STURGEON BAY
RESOURCE INVENTORY AND
AQUATIC PLANT MANAGEMENT PLAN

July 15, 2003

STURGEON BAY
RESOURCE INVENTORY AND
AQUATIC PLANT MANAGEMENT PLAN

July 15, 2003

Prepared for:

City of Sturgeon Bay
Parks and Recreation
835 North 14th Avenue
Sturgeon Bay, Wisconsin 54235

Prepared By:

Northern Environmental Technologies, Incorporated
1203 Storbeck Drive
Waupun, Wisconsin 53963

Project Number: STB 08-3100-0574

Clint W. Wendt
Environmental Scientist/Project Manager

Marty L. Koopman, PG
District Director

Aaron C. Gruenewald
Environmental Scientist

CWW:alw

TABLE OF CONTENTS

FIGURES

TABLES

APPENDICIES

1.0 EXECUTIVE SUMMARY

The waters of Sturgeon Bay (the Bay) and the ship canal connect Lake Michigan and Green Bay in central Door County. The Bay is important to many diverse users including recreational boaters, fisherman, local businesses, swimmers, conservationists, and the commercial shipping industry. The area relies heavily on tourism and navigation on the Bay is vital to that economy. Sturgeon Bay began to experience nuisance aquatic plant growth which interfered with recreational uses of the Bay. The City of Sturgeon Bay began an Aquatic Plant Management Program to help alleviate heavy plant growth. Aquatic plant harvesting and chemical treatment in marinas are the management methods employed.

In an effort to further understand the Bay ecosystem and aquatic plant problems, and to secure a long-term aquatic plant management permit, The City hired Northern Environmental Technologies to complete a resource inventory and develop an aquatic plant management plan. This project included public education and involvement through a radio broadcast, newsletters, newspaper articles, open house information meetings, a public survey, and a television broadcast on Wisconsin Public Television's Outdoor Wisconsin to be aired later in 2003. The public listed water quality and aquatic plant growth as the most important concerns and the following project goals as most important:

- Studying and understanding aquatic plant problems
- Identifying pollutant sources
- Identifying other APM strategies
- Promoting voluntary pollution and runoff controls

The results of this project's aquatic resource inventory component indicate that the Bay receives water from a variety of sources including Lake Michigan, Green Bay, ground water, tributary streams, and urban storm sewer systems. Water levels are variable following the long term rises and falls of Lake Michigan and are at a historic low. The Bay ecosystem is important to a multitude of plants, fish, mammals, birds, crustaceans, mollusks, and insects, including several exotic plants and animals. The Bay offers critical habitat for many fish species including yellow perch whose population has declined on Lake Michigan. The introduction of exotic species from other parts of the world has contributed to the problems on the Bay. Water quality of Sturgeon Bay varies with numerous factors but an overall assessment is good water quality. Nutrients such as phosphorus and sediments are contributed to Sturgeon Bay from both rural and urban sources.

Nuisance aquatic plant species including *Myriophyllum spicatum* (Eurasian watermilfoil), *Potomageton crispus* (Curly lead pondweed), and *Elodea conadensis* (Elodea) have grown to nuisance levels in the Sturgeon Bay APM management area, impeding navigation and recreation. The prolific growth of these aquatic plants is attributed to a multitude of factors including: introduction of exotic plant species; lower water levels allowing light to penetrate to deeper areas; zebra mussel increasing water clarity; soft sediment substrate; and an adequate supply of nutrients from Green Bay, sediments, and storm water runoff.

A comparison of aquatic plant management strategies concluded that continued selective aquatic plant harvesting and chemical treatment in marinas is the most appropriate aquatic plant management method at this time. The APM Plan includes: depth restrictions, restrictions on harvesting in sensitive areas, multi-use priority channels, a shoreline navigation access request process, a special conditions process, continued herbicide treatment in marinas, public education; and record-keeping components. Additional recommendations included: composting of harvested aquatic plant material; mandated and voluntary efforts to curb storm water runoff containing sediments and phosphorus; public education; continued aquatic plant and water quality monitoring; keeping informed of current research; and evaluating funding sources for monitoring or managing Sturgeon Bay's aquatic resources.

2.0 INTRODUCTION AND PROJECT GOALS

Sturgeon Bay (the Bay) splits the Door County, Wisconsin peninsula and in conjunction with the ship canal connects Lake Michigan's main basin and Green Bay. Sturgeon Bay is illustrated in Figure 1. The Bay is a unique environmental ecosystem with habitat for warm, cool, and cold water fish species. The Bay is important to various stakeholders and users, including, but not limited to: property owners; recreational boaters; swimmers; anglers; conservationists; and the commercial shipping industry. Government entities, including the City of Sturgeon Bay (the City), the Door County Soil and Water Conservation Department, the Bay-Lake Regional Planning Commission, and the Wisconsin Department of Natural Resources (WDNR) also have interests, as well as planning and management responsibilities for the Bay.


Sturgeon Bay Mooring Area

As is the case with many water bodies near population centers, Sturgeon Bay's natural resources (water quality, wildlife, and plant communities) have suffered since European settlement. Approximately 15 years ago, changes in Sturgeon Bay were becoming evident, the most prominent change being excessive aquatic plant growth. Nuisance levels of aquatic plant growth restricted boat navigation. Many issues are believed to have contributed to the current problems in Sturgeon Bay.

In response to these problems, the City of Sturgeon Bay initiated an aquatic plant management (APM) program in which aquatic plants are harvested mechanically and treated with herbicides. The Parks and Recreation department is responsible for providing APM services for boat navigation relief within select areas of the Bay. The management area is illustrated in Figure 1. The City's APM program is 10 years old. Despite the City's management efforts, nuisance aquatic plant growth is prolific at times and impedes boat navigation. The City and WDNR have expressed concern that aquatic harvesting areas continue to expand and the City is concerned that harvesting may be damaging some critical fish nursery areas that are vital to sustaining sport fish populations.

The Wisconsin Department of Natural Resources (WDNR) recently developed a new regulatory permit program for any management of aquatic plants. The new rule requires that an APM Plan must be developed (and approved by WDNR) prior to issuance of a long-term APM permit. Therefore, the City decided to complete an aquatic plant study and update their APM Program. The City applied for and received a coastal management grant to develop an updated comprehensive integrated long-term APM plan. The proposed project included identifying the aquatic plants causing problems, evaluating potential factors leading to nuisance plant growth, reviewing management alternatives, and providing a recommended APM plan. The City's Water Weeds Committee and the Parks and Recreation department developed the scope of the proposed study and identified the following initial project goals:

- Map existing cutting areas and cutting patterns
- Incorporate the WDNR's aquatic plant survey
- Identify critical fish and game habitat areas
- Measure the spread of invasive aquatic species

- Sediment collection and sampling
- Collect depth soundings to correlate water depth and clarity measurements with spread of plant growth
- Evaluate the equipment and technology needs
- Evaluate alternatives to cutting for invasive plant control
- Evaluate the success and value of restocking native plants
- Map the city storm sewer system to evaluate nutrient loading

The City hired Northern Environmental Technologies, Incorporated (Northern Environmental) to complete the project in conjunction with the WDNR and applicable City Parks and Recreation staff. The City and Northern Environmental developed a workplan to accomplish the above goals and update the APM. The workplan included the following elements.

- Complete aquatic resource inventory
- Evaluate existing APM Program
- Map, model, and evaluate storm sewers
- Evaluate alternative aquatic plant management options
- Public Education and Involvement
- Develop updated APM Plan
- Provide recommendations for overall management of Sturgeon Bay

This document is the culmination of the APM Plan development describing project methods, providing an inventory of the Sturgeon Bay aquatic resource, summarizing water quality, describing existing and alternative APM methods, and providing a recommended action plan for APM, storm water runoff, additional public education, continued monitoring, and disposal of harvested aquatic plants.

3.0 PROJECT METHODOLOGIES

The process of updating the APM program involved a number of tasks completed by a considerable number of people from July of 2002 to April 2003. This section briefly describes the methods used to complete the various components of this project.

3.1 Public Education and Involvement

The City realized that a comprehensive resource inventory and updated APM process of this scale should be shared through public education and involvement. The goal of the endeavor was to educate the stakeholders to the realities and the challenges facing APM on Sturgeon Bay. The City and Northern Environmental used a variety of media to distribute information to the public. These efforts included the following:

- Semi-annual project newsletters
- Open format public informational meetings
- Solicitation of public comments from a questionnaire
- Use of print media and radio/television announcements and feature stories
- Creation of a web-based information and comment site

Public education components are discussed in greater detail in Section 4.0.

3.2 Resource Inventory

3.2.1 Existing Data Collection

A great deal of information has been collected over the years that benefit the project. Information regarding the history and natural resources of Sturgeon Bay and watershed is available. Varieties of resources were consulted to provide important data for the project, help focus tasks to gather needed information, and avoid duplication of effort. This information helped the City and Northern Environmental make informed decisions for updating the APM Program. Some of the primary information resources included:

- Interviews with local government officials
- Interviews with groups who have similar programs on other water bodies
- Local topographic maps, and aerial photographs
- Relevant predictive computer models
- Ongoing, intended, and potential future research into APM strategies
- Publications describing physiography, soils, geology, and hydrology of Sturgeon Bay area
- Publications regarding both the species and distribution of terrestrial and aquatic flora and fauna
- Publications identifying and evaluating potential sources of contaminants
- Fish Surveys by WDNR
- Aquatic Plant Surveys by WDNR

Section 10.0 lists some of the important references used to produce the information database. Some of the references are not cited in the report sections, but are believed to be relevant enough to be included in the reference list. The data were used to generate much of the resource inventory reporting, aquatic water quality information, and plant management information in Sections 5.0, 6.0, and 7.0.

Dense stand of aquatic vegetation

3.2.2 Aquatic Plant Evaluation and Surveys

Sturgeon Bay formerly had a rich assemblage of emergent, submergent, and floating-leaf aquatic plants. The introduction of exotic (non-native) aquatic plant species dramatically altered aquatic plant distribution and speciation. To help evaluate the existing aquatic plant community, Northern Environmental completed a qualitative assessment of aquatic plant communities during the water quality sampling events. Aquatic plants were collected by hand or with a weed rake at several locations in the management portion of the

Bay. Additionally, City harvesting crews provided records and notes on major species of plants harvested in several areas within the management zone. Crew notes also described fish present if they were observed and then moved to other areas.

The WDNR assisted in this project by completing two formal aquatic plant surveys on Sturgeon Bay in June 2002 and August 2002. The 2002 WDNR survey was completed to compare changes in aquatic plant communities since the last aquatic plant survey in 1993. The methods of these surveys are available in the WDNR survey reports. At the time of this publication, the final 2002 aquatic plant survey report has not been completed., however Northern Environmental reviewed the data from the important surveys and incorporated it into the resource inventory and APM development. The results are discussed in Section 5.6.

3.2.3 Water Quality Sampling

Water quality information is useful to evaluate overall aquatic ecosystem health, its potential for change, and factors that may be sensitive to change. To help evaluate Sturgeon Bay's water quality, Northern Environmental collected surface water grab samples from select locations on July 19, 2002. Sample locations were chosen to represent water quality near tributary streams, shallow bays, and the ship channel during mid- summer conditions. One sample was collected at depth within the shipping canal using a Kemmerer water bottle. Water was evaluated for temperature, oxygen, nutrients, chlorophyll _a_, and transparency. Select samples were placed in appropriate sample containers and sent to Northern Lakes Laboratory in Crandon, Wisconsin for analysis.


Water Sampling on Sturgeon Bay

In addition to the sampling completed by Northern Environmental, City aquatic plant harvesting crews collected surface water quality "grab" samples across Sturgeon Bay. Selected locations of water quality sampling included random locations within the aquatic plant harvesting areas, at mouths of tributary streams, and at entrances to Sturgeon Bay (Lake Michigan side and Green Bay side). Water was evaluated for temperature, clarity, temperature, pH, alkalinity, and/or nutrients. Random samples were analyzed for pH, alkalinity, and nutrients using HACH field test strips. Select samples were placed in appropriate sample containers and sent to Northern Lakes Laboratory in Crandon, Wisconsin for analysis. A map illustrating water quality sampling locations is included as Figure 2. The results are discussed at length in Section 6.0.

3.2.4 Sediment Sampling

To help evaluate sediment and substrate conditions on Sturgeon Bay, Northern Environmental collected sediment samples from select locations on July 19, 2002. Sample locations were chosen to represent conditions near tributary streams and shallow bays. Northern Environmental collected sediment samples using a stainless steel cylinder type soft sediment sampler. Extension handles were attached to the sampler, which was manually driven into the sediments until firm resistance was encountered. When the depth of water was greater than the handle extensions, the sampler was attached to a rope and dropped from the side of the boat. The sampling device was retrieved and the plastic sample liner was removed from the cylinder. Sediment samples were evaluated for composition and texture, nutrients, and minerals. Select sediment samples were placed in appropriate sample containers and sent to the UW Soil and Plant

Laboratory in Madison, Wisconsin for analysis. Sediment sample locations are depicted in Figure 2. The results are discussed in Section 6.2.

3.2.5 Storm water Sampling

Storm water quality information is useful to evaluate what tributaries are contributing to nutrient and sediment loading to the management area in Sturgeon Bay. Storm water samples were collected from the following tributaries draining into the study area of Sturgeon Bay.

- Little Creek
- Big Creek
- Samuelson's Creek
- Strawberry Creek

The location of these creeks or streams is illustrated on Figures 1 and Figure 2. Storm water quality information is useful to evaluate what tributaries are contributing nutrient and sediment loading to the management area in Sturgeon Bay. The City of Sturgeon Bay collected storm water samples from tributaries on July 31, 2002. Samples were collected at the stream's lowermost road crossing, or the street nearest to Sturgeon Bay. Storm water samples were visually described and evaluated for temperature and nutrients. Select samples were placed in appropriate sample containers and sent to Northern Lakes Laboratory in Crandon, Wisconsin for analysis. Storm water sample locations are depicted in Figure 3. The results are discussed at length in Section 6.2.

3.2.6 Land Use Characterization and Phosphorus Load Estimation

The Sturgeon Bay watershed is composed of urban, agricultural, and rural residential land uses. A detailed study of the entire watershed was outside the scope of this project, however an evaluation of land use within the management area (Figure 1) sub-watershed was completed. The land area draining into the management area was evaluated for potential sediment and nutrient runoff into the management area. The sub-watershed is illustrated on Figure 3.

A relatively simple land management screening model, the Wisconsin Lake Modeling Suite (WiLMS® Version 3.3.8), was used to estimate limited nutrient loading from the land area contributing storm water runoff to Sturgeon Bay's aquatic plant management area. The WiLMS® model predicts phosphorus sediment delivery rates given certain land uses. Unlike more complicated and thorough models, topography of the watershed is not considered. Default data for Door County was used for net precipitation and annual runoff. Results of the WiLMS® model are discussed in Subsection 6.2.4.

3.2.7 Storm Sewer Mapping

Much of the storm water runoff within the City of Sturgeon Bay is drained by man-made storm sewer conveyances including open swales and underground concrete pipes. Northern Environmental and City staff completed a comprehensive survey of storm sewers in the summer 2002. The invert elevations and top elevations of catch basins, junctions, and outfalls were surveyed to the nearest 0.01-foot above mean sea level (msl) using the nearest vertical elevation control. Storm sewer outfalls are illustrated on Figure 4.

4.0 PUBLIC EDUCATION AND INVOLVEMENT

Updating and developing a APM Program of this scale can potentially affect a variety of Bay users with differing opinions and ideas about managing aquatic plants. The realities and challenges of a comprehensive APM Program may not be well understood. Therefore, public education, involvement, and solicitation of public comments were incorporated into the project workplan from the start of the project. These elements serve to identify the public's concerns, goals and provide information to stakeholders about Sturgeon Bay's ecosystem, feasible and realistic goals, APM program limitations, and sound ecosystem management.

4.1 Radio Broadcast

On July 19, 2002, a live radio interview and discussion was broadcast on AM WDOR "the Door" with City Parks and Recreation APM staff and Northern Environmental personnel. The discussion covered what makes aquatic plants grow, the value of aquatic plants, aquatic plant problems on Sturgeon Bay, what the City does to manage aquatic plants, the APM Program update, and what the public can do to help prevent water quality and aquatic plant problems.

4.2 Summer 2002 Open House

A public meeting or "open house" was held at City Hall on July 31, 2002. City staff discussed the history of the APM program and the new WDNR permit program for APM (NR 109 Wisconsin Administrative Code). The meeting included a presentation by Northern Environmental on the habitats and values of aquatic plants, water quality, and potential aquatic plant problems, causes, and management techniques. At the end of the presentations, the audience was allowed to ask questions about the APM Program.

4.3 Project Website

Northern Environmental hosted and maintained a project website throughout the APM update process. The website located at www.northernenvironmental.com/sturgeonbay provided background information, included technical information, established links to other websites of interest, and included a place for public comments.

4.4 Public Questionnaire

After discussions at the summer 2002 open house meeting, a public questionnaire was distributed to audience members. The questionnaire was used to solicit public opinion for the most important issues. A survey such as this may often yield a large "wish list," a list with conflicting issues and goals. For example, fishermen may think that harvesting aquatic plants is harming a fishery, while boaters may believe that excessive vegetation is limiting their recreation opportunities. Additionally, some individuals may unknowingly have unrealistic expectations, yielding spurious issues and goals. Therefore, the survey asked people to rank a list of potential concerns and goals that were provided in the questionnaire. Respondents were given the opportunity to write down comments or items that could be included as "additional or other" concerns and goals. This questionnaire was also made available on the project website. A copy of this questionnaire is included in Appendix A.

A limited number of questionnaires were returned. Most respondents (52%) were year round residents. Respondents used Sturgeon Bay for a variety of recreational activities including fishing, nature viewing, boating, and swimming. 46% of respondents used the Bay greater than 10 days per month and 67 % rated their experiences on the Bay as very enjoyable. 75 % of those surveyed strongly supported the City's current APM program.

A ranking of project concerns indicated that the following concerns were considered most important to respondents.

- Water Quality
- Aquatic Plant Growth

A ranking of project goals indicated that the following goals were considered most important to respondents:

- Studying and understanding aquatic plant problems
- Identifying pollutant sources
- Identifying other APM strategies
- Promoting voluntary pollution and runoff controls

The questionnaire results and ranking of concerns and goals were considered throughout the updating of the APM Program. The results of the public questionnaires are presented in graphic form in Appendix A.

4.5 Newsletters and Newspaper

At the July 2002 open house, the Summer 2002 newsletter was distributed to attendees. This newsletter summarized the history of the aquatic plant harvesting program and introduced the nuisance aquatic plants of concern in Sturgeon Bay. In November 2002, an article was published in the Door County Advocate describing the aquatic plant problems and the APM Program update. A second newsletter describing project progress was prepared by Northern Environmental and published in a City wide newsletter in April 2003. Newsletters and newspaper articles were also made available on the project website.

4.6 Television Broadcast

A larger Wisconsin public audience will also be introduced to the recreation on Sturgeon Bay and challenges of Sturgeon Bay's APM program through a feature story broadcast on Wisconsin Public Broadcast System "Outdoor Wisconsin" Television Program. Host Dan Small interviewed City APM managers and Northern Environmental in the fall of 2002. In the summer of 2003, City harvesting operations will be filmed and the story will be broadcast later in 2003.

5.0 NATURAL RESOURCE CHARACTERISTICS

5.1 Cultural

Archaeological evidence suggests that the first humans to enter Wisconsin were big-game hunters and plant gatherers. These Nomadic Tribes are referred to as Paleo Indians. The evidence suggests that Native Americans first inhabited the area about 11,000 years ago (History of Peninsula State Park & Surroundings).

It appears that Native Americans lived and visited Door County up until the 1800's. During that time, the Native Americans were relocated by the US Government through the Indian Removal Act.

In the 1800's, many immigrants began to move to Wisconsin. Door County was a popular place for the mostly European settlers. These early settlers were mariners, fisherman, lumberjacks, and farmer. Tourism also became a part of the local economy.

As the timber industry declined and lands were cleared, farming became a more important industry. Shipping also was becoming an important part of the local economy. In 1873, work began on the Sturgeon Bay ship canal. The Federal government purchased the canal in 1893 and placed its management under the authority of the US Corps of Engineering. Shipbuilding became an integral part of the Sturgeon Bay economy.

The 1900's saw an increase in tourism, shipbuilding, and farming. Apple and cherry orchards were planted throughout the area. Later in the century, shipbuilding saw a drastic decline. The number of farms decreased; as farm size in general has increased. Residential development throughout the area has seen a dramatic growth, as many people have built second homes along the water and inland on previous farmed land.

The last census identified that as much as half of the Sturgeon Bay work force, work in jobs directly related to the tourism industry. The Department of Administration predicts almost no population growth for the city in the next 10 years. Tourism will continue to be the number one industry for the community.

5.2 Climate

The climate in Wisconsin has never been static. The climate has been considerably warmer and cooler in the past 15,000 years. Climate change affects flora and fauna. As a result, the vegetation present at the time of European settlement was not always present. In fact, it is believed that the ranges of all plant and animal species were once compressed toward the equator and then expanded as the ice sheets melted northward (IAT, 2002). The term "ice age" is generally used to describe long, generally cool intervals during which glaciers advance and retreat. Many scientists believe that our current climate represents a very short, warm period between glacial advances (ISM, 2002).

Temperatures change frequently in southern Door County although not as drastically as most of Wisconsin. Temperature extremes are modified by Green Bay and Lake Michigan. Spring is usually delayed slightly by the lakes modifying effects as is the onset of the first freeze. Winters are generally long, cold, and snowy with average temperatures of 29° F. Spring often contains both warm and cold temperatures, while summer is mostly warm with occasional hot and humid periods. The growing season is approximately 137 days long, and the average summer temperature is 65° F. Fall extends from mid-September through November. The average date of the first frost is October 2 and the last day is May 17. Transitions between seasons can be abrupt and are usually accompanied by storms (USDA, 1980).

Although the area is often dry during July and August, approximately 55 percent of the total annual precipitation falls between May and September. The following table illustrates monthly precipitation averages for the area. Snowfall averages 40.3 inches and occurs more frequently between the end of November and mid-February (USDA, 1980).

Annual Average Precipitation at Sturgeon Bay, Wisconsin

Month	Average (inches)
January	1.19
February	1.30
March	1.73
April	2.53
May	2.65
June	3.07
July	2.87
August	3.00
September	3.18
October	2.17
November	2.30
December	1.39
Annual Average	27.20

Source: WSCO, 2002

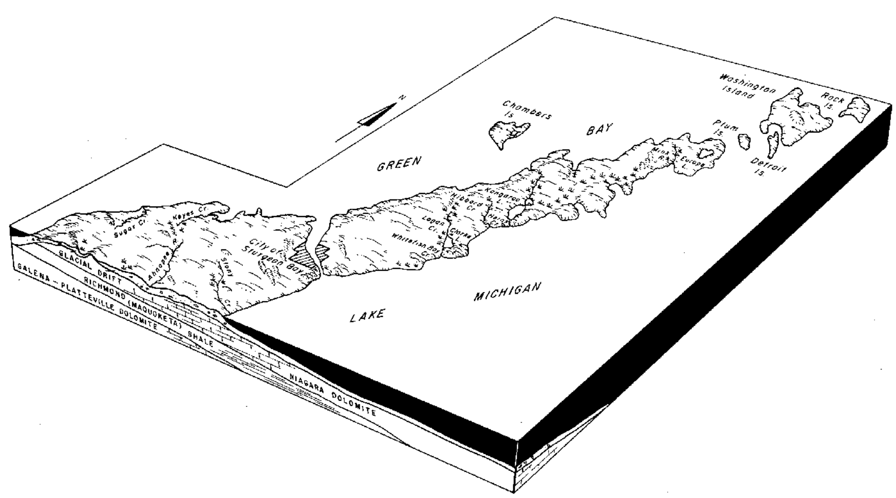
Winds prevail from the northwest or southwest, except in spring when northeast winds are dominant. Average wind speed during April and November is 12 miles per hour (mph), making these the windiest months of the year.

5.3 Physiography and Sturgeon Bay Morphology

The study area consists of approximately 800 acres of the waters of Sturgeon Bay. The approximate limits are Strawberry Creek Estates to the southeast to Bullhead Point to the northwest (Figure 1). Bottom sediments within this area consist of shallow soft sediments, silty sand, and dolomite bedrock. The center of the bay is a navigation channel that has been periodically dredged to depths of over 25 feet. Average depth outside the channel is 10-12 feet. The current bathymetry of Sturgeon Bay is illustrated in Figure 5. Shallow estuaries near the creek outlets are typically three feet deep and appear to be several acre fans of composed, soft, sediment.

5.4 Geology

Wisconsin bedrock geology is quite complicated. In general, it is a series of sedimentary rocks which were formed in shallow sea over laying crystalline bedrock. The sedimentary rock thickness varies, but it can be well over 1,000 feet thick.



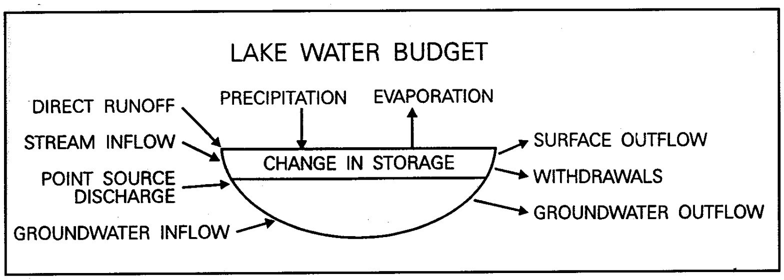
Source: USDA Soil Survey
Door County

The Niagara dolomite is the primary sedimentary unit exposed on the Door Peninsula. This highly fractured rock is well known for its karst formations. Primary fractions transect northwest to southeast with secondary fractures perpendicular to that. Its westward terminus forms the bluffs along Door County's Green Bay coast. This fossil-rich dolomite is mined in several localities to be used in construction projects.

Glacial till, drumlins, and beach sands cover large parts of the study area water shed. In several locations, the till is very thin or absent, exposing the Niagara Dolomite at the surface. The Niagara Dolomite is exposed in parts of Sturgeon Bay, itself, and is also exposed along the shores.

5.5 Water Resources

Water resources of the Sturgeon Bay area include precipitation, abundant ground water resources, Lake Michigan, Green Bay, surface streams, and wetlands. All of these water resources are somehow related to Sturgeon Bay. A comprehensive water budget was outside the scope of this project and would be extremely complex. The following illustrates the components of a water budget.



Source: NALMS, Managing Lakes and Reservoirs

The following discussions offer explanations of the various water resources contributing to Sturgeon Bay.

5.5.1 Groundwater

Groundwater in the area is generally found in the fractured dolomite and thicker glacial deposits. It typically is 10 to 20 feet from the surface in the study area watershed. Groundwater recharge typically occurs in topographically higher upland areas with discharge occurring into topographically low areas such as wetlands, streams, and Sturgeon Bay,. Because of the thin overburden aquifer recharge from surface water is quite rapid.

The upper aquifer is quite susceptible to contamination from septic fields and farm fertilizers. Many wells in the area have been found to have high levels of nitrates. Discharge of the nitrate-rich groundwater into Sturgeon Bay is most likely one of many sources for nutrients reaching Sturgeon Bay water.

5.5.2 Surface water and Hydrology

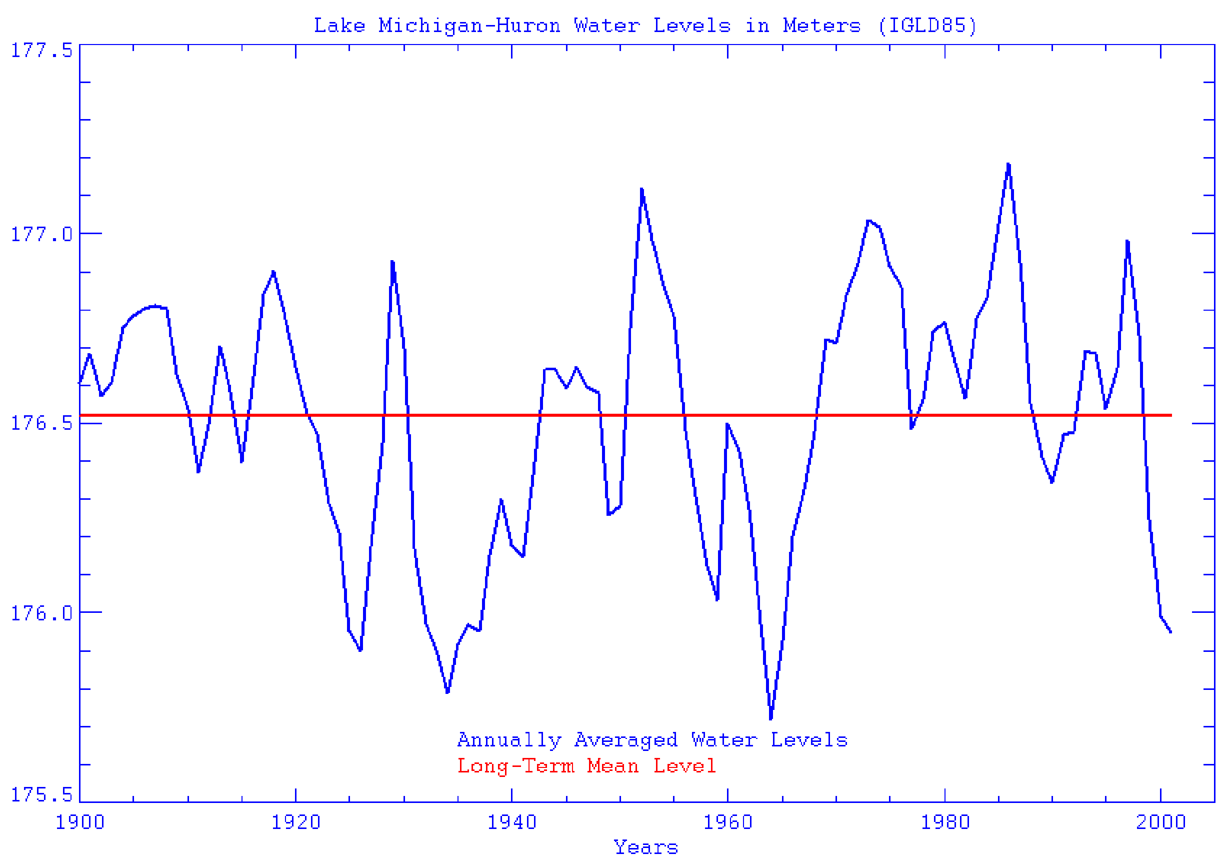
Rain events and snow melt create rapid runoff in the City. Localized flooding occurs in several areas of town. Big Creek, Little Creek, Samuelson's Creek, and Strawberry Creek also drain directly into the Bay. Little Creek has been channelized in the City of Sturgeon Bay and virtually all its watershed is within the city. Prolific macrophyte growth occurs at the confluence with the Bay. Big Creek has a relatively large watershed. The watershed encompasses portions of the city, wood lots, farm fields, and orchards. Aquatic plant growth can be heavy in the shallow estuary at the mouth of the creek. This area is also a known fish spawning area. Further discussions on surface water quality and storm water drainage through streams is provided in Section 6.0.

Strawberry Creek is a very cold water creek on the south side of Sturgeon Bay. Trout and other salmonoids migrate up this creek to spawn. The WDNR captures fish in the creek to use in their stocking program. The stream flow is augmented with flow from a WDNR owned high capacity well. Aquatic plant growth was not extensive at the mouth of Strawberry Creek. The watershed for Strawberry Creek includes residential properties and agricultural farm fields.

Several areas around Sturgeon bay have wetlands with no apparent outlets and small creeks that appear to disappear. This phenomenon is a function of the karst dolomite bedrock. Water infiltrates to the bedrock, follows fractures within the dolomite, is ultimately discharged into Sturgeon Bay, Lake Michigan or Green Bay.

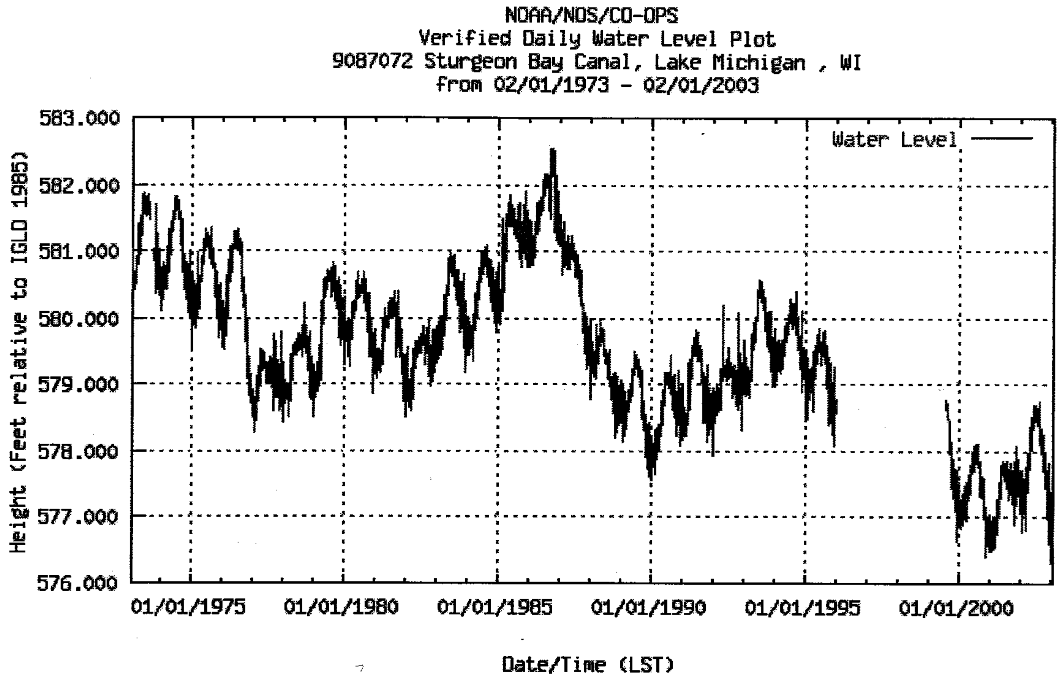
Flow through Sturgeon Bay is typically from warm nutrient-rich Green Bay to clear, colder water of Lake Michigan. However, when winds are from the east, this flow is reversed. If strong winds are from the west, a seiche occurs on Sturgeon Bay. Water is blown into Sturgeon Bay faster than it can exit through the shipping canal. At times, this seiche can be over 3 feet high. Further discussions on surface water quality of Lake Michigan and Green Bay is provided in Section 6.0.

The following graph illustrates, lake elevations have fluctuated nearly 5 feet in the past 100 years. Currently, water levels are near a historic low. Historically Lake Michigan water levels average 580 feet above msl. Low water levels typically recover to normal elevations in less than five years, once water levels begin to rise. This cycle may repeat in the future.



Source: Great Lakes Environmental Research Website, National Ocean and Atmosphere Administration

The following graph illustrates water levels on the Sturgeon Bay ship canal. The fluctuation for the last 25 years is similar to the Lake Michigan-Huron hydrograph above.



Source: Great Lakes Environmental Research Website, National Ocean and Atmosphere Administration

5.5.3 Storm Sewer Improvements

Water from precipitation and snow melt infiltrates to ground water or occurs as overland runoff flow to the streams described above and ultimately Sturgeon Bay. When urban areas are built, increases in the amount of impervious areas (e.g. parking lots, building roofs) and subsequent increases in storm water runoff are observed. Municipal storm sewer conveyances such as underground concrete channels are often installed in urban areas to facilitate quick removal of the storm water runoff. As part of the project, storm sewer mapping was completed. Storm sewers drain directly into Sturgeon Bay. The storm sewer locations are illustrated in Figure 4. Storm water from municipal storm sewer systems has the potential to deliver significant nutrient and sediment loads to a waterway. Nutrients and sediments contribute to aquatic plant growth and accumulations of sediments in the waterway. Further discussions on storm-water quality are provided in Section 6.2.

5.6 Aquatic Vegetation

Aquatic plants are vital to the health of a water body. Unfortunately, much too often, people refer to all rooted aquatic plants as weeds and their ultimate goal is to eradicate them. This line of thinking must be avoided when trying to manage an aquatic ecosystem. Rooted aquatic plants are extremely important for the well being of the aquatic ecosystem and posses many positive attributes. These attributes are what make the littoral zone the most important and productive aquatic habitat in freshwater lakes. However, aquatic macrophytes can become a nuisance when native and exotic plant species occupy large portions of a water body. Excessive aquatic plant growth can negatively affect navigational and recreational activities. When “managing” aquatic plants, it is important to maintain a well-balanced, stable, and diverse aquatic plant community that contain high percentages of desirable native vegetation while maintaining areas conclusive to many types of activities. The overall health of the Green Bay aquatic ecosystem is dependent upon the high density aquatic plant habitat within Sturgeon Bay. This area provides critical habitat for spawning, game nursery fish, forage fish production, and macroinvertebrate habitat which are vital to the aquatic food chain.

5.6.1 The Ecological Role of Aquatic Plants

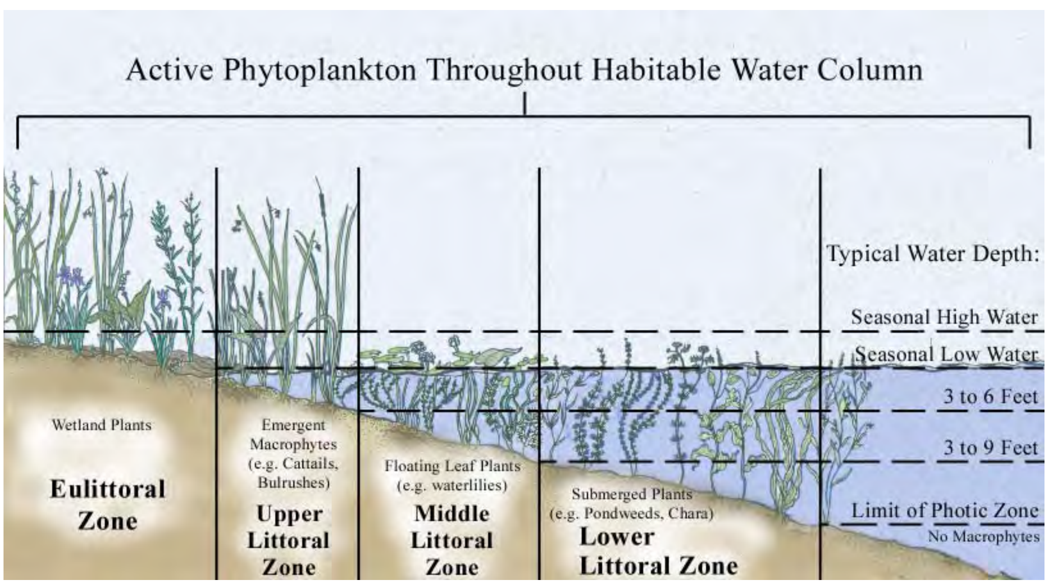
Aquatic plants can be divided into two major groups: microphytes (phytoplankton and epiphytes) composed mostly of single-celled algae, and macrophytes that include macroalgae, flowering vascular plants, and aquatic mosses and ferns. Wide varieties of microphytes co-inhabit all hospitable areas of a lake. Their abundance depends solely on light, nutrient availability, and other environmental factors. In contrast, macrophytes are predominantly found in distinct habitats in the littoral (shallow near shore) zone where sufficient light can penetrate to the lake bottom. The littoral zone is subdivided into four distinct transitional zones: the eulittoral, upper littoral, middle littoral, and lower littoral (Wetzel, 1983).

Eulittoral Zone: Includes the area between the highest and lowest seasonal water levels, and often contains many wetland plants.

Upper Littoral Zone: Dominated by emergent macrophytes and extends from the water edge to water depths between 3 and 6 feet.

Middle Littoral Zone: Occupies water depths of 3 to 9 feet, extending lakeward from the upper littoral zone. The middle littoral zone is dominated by floating-leaf plants.

Lower Littoral Zone: Extends to a depth equivalent to the limit of the photic zone, which is defined as percent of surface light intensity.



Relationship of phytoplankton and macrophyte communities.
Source: WDNR

The abundance and distribution of aquatic macrophytes are controlled by other factors than dissolved nutrient availability. These factors include light availability, lake trophic status as it relates to nutrients and water chemistry, sediment characteristics, and wind energy. Lake morphology and watershed characteristics relate to these factors independently and in combination (NALMS, 1997).

In many instances aquatic plants serve as indicators of water quality due to the sensitive nature of plants to water quality parameters such as water clarity and nutrient levels. To grow, aquatic plants must have adequate supplies of nutrients. Microphytes and free-floating macrophytes (e.g., duckweed) derive all their nutrients directly from the water. Rooted macrophytes can absorb nutrients from water and/or sediment. Therefore, the growth of phytoplankton and free-floating aquatic plants is regulated by the supply of critical available nutrients in the water column. In contrast, rooted aquatic plants can normally continue to grow in nutrient-poor water if lake sediment contains adequate nutrient concentrations. Nutrients removed by rooted macrophytes from the lake bottom may be returned to the water column when the plants die. Consequently, killing aquatic macrophytes may increase nutrients available for algal growth.

In general, an inverse relationship exists between water clarity and macrophyte growth. That is, water clarity is usually improved with increasing abundance of aquatic macrophytes. Two possible explanations are postulated. The first is that the macrophytes and epiphytes out-compete phytoplankton for available nutrients. Epiphytes derive essentially all of their nutrient needs from the water column. The other explanation is that aquatic macrophytes stabilize bottom sediment and limit water circulation, preventing re-suspension of solids and nutrients (NALMS, 1997).

If aquatic macrophytes are reduced in abundance, water clarity can suffer. Water clarity reductions can further reduce the vigor of macrophytes by restricting light penetration, reducing the size of the littoral zone, and further reducing water clarity. Studies have shown that if 30 percent or less of the area of a lake occupied by aquatic plants is controlled, water clarity will generally not be affected. However, lake water clarity will likely be reduced if 50 percent or more of the macrophytes are controlled (NALMS, 1997).

Aquatic plants also play a key role in the ecology of a lake system. Aquatic plants provide food and shelter for fish, wildlife and invertebrates. Plants also improve water quality by protecting shorelines and the lake bottom from erosion due to boat wakes, improving water quality by providing dissolved oxygen and using nutrients otherwise available algae blooms.

5.6.2 Aquatic Plant Survey

Three particular species have grown to nuisance levels in Sturgeon Bay, impeding navigation and recreation. Nuisance species include *Myriophyllum spicatum* (Eurasian watermilfoil), *Potomageton crispus* (Curly lead pondweed), and *Elodea conadensis* (Elodea).

The WDNR completed an inventory of aquatic plants covering Sturgeon Bay in the summer of 2002. Eighteen species of floating leaved and submerged aquatic vascular plants and algae were identified during the surveys, however, only nine species of plants were present in June and fourteen species of plants were present in August. Aquatic plant species identified in Sturgeon Bay are summarized in Table 1. June and August Distribution of aquatic plant species are illustrated in Figure 6 and Figure 7, respectively. Plant survey information, including transect locations and species abundance ratings, from the 2002 aquatic plant surveys is included in Appendix B.

During the June and August 2002 survey, the most abundant species found in Sturgeon Bay was *Elodea canadensis* (Elodea) with an average 64 percent frequency of occurrence (percent of sample points containing that species) in June and 68 percent in August. It is important to note that these percentages are an average frequency of occurrence for all transects and depths, including areas of Sturgeon Bay outside the City's management area. *Myriophyllum spicatum* (Eurasian watermilfoil) was the second most abundant species in the June survey with a 45 percent frequency of occurrence June. *Ceratophyllum demersum* (Coontail) was the second most abundant species in the August survey with a 48 percent frequency of occurrence.

Using relative frequency (the frequency of occurrence compared to the occurrence of all species) as a measure of aquatic plant abundance, Elodea had an average relative frequency (in June of 21 percent and 22 percent in August. Eurasian watermilfoil had a 13 percent relative frequency in June and Coontail had a 15 percent relative frequency in August. Species abundance ratings are included in Table 2. These abundance ratings include the aquatic plant survey data from across all of Sturgeon Bay. While the survey data did not indicate curly leaf pondweed as abundant across Sturgeon Bay, it is abundant within the APM harvesting areas.

Filamentous alagae (*Amblostegia spp.*) was identified in Sturgeon Bay. Other forms of algae may also be present. Filamentous algae mats form over dense stands of aquatic macrophytes. Occasional uni-cellular algae blooms may also occur when high levels of nutrients become available in the water column.

An aquatic plant survey was also previously completed in 1993. In 1993, only eight species of aquatic macrophytes were identified. This is compared to nine plant species in the June 2002 and fourteen species in the August 2002 survey. Relatively the same levels of percent frequencies for aquatic macrophytes were seen in the two surveys conducted in 2002 and the survey completed in 1993. *Myriophylum spicatum* (Eurasian watermilfoil) and *Elodea canadensis* (Elodea) had the highest frequency of occurrence during both 1993 and 2002. However, *Elodea canadensis* (Elodea) had the higher frequency of occurrence in 2002, while *Myriophylum spicatum* (Eurasian watermilfoil) had the highest frequency of occurrence in 1993. A copy of the 1993 aquatic plant survey is also included in Appendix B.

The littoral zone, the depth to which light penetrates permitting photosynthesis and colonization of aquatic macrophytes. The littoral zone can fluctuate based on water quality and the amount of turbidity in the water, Areas of the littoral zone that are more conducive to supporting certain aquatic plant species. Sturgeon Bay has areas of soft sediments that are able to support higher numbers of aquatic macrophyte populations due to rich mineral content. Most aquatic macrophytes are found growing in an area in which they are able to maximize their ability to absorb varying levels of light intensity. These areas are generally composed of a substrate that is also most conducive to supporting aquatic macrophytes as well.

