duplicates for microbiological analyses might be considered acceptable. When multiple replicates are analyzed, precision of the test will be expressed in terms of standard deviation and the ability to detect the target organism. Analysts should be able to duplicate bacterial colony counts on the same membrane within 5 percent and the counts of other analysts within 10 percent; otherwise, procedures should be reviewed and corrective action implemented.

(b) Accuracy

Accuracy is determined through the use of field blanks and through the adherence to all sampling handling and holding times. Because accuracy is the measurement of the degree of agreement between and observed value and an accepted reference value or a true value, and the true values of environmental physicochemical and biological characteristic cannot be known, accuracy is assessed by the use of a surrogate. To estimate the densities of bacteria, use of samples prepared from known quantities of freeze-dried and cultured bacteria as a surrogate can result in 97.9 percent recovery of the bacteria from water samples. Based on the mTEC medium, bias was determined to be 2 percent of the true value. This information is helpful in establishing the most appropriate methods to be followed.

(c) Representativeness

In the sample design, care is taken to determine if the area of sample collection is typical and representative of each area of concern.

1) For lengthy beaches, if bathers are relatively evenly distributed along the beach area, samples will be spaced a maximum of 500 meters apart.
2) For beaches where bathers are concentrated in one area, 1 sample will be taken where most of the swimmers congregate and then a sample shall be taken 15 meters on either side.

6. Data Management

Wisconsin DNR contracts with USGS to develop a database to store all pertinent information about each participating beach. The data is stored in an accessible form usable to the local decision-makers. The WEB address is www.wibeaches.us. A system of quality control checks is performed to assure that all data is accurately entered into any data storage system. All data are analyzed statistically immediately upon completion of tests so that beach advisory decisions can be made quickly. Additionally, all beach data are reported electronically in an acceptable form for reporting to USEPA. Appropriate user instructions and system documentation have been developed and made available to all staff using the database system.

D. ASSESSMENT/OVERSIGHT

The effectiveness of the monitoring program will be assessed at regular intervals through the use of technical systems audits, performance evaluations, and audits of data quality to verify that sampling and analysis are performed in accordance with the established QC procedures and that all operational aspects of the program are acceptable. This Project will identify specific assessment methods and procedures for project documentation as well as collection, preservation, and storage of water samples. The laboratory is responsible for the compliance regarding the analytical aspects of the Project.

The QA program will include procedures for identifying and defining a problem, assigning responsibility for investigating the problem, determining the cause of the problem, assigning responsibility for implementing corrective action, and assigning responsibility for determining the effectiveness of the corrective action and verifying that the corrective action has eliminated the problems.

E. RECONCILIATION WITH DATA OBJECTIVES

Sample records, chain of custody records, and sample tracking records will be reviewed to verify that all the samples collected were analyzed so the data set will be complete. Data entries and analyses will also be verified. The input of large quantities of historical data will be spot checked to detect potential data entry errors. Calculations will be reviewed by rechecking the computations, reviewing the assumptions used and checking the input data against the original sources to be sure transcription errors have not occurred.

Once the data have been confirmed to meet standards, a report that provides an assessment of the usability of the data, a summary of sample results, and a summary of QC and QA results will be prepared. The report will discuss any discrepancies between the Data Quality Objectives (DQOs) and the data collected and any effects such discrepancies might have on the ability to meet the DQOs.