5.6.2.1 Submergent Plants

The submerged aquatic plant species identified during the 2002 aquatic plant surveys are listed in Table 1. A brief description about these plants follows.

Eurasian watermilfoil

Eurasian watermilfoil (EWM) is a submersed aquatic plant native to Europe, Asia and northern Africa. It was introduced to the United States by early European settlers. Eurasian watermilfoil has

Source: UW Herbarium Website

proliferated in waterways across North America. Eurasian watermilfoil was first detected in Wisconsin lakes during the 1960's. In the past three decades, this exotic species has significantly expanded its range to about 310 lakes in 54 of Wisconsin's 72 counties. The range of Eurasian watermilfoil continues to expand in Wisconsin from 1994 to 2001 (DNR, 2002). Because of its potential for explosive growth and its incredible ability to regenerate, Eurasian watermilfoil can successfully out compete most native aquatic plants, especially in disturbed areas.

Eurasian watermilfoil shows no substrate preference, and can grow in water depths greater than 4 meters (Nichols, 1999). Eurasian watermilfoil does not rely on seed for re-production; its seeds germinate poorly under natural conditions. It reproduces vegetatively by fragmentation, allowing it to disperse over long distances. The plant produces fragments after fruiting once or twice during the summer. These shoots may then be carried down or up the Bay by water currents or inadvertently picked up by boaters. EWM is readily dispersed by boats, motors, trailers, bilges, live wells, or bait buckets, and can stay alive for weeks if kept moist. Once established in an aquatic community, milfoil reproduces from shoot fragments and stolons (runners that creep along the substrate).

As an opportunistic species, Eurasian watermilfoil is adapted for rapid growth early in spring. Stolons, lower stems, and roots persist over winter and store the carbohydrates that help milfoil claim the water column early in spring, photosynthesize, divide, and form a dense leaf canopy that shades out native aquatic plants. Its ability to spread rapidly by fragmentation and effectively block out sunlight needed for native plant growth often results in monotypic stands. Monotypic stands of Eurasian watermilfoil provide only a single habitat, and threaten the integrity of aquatic communities in a number of ways. For example, dense stands disrupt predator-prey relationships by fencing out larger fish, and reducing the number of nutrient-rich native plants available for waterfowl (DNR 2002).

<u>Elodea</u>

Elodea or common waterweed (*Elodea canadensis*) is an abundant native plant species that is distributed statewide. It prefers soft substrate and water depths to 3.9 meters (Nichols, 1999). Elodea reproduces by seed and sprigs (USDA, 2002). Elodea offers critical spawning habitat for perch and other fish. The stems of elodea offer shelter and grazing to fish, but very dense elodea can interfere with fish movement. Elodea can be considered invasive at times and out-competes other more desirable plants. After the 2002 curly leaf pondweed bloom subsided, elodea was the predominant vegetation removed by harvesting.

Source: UW Herbarium Website

<u>Curly leaf Pondweed</u>

Curly leaf pondweed (*Potamogeton crispus*) is also an exotic plant of eurasian origin that forms surface mats that interfere with aquatic recreation. Curly-leaf pondweed was the most severe nuisance aquatic plant in the Midwest until Eurasian watermilfoil appeared. Curly-leaf pondweed grows under the

Source: UW Herbarium Website

ice, but dies back relatively early, releasing nutrients to the water column in summer possibly leading to algal blooms. It provides cover and foraging opportunities to fish and invertebrates. It also provides critical spawning habitat for perch in March and April. The plant usually drops to the lake bottom throughout July. It prefers soft substrate and shallow water depths (Nichols, 1999). Curly leaf pondweed reproduces by seed and vegetative buds called turions. Seeds play a relatively small role in reproduction compared to germination of turions. Curly leaf pondweed can also out-compete more desirable native plant species. In 2002, early cutting operations saw an increase in the overall amounts of curly leaf pondweed harvested.

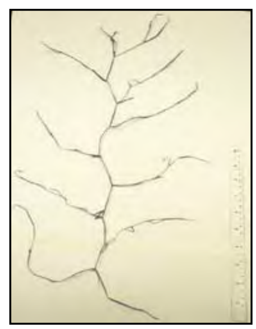
<u>Coontail</u>

Coontail (*Ceratophyllum demersum*), a submergent aquatic plant. Unlike most other submergent aquatic plants, coontail is not rooted and can drift, making it tolerant to higher water levels. Because it does not have roots, it absorbs nutrients dissolved in the lake water. Coontail provides excellent shelter and foraging opportunities for fish and invertebrates, and waterfowl consume its foliage and fruit (Borman, et al., 1997).

Coontail

<u>Sago Pondweed</u>

Sago pondweed (*Pomatogeton pectinatus*) was found in scattered locations throughout Sturgeon Bay with the densest stands being found in the 1.75 to 5.0 foot depth zone. Sago pondweed resembles two other pondweeds with needle-like leaves, but sago pondweed tends to be much more common. The fruit and tubers of sago pondweed are very important food sources for waterfowl, while leaves and stems provide shelter for small fish and invertebrates (Borman, et al., 1997).



Sago Pondweed

<u>Leafy Pondweed</u>

Leafy pondweed *(Pomatogeton foliosus*) is a freely branched stems that emerge from slender rhizomes. This plant is easily identifiable by a stipule that is found wrapped around the stem. However, leafy pondweed can be confused with small pondweed. Leafy pondweed tends to bloom early in the season with a short flower stalk and a tight cluster of flowers. Waterfowl eat the fruits of this early to mature aquatic and can be of local importance. Muskrat, beaver, and deer eat the foliage and fruit. Invertebrates and fish forage and hide in the foliage (Borman, et al., 1997).

<u>Small Pondweed</u>

Small pondweed (*Potamogeton pusillus*) has small slender stems and emerge from the slight rhizome and branch repeatedly near the ends. Small pondweed overwinters by rhizomes and winter buds. There is some limited reproduction by seed with leaving fragments overwintering with buds in the sediments. Small pondweed can be locally important as a food source for a variety of wildlife. Waterfowl tend to feed on small pondweed as well as deer, muskrat, and other small fish (Borman, et al., 1997).

Flat-stem pondweed

Flat stem pondweed (*Potamogeton zosteriformis*) is easily identifiable from other pondweeds by its flattened stem and noticeable stipules. Flat stem pondweed grows in a variety of water depths and is usually found in soft sediments. Flowering occurs early in the growing season with leaves dieing back in the fall and leaf fragments overwintering on the sediment. This plant to can be locally important to many types of wildlife (Borman, et al., 1997).

Variable pondweed

Variable pondweed (*Potamogeton diversifolius*) or water-thread pondweed is a freely branched plant with an obvious midvein bordered by single row lacunar cells on both sides of the stem. New shoots are produced in spring form overwintering rhizomes. Flowering occurs by midsummer with fruiting structures becoming evident in late summer. A locally important food source for a variety of wildlife from waterfowl to small mammals (Borman, et al., 1997).

Clasping-leaf pondweed

Clasping-leaf pondweed (*Potamogeton richardsonii*) is often found growing with coontail and small pondweed. Stems emerge in spring form overwintering rhizomes and flowers appear by midsummer. Fruit develops by mid-growing season and are feed on by waterfowl. Leaves also are colonized by invertebrates and offer foraging opportunities and cover for fish (Borman, et al., 1997).

Muskgrass

Although muskgrass (*Chara, spp.*) looks like a higher plant, it actually is a multi-celled algae. According to many people familiar with Rush Lake, muskgrass was once very common, if not overly abundant. During the 2001 plant reconnaissance, muskgrass was only found in clearer water in protected bays and near creek mouths. Waterfowl eat muskgrass spores. Muskgrass beds provide valuable habitat for small fish and invertebrates (Borman, et al., 1997).

Slender Naiad

Slender Naiad (*Najas flexilis*) or sometimes called bushy pondweed has fine branched stems that emerge from a slight rootstalk. Leaves are paired, but there are some sometimes bunches of smaller leaves. Slender Naiad can grow in very shallow to several meters in depth. Waterfowl, marsh birds, and muskrats consume the stems, leaves, and seeds of naiads. The foliage produces forage and shelter opportunities for fish and invertebrates (Borman, et al., 1997).


Slender Naiad

White-stem Pondweed

White-stem pondweed (*Potamogeton praelongus*) can be easily confused with clasping leaf pondweed, however, clasping leaf has smaller leaves that are not boat-shaped at the tip and fruit do not have a sharp dorsal ridge. White-stemmed pondweed is considered to be a plant that is sensitive to water quality changes. Some researchers have shown that white-stem pondweed can not tolerate turbid water. This plant can be considered an indicator species of degrading water quality (Borman, et al., 1997).

Wild Celery

Wild celery (*Valisneria americana*) or also commonly called eel-grass or tape-grass has ribbon like leaves that tend to grow till they emerge in clusters along the waters surface. Wild celery is a premiere source of food for waterfowl. All portions of the plant are consumed. This plant is an extremely important food source for canvasbacks which feed on the tubers of this plant. Beds of wild celery are also considered good fish habit providing shade, shelter and feeding opportunities.

Creeping spearwort

Creeping spearwort (*Ranunculus sp*.) is a small plant that is found growing near the lakes bottom. It is found commonly in shallow waters and provides habitat for valuable invertebrates.

Nitellas

Nitella (*Nitella sp*.) is a type of algae that looks like a higher plant. This plant has no conductive tissue and has simple anchoring structures called rhizoids rather than true roots. Nitella is similar in appearance to muskgrass and is often found in similar habitats.

Northern watermilfoil

Northern watermilfoil (*Myriophyllum sibiricum*) was found in Sturgeon Bay, however not at nuisance levels like Eurasian watermilfoil (*Myriophyllum spicatum*). Northern watermilfoil can also reach nuisance levels posing problems for recreational and navigational patron. Waterfowl eat the foliage and fruit of northern watermilfoil, while beds of this plant provide cover and foraging opportunities for fish and invertebrates.

Northern watermilfoil

5.6.2.2 Floating-Leaf Plants

No species of floating leaf plants were identified by the WDNR aquatic plant surveys in 2002. However, floating leaf plant species such as white water lily and spatterdock may be present in shallow water areas of Sturgeon Bay along undeveloped shorelines.

5.6.2.3 Free-Floating Plants

No species of free floating leaf plants were identified by the WDNR aquatic plant surveys in 2002. However, free floating plant species such as duckweed (lemna sp.) may be present in Sturgeon Bay.

5.6.2.4 Emergent Plants

No species of emergent plants were recorded by the WDNR aquatic plant surveys in 2002. However, emergent plant species are present in undeveloped shoreline wetland areas of Sturgeon Bay.

5.6.3 Sensitive Areas

Based upon the 2002 aquatic plant survey, WDNR designated approximately 260 acres of the Bay's management area as a "Sensitive Area". Sensitive areas are areas of aquatic vegetation identified by the WDNR as offering critical or unique fish and wildlife habitat, including seasonal or lifestage requirements, or offering water quality or erosion control benefits to the body of water. The sensitive areas in the APM area are depicted in Figure 8.

5.7 Wildlife

Sturgeon Bay is important for area wildlife, including: fish; birds; mammals; amphibians and reptiles; crustaceans and mollusks; and insects. Urban areas of the Bay have developed much of the suitable habitat for wildlife. Animals that are not completely aquatic are generally limited to any remaining wetland and woodlands adjacent to the urban areas. No known threatened and endangered species are known to occur within the aquatic plant management area.

5.7.1 Fish

The Bay contains habitat for warm, cool, and cold water fish species. The following lists fish species observed at six locations within the Sturgeon Bay management area following electroshocking by the WDNR during the fall of 2002.

Common Name	Scientific Name
Bullhead	*Ictalurus* spp.
Channel Catfish	*Ictalurus punctatus*
Carp	*Cyprinus carpio*
White Sucker	*Catostomus commersoni*
Gizzard Shad	*Dorosoma cepedianum*
Pumpkin Seed	*Lepomis gibbosus*
Sunfish	*Lepomis* spp.
Small Mouth Bass	*Micropterus dolomieui*
Rock Bass	*Ambloplites rupestris*
Yellow Perch	*Perca flavescens*
Freshwater Drum	*Aplodinotus grunniens*
Northern Pike	*Esox lucius*
Bowfin	*Amia calva*

Source: Toneys, 2002

Bullheads, catfish, and non-native carp, favor warm water, however they as well as white suckers are hardy fish that can tolerate a wide variety of conditions, including low oxygen and high pollutant concentrations. Carp are known to degrade water quality by uprooting vegetation, consuming desirable plants, and re-suspending sediments during bottom feeding and spawning. White suckers and gizzard shad are important food sources for larger fish. Members of the sunfish family (including pumpkinseed, small mouth bass, and rock bass) are among the most common fish found in Wisconsin. They prefer cool to moderately warm water of rivers, ponds, and lakes with moderate amounts of vegetation. Northern pike are also found in cool to moderately warm waters, but have a preference for dense vegetation. The freshwater drum is commercially fished in Green Bay. It prefers turbid water and is seldom found in shallow weedy areas. The bowfin, however, prefers clear water and abundant vegetation. Yellow perch are most often found in moderate amount of vegetation, but their range is limited by high summer temperatures (Becker, 1983).

Other fish species known to inhabit Sturgeon Bay include the following.

Common Name	Scientific Name
Walleye	*Stizostedion vitreum*
Bluegill	*Lepomis macrochirus*
Muskellenge	*Esox masquinongy*
Round Goby	*Neogobius melanostomus*

While the electroshock fish survey did not identify round gobies, significant numbers of gobies have been documented in Sturgeon Bay. Gobies probably were not affected by the eleoctroshocking due to their proximity to the bottom and possibility of being buried within sediments and under rocks (Toneys, 2003). Two species of special concern, banded killifish and lake sturgeon, may also occur in the Bay (Becker, 1983). Since the Bay is linked to Green Bay and Lake Michigan, other great lake fish such as coho salmon *(Oncorhynchus kisutch)* and chinook salmon *(Oncorhynchus tshawytscha)* are also likely to be present and reportedly spawn in Strawberry Creek.

5.7.1.1 Yellow Perch

Yellow perch were once common to Green Bay and Lake Michigan, and the species was valuable to both the sport and commercial fishing industries (Becker, 1983). However, yellow perch numbers have been declining since the late 1980's (Horns, 2001). The WDNR believes sensitive habitat for yellow perch is present in Sturgeon Bay. Relevant aspects of the perch life history will be discussed in detail below.

Yellow Perch

Yellow perch reach maturity after 2-3 years (Holtan, 1990). Spawning occurs shortly after ice-out (approximately during April or early May) at water temperatures of 45-52 ^{o}F. Yellow perch are random spawners that do not construct nests or guard their eggs. Eggs are generally deposited at night, over submergent vegetation, or gravel, sand, or rubble bottoms at depths of 2-9 feet (Becker, 1983). The number of eggs produced depends on the age and size of the fish. Yellow perch can produce as many as 210,000 eggs, but the average is 28,000 eggs. Eggs are held together in a distinctive strand with accordion folds (Holtan, 1990).

It can take anywhere from 8 days to a month for eggs to hatch, depending on water temperature. For 3-5 days, the fry survive on the yolk sack. Then they begin eating zooplankton and later small insects. Perch grow rapidly in length during their first two years. Then they grow more in weight than length. As they grow, minnows and other small fish make up more of their diet (Holtan, 1990).

Perch form schools of fish the same size and age. Smaller fish tend to stay in shallower water near vegetation. Larger fish move into open water. Generally, perch move toward shore in spring to spawn, out to deeper water during summer as temperatures increase, and into very deep water during winter. Yellow perch populations tend to do best in clear water with moderate amounts of vegetation. Lack of good cover for spawning habitat can reduce populations (Holtan, 1990).

The reason for the Green Bay perch population decline is not currently known. Some causes may include the following or a combination of the following: presence of exotic species (zebra mussels, alewife, white perch); reduction of quality/quantity of spawning and nursery habitats; cormorant populations; natural population dynamics; and low water levels (Horns, 2001), (Cahoe, 2003).

5.7.2 Amphibians and Reptiles

Several herptile species may be located in the vicinity of the Bay. If enough suitable wetland and woodland habitat occurs adjacent to the Bay, habitat may be present for American toads, green frogs, Eastern gray tree frogs, Northern spring peepers, or Northern Leopard frogs. The common mudpuppy is an aquatic salamander common to Wisconsin lakes and rivers. The common snapping turtle and painted turtle are probably located in the Bay as well. Both turtles are found in most permanent water bodies in the state. The painted turtle is able to survive in heavily urbanized areas and degraded wetlands (Casper, 1996) (Korb, 2001). Two snakes, common garter snake and northern water snake, may also occur nearby. The common garter snake can generally be found in nearly every type of habitat throughout the state. The Northern water snake prefers rivers, but can generally be found close to any permanent water body (Christoffel, et al., 2000)

5.7.3 Birds

It is believed that many migratory birds may use the Niagara Escarpment as a landmark during their spring and fall migrations (WDNR, 2003). Nearly 100 species of birds, mostly migratory, have been confirmed in the greater Sturgeon Bay area (WBBA, 2003). Most of these prefer more rural and wooded areas. However, a number may be found in the project area and nearby shore. The following birds are likely to use Sturgeon Bay in the management area:

Birds That May Inhabit the Sturgeon Bay Area

Pied-billed Grebe	Ring Billed Duck	Chipping Sparrow
Canada Goose	Killdeer	Red-winged Blackbird
Mallard Duck	Black Tern	Brown-headed Cowbird
Blue-winged Teal	Herring Gull	House Finch
Green Wing Teal	Chimney Swift	House Sparrow
Wood Duck	Cliff Swallow	Greater Scaup
Red Head Duck	American Robin	Lesser Scaup
Canvasback	American Crow	European Starling
Cedar Waxwing		

Large numbers of Canada geese and herring gull occur in urban area lakes as well as smaller numbers of mallards and black tern. Killdeer may be found on the beaches and parking lots nearby. Lakes with adjacent wetland may attract pied-billed grebes and blue-winged teal. Many species of birds have adapted to living near humans. Rock dove, cliff swallow, American crow, and brown-headed cowbird are frequently found near buildings, bridges, or cities. Others such as American robin, chipping sparrow, house sparrow, and house finch often inhabit quieter residential areas (ODNR, 2003)(INHS, 2003). The greater Sturgeon Bay ecosystem is also a resting place for a wide variety of migratory waterfowl.

5.7.4 Mammals

The following mammals occur in Door county where appropriate wetland or woodland habitats border a waterbody: short-tailed shrew, meadow vole, common muskrat, raccoon, New York long-tailed weasel, and otter. Although the Norway rat and house mouse do not favor aquatic environments, they are common to urban areas (Jackson, 1961), and may be found along the shoreline of Sturgeon Bay.

5.7.5 Crustaceans and Mollusks

Crustaceans are a group of aquatic organisms that include shrimp, crab, lobster, crayfish, and zooplankton. Crustaceans that occur in Wisconsin include crayfish and zooplankton. Zooplankton are microscopic or barely visible animals that often eat algae. They are an important component of the lake food chain, because they are a primary source of food for fish (Shaw, et al., 1994). Eight species of crayfish are known to occur in Wisconsin (BYU, 2003). *Orconectes propinquus* (threatened) and *Orconectes virilus* are two native species that inhabit lakes. Rusty crayfish (*Orconectes rusticus*), an aggressive invasive species that is known to displace native crayfish, also inhabits many lakes and streams throughout the state and have been found in Sturgeon Bay (Stocker, 2003) (Gunderson, 2003).

Freshwater mollusks of Wisconsin include mussels and snails. Mussels are a food source for many animals, including muskrat, otters, and birds. Fatmucket (*Lampsilis siliquoidea)* and giant floater (*Pyganodon grandis)* are commonly located in the mud, sand, or gravel bottoms of Wisconsin lakes. Spike mussels (*Elliptio dilatata*) also occur in lakes with mud or gravel bottoms, but their distribution in Wisconsin is sporadic (Cummings and Mayer, 1992). It is not known what snail species may occur in the Bay.

Zebra mussels (*Dreissena polymorpha)* have invaded Lake Michigan, Green Bay, and increasing numbers of inland lakes. Zebra mussels were transported from the Caspian Sea in ship's ballast water. They have been documented in Sturgeon Bay. Zebra mussels are able to attach to nearly any hard surface, including other mussels (Cummings and Mayer, 1992).

6.0 WATER QUALITY

6.1 Surface Water

Water quality is very dynamic and varies greatly from day to day and from season to season. Water in Sturgeon Bay comes from a variety of sources including ground water, surface runoff, tributaries, precipitation, Green Bay, and Lake Michigan. The following explains water quality parameters collected as part of the 2002 aquatic plant study. Data that is specific to Sturgeon Bay were collected during summer 2002 by Northern Environmental personnel and/or City of Sturgeon Bay aquatic plant harvesting crews. The locations of water quality samples collected for laboratory analysis are located in Figure 2. Results of these water quality samples are summarized in Table 3. The laboratory analytical reports for water sampling are included in Appendix C.

Furthermore, the City collected various important data on water clarity, water depth, pH, alkalinity, type of aquatic plants harvested, etc. A summary of their data collection efforts is included in Appendix D.

6.1.1 Temperature

Water temperature profoundly affects a water body's characteristics. Temperature influences water circulation patterns, solubility of various compounds, chemical reaction rates, and species and distribution of aquatic plants and animals. The temperature regimens of a water body are controlled by climatic and wind conditions, basin morphology, surrounding topography and vegetation, water inflows and outflows, and water chemistry.

Surface water temperatures were collected on Sturgeon Bay throughout June, July, and August 2002. Surface water temperatures in June ranged from 57 degrees Fahrenheit (^{o}F) to 80 ^{o}F with most temperatures in the 60 ^{o}F range. Surface water temperatures in July ranged from 56 ^{o}F to 90 ^{o}F with most temperatures in the 60 ^{o}F and 70 ^{o}F ranges. Surface water temperatures in August ranged from 65 ^{o}F to 77 ^{o}F with most temperatures in the 70 ^{o}F range. Temperature data indicate that bays and protected near-shore areas were generally warmer than open channel areas, indicating that wind mixing or a seiche effect may play a role in mixing the waters of Sturgeon Bay, but at the same time sheltered areas may not mix completely with the middle open water areas of Sturgeon Bay.

Temperature measurements from outside the ship canal in Lake Michigan were consistently lower than measurements in Sturgeon Bay. Green Bay water was also cooler than Sturgeon Bay water, however not as cool as Lake Michigan water. This data suggests that Sturgeon Bay may act as a "mixing" zone between Green Bay and the Lake Michigan basin.

Most deeper water bodies in Wisconsin thermally stratify. Temperature-induced density changes cause the waterbody to develop three distinct temperature zones. During summer, these zones include the epilimnion (warm surface layer), metalimnion (transitional layer), and the hypolimnion (cold bottom layer). Little mixing occurs between these layers while the waterbody is stratified. Since the hypolimnion is not exposed at the lake surface, it does not exchange gases with the atmosphere. In eutrophic lakes, decomposing organic debris in the hypolimnion can deplete oxygen, leading to an anoxic hypolimnion. Anoxic water is not habitable for most desirable aquatic life and encourages dissolution of phosphorus from bottom sediment (Shaw, et al., 1994).

In most water bodies, thermal stratification breaks down each fall as the atmosphere cools, allowing deeper water formerly trapped in the hypolimnion to mix with surface layers. During winter, many water bodies again stratify. Since water reaches its maximum density at 4° centigrade (a temperature slightly above the freezing point of water), warmer water is found at depth, while cooler, near-freezing water is found directly below the ice. This inverse temperature stratification is easily disrupted, and the water bodies usually mix during spring. Mixing can bring large amounts of nutrients to the surface of a lake, enhancing productivity. Water bodies that stratify and undergo two periods of mixing are termed "dimitic."

Temperature/depth information was collected in July 2002 in the navigation channel just north of the Bay View bridge. This measurement indicated that the Bay was not thermally stratified. This observation was taken after a large seiche occurred, which may have mixed any stratified layers. Observations of secchi disk measurements taken during this sampling event indicated that the disk was had drifted at least 15 degrees from perpendicular away from the boat. This observation suggests that there was an appreciable current in the Bay moving from Lake Michigan to Green Bay (northwest). Conversations with City aquatic plant harvesting staff indicates that there is indeed a considerable seiche effect at times and Bay currents are affected by the wind.

Even though thermal stratification normally occurs in deeper water, relatively shallow areas protected from the wind and current and/or fed by large amounts of ground water can stratify during hot weather under some instances. For example, shallow protected bays could conceptually stratify if the wind is minimal for several days. Given the higher surface water temperatures collected in shallow areas and the fact that significant amounts of ground water discharge contributes to Sturgeon Bay, it is likely that some or all of the Bay can stratify in some instances.

6.1.2 Oxygen

Oxygen solubility varies with temperature, water purity, and atmospheric pressure. More oxygen can dissolve into pure cold water at low elevations. Increasing water temperature, salinity, and elevation decrease oxygen saturation potential. Dissolved oxygen is also affected by biological productivity. Aquatic plants produce oxygen, but plant and animal decomposition and respiration use oxygen. When respiration and decomposition use more oxygen than can be replenished by exchange with the atmosphere and plant oxygen production, oxygen levels decrease. Oxygen can be exhausted in some cases, especially when water cannot freely mix and exchange gases with the atmosphere. Fish kills can occur during winter because ice does not allow air to water oxygen transfer while ice and snow limit light penetration, hindering photosynthetic oxygen production. Although less common, excessive aquatic plant growth and subsequent decomposition of dead organic matter can also cause excessively low dissolved oxygen concentrations. This can cause fish mortality in species inhabiting the cold water portions of a lake. In some lakes, abundant aquatic plant growth can cause dissolved oxygen concentrations to rise above saturation values. Supersaturated oxygen concentrations can also be detrimental to aquatic organisms.

Summer stratified dissolved oxygen levels vary greatly throughout a 24-hour period. Higher DO concentrations will be found in the afternoon because of a peak in photosynthetic activity by aquatic plants. The lowest DO concentrations will be found in the hours just before daylight due to respiration by these plants.

Water should contain at least 5 milligrams per liter (mg/l) oxygen to support a healthy warm-water fishery. To support trout, at least 7 mg/l oxygen should be present. Even though fish can tolerate lower oxygen concentrations for variable periods, low oxygen levels stress the fish, and often promote the success of less desirable species, such as carp and bullheads.

Dissolved oxygen (DO) levels measured during July 2002 indicate that the surficial waters of Sturgeon Bay become supersaturated with oxygen at the surface. Oxygen super-saturation normally results from prolific growth of aquatic plants, wind, or rapidly increasing water temperature thus decreasing the oxygen saturation potential. It is probable that excessive macrophyte growth is contributing to oxygen super-saturation on Sturgeon Bay. This phenomenon is accompanied by depressed oxygen at night (very early morning hours being the worst). It does not appear the supersaturation of oxygen or depressed oxygen levels at night are harmin fish in Sturgeon Bay. Adequate oxygen is present to support the fishery.

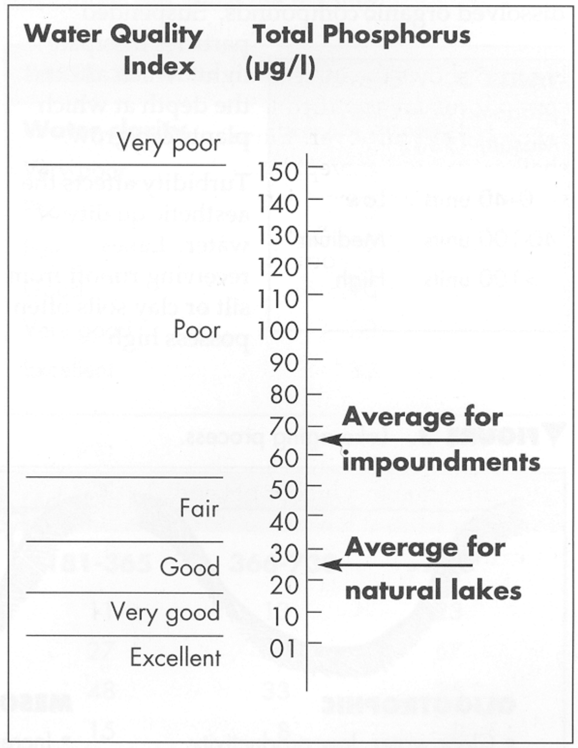
Oxygen profiles measured during July 2002 suggest that the deepest portions of Sturgeon Bay contains sufficient oxygen to support fish life. As mentioned above, sheltered areas of Sturgeon Bay have the potential to thermally stratify. Therefore, anoxic conditions could occur, however these areas would soon become mixed from water movement through the Sturgeon Bay ship canal. In conclusion, anoxic conditions do not appear to be harming the fishery in Sturgeon Bay.

6.1.3 Nutrients

Nitrogen and phosphorus are macronutrients essential to plant growth. While plants require many compounds to live, most are readily available in sufficient quantities to allow growth. Nitrogen and phosphorus are typically not as available, and the concentrations of one or the other usually limit aquatic plant growth. Consequently, knowing the concentration of these compounds in water can help us identify current and potential aquatic plant growth limitation factors.

6.1.3.1 Phosphorus

Phosphorus is the key nutrient controlling aquatic plant growth in 80 percent of Wisconsin lakes (Shaw, et al., 1994). Lake water phosphorus concentrations are usually measured as soluble reactive phosphorus and total phosphorus. Soluble reactive phosphorous is readily available to plants. Consequently, its concentration can vary widely over short periods. A potentially better measure of lake water phosphorus level is total phosphorus, which measures dissolved phosphorus as well as phosphorus in plants and animal fragments suspended in lake water.



Total phosphorus concentrations for Wisconsin's natural lakes and impoundments. (*Adapted from Lillie and Mason, 1983.*)

Source: UW Extension, Understanding Lake Data

Phosphorus is very reactive in the environment, being absorbed by plants and attaching itself tightly to sediments. Consequently, sediments carried by surface water are typically the largest external source of phosphorus to lakes. Phosphorus does not readily dissolve in lake water, forming insoluble precipitate with iron, calcium, and aluminum. Consequently, most fully oxygenated waters with abundant calcium or iron ions have a net flux of phosphorus to the lake bottom.

Rooted aquatic plants still can obtain phosphorus from sediments, therefore, hard water lakes may have clear water, but still be weedy. However, if water lacks oxygen, iron precipitates become unstable and release phosphorus to the overlying water. The hypolimnia in eutrophic lakes are often devoid of oxygen during summer, increasing the concentration of dissolved phosphorus available to plant growth.

Waters with total phosphorous levels below 20 micrograms per liter (ug/l) will generally not have nuisance algae blooms (Shaw, et al., 1994). It should be noted that phosphorus levels are discussed in here in ug/l while other water quality parameters are expressed milligrams per liter (mg/l). There are 1,000 micrograms in a milligram.

The median total phosphorous concentration measured in 242 northeastern Wisconsin lakes is 16 ug/l (Lillie and Mason, 1983). According to EPA Great Lakes monitoring data from the nearest monitoring point, 1990 to 1999 total phosphorus levels in Lake Michigan average between 10 and

20 ug/l. Phosphorus concentrations were determined from surface water samples collected in selected areas across Sturgeon Bay. One sample was also collected near the Sturgeon Bay channel bottom (25 feet).

Total phosphorus levels ranged from 17 ug/l to 86 ug/l with most results in the 20 to 50 ug/l range (Table 3). The higher than average phosphorus concentrations found in Sturgeon Bay may be attributed to any one or a combination of the following:

- External sources of phosphorus (see storm water discussion later)
- Internal cycling from sediments (see above discussions on stratification and mixing)
- Aquatic plants dying and subsequently releasing phosphorus into the water column.

One sample collected from Purves lagoon contained a particularly high concentration of phosphorus (86 ug/l). According to City aquatic plant program staff, this area was recently chemically treated with herbicides for aquatic plants. This high level of phosphorus may be attributed to the dead aquatic plants releasing the phosphorus from their tissue into the water column. (See discussions later on chlorophyll *a*, Secchi disk measurements, and water clarity).

A sample collected from the Green Bay side of Sturgeon Bay (off Sherwood Point) contained 23 ug/l total Phosphorus. Comparatively, a sample collected in Lake Michigan on the other side of Sturgeon Bay (at Coast Guard Station) contained a non-quantifiable amount of Phosphorus. This suggests that Green Bay water may be more nutrient enriched than Lake Michigan waters. Sturgeon Bay contains higher levels of Phosphorus than both Green Bay and Lake Michigan, suggesting that external sources of phosphorus are present within Sturgeon Bay.

6.1.3.2 Nitrogen

Nitrogen is another nutrient limiting the growth of aquatic plants, usually second in importance to phosphorus. Nitrogen limits the growth of plants in a few Wisconsin lakes. Nitrogen can enter a lake via precipitation (which can have concentrations of nitrogen as high as 0.5 mg/l), breakdown of organic compounds (forming ammonia), and human-induced sources of nitrogen such as fertilizers, sewage effluent, and animal waste. Even though nitrogen demand in vegetated terrestrial soils is high during active growing periods, nitrogen can move through soil and reach ground water if:

- Vegetation is not actively growing
- Nitrogen supply exceeds vegetative demand
- Nitrogen is injected directly to subsurface sediment (e.g., septic system drainfields)

Once nitrogen “leaches” to the ground-water table, it can migrate freely with ground water moving towards discharge points such as surface waters, wetlands, and drinking water wells.

Various forms of nitrogen can be found in soils, surface water and ground water. Water samples are commonly collected and analyzed for these nitrogen forms to determine nutrient cycles, budgets, or limiting nutrients. These forms of nitrogen include:

- Nitrate (NO_3^-) - leaches readily into ground water
- Nitrite (NO_2^-) - usually present in only trace quantities and is readily transformed to nitrate in oxygenated water.

- Ammonia – Produced by bacteria during decomposition of nitrogen containing organic matter. Ammonia in water is measured as the total of ammonium ion (NH_4^+) and ammonia gas (NH3)

- Ammonium – (NH4+) is an ionic form of ammonia in water

- Total Kjeldal Nitrogen (TKN) – Sum of nitrogen in suspended organic matter and ammonium

- Total Inorganic Nitrogen – Sum of Nitrate (NO3), Nitrite (NO2), and Ammonium (NH4+)

- Total Organic Nitrogen – TKN minus Ammonium (NH4+)

- Total Nitrogen – Sum of TKN, Nitrate (NO3), and Nitrite (NO2)

Nitrogen levels were measured in Sturgeon Bay for ammonia-nitrogen, nitrate, nitrite, and TKN.

According to EPA Great Lakes monitoring data from the nearest monitoring point, 1990 to 1999 nitrite + nitrate levels in Lake Michigan average between 0.2 to 0.3 mg/l and according to the UW Extension, if spring inorganic nitrogen levels are below 0.3 mg/l, summer algae blooms are less likely (Shaw, et al., 1994). Sturgeon Bay samples contained inorganic nitrogen ranging from 0 to 0.384 mg/l, most of which was ammonia and nitrate. Most samples contained less than 0.1 mg/l inorganic nitrogen. The highest inorganic nitrogen samples were collected from a depth of 25 feet in the ship canal and at the mouth of Big Creek (Table 3).

The mean total nitrogen concentration in a study of 243 northeastern Wisconsin lakes was 0.66 mg/l (Lillie and Mason, 1983). A sample collected from the Green Bay side of Sturgeon Bay contained 1.3 mg/l total Nitrogen. Comparatively, a sample collected in Lake Michigan on the other side of Sturgeon Bay contained 0.4 mg/l total Nitrogen. This indicates that Green Bay waters may be more nutrient enriched than Lake Michigan waters. Total nitrogen concentrations for water samples collected in Sturgeon Bay in 2002 ranged from 0.39 mg/l to 1.22 mg/l. Sturgeon Bay's nitrogen levels may be indicative of a mixing effect between the waters of Green Bay and Lake Michigan.

6.1.3.3 Nitrogen/Phosphorous Ratio

When the ratio of total nitrogen to total phosphorus is greater than 15 to 1, plant and algal growth in a lake is controlled by the amount of phosphorus available and is considered "phosphorus-limited." When the ratio is below 10 to 1, nitrogen is the limiting nutrient for plant and algae growth; values between 10 to 1 and 15 to 1 are considered transitional (Shaw, et al., 1994). Most Wisconsin lakes are phosphorus-limited.

During July and August 2002, the total nitrogen to total phosphorus ratios (N:P) of Sturgeon Bay ranged from 5:1 to 28:1 with most ratios in the 13:1 to 17:1 range. The water exhibiting the 5:1 nutrient ratio was collected from a lagoon at Samuelson's Creek. This nitrogen-limited water may be contributed to an algal bloom that was apparent in this area at that time (see above discussion of phosphorus and below discussion of chlorophyll a). Several samples collected in July and most samples collected in August 2002 indicated that Phosphorus was the limiting nutrient. Therefore, adequate nitrogen was present in these areas at this time to support aquatic plant growth. Additional phosphorous will fuel additional plant growth.

6.1.4 Chlorophyll *a*

Chlorophyll *a* concentrations correspond to the abundance of suspended algae in natural waters. Chlorophyll *a* concentrations respond to seasonal light changes, water nutrient content, transparency, aquatic macrophyte growth, temperature, and zooplankton abundance. High chlorophyll *a* concentrations relate to algal blooms. Algal blooms most often occur after spring and fall turnovers in lakes with anoxic hypolimnia. Algal blooms can also occur when other events liberate nutrients into the surface water system or otherwise upset nutrient equilibrium. Examples of events that could cause an algal bloom are:

- Severe thunderstorms washing nutrient-laden water or sediment into a lake
- Mid-season circulation of the hypolimnion caused by storms, flood flows, etc.
- Decrease in zooplankton abundance
- Anoxic water conditions destabilizing phosphorus bound in bottom sediments
- Significant manipulation of the macrophyte community

If macrophytes are destroyed, the demand for limiting nutrients is decreased, and nutrients are returned to the water from decomposing aquatic plants. This chain of events can cause algal blooms.

During summer 2002, chlorophyll *a* concentrations ranged from 0.84 to 83 ug/l with most results in the 5 to 10 ug/l range (Table 3). Northeastern Wisconsin lakes median chlorophyll *a* concentration is 6.7 µg/l. Values of 10 ug/l or higher are associated with algae blooms. Chlorophyll *a* readings less than 5 ug/l indicate very good water quality, while values less than 1 µg/l are indicative of excellent water quality (Lillie and Mason, 1983).

Chlorophyll *a* concentrations on Sturgeon Bay are generally within the range indicating normal to good water quality. One sample however indicated an algal bloom. The highest chlorophyll *a* concentration (83 ug/l) was from a sample collected in Purves lagoon. According to City aquatic plant program staff, this area was recently chemically treated with herbicides for aquatic plants. This likely resulted in the release of Phosphorus from the dead plant material into the water column, which caused increased algae growth. The high chlorophyll *a*, somewhat higher level of phosphorus, and reduced water clarity support this determination (see also sections discussing phosphorus and water clarity).

A sample collected from the Green Bay side of Sturgeon Bay contained 6.1 ug/l chlorophyll *a*. Comparatively, a sample collected in Lake Michigan on the other side of Sturgeon Bay contained 0.84 ug/l chlorophyll *a*. This indicates that Green Bay water is potentially more nutrient enriched and supportive of algae than Lake Michigan waters (see also discussions about phosphorus and water clarity or transparancy).

6.1.5 Alkalinity and pH

Surface water alkalinity is largely attributable to bicarbonate and carbonate that are typically released from dissolution of calcite and dolomite. Dissolution of calcite and dolomite also releases calcium and magnesium, producing hard water. Median alkalinity concentration in 243 northeastern Wisconsin lakes is 22 mg/l. Alkalinity buffers the effects of acidic rainfall by neutralizing low pH.

In hard waters where limestone is dissolved in the water, marl (calcium carbonate) forms a precipitate and falls to the bottom sediments (Shaw, et al., 1994). Lakes with abundant plant growth and high alkalinity water often have marl deposits. Marl is composed primarily of calcium carbonate but also includes phosphorus. Plant growth fosters marl formation by removing carbon dioxide from the water, increasing pH. Marl in often visible on the leaves of certain aquatic macrophytes.

The summer 2002 water samples collected from Sturgeon Bay had alkalinity values ranging from 80 mg/l to 240 mg/l with most results in the 100 to 200 mg/l range. The high alkalinity means that the water likely has equivalently high hardness values. The high alkalinity of Sturgeon Bay protects it from acid rain. Sturgeon Bay's high alkalinity and abundant macrophyte growth encourages marl formation. Marl formation is likely a sink for phosphorous dissolved in the water. The high alkalinity of Sturgeon Bay is most likely a direct result of ground-water discharge to the Sturgeon Bay from dolomite bedrock aquifers underlying Door County.

pH is an exponential index of hydrogen ion concentration used to measure acidity. pH is represented on a logarithmic scale from 1 to 14, 7 being neutral. Readings above 7 have less hydrogen ions and are basic (alkaline); readings below 7 have more hydrogen ions and are considered acidic. The Sturgeon Bay water pH readings ranged from 6.5 to 9 with most results between 8 and 9. These data are reasonable given the high alkalinity of the water and abundant aquatic plant growth. The median pH of 243 northeastern Wisconsin lakes is 7.1. Lower pH measured may result from abundant rainfall. Rainfall in southeastern Wisconsin is acidic, having a pH of about 4.4.

6.1.6 Transparency

Water clarity index.

Water clarity	Secchi depth (ft.)
Very poor	3
Poor	5
Fair	7
Good	10
Very good	20
Excellent	32

Source: UW Extension, Understanding Lake Data

Transparency is a function of water color and turbidity and is usually measured with a secchi disk. A secchi disk is an 8-inch circular plate with alternating black and white quadrants fixed to a length of graduated cord. During the middle of the day, the disk is lowered on the shaded side of the boat until an observer can no longer see the secchi disk. The depth is noted, the disk is then raised until it just again is visible, and the depth again is noted. The two measurements are averaged to give a reading. The deeper the secchi disk reading, the clearer the water. High concentrations of algae or suspended sediment usually account for shallow secchi disk readings. In some instances, colored water can also account for low secchi readings.

The summer 2002 secchi disk readings were variable across Sturgeon Bay. Secchi disk readings ranged from 1.5 feet to over 16 feet with most results in the 5 to 10 foot range. Water clarity of 10 feet or greater is considered "good" while 7 feet or less would be considered "fair or poor" (Shaw, et al., 1994). Sturgeon Bay is generally more transparent than the median of 8.8 feet for northeastern Wisconsin lakes.

As previously mentioned in the aquatic plant discussion, the photic zone is the depth at which light can penetrate to the bottom of the water column. This area is the limit of rooted aquatic plant (macrophyte) growth. Good water clarity (indicated by greater secchi depth readings) results in an increased photic zone. That is, rooted aquatic macrophytes can colonize deeper water areas.

The results of Secchi depth readings on Sturgeon Bay indicate that water clarity varies from good to poor. Secchi depth measurements are summarized on Table 3. Certainly, many factors contribute to these water clarity measurements. Generally, the benefits of water clarity information derived from secchi disk readings may be observed in the long-term. Weekly secchi depth readings collected over a number of years during open water periods provide an excellent, low-cost method to evaluate changes in water clarity that may relate to other biological and/or chemical changes in Sturgeon Bay's conditions. Long-term lower average secchi disk readings may be an indicator of increased nutrient loading, increased algal productivity, increased runoff or erosion, reduction in zebra mussels, etc. Increased secchi disk depths may be an indicator of reduced nutrient loading, decreased erosion, or an increase in zebra mussel activity and other factors. Long-term secchi monitoring trends can be an important tool in determining changes in Sturgeon Bay and developing management strategies.

6.1.7 Chloride

Under natural conditions, chloride concentrations in natural surface water in Wisconsin should be quite low. For example, in sparsely populated northern Wisconsin, median lake water chloride concentrations are between 1 and 2 mg/l. The presence of high chloride levels usually is accountable to human pollutants like road salt, fertilizers (potash), septic system effluent, and animal wastes. Septic effluent commonly contains 50 to 100 mg/l chloride (Shaw, et al., 1994). The Door County peninsula is home to agriculture and large numbers of summer residents. Additionally, bedrock aquifers in some portions of eastern Wisconsin have brackish water. Therefore, this area's surface waters may contain more chlorides than other parts of the state.

Mean chloride concentration of northeastern Wisconsin lakes is 2 mg/l (Lillie and Mason, 1983). According to EPA Great Lakes monitoring data, 1990 to 1999 chloride levels in Lake Michigan average between 5 to 10 mg/l. Chloride concentrations in water from Sturgeon Bay ranged from 11 to 33 mg/l chloride with most concentrations between 11 and 15 mg/l (Table 3). These concentrations are higher than typical for northeastern Wisconsin lakes and Lake Michigan suggesting human pollutant sources.

The water sample collected from the mouth of Big Creek contained elevated chloride levels (24 mg/l on July 19, 2002 and 33 mg/l on August 7, 2002). This creek drains a rural watershed. Potential sources of the elevated chloride include rural residential septic systems, agricultural/orchard fertilizers, and/or animal waste. Higher chloride levels in Sturgeon Bay suggest that elevated concentrations of other man-induced chemicals may also be entering surface water (Shaw, et. al., 1994). The full effects of chloride on aquatic plant growth or the fishery are not known, however current chloride levels do not appear to be harmful to aquatic plants or fish in Sturgeon Bay. Since natural waters vary in natural chloride content, it is important to have an adequate level of background data or a long-term database to document changes.

6.1.8 Trophic Status

Total phosphorus, chlorophyll <u>a</u>, and secchi disk depths are collectively used to classify the trophic state of a surface water body, typically lakes. A trophic state is an indicator of water quality. Reviewing the July and August 2002 data for Sturgeon Bay - total phosphorus concentrations of 0.03 to 0.05 mg/l, chlorophyll <u>a</u> concentrations of 5 to 10 µg/l, and secchi depths of 5 to 10 feet classify the water body as mesotrophic (Shaw et al., 1994). Mesotrophic waters typically have moderately clear water, can develop anoxic hypolinia during the summer, may have excessive aquatic macrophytes, and will normally only support warm-water fisheries. According to the EPA's Great Lakes monitoring data, the trophic status of Lake Michigan is oligotrophic. Therefore, looking at water quality parameters collectively, the water quality of Sturgeon Bay is poorer than that of Lake Michigan.

Reviewing the trophic state parameters individually, total phosphorus concentration is the most eutrophic parameter. Sturgeon Bay generally has higher water transparency than would be expected given the total phosphorus levels measured. This may partially be attributed to the zebra mussels, which feed on phytoplankton causing increased water clarity. Water clarity and chlorophyll a concentrations indicate mesotrophic conditions. In other words, the total phosphorus values may skew the results suggesting worse than actual water quality.

Trophic classification of Wisconsin lakes based on chlorophyll *a*, water clarity measurements, and total phosphorus values. (*Adapted from Lillie and Mason, 1983.*)

Trophic class	**Total phosphorus** µg/l	**Chlorophyll *a*** µg/l	**Secchi Disc** feet
Oligotrophic	3	2	12
	10	5	8
Mesotrophic	18	8	6
	27	10	6
Eutrophic	30	11	5
	50	15	4

Source: UW Extension, Understanding Lake Data

The fact that total phosphorus indicates poorer water quality than secchi transparency and chlorophyll a may also partially be explained by the fact that numerous secchi depth readings were collected at locations across Sturgeon Bay throughout a large geographic range and over the course of the entire summer, therefore many variables resulted in a wide range of secchi readings. Comparatively, relatively few water samples were submitted for Phosphorus analysis. These samples were collected at pre-determined locations for phosphorus analysis due to their potential for being Phosphorus source areas (i.e. at the mouths of creeks and in relatively shallow sheltered areas. Based upon the general water quality parameters collectively, Sturgeon Bay would fit the mesotrophic water quality category.

An exception to the mesotrophic trophic status determination was apparent at the lagoon at Samuelson's Creek. The sample collected after herbicide treatment of aquatic macrophytes in the lagoon at Samuelson's Creek contained 0.086 mg/l P, 83 ug/l chlorophyll a, and had a secchi depth reading of 3.5 feet. These measurements indicate that this area was eutrophic. Eutrophic waters typically have poor water quality exhibiting lower secchi disk depths, higher chlorophyll a results, and higher total phosphorus concentrations. It is probable that at times areas of Sturgeon Bay exhibit eutrophic conditions due to dying off of excessive aquatic macrophytes and a subsequent release of phosphorus.

6.2 Storm water Runoff

As described earlier, nutrients are essential to aquatic plant growth. The amount of nutrients entering an aquatic ecosystem can have profound effects on water quality and the amounts and types of aquatic vegetation. Tributary streams, surface runoff, and/or storm sewer conveyances can deliver storm water carrying nutrients and sediments. The following describes nutrients contained in storm water and sediments.

6.2.1 Nutrients

Storm water samples were collected during a rain event on July 31, 2002. Samples were collected from the following tributaries and analyzed for nutrients.

- Little Creek – A small stream draining an urban landscape
- Big Creek – An urban and rural drainage
- Samuelson's Creek- An urban drainage
- Strawberry Creek – A rural stream

Streams sampled are illustrated on Figures 1 and 2. Samples were collected from the lowermost street crossing. One sample was also collected from a PVC drain pipe located in the lagoon near Samuelson's Creek. Storm water from Big Creek contained the highest reported nitrogen (NO3 + NO2) results at 4.6 mg/l. Storm water from Little Creek contained the highest reported total phosphorus concentrations at 110 ug/l. Both of these streams drain urban watersheds. This limited storm water sampling illustrates that the urban streams within Sturgeon Bay potentially contribute more nutrients to Sturgeon Bay than do rural tributaries. Phosphorus appears to be the plant growth-limiting nutrient in Sturgeon Bay. Little Creek contained the most phosphorus in collected storm water samples. The storm water sample results are summarized on Table 4. A copy of the laboratory analytical reports for storm water samples is included in Appendix C.

The drain pipe in Purves lagoon sampled contained 1.1 mg/l of nitrogen and 22 ug/l total phosphorus. The source of this pipe is unknown but could be basement foundation / sump pump drains. The source of the pipe should be located. The WDNR does not allow non-storm water discharges to waters of the State without a permit. If this is indeed a basement drain, then it may be a permitted discharge, however if it is wash water or wastewater, then it is an illegal discharge and must be connected to the City sanitary sewer system.

6.2.2 Sediments

Sediments carried by surface water are typically the largest external source of phosphorus in lakes (see Subsection 6.1.3.1 for additional information). Besides delivering excess nutrients, sediments also decrease water clarity and deposit themselves over natural lake bottom sediments. As discussed earlier, phosphorus appears to be the aquatic plant growth limiting nutrient in Sturgeon Bay. Phosphorus has a high affinity for soil particles and is contributed to an aquatic ecosystem primarily through sediment-laden storm water runoff.

Soft sediment accumulation on the bottom offers suitable habitat for rooted aquatic plants. Excessive nutrient levels in these sediments can support prolific aquatic plant growth. Furthermore, the oxygen levels, pH, and alkalinity water quality data collected suggest that dissolved phosphorus in the water is likely precipitated out of the water column into the sediments.

Sediments contained an average of 348 milligrams per kilogram (mg/kg) phosphorus. Nutrient and mineral analysis of sediments suggests that ample phosphorus is available in the sediments to promote rooted aquatic plant growth. Sediment sample locations are illustrated in Figure 2. The results of sediment sampling are included in Table 5. Laboratory analytical reports for sediment sampling are included in Appendix E.

6.2.3 Storm Sewers

The City of Sturgeon Bay drains urban areas through man–made storm sewer conveyances. A formal survey of the storm sewer system was completed. These storm sewers drain into tributary streams of Sturgeon Bay and the Bay itself discharging sediment and nutrients to Sturgeon Bay as described above. A map of the storm sewer outfalls is included as Figure 4. Elevation data collected during the storm sewer mapping was submitted to the City Engineer under separate cover. This information will be useful should the City decide to install storm water detention ponds or other best management practices in the future. Storm water from storm sewer conveyances was not sampled, however water quality of storm water from these conveyances would most likely be similar or worse than that reported for storm water samples from the streams described above.

6.2.4 Phosphorus Load Estimation and WiLMS® Model

Considering the land use, water quality, storm water sampling, and sediment sampling data collectively, nutrients are being contributed to Sturgeon Bay from storm water runoff, through internal cycling, streams, and improved storm sewer structures. Since phosphorus is the limiting nutrient, increases in phosphorus loading will likely result in increases in aquatic plant growth. A comprehensive phosphorus budget was outside the scope of this project and would be extremely complex. The figure to the right illustrates the components of a phosphorus budget.

Source: NALMS, Managing Lakes and Reservoirs

Increased sediments carried into a body of water due to high runoff levels will also increase the nutrients brought into that body of water. The management area within Sturgeon Bay is not well buffered from potential contribution of nutrients and sediments; some of the streams discharging into Sturgeon Bay do carry sufficient nutrient loads. The stream water-quality monitoring data suggests some impact from the uplands. External loads of phosphorus are therefore, a source of phosphorus in addition to the nutrient cycling that occurs within a water body (See also Sections 6.1.1 through 6.1.3). A computer model (the WiLMS model) was used to estimate phosphorus loading to the management area of Sturgeon Bay based on existing land uses

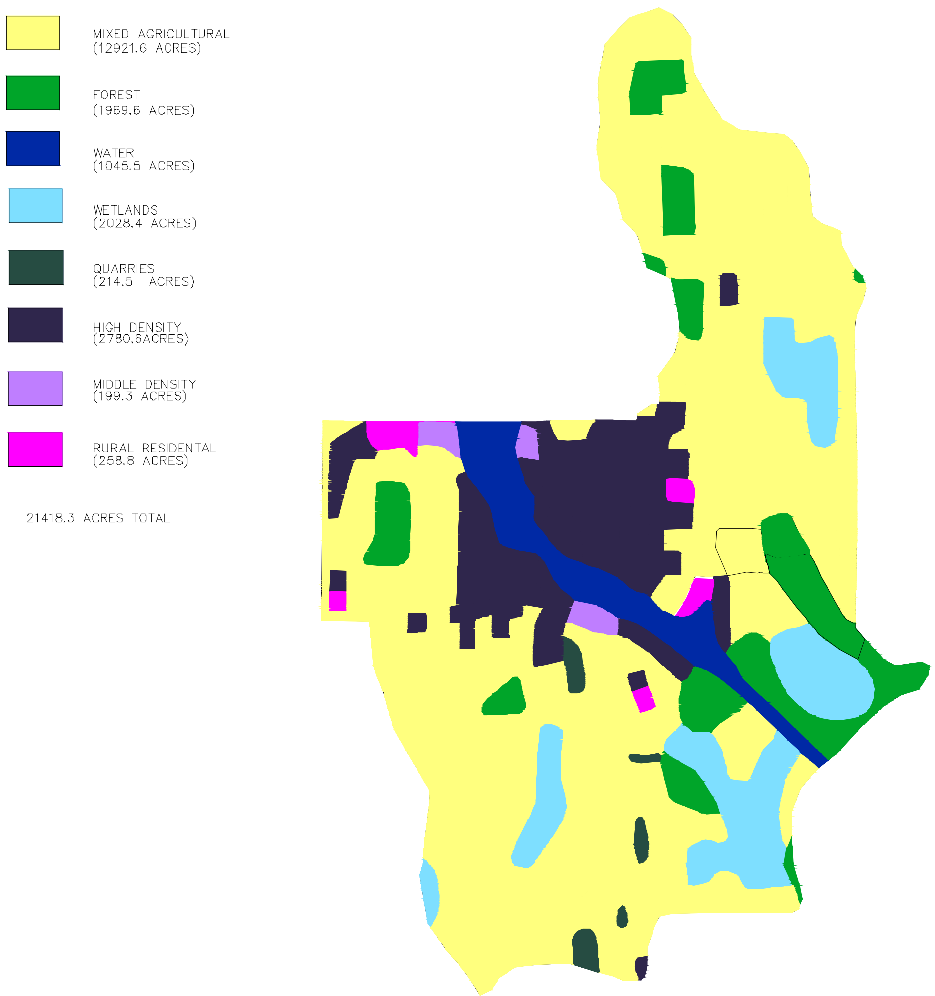
The entire Sturgeon Bay watershed was not used in the model. An imaginary boundary was chosen for the Sturgeon Bay Aquatic Plant management area (Figure1) and a corresponding watershed was delineated on a USGS topographic map. The Sturgeon Bay management area sub-watershed is approximately 21,500 acres in size (including the water surface) and is illustrated on Figure 3. Development within the watershed is diverse and incorporates a variety of land uses. Based on information from the Wisconsin Department of Natural Resources WISCLAND Data CD, the watershed has the following land uses (May, 1993):

▲ Residential	1,690 acres (7.9 %)
▲ Commercial and Services	654 acres (3.0 %)
▲ Industrial	167 acres (0.8 %)
▲ Transportation, Communications and Utilities	269 acres (1.3 %)
▲ Other Built-Up Land	199 acres (0.9 %)
▲ Cropland and Pasture	11,947 acres (55.8 %)
▲ Orchards, Groves, Vineyards and Nurseries	974 acres (4.5 %)
▲ Deciduous Forest Land	203 acres (0.9 %)
▲ Evergreen Forest Land	282 acres (1.3 %)
▲ Mixed Forest Land	1,586 acres (7.4 %)
▲ Streams and Canals	1,045 acres (4.9 %)
▲ Forested Wetlands	2,028 acres (9.5 %)
▲ Strip Mines, Quarries and Gravel Pits	215 acres (1.0 %)
▲ Transitional Areas	157 acres (0.7 %)

Phosphorus is typically an important nutrient to a lake's biological dynamics (see also section 6.3.1). Phosphorus can be contributed to a lake ecosystem through storm water runoff. Existing land uses within the watershed were modeled to allow current phosphorus loading to be estimated. Several land use categories were also determined based on Wisconsin Department of Natural Resources WISCLAND Data CD. These land use categories were assigned a general land use that could be used in the WiLMS® model to evaluate phosphorus loading. The data categories and corresponding model land uses follow:

WISCLAND Data CD	WiLMS® Model Land Use
Residential	High Density Urban
Commercial and Services	High Density Urban
Industrial	High Density Urban
Transportation, Communications and Utilities	High Density Urban
Other Built-Up Land	Middle Density Urban
Cropland and Pasture	Mixed Agricultural
Orchards, Groves, Vineyards and Nurseries	Mixed Agricultural
Deciduous Forest Land	Forest
Evergreen Forest Land	Forest
Mixed Forest Land	Forest
Streams and Canals	Lake Surface
Forested Wetlands	Wetlands
Strip Mines, Quarries and Gravel Pits	Quarries

Land uses are illustrated in the following figure.



In addition to Sturgeon Bay management area water surface, the above land use categories were analyzed for current phosphorus loading. One point source contribution, the Sturgeon Bay Municipal Wastewater Treatment Plant, was also entered into the model using recent effluent records. Records were analyzed for effluent flow rate and phosphorus based on an average yearly flow rate of 523.7 million gallons per year and an average yearly discharge of 0.4 mg/L of Total phosphorus. Flow rate and phosphorus levels were based on Wastewater Discharge Monitoring Reports from May 2001 to June 2002.

Model results indicate that approximately 15,600 pounds of phosphorus are contributed from the Sturgeon Bay management area sub-watershed. Mixed agricultural is the largest land use in the sub-watershed (12,922 acres) and contributes approximately 59.1 percent (9,226 pounds) of phosphorus entering the management area. High density urban land use encompasses 2,781 acres and contributes 23.8 percent (2,480 pounds) of the phosphorus loading to the management area. The Sturgeon Bay Municipal Wastewater Treatment Plant in an average year is contributing 12.4 percent (1930.4 lbs.) of the phosphorus load to the management area.

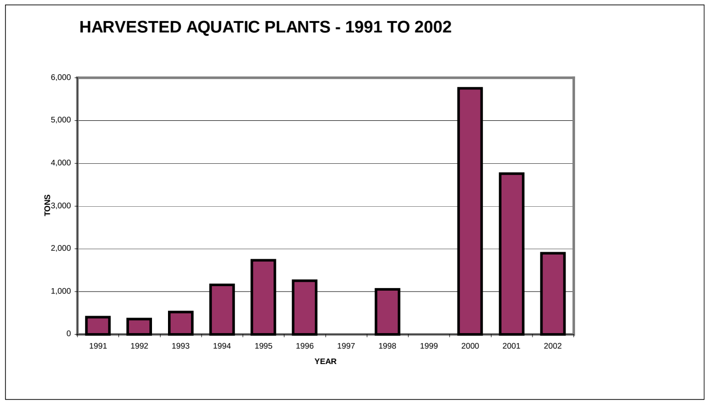
The remaining land use categories collectively contributed less than 4.7 percent of phosphorus entering the Management Area. Model results are included in Appendix F.

Of course, Sturgeon Bay has a “flow through” effect, receiving water from Green Bay and Lake Michigan depending on wind and current conditions. Therefore nutrients are also contributed from these sources.

7.0 AQUATIC PLANT MANAGEMENT

7.1 Existing Aquatic Plant Management Program

7.1.1 History



In the early 1980’s, Sturgeon Bay began to experience aquatic plant problems. In 1985 a group of private citizens contracted with an aquatic plant harvesting company to cut and remove plants from specific locations in the bay. This practice continued until 1989. No harvesting was completed in 1990 and dense stands of aquatic plants inhibited navigation. The City then contracted with a plant harvesting company. This company completed the harvesting for 1991 and 1992. In 1993 the city bought its first harvester and shore conveyor. As aquatic plant growth became more of a problem, additional costs and personnel were added to the program. Two more harvesters were purchased and the tonnage of plants harvested have increased. The following graph illustrates the harvested amounts of aquatic plants since 1992. Data from 1997 and 1999 were unavailable. Current aquatic plant management in Sturgeon Bay is a combination of harvesting and chemical treatment.

In 2002, the Wisconsin Department of Natural Resources established a new permitting process for the harvesting of aquatic plants (NR 109). The primary goals of the program are to protect fish spawning areas, reduce lake bottom disturbance, reduce shoreline erosion and protect endangered species. The new permit for Sturgeon Bay has reduced the acreage, locations and depths of the city’s mechanical harvesting program. Also, the new rule does not affect individuals from harvesting aquatic plants by hand in a 30 foot or less zone by their pier, dock, or swimming raft. Any removal greater than 30 feet requires a permit.

7.1.2 Harvesting Operations

City crews operate three aquatic plant harvesters. Harvested plants are transferred from the harvesters to either a transport barge or directly to a shore conveyor for unloading. The transport barge can also connect directly to the shore conveyor. The shore conveyor loads aquatic plants into trucks for disposal. Trucks then haul the harvested plant material to the disposal site. The City will also transport full loads of fresh harvested aquatic plant material to nearby locations at no charge (see following discussion on value of harvested plant material) provided a holds harmless agreement is signed. Harvesting occurs within open water areas where boat navigation and mooring is impeded by excessive plant growth. The approved aquatic plant management areas are illustrated in Figure 9.

The aquatic plant harvesting is now subject to the WDNR requirements of Chapter NR 109, Wisconsin Administrative Code. NR 109 was passed as an emergency rule in 2002 and is effective as a final rule for any APM in 2003. Essentially, the code requires that an APM Plan be developed by the applicant and approved by the WDNR before an APM permit for any management activities is issued. See also discussion in subsection 8.2.1.1 about the proposed APM Permit.

7.1.3 Nutrient Removal from Harvesting

The City is removing nutrients from the Bay's management area through aquatic plant removal by harvesting. A detailed nutrient budget is outside the scope of this project and inputs of phosphorus on a complex aquatic ecosystem like Sturgeon Bay would be difficult to quantify. However, the amounts of nutrients removed through harvesting can be quantified from the amounts of aquatic plants removed.

In 2002, approximately 1,900 tons of aquatic plants were removed from the Bay through harvesting. This plant material was sampled and contained 92 percent water and 251 ppm of phosphorus. Approximately 1,000 pounds of phosphorus were removed from the Bay through harvesting in 2002.

7.1.4 Disposal Operations

Harvested plants are currently composted at a disposal site. The harvested plant material is dumped into piles and allowed to dry and decompose at the composting site. Fresh plant material can contain long stems and is mostly water weight. A sample was collected from freshly harvested aquatic plant material (primarily elodea) on July 19, 2002 for laboratory analysis of solids and nutrients. Results demonstrate that the freshly harvested material contains approximately 92 percent water. This finding indicates that the material would make excellent mulch capable of maintaining moisture in soil. Aquatic plants also have the potential to uptake significant amounts of nutrients and minerals. Sample results indicate that large amounts of nitrogen, phosphorus and potassium (macronutrients essential for plant growth) are present in the harvested plant tissue. Therefore, this freshly harvested material also has a nutrient value making the material desirable for gardens, orchards, etc. Composted plant material that had decomposed for a year was also sampled. Sample results indicate that the composted plant material also contains large amounts of nitrogen and phosphorus indicating that harvested plants would make a good slow-release fertilizer and long-term soil conditioner. Nutrient and mineral composition of aquatic plant material is summarized in Table 6. Laboratory analytical reports for plant sampling are included in Appendix E.

While some area residents know the benefits of this material, much of it is un-used. The material is made available to area residents free of charge if they wish to load it from the composting site. Furthermore, the City will transport full truck loads to nearby locations at no cost.

7.1.5 Chemical Treatments

The current APM program also uses a contract chemical APM applicator to manage nuisance levels of aquatic plants in areas where the harvester cannot operate. Docking areas and marinas are examples. The application of chemicals for APM has historically been regulated under Chapter NR 107, Wisconsin

Administrative Code “Aquatic Plant Management”. The application of herbicides varies from year to year based on the number of marina or riparian owners that sign up for treatment. Only chemicals registered with the EPA’s pesticide program and approved by WDNR for aquatic use are used in Sturgeon Bay.

7.2 Dane County, Wisconsin Aquatic Plant Management

A newspaper article reported about the APM Program in Dane County managed by the Dane County Parks and Recreation Department. Realizing the Dane County program’s similarities in aquatic plant problems and existing management practices, the City and Northern Environmental arranged for a field trip to Madison to discuss the operation with the Dane County staff. The City and Northern Environmental traveled to Dane County in February 2003 to review the Dane County Parks and Recreation Department’s approach to aquatic plant harvesting. Dane County provides navigation and nuisance relief for several high use lakes in the Madison area. Ideas were shared on equipment selection and maintenance. Dane County manufactures much of their own conveyors and harvesting equipment on barges.

Perhaps of most interest was their aquatic plant disposal operation. Dane County staff transport freshly harvested aquatic plants to nearby agricultural fields. There is a local demand for a large amount of the harvested material. Harvested plant material that is not applied to fields is composted in the same manner that is completed at Sturgeon Bay’s disposal site (See section 7.1.3). Dane County also makes the material available to county residents free of charge. Dane County, however, does charge residents for yard waste and brush that has been screened or ground. Dane County is considering a similar program to charge a fee for “processing” harvesting aquatic plant material. This may be of interest to the City’s program if there were a demand for harvested aquatic plant material.

7.3 Other Aquatic Plant Management Strategies

The updating of the APM program included an evaluation of alternative APM strategies. Existing management techniques and current available research were reviewed in detail. A comprehensive comparision of APM techniques and methods was completed. Detailed description of each of these potential management methods, describing the technology, benefits, drawbacks, and costs is included in Appendix G. Based on these comparisons and the specific aquatic plant problems on Sturgeon Bay, the following potential management strategies were considered.

7.3.1 Chemical Treatment

Chemical herbicides for aquatic plants can be divided into two categories, systemic and contact herbicides. Systemic herbicides are absorbed by the plant, translocated throughout the plant, and are capable of killing the entire plant, including the roots and shoots. Contact herbicides kill the plant surface in which it comes in contact, leaving roots capable of re-growth. Systemic herbicides are not appropriate for use in Sturgeon Bay due to the effects of wind and current mixing water and diluting the applied chemical to ineffective concentrations.

Contact herbicides may provide seasonal relief of an aquatic plant nuisance problem, however the application of chemicals for aquatic plant control in Sturgeon Bay has several drawbacks. The widespread use of contact herbicides on Sturgeon Bay may not be feasible for the following reasons.

- Widespread nuisance aquatic plant growth over numerous acres and in high use areas

- Recreational water use restrictions may apply after application, therefore swimming, boating, and fishing restrictions would need to be placed on Sturgeon Bay during and after chemical treatment. Therefore, it would not be feasible to restrict the use of the entire management area, however smaller areas of restriction would be acceptable.

- Chemical treatment of a large scale can be cost prohibitive (Appendix G)

- Different types of aquatic plants growing at different times of the year.

- Not one herbicide or one treatment would control, all of the nuisance plant growth throughout the summer. Multiple chemical treatments would be required to address multiple species problems at different times of the year. For example, one may need to chemically treat curly leaf pondweed early in the year and provide a follow up treatment for Eurasian watermilfoil or elodea later in the summer.

7.3.2 Biological Controls

Biologic controls include herbivorous fish, herbivorous insects, and native plantings. Herbivorous fish are not feasible in Sturgeon Bay because they cannot be contained within the treatment area. The native milfoil weevil has shown the most promise of herbivorous insects (Appendix G). Weevils currently cost approximately $1.00 each and it may be appropriate to use 5 to 7 weevils per stem. Dense stands of milfoil may contain 1 to 2 million stems per acre. Therefore, costs of this new technology are currently prohibitive. Furthermore, the milfoil weevil would have no effect on other nuisance aquatic plants such as curly leaf pondweed.

Native plantings involve removing the nuisance plant species through chemical or physical means and re-introducing seeds, cuttings, or whole plants of desirable species. Considering how opportunistic the Eurasian watermilfoil and curly leaf pondweed are, and how widespread they are across Sturgeon Bay, it is unlikely that native plantings could out-compete these nuisance plants (Appendix G). Furthermore, the greater depths at which the nuisance aquatic plants are actively growing would require that plantings be done with SCUBA divers, a costly and labor-intensive endeavor.

7.3.3 Harvesting

Harvesting is suited for large open areas with dense stands of exotic or nuisance plant species (Appendix G). The harvester can be moved to where it is needed, when it is needed, and used to target problem areas and problem plant species. This technique is suitable for Sturgeon Bay since there is a large management area to cover. Costs are variable depending on program scale. The City has, however, already made equipment investments for previous APM techniques, increasing the cost effectiveness of this technique for use on Sturgeon Bay.

8.0 CONCLUSIONS AND RECOMMENDED ACTION PLAN

The following discussion provides conclusions for the public education and resource inventory components of the overall updating of the APM Program. The discussion is limited to the most important components of the resource inventory relating to aquatic plant growth and APM within the management area of Sturgeon Bay. This section also provides a recommended action plan for the aquatic plant management program on Sturgeon Bay.

8.1 Conclusions of Public Involvement and Resource Characteristics

8.1.1 Public Involvement

Public education, involvement, and solicitation of public comments were incorporated into the project workplan from the start of the project. Public education was promoted through a radio broadcast, open house meetings, a project website, news articles and newsletters, and a television broadcast (to be aired later in 2003). A questionnaire was distributed to solicit public opinion for the most important issues. Respondents stated that water quality and aquatic plant growth were their most important concerns. Respondents also stated that studying and understanding current aquatic plant problems, and identifying pollutant sources were the most important goals of updating the APM Program.

8.1.2 Water Resources

The aquatic ecosytem of Sturgeon Bay is not a “closed” system, such as a seepage lake with a defined watershed. Sturgeon Bay receives water from ground water, storm water runoff, streams, storm sewers, precipitation, Lake Michigan, and Green Bay. Water levels on Sturgeon Bay fluctuate over time and are currently approaching a historic low.

8.1.3 Aquatic Plants

Aquatic plants are vital to the health of a water body. Rooted aquatic plants are important for the health of an aquatic ecosystem and fishery. However, aquatic macrophytes can become a nuisance when native and exotic plant species occupy large portions of a water body. Exotic plants that replace more desirable native aquatic plants may still offer some benefits to aquatic organisms such as shelter from predators. However, excessive aquatic plant growth can also negatively affect the ecosystem and impede navigational and recreational activities. When “managing” aquatic plants, it is important to maintain a well-balanced, stable, and diverse aquatic plant community that contain high percentages of desirable native vegetation if possible.

In 1992, the two most abundant aquatic plants were *Elodea canadensis* (Elodea) and *Myriophyllum spicatum* (Eurasian watermilfoil). During the June and August 2002 survey, the most abundant species found in Sturgeon Bay was *Elodea canadensis* (Elodea). *Myriophyllum spicatum* (Eurasian watermilfoil) was the second most abundant species in the June survey. *Ceratophyllum demersum* (Coontail) was the second most abundant species in the August survey. Several other aquatic plant species were identified in the aquatic plant surveys, many of which are important for fish and wildlife habitat (i.e. Pondweeds - *Potamogeton spp*. and Wild celery – *Valisneria americana*).

Three particular aquatic plant species have grown to nuisance levels in the Sturgeon Bay APM management area, impeding navigation and recreation. Nuisance species include *Myriophyllum spicatum* (Eurasian watermilfoil), *Potomageton crispus* (Curly lead pondweed), and *Elodea conadensis* (Elodea).

Large dense stands of nuisance aquatic plant vegetation form and cause further problems when they break off causing floating vegetation mats, or "floaters" that drift with the wind or seiche.

Prolific aquatic plant growth in Sturgeon Bay is likely attributed to a combination of all the factors listed above (i.e. lower water levels, increased water clarity, nutrients in storm water runoff, seiche etc.). Indeed the fact that Sturgeon Bay receives nutrient rich waters from Green Bay, surface streams, and storm sewers can increase the potential for nuisance aquatic plant growth. Their potential growth areas are further expanded with increased water clarity, and decreased water levels.

8.1.4 Fish

The Bay contains habitat for warm, cool, and cold water fish species. The Sturgeon Bay area offers a renowned fishery. Of particular concern in this fishery and Lake Michigan as a whole, is the yellow perch.

Yellow perch were once common to Green Bay and Lake Michigan, and the species was valuable to both the sport and commercial fishing industries, however, yellow perch numbers have been declining since the late 1980's. The WDNR believes sensitive habitat for yellow perch is present within Sturgeon Bay. Aquatic plant management activities within the City's management area can potentially affect young of year perch.

8.1.5 Water Quality

Sturgeon Bay water quality varies with many factors. Water quality varies on an annual, seasonal, monthly, weekly, and even a daily basis. Storm events and/or a significant seiche effect can have dramatic effects on water quality. An overall evaluation of water quality parameters measured throughout 2002 suggests that Sturgeon Bay's water quality is good and that the trophic status of Sturgeon Bay is mesotrophic. Sheltered areas of Sturgeon Bay may potentially thermally stratify during long periods of calm hot weather. However wind and currents would most likely disrupt this stratification fairly easily.

Phosphorus was determined to primarily be the limiting nutrient for aquatic plant growth. Increases in phosphorus to the aquatic ecosystem can fuel additional aquatic plant growth.

The waters of Sturgeon Bay are mixed through movement of water through the ship canal. When winds are out of the northwest, Green Bay water enters Sturgeon Bay and exits through the ship canal. When the wind direction is reversed, Lake Michigan water enters Sturgeon Bay. Therefore, there is considerable water flow through the Bay and water residence time in Sturgeon Bay is most likely short. However, waters in sheltered areas such as marinas or protected bays can thermally stratify if there is calm and hot weather period.

Green Bay's water appeared more nutrient enriched, while Lake Michigan water was clearer, colder, and contained less nutrients. Water clarity has increased in the Great Lakes over the last 20 or more years due to pollution prevention and the invasion of the zebra mussel. This increased water clarity has most likely contributed to an increase in the photic zone of Sturgeon Bay, thus allowing rooted aquatic plant growth in deeper areas of the Bay. Recommendations for continued monitoring of water quality are included in Section 8.2 (recommendations) of this report.

8.1.6 Storm water Runoff

Storm water enters the Bay from storm water runoff, tributary streams, and urban storm sewer conveyances. Storm water affects water quality within Sturgeon Bay. Storm water delivers phosphorus to Sturgeon Bay, which can precipitate out of the water and is available for rooted plant growth. A simple computer model predicted that agricultural land uses contribute the most phosphorus to Sturgeon Bay's management area. Storm water runoff also contributes sediments to Sturgeon Bay, which can alter substrate habitat and promote nuisance rooted aquatic plant growth in expanded soft sediment areas.

8.1.7 Nutrient Considerations

The nutrient loading model indicates that approximately 15,600 pounds of phosphorus are delivered to the Sturgeon Bay management area each year. Approximately 1,000 pounds are removed through harvesting each year. Inputs exceed what is removed from plant harvesting. The amount of phosphorus stored in the sediments is unknown. Inputs of phosphorus should be reduced to help reduce nutrient availability to aquatic plant growth.

8.2 Recommended Action Plan

The following components of the recommended action plan describe not only the APM plan, but additional activities to support protection of Sturgeon Bay and recreation on the Bay. These additional items are for the City's consideration to improve the Sturgeon Bay resource.

8.2.1 Aquatic Plant Management Plan

Based on the review of aquatic plant management alternatives in Section 7.0, The recommended APM techniques are continued aquatic plant harvesting using City equipment and selective treatment with aquatic herbicides in marinas. This recommendation was based on the extent and type of aquatic plant problems on Sturgeon Bay, the discussions above, and the more thorough comparisons provided in Appendix G.

8.2.1.1 APM Permit

The City should obtain a 5-year APM permit from the WDNR. An approved APM Plan is required prior to issuance of a harvesting APM permit. A letter from Jim Cahow of WDNR listing WDNR positions, concerns, and recommended elements of the APM Plan is included in Appendix H. These items are numerous but have been summarized here for convenience.

- Mapping different use areas, aquatic plant sensitive areas, and critical habitat areas
- Education of all user groups
- Map of approved priority navigation channels
- Map of approved areas of chasing floaters
- Map of approved herbicide treatments
- Map of conflicting use areas
- Protection of critical habitat for perch
- Consider reduction of mooring by attrition or moving mooring

- If Riparian landowners would like to remove or reduce vegetation, they should first consider the feasibility of hand raking or pulling. If hand raking or pulling is feasible, they should not pursue mechanical or chemical treatments
- Harvesting should be restricted to areas required for public navigation
- The decision for vegetation removal in front of private property should be left to owner
- Private landowner should request clearing of vegetation
- City should provide landowner with informational handout explaining aquatic plant benefits
- Exotics may also provide habitat functions
- Must allow chasing floaters in shipping channel and designated priority navigation channels
- Halt harvesting operations if moderate numbers of fish are encountered
- Report an incident with such fish encounters to WDNR
- Discussion about water levels in Lake Michigan
- Additional aquatic plant surveys to update APM Plan
- Rock rubble habitat identified by WDNR fisheries staff included in larger management plan
- Harvesting only operated in approved areas
- Harvesting to mid-depth of water column.
- No harvesting in areas less than 2 feet
- Systemic herbicides should not be used
- Copper containing algacides restricted to nuisance algae blooms of appropriate target species
- Mapping non-point source problem areas
- Develop integrated storm water management plan
- Restore shoreline buffers
- Protect other critical habitat for spawning fish
- Restoration and protection of green space

The above concerns, guidances, practices, and recommendations were ultimately considered when developing this APM Plan. The revised APM Plan (Section 8.2.1) provided has incorporated the above issues, concerns, and recommended components listed above.

The WDNR is also preparing a "Sturgeon Bay Lake Sensitive Area Survey Report and Management Guidelines" Report to discuss the importance of the sensitive areas. Once available, the APM Program staff will review this document and consider its elements in management decisions. A copy of this document will be included in Appendix H. A companion document "Guidelines for Protection, Maintaining, and Understanding Lake Sensitive Areas and Critical Habitat" is included in Appendix H. Again the key points in this document were considered throughout development of this APM Plan.

8.2.1.2 Harvesting Operations

The City, while recognizing the importance of aquatic plants to Sturgeon Bay and the important items listed above, ultimately has responsibilities to Bay users to provide access and navigation through dense stands of aquatic plants. The City recognizes that the fishery is extremely important and will strive to protect sensitive areas and critical habitat. However, Sturgeon Bay also has many other Bay users other than anglers that are essential to the local tourism industry and vital to the community. The surveys distributed last summer indicated that the number one concern in Sturgeon Bay was nuisance aquatic plant growth. Therefore, the WNDR must also recognize that there is such a phenomenon as nuisance aquatic plant growth and that there is an important need for nuisance aquatic plant relief for navigational access and recreation. Sturgeon Bay has and will continue to implement educational efforts about the value of aquatic plants.

The following is the proposed method of completing aquatic plant harvesting in the Sturgeon Bay APM area. The harvesting operations will be completed according to the following harvesting guidelines. These guidelines incorporate the 2002 WDNR permit guidance.

Harvesters

Initially, approved aquatic plant harvesting areas are located with GPS equipment and marked with buoys if needed. Water depths in approved areas are measured prior to harvesting in approved harvesting areas. Furthermore, a bathymetric map of Sturgeon Bay management area is included on the harvester as an additional tool to determine depth in approved harvesting areas. The harvesters are also equipped with depth gauges along the cutter head to know the cutter head depth. A copy of the APM permit is maintained and updated on each harvester. During harvesting, aquatic plant fragments are recovered by the harvester to the maximum extent practicable.

Operators

Prior to each harvesting season, each operator is required to review the APM Permit and conditions of the permit. Harvester operators as well as APM Program managers learn to identify the common nuisance aquatic plants in Sturgeon Bay. More aquatic plant information is available in section 5.6 of this report, on the project website, or from Northern Environmental upon request.

Harvesting operations are completed in two shifts each day. Operators are relieved from their shift mid-day. Harvesting operators receive clear instructions at each shift change about their assigned harvesting route.

Harvester operators are trained to know the limitations of harvesting (areas and depths). Harvester operators are also trained to stop harvesting if the bottom or moderate numbers of fish are encountered. Harvester operators are trained to recognize and gauge the cutter head depth.

Fish

If moderate numbers of any gamefish or young of year perch are encountered, harvesting is stopped, the location recorded, and reported to WDNR. The harvester moves to another approved cutting area. The area will be checked for fish prior to continued harvesting. This applies to management in all areas.

Depth

Harvesters do not harvest aquatic plants in less than 2 feet of water to prevent disruption of the bottom sediments, turbidity, and/or damage to the cutting head.

Harvesters cut approved harvesting areas at half the water column depth unless requested as a "special condition". Full cutter depth (5 feet) is only operated at water depths of 10 feet or greater. Depth poles will be used periodically to identify depths. If any sediments are encountered, the cutter head is raised immediately and re-set to an appropriate depth using the depth measuring device on the cutting head. These guidelines apply to harvesting in all areas.

Areas

A. Management Area [A]

The amount of boat traffic, level of invasive plant species, and lack of undeveloped shoreline allow for aquatic plant management in the area labeled as management area [A]. This area is illustrated on Figure 9. Aquatic plant harvesting in this area is unrestricted except for the fish, depth, and bottom guidelines listed above.

B. Mooring Areas

Mooring Area #1

Harvesting is allowed in this area (Figure 9) subject to the fish, depth, and bottom guidelines listed above.

Mooring Area #2

This mooring area is located in a WDNR-designated sensitive area. and has been labeled by WDNR as a Conflicting Use Area. Harvesting is currently allowed in this area (Figure 9) subject to the fish, depth, and bottom guidelines listed above. See also the conflicting use area discussion in Subsection 8.2.1.8 for potential alternatives to mooring in this area.

C. Multi-Use Priority Navigation Channels

Based upon past navigation needs, proposed multi use channels are illustrated on Figure 9. These channels are located where the City has determined navigation access has historically been required. These are permitted harvesting areas subject to the fish, depth, and bottom guidelines listed above.

The use of multi-use navigation channels is an important APM tool to provide navigational access and protect fish habitat. Multi-use channels are the preferred management method Advantages of Multi-Use Priority Navigation Channels include the following:

Multi-use channels are typically 50 feet wide and are wider than single use channels. Single channels often plug with floaters, therefore multi-use navigation channels alleviate this problem somewhat.

Multi-use navigation channels are consistently cut in the same areas, reducing the likelihood that an operator will cut too deep as depths will be known and taught through repetition.

Channels may also have added benefits to a fishery. Studies have documented that harvested channels in dense aquatic plant stands can provide desirable edge habitat for gamefish and other fish.

The following multi-use channels are considered permitted and not subject to the special conditions or shoreline landowner request components of the APM Plan (see following sections).

Memorial Drive Channels [1], [2], [3], [4], and [5]

These channels are located in a WDNR-designated sensitive area (Figure 8). These channels as illustrated on Figure 9, are harvested to a maximum width of 50 feet wide and are subject to the fish, depth, and bottom guidelines listed above. Single shoreline landowner access requests are processed to provide access from a private dock to the multi-use navigation channel (See section D that follows).

Tacoma Beach Channels [6], [7], and [8]

These channels are located in a WDNR-designated sensitive area (Figure 8). These channels as illustrated on Figure 9, are harvested to a maximum width of 50 feet wide and are subject to the fish, depth, and bottom guidelines listed above. Single shoreline landowner access requests are processed to provide access from a private dock to the multi-use navigation channel (See section D that follows).

Strawberry Creek Estates Access Channel

This area is located in a WDNR-designated sensitive area (Figure 8). This area as illustrated on Figure 9, are harvested to a maximum width of 50 feet wide and are subject to the fish, depth, and bottom guidelines listed above.

D. Private Access to Shoreline Landowners in Sensitive Areas

Access navigation channels for single docks or piers of shoreline landowners are allowed only if the shoreline landowner requests it. The access is provided to the nearest multi-use navigation channel or to the main shipping canal whichever is shorter. The shoreline landowner must consider the importance of aquatic plants and evaluate the feasibility of manual removal prior to requesting a navigation access channel. See discussions in sub-section 8.2.1.5 below for further detail on the process for submitting access requests. An access channel to a riparian landowner is no greater than 10 feet wide and is subject to the fish, depth, and bottom guidelines listed above.

Floaters

Floaters are removed from all approved aquatic plant harvesting areas such as the multi-use channels and also in the main shipping channel (Figure 9). Floaters along shorelines are also removed, however the cutter head is not operated lower than the minimum depths established above.

Timing

Timing of aquatic plant harvesting is a useful tool in selective management and therefore is considered an important component of the APM Program activities. Aquatic plant harvesting activities normally begin after Memorial Day. This date is protective of the perch spawn and nursery fish in April and May.

Early (June) harvesting in approved areas targets areas with higher densities of curly leaf pondweed. By harvesting curly leaf pondweed before their turions are dropped in July, the spread of this exotic may be reduced. After the turions have dropped from the Curly leaf pondweed, (typically in July), then harvesting in approved areas focuses on the denser stands of Elodea and Eurasian watermilfoil.

8.2.1.3 Hand pulling

Riparian landowners are required to assess the feasibility of hand raking or hand pulling prior to requesting an access channel to a multi-use navigation channel or to the main shipping canal. Hand pulling or raking by individual landowners can be completed to a maximum width of 30 feet to provide pier or swimming raft access. A permit is not required for hand pulling or raking if the maximum width cleared does not exceed a 30 foot width as required in NR 109. Greater than 30 foot width requires a permit from the WDNR.

If hand raking or pulling aquatic plants is not feasible, the shoreline landowner must make a formal request that the City provide an access channel. However, the City harvester cannot operate in less than 2 feet of water. A system has been proposed to implement these requests (see Section 8.2.1.5).

8.2.1.4 Public Education

Pubic education has been an on-going part of this APM Plan development. The City supports public education for the APM Program. The technical information button or links button on the project website http://www.sturgeonbaywi.org is a starting point for continued education. The City will administer the project website to develop and enhance after the final delivery of the project report. Several fact sheets about aquatic plants and aquatic plant management are included in Appendix I.

Conservation groups such as In-Fisherman, Fishing Facts, Wisconsin Outdoors, BASS, Walleyes for Tomorrow, etc. should also be contacted to further develop the educational component of the APM Plan. These groups, if willing could run media specials or write articles about fishing, wildlife, value of aquatic plants for habitat and food, and conservation of natural resources.

Riparian property owners that request access channels are required to read an informational handout about the value of aquatic plants. This discussion is included on the shoreline navigation access request form (see next section). The landowner is invited to read more about the value of aquatic plants by checking out the project report on the project website or visiting the City library to review the project report. Links to other sources of information about aquatic plants are provided on the shoreline request form itself, on the project website, and in the project report.

8.2.1.5 Shoreline Navigation Access Request

As described in the elements of the APM program above, the shoreline landowners must request access from the City prior to the City cutting a private access channel to the shoreline landowner. The City will implement this request program and require the use of a Shoreline Landowner Navigation Access Request Form, which is included in Appendix J. The form includes an excerpt on the value of aquatic plants. The form also requires the user to acknowledge that they considered hand pulling or raking prior to requesting the navigational access and the reasons that hand raking or pulling is not feasible for this site. Examples include:

- Vegetation is too dense for hand pulling or raking
- Landowner is elderly or disabled and unable to complete manual removal
- Vegetation is too far from shore for hand removal
- Water too deep to effectively hand remove or rake

The form must be returned to the City APM Program Staff before May 1st to ensure that sufficient advanced notice is provided for scheduling efforts and timely harvesting operations. The City encourages the property owner to deliver the form in person to facilitate timely response by APM harvesting staff. The City will keep a record of all request forms. The shoreline land owner must demonstrate a navigational need and cannot request harvesting for aesthetic reasons. The landowner must recognize that the city is operating within the APM permit and cannot provide more nuisance aquatic plant harvesting than designated navigational or recreational access needs.

The City will determine when multiple requests can be combined into a single multi use channel. Multi-use access channels will be wider to prevent blockage by floaters. These additional multi-use channels are will be subject to the special conditions

8.2.1.6 Special Conditions

The potential for excessive aquatic plant growth in areas of high boat use across the APM area requires some level of flexible latitude to complete harvesting for navigation and recreation. The City has demonstrated a willingness to accommodate WDNR concerns and guidelines in their APM Program. However, the APM Permit in some instances may be too restrictive for adequate navigation for the many types of Bay users through dense vegetation. Therefore, the City proposes a “Special Condition” Program in which it may request to operate outside the confines of the permit requirements when site specific and/or extraordinary circumstances necessitate the additional activities. Since the WDNR has specifically stated that “designating an area as a sensitive area or as critical habitat does not prevent or eliminate potential consideration for treatment or removal; but should limit them to what is absolutely necessary for minimal navigation access” and has offered a willingness to work with the City throughout the APM Program implementation, this should be an acceptable component of the APM Program.

Examples of Special Conditions where WDNR will be contacted may include, but are not limited to:

- A significant seiche, wind, or current tears large amounts of aquatic plants and deposits "mats" in areas outside the approved harvesting areas and is impeding watercraft navigation.
- A moored vessel such as a deep keel sailboat cannot navigate to the access channel and/or the mooring station in the conflicting use area.
- The City receives multiple complaints from watercraft owners and/or riparian landowners about dense vegetation outside the approved harvesting area impeding navigation from public launches, marinas, mooring areas or private docks to the main navigation channel. Complaints about the aesthetics of aquatic plant growth do not justify a special condition request.
- The City receives multiple harvesting request forms from dock owners with adjacent docks within close proximity to eachother. The city expects this to be the case in some areas from past experience. In this case, the City would propose a 30 to 50 foot wide multiple use navigation channel rather than numerous 10-foot wide single access channels. Again, complaints about the aesthetics of aquatic plant growth do not justify a special condition request.

The Special Conditions component of this program is aimed at allowing the City some discretion based upon their experience. The APM Program managers recognize the need for navigation vs. aesthetic harvesting. APM Program managers do not wish to harvest in areas that do not provide necessary navigation.

Past experience indicates that certain property owners have always needed navigation access to their dock. The City provides harvesting as an important service to local residents where equipment and staff are partially funded by local taxes. The City APM Program has a good relationship with most Bay users. APM program managers want to continue the positive relationship and avoid excessive complaints from riparian landowners needing navigational access. Therefore, latitude is given to them in providing the necessary navigational access.

The Special Conditions will be requested by fax on a form submitted to the appropriate WDNR APM coordinator or water resource management specialist responsible for Sturgeon Bay. A phone call will also be placed to the WDNR explaining the situation. The WDNR APM coordinator will review the faxed request, make an inspection of the problem area at his or her discretion, and make a decision regarding the special condition. A copy of this fax form is included in Appendix K. All special conditions are subject to WDNR approval. Small scale special conditions may be approved verbally, with a follow-up request with specific details in writing not to exceed 5 business days, however the WDNR reserves the right to restrict a special condition until a further review and written confirmation is granted (not to exceed 5 business days). The written confirmation will be used for special condition requests that the WDNR feels is a larger scale request.

8.2.1.7 Chemical Treatments

Chemical treatment using contact herbicides is allowed in high use areas where a harvester cannot navigate such as marinas. The sites where chemical treatment occurs is illustrated in Figure 9. A qualified licensed aquatic herbicide applicator will be selected to complete these treatments. Individual riparian landowners should not contract for chemical aquatic plant control, rather should utilize hand raking or contact the City about harvesting a navigation channel to a multi-use navigational channel.

8.1.2.8 Record Keeping

The City will maintain detailed records including harvesting dates, harvesting areas, types, and amounts of aquatic plants harvested, and fish encounters. A sample record keeping form is included in Appendix L. Records of chemical treatment are also be maintained. Special conditions and shoreline navigation request forms are also maintained in a file for potential future reference. The mooring area waiting list and contracts are also maintained.

8.2.1.9 Management Decision Matrix

In order to implement the WDNR concerns and the above components of the APM Program, Northern Environmental has developed a management decision matrix to assist the APM Program managers in determining when and where to prescribe aquatic plant treatment. A copy of this matrix is included as Figure 10.

8.2.1.10 Conflicting Use Area / Mooring Area #2

The WDNR has expressed concern with mooring area #2, considering it is a conflicting use area (Figure 8). Since mooring occurs in a sensitive area, WDNR recommended reduction of mooring slips by attrition. There is a significant waiting list, however to rent mooring stations. Therefore, reduction by attrition is not considered feasible at this time. The City will continue to evaluate reduction by attrition in the future.

When applying for APM Permits, Sturgeon Bay will copy applicable portions of this document (essentially the APM Plan is all of Section 8.2.1,Figures 8 and 9, and Appendices H through L).

8.2.2 Storm water Runoff Considerations

Nutrient loading to Sturgeon Bay is one factor contributing to the growth of aquatic plants. As time, staff, and funding permits The City of Sturgeon Bay should consider the following actions to decrease the amount of phosphorus entering Sturgeon Bay.

8.2.2.1 Urban Storm water Runoff

The watershed land use model predicted that urban areas contributed approximately 24% of phosphorus to the Bay. Northern Environmental recommends evaluating storm sewer improvements. The storm sewer mapping completed as part of this project should assist in determining the feasibility and location of potential storm water control structural BMPs to reduce sediment and nutrient loading to Sturgeon Bay. The WDNR provides financial assistance for runoff management. Please visit www.dnr.state.wi.us/org/water/wm/nps/grants/npsprogram.html for information on these grant programs. Additional information about financial assistance is included in Section 8.2.6 of this report.

City's with a population over 10,000 are required to comply with Subchapter I of Chapter NR 216, Wis. Adm. Code. This WDNR program requires that the municipality with a separate storm sewer system obtain a storm water discharge permit. The 2000 census results indicated that the population was 9,437 people so coverage under this program is not mandatory at this time. Population is expected to remain stable in Sturgeon Bay. The City should consider preparing to comply with the municipal storm water discharge requirements in NR 216 if the population increases to over 10,000 by the next census.

The City should also continue to enforce their City Ordinance No. 15.075 Land disturbing and land development activities. This ordinance should be reviewed periodically for compliance with the current applicable requirements listed in Subchapter III of Chapter NR 216, Wis. Adm. Code for construction site storm water discharges.

8.2.2.2 Rural Storm water Runoff

The watershed land use model predicted that rural land uses (nearly all agricultural) contribute approximately 60 percent of phosphorus to the Sturgeon Bay management areas. Therefore, the City of Sturgeon Bay should support Door County's efforts in rural conservation and agricultural best management practices outside the City limits. New agricultural non-point performance standards and prohibition requirements are being implemented through Chapter NR 151, Wis. Adm. Code – Runoff Management. The County Soil and Water Conservation Department has more detail on implementing these new programs. The City should work cooperatively with the Door County Soil and Water Conservation Department to achieve reductions in non-point source pollution from agricultural and other rural sources. The Door County Soil and Water Conservation Department can be reached through the following Door county web link http://www.co.door.wi.gov/ by clicking on the Department's button.

8.2.2.3 Voluntary Practices

In addition to runoff controls from government regulation, voluntary best management practices (BMPs) should also be encouraged to minimize sediment and nutrient runoff. Examples of voluntary practices that should be promoted include:

- Compost all yard waste and grass clippings. No yard waste should be washed into storm sewers
- Use no phosphorus fertilizers on lawns. A fertilizer rating has three numbers: The first is for nitrogen; the second is for phosphorus; and the third is for potassium. Evidence suggests that nitrogen alone can "green up" a lawn.
- Encourage shoreline buffers of at least 35 feet in both rural and urban areas.
-

Natural shorelines are beneficial in that they filter nutrients and sediments from storm water runoff. County zoning limits vegetation removal in shoreland areas within unincorporated areas of the County. The City should promote natural vegetative buffers of at least 35 feet from the ordinary high water mark on shoreline properties. The City may wish to provide a demonstration site of vegetative buffers at one of the City waterfront parks with signs or information regarding the buffer. The City may also consider incorporating requirements for natural vegetative buffers into the City shoreland zoning program.

8.2.2.4 Public Education

Area residents and Bay users should also be provided educational materials about the effects of erosion and storm water runoff, the value of shoreline buffers, and the value of implementing BMPs. Educating the public will assist in the efforts to promote voluntary runoff management BMPs as well as those mandated by regulatory programs. This project report and the project website can serve as a starting point for educational materials. The WDNR, UW Extension Offices, and County Conservation Departments all have good educational materials on storm water runoff and BMPs. Some UW Extension and WDNR fact sheets about storm water runoff and BMPs are included in Appendix M. The Lakeshore Natural Resource Partnership was formed and works within the geographic area described as the Lakeshore Basin. The basin is comprised of Door and Kewaunee and portions of Brown, Calumet, and Manitowoc Counties, and consists of areas that drain into Lake Michigan and Green Bay. This Partnership has been formed to cooperatively address natural resource issues in the basin. Contact and educational materials area available on their website: http://clean-water.uwex.edu/lakeshore/index.htm

8.2.3 Disposal and Composting of Harvested Plant Material Management

8.2.3.1 Composting

As discussed in Section 7.1.4, harvested aquatic plant material has the potential to be a great soil amendment, offering nutrients and moisture holding capabilities. It's use for landscaping and garden uses should be promoted. Local landscaping businesses should also be contacted to see if they would be interested in harvested aquatic plant material to incorporate into their own mulches or compost materials. Free transportation of full un-proceessed truckloads to nearby areas should continue to promote beneficial re-use of this material. A fact sheet on composting aquatic plants is included in Appendix I.

As the amount of aquatic plant material dicates and funding permits, the City may consider purchasing a piece of equipment to process the harvested aquatic plant material. Currently, the long stem fragments make handling the material by hand difficult. A combination of a belt press to remove moisture and a large grinder to grind the plant material may be an option to make the material more suitable for handling and therefore, potentially more appealable to residents. A commercial "Biogrinder" unit would be needed to efficiently operate a composting program of this nature.

8.2.3.2 Landspreading

Landspreading of freshly harvested aquatic plant material on rural orchards and agricultural fields is a beneficial re-use of the aquatic plant material and should be promoted. If property owners are not located close enough to deliver full loads with City trucks, they can drive to the shore conveyor site and load the material onto their vehicles provided a holds harmless agreement is signed. These sites are located under the Bay view bridge or at the Sturgeon Bay Yacht Club.

8.2.4 Continued Monitoring Plan

To evaluate the effectiveness of the APM Program, monitoring of multiple components should be completed. The City should constantly evaluate their program for potential ways of improvement, however the following items are considered minimum monitoring components.

8.2.4.1 Periodic Macrophyte Surveys

Northern Environmental recommends completing aquatic macrophyte surveys every 5 to 10 years to monitor changes in the aquatic plant community and the effects of APM in the management area. Aquatic plant communities may change with varying water levels, water clarity, nutrient levels, and aquatic plant management. The aquatic plant surveys at a minimum should attempt to duplicate transect locations of past aquatic plants surveys. Similar measurements of aquatic plant abundance should be calculated.

8.2.4.2 Water Quality

Sturgeon Bay may consider developing a long-term water-quality monitoring program to accurately characterize current and future water-quality conditions in Sturgeon Bay and determine if implemented management strategies yield desired results. An appropriate water quality monitoring approach would include sampling for the following parameters on the frequency and locations indicated.

Parameter	Frequency
Water Clarity	Bi-monthly in summer Once in fall Once in winter Once in spring
Total Phosphorus	Monthly in summer Once in fall Once in winter Once in spring
TKN and nitrate/nitrite	Monthly in summer
Chlorophyll *a*	Monthly in summer
Dissolved Oxygen/temperature	Monthly in summer Once in fall Once in winter Once in spring

These parameters should be collected from at least four sampling points illustrated on Figure 2 during the summer month sampling and two points in fall, winter, and spring sampling events.

Another method of completing the valuable water quality sampling for a lower cost is to establish a volunteer Self-Help Monitoring Program. The Self-Help Monitoring Program is a lake monitoring program administered by the WDNR. It is designed to use the assistance of local residents to monitor water quality over time. It would be desirable to establish a few data collection points within the Sturgeon Bay management area. Water quality sample locations could be the same as locations for samples collected in 2002 (Figure 2). Key water sampling parameters include water depth, clarity, chlorophyll *a*, total phosphorus, nitrate + nitrite, and total kjeldahl nitrogen. The WDNR provides for the cost of supplies, sample shipping, and laboratory analyses. This allows individuals to get an idea of the existing water quality on their water body of interest, while providing the user and WDNR with useful information as part of a larger data set.

8.2.5 Current, Ongoing, and Future Research

The professional environmental science community includes universities, state natural resource regulatory agencies (e.g. WDNR), and federal regulatory agencies (e.g. USFWS, USACE, EPA, and USGS). These parties along with private conservation groups continuously seek government funding for research about natural resource issues such as the effects of land use, runoff, hydrology, climate change, exotic species, fisheries, aquatic plant management, and toxins on water resources. A great deal of research is completed on the Great Lakes. Numerous short and long term studies are being completed on Lake Michigan and beyond. The City is encourage to “stay current” with this research as the knowledge gained from these endeavors may prove useful or affect aquatic plant management or overall aquatic ecosystem management in the future.

8.2.6 Evaluate Funding Sources

The above recommendations could benefit the APM program and the Sturgeon Bay ecosystem as a whole, however many activities, particularly pollution prevention and control activities are costly and require financial assistance. Numerous funding sources could be pursued. Other governmental agencies, local governments, conservation organizations, corporate sponsorship, individuals, etc., may be able to provide monetary assistance related to lake rehabilitation/restoration activities. A potential list of funding sources is included in Table 7.

9.0 GLOSSARY

Much of the following glossary of limnology terms is adapted from a UW-Extension Publication entitled *Understanding Lake Data* (Shaw, et al., 1994). Also included in the glossary is a list of frequently used acronymns.

APM: Aquatic Plant Management

Algae: One-celled (phytoplankton) or multi-cellular plants either suspended in water (plankton) or attached to rocks, rooted aquatic plants, and other substrates (epiphytes). Their abundance, as measured by the amount of chlorophyll a (green pigment) in an open water sample, is commonly used to help classify the trophic status of a lake. Algae are essential to the lake ecosystems and provide the food base for most lake organisms, including fish. Phytoplankton abundance and specie distribution vary widely from day to day, as life cycles are short.

Alkalinity: A measure of the amount of carbonates, bicarbonates, and hydroxide present in water. Low alkalinity is the main indicator of susceptibility to acid rain. Increasing alkalinity is often related to increased algae productivity. Expressed as mg/l of calcium carbonate ($CaCO_3$) or as microequivalents per liter (μeq/l). 20 μeq/l = 1 mg/l of $CaCO_3$.

Ammonia: A form of nitrogen found in organic materials and many fertilizers. It is the first form of nitrogen released when organic matter decays, can be used by most aquatic plants, and is, therefore, an important nutrient. Ammonia converts rapidly to nitrate (NO_3^-) if oxygen is present. The conversion rate is related to water temperature. Ammonia is toxic fish at relatively low concentrations in pH-neutral or alkaline water. Under acidic conditions, non-toxic ammonium ions (NH_4^+) form, but at high pH values, the toxic ammonium hydroxide (NH_4OH) occurs. The water quality standard for fish and aquatic life is 0.02 mg/l of NH_4OH. At a pH of 7 and a temperature of 68°F (20˚°C), the ratio of ammonium ions to ammonium hydroxide is 250:1; at pH of 8, the ratio is 26:1.

Anion: Refers to the chemical ions present that carry a negative charge in contrast to cations, which carry a positive charge. There must be equal amounts of positive and negative charged ions in any water sample. Following are the common anions in decreasing order of concentration for most lakes: bicarbonate (HCO_3^-), sulfate $SO_4^=$), chloride (Cl^-), carbonate ($CO_3^=$), nitrate (NO_3^-), nitrate (NO_2^-), and phosphates ($H_2PO_4^-$, $HPO_4^=$, and $PO_4^=$).

Anoxic: Without or devoid of oxygen.

Aquatic Invertebrates: Aquatic animals without an internal skeletal structure, such as insects, mollusks, and crayfish.

Aquifer: Rock units that yield water in usable amounts.

BMP: Best Management Practices: These practices are encouraged or required by regualatory programs to minimize polluted runoff.

Benthic Organism: Organism living on the lake bottom.

Bioturbation: The act of benthic organism stirring up lake bottom sediments.

Blue-Green Algae: Algae that are often associated with problem blooms in lakes. Some produce chemicals toxic to other organisms, including humans. They often form floating scum as the die. Many can fix atmospheric nitrogen (N_2) to provide their own nutrient source.

Calcium: The most abundant cation found in Wisconsin lakes. Its abundance is related to the presence of calcium-baring minerals in the lake watershed, and reported in mg/l as calcium carbonate ($CaCO_3$) or mg/l as calcium ion (Ca^{++}).

Cation: Refers to chemical ions present that carry a positive charge. The common cations present in lakes in normal order of decreasing concentrations follow: calcium (Ca^{++}), magnesium (Mg^{++}), potassium (K^+), sodium (Na^+), ammonium (NH_4^+), ferric iron (Fe^{+++}) or ferrous iron (Fe^{++}), manganese (Mn^{++}), and hydrogen (H^+).

Chloride: Chlorine in the chloride ion (Cl^-) form has very different properties from chlorine gas (Cl_2), which is used for disinfecting. The chloride ion (Cl^-) in lake water is commonly considered an indicator of human activity. Agricultural chemicals, human and animal wastes, and road salt are the major sources of chloride in lake water.

Chlorophyll *a*: Green pigment present in all plant life and necessary for photosynthesis. The amount present in lake water depends on the amount of algae, and is therefore commonly used as a water-quality indicator.

Color: Measured in color units that relate to a standard. A yellow-brown natural color is associated with lakes or rivers receiving wetland drainage. The average color value for Wisconsin lakes is 39 units, with the color of state lakes raging from zero to 320 units. Color also affects light penetration, and therefore, the depth at which plants can grow.

Concentration Units: Express the amount of a chemical dissolved in water. The most common ways chemical data are expressed is in mg/l and micrograms per liter (µg/l). One mg/l is equal to one part per million (ppm). To convert µg/l to mg/l, divide by 1000 (e.g., 30 µg/l = 0.03 mg/l). To convert mg/l to µg/l, multiply by 1000 (e.g., 0.5 mg/l = 500 µg/l). Microequivalents per liter (µeq/l) is also sometimes used, especially for alkalinity; it is calculated by dividing the weight of the compound by 1000 and then dividing that number into the mg/l.

Conductivity (Specific Conductance):	Measures the ability of water to conduct an electric current. Conductivity is reported in micromhos per centimeter (µmhos/cm) or an equivalent in microsiemens (µs), and is directly related to the total dissolved inorganic chemicals in the water. Values are commonly two times the water hardness unless the water is receiving high concentrations of contaminants introduced by humans.
Drainage Basin:	The total land area that drains toward a surface water.
Drainage Lakes:	Lakes fed primarily by streams and with outlets into streams or rivers. They are more subject to surface runoff problems but generally have shorter residence times than seepage lakes. Watershed protection is usually needed to manage lake water quality.
EPA:	United States Environmental Protection Agency
Emergent Vegetation:	Plants with leaves that extend above the water surface.
Epiphyte:	See "Algae."
Estuary:	The lower portion or wide mouth of a river.
Evapo-transpiration:	The total water loss from the soil, including that by direct evaporation and that by transpiration from the surfaces of plants.
Fauna:	Animals.
Filamentous Algae:	Algae that forms filaments or mats attached to sediment, weeds, piers, etc.
Flora:	Plants.
Food Chain:	The sequence of algae being eaten by small aquatic animals (zooplankton) that in turn are eaten by small fish that are then eaten by larger fish, and eventually by people or predators. Certain chemicals, such as polychlorinated biphenyls (PCBs), mercury, and some pesticides, can be concentrated from very low levels in the water to toxic levels in animals through this process.
Hardness:	The quantity of multivalent cations, primarily calcium (Ca^{++}) and magnesium (Mg^{++}) in the water, expressed as mg/l of $CaCO_3$. Amount of hardness relates to the presence of soluble minerals, especially limestone and dolomite, in the lake watershed.

Herptile: A reptile or amphibian. In Wisconsin, these include turtles, snakes, frogs, toad, salamanders, and a few lizards.

Hypolimnion: see "Stratification."

Ion: A charged atom or group of atoms that have separated from an ion of the opposite charge. In water, some chemical molecules separate into cations (positive charge) and anions (negative charge). Thus, the number of cations equals the number of anions.

Insoluble: Incapable of dissolving in water.

Intermittent Stream: A stream that periodically flows and typically is not supplied by substantial amounts of ground water.

Kjeldahl Nitrogen: The most common analysis run to determine the amount of organic nitrogen in water. The test includes ammonium and organic nitrogen.

Limiting Factor: The nutrient or condition in shortest supply relative to plant growth requirements. Plants will grow until stopped by this limitation; for example, phosphorus in summer, temperature or light in fall or winter.

Lower Littoral Zone: Zone of submersed rooted plants

Macrophytes: see "Rooted aquatic plants."

Marl: White to gray accumulation on lake bottoms caused by precipitation of calcium carbonate ($CaCO_3$) in hard water lakes. Marl may contain many snail and clamshells, which also are $CaCO_3$. While it gradually fills in lakes, marl also precipitates phosphorus, resulting in low algae populations and good water clarity. In the past, marl was recovered and used to lime agricultural fields.

Metalimnion: see "Stratification."

Middle Littoral Zone: Zone of floating-leaved vegetation.

Morphometric: Parameters of a lake basin, such as length, width, area, and volume.

Nitrate: An inorganic form of nitrogen important for plant growth. Nitrogen is in this stable form when oxygen is present. Nitrate (NO_3^-) often contaminates ground water when water originates from manure pits, fertilized fields, lawns, or septic systems. High levels of nitrate-nitrogen (over 10 mg/l) are dangerous to infants and expectant mothers. A concentration of nitrate-nitrogen (NO_3^-N) plus ammonium-nitrogen (NH_4^-N) of 0.3 mg/l in spring will support summer algae blooms if enough phosphorus is present.

Nitrite: A form of nitrogen that rapidly converts to nitrate (NO_3^-) and is usually included in the NO_3^- analysis.

Overturn: Fall cooling and spring warming of surface water increases density and gradually makes temperature and density uniform from top to bottom. This allows wind and wave action to mix the entire lake. Mixing allows bottom waters to contact the atmosphere, raising the oxygen content of the water. However, warming may occur too rapidly in the spring for mixing to be effective, especially in small sheltered kettle lakes.

Perennial Stream: A stream that almost always flows. Typically a perennial stream received substantial quantities of water from ground water.

Periphyton Invertebrates that use submergent vegetation for their substrate.

Phosphorus: Key nutrient influencing plant growth in more than 80% of Wisconsin lakes. Soluble reactive phosphorus is the amount of phosphorus in solution that is available to plants. Total phosphorus includes the amount of phosphorus in solution (reactive) and in particulate form.

Photosynthesis: Process by which green plants convert carbon dioxide (CO_2) dissolved in water to sugar and oxygen using sunlight for energy. Photosynthesis is essential in producing a food base for a lake and is an important source of oxygen for many lakes.

Phytoplankton: see “Algae.”

Potable Water: Water fit for human consumption and other high-grade processes and uses.

Precipitate: A solid material that forms and settles out of water as a result of certain negative ions (anions) combining with positive ions (cations).

Retention Time: The average length of time water resides in a lake, ranging from several days in small impoundments to many years in large seepage lakes. Retention time (turnover rate or flushing rate) is important in determining the impact of nutrient inputs. Long retention times result in recycling and greater nutrient retention in most lakes. Calculate retention time by dividing the volume of water passing through the lake per year by the lake volume.

Respiration: The process by which aquatic organisms convert organic material to energy. It is the reverse of photosynthesis. Respiration consumes oxygen (O_2) and releases carbon dioxide (CO_2). It also takes place as organic matter decays.

Rhizome: A creeping, underground stem.

Rooted Aquatic Plants: Refers to higher (multi-celled) plants growing in or near water. Macrophytes are beneficial to lakes because they produce oxygen and provide substrate for fish habitat and aquatic insects. Overabundance of such plants, especially problem species, is related to shallow water depth and high nutrient levels.

Secchi Disc: An 8-inch diameter plate with alternating quadrants painted black and white that is used to measure water clarity (light penetration). The disc is lowered into water until it disappears from view. It is then raised until just visible. An average of the two depths, taken from the shaded side of the boat, is recorded as the Secchi disc reading. For best results, the readings should be taken on sunny, calm days.

Sedimentation: Accumulated organic and inorganic matter on the lake bottom. Sediment includes decaying algae and weeds, marl, and soil and organic matter eroded from the watershed of the lake.

Soluble: Capable of being dissolved.

Stratification: The layering of water due to differences in density. The greatest density of water occurs at 39°F (4°C). As water warms during the summer, cool water remains near the bottom. Wind mixing determines the thickness of the warm surface water layer (epilimnion), which usually extends to a depth of about 20 feet. The narrow transition zone between the epilimnion and cold bottom water (hypolimnion) is called the metalimnion or thermocline.

Submergent Vegetation: Plants with most of their leaves growing below the water surface.

Suspended Solids: A measure of the particulate matter in a water sample expressed in milligrams per liter. When measured on inflowing streams, it can be used to estimate the sedimentation rate of lakes or impoundments.

Thermocline: see “Stratification.”

Transparency: see “Secchi disc.”

Transpiration: The process of plants giving up water to the air via their leaves and stems.

Trophic State: The degree to which a lake is enriched with nutrients, increasing the production of rooted aquatic plants and algae. The extent to which this process has occurred is reflected in a lake’s trophic classification: oligotrophic (nutrient poor), mesotrophic (moderately productive), and eutrophic (very productive and fertile).

Upper Littoral Zone: Zone of emergent rooted vegetation

USACE: United States Army Corps of Engineers

USFWS United States Fish and Wildlife Service

USGS United States Geological Survey

WDNR Wisconsin Department of Natural Resources

Watershed: see “Drainage basin.”

Winterkill: Photosynthesis is greatly reduced when snowcover on the lake prevents sunlight from reaching aquatic plants. The death and subsequent decomposition of the plants consumes levels of oxygen that result in fish die-off.

Zooplankton: Microscopic or barely visible animals that often eat algae. These suspended plankton are an important component of the lake food chain and ecosystem. For many fish, they are the primary source of food.

10.0 REFERENCES

While not all references are specifically cited, the following references were used in conjunction with this study and preparation of this report.

Becker, George C., *Fishes of Wisconsin,* Madison, Wisconsin: University of Wisconsin Press, 1983.

Borman, Susan, Robert Korth, and Jo Temte, *Through the Looking Glass…A Field Guide to Aquatic Plants*. Wisconsin Lakes Partnership, 1997.

Bradbury, K., *A Circuitous Path: Protecting Groundwater in Wisconsin*, Geotimes website of American Geological Institute, http://www.geotimes.org/apr03/feature_wisconsin.htm., On-line access April 14, 2003.

Brigham Young University (BYU), "State of Wisconsin Crayfish Species Checklist," http://crayfish.byu/edu/country_pages/state_pages/wisconsin.htm, On-line access April 16, 2003.

Cahow, Jim (WDNR) conversations with Clint Wendt (Northern Environmental), several dates 2002-2003.

Cahow, Jim (WDNR) letter to Sturgeon Bay Staff, "Subject: Aquatic Plant Management Plan", April 8 2003.

Cahow, Jim (WDNR) letter to Sturgeon Bay Staff, "Subject: Aquatic Plant Management Plan", January 8 2003.

Casper, Gary S., *Geographic Distributions of the Amphibians and Reptiles of Wisconsin,* Milwaukee Public Museum, Inc., 1996

Clayton, Lee, et al., "Glaciation of Wisconsin," Geological and Natural History Survey, Educational Series 36, 1992.

Christoffel, Rebecca, Robert Hay, and Lisa Ramirez, *Snakes of Wisconsin,* Wisconsin Department of Natural Resources Bureau of Endangered Resources, PUB-ER-100 00, 2000

Cummings, Kevin S. and Christine A. Mayer, "Field Guide to Freshwater Mussels of the Midwest," *Champaign, Illinois Natural History Survey,* Manual 5, December 1992.

Cummings, Kevin S. and Christine A. Mayer, *Field Guide to Freshwater Mussels of the Midwest*, Champaign, Illinois Natural History Survey, Manual 5, 1992, http://www.inhs.uiuc.edu/cbd/collections/mollusk/fieldguide.html, On-line access April 16, 2003.

Department of the Interior (DOI), *Wisconsin Land Cover Interpreted from Satellite Imagery*, Geological Survey, 1999.

Door County Geographic Information System (GIS) Coordinator, "Selected Door County GIS data" Data CD, aerial image Spring 1992, data November 11, 2001.

Dunn, Gary A., *Insects of the Great Lakes Region*, 1996.

Gunderson, Jeffrey, "Rusty Crayfish Factsheet," www.seagrant.umn.edu/exotics/rusty.html, On-line access April 16, 2003.

Holtan, Paul, "Yellow Perch," Wisconsin Department of Natural Resources Bureau of Fisheries Management, PUBL-FM-710 90, February 1990.

Illinois Natural History Survey (INHS), Illinois Birds-Individual Species Profiles, www.inhs.uiuc.edu/chf/pub/ifwis/birds/index/html, On-line access April 16, 2003.

Jackson, H.T., *Mammals of Wisconsin*, University of Wisconsin Press, 1961.

Korb, Randy M., *Wisconsin Frogs*, Northeastern Wisconsin Audubon Society, 2001.

Lillie, R. and J. Mason, *Limnological Characteristics of Wisconsin Lakes*, Wisconsin Department of Natural Resources Technical Bulletin No. 138, 1983.

National Oceanic and Atmospheric Administration, Great Lakes Environmental Research Laboratory, "Great Lakes Water Levels", http://www.glerl.noaa.gov/data/now/wlevels/, On-line access, 2003.

Nichols, Stanley, *Distribution and habitat descriptions of Wisconsin lake plants*, Wisconsin Geological and Natural History Survey Bulletin 96, 1999.

North American Lake Management Society, *Managing Lakes and Reservoirs*, Third Edition 2001.

Northern Illinois University Department of Geology and Environmental Geosciences, *Geological Tour Through the Northern Door Peninsula, Wisconsin,* March 30 2002.

Ohio Department of Natural Resources (ODNR), Ohio Breeding Bird Atlas – Species Account, www.dnr.state.oh.us/dnap/ohiobirding/breedingbirdatlas/SpeciesAccounts.htm, On-line access April 16, 2003.

Shaw, Byron, Christine Mechevich, and Lowell Klessig, *Understanding Lake Data*, University of Wisconsin Extension Publication G3582, 1994.

Stocker, Whitney, "Rusty Crayfish: A Small Invader Causing Big Problems," www.biopoint.com/rustywebpage/rustywebpage.html, On-line access April 16, 2003.

Toneys, Mike (WDNR), "Fall 2002 Fish Survey," September 4, 2002.

Toneys, Mike (WDNR), "Conversation with Clint Wendt (Northern Environmental)

United States Census Bureau, "Profile of General Demographic Characteristics: 2000", 2000 census data.

United States Department of Agriculture, Soil Conservation Service, *Soil Survey of Door County, WI*, 1978.

United States Environmental Protection Agency (EPA), "Great Lakes Limnology Program", www.epa.gov/glno/monitoring/indicators/limnology/index.htm, On-line access April 7, 2003.

United States Geological Survey (USGS), "Factsheet: Zebra Mussels" www.glsc.usgs.gov/information/factsheets/zebra_mussels00/zebra_mussels00_pg2.htm, On-line access April 5, 2003.

Welch, E.B. and T. Lindell, *Ecological Effects of Wastewater*, Chapman & Hall1992.

Wisconsin Breeding Bird Atlas (WBBA), "Sturgeon Bay East and West Quads," www.uwgb.edu/birds/wbba/data/quadlist.asp, On-line access April 9, 2003.

Wisconsin Department of Natural Resources (WDNR), *Wisconsin Lake Modeling Suite Program Documentation and User's Manual*, August 2002.

Wisconsin Department of Natural Resources (WDNR), "Niagara Escarpment Report," www.dnr.state.wi.us/org/land/er/publications/niagara/index.htm, On-line access April 7, 2003.

Wisconsin Department of Natural Resources (WDNR), "Wisconsin Natural Heritage Inventory Map for Door County," http://www.dnr.state.wi.us/org/land/er/workinglists/mapsbycounty.htm, On-line access April 9, 2003.

Wisconsin Department of Natural Resources (WDNR), "Wisconsin Natural Heritage Inventory Map for Door County," http://www.dnr.state.wi.us/org/water/fhp/lakes/aquaplan.htm On line access 2002-2003.

Wisconsin Department of Natural Resources, Enterprise Data Management Section, "Statewide Representation of Land Cover" Geodisc 3 Data CD, October 1998.

Wisconsin State Herbarium, "Wisconsin Vascular Plants and Lichens", http://www.botany.wisc.edu/wisflora.htm, On-line access 2002-2003.

APPENDIX A

PUBLIC QUESTIONNAIRE AND RESULTS

APPENDIX B

AQUATIC PLANT SURVEY DATA

APPENDIX C

LABORATORY REPORTS FOR SURFACE WTER QUALITY AND STORM WATER SAMPLING

APPENDIX D

CITY HARVESTING CREW WATAR QUALITY AND WATER DEPTH SAMPLING RESULTS

APPENDIX E

LABORATORY REPORTS FOR SEDIMENT AND AQUATIC PLANT SAMPLING

APPENDIX F

WiLMS® MODEL PARAMETERS AND PHOSPHORUS LOADING RESULTS

APPENDIX G

AQUATIC PLANT MANAGEMENT ALTERNATIVES COMPARISON

APPENDIX H

WDNR GUDANCE FOR APM PROGRAM

APPENDIX I

PUBLIC EDUCATIONAL MATERIALS FOR AQUATIC PLANTS AND MANAGEMENT

APPENDIX J

SHORELINE NAVIGATION ACCESS REQUEST FORM

APPENDIX K

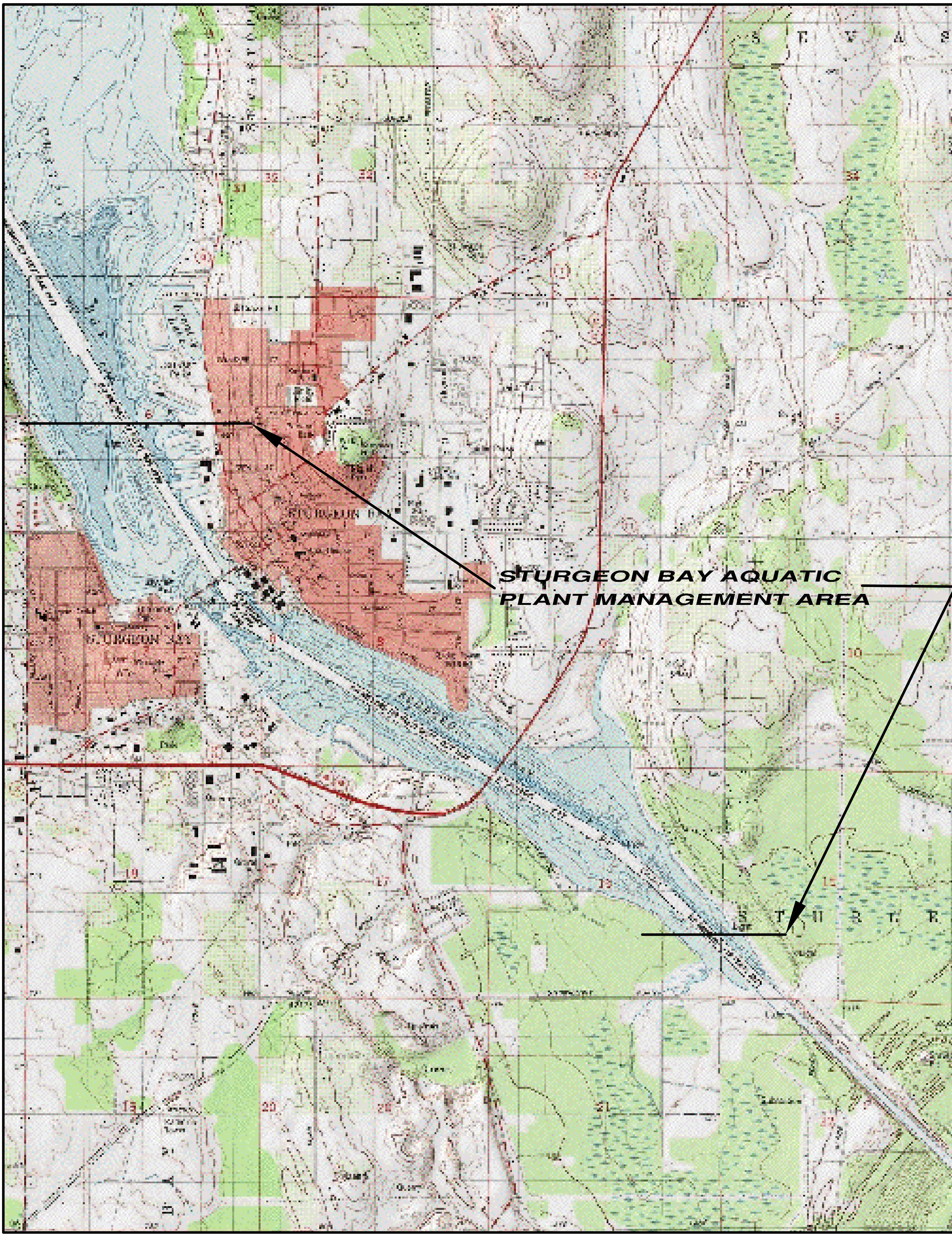
SPECIAL CONDITIONS REQUEST FORM

APPENDIX L

SAMPLE RECORD KEEPING FORMS

APPENDIX M

PUBLIC EDUCATIONAL MATERIALS FOR STORM WATER RUNOFF AND BMPS



SCALE IN FEET
1" = 1000'
0 1000 2000 3000 4000 5000 6000 7000 8000

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

QUADRANGLE LOCATION

BASE MAP SOURCE: USGS 7.5 MINUTE QUADRANGLES, STURGEON BAY EAST AND STURGEON BAY WEST, WISCONSIN, 1981 (NATIONAL GEOGRAPHIC TOPO! 2001)

REVISIONS

THIS DRAWING AND ALL INFORMATION CONTAINED THEREON IS THE PROPERTY OF NORTHERN ENVIRONMENTAL INCORPORATED AND SHALL NOT BE COPIED OR USED FOR THE PURPOSE FOR WHICH IT IS EXPRESSLY FURNISHED.

Northern Environmental℠
Hydrologists · Engineers · Geologists
1203 Storbeck, Waupun, Wisconsin
PHONE: 800-498-3921 FAX: 920-324-3023
Website: www.northernenvironmental.com
WISCONSIN MICHIGAN ILLINOIS MINNESOTA IOWA

SITE LOCATION AND LOCAL PHYSIOGRAPHY

CITY OF STURGEON BAY
STURGEON BAY, WISCONSIN

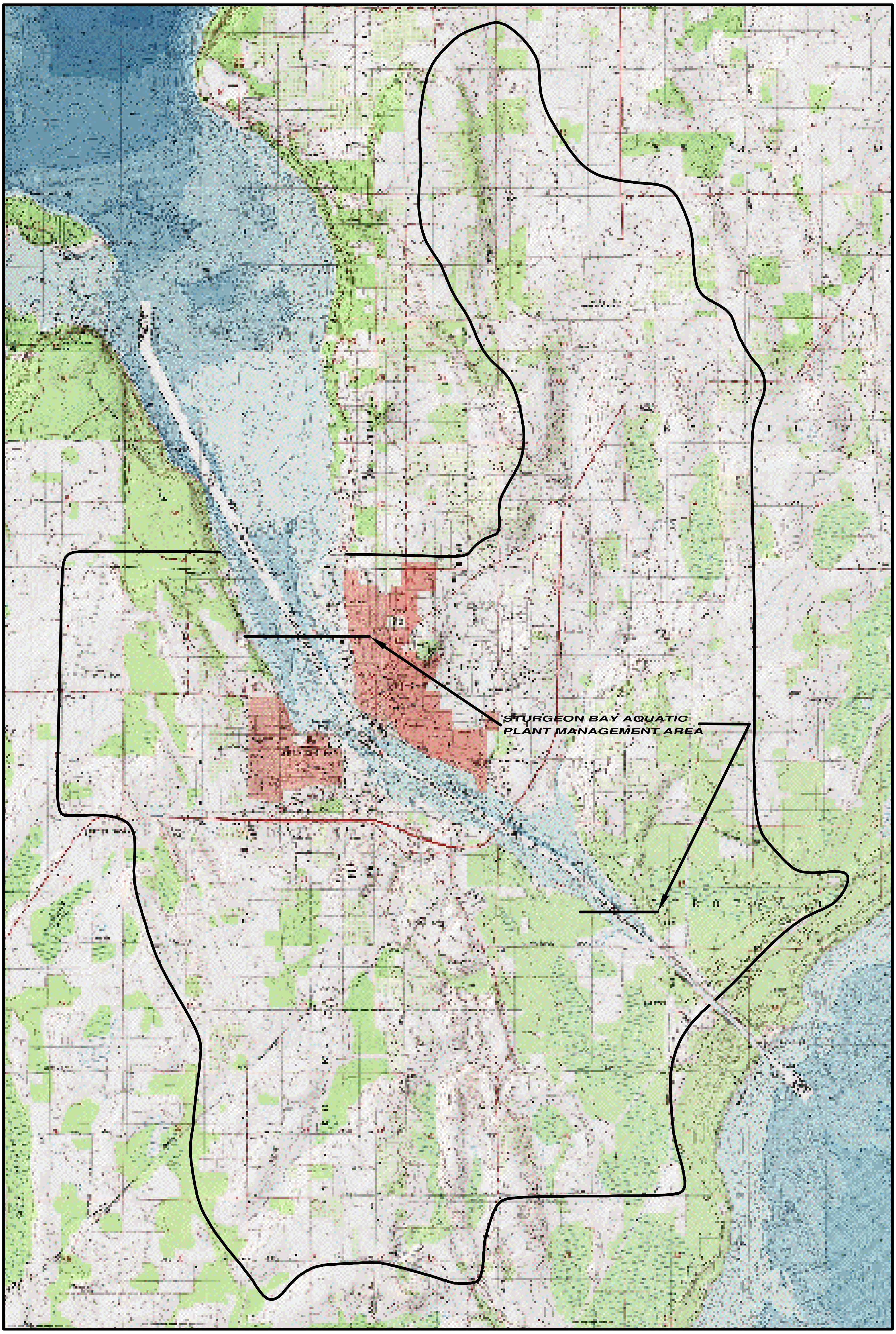
DATE: 04/26/03 | CREATED BY: DDP | APPROVED BY: CWW | PROJECT NUMBER: STB08-3100-0574 | FIGURE 1

K:\WAU\PROJECTS\STB\0574\dwg\041803-MASTER_recover.dwg, FIG1, 7/16/2003 2:20:28 PM

DIGITAL ORTHOPHOTOGRAPHY AND SHAPEFILE (.shp) PROVIDED BY DOOR COUNTY GIS DEPT.

REVISIONS	Northern Environmental℠ Hydrologists · Engineers · Geologists	WATER AND SEDIMENT SAMPLE LOCATIONS
THIS DRAWING AND ALL INFORMATION CONTAINED THEREON IS THE PROPERTY OF NORTHERN ENVIRONMENTAL INCORPORATED AND SHALL NOT BE COPIED OR USED FOR THE PURPOSE FOR WHICH IT IS EXPRESSLY FURNISHED.	1203 Storbeck, Waupun, Wisconsin PHONE: 800-498-3921 FAX: 920-324-3023 Website: www.northernenvironmental.com WISCONSIN · MICHIGAN · ILLINOIS · MINNESOTA · IOWA	CITY OF STURGEON BAY STURGEON BAY, WISCONSIN
	DATE: 04/29/03 CREATED BY: DDP APPROVED BY: CWW	PROJECT NUMBER: STB08-3100-0574 FIGURE 2

K:\WAU\PROJECTS\STB\0574\dwg\041803-MASTER_recover.dwg, FIG 2, 7/16/2003 2:22:19 PM



SCALE IN FEET

1" = 2000'

0 2000 4000 6000 8000 10000 12000 14000 16000

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

N

QUADRANGLE LOCATION

BASE MAP SOURCE: USGS 7.5 MINUTE QUADRANGLES, STURGEON BAY EAST AND STURGEON BAY WEST, WISCONSIN, 1981 (NATIONAL GEOGRAPHIC TOPO! 2001)

REVISIONS

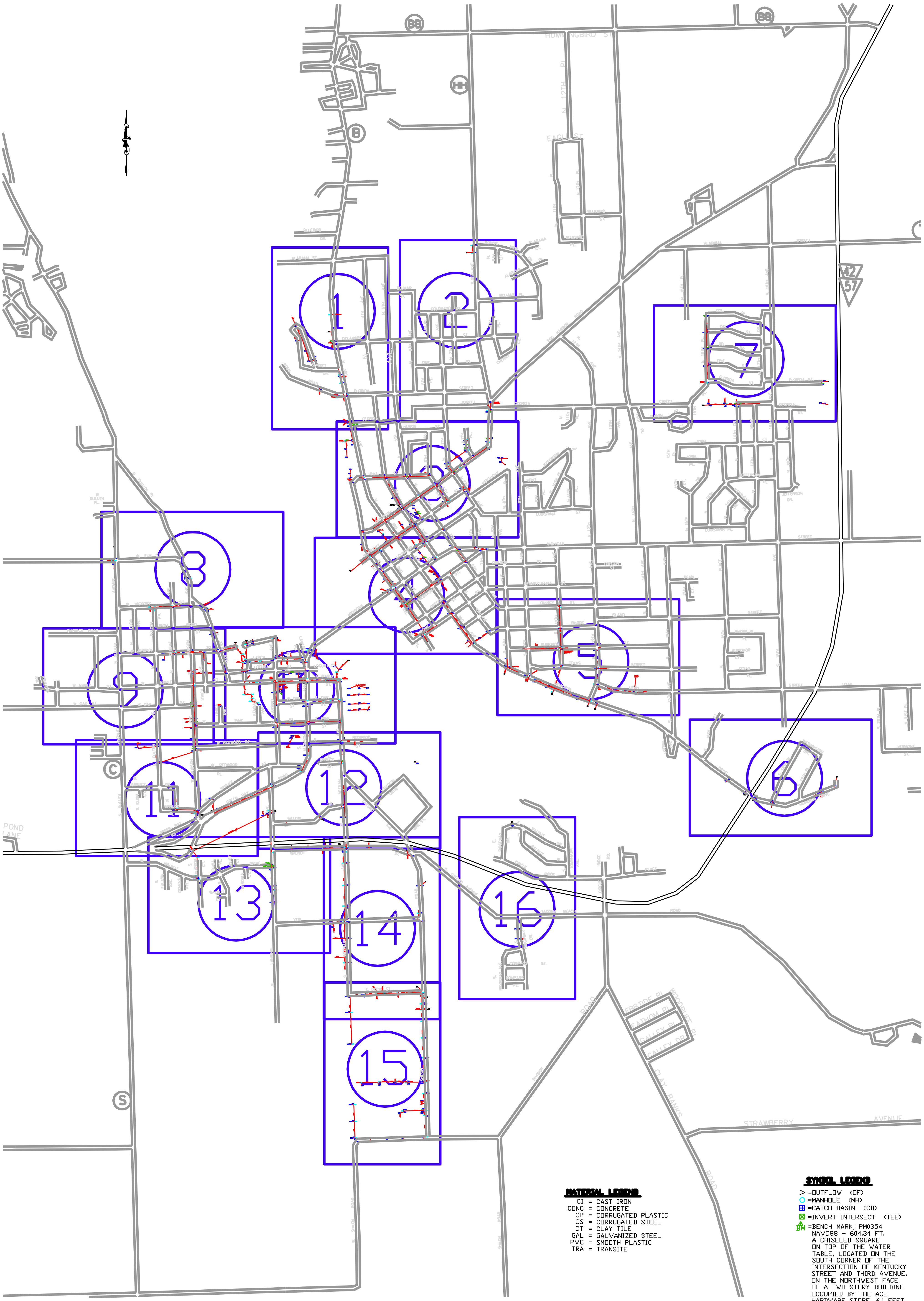
Northern Environmental℠
Hydrologists · Engineers · Geologists
1203 Storbeck, Waupun, Wisconsin
PHONE: 800-498-3921 FAX: 920-324-3023
Website: www.northernenvironmental.com
WISCONSIN MICHIGAN ILLINOIS MINNESOTA IOWA

DATE: 04/26/03 | CREATED BY: DDP | APPROVED BY: CWW

AQUATIC PLANT MANAGEMENT AREA SUB-WATERSHED

CITY OF STURGEON BAY
STURGEON BAY, WISCONSIN

PROJECT NUMBER: STB08-3100-0574 | FIGURE 3



MATERIAL LEGEND

CI = CAST IRON
CONC = CONCRETE
CP = CORRUGATED PLASTIC
CS = CORRUGATED STEEL
CT = CLAY TILE
GAL = GALVANIZED STEEL
PVC = SMOOTH PLASTIC
TRA = TRANSITE

SYMBOL LEGEND

=OUTFLOW (OF)
=MANHOLE (MH)
=CATCH BASIN (CB)
=INVERT INTERSECT (TEE)
=BENCH MARK; PM0354 NAVD88 - 604.34 FT. A CHISELED SQUARE ON TOP OF THE WATER TABLE, LOCATED ON THE SOUTH CORNER OF THE INTERSECTION OF KENTUCKY STREET AND THIRD AVENUE, ON THE NORTHWEST FACE OF A TWO-STORY BUILDING OCCUPIED BY THE ACE HARDWARE STORE, 6.1 FEET SOUTHWEST FROM THE NORTH CORNER OF THE BUILDING.

REVISIONS

THIS DRAWING AND ALL INFORMATION CONTAINED THEREON IS THE PROPERTY OF NORTHERN ENVIRONMENTAL INCORPORATED AND SHALL NOT BE COPIED OR USED FOR THE PURPOSE FOR WHICH IT IS EXPRESSLY FURNISHED.

Northern Environmental℠
Hydrologists · Engineers · Surveyors
330 South 4th Avenue, Park Falls, Wisconsin
PHONE: 800-498-3913 FAX: 715-762-1844
Website: www.northernenvironmental.com
WISCONSIN MICHIGAN ILLINOIS MINNESOTA IOWA

DATE: 02-19-2003 CREATED BY: NLS APPROVED BY: KJA

STORM SEWER SYSTEM

CITY OF STURGEON BAY
DOOR COUNTY
WISCONSIN

PROJECT NUMBER: STB04-3700-0460 FIGURE 4

LEGEND

—#— BOTTOM CONTOURS IN FEET

x ##.## CHANNEL DEPTHS

NOTE: 1. WATER DEPTH MEASURMENTS COLLECTED IN SUMMER 2002 FROM CITY HARVESTING CREWS

2. CONTOURS CREATED FROM 2002 DEPTH MEASURMENTS AND 1980 USGS TOPOGRAPHY MAP WITH SOUNDINGS (METERS) IN STURGEON BAY SHIPPING CANAL

N

SCALE IN FEET

800 0 800 1600

DIGITAL ORTHOPHOTOGRAPHY AND SHAPEFILE (.shp) PROVIDED BY DOOR COUNTY GIS DEPT.

K:\WAU\PROJECTS\STB\0574\dwg\041803-MASTER_recover.dwg, FIG5, 7/16/2003 2:24:33 PM

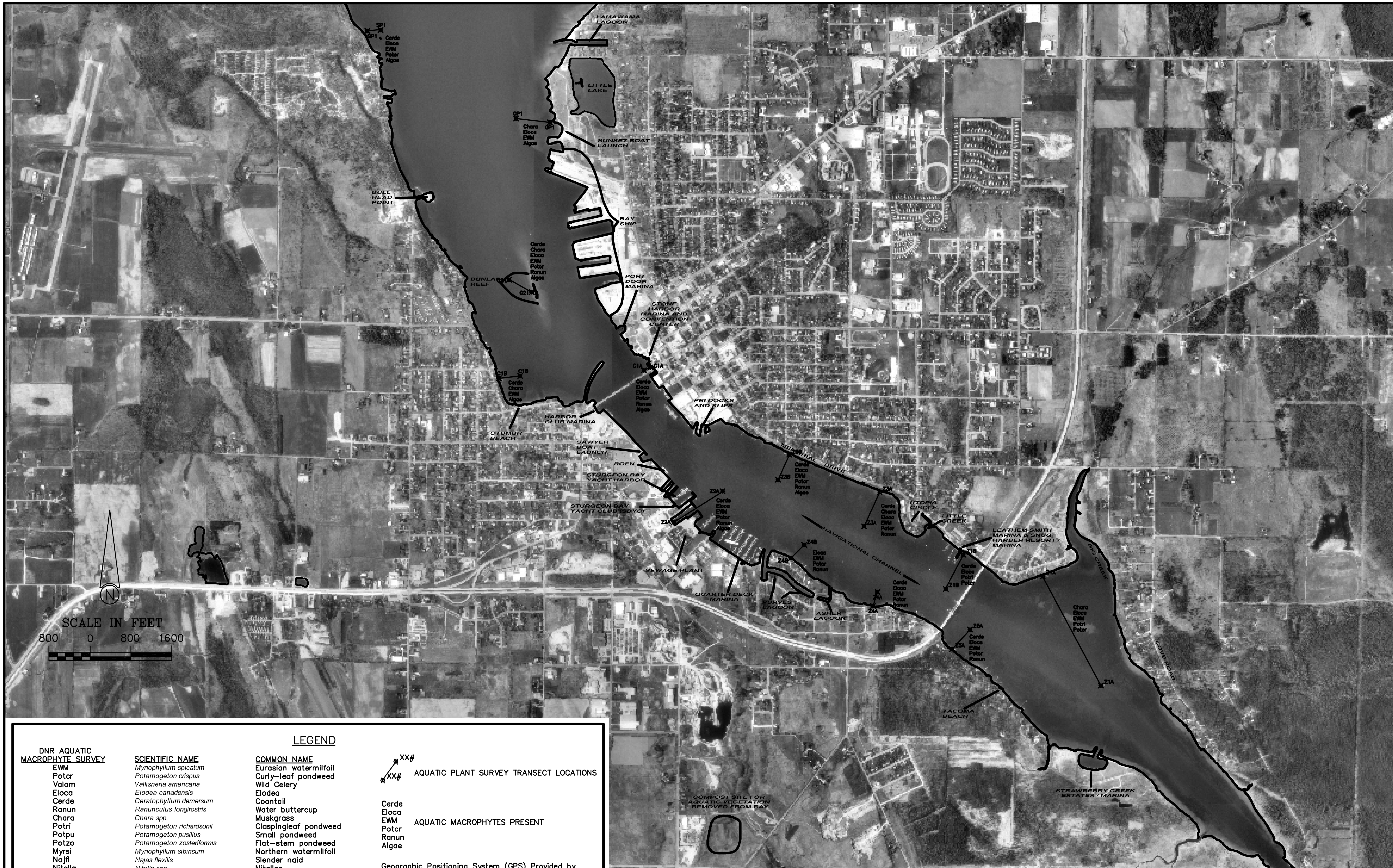
REVISIONS

Northern Environmental℠
Hydrologists · Engineers · Geologists
1203 Storbeck, Waupun, Wisconsin
PHONE: 800-498-3921 FAX: 920-324-3023
Website: www.northernenvironmental.com
WISCONSIN MICHIGAN ILLINOIS MINNESOTA IOWA

BATHYMETRIC MAP

CITY OF STURGEON BAY
STURGEON BAY, WISCONSIN

DATE: 4/29/03	CREATED BY: DDP	APPROVED BY: CWW	PROJECT NUMBER: STB08-3100-0574	FIGURE 5



LEGEND

DNR AQUATIC MACROPHYTE SURVEY	SCIENTIFIC NAME	COMMON NAME
EWM	*Myriophyllum spicatum*	Eurasian watermilfoil
Potcr	*Potamogeton crispus*	Curly-leaf pondweed
Valam	*Vallisneria americana*	Wild Celery
Eloca	*Elodea canadensis*	Elodea
Cerde	*Ceratophyllum demersum*	Coontail
Ranun	*Ranunculus longirostris*	Water buttercup
Chara	*Chara spp.*	Muskgrass
Potri	*Potamogeton richardsonii*	Claspingleaf pondweed
Potpu	*Potamogeton pusillus*	Small pondweed
Potzo	*Potamogeton zosteriformis*	Flat-stem pondweed
Myrsi	*Myriophyllum sibiricum*	Northern watermilfoil
Najfl	*Najas flexilis*	Slender naid
Nitella	*Nitella spp.*	Nitellas
Potdi	*Potamogeton diversifolius*	Variable pondweed
Potpe	*Potamogeton pectinatus*	Sago pondweed
Potpr	*Potamogeton praelongus*	White-stem pondweed
Hetdu	*Zosterella dubia*	Water stargrass
Amblostegia	*Amblostegia sp.*	Algae
Algae	----	Algae

XX# — XX# AQUATIC PLANT SURVEY TRANSECT LOCATIONS

Cerde
Eloca
EWM
Potcr
Ranun
Algae
AQUATIC MACROPHYTES PRESENT

Geographic Positioning System (GPS) Provided by Wisconsin Department of Natural Resources

GIS Coordinate Conversion to UTM Projection by Northern Enviromental

DIGITAL ORTHOPHOTOGRAPHY AND SHAPEFILE (.shp) PROVIDED BY DOOR COUNTY GIS DEPT.

REVISIONS

Northern Environmental℠
Hydrologists · Engineers · Geologists
1203 Storbeck, Waupun, Wisconsin
PHONE: 800-498-3921 FAX: 920-324-3023
Website: www.northernenvironmental.com
WISCONSIN MICHIGAN ILLINOIS MINNESOTA IOWA

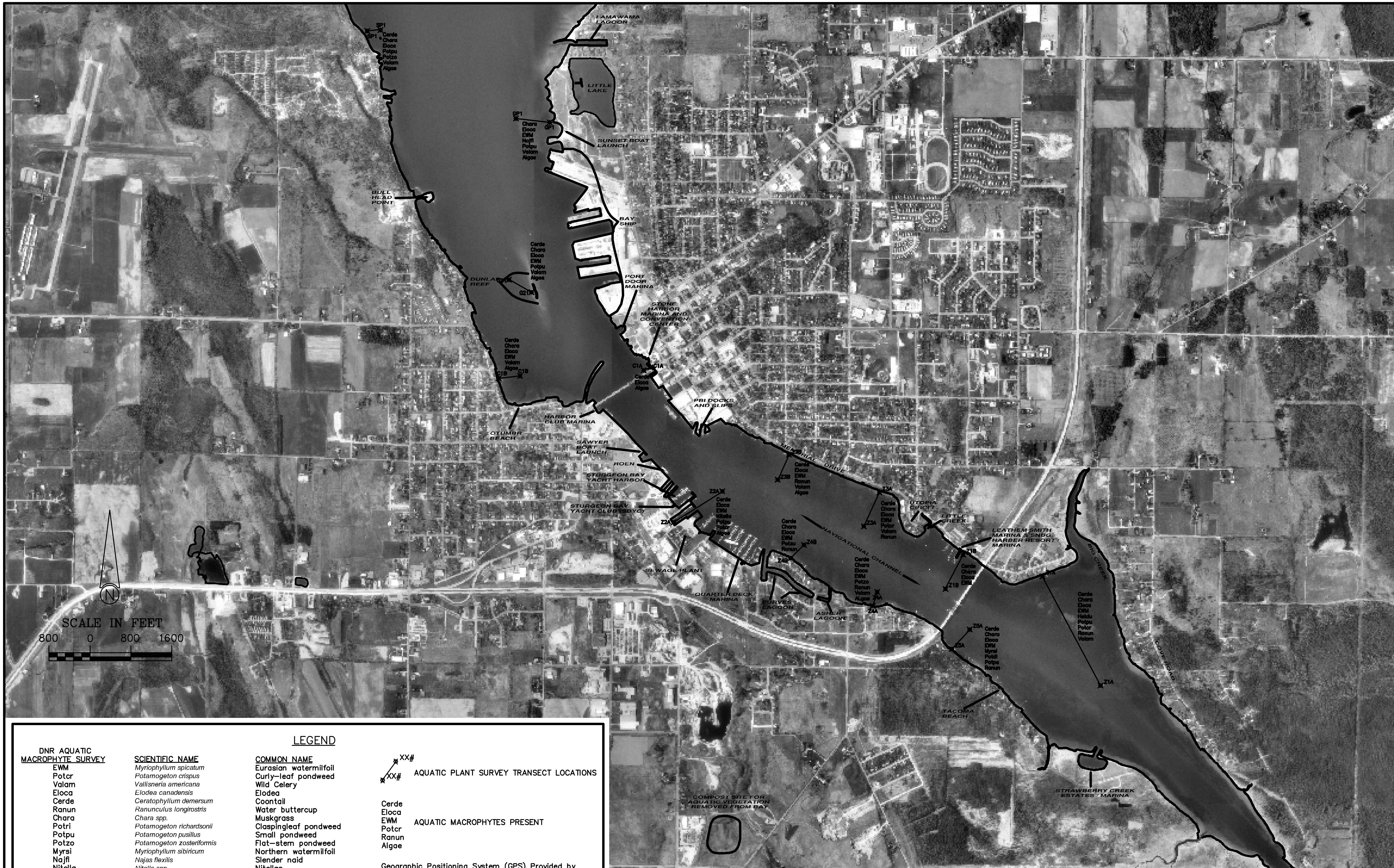
AQUATIC MACROPHYTE DISTRIBUTION JUNE 2002

CITY OF STURGEON BAY
STURGEON BAY, WISCONSIN

DATE: 04/29/03 | CREATED BY: DDP | APPROVED BY: CWW

PROJECT NUMBER: STB08-3100-0574 | FIGURE 6

K:\WAU\PROJECTS\STB\0574\dwg\041803-MASTER_recover.dwg, FIG6, 7/22/2003 12:15:19 PM



LEGEND

DNR AQUATIC MACROPHYTE SURVEY	SCIENTIFIC NAME	COMMON NAME
EWM	*Myriophyllum spicatum*	Eurasian watermilfoil
Potcr	*Potamogeton crispus*	Curly-leaf pondweed
Valam	*Vallisneria americana*	Wild Celery
Eloca	*Elodea canadensis*	Elodea
Cerde	*Ceratophyllum demersum*	Coontail
Ranun	*Ranunculus longirostris*	Water buttercup
Chara	*Chara spp.*	Muskgrass
Potri	*Potamogeton richardsonii*	Claspingleaf pondweed
Potpu	*Potamogeton pusillus*	Small pondweed
Potzo	*Potamogeton zosteriformis*	Flat-stem pondweed
Myrsi	*Myriophyllum sibiricum*	Northern watermilfoil
Najfl	*Najas flexilis*	Slender naid
Nitella	*Nitella spp.*	Nitellas
Potdi	*Potamogeton diversifolius*	Variable pondweed
Potpe	*Potamogeton pectinatus*	Sago pondweed
Potpr	*Potamogeton praelongus*	White-stem pondweed
Hetdu	*Zosterella dubia*	Water stargrass
Amblostegia	*Amblostegia sp.*	Algae
Algae	----	Algae

XX# — XX# AQUATIC PLANT SURVEY TRANSECT LOCATIONS

Cerde
Eloca
EWM
Potcr
Ranun
Algae
AQUATIC MACROPHYTES PRESENT

Geographic Positioning System (GPS) Provided by Wisconsin Department of Natural Resources

GIS Coordinate Conversion to UTM Projection by Northern Enviromental

DIGITAL ORTHOPHOTOGRAPHY AND SHAPEFILE (.shp) PROVIDED BY DOOR COUNTY GIS DEPT.

REVISIONS

THIS DRAWING AND ALL INFORMATION CONTAINED THEREON IS THE PROPERTY OF NORTHERN ENVIRONMENTAL INCORPORATED AND SHALL NOT BE COPIED OR USED FOR THE PURPOSE FOR WHICH IT IS EXPRESSLY FURNISHED.

Northern Environmental℠
Hydrologists · Engineers · Geologists
1203 Storbeck, Waupun, Wisconsin
PHONE: 800-498-3921 FAX: 920-324-3023
Website: www.northernenvironmental.com
WISCONSIN MICHIGAN ILLINOIS MINNESOTA IOWA

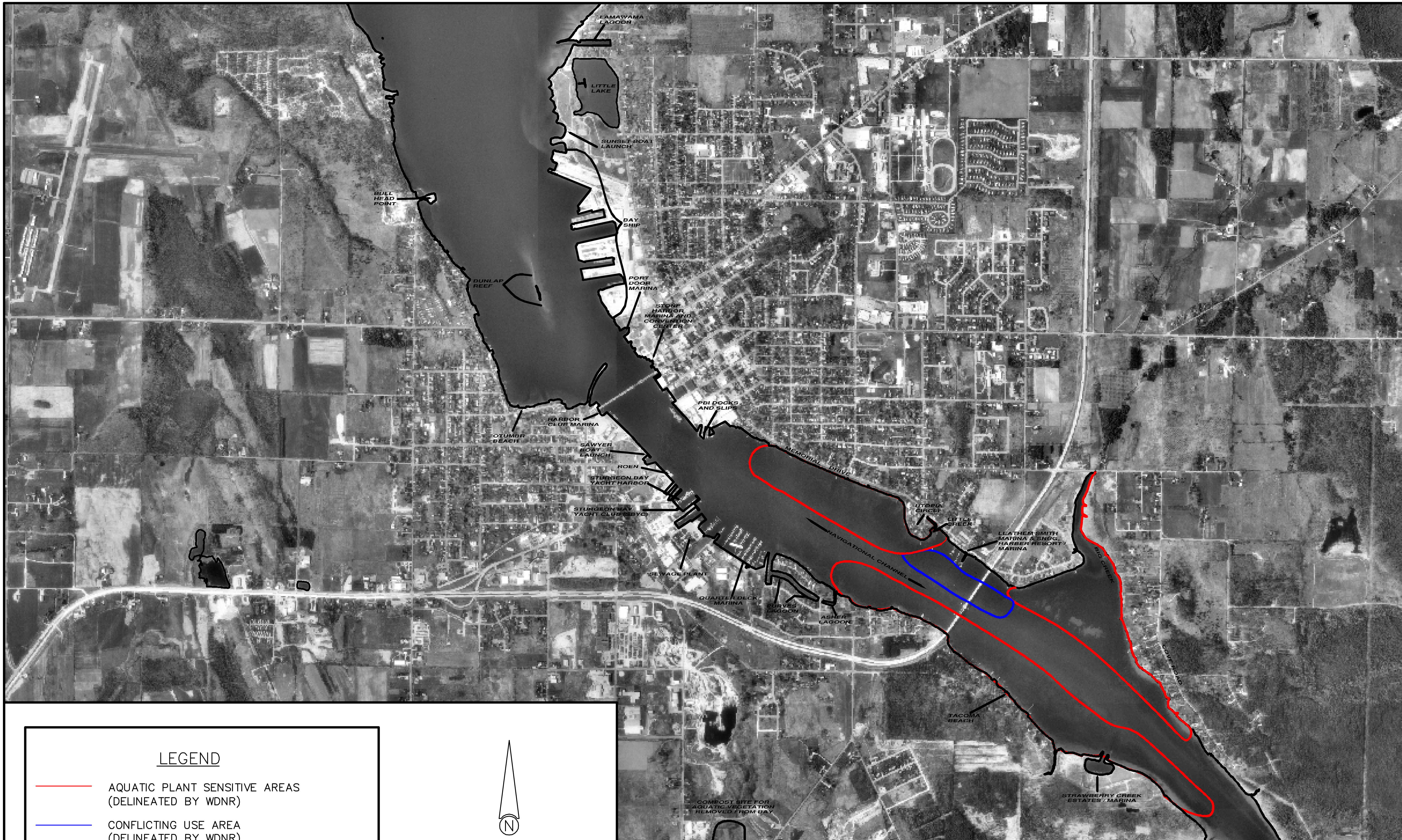
AQUATIC MACROPHYTE DISTRIBUTION AUGUST 2002

CITY OF STURGEON BAY
STURGEON BAY, WISCONSIN

DATE: 04/29/03 | CREATED BY: DDP | APPROVED BY: CWW

PROJECT NUMBER: STB08-3100-0574 | FIGURE 7

K:\WAU\PROJECTS\STB\0574\dwg\041803-MASTER_recover.dwg, FIG7, 7/16/2003 2:26:10 PM



LEGEND

AQUATIC PLANT SENSITIVE AREAS (DELINEATED BY WDNR)

CONFLICTING USE AREA (DELINEATED BY WDNR)

SCALE IN FEET

800 0 800 1600

DIGITAL ORTHOPHOTOGRAPHY AND SHAPEFILE (.shp) PROVIDED BY DOOR COUNTY GIS DEPT.

REVISIONS

THIS DRAWING AND ALL INFORMATION CONTAINED THEREON IS THE PROPERTY OF NORTHERN ENVIRONMENTAL INCORPORATED AND SHALL NOT BE COPIED OR USED FOR THE PURPOSE FOR WHICH IT IS EXPRESSLY FURNISHED.

Northern Environmental℠

Hydrologists · Engineers · Geologists

1203 Storbeck, Waupun, Wisconsin
PHONE: 800-498-3921 FAX: 920-324-3023
Website: www.northernenvironmental.com

WISCONSIN · MICHIGAN · ILLINOIS · MINNESOTA · IOWA

DATE: 04-29-03 | CREATED BY: DDP | APPROVED BY: CWW

WDNR DESIGNATED SENSITIVE AREAS, 2002

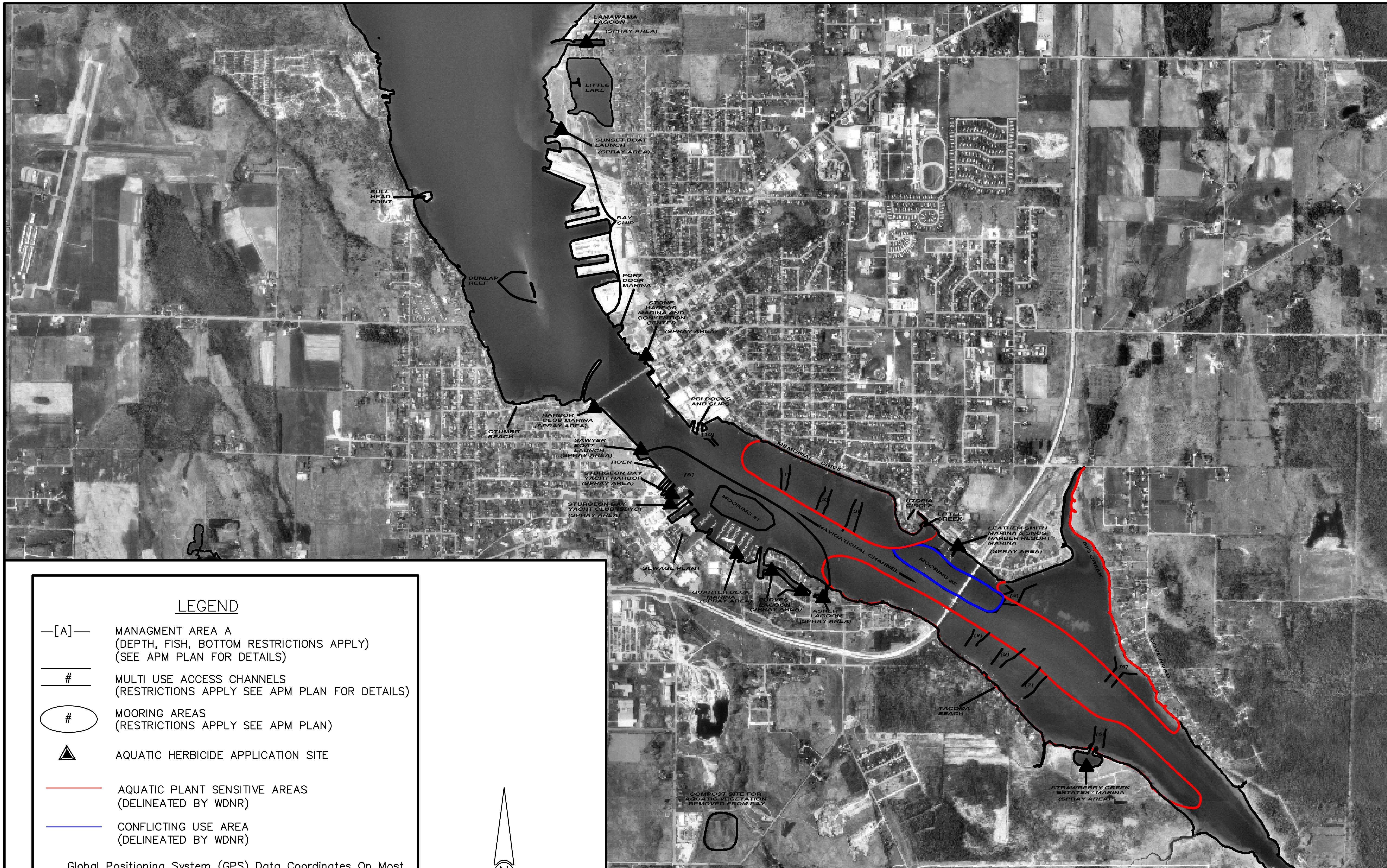
CITY OF STURGEON BAY
STURGEON BAY, WISCONSIN

PROJECT NUMBER: STB08-3100-0574

FIGURE 8

K:\WAU\PROJECTS\STB\0574\dwg\041803-MASTER_recover.dwg, FIG8, 7/22/2003 11:40:55 AM

2002 AQUATIC PLANT MANAGEMENT AREAS



LEGEND

—[A]— MANAGMENT AREA A (DEPTH, FISH, BOTTOM RESTRICTIONS APPLY) (SEE APM PLAN FOR DETAILS)

\# MULTI USE ACCESS CHANNELS (RESTRICTIONS APPLY SEE APM PLAN FOR DETAILS)

\# MOORING AREAS (RESTRICTIONS APPLY SEE APM PLAN)

AQUATIC HERBICIDE APPLICATION SITE

AQUATIC PLANT SENSITIVE AREAS (DELINEATED BY WDNR)

CONFLICTING USE AREA (DELINEATED BY WDNR)

Global Positioning System (GPS) Data Coordinates On Most Channels Provided by City of Sturgeon Bay Harvesting Staff

GPS Coordinate Conversion From Lat/Long to UTM Projection by Northern Environmental

SCALE IN FEET

800 0 800 1600

DIGITAL ORTHOPHOTOGRAPHY AND SHAPEFILE (.shp) PROVIDED BY DOOR COUNTY GIS DEPT.

REVISIONS

THIS DRAWING AND ALL INFORMATION CONTAINED THEREON IS THE PROPERTY OF NORTHERN ENVIRONMENTAL INCORPORATED AND SHALL NOT BE COPIED OR USED FOR THE PURPOSE FOR WHICH IT IS EXPRESSLY FURNISHED.

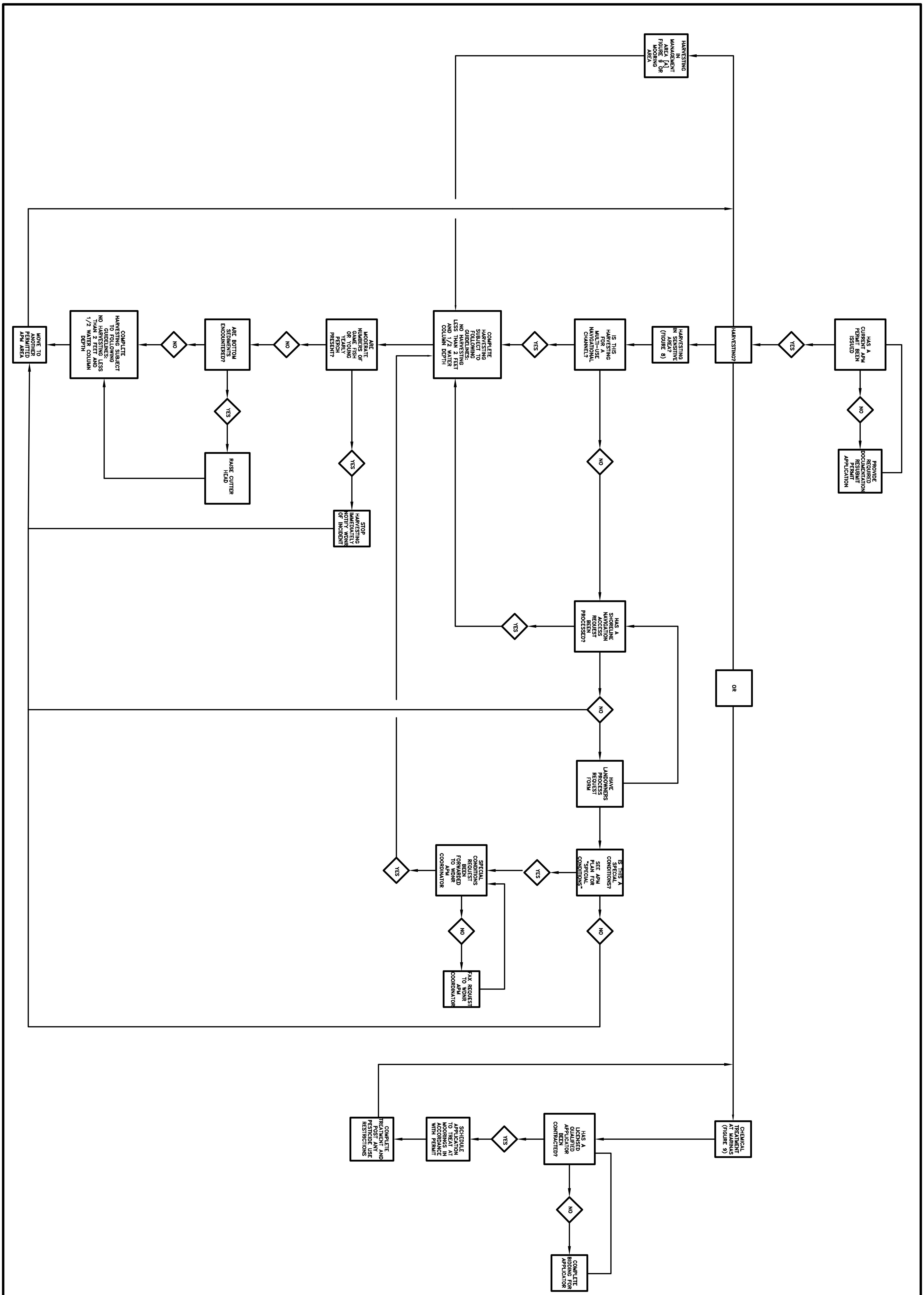
Northern Environmental[SM]
Hydrologists · Engineers · Geologists
1203 Storbeck, Waupun, Wisconsin
PHONE: 800-498-3921 FAX: 920-324-3023
Website: www.northernenvironmental.com
WISCONSIN MICHIGAN ILLINOIS MINNESOTA IOWA

CITY OF STURGEON BAY
STURGEON BAY, WISCONSIN

DATE: 04-29-03 | CREATED BY: DDP | APPROVED BY: CWW | PROJECT NUMBER: STB08-3100-0574 | FIGURE 9

K:\WAU\PROJECTS\STB\0574\dwg\041803-MASTER_recover.dwg, FIG9, 7/16/2003 2:28:07 PM

K:\WAU\PROJECTS\STB\0574\dwg\FLOWCHART.dwg, Layout2, 7/16/2003 2:53:02 PM



Northern Environmental SM

Hydrologists · Engineers · Geologists

1203 Storbeck Drive, Waupun, Wisconsin

Phone: 800-498-3921 Fax 920-324-3023

WISCONSIN MICHIGAN ILLINOIS IOWA

MANAGMENT DECISION MATRIX

CITY OF STURGEON BAY
STURGEON BAY, WISCONSIN

CREATION DATE:	07/15/03	
DRAWN BY:	DDP	
REVISION DATE:	00/00/00	

PROJECT NUMBER: STB08-3100-0574

FIGURE 10

Table 1: Surface Water Physical and Chemical Characteristics, Summer 2002, Sturgeon Bay, Wisconsin

Sample Label	Location			Date Collected	Depth (feet)	Secchi Disk (feet)	Temperature (degrees C)	Temperature (degrees F)	Dissolved Oxygen (mg/l)	% Oxygen Saturation [1]	Laboratory Analytical Results: Nutrients and Inorganics Analysis (mg/l)											Total Nitrogen (m/l) **Sum of NO3, NO2, and TKN**	Total Inorganic Nitrogen (m/l) **Sum of NH3, NO3, and NO2**	N to P Ratio Total N to Total P Ratio	N or P Limited
	Description	Latitude	Longitude								Total Alkalinity (as $CaCO_3$)	Chloride	Ammonia $(NH_3)+(NH4+)$	Nitrate (NO_3)	Nitrite (NO_2)	Nitrate + Nitrite	TKN	Total Phosphorus (P)	Total Dissolved Phosphorus	Sulfate (SO_4)	Chlorophyll a (ug/l)				
W1	Mouth of Strawberry Creek	44º 48.505'	87º 20.209'	07/19/02	Surface Grab	1.5B	24.9	76.8	11.8	140	170	14	[0.039]	<0.075	0.005	0.08	0.55	0.054	0.056	16	NA	0.635	0.044	10:1	Transitional
W2	Mouth of Big Creek	44º 49.337'	87º 20.775'	07/19/02	Surface Grab	3B	26	78.8	9.9	115	130	24	0.12	<0.075	0.008	0.08	0.54	0.041	0.04	17	NA	0.628	0.128	13:1	Transitional
W3	Mouth of Little Creek	44º 49.406'	87º 21.510'	07/19/02	Surface Grab	4.5B	25.6	78.1	9	105	110	15	[0.063]	<0.075	0.01	0.02	0.45	0.03	0.03	18	NA	0.4775	0.073	15:1	Transitional
W4	Just northwest of Bayview Bridge	44º 49.249'	87º 21.452'	07/19/02	1		25.4	77.7	7.5	85	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	---	---	---	---
					5	5	25.1	77.2	7.1	80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	---	---	---	---
					15		23.1	73.6	7.1	80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	---	---	---	---
					20		20.5	68.9	7.7	80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	---	---	---	---
					25		20.2	68.4	7.4	78	110	11	0.19	0.19	0.004	0.194	[0.28]	0.035	0.042	18	NA	0.388	0.384	5:1	N-limited
W5	Lagoon at mouth of Samuelson's Creek	44º 49.303'	87º 22.228'	07/19/02	Surface Grab	3.5	25.4	77.7	8.8	100	120	15	0.11	0.15	0.012	0.172	0.97	0.086	0.095	19	83	1.304	0.272	13:1	Transitional
101	Entry to Sturgeon Bay - Green Bay side, off Sherwood Point	44º 53.364'	87º 25.036'	08/07/02	Surface Grab	9	20.3	68.5	NA	---	120	14	0.13	<0.075	<0.0030	<0.078	0.4	0.023	<0.0070	20	6.1	0.4	0.13	17:1	P-limited
102	Sawyer Harbor @ Idleweed Creek	44º 52.874'	87º 26.270'	08/07/02	Surface Grab	2.4B	21.2	70.1	NA	---	79	12	<0.025	<0.075	<0.0030	<0.078	0.41	0.017	<0.0070	20	1.4	0.41	0	24:1	P-limited
103	Open water - off Bay Ship	44º 50.593'	87º 23.371'	08/07/02	Surface Grab	6.5	21.8	71.3	NA	---	110	13	[0.028]	<0.075	[0.0030]	0.080	0.44	0.029	<0.0070	19	8.2	0.52	0.031	15:1	Transitional
104	Open water - South of Dunlop Reef	44º 50.075'	87º 23.315'	08/07/02	Surface Grab	7	22.1	71.7	NA	---	120	14	[0.026]	<0.075	0.007	0.082	0.47	0.031	<0.0070	19	5.7	0.56	0.033	15:1	Transitional
105	Middle of Canal - off Roehn Salvage	44º 49.659'	87º 22.519'	08/07/02	Surface Grab	5	21.9	71.5	NA	---	110	14	<0.025	<0.075	0.005	0.080	0.67	0.031	<0.0070	20	8.9	0.76	0.005	22:1	P-limited
106	Off-Quarterdeck Marina	44º 49.574'	87º 22.217'	08/07/02	Surface Grab	5	21.9	71.4	NA	---	110	13	[0.035]	<0.075	0.006	0.081	0.49	0.031	<0.0070	18	6.4	0.58	0.041	16:1	P-limited
107	Entry to Sturgeon Bay - Lake Michigan side, off Coast Guard Station	44º 47.481'	87º 18.473'	08/07/02	Surface Grab	16	19.6	67.2	NA	---	110	11	<0.025	0.2	<0.0030	0.206	[0.18]	[0.0070]	<0.0070	20	0.84	0.41	0.2	28:1	P-limited
108	Mouth of Strawberry Creek	44º 48.515'	87º 20.183'	08/07/02	Surface Grab	1.7B	20.0	68.0	NA	---	120	14	<0.025	<0.075	0.005	0.08	0.41	0.025	<0.0070	20	7.3	0.50	0.005	17:1	P-limited
109	Mouth of Big Creek	44º 49.3969'	87º 20.795'	08/07/02	Surface Grab	2B	21.4	70.6	NA	---	180	33	<0.025	0.22	0.014	0.234	0.75	0.048	<0.0070	18	12	1.22	0.234	19:1	P-limited
110	Mouth of Little Creek	44º 49.418'	87º 21.509'	08/07/02	Surface Grab	2.2B	21.7	71.0	NA	---	110	13	<0.025	<0.075	0.006	0.081	0.4	0.024	<0.0070	19	4.3	0.49	0.006	17:1	P-limited

Notes:

1 = oxygen saturation referenced to pure water at sea level

#B = Secchi disk visible on bottom

TKN = Total Kjeldahl Nitrogen

mg/l = milligrams per liter = parts per million (ppm)

ug/l = micrograms per liter = parts per billion (ppb)

<x = not detected above laboratory detection limit

[x] = value is bracket detected between laboratory detection limit and quantitation limit

NA = not analyzed

Table 2: Sediment Sampling Analytical Results, Summer 2002, Sturgeon Bay, Wisconsin

Sample Label	Location		Depth	Date Collected	Laboratory Analytical Results													
					Nutrients and Minerals Analysis (ppm)													
	Latitude	Longitude			% Solids	Total Nitrogen (N)	Phosphorus (P)	Potassium (K)	Calcium (Ca)	Magnesium (Mg)	Sulfur (S)	Zinc (Zn)	Boron (B)	Mangenese (Mn)	Iron (Fe)	Copper (Cu)	Aluminum (Al)	Sodium (Na)
S1	44º 48.505'	87º 20.209'	Surface Grab	07/19/02	61	1,501.10	307.58	529.45	74,144.87	35,304.21	1,241.06	2,307.73	<3	138.68	4,782.24	8.97	2,311.55	239.48
S2	44º 49.337'	87º 20.775'	Surface Grab	07/19/02	39.7	4763	326.74	402.77	166,666.67	16,655.63	3,833.19	26.47	6.1	126.13	4,946.22	12.94	2,098.36	366.39
S3	44º 49.406'	87º 21.510'	Surface Grab	07/19/02	40.5	2,502.80	332.51	774.02	94,879.52	23,476.90	2,356.43	50.77	<3	209	6,409.66	16.89	3,329.69	203.93
S4	44º 49.249'	87º 21.452'	25 Feet	07/19/02	38.1	3,573.80	503.99	1,085.91	100,000	35,224.42	2,992.74	79.76	<3	318.41	10,646.96	23.33	5,803.74	214.07
S5	44º 49.303'	87º 22.228'	Surface Grab	07/19/02	63.7	542.7	271.12	268.15	46,285.14	24,675.65	644.99	16.09	<3	65.66	3,533.04	7.49	1,448.49	110.85

Notes:

ppm = parts per million

Results reported on dry weight basis

<x = not detected above laboratory detection limit

Table 3: Surface Water Quality Sampling Results, Sturgeon Bay, Wisconsin, Summer 2002

Sample Label	Location: Description	Location: Latitude	Location: Longitude	Date Collected	Depth (feet)	Secchi Disk (feet)	Temperature (degrees C)	Temperature (degrees F)	Dissolved Oxygen (mg/l)	% Oxygen Saturation [1]	Laboratory Analytical Results – Nutrients and Inorganics Analysis (mg/l): Total Alkalinity (as $CaCO_3$)	Chloride	Ammonia (NH_3) + (NH4+)	Nitrate (NO_3)	Nitrite (NO_2)	Nitrate + Nitrite	TKN	Total Phosphorus (P)	Total Dissolved Phosphorus	Sulfate (SO_4)	Chlorophyll a (ug/l)	Total Nitrogen (m/l) **Sum of NO3, NO2, and TKN**	Total Inorganic Nitrogen (m/l) **Sum of NH3, NO3, and NO2**	N to P Ratio Total N to Total P Ratio	N or P Limited
W1	Mouth of Strawberry Creek	44º 48.505'	87º 20.209'	07/19/02	Surface Grab	1.5B	24.9	76.8	11.8	140	170	14	[0.039]	<0.075	0.005	0.08	0.55	0.054	0.056	16	NA	0.635	0.044	10:1	Transitional
W2	Mouth of Big Creek	44º 49.337'	87º 20.775'	07/19/02	Surface Grab	3B	26	78.8	9.9	115	130	24	0.12	<0.075	0.008	0.08	0.54	0.041	0.04	17	NA	0.628	0.128	13:1	Transitional
W3	Mouth of Little Creek	44º 49.406'	87º 21.510'	07/19/02	Surface Grab	4.5B	25.6	78.1	9	105	110	15	[0.063]	<0.075	0.01	0.02	0.45	0.03	0.03	18	NA	0.4775	0.073	15:1	Transitional
W4	Just northwest of Bayview Bridge	44º 49.249'	87º 21.452'	07/19/02	1		25.4	77.7	7.5	85	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	---	---	---	---
					5	5	25.1	77.2	7.1	80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	---	---	---	---
					15		23.1	73.6	7.1	80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	---	---	---	---
					20		20.5	68.9	7.7	80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	---	---	---	---
					25		20.2	68.4	7.4	78	110	11	0.19	0.19	0.004	0.194	[0.28]	0.035	0.042	18	NA	0.388	0.384	5:1	N-limited
W5	Lagoon at mouth of Samuelson's Creek	44º 49.303'	87º 22.228'	07/19/02	Surface Grab	3.5	25.4	77.7	8.8	100	120	15	0.11	0.15	0.012	0.172	0.97	0.086	0.095	19	83	1.304	0.272	13:1	Transitional
101	Entry to Sturgeon Bay - Green Bay side, off Sherwood Point	44º 53.364'	87º 25.036'	08/07/02	Surface Grab	9	20.3	68.5	NA	---	120	14	0.13	<0.075	<0.0030	<0.078	0.4	0.023	<0.0070	20	6.1	0.4	0.13	17:1	P-limited
102	Sawyer Harbor @ Idlewild Creek	44º 52.874'	87º 26.270'	08/07/02	Surface Grab	2.4B	21.2	70.1	NA	---	79	12	<0.025	<0.075	<0.0030	<0.078	0.41	0.017	<0.0070	20	1.4	0.41	0	24:1	P-limited
103	Open water - off Bay Ship	44º 50.593'	87º 23.371'	08/07/02	Surface Grab	6.5	21.8	71.3	NA	---	110	13	[0.028]	<0.075	[0.0030]	0.080	0.44	0.029	<0.0070	19	8.2	0.52	0.031	15:1	Transitional
104	Open water - South of Dunlop Reef	44º 50.075'	87º 23.315'	08/07/02	Surface Grab	7	22.1	71.7	NA	---	120	14	[0.026]	<0.075	0.007	0.082	0.47	0.031	<0.0070	19	5.7	0.56	0.033	15:1	Transitional
105	Middle of Canal - off Roen Salvage	44º 49.659'	87º 22.519'	08/07/02	Surface Grab	5	21.9	71.5	NA	---	110	14	<0.025	<0.075	0.005	0.080	0.67	0.031	<0.0070	20	8.9	0.76	0.005	22:1	P-limited
106	Off-Quarterdeck Marina	44º 49.574'	87º 22.217'	08/07/02	Surface Grab	5	21.9	71.4	NA	---	110	13	[0.035]	<0.075	0.006	0.081	0.49	0.031	<0.0070	18	6.4	0.58	0.041	16:1	P-limited
107	Entry to Sturgeon Bay - Lake Michigan side, off Coast Guard Station	44º 47.481'	87º 18.473'	08/07/02	Surface Grab	16	19.6	67.2	NA	---	110	11	<0.025	0.2	<0.0030	0.206	[0.18]	[0.0070]	<0.0070	20	0.84	0.41	0.2	28:1	P-limited
108	Mouth of Strawberry Creek	44º 48.515'	87º 20.183'	08/07/02	Surface Grab	1.7B	20.0	68.0	NA	---	120	14	<0.025	<0.075	0.005	0.08	0.41	0.025	<0.0070	20	7.3	0.50	0.005	17:1	P-limited
109	Mouth of Big Creek	44º 49.3969'	87º 20.795'	08/07/02	Surface Grab	2B	21.4	70.6	NA	---	180	33	<0.025	0.22	0.014	0.234	0.75	0.048	<0.0070	18	12	1.22	0.234	19:1	P-limited
110	Mouth of Little Creek	44º 49.418'	87º 21.509'	08/07/02	Surface Grab	2.2B	21.7	71.0	NA	---	110	13	<0.025	<0.075	0.006	0.081	0.4	0.024	<0.0070	19	4.3	0.49	0.006	17:1	P-limited

Notes:

1 = oxygen saturation referenced to pure water at sea level

#B = Secchi disk visible on bottom

TKN = Total Kjeldahl Nitrogen

mg/l = milligrams per liter = parts per million

ug/l = micrograms per liter = parts per billion (ppb)

<x = not detected above laboratory detection limit

[x] = value is bracket detected between laboratory detection limit and quantitation limit

NA = not analyzed

Table 4: Storm Water Grab Sampling Results, Sturgeon Bay, Summer 2002

Sample Label	Date Collected	Laboratory Analytical Results			Location	Comments
		Nutrients Analysis (mg/L)				
		Ammonia (NH_3)	Nitrogen ($NO_2 + NO_3$)	Total Phosphorus (P)		
Strawberry Creek	07/31/02	<0.025	0.38	0.054	Slightly upstream of Strawberry Ln. crossing	amber color
Drainpipe	07/31/02	<0.025	1.1	0.022	pvc pipe near mouth of Samuelsons creek	clear
Samuelsons Creek	07/31/02	[0.075]	0.83	0.031	Slightly upstream of E. Walnut S. crossing	clear
Little Creek	07/31/02	0.14	0.78	0.11	Slightly upstream of Utah St. crossing	clear
Big Creek	07/31/02	<0.025	4.6	0.028	Slightly upstream of Utah St. crossing	clear

Notes:

<x = less than laboratory detction limit
[x] = value in brackets detected between laboratory detection limit and quantitation limit
mg/l = milligrams per liter = parts per million (ppm)

All samples collected within 12 hours following major rain event

Table 5: Sediment Sampling Results, Sturgeon Bay, Summer 2002

Sample Label	Location		Depth (feet)	Date Collected	Laboratory Analytical Results													
					Nutrients and Minerals Analysis (ppm)													
	Latitude	Longitude			% Solids	Total Nitrogen (N)	Phosphorus (P)	Potassium (K)	Calcium (Ca)	Magnesium (Mg)	Sulfur (S)	Zinc (Zn)	Boron (B)	Mangenese (Mn)	Iron (Fe)	Copper (Cu)	Aluminum (Al)	Sodium (Na)
S1	44º 48.505'	87º 20.209'	1.5 Surface/Grab	07/19/02	61	1,501.10	307.58	529.45	74,144.87	35,304.21	1,241.06	2,307.73	<3	138.68	4,782.24	8.97	2,311.55	239.48
S2	44º 49.337'	87º 20.775'	3 Surface/Grab	07/19/02	39.7	4763	326.74	402.77	166,666.67	16,655.63	3,833.19	26.47	6.1	126.13	4,946.22	12.94	2,098.36	366.39
S3	44º 49.406'	87º 21.510'	4.5 Surface/Grab	07/19/02	40.5	2,502.80	332.51	774.02	94,879.52	23,476.90	2,356.43	50.77	<3	209	6,409.66	16.89	3,329.69	203.93
S4	44º 49.249'	87º 21.452'	25 Feet	07/19/02	38.1	3,573.80	503.99	1,085.91	100,000	35,224.42	2,992.74	79.76	<3	318.41	10,646.96	23.33	5,803.74	214.07
S5	44º 49.303'	87º 22.228'	5 Surface/Grab	07/19/02	63.7	542.7	271.12	268.15	46,285.14	24,675.65	644.99	16.09	<3	65.66	3,533.04	7.49	1,448.49	110.85

Notes:

ppm = parts per million

Results reported on dry weight basis

<x = not detected above laboratory detection limit

Table 6: Aquatic Plant Nutrient and Mineral Sampling Results, Sturgeon Bay, Summer 2002

Sample Label	Date Collected	Laboratory Analytical Results – Nutrient and minerals analysis (ppm)														N:P:K Nutrient Ratio	Notes
		% Solids	Total Nitrogen (N)	Phosphorus (P)	Potassium (K)	Calcium (Ca)	Magnesium (Mg)	Sulfur (S)	Zinc (Zn)	Boron (B)	Mangenese (Mn)	Iron (Fe)	Copper (Cu)	Aluminum (Al)	Sodium (Na)		
P1	07/19/02	8.00	31,232.30	3,141.91	26,312.59	36,773.55	2,867.25	3,996.38	26.97	46.82	721.94	396.61	9.27	167.28	10,831.56	3:1:3	Freshly harvested aquatic plant material
C1	07/19/02	50.3	18,387.40	3,625.72	2,084.51	128,514.00	9,833.78	2,680.91	52.48	<3	1,465.06	3,817.61	35.8	1,817.91	1,547.62	2:1:0	Year old composted material

Notes:

ppm = parts per million

Results reported on a dry weight basis

Table 7 Potential Funding Sources

Funding Source*	Grant Description	Eligible Applicants	Eligible Projects	Eligibility Criteria	Funding Award	Grant Cycle	Funding Term	Application Deadline	Contact
WDNR	**"River Protection Grant Program"** *Protect rivers through water quality, fisheries habitat and natural beauty enhancements.*	• Units of local government • Non-profit conservation organizations • Qualified river management organizations.	1. River organization development 2. Information and education 3. Assessments of water quality, fish aquatic life and non-point source evaluation. 4. Purchase of land or easements 5. Development of local ordinances 6. Restoration of in-stream or shoreland habitat	Contact WDNR Regional Office Environmental Grant Specialist	• **River Planning Grants:** \$10,000 max per grant and 75% state-share mix • **River Management Grants:** \$50,000 max per grant and 75% state-share max			May 1st of each year	WDNR Regional Office Environmental Grant Specialist: Northeast: Sue Kocken, Green Bay kockes@dnr.state.wi.us 920-492-5797
WDNR	**"Lake Protection Grant"** *Protection and improvement (restoration) of lake water quality and their ecosystems*	• Governmental units • Qualified Lake Associations • Public inland lake protection and rehabilitation districts • Qualified nonprofit conservation organizations	1. Wetland restoration or restoration of lands draining to wetlands. 2. Regulation development (protection of water quality)	Priorities are based on: 1. Previous lake protection grants 2. End result of project focusing on protection or improvement of water quality 3. Enhancement of additional ecosystems aspects (i.e., fish, wildlife, natural beauty). 4. Amount and type of public access 5. Does the project compliment other lake and watershed protection efforts 6. Support from other affected management units 7. Financial support from applicant.	***Formula and Matching Requirements:*** • 75% reimbursement of project costs, up to \$200,000. • Cost share amounts are acceptable in the form of cash; funds from a third party; donated labor, services, materials, or equipment; or in land.			May 1st of each year	Lakeshore Basin Water Resource Specialist (920) 746-2860
WDNR	**"Targeted Runoff Management Grants"** *Control pollution and other factors*	• Local governmental units	1. Runoff grants	Selection is based on geographical water-quality priorities, local support for the project, the ability to control non-point pollution, and other factors	• 2001 Funding \$1.043 million • 2002 Undetermined	Every 2 Years	2 years with a possible 2-year extension	April 15, 2002 (Estimated)	John Young, Green Bay (920) 492-5854

Table 7 Potential Funding Sources

Funding Source*	Grant Description	Eligible Applicants	Eligible Projects	Eligibility Criteria	Funding Award	Grant Cycle	Funding Term	Application Deadline	Contact
WDNR	**"Urban Nonpoint Source Grants"** *Promote urban runoff management for existing, developing, and redevelopment of urban areas*	• Local governmental units	1. Storm-water detention pond 2. Urban streambank stabilization 3. Land acquisition to increase permeable areas for infiltration.	Implement urban runoff performance standards (NR 151, Wis. Adm. Code) to achieve water-quality standards that protect ground water.	• Funding amount depends on the biennial budget • 70% technical assistance • Standard cost-share funds for 50% of the project cost	Every second year Note: depends on funding and number of projects	2 years with a possible 1 year extension	April 15, 2003	John Young, Green Bay (920) 492-5854
WDNR	**"Stewardship Program"** *To provide outdoor recreation, protect lands sensitive to environmental degradation, and conserve and restore wildlife habitat and protect water quality*	• Local governmental units • Non-profit conservation	1. Property acquisition 2. Urban Rivers: to restore and protect river corridors and river fronts in urban areas for outdoor recreation and economic revitalization 3. State Trails: to provide a comprehensive state trails system for hikers, equestrians, bicyclists and cross-country skiers. 4. Urban Green Space: to provide green space, protect scenic, ecological or other natural features or provide land for noncommercial gardening.	Non-profit organization with 501(c) (3) status or a local government: Please see information related to non-profit status: http://www.dnr.state.wi.us/org/caer/cfa/lr/stewardship/stewardship.html Please see information related to local government status: http://www.dnr.state.wi.us/org/caer/cfa/lr/stewardship/stewardship.html#local	Funding varies by programs: • State Trails: $1million per year • Urban Rivers: $1.9 million per year • Urban Green Space: $750,000 per year Non-profit organizations: Stewardship provides 50% match grants to eligible sponsors for qualified projects.	Contact local Community Service Specialist WDNR	Contact local Community Service Specialist WDNR	May 1st of each year	Contact local Community Service Specialist **WDNR** P.O. Box 7921 Madison, WI 53707-7921 (608) 266-5891 **Lake Michigan District:** Jeff Pagels 414-492-5821 Gary Hanson 414-492-5823
EPA	**"Wetlands Grants"** *"To protect, manage, and restore wetlands."*	• State and local governments • Tribes • Interstate/intertribal • Non-profit organizations	1. Protect, restore wetlands, 2. Management program or support enhancement/refinement of an existing program.	1. Funding priority focused on developing plans and management tools for protection of wetland resources; advancing the science and technical tools to evaluate, protect, and restore wetland health; facilitating development of watershed stakeholder partnerships, and improving public access to and education about wetlands information. 2. EPA will review each	• FY 01 est. $15,000,000; • FY 02 est. not available. ***Formula and matching requirements:*** Total Requirements: Total grant project is the Federal share and the required minimum State, Tribal, or local match. For grants awarded through the WPDG competition, the required minimum match is 25 % of the total project costs. This does not preclude applicants from putting additional funds	Length and time is determined at time of grant award.	Determined annually	Contact Regional or Headquarters Office.	EPA Regional or Headquarters Office. For general information contacts the EPA Wetlands Helpline at (800) 832-7828. http://www.epa.gov/owow/wetlands

Table 7 Potential Funding Sources

Funding Source*	Grant Description	Eligible Applicants	Eligible Projects	Eligibility Criteria	Funding Award	Grant Cycle	Funding Term	Application Deadline	Contact
				application according to the following criteria: (1) Clarity of proposal work plan (2) Success of previous projects (3) Transferability of results or methods (4) Potential environmental results (5) Involvement/commitment of applicant.	into the project.				
EPA	**"Non-point Source Implementation Grants"** *To establish non-point source management projects.*	• State and local governments, interstate and intrastate agencies • Public and private non-profit organizations and institutions	1. Best Management Practices 2. Installation for animal wastes, sediment, pesticide and fertilizer control 3. Design and implementation of BMP systems for stream, lake, and estuary watersheds 4. Basin-wide landowner and homeowner education programs.	1. Requirements of under Section 319 include: • Non-federal matching funds of at lease 40 percent of project costs (except for tribal grants where financial hardship is demonstrated) • Maintenance of effort • Proceeds of state grants may be used for financial assistance to individual persons in the case of demonstration projects only; a limit on administrative costs • Annual reporting; and EPA determinations of adequate state progress before additional funding.	Funds are provided to States to carry out non-point source projects and programs pursuant to Section 319 of the Clean Water Act as amended by the Water Quality Act of 1987. • FY 01 est. $237,476,400 • FY 02 not available ***Formula and Matching Requirements:*** Non-federal match of at least 40 % of project or program costs is required except for grants to Indian Tribes, where following demonstration of financial hardship. The non-federal match may be reduced to as low as 10 % of project or program costs. State must also meet maintenance of effort requirements contained in statute.	As determined in accordance with Section 319 (h).		Contact appropriate EPA Regional Office.	Contact appropriate EPA Regional Office. http://www.epa.gov/owow/nps

Table 7 Potential Funding Sources

Funding Source*	Grant Description	Eligible Applicants	Eligible Projects	Eligibility Criteria	Funding Award	Grant Cycle	Funding Term	Application Deadline	Contact
NRCS	**"Watershed Protection and Flood Protection"** *Improve to protect, develop, and utilize the land and water resources to improve and prevent flooding within small watersheds.*	• Local governmental units. • State governments • Flood prevention or flood control district • Non-profit agency	1. Watershed area must not exceed 250,000 acres. 2. Problems caused by flooding, erosion and sediment damage 3. Conservation, development, utilization and disposal of water including the development of multipurpose facilities for such uses as recreation, improvement of fish and wild-life habitat, irrigation, and water supply to municipal and industrial users.	1. Carry out, maintain and operate watershed works of improvement.	• Average Financial Assistance $2,164 to $650,000 • FY 02 est. $41,368,676		No extension	Contact NRCS regional office or local office	Contact NRCS regional office or local. http://www.nrsc.usda.gov.
NRCS	**"Wetland Reserve Program"** *To restore and protect farmed wetlands, prior converted wetlands, wetlands farmed under natural condition, riparian areas, and eligible buffer that agree to permanent or long-term easement or restoration agreement.*	• Individual landowner partnership, association, corporation, estate, trust • state agency owning private croplands	1. Eligible landowners may offer farmed wetlands, prior converted wetlands, wetlands farmed under natural condition, intensively managed pasture and hayland riparian areas, along with eligible buffer areas to be placed under a permanent or 30-year easement or restoration agreement.	1. The landowner must have owned the land offered for at least the preceding 12 months before the end of the period in which the intent of participate in an easement is declared unless the land was acquired by will or succession as a result of the death of the previous owner; or the Department determines that the new owner did not acquire such land for the purpose of placing it in the WRP. 2. Evaluation is based on the environmental benefits and government expenditures on restoration and easement purchase and the requirement that wildlife benefits be maximized.	• FY 02 est. 0 • FY 01 est. $183,569,000 ***Formula and Matching Requirements:*** Lump-sum payments or annual payments (e.g., first to thirty) are made for easements. Cost-share payments are 100% of the cost of implementing the Wetland Restoration Plan and will be paid for a permanent easement with 75% of permanent easement amounts being paid for 30-year easements and cost-share agreements.			Open continuous sign-up period	Contact Regional or Local Office http://www.nrsc.usda.gov

Table 7 Potential Funding Sources

Funding Source*	Grant Description	Eligible Applicants	Eligible Projects	Eligibility Criteria	Funding Award	Grant Cycle	Funding Term	Application Deadline	Contact
NRCS	**"Wildlife Habitat Incentive Program"** *Provide financial incentives to develop habitat for fish and wildlife on private lands*	• Individual landowner	1. Improve fish and wildlife habitat on all lands and aquatic areas	1. Development of a wildlife habitat plan. 2. Part of a larger project 3. WHIP funds cannot be used for mitigation or on land designated as converted wetland.	***Formula and Matching Requirements:*** Provides technical assistance and 75% cost-share assistance. Landowner agrees to install and maintain the WHIP practices.	Agreement lasts a minimum of 10 years.			Contact your local conservation district. http://www.nrcs.usda.gov
USDA	**"Water and Waste Systems"** *Construct or modify water and wastewater systems, which include solid waste disposal and storm drainage*	• Governmental units • Non-profit corporation • Rural municipalities • Special Purpose districts	1. Storm sewer systems 2. Solid-waste disposal equipment 3. Reservoirs 4. Pipelines 5. Wells 6. Pumping stations 7. Sewer systems (collection lines, treatment plants, disposal field, and stabilization ponds) 8. Professional Fees 9. Acquisition of rights of ways and easements 10. Relocation of roads and utilities	1. Applicant must be in rural areas with less than 10,000 population 2. Applicants must be unable to obtain "reasonable" commercial credit 3. Grants/loans are based upon median household incomes. 4. Areas with less than 5500 population receive priority. Priority is also given to requests involving merging of small facilities and those serving low-income communities.	***Formula and Matching Requirements:*** • Up to 75% based upon median household income (MHI). MHI is based on 1990 census			Pre-applications are accepted throughout the fiscal year: October 1 to September 30	

Invasive Aquatic Plant Management Plan Questionnaire

All questionnaires must be completed and returned to the City or Northern Environmental no later than November 15, 2002.

To help establish meaningful goals for the Invasive Aquatic Plant Management Plan, the City of Sturgeon Bay (the City) believes that it is essential to get opinions of individuals affected by the plan. Questions 1 through 3 are designed to give the City an idea of who is completing this questionnaire.

1. Please circle the response that best describes your affiliation with Sturgeon Bay and the community (circle all that apply)

   A. Year round area resident
   B. Seasonal area resident
   C. Shoreline Property owner
   D. Area Business owner
   E. Tourist or vacationer
   F. Other ____________________

2. Do you utilize Sturgeon Bay for any of the following activities? (circle all that apply). If none, leave blank.

   A. Sailboating and Yachting
   B. Recreational Boating , waterskiing, personal water craft riding
   C. Swimming
   D. Fishing
   E. Hunting
   F. Nature viewing

3. From the following list, please circle the statement that best describes how often you use Sturgeon Bay.

   A. 0 days/month
   B. 1 day/month
   C. 5 days/month
   D. 10 days/month
   E. > 10 days/month

Questions 4 through 7 will be used to give the City an idea of what you think of the current condition of the Bay.

4. Overall, how would you rate your experiences on the Bay?

   A. Very enjoyable
   B. Somewhat enjoyable
   C. Somewhat unpleasant
   D. Unpleasant

5. How would you rate the quality of the Sturgeon Bay as an aquatic resource?

   A. Excellent
   B. Good
   C. Fair
   D. Poor

6. Do you believe that Sturgeon Bay's aquatic resources could be improved? Consider cost and practicality.

   A. Yes
   B. No

7. If you answered yes to question # 6, please rank the following concerns with 1 being most important and 6 being least important.

   A. Water quality/Pollution_____
   B. Runoff_____
   C. Aquatic plant growth_____
   D. Boat traffic_____
   E. Exotic and invasive plants, fish and animals_____

Northern Environmental℠

Hydrologists • Engineers • Geologists

Invasive Aquatic Plant Management Plan Questionnaire

F. Other______________________________ ____

The economy of Sturgeon Bay is based on tourism. Most tourism in the area uses the Bay for fishing, boating or swimming. In the early 1990's, the City recognized that weed harvesting was essential to maintain the tourism industry. The City's costs for harvesting have steadily increased since the early 1990s. The 2002 budget for harvest and chemical treatment is approximately $100,000. The following questions are designed to give the City an idea of what the Bay stakeholders think of current management strategies.

8. Please rank your opinion of the City's current management strategy (cutting and chemical treatment) for aquatic plants on Sturgeon Bay.

A. Strongly support
B. Support
C. Neither Support or Oppose
D. Oppose
E. Strongly Oppose

9. Compared to the current budget, how much do you think the City should invest each year in aquatic plant management (harvesting, chemical treatment, and studies)?

A. Less
B. About right
C. More

Ultimately, the Invasive Aquatic Plant Management Plan will be used to determine the practical methods for controlling invasive weeds in the Bay. Input from concerned stakeholders will help develop this plan. Questions 10 and 11 are designed to give the stakeholders an opportunity to assist with plan development.

10. Please rank the following element of the Invasive Plant Study and Management Program with 1 being most important and 8 being least important.

A. Study and understand current aquatic plant problems____
B. Identify pollutant sources____
C. Promote voluntary pollution and runoff controls____
D. Mandate pollution and runoff controls____
E. Improve existing cutting operations____
F. Identify other aquatic plant management strategies____
G. Identify affects on wildlife and fishery ____
H. Other______________________________ ____

11. Please list additional comments and suggestions that you would like to see incorporated into the Invasive Aquatic Management Plan.

____

____

____

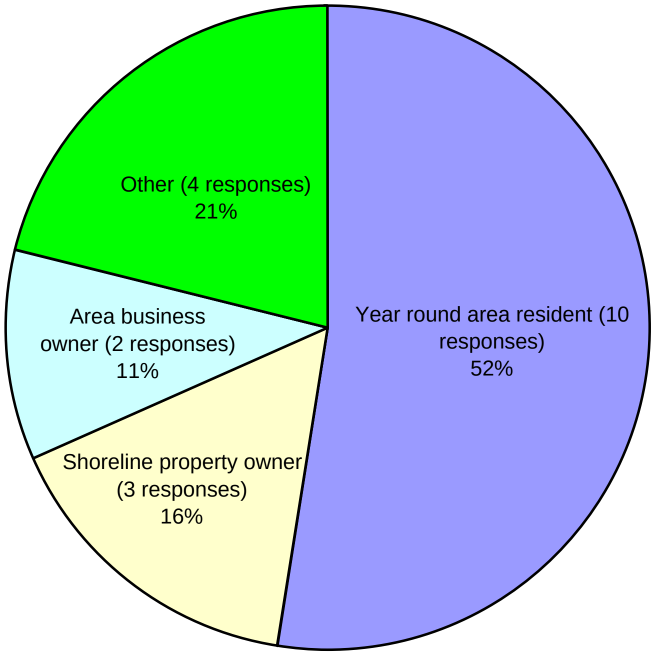
Forms may be mailed to the City (City of Sturgeon Bay, Attn: Tony Depies, 835 North 14th Avenue, Sturgeon Bay, Wisconsin 54235), Northern Environmental (Northern Environmental, Attn: Clint Wendt, 1203 Storbeck Drive, Waupun, Wisconsin 53963), or complete this survey on our website at http://www.northernenvironmental.com/sturgeonbay/Tell%20us%what%20you%20think/Invasive%20...10/2/2002.

All questionnaires must be completed and returned to the City or Northern Environmental no later than November 15, 2002.

Northern Environmental℠

Hydrologists • Engineers • Geologists

Respondant's affiliation with Sturgeon Bay



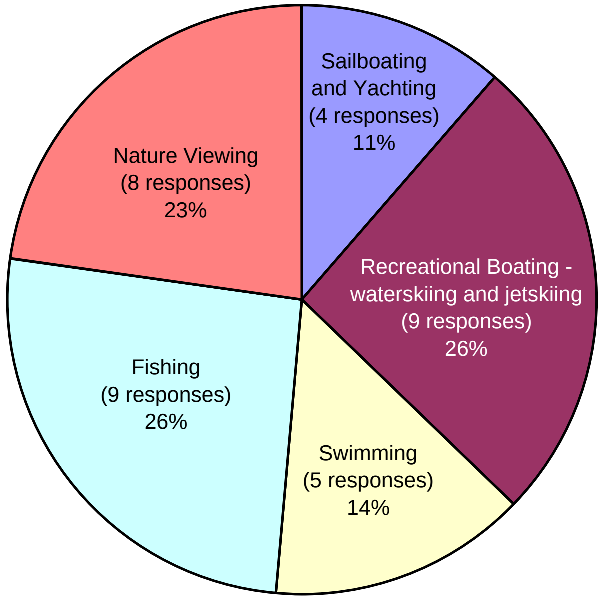
Notes :

Twelve surveys returned. A total of 19 responses were given.

"*Other"* responses included 2 marina owners, city council, buisiness manager

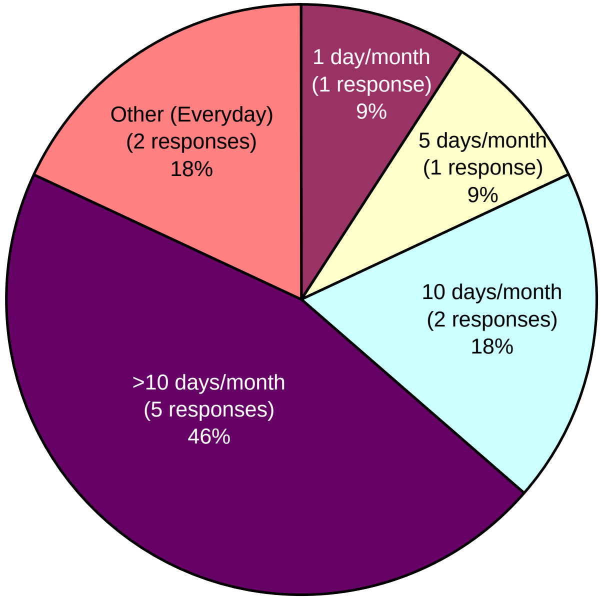
No responses given for *"seasonal area resident"* or *"tourist"* choices

What recreational activity do you use the Sturgeon Bay for?



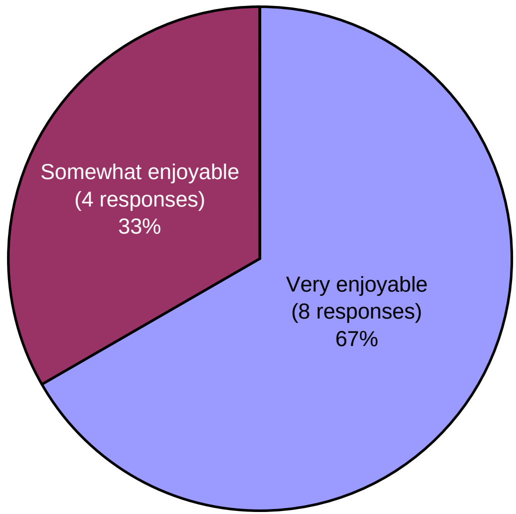
Notes:
Twelve surveys returned. A total of 35 responses were given.
No responses given for *"hunting"* choices

How often do you use Sturgeon Bay?



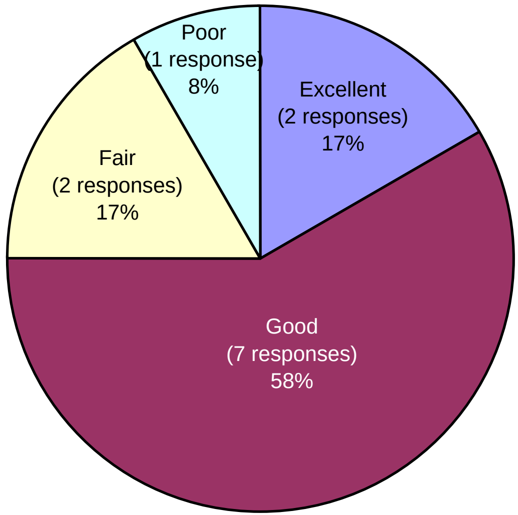
Notes:
Twelve surveys returned - one response was not completed. A total of 11 responses were given.
No responses given for *"0 days/month"* choices

Overall, how would you rate your experiences on the Bay?



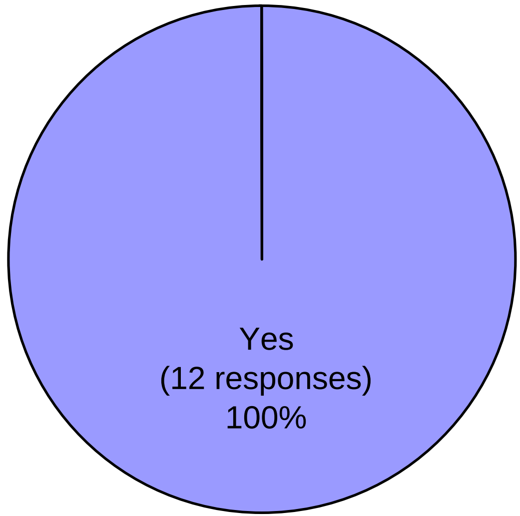
Notes :
Twelve surveys returned. A total of 12 responses were given.
No responses given for *"not very enjoyable"* or *"un-enjoyable"* choices

How would you rate the quality of the Sturgeon Bay as an aquatic resource?

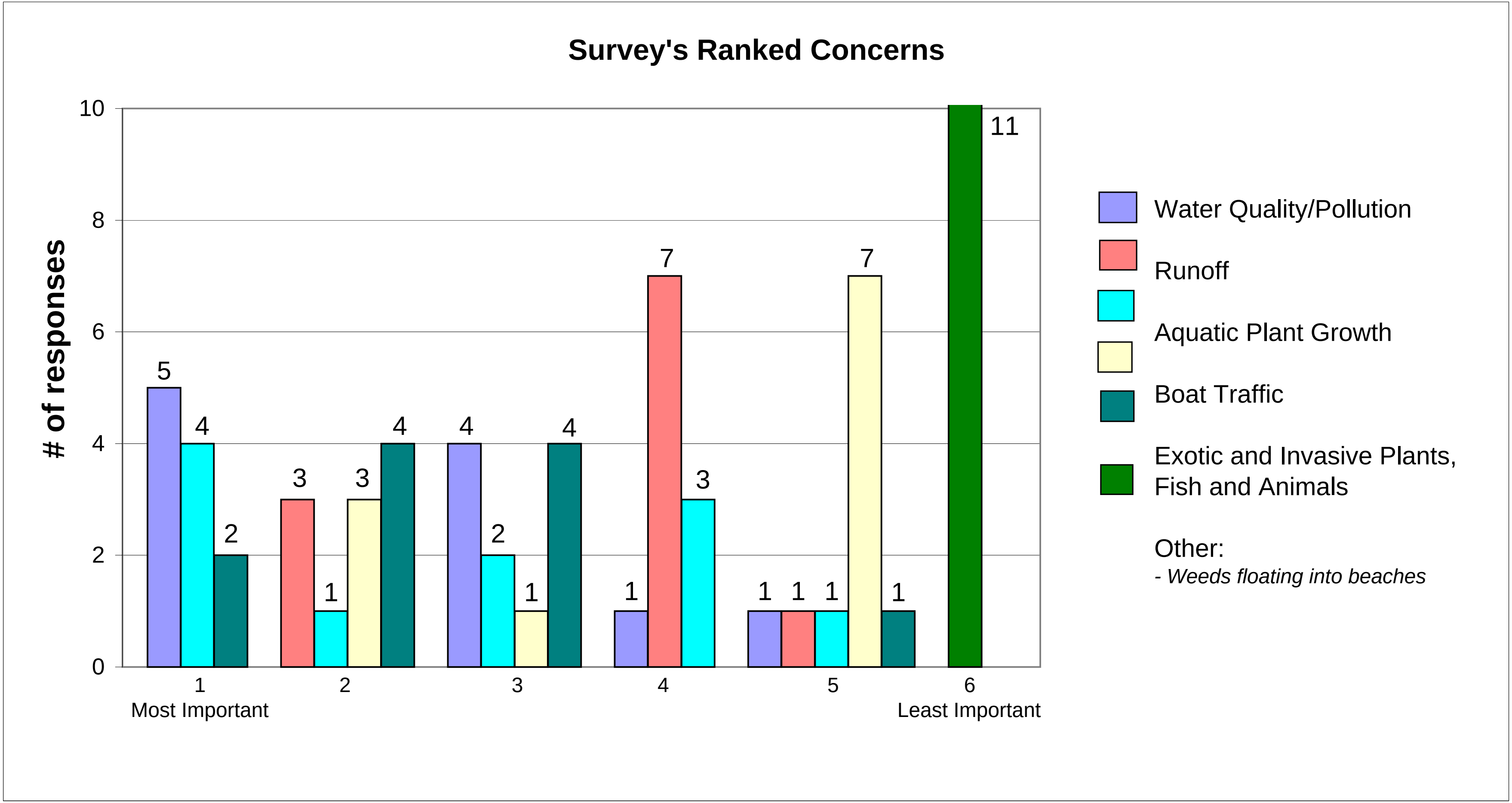


Notes:
Twelve surveys returned. A total of 12 responses were given.

Are you concerned about the quality of Sturgeon Bay?

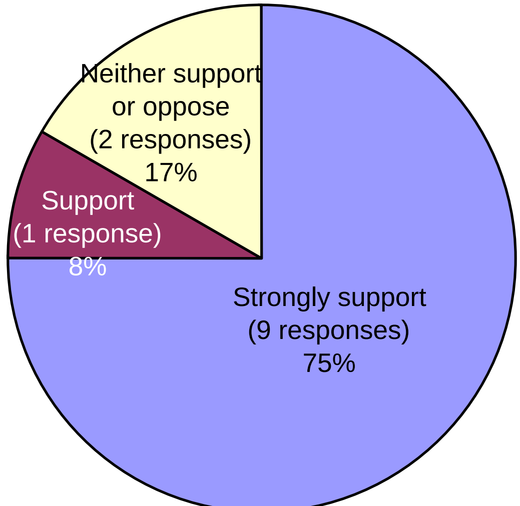


Notes:
Twelve surveys returned. A total of 12 responses were given.
No responses given for "no" choices



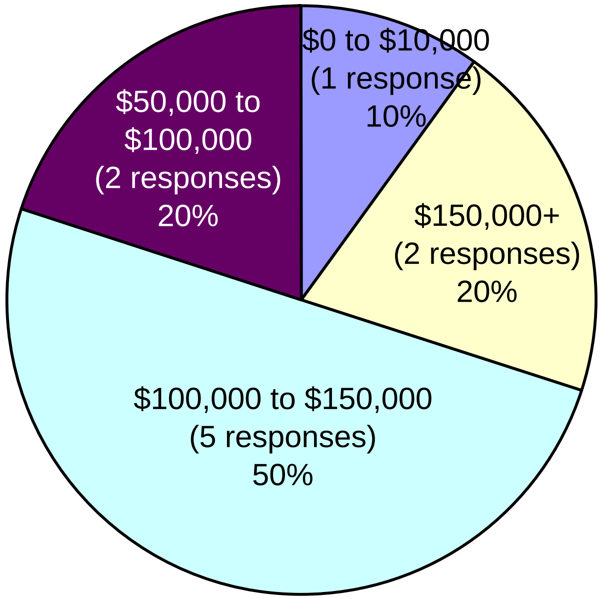
Survey's Ranked Concerns
# of responses
10
8
6
4
2
0
5
4
2
3
1
3
4
4
2
1
4
1
7
3
1
1
1
7
1
11
1
Most Important
2
3
4
5
6
Least Important
Water Quality/Pollution
Runoff
Aquatic Plant Growth
Boat Traffic
Exotic and Invasive Plants, Fish and Animals
Other:
- Weeds floating into beaches

Rank your opinion of the City's current management strategy (harvesting and chemical treatment) for aquatic plants on Sturgeon Bay.



Notes :
Twelve surveys returned. A total of 12 responses were given.
No responses given for *"Oppose"* and *"Strongly Oppose"* choices

How much do you think the City should invest in aquatic plant management?



Notes :
Twelve surveys returned. A total of 10 responses were given.
No responses given for *"$10,000 to $50,000"* choices

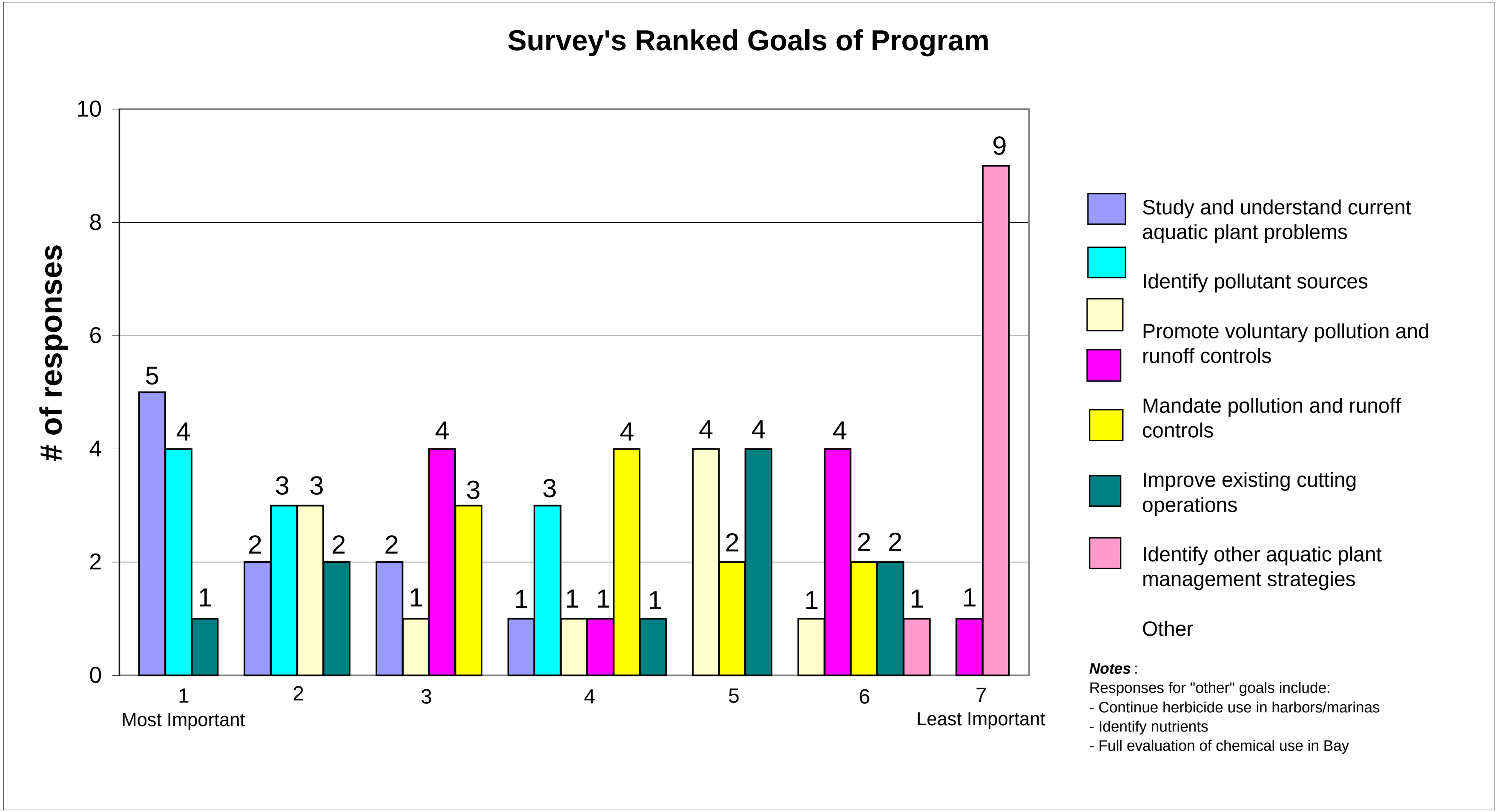

Survey's Ranked Goals of Program
# of responses
0
2
4
6
8
10
5
4
1
2
3
3
2
2
1
4
3
1
3
1
1
4
1
4
2
4
1
4
2
2
1
1
9
1
Most Important
2
3
4
5
6
7
Least Important
Study and understand current aquatic plant problems
Identify pollutant sources
Promote voluntary pollution and runoff controls
Mandate pollution and runoff controls
Improve existing cutting operations
Identify other aquatic plant management strategies
Other
Notes :
Responses for "other" goals include:
- Continue herbicide use in harbors/marinas
- Identify nutrients
- Full evaluation of chemical use in Bay

Table 1: June 2002 Aquatic Macrophyte Survey Results, Sturgeon Bay, Door County, Wisconsin

	EWM	Potcr	Valam	Eloca	Cerde	Ranun	Chara	Potri	Potpu	Potzo	Amblostegia	Algae
Depth Zone <1.75'	0	0	0	26.7	0	0	26.7	6.7	33.3	0	0	60
Depth Zone 1.75 to 5.0'	63.2	36.8	0	68.4	31.6	36.8	31.6	26.3	21.1	15.8	5.3	36.8
Depth Zone 5.0 to 10.0'	64.7	58.8	0	82.4	76.5	52.9	17.6	5.9	5.9	5.9	0	23.5
Depth Zone >10.0'	53.8	84.6	0	76.9	23	7.7	7.7	0	0	0	0	15.4
Average Frequency of Occurrence	45.425	45.05	0	63.6	32.775	24.35	20.9	9.725	15.075	5.425	1.325	33.925

	EWM	Potcr	Valam	Eloca	Cerde	Ranun	Chara	Potri	Potpu	Potzo	Amblostegia	Algae
Depth Zone <1.75'	0	0	0	17.4	0	0	17.4	4.4	21.7	0	0	39.1
Depth Zone 1.75 to 5.0'	16.9	9.8	0	18.3	8.5	9.8	8.5	7	5.6	4.2	1.4	9.8
Depth Zone 5.0 to 10.0'	16.4	14.9	0	20.9	19.4	13.4	4.5	1.5	1.5	1.5	0	6
Depth Zone >10.0'	20	31.4	0	28.6	8.5	2.9	2.9	0	0	0	0	5.7
Average Relative Frequency	13.325	14.025	0	21.3	9.1	6.525	8.325	3.225	7.2	1.425	0.35	15.15

	EWM	Potcr	Valam	Eloca	Cerde	Ranun	Chara	Potri	Potpu	Potzo	Amblostegia	Algae
Depth Zone <1.75'	0	0	0	0.22	0	0	0.43	0.03	0.22	0	0	1.77
Depth Zone 1.75 to 5.0'	0.53	0.26	0	1.6	0.18	0.34	0.25	0.24	0.08	0.04	0.01	0.5
Depth Zone 5.0 to 10.0'	0.44	0.72	0	1.7	0.65	0.49	0.12	0.06	0.04	0.06	0	0.26
Depth Zone >10.0'	0.25	2	0	1.8	0.25	0.02	0.02	0	0	0	0	0.15
Average Density	0.305	0.745	0	1.33	0.27	0.2125	0.205	0.0825	0.085	0.025	0.0025	0.67

Table 2: August 2002 Aquatic Macrophyte Survey Results, Sturgeon Bay, Door County, Wisconsin

	EWM	Myrsi	Potcr	Valam	Eloca	Cerde	Najfl	Ranun	Chara	Nitella	Potdi	Potri	Potpe	Potpu	Potpr	Potzo	Hetdu	Algae
Depth Zone <1.75'	5.6	0	0	22.2	38.9	5.6	11.1	0	44.4	0	0	5.6	0	0	0	0	0	66.7
Depth Zone 1.75 to 5.0'	31.6	10.5	10.5	63.2	63.2	36.8	15.8	31.6	57.9	5.3	5.3	21.1	10.5	31.6	0	0	5.3	21.1
Depth Zone 5.0 to 10.0'	61.1	11.1	11.1	33.3	83.3	72.2	11.1	22.2	16.7	0	0	0	0	22.2	5.6	16.7	0	27.8
Depth Zone >10.0'	26.7	6.7	0	6.7	86.7	80	0	0	6.7	0	0	0	0	20	0	6.7	0	13.3
Average Frequency of Occurrence	31.25	7.075	5.4	31.35	68.025	48.65	9.5	13.45	31.425	1.325	1.325	6.675	2.625	18.45	1.4	5.85	1.325	32.225

	EWM	Myrsi	Potcr	Valam	Eloca	Cerde	Najfl	Ranun	Chara	Nitella	Potdi	Potri	Potpe	Potpu	Potpr	Potzo	Hetdu	Algae
Depth Zone <1.75'	2.8	0	0	11.1	19.4	2.8	5.5	0	22.2	0	0	2.8	0	0	0	0	0	33.3
Depth Zone 1.75 to 5.0'	7.5	2.5	2.5	15	15	8.7	3.8	7.5	13.7	1.26	1.26	5	2.5	7.5	0	0	1.26	5
Depth Zone 5.0 to 10.0'	15.5	2.8	2.8	8.4	21.1	18.3	2.8	5.6	4.2	0	0	0	0	5.6	1.4	4.2	0	7
Depth Zone >10.0'	10.5	2.6	0	2.6	34.2	31.6	0	0	2.6	0	0	0	0	7.9	0	2.6	0	5.2
Average Relative Frequency	9.075	1.975	1.325	9.275	22.425	15.35	3.025	3.275	10.675	0.315	0.315	1.95	0.625	5.25	0.35	1.7	0.315	12.625

	EWM	Myrsi	Potcr	Valam	Eloca	Cerde	Najfl	Ranun	Chara	Nitella	Potdi	Potri	Potpe	Potpu	Potpr	Potzo	Hetdu	Algae
Depth Zone <1.75'	0.014	0	0	0.125	0.36	0.097	0.21	0	1.03	0	0	0.014	0	0	0	0	0	0.92
Depth Zone 1.75 to 5.0'	0.37	0.12	0.039	1.05	1.13	0.58	0.066	0.21	0.97	0.01	0.01	0.33	0.16	0.34	0	0	0.026	0.46
Depth Zone 5.0 to 10.0'	0.74	0.028	0.056	0.79	1.79	1.06	0.04	0.18	0.097	0	0	0	0	0.31	0.11	0.097	0	0.35
Depth Zone >10.0'	0.2	0.017	0	0.017	2.25	0.97	0	0	0.03	0	0	0	0	0.27	0	0.083	0	0.23
Average Density	0.331	0.04125	0.02375	0.4955	1.3825	0.67675	0.079	0.0975	0.53175	0.0025	0.0025	0.086	0.04	0.23	0.0275	0.045	0.0065	0.49

Date of Survey: 5 June 2002

Jim Cahow
&
Ken Royseck

TRANSECT	SITE DEPTH	DRAG 1	DRAG 2	DRAG 3	DRAG 4	DENSITY RATING (1-5)	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth incidental plant spp.
Z2A	0-1.75'	NA	NA	NA	NA	NA	NA	Inside Marina → No Shallow depth
	1.75-5.0	ElnCa → 2	ElnCa → 2	ElnCa → 2	ElnCa → 2			Cobble w/ Silt & Sand
		Cerde → 1	Ranunculus → 2	Ranunculus → 2	Ranunculus → 2			4.7' depth Sampled
		EWM → 1	EWM → 1	EWM → 1				
		Aphlostoala? → 1		Curly Pond → 1				N4449.49 W8772.65
		Filamentous 1						
	5.0-10.0	EWM → 1	ElnCa → 1	ElnCa → 1	Crispus → 3			
		ElnCa → 1	Ranunculus → 1	Cerde → 1	ElnCa → 2			Some rock, Silt, & Sand & Pockets
			Filamentous → 1	Crispus → 1	Cerde → 1			More Crispus further out on
				Filamentous → 3	Filamentous → 1			transect 7-8' depths 60% coverage -
								growing to w/in 1.5 to 2' of surface
	>10	Crispus → 3+	Crispus → 3	Crispus 3	Crispus 3			depth Sampled = 11.5'
		Elodea - 1	Elodea → 1	Elodea → 1	Elodea → 2			Plants are 2-3' from surface
		Filamentous 1	Fil → 1	Fil 1				End Point N 4449.579'
								W 87°22.419'
								deep Silt
Z4B	0-1.75	Elodea → 1	Elodea → 1	Elodea → 1	Fine leaved → 1		Sand 100%	N44°49.377
		Fine leaved Pondweed → 1		Fine leaved → 1				W87°77.113
								Minimal Vegetative Cover → Sand
								5 houses East of [illegible] opening
	1.75-5.0	Elodea → 4	Elodea 3	Elodea → 4	Elodea → 3			Sand & Silt → 4.5' sampled
		EWM → 1	EWM - 2	EWM → 1	EWM → 1			Plants 2-2.5 below surface
			Crispus 1					Wind 5-10 m.p.h.
	5-10'	Elodea → 1	Elodea → 3	Elodea → 3	Elodea → 1			9' depth Sampled
		Crispus → 3	Crispus → 3	Crispus → 3	Crispus → 3			Silt & Fine Sand
	>10'	Crispus 5	Elodea - 4	Elodea → 2	Elodea → 2			Crispus → w/in 24" to 18" of surface
		Elodea → 1	Crispus 2	Crispus 4	Crispus 3			Silt dominated
					Ranunculus 1			Crispus w/in 18" to 24" of surface
								11' depth Sampled
								End Transect N44°49.438'
								W87°22.062'
								Max rooting depth crispus 11'
								Max rooting depth Elodea = 12.5'

max rooting depth = 12.5'

Date of Survey: 7 June 2002

See other Data sheet for G21 depths 75'

Survey Conducted by: Jim Cahow & Ken Royseck

TRANSECT	SITE DEPTH	DRAG 1	DRAG 2	DRAG 3	DRAG 4	DENSITY RATING (1-5)	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth incidental plant spp.
G21 -	0-1.75	Cladophora-5	Cladophora-4	Cladophora-4	Cladophora-4			Start of Transect → Near Wood Pilings
								N44° 50.207
								W 87° 23.307
								Rock Rubble 70
								Boulder 15%
								Sand 15%
	[illegible]	Cladophora-4	Cladophora-4	Cladophora-3	Cladophora-7			depth Sampled = 1.5'
			Elodm-1					Sand 60% - Rubble 40%
								No plants Visible at Surface
	5-10'							

Other data Sheet for 621 - depths >5'

Date of Survey: 7 June 2002 Survey Conducted by: Jim Cahow & Ken Royseck

TRANSECT	SITE DEPTH	DRAG 1	DRAG 2	DRAG 3	DRAG 4	DENSITY RATING (1-5)	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth incidental plant spp.
621	5-10'	Chara - 2	Chara - 2	Chara - 1	Chara - 1			
		Cladophora - 2	Cerdo - 2	Cerdo - 2	Rannunculus - 1			Depth Sampled = 7'
			Rannunculus - 1	Rannunculus - 1	Cladophora - 1			No Plants Near surface
			Cladophora - 1	Cladophora - 1	Ellum - 1			Sand 90% - Rock 10%
	>10'	Crispus - 2	Crispus - 4	Crispus - 3	Crispus - 3			
		Eldea - 3		Elodea - 2	Elodea - 2			
		Cerdo - 2		Cerdo - 1	Cerdo - 2			
				Ellum - 1				End of Transect
								N44° 50.184
								W87° 23.351
								Sand & Silt
								No plants visible from surface.

Date of Survey: 7 June 2002

Jim Cahow
&
Ken Royseck

TRANSECT	SITE DEPTH	DRAG 1	DRAG 2	DRAG 3	DRAG 4	DENSITY RATING (1-5)	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth incidental plant spp.
GP1.	0-1.75'	Cladophora – 3	Clad – 2	Clad – 4	Clad – 3		Rubble/Boulder	Start of Transect
								N' 44°50.768
	1.75-5.0'	Cladophora	Clad EWM	Clad	Clad		Sand 80%	W 87° 23.211
	5-10'	—	Clad Elodea	—	Chara		20 Rubble	Clumps of EWM 1' Tall Visible from 3-7'
							Sand 90%	
	>10'	EWM – 1	—	Chara – 1 EWM – 1	EWM – 1		10% Rubble Sand	
								End of Transect N44° 50.812 W87° 23.385
SP1.	<1.75'	Cladophora – 3	Cladophora – 3	Cladophora – 2	Cladophora – 4			Start of Transect N44°51.069 W87°24.041
	1.75-5.0'	Cladophora – 3	Cladophora –					Rock Rubble & Boulder
	5-10'	Elodea – 1	Elodea – 2	Elodea – 2 Cerda – 2	EWM – 1			Sand 80%, Rock 20%
	>10'	Crispus – 3 Elodea – 2	Elodea – 3 Crispus 1 Cerda – 2	Elodea – 2 EWM – 1 Cerda – 1	Elodea – 2 Crispus – 1			Sand
								No plants Near Surface
								End Transect N44°51.112 W87° 24.052

Date of Survey: 7 June 2002

Jim Cahow
&
Ken Royseck

TRANSECT	SITE DEPTH	DRAG 1	DRAG 2	DRAG 3	DRAG 4	DENSITY RATING (1-5)	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth incidental plant spp.
South of Quarry	0-1.75	Cladophora-3 Chara-1	Cladophora-3	Cladophora-3 Chara-1	Cladophora-2			Transect Start N44° 53.640' W87° 23.311
	1.75-5.0	Cladophora-2	Cladophora-1 Chara-1	No Veg	Cladophora-1			150 meters East of Rock Jettie
	5-10.0	No Veg	EWM-1	No Veg	No Veg			
	>10.0	No	Veg					End of Transect N44° 53.566' W87° 23.961
Farther South of Quarry	0-1.75	Cladophora-4	Cladophora-4 Chara-1	Cladophora-3	Cladophora-3			Start of Transect N44° 53.185 W87° 23.060 East of Rock Road 50m
	1.75-5.0	Cladophora-2	No Veg	Cladophora-1	No Veg			
	5.0-10.0	No	Veg					
	>10.0	No	Veg					
								End of Transect N44° 53.195
								Depth sampled 1? W87° 23.166

Date of Survey: 5 June 2002

Jim Cahow &
Ken Royseck

TRANSECT	SITE DEPTH	DRAG 1	DRAG 2	DRAG 3	DRAG 4	DENSITY RATING (1-5)	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth incidental plant spp.
24A	0-1.75'	Elodea → 1	Elodea → 1	Elodea → 1	Elodea → 1			GPS Start Transect N44°49.288'
			Fine leaf Pondweed → 1					W87° 21.762'
	1.75-5.0	Elodea → 3	Elodea → 2					Sand
		EWM → 3	EWM → 2	Elodea → 3	Elodea → 2		Sand/silt	depth Sampled 3.5'
		Carde → 1		EWM → 2	EWM → 1			Plants are 2' below Surface
		Crispus → 1		Ranunculus → 1				
	5.0-10.0	Elodea → 4	Elodea → 3	Elodea → 3	Elodea → 3			
		EWM → 2	EWM → 1	EWM → 1	EWM → 2			Depth Sampled 6-7'
			Ranunculus → 1	Ranunculus → 2	Cerde → 1			Sand / silt
								No Plants Visible at Surface
	>10.0	Elodea → 3	Elodea → 4	Elodea → 3	Elodea → 3	Silt		>2' below Surface
		Crispus → 1	Crispus → 1	Crispus → 1	Crispus → 1			End transect N44°49.307'
			EWM → 1	EWM → 1				W 87°21.096'
								Depth Sampled 11'
								Very few Plants Visible from Surface
25A	0-1.75'	Elodea → 1	Elodea → 1					Start Transect: N44°49.085'
		Fine leaf → 1	Fine leaf → 1	Fine leaf 1	Elodea → 1			W87°21.349'
					fine leaf → 1			Sand → minimal vegetation
	1.75-5.0	Ranunculus → 5						depth Sampled = 1.5'
		Elodea → 2	Elodea → 3	Elodea → 3	Elodea → 3		Sand/Silt	Plants Growing to w/in 18" Surface = Crispus
		Crispus → 1	EWM → 1	EWM → 1	EWM → 2			
		EWM → 1	Crispus → 1	Crispus → 1	Crispus → 1			
	5.0-10	Elodea → 5	Elodea → 4	Elodea → 3	Elodea → 3			
		EWM → 2	EWM → 1	EWM → 1	EWM → 2			Depth Sampled — 6-7'
		Carde → 1	Crispus 1					Sand & Silt
	>10	Elodea → 5	Elodea → 4	Elodea 4	Elodea → 4			Plants are 2-3' below Surface
		Crispus → 2	Crispus → 1	EWM → 1	Crispus → 1			
			EWM → 1					depth Sampled = 11'
								Very few Plants w/in 3' of surface
							Silt	
								End of Transect =
								N44°49.138'
								W87°21.292'

Date of Survey: 6 June 2002

Jim Cahow
&
Jamie Corbisier

TRANSECT	SITE DEPTH	DRAG 1	DRAG 2	DRAG 3	DRAG 4	DENSITY RATING (1-5)	SUBSTRATE silt,snd,grvl	COMMENTS: Max rooting depth incidental plant spp.
SW1	0-1.75'	Chara - 4	Chara - 3	Chara - 3	Chara - 2			Start Transect N44° 52.776
	1.75-5							W87° 25.797
								Sand, rock rubble
								plants within 6 inches
								of bottom
	1.75-5	Elodea 2	pot R1 2	Chara 2	Chara 1			
		chara 1	Elodea 2	GWM 1	pot R1 3			
		fine leafed 1		Elodea 3	GWM 1			Sand with silt
		pot 20. 1		pot R1 1	Elodea 1			some plants w/in
								18-20 inches of surface
	5+ ft. (6'3")	Ranunculus 4	Ranunculus 1	Ranunculus 1	0			pot. R1 - tallest of spp.
		Elodea 1	Elodea 1					
		Cert. Dem 1	Cert. 1					Silt w/ some sand
			Crispus 1					
								4452.98
								8725.7982 END
SW2	0-1.75	0	0	0	0			START TRANSECT
								4452.833 N
	1.75-5	pot R1 1	pot R1 1	Elodea 1	0			87 26.199 W
			Elodea 1	pot R1 1				
			fine leafed 1					plants varied some at 18-24"
	4.5 ft.	pot 20 1	Ranunculus 2	Cert. Dem 1	pot 20 1			
		Pot R1 1	Elodea 1	Ranunculus 1				silt w/ some sand
		Elodea 1	pot 20 1	pot 20 1				
								44 53.075
								W 87 26.089 END TRAN
SW3	0-1.75	Chara 4	Chara 2	Chara 2	Chara 3			4453.217 By the red and ...
			fine leafed 1	pot R1 1	Pot R1 1	vegetation	for	87 25.8?? boat house
						w/in 10"	of bottom	80% sand 10% rock
	1.75-5	Pot ri -1	Pot ri -1	Pot ri -1	Pot ri -1			10% rock rubble
		Elodea -1	fine leaf -1	Elodea -1	Elodea -1			depth sampled = 3-4'
					Pot 20 -1			Sand 85% 15% silt
	3.0	pot ri 1	pot ri 1	pot ri 1	cert dem 1			
		Elodea 1	pot 20 1	pot 20 1	ranunculus 1			4453.106 N END
		pot 20 1	Elodea 1	Elodea 1	pot ri 1			8725.900 W TRANSECT
			fine leafed 1	fine leafed 1	pot 20 1			
					Elodea 1			more silt than sand
					fine leafed 1			80% - 20%
								pot ri within 2 ft of surface

Date of Survey 6 June 2002

Jim Gahow + Jamie Corbisier

TRANSECT	SITE DEPTH	DRAG 1	DRAG 2	DRAG 3	DRAG 4	DENSITY RATING (1-5)	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth incidental plant spp. 60%.
SW4								
Cabots Pt	0-1.75	Cladophora 1-2						Rubble/cobble/boulder 20%
								sand/gravel 20%
								START TRANSECT
								44 53.172 N
	1.75-5.0	Elodea - 1	Elodea - 1	Elodea - 1				87 25.534 W
		EWM - 1	EWM - 1	EWM - 1	Elodea - 1			depth Sampled = 4'
		Chara - 1	Chara - 1	Chara - 1	EWM - 2			80% sand, 20 cubble
					Chara - 4			
					Ranunculus - 1			
					Cerde - 1			
	5-10				Potzo - 1			
	7'3" capuli	crispus 1	Cert Dem 2	EWM 1	Cert Dem 3			
		Elodea 1	Ranunculus 3	Ranunculus 2	Ranunculus 3			N 4453.101 END
		EWM 2	EWM 2	Cert Dem 1	EWM 1			W 9725.567 TRAN
		Cert Dem 3	Elodea 1		Elodea 1			Sand 10-15%
		Ranunculus 3	Crispus 1				~60%	Silt w/ some
			Chara 1					cobble, rock, rubble
								10-15%
								NO TOP OUT APPARENT
								NOTHING VISIBLE
								W/IN 3'

Date of Survey: 6 June 2002 Survey Conducted by: Jim Cahow

TRANSECT	SITE DEPTH	DRAG 1	DRAG 2	DRAG 3	DRAG 4	DENSITY RATING (1-5)	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth incidental plant spp.
C1A	0-1.75	Cladophora-3	Cladophora-3	Cladophora-2	Cladophora-3			
								Boulder → rip rap
								Transect Start N44°49.936
								W87°22.750
	1.75-5.0	Elodea-4	Elodea-3	Elodea-3	Elodea-4			15 feet Northwest of Bridge → Parallel
		Crispus-3	Crispus-2	Crispus-2	Crispus-1			Silt 80%, Sand 20%
		Cerde-2	Cerde-2	Cerde-1	Cerde-1			Depth Sampled = 4-5'
		Ranunculus-1	Ranu-1	Ranunculus-1				Some crispus w/in 18"-24" of surface
	5-10'	Elodea-2	Elodea-4	Elodea-4	Elodea-3			
		Crispus-2	Crispus-2	Crispus-1	Crispus-2			Depth Sampled 6-7'
		Ranu-1	EWM-1	Cerde-2	Cerde-2			80% Silt, 10% Sand, 10% org
		Cerde-1	Cerde-2	Ranunculus-2	Ranunculus-1			
			Ranu-1					
	>10'	Crispus-4	Crispus-3	Crispus-3	Crispus-2		90% Silt	End of Transect N44°49.971'
			Elodea-3	Elodea-2	Elodea-3		5% Sand/5% org	W87°22.780'
								Depths Sampled 11-12'
C1B	0-1.75	Cladophora-3	Cladophora-3	Cladophora-2	Cladophora-3			Start of Transect: N44°49.938
								W87°23.441
								depth Sampled 1.5'
								boulder 25%, rubble 50%, gravel 15%, Sand 10
	1.75-5.0	Cladophora-2	Cladophora-2	Cladophora-2	Cladophora-3			No Vascular Plants <2'
		Chara-1	EWM-1 → small 3"	Chara 1	Chara-1			depth Sampled 4'
								No Plants Near Surface → marginal growth
	5-10'	Cladophora-2	Cladophora-2	Cladophora-1	Cladophora-2			Sand 80%, rubble 20%
		Cerde-2	Cerde-2		Cerde-1			80% Sand, 20% rubble boulder
								lots of attached Zebra mussels
	>10'	Cladophora-1	Cerde-1	Cerde-2	Cerde-1			depth Sampled = 8-9'
		Cerde-1	Cladophora-2	Cladophora-1	Cladophora-1		Sand-80%	
							rubble 20%	No visible Vegetation
								End of Transect:
								N44°49.964
								W87°23.367

Max rooting depth ≈ 13'

Date of Survey: 5 June 2002

Jim Cahow & Ken Royseck

TRANSECT	SITE DEPTH	DRAG 1	DRAG 2	DRAG 3	DRAG 4	DENSITY RATING (1-5)	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth incidental plant spp.
Z1A	0-1.75'	Fineleaved Pondweed-1 Elodea → 1	" " " "	" " " "	" " " "			Start Transect N44°49.313' W87°20.966' Sand No dense Vegetation in front of Homeowner's Rock Rip-Rap Depth Sampled = 3.0' No Plants Near Surface → Short growing
	1.75-5.0	Elodea → 2 Fine leaved Pond → 1	Elodea → 2 Chara → 1 PotRich → 1 EWm → 1	Elodea → 2 Chara → 1 PotRich → 1 Fine leaved → 1	Elodea → 2 Chara → 1 PotRich → 1 Fine leaved → 1	Sand		
	5.0-10.0	Crispus → 5 Elodea → 2 EWm → 1	Crispus → 4 Elodea → 2 EWm - 1	Crispus → 4 Elodea → 2 EWm - 1	Crispus 3 Elodea - 4	Sand/Silt		N44°49.098' W87°20.885' depth Sampled 6' Some Crispus w/in 12-18" of surface
	>10.0	Elodea → 3 Crispus → 1	" " " "	" " " " EWm - 1	" " " " EWm - 1	Silt		depth Sampled 11' No Plants Visible from Surface End Transect = N44°49.063 W87°20.899
Z1B	0-1.75	NO Veg						Start Transect N44°49.384' W87°21.334'
	1.75-5.0	Elodea → 4 Crispus → 1	Elodea → 3 Crispus → 1 PotRich → 1 Cerde → 1	Elodea - 3 Pot Rich - 1	Elodea - 3 Crispus - 1		Silt Silt/Sand	No vegetation No Veg Near Surface depth Sampled 3.5'
	5.0-10.0	Elodea - 4 Cerde - 1	Elodea - 3 Cerde - 1	Elodea - 2 Cerde - 1	Elodea - 3 Cerde - 1		Silt/Sand	depth Sampled 6-7' No visible Veg → Harvesters dredging bottom!
	>10'	Elodea - 3 Crispus - 2	Elodea - 2 Crispus - 1	Elodea - 3 Crispus - 1	Crispus - 3			Silt/bottom depth Sampled = 11' Some Crispus W/in 2' of Surface Transect ends: N44°49.273' W87°21.390'

Follow signs for Morris — CTH MM

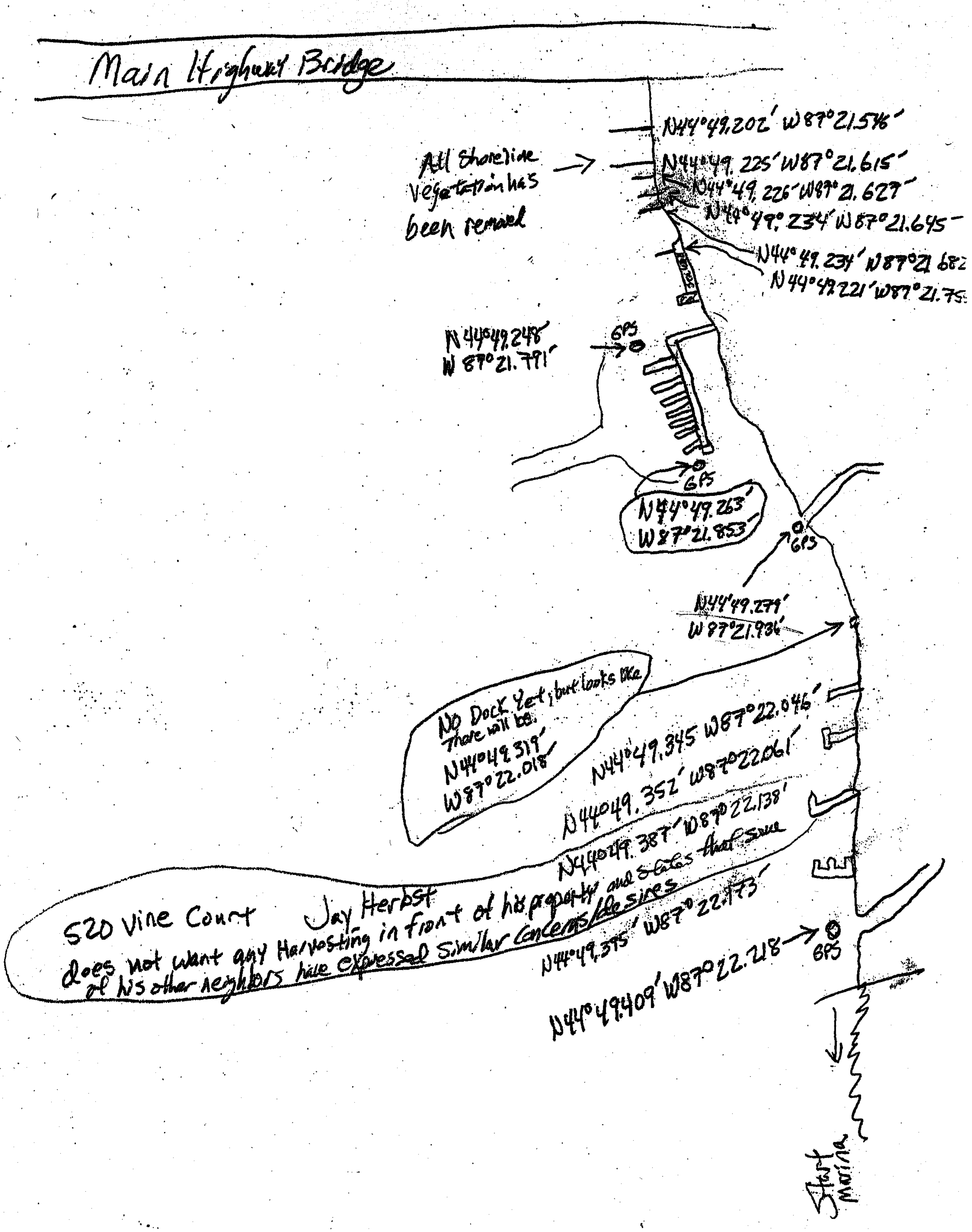
Take a right Near a Bar

Date of Survey: 5 June 2002

Jim Cahow & Ken Royseck

TRANSECT	SITE DEPTH	DRAG 1	DRAG 2	DRAG 3	DRAG 4	DENSITY RATING (1-5)	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth incidental plant spp.
Z3A	0-1.75							
		No Vegetation						Transect Start:
								N44° 49.576 → In Front of Pipe outfall
								W87° 21.722
	1.75-5.0	Elodea—4	" "	" "				Sand
		Ranunculus—2	" "	" "	Elodea—3			No Veg
		EWM—1	" "	" "	EWM—1			Sandy
	5.0-10.0	Elodea-3			Chara—1			depth Sampled 4'
		Cerdo—1	Elodea—3	Elodea—2	Elodea—3			Some plants W/in 1.5-2.0' of Surface
			Ranunculus—1	Ranunculus—1	Cerdo—1		Silt/Sand	depth Sampled = 7-8'
			EWM—1	Cerdo—1	Crispus—1			Some Crispus W/in 1-2' of Surface
	>10'	Crispus—4		Crispus—1				
		Elodea—1	" "	" "	" "			
			" "	" "	" "		Silt	depth Sampled — 11-12'
				EWM—1	" "			Some Crispus W/in 2' of Surface
								End of Transect:
								N44° 49.473'
								W87° 21.815'
								Went over a shallower hump 3-4'
								between previous 7-8' depth and
								10+ Sampled
Z3B	0-1.75	Cladophora—3	" "	" "	" "			
								Start Point: N44° 49.698'
								W87° 22.115'
	1.75-5.0	Elodea—3	" "	" "	" "			No Macrophytes
		EWM—1	" "	" "	" "			Sand/Silt
		Cerdo—1	" "	" "	" "			Sand & Some Silt
		Ranunculus—1	" "	" "	" "			depth Sampled = 3.5'
				" "	" "			Very little Plants W/in 1.5-2.0' of Surface
			Crispus—1	" "				
	5.0-10.0	Elodea—3	Elodea—4					
		Cerdo—1	EWM—1	" "	Elodea—3			
		Crispus—1	Crispus—1	" "	EWM—1			depth Sampled = 6-7'
				" "	Cerdo—1			Some Plants W/in 2-3' of Surface
				Ranunculus—1	Crispus—1			Silt/Sand
				Cerdo—1				
	>10	Crispus—5	Crispus—4	Crispus—5	Crispus [illegible]			
								Crispus W/in 2' of Surface
								Silt
								End Transect
								N44° 49.592
								W87° 22.168
								depth Sampled = 12'

Max rooting depth = 13'


Main Highway Bridge
N44°49.202' W87°21.546'
All Shoreline vegetation has been removed
N44°49.225' W87°21.615'
N44°49.226' W87°21.627'
N44°49.234' W87°21.645'
N44°49.234' W87°21.682
N44°49.221' W87°21.75
N44°49.248' W87°21.791'
GPS
GPS
N44°49.263' W87°21.853'
GPS
N44°49.279' W87°21.936'
No Dock Yet, but looks like there will be.
N44°49.319' W87°22.018'
N44°49.345 W87°22.046'
N44°49.352' W87°22.061'
N44°49.387' W87°22.138'
520 Vine Court Jay Herbst
does not want any Harvesting in front of his property and states that some of his other neighbors have expressed similar concerns/desires
N44°49.395' W87°22.173'
N44°49.409' W87°22.218
GPS
Start Marina

Good reference or background conditions

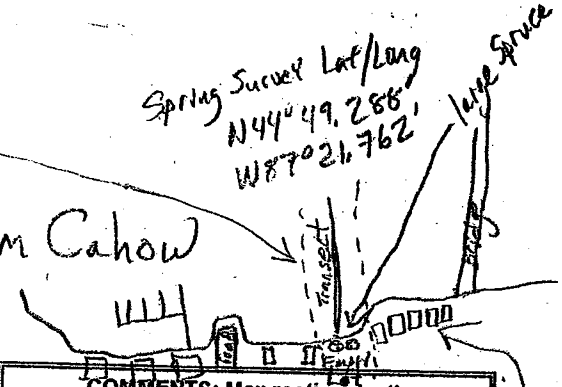
Spring Survey Lat/Long N44°49.288' W87°21.762'

Waterbody Name: Sturgeon Bay

County:

Date of Survey: 5 Aug 2002

Survey Conducted by: Jim Cahow



TRANSECT	SITE DEPTH	Species and Density Rating (0-5) DRAG 1	DRAG 2	DRAG 3	DRAG 4	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth Incidental plant species not on Transect
Z4A	0-1.75'	Chara-2 Hydrodictyon-1	Chara-2 Elodea-1	Chara-1	Chara-1	Sand 80% gravel 20%	Difficulty w/ GPS points agreeing w/ Previous Lat/Longs New Start of Transect N44°49.219' W87°21.920' In front of Empty Lot between 2nd & 3rd house East of Road and 3 large Condos w/ Piers See drawing
	1.75-5.0'	Pot pusillus-4 Elodea-1 Chara-1	Pot Pusillus-2 Elodea-3 Valisneria-2 Chara-1	Elodea-4 Chara-1 Pot Pusillus-2	Elodea-4 EWM-1 Ranunculus-1 Pot pusillus-1 Chara-1 Valisneria-1	Silt 70% Sand 30%	depth Sampled = 3' lots of EWM & Cerato. w/in 1 foot of surface in the 4' to 5' range
	5.0-10.0	Elodea-3 Cerato-2 EWM-2	Elodea-4 Cerato-3 EWM-2	Elodea-2 Cerato-2 EWM-1	Elodea-3 Cerato-3 EWM-2	Silt 80% Sand 20%	depth Sampled = 6' Lots of EWM & Cerato at Surface
	>10'	EWM-2 Elodea-2 Cerato-1	EWM-2 Elodea-1 Cerato-1	EWM-2 Elodea-1 Cerato-1	Cerato-2 Elodea-1	Silt 80% Sand 20%	depth Sampled 10-11' End of Transect N44°49.291' W87°21.896' Max rooting depth 12' Most plants spotty or weak deeper than 10'

N 44° 49.377
Spring Lat/Long W87°22.113

Waterbody Name: Sturgeon Bay

County:

Date of Survey: 5 Aug 2002

Survey Conducted by: Jim Cahow

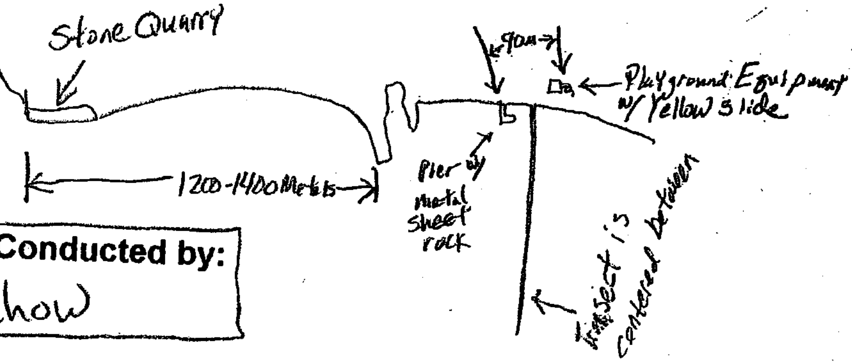
lots of Floating Plants near Shore - tried to avoid when sampling

TRANSECT	SITE DEPTH	Species and Density Rating (0-5) DRAG 1	DRAG 2	DRAG 3	DRAG 4	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth Incidental plant species not on Transect
24B	0-1.75'	Hydrodiction-4	Hydrodiction-4	Hydrodiction-4	Hydrodiction-4	Sand 60%	Start of Transect N 44°49.367'
		Elodea-2	Elodea-1	Elodea-1	Elodea-2	Silt 40%	W 87°22.108'
		Chara-2	Chara-2	Chara-2	Chara-2		5th house East of Aurves lagoon opening
	1.75-5.0	Hydrodiction-4	Hydrodiction-4	Hydrodiction-4	Hydrodiction-4		depth Sampled 1.5'-1.75'
		Chara-2	Chara-3	Chara-2	Chara-2	Sand 60%	
						Silt 40%	depth Sampled = 3'
	5.0-10.0	Cerdo-3	Cerdo-2	Cerdo-1	Cerdo-3		NO rooted Plants Visible from Surface
		Hydrodiction-2	Elodea-1	Elodea-1	Elodea-1	Silt-30%	depth Sampled - 6-7'
		Elodea-1	Hydrodiction-1	Hydrodiction-1	Hydrodiction-2	Sand-70%	No rooted Plants Visible from Surface
		Pot Zo-1		Milfoil→1			→ only 10-12 leaflet pairs → Immature
	>10'	Elodea-4	Elodea-3	Elodea-3	Elodea-3	Silt-60%	depth sampled 11-12'
		Cerdo-2	Cerdo-1	Cerdo-2	Cerdo-1	Sand-40%	Approx 180 yards off shore
			Milfoil-1				No rooted Plants Visible from Surface
							End of Transect N 44°49.413'
							W 87°22.049'
							Max rooting Depth = 12-15'

Waterbody Name: Sturgeon Bay

Date of Survey: 7 Aug 2002

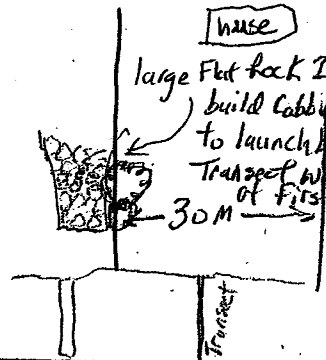
County:



Survey Conducted by: Jim Cahow

TRANSECT	SITE DEPTH	Species and Density Rating (0-5) DRAG 1	DRAG 2	DRAG 3	DRAG 4	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth Incidental plant species not on Transect
South of Quarry	0-1.75'	Cladophora-3	Cladophora-3 Chara-1	Cladophora-2	Cladophora-3	85% Cobble 5% boulder 5% gravel 5% Sand	Start of Transect N44°53.670' W87°23.314' depth Sampled 1' to 1.5' → 15' from Shore No Macrophytes <2'
	1.75'-5.0	EWM-3 Chara-3 Elodea-1	Chara-2	Chara-1 EWM-2	EWM-2 Valam-1	50% Cobble 5% boulder 30% gravel 15% Sand	Most plants appear stunted Small pockets of Taller EWM reach surface 6-12 plants in a bunch → 5% of surface area depth Sampled = 3.5-4' → 50'-60' from Shore
	5-10'	EWM-1 Val-1 Cladophora-1	EWM-2 Cladophora-2	EWM-1 Cladophora-1	EWM-2 Val-1 Native milfoil-1	Cobble 60% boulder-5% gravel-20% Sand-15%	depth Sampled 5-6' → 500-600' from Shore Sparse EWM reaching to w/in 12"-18" of surface.
	>10'	Hydrodiction-3	Hydrodiction-2 Pot pusillus-2	Hydrodiction-3 Pot pusillus-1	Hydrodiction-2 Pot pusillus-2	Cobble 80% boulder-5% gravel-10% Sand-5%	depth Sampled-12-13' No Vegetation Visible from Surface
							End of Transect N44°53.564' W87°23.504'

Spring Start of Transect N44°53.185 W87°23.060'



large Flat Rock 1'x3-4' used to build Cobblestone road to launch boats → Very visible
Transect was located in front of first property South of Ornamental Launch

Waterbody Name: Sturgeon Bay

County: Door

Date of Survey: 7 August 2002

Survey Conducted by: Jim Cahow

TRANSECT	SITE DEPTH	Species and Density Rating (0-5) DRAG 1	DRAG 2	DRAG 3	DRAG 4	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth Incidental plant species not on Transect
Further	0-1.75'	Cladophora-1	None	None	Cladophora-1	Cobble-80%	Start of Transect N44°53.187'
South						boulder-5%	W87°23.036'
of						gravel-10%	Approx 1200 meters further South
Quarry						sand-5%	than site just South of Stone Quarry
							No vegetation <2'
							depth sampled 1.5-1.75' → 15' from shore
	1.75-5.0	Chara-2	Chara-2	Chara-2			
		Cladophora-2	Cladophora-2	Cladophora-2	Chara-2	Cobble-80%	depth sampled 3.5-4.0' → 60' from shore
			Pot pusillus-1		Cladophora-2	boulder-5%	Very sparse even <2% of surface area
					Pot pusillus-1	gravel-10%	
						sand-5%	
	5.0-10'	Cladophora-2	Cladophora-2	Cladophora-2	Cladophora-2	Coble-80%	depth sampled 6-7' → 140 meters from shore
			Chara-1		Chara-1	boulder-5%	No plants visible from surface
			Pot pusillus-1		Pot pusillus-1	gravel-10%	
						sand-5%	
	>10'	Pot pusillus-1	Chara-1	Chara-1	Cladophora-1	Coble-80%	
		FWM-1	Hydrodictyon-1	Cladophora-1		boulder-5%	End of Transect N44°53.157'
		Hydradiction-1	Pot pusillus-1			gravel-15%	W87°23.176'
							depth sampled 11-12' → 300 meters from shore

June 2002 Start of Transect N44° 53.172'
W87° 25.534'

Waterbody Name: Sawyer Harbor

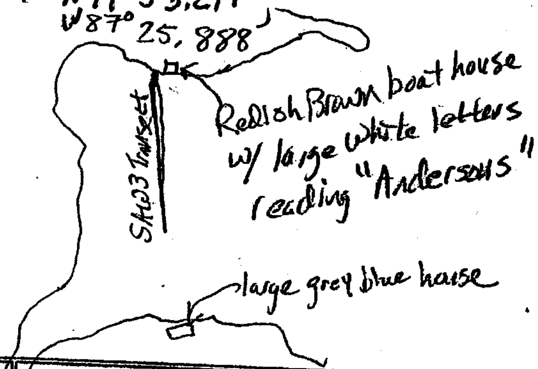
County: Door

Date of Survey: 8 August 2002

Survey Conducted by: Jim Cahow

TRANSECT	SITE DEPTH	Species and Density Rating (0-5) DRAG 1	DRAG 2	DRAG 3	DRAG 4	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth Incidental plant species not on Transect
SAW-4	0-1.75	Cladophora-3	Cladophora-3	Cladophora-4	Cladophora-2	Boulder-40%	Start of Transect N44°53.172'
		Pithophora-2	Pithophora-1	Pithophora-2	Pithophora-2	Cobble-40%	W87°25.541'
		Hydrodiction-1				gravel-15%	depth Sampled 1-1.75'
						Sand-5%	distance from shore = 5-10'
							No Vascular Macrophytes < 2'
	1.75-5.0	Val-4	Val-3	Val-3	Val-3		
		Chara-2	Pot rich-2			Sand-50%	depth Sampled 4-5'
		Pot rich-1				Silt-50%	60-70' from Shore
							lots of plants 18" to 24" from Surface
	5-10'	Val-4	Val-4	Val-4	Val-4		
		Elodea-1	Elodea-1	Elodea-1		Sand-50%	
			Cerde-1	Ranunculus-1		Silt-50%	depth Sampled 7-8'
							Some Val reproductive structures visible
							from surface.
							N44°53.068' W87°25.009'

Julie Start of Transect N44°53.217' W87°25.888'



Waterbody Name: Sawyer Harbor

Date of Survey: 8 August 2002

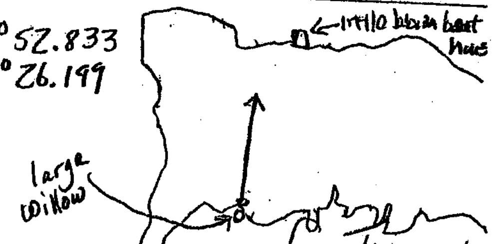
County: Door

Survey Conducted by: Jim Cahow

TRANSECT	SITE DEPTH	Species and Density Rating (0-5) DRAG 1	DRAG 2	DRAG 3	DRAG 4	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth Incidental plant species not on Transect
SAW-3	0-1.75'	Najas-3	Najas-3	Najas-3	Najas-3	Sand 65%	Start of Transect N44°53.219'
		Pot rich-1	Val-1	EWM-1		silt-20%	W87°25.887'
						boulder-5%	depth Sampled = 1-1.75' → 5-10' from shore
						gravel-5%	
						cobble-5%	
	1.75'-5'	Val-3	Val-3	Val-4	Val-4		
		Elodea-2	Elodea-2	Elodea-1	Elodea-1	Sand-50%	depth sampled 3-4' → 120' from shore
		Pot rich-2	Pot rich-2	Pot rich-2	Pot rich-3	silt-50%	
		Pot pectinatus-2	Pot pectinatus-1	Pot pectinatus-2	Pot [illegible]-1		
					Pot pusillus-1		
	5-5.3'	Val-4	Val-3	Val-3	Val-3		
		Elodea-2	Elodea-2	Elodea-2	Elodea-1		
		Ranunculus-3	Ranunculus-3	Ranunculus-2	Ranunculus-2	Sand 40%	End Transect N44°53.061'
		Pot pusillus-2	Pot pusillus-2	Pot pusillus-1	Pot pusillus-1	silt 60%	W87°25.894'
					Pot zo-1		depth Sampled 5-5.3'

Pier under construction N44 53.... W87°26.002 ← recent ...

June Start of Transect N44° 52.833 W 87° 26.199



Waterbody Name: Sawyer Harbor

County: Door

Date of Survey: 8 August 2002

Survey Conducted by: Jim Cahow

See Map for Exact Transect Start & End Points

TRANSECT	SITE DEPTH	Species and Density Rating (0-5) DRAG 1	DRAG 2	DRAG 3	DRAG 4	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth Incidental plant species not on Transect
SAW-2	0-1.75	Val-2	Val-1	None	Val-1	Cobble 70%	Start of Transect N44°52.821'
		Najas-2	Najas-1			Sand-10%	W87°26.205'
		Elodea-1				gravel-20%	depth Sampled 1-1.75' → 20' from Shore
	1.75-5.0'	Val-3	Val-4	Val-3	Val-3	Sand-50%	Depth Sampled 3-4' → 180 meters from Shore
		Elodea-2	Elodea-2	Pot Rich-1	Elodea-1	Silt-50%	
		Ranunculus-1	Pot Rich-1				
		Pot richardsonii-1	Najas-1				
	4-4.5'	Val-3	Val-4	Val-4	Val-3	Sand-60%	
		Elodea-2	Ranunculus-2	Ranunculus-3	Ran-2	Silt-40%	End of Transect N44°53.028'
		Najas-2	Elodea-1	Elodea-2	Elodea-1		W87°26.109'
		Ranunculus-1		Pot Zost-1	Pot Zo-1		
							Passed over Some Pot Zo & Pot praelongus on Transect

June Start of Transect N44°52.776 W87°25.797

Waterbody Name: Sawyer Harbor

County: Door

Date of Survey: 8 August 2002

Survey Conducted by: Jim Cahow

TRANSECT	SITE DEPTH	Species and Density Rating (0-5) DRAG 1	DRAG 2	DRAG 3	DRAG 4	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth Incidental plant species not on Transect
SAW 1	0-1.75'	Chara-4 Val-2	Chara-3	Chara-3	Chara-2	Sand-35% gravel-30% Cobble-25% boulder-10%	Start of Transect N44°52.777 W87°25.790 depth Sampled 0-1' → 20' from Shore Sparse Vascular macrophytes <1.5' lots of Chara = 0-1' = 80% 1-1.5 = 60%
	1.75-5.0	Chara-3 Pot rich-2 Val-1 Pot pusillus-1	Pot rich-3 Chara-2 Val-1 Elodea-1 Pot perfoliatus-1	Pot perfoliatus-3 Pot rich-2 Val-1 Elodea-1 Chara-2	Pot rich-3 Pot perf-2 Val-2 Chara-1 Najas-2	Sand-50% Silt-50%	Dense macrophytes start at about 2' depth depth Sampled ~ 2 to 3' → 100' from shore lots of Vegetation w/in 12-18" of surface Excellent habitat → especially as water levels come back up to historic average → +2'
	5-10'	Pot praelongus-2 Val-2 Ranunculus-1	Pot praelongus-2 Val-2	Pot praelongus-2 Val-2	Pot praelongus-2 Val-2 Najas flexilis-1	Sand-50% Silt-50%	depth Sampled = 5-6' End of Transect N44°52.963' W87°25.841' Max depth 6-7'

Waterbody Name: Sturgeon Bay

County: Door

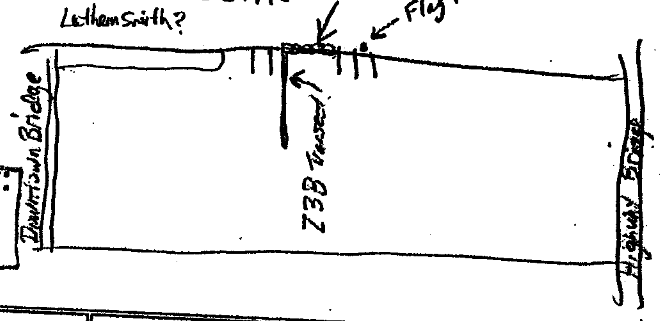
Date of Survey: 8 August 2002

Survey Conducted by: Jim Cahow

Most of the Plants on this Transect appear to be Fragments that have drifted and been deposited on or near the bottom!

TRANSECT	SITE DEPTH	Species and Density Rating (0-5) DRAG 1	DRAG 2	DRAG 3	DRAG 4	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth Incidental plant species not on Transect
C.I.A	0-1.75'	Cladophora-1	None	None	Cladophora-1	Boulder-80%	depth Sampled - 1 to 1.75'
						Cobble-20%	1-4' from Shore
							Start of Transect N 44° 49.981'
							W 87° 22.755'
	1.75-5.0'	Elodea-1	Elodea-1	Elodea-2	Elodea-1	Sand 40%	depth Sampled 4-5'
		Cerdo-2	Cerdo-1	Cerdo-1	Cerdo-1	Silt 40%	25' to 30' from Rock Rip-Rap Shore line
						Detritus 20%	17' North of Bridge.
	5-10'	Elodea-2	Elodea-1	Elodea-1	Elodea-1	Sand-40%	depth Sampled 6-7'
		Cerdo-1	Cerdo.-1			Silt-40%	60' from Shore
						detritus-20%	
	>10'	Elodea-1	Elodea-1	Elodea-1	Elodea-1	Sand-30%	depth Sampled - 12-13'
			Cerdo.-1		Cerdo.-1	Silt-30%	distance from Shore = 130'
						detritus-40%	

June Start of Transect: N44° 49.698'
W87° 22.115'



Waterbody Name: Sturgeon Bay

Date of Survey: 8 August 2002

County: Door

Survey Conducted by: Jim Cahow

TRANSECT	SITE DEPTH	Species and Density Rating (0-5) DRAG 1	DRAG 2	DRAG 3	DRAG 4	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth Incidental plant species not on Transect
Z3B	0-1.75'	None	None	Elodea-1 Cladophora-1	None	Gravel-75% Cobble-10% Sand-15%	Start of Transect N44° 49.698' W87° 22.120' depth Sampled 1-1.75' No rooted Macrophytes < 2'
	1.75-5.0'	Elodea-4 Cerde-2 Ranunculus-1 Hydrodiction-2	Elodea-4 Cerde-2 Ranunculus-1 Hydrodiction-2 Val-1	Elodea-5 Cerde-2 Ranunculus-1 Hydrodiction-2	Elodea-4 Cerde-3 Ranunculus-1 Hydrodiction-2 Val-1	Sand-60% Silt-40%	depth Sampled ~3-4' 25' from shore Macrophytes are heavily covered w/ Hydrodiction - Plants are to surface
	5-10'	Elodea-3 Cerde-3 EWM-2	Elodea-1 Cerde-1 EWM-1	Elodea-1 Cerde-1 EWM-1	Elodea-1 Cerde-1 EWM-1	Sand-50% Silt-50%	depth Sampled ~6-7' 350' from shore No rooted Macrophytes visible from surface
	>10'	Elodea-5 Cerde-3	Elodea-3 Cerde-2	None	None	Sand 40% Silt 60%	depth Sampled 11' to 12' End of Transect N44° 49.617' W87° 22.171'

Could have been part of a large drifting clump near bottom

June Start of Transect N44°49.576' W87°21.722 → In Front of pipe outfall

Waterbody Name: Sturgeon Bay

County: Door

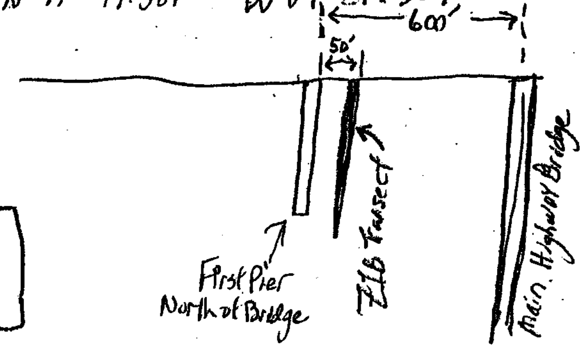
Date of Survey: 8 August 2002

Survey Conducted by: Jim Cahow

TRANSECT	SITE DEPTH	Species and Density Rating (0-5) DRAG 1	DRAG 2	DRAG 3	DRAG 4	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth Incidental plant species not on Transect
23A	0-1.75'	Cladophora-1	Cladophora-2	None	Cladophora-1	Sand-90% gravel-5% detritus-5%	Start of Transect N44°49.579' W87°21.711' depth sampled 1 to 1.75' 10 to 15' from shore. lots of drifting plants near shore.
	1.75-5'	Val-3 Chara-3	Val-3 Chara-3 Elodea-1	Val-4 Chara-3 Elodea-1	Val-3 Chara-3 Elodea-1	Sand-80% Silt-20%	depth sampled 3 to 4' 130' from shore
	5-10'	Elodea-4 Cerdo-3	Elodea-4 Cerdo-3 EWM-1	Elodea-4 Cerdo-2 EWM-1	Elodea-3 Cerdo-2	Sand-60% Silt-40%	depth sampled 7-8' passed back over a large hump of 4' water before reaching >10' depth No Plants visible from surface
	>10'	Elodea-2 Cerdo-2 EWM-1	Elodea-1 Cerdo-1 Crispus-1	Cerdo-1 EWM-1	Elodea-1 Cerdo-1	Sand-50% Silt-50%	depth sampled 11 to 12' End of Transect N44°49.471' W87°21.777'

Jaime – ...
N44°49.445' W87°21.495'
Mouth of little Creek

June Start of Transect N 44 49.384' W 87° 21.354'



Waterbody Name: Sturgeon Bay

County: Door

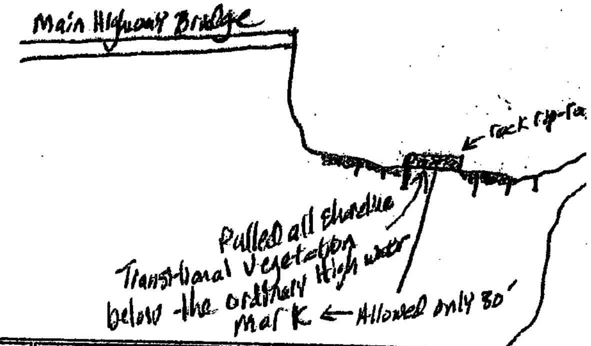
Date of Survey: 9 August 2002

Survey Conducted by: Jim Cahow

TRANSECT	SITE DEPTH	DRAG 1	DRAG 2	DRAG 3	DRAG 4	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth Incidental plant species not on Transect
Z1B	0-1.75	Elodea - 3 Cerde - 2 Chara - 2	Elodea - 3 Cerde - 2 Chara - 2	Elodea - 2 Cerde - 2 Chara - 1	Elodea - 3 Cerde - 1 Chara - 1	Sand 40% Silt 60%	Start of Transect N 44° 49.385' W 87° 21.335' depth Sampled 1.5 - 1.75' 20' from shore.
	1.75-5.0	Elodea - 1 Chara - 1	Elodea - 1 Cerde - 1	Elodea - 1 Chara - 1 Cerde - 1	Elodea - 1 Cerde - 1	Sand 80% Silt 70%	depth Sampled 2-3' 60' from shore. Plants beginning to Collapse Some plants Visible at Surface
	5-10'	Elodea - 3 Cerde - 3 EWM - 2	Elodea - 3 Cerde - 2	Elodea - 3 EWM - 2	Elodea - 3 Cerde - 2 EWM - 1	Sand 30% Silt 70%	depth Sampled 9' to 10' Midway between 1st + 2nd row of Mooring buoys No plants Visible at Surface.
	>10'	Elodea - 5 Cerde - 3	Elodea - 1 Cerde - 1 EWM - 1	Elodea - 1 EWM - 1	Elodea - 1 EWM - 1	Sand 20% Silt 80%	depth Sampled - 11-12' End of Transect N 44° 49.290' W 87° 21.416' Outer Mooring buoys No plants Visible at Surface

Could be a part of a large drifting Clump near bottom

June Start of Transect N44° 49.313' W87° 20.966'



Waterbody Name: Sturgeon Bay

County: Door

Date of Survey: 9 August 2002

Survey Conducted by: Jim Cahow

TRANSECT	SITE DEPTH	Species and Density Rating (0-5) DRAG 1	DRAG 2	DRAG 3	DRAG 4	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth Incidental plant species not on Transect
Z1A	0-1.75'	Chara-4	Chara-3	Chara-4	Chara-3		Start of Transect N44°49.317'
		Elodea-1	Elodea-1	Elodea-1	Elodea-1	Sand-70%	W87°20.973'
		Val-1			Val-1	Silt-30%	In front of out of Place Rip-rap
							landowner has cleared all of their
							place w/s bullrushes, Sedges, Cat tails,
							and bur reeds. Only allowed 30'
							depth Sampled = 1 to 1.75'
							15' to 20' from Shore
	1.75' to 5'	Chara-4	Chara-3	Het du-2	Chara-2	Sand 60%	depth Sampled 3 to 4'
		Pot pusillus-3	Pot pusillus-3	Pot pusillus-2	Pot pusillus-2	Silt-40%	distance from Shore 130'
		Val-1	Cerde-2	Chara-2	Elodea-2		Some Plant 12" to 18" from surface
		Elodea-1	EWM-1	Elodea-1			Sago Pondweed also Common in Area
		Ranunculus-1	Crispus-1				
			Val-1				
	5 to 10'	Elodea-5	Elodea-4	Elodea-5	Elodea-4	Sand 60%	depth Sampled 7-8'
		EWM-1		EWM-1	Cerde-1	Silt 40%	50' from large Channel Buoy
	>10'	Elodea-5	Elodea-5	Elodea-4	Elodea-5	Sand 50%	End of Transect N44°48.963'
				Cerde-2		Silt 50%	W87°20.705'
							depth Sampled 11 to 12'
							20' from large Shipping Channel Marker Buoy
							No plants w/in 5' of Surface

Waterbody Name: Sturgeon Bay

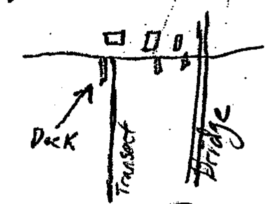
County: Door County

Date of Survey: 5 Aug 2002

Survey Conducted by: Jim Cahow

TRANSECT	SITE DEPTH	DRAG 1	DRAG 2	DRAG 3	DRAG 4	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth Incidental plant species not on Transect
22.0	0-1.75'	No depths	< 2.0' →				
							Start of Transect N44°49.485'
	1.75'-5.0	Cerde-2	Milfoil-2			Rock Rubble-20%	W87°22.655'
		Ranunculus-1	Crispus-2	Cerde-3	Cerde-3	Silt-60%	Inside Marina-between docks C&D
		Elodea-2	Cerde-2	Ranunculus-3	Elodea-2	Sand-20%	Depth Sampled = 4-5'
		Nitella-1	Ranunculus-1	Elodea-3	Ranunculus-2		Very little rooted vegetation
			Elodea-2				Visible from surface → Fragment: floats
	5.0-10.0	Cerde-3	Cerde-3	Cerde-3	Cerde-2	Rock-25%	Midway out on Pier Length - Inside Piers
		Crispus-1	Elodea-1	Ranunculus-1	Elodea-1	Sand-20%	
			Nitella-1	Elodea-1	Crispus-1	Silt-60%	Depth Sampled = 7-8'
			Milfoil-1	Milfoil-1			
				Crispus-1			
							Contrast
10-20' outside of Pier	5-10.0	Cerde-3	Elodea-2	Elodea-3	Cerde-2	Silt-90%	Depth Sampled = 8.0'
		Elodea-2	Pot pusillus-1	Cerde-2	Elodea-1	Sand-10%	10-20' outside of Pier
		Crispus-1					
	≥10.0'	Elodea-1	Elodea-2	Elodea-2	Elodea-1		
			Cerde-2	Cerde-1	Cerde-1	Silt 90%	End of Transect N44°49.590'
						Sand 10%	W87°22.430'
							Parallel to outside edge of Anchoring Area bouys
							Max rooting Depth = 12-13'

Spring Transect Started at N44°49.085' W87°21.349'



Waterbody Name: Sturgeon Bay

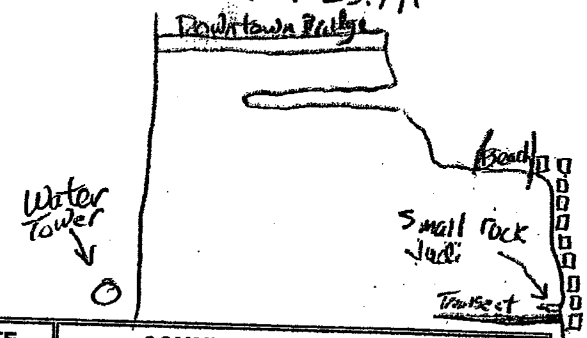
County:

Date of Survey: 5 Aug 2002

Survey Conducted by: Jim Cahow

TRANSECT	SITE DEPTH	Species and Density Rating (0-5) DRAG 1	DRAG 2	DRAG 3	DRAG 4	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth Incidental plant species not on Transect
7SA	0-1.75	Chara-3	Chara-1	Chara-3	Chara-3	Sand 70%	Start of Transect N44°49.076'
		Elodea-1		Elodea-1	Elodea-1	gravel 20%	W87°21.379'
						Cobble 10%	3rd house East of Bridge
							depth Sampled = 1'
							Shoreline Species Present
							Cat-tail, Impatiens, Various sedges, rushes, 3 species
	1.75-5.0	Elodea-5	Elodea-3	Elodea-5	Elodea-4	Sand 70%	depth Sampled = 3'
		Pot diversifolius-1	Ranunculus-1	Cerde-2	Cerde-1	Silt 30%	
			Milfoil-1 (10 [illegible])		Ranunculus-1		
					Milfoil-1		No rooted Plants visible from Surface → Turbid
	5.0-10.0	Elodea-2	Elodea-4	Elodea-3	Elodea-5	Sand 40%	
		EWM-3	Cerde-2	EWM-2	EWM-2	Silt 60%	
		Cerde-2	EWM-3	Cerde-2	Cerde-2		depth sampled 6'
		Crispus-1					
	>10'	Elodea-5	Elodea-3	Elodea-4	Elodea-3	Sand 30%	End of Transect N44°49.140'
			Cerde-2			Silt 70%	W87°21.296'
							No rooted Plants visible from Surface

Spring Start of Transect N44° 49.938
W87° 23.441



Waterbody Name: Sturgeon Bay

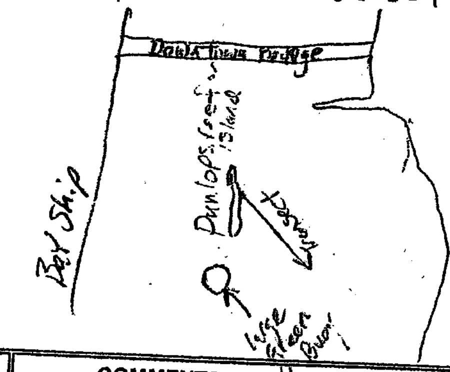
County: Door

Date of Survey: 7 August 2002

Survey Conducted by: Jim Cahow

TRANSECT	SITE DEPTH	Species and Density Rating (0-5) DRAG 1	DRAG 2	DRAG 3	DRAG 4	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth Incidental plant species not on Transect
C1B	0-1.75'	Chara-4 Cladophora-2	Chara-5 Cladophora-2	Chara-4 Cladophora-2	Chara-4 Cladophora-2	Cobble-50% Boulder-10% Gravel-10% Sand-30%	Start of Transect N44° 49.930' W87° 23.431' Some EWM & Val growing in 1.75' of water
	1.75-5'	Chara-4 EWM-3 Val-1	Chara-4 EWM-2 Val-1	Chara-2 EWM-1 Val-2	Chara-2 Val-1	Cobble 35% Gravel-15% Sand-20% Zebra Mussel Shells-30%	depth Sampled 3-4' → 90' From shore
	5-10'	EWM-3 Val-2 Cerde-1 Elodea-1 Cladophora-2	EWM-3 Val-3 Cladophora-1	Cladophora-4 EWM-2 Chara-2 Val-1 Elodea-1	EWM-2 Chara-1 Val-1 Elodea-1 Cladophora-2	Sand-70% Zebra Mussel Shells-15% Silt-15%	Depth Sampled 7-8' → 130 meters from Shore Some EWM visible from surface
	>10'	Elodea-5 Cerde-2	Elodea-4 Cerde-1	Elodea-4 Cerde-1	Elodea-5 Cerde-2	Sand 50% Silt 50%	depth Sampled ~11-12' → 200 m from Shore No Plants visible from Surface End of Transect N44° 49.954' W87° 23.358'

Spring Start of Transect N44° 50.207 W87° 23.307



Waterbody Name: Sturgeon Bay

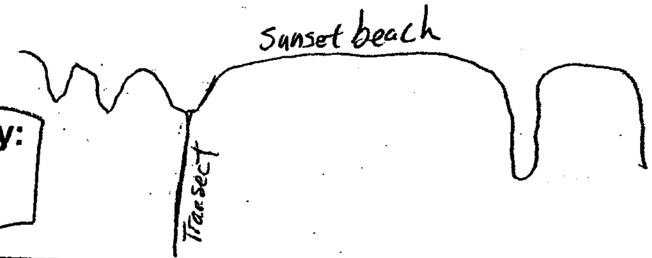
County: Door

Date of Survey: 7 August 2002

Survey Conducted by: Jim Cahow

TRANSECT	SITE DEPTH	Species and Density Rating (0-5) DRAG 1	DRAG 2	DRAG 3	DRAG 4	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth Incidental plant species not on Transect
B-21	<1.75'	Cladophora-1	Cladophora-2	Cladophora-1	Cladophora-1	Cobble-90% Sand-5% gravel-5%	Start of Transect N44°50.221' W87°23.291' depth Sampled .75'-1.5' → 30' from shore
	1.75-5'	EWM-3 Val-2	EWM-2 Val-2	EWM-3 Val-2	EWM-3 Val-1	Cobble-50% gravel-25% Sand-25%	Depth Sampled 3-4' → 65' from shore EWM Covers 80% of Area 3-5' deep
	5-10'	Elodea-3 Pot pusillus-1	Elodea-2 Cerde-1 Pot pusillus-1 EWM-1 Hydrodictyon-1	Elodea-3 Chara-2 Pot pusillus-1 EWM-1 Hydrodictyon-1	Elodea-3 Pot pusillus-2	Cobble-20% Gravel-60% Sand-20%	depth Sampled 6-9' → 210' out on Transect Some EWM visible from surface
	>10'	Elodea-4 Cerde-3	Elodea-3 Cerde-2	Elodea-5 Cerde-2	Elodea-3 Cerde-2	Silt 50% Sand 50%	depth Sampled 11-12' deep No Plants visible from surface
							End of Transect N44°50.267 W87°23.389
							Max rooting depth 12' to 13'

Spring start of Transect N44°50.768 W87.23.211



Waterbody Name: Sturgeon Bay

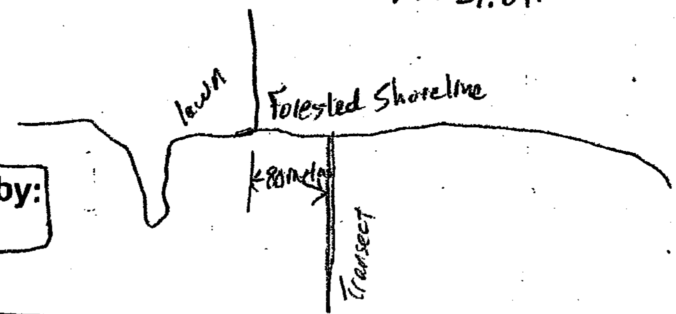
Date of Survey: 7 August 2002

County: Door

Survey Conducted by: Jim Cahow

TRANSECT	SITE DEPTH	DRAG 1	DRAG 2	DRAG 3	DRAG 4	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth Incidental plant species not on Transect
		Species and Density Rating (0-5)					
CP-1	0-1.75'	Cladophora-1	NA	NA	Cladophora-2	boulder-60% Cobble-40%	Start of Transect N44°50.762 W87.23.218
	1.75-5.0	Chara-2 Najas-1	Chara-2 Val-1	Chara-3 Najas-1	Chara-2	Sand 80% Cobble-20%	depth Sampled <3-4' - 20' from shore
	5.0-10.0	Pot pusillus-3 Val-2 EWM-1 Najas-1 Elodea-1	Val-3 Pot pusillus-2 Najas-1 Elodea-1 EWM-1	Val-3 Pot pusillus-2 Elodea-1	Val-3 Pot pusillus-2 Elodea-1	Sand-95% Cobble-5%	depth sampled 7-8' ~150' from point Thick Bed of Pot Richardsonii in 7' N44°50.778 W87°23.362' w/in 18" of surface
	≥10.0'	Elodea-2 Pot pusillus-2	Elodea-3 Pot pusillus-2	Elodea-2 Pot pusillus-3	Elodea-3 Pot pusillus-2	Sand/silt 100%	depth Sampled - 10-11'
							End of Transect N44°50.778 W87°23.364

Spring Start of Transect N44°51.069' W87°24.041'



Waterbody Name: Sturgeon Bay

Date of Survey: 7 August 2002

County: Door

Survey Conducted by: Jim Cahow

TRANSECT	SITE DEPTH	Species and Density Rating (0-5) DRAG 1	DRAG 2	DRAG 3	DRAG 4	SUBSTRATE slt,snd,grvl	COMMENTS: Max rooting depth Incidental plant species not on Transect
SP-1	0-1.75	None →	→	→	Cladophora-1	Cobble-80% boulder-15% gravel-5%	Start of Transect N44°51.069' W87°24.069'
	1.75-5.0	Val-2 Pot pusillus-1 Chara-1 Hydrodictyon-1	Val-3 Pot pusillus-1 Cladophora-1	Val-2 Chara-1 Hydrodictyon-1	Val-1 Chara-1 Pot pusillus-1	Cobble 80% boulder-15% gravel-5%	depth Sampled - 1.5-1.75 → 7' from shore depth sampled 4-5' → 25' from shore
	5.0-10.0	Elodea-3 Cerdo-3 Pot zo-2	Elodea-4 Cerdo-3 Pot zo-1	Elodea-3 Cerdo-2 Pot zo-1	Elodea-2 Cerdo-1 Pot zo-1	Cobble-40% Silt-40% Sand-20%	depth Sampled - 8-9' → 100' from Shore No Plants visible from surface → Plants to dense to accurately assess bottom substrate → Wind deposits?
	>10.0	Elodea-3 Cerdo-2 Pot zo-1	Elodea-2 Cerdo-2 Pot zo-2	Elodea-2 Cerdo-2 Pot zo-1	Elodea-3 Cerdo-2 Pot zo-1	Cobble-40% Silt-40% Sand-20%	depth sampled 11-12' No Plants visible from surface 130' from Shore End of Transect N44°51.068' W87°24.036'

AQUATIC PLANT SURVEY
STURGEON BAY CHANNEL AND SURROUNDING AREA

INTRODUCTION

Water use in the Sturgeon Bay Channel and surrounding area has been affected in recent years by the presence of large numbers of aquatic plants. Commercial as well as recreational use has increased in the channel. New marinas and launch facilities have provided greater access to the area. The increase in use, has resulted in more complaints regarding nuisance aquatic plants.

Resource managers are faced with the task of providing a solution to the problem as well as educating the public on the value aquatic plants play in the environment. Aquatic plants are critical for fish and other aquatic life as well as waterfowl and small mammals. They provide habitat and are a direct source of food in many instances. They stabilize sediments and protect shoreline from wind and water erosion. They are important in taking up nutrients in the form of nitrogen and phosphorus that enter the system.

Committees made up of local citizens, city, county, state and federal officials have met to discuss alternatives for managing the situation. Local media have regularly reported progress as well as some of the frustrations resulting from attempts to find a solution to the problem.

The county passed a resolution in September of 1990 requesting "that the Wisconsin DNR deny the issuance of requested permits for the use of aquatic chemical herbicides in the waters of Door County...". Some success in managing plants has resulted when local citizens along the channel contracted with private consultants to cut and harvest aquatic plants. More recently, the City of Sturgeon Bay has been cutting and harvesting plants with a machine they purchased.

A "Reconnaissance Report" prepared for the purpose of attracting the US Army Corps of Engineers Aquatic Plant Control program is attached as an appendix to this report. A report by Mr. Herb Nelson, formerly with the US Army Corps of Engineers, is also attached as an appendix further documenting the issue. The Corps program remains on hold with no support foreseen in the near future.

Land use along the Sturgeon Bay Channel has undergone major changes over the years. Increased development along the channel including more impermeable surfaces has changed the quality and quantity of runoff water entering the channel. This has resulted in an increase in nutrient and sediment delivery to the surrounding waters. Ideal conditions have resulted for the growth of aquatic plants.

RESULTS

The data is reported through a series of tables and graphs. Permanent references for the vegetation survey are shown on Table 1. Table 2 is a list of aquatic plants observed along the transects and sites where the rake was cast. Table 3 presents percent occurrence of aquatic plants that were observed at various depths where SCUBA was used. Figure 1 graphically presents the vegetation observed at various depths.

DISCUSSION

The two most abundant plants observed were Elodea and Eurasian Milfoil. Eurasian Milfoil was observed at the most sites during the survey. However, Elodea was the most abundant plant at sites where it was observed. What I'm saying is that Eurasian Milfoil stands of vegetation were not as lush or concentrated as Elodea were. In terms of biomass Elodea was the most abundant plant. In terms of what plant was observed at the greatest number of sites, Eurasian Milfoil was.

Data that is summarized on the accompanying graph (figure 1) shows that rooted vegetation was most abundant at a depth of 5 to 10 feet. What the graph doesn't take into account is the tremendous amount of floating plant biomass in the form of uprooted plants that settle along the windward shore. Winds were primarily out of the west and southwest during the three day survey. Vegetation that was uprooted and floating along the surface ended up on the east shore. This was observed in Zones 1, 3 and C. The vegetation in Zone C extended from shore 90 feet into open water. The water column was full of this material to a depth of 7 feet. The last day of our survey the winds shifted to the east and vegetation along the east shore began moving across the channel toward the west shore. The last day on the water vegetation began piling up at the municipal launch ramp, keeping the city busy cleaning the area up.

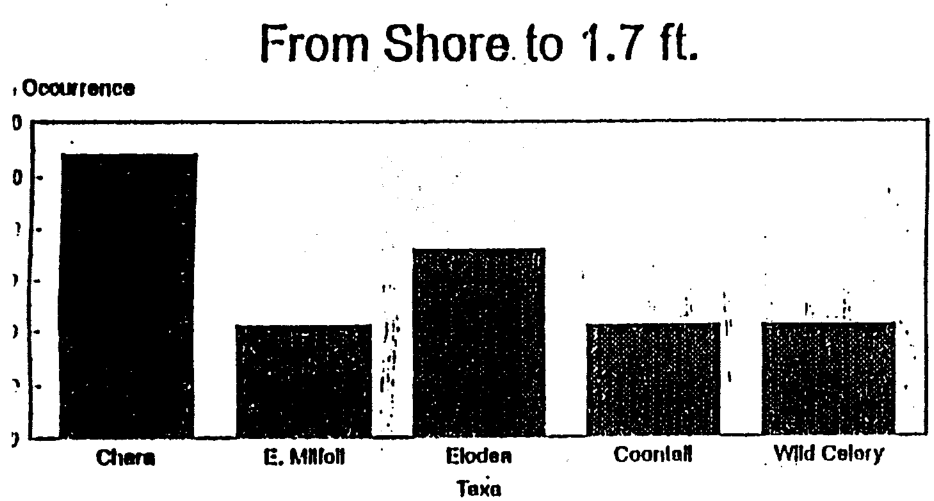
As a personal observation, I do quite a bit of boating in and around the Sturgeon Bay Channel. This summer going from the Channel on the Green Bay side up to Egg Harbor, I observed mats of floating milfoil and elodea plants.

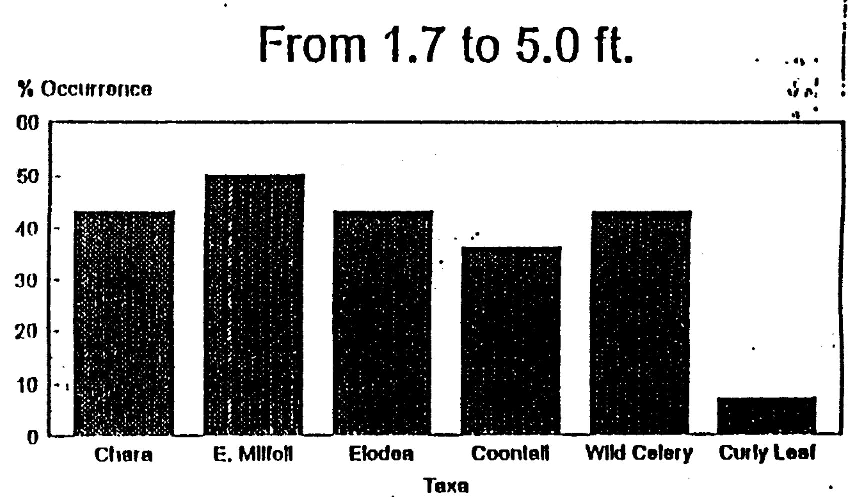
The survey also included obsertions north of the Green Bay Road bridge. This area contained the greatest variety of plants, primarily in the form of small stands of Potamogetons or pondweeds. These plants are much more desirable and provide greater habitat for fish and other aquatic life.

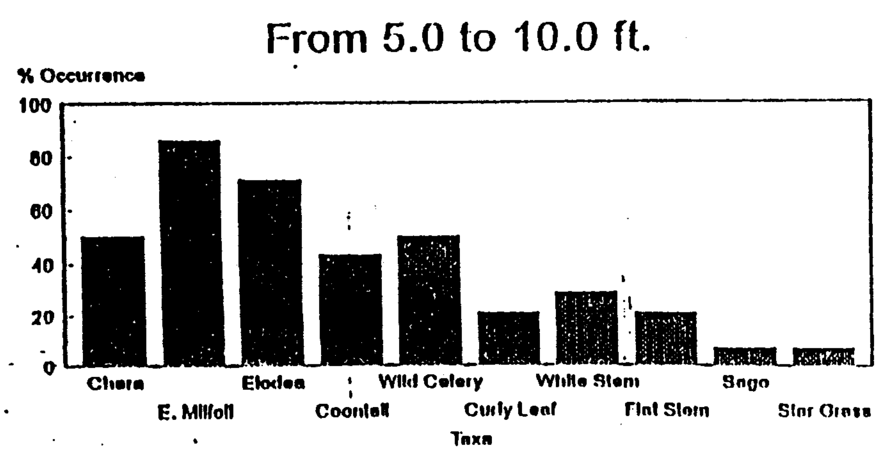
Vallisneria or wild celery was also observed at a number of sites. This is a very desirable plant that provides a direct source of food for waterfowl and habitat for aquatic life.

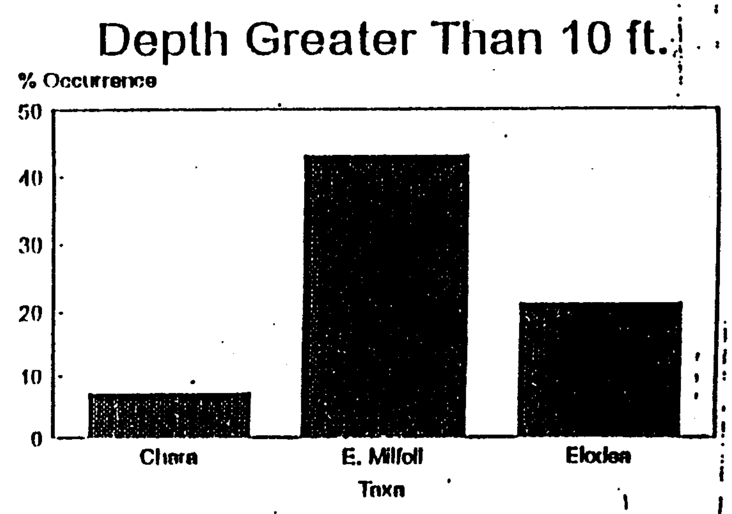
Figure 1

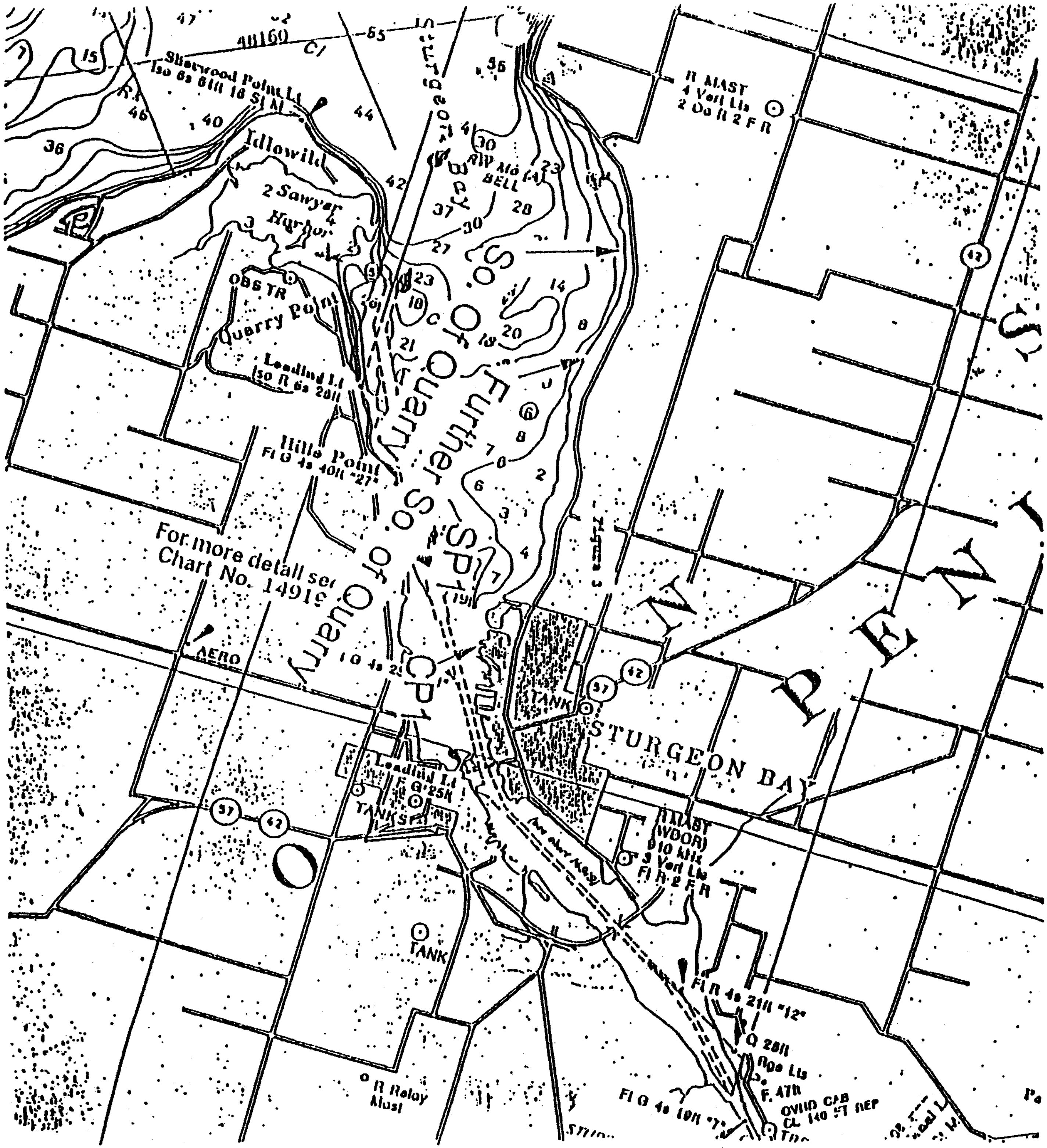
Occurrence & Relative Abundance
Sturgeon Bay Macrophyte Survey











Sherwood Point Lt
Idlewild
2 Sawyer Harbor
Quarry Point
OBSTR
Leading Lt
Hills Point
For more detail see
Chart No. 1491
So. of Further So. of Quarry
SP1
So. of Quarry
CP1
R MAST
4 Vert Lts
2 Oc R 2 F R
BELL
AERO
TANK
STURGEON BAY
TANKS
R MAST
(WDOR)
3 Vert Lts
Fl R 2 F R
Q 28ft
F 47ft
R Relay
Mast
P E N I
O

Table 1

DOOR COUNTY - WISCONSIN

Transect Descriptions and Permanent References

Site	Lat/Lon	Trans Ends
Z1A - Zone 1 S.E. Side of HWY 42-57 Bridge	4449.09 8721.06	
Z5A - Zone 5 S.W. Side of HWY 42-57 Bridge	4448.33 8721.36	
Z1B - Just Above HWY 42-57 Bridge (N.E. Comer	4449.2 8721.62	
Z4A - Just Above HWY 42-57 Bridge (N.W. Come	4449.03 8721.86	
Z3A - Perpindicular to 1300 block of Memorial Dr.	4449.35 8721.43	
Z4B - In area of circle Rd., above Z4A	4449.11 8722.07	
Z3B - Perpindicular to 800 to 900 Memorial Dr.	4449.48 8722.31	4449.41 8722.35
Z2A - Sturgeon Bay Yacht Club (Rake casts)	4449.3 8722.65	
C1A - N.E. Comer just above old bridge	4449.79 8722.96	
C1B - N.W. Comer just above old bridge	4449.88 8723.63	
G21 - Green Channel Marker in front Bay Ship	4450.19 8723.46	
CP1 - Perpindicular to County Park N. of dock	4450.69 8723.44	
SP1 - Perpindicular to State Park	4450.95 8724.77	
SAW1 - Sawyer Harbor (rake cast site)	4452.61 8725.67	
SAW2 - Sawyer Harbor (rake cast site)	4452.8 8725.9	
SAW3 - Sawyer Harbor (rake cast site)	4452.35 8727.72	
SAW4 - Sawyer Harbor (rake cast site)	4452.98 8726.07	
South of Quarry E. side	4453.53 8724.07	
Further South of above site	4452.59 8723.26	

AQUATIC PLANT TRANSECT SURVEY - STURGEON BAY
DOOR COUNTY - WISCONSIN
Conducted July 19 through July 21 1993

Table 2

Scientific Name (Common Name)	Zone/Substrate	Transect/Bearing	Depth (feet)	Abundance
CHARA (Muskgrass)	Z1 Muck	A - 200 degrees	0 to 1.7	Common
	Z1 sand	A 200 degrees	8 to 10	Little or no veg.
	Z1 Silt	A - 200 degrees	10 to 12	Occasional
	Z1	A stems growing to 5.5' tall	10 to 12	Occasional
	Z5 Sand/Marl	A - 40 degrees	0 to 1.7	Abundant
	Z5 Sand/Marl	A - 40 degrees	1.7 to 5	Abundant
	Z4 Rubble/Gravel/Sand	A - 340 degrees	0 to 1.7	Common
	Z3 Sand/Marl	A - 100 degrees	5 to 7	Common
	C1 Rock/Sand/Silt	B - 30 degrees	0 to 3	Common
	C1 Sand/Rock	B - 30 degrees	5 to 10	Very common
	G21 Sand	Grn Buoy #21 - 30 deg.	8.5 to 10	Very common
	CP Cnty Pk Sand	County Park - 270 deg.	0 to 8	Occasional
	SP Rock/Rubble/Sand/Silt	State Park - 45 deg.	0 to 10	Common
	S. Quarry Sand/Rock/Rubble	Below Quarry - 230 deg.	0 to 8	Common
	S. of above site Rock/Rubble	Below Quarry - 270 deg.	0 to 3.5	Present
MYRIOPHYLLUM SPICATUM (Eurasian Milfoil)	Z1	A - 200 degrees	0 to 1.7	Rare
	Z1	A	1.7 to 5.0	Rare
	Z1	A all sand bottom	8.0 to 10.0	Little or no veg.
	Z1	A stems growing 7 feet tall	10 to 12	Occasional
	Z5	A - 40 degrees	5.0 to 5.5	Common
	Z1 - Muck	B - 190 degrees	5.5 to 8.0	Common
	Z4 - Gravel, sand, silt	A - 340 degrees	5 to 8	Common
	Z4 - Rock, silt	A - 340 degrees	8 to 8.5	Occasional
	Z3 - Sand, marl or silt	A - 160 degrees	3.5 to 8.0	Occasional
	Z3	A - stems growing 8' tall	8.5 to 11.5	Occasional
	Z4 - Marl, silt, muck	B - 30 degrees	4.0 to 5.5	Common
	Z4	B	5.5 to 10	Very Common
	Z4	B	10 - 12	Common (Clumps)
	Z3 - Muck	B - 10 degrees	5.5 to 8.0	Rare
	Z3	B	8.0 to 10	Common
	Z3	B	10 to 11.5	V/Common (Clumped)
	Z2 quarter deck marina area	A - Rake was used	7.5	Occasional
	Old municipal dock	Small area visually observed	0 to 5	Common
	C1 0' to 90' from shore/depth to 7'	A - Veg. fills the water column	0 to 7	Mostly Elodea w/E. Mil
	C1	A - 100 degrees	7 to 10	Common
	C1	A - 100 degrees	10 to 12	Occasional (Clumps)
	C1 - Rock, sand, silt	B - 30 degrees	5.5 to 10	Rare
	C1	B - 30 degrees	10 to 12	Rare
	G21 - Green marker buoy, sand	G21 - 30 degrees	8.5 to 10	Occasional
	G21 - Rock, silt, sand	G21 - 30 degrees	10 to 12	Rare
	CP1 - In front of Cnty Pk, sand	CP1 - 270 degrees	3 to 5.5	Rare
	CP1 - Silt and sand	CP1 - 270 degrees	5.5 to 8	Common (Clumps)
	CP1 - Silt, sand	CP1 - 270 degrees	8' for 100 yds	Common (Clumps)
	SP1 - In front of State Pk, rock, rubble, sand	SP1 - 45 degrees	0 to 8	Rare
	SP1 - Rock, rubble, sand & silt	SP1 - 45 degrees	8 to 10	Rare

INCIDENCE OF OCCURRENCE AND RELATIVE ABUNDANCE OF TAXA IDENTIFIED IN STURGEON BAY TRANSECT SURVEY

Scientific Name (Common Name)	Observation Depth 0.0 - 1.7 ft.	Observation Depth 1.7 - 5.0 ft.	Observation Depth 5.0 - 10.0 ft.	Observation Depth >10 ft.	Relative Abundance Scale of 1 to 5*
CHARA (Muskgrass)	57%	43%	50%	7%	Occasional to V. Common
MYRIOPHYLLUM SPICATUM (Eurasian Milfoil)	21%	50%	86%	43%	Rare to V. Common
ELODEA CANADENSIS (Common Elodea)	36%	43%	71%	21%	Rare to Abundant
CERATOPHYLLUM DEMERSUM (Coontail)	21%	36%	43%	0%	Rare to Common
VALLISNERIA AMERICANA (Wild Celery)	21%	43%	50%	0%	Rare to Common
POTAMOGETON CRISPUS (Curly Leaf Pondweed)	0%	7%	21%	0%	Rare to Common
POTAMOGETON PRAELONGUS (White Stem Pondweed)	0%	0%	29%	0%	Rare to Common
POTAMOGETON ZOSTERIFORMIS (Flat-stemmed pondweed)	0%	0%	21%	0%	Rare to Occasional
POTAMOGETON PECTINATUS (Sago Pondweed)	0%	0%	7%	0%	Rare
HETERANTHERA DUBIA (Water Star Grass)	0%	0%	7%	0%	Common

* Relative abundance:
1. Rare
2. Occasional
3. Common
4. Very Common
5. Abundant

Appendix A

CENCS-PD-PF 6 August 1990

MEMORANDUM FOR RECORD

SUBJECT: Sturgeon Bay, WI; Aquatic Plant Control Reconnaissance

1. On 2 August 1990, I met with Mayor Norbert Schachtner and Dennis Jordan, City Administrator of the City of Sturgeon Bay, WI and Mr. Tim Rasman, from the Wisconsin Department of Natural Resources' (WDNR) Green Bay District office. We discussed and inspected nuisance levels of aquatic plants in Sturgeon Bay. See pictures and map in study manager's files. The area has been affected by nuisance levels of Eurasian watermilfoil and Elodea since about 1987. The dominant nuisance species shifts back and forth between these two species from year to year, probably controlled by variations in seasonal growth factors, such as water temperature and clarity. The nuisance levels of the dominant species in any given year is typically made worse by coatings of filamentous algae in some areas. Many other native, desirable plant species are also present, including Water celery. History

2. Mr. Rasman indicated that very similar problems exist at Little Sturgeon Bay and Sawyer Harbor, both within about 10 miles of the City of Sturgeon Bay. It is very likely that boat traffic has moved the nuisance plants from harbor to harbor. The WDNR is concerned that without the public awareness generated by a well organized APC project, many other harbor areas will be affected with nuisance aquatic plants. It is possible that these three harbors and the surrounding area (Door County) could be viewed as one project.

3. A federal interest clearly exists in the aquatic plant problem in Sturgeon Bay. Nuisance levels of aquatic plants interfere with numerous public, riparian and commercial activities, including: sport fishing charters, recreational boating, deep keel sailboats, fishing, swimming beaches, public fishing/viewing platform, marinas and boat accesses (city owned and commercial). Also present, but not significantly affected by current levels of plants, are a Coast Guard Station, a wooden boat contractor (Peterson) for Navy minesweepers, small craft safe harbor from Lake Michigan and facilities for deep draft commercial shipping. Mr. Dennis Jordan, the City Administrator, will provide statistics on public and riparian owner use for possible benefit evaluation purposes. The aquatic plant nuisance may also interfere with redevelopment of abandoned commercial waterfront areas being planned by the city. My first impression is that the conceptual APC project is likely be found economically justified.

4. City officials and Mr. Rasman support inclusion of the area as a project in the current Wisconsin Statewide Reconnaissance Report. Further, Mr. Jordan indicated that the city wants to begin harvesting next summer, even if it needs to be at a reduced scope. I agreed to include Sturgeon Bay in the report, but explained that the WDNR at Madison would need to place a number 1 or 2 priority

Door County, Wisconsin - Outlying Waters
Aquatic Plant Management
Reconnaissance Report

Aquatic plants play a critical role in the ecosystem of Lake Michigan as well as Green Bay. The plants provide needed habitat for the diversity of cold and warm water fish that abound in the system. The vegetation also provides needed habitat for the diversity of wildlife, particularly waterfowl, that inhabit the area. The physical size of Green Bay as well as Lake Michigan, that are referred to as "Wisconsin Waters", make the system difficult to manage. The problems are created because of the large ratio between pelagic and littoral areas. The littoral areas are more productive and make up a small percent of the toatal area. The littoral provides needed spawning and nursery areas for aquatic life. The recent draught, 1987 through 1990, has created low water conditions. Along the west shore of the Bay vegetation beds dried up, no longer providing habitat. The opposite effect occurred along part of the east shore. Low water increased vegetation on the east shore in some areas because the sun was able to penetrate to the bottom in areas it previously couldn't. Dense beds of *Myriophyllum* species including *spicatum* or eurasian milfoil, as well as other taxa such as *Ceratophyllum*, *Elodea*, and *Najas* developed. The vegetation has reached nuisance proportions in outlying waters of Door County that include the Sturgeon Bay Channel, Sawyer Harbor and the Bay of Little Sturgeon.

Green Bay supports one of the best fresh water fisheries nationally and quite possibly worldwide. Resident fishing licenses sold just in Door County totaled 8137 in 1989. Non-resident licenses over the same period in the County totaled a whopping 20,576; for a total of 28,713 licenses (D. Jordan 11/19/90). According to the US Department of Interior Fish and Wildlife Service, Wisconsin in 1985 sold more out of state fishing licenses than any other state.

Fisherman from around the state as well as surrounding Great Lakes States, come to fish the outlying waters of Wisconsin. This past winter a total of 2,059,000 perch were taken by ice fisherman during the months of January, February, and March in Green Bay. 1,415,000 perch were taken in all of 1989 (Belonger Wis. DNR personnel communication 11/21/90).

Manipulating any aspect of a large ecosystem can have a devastating impact. The proper management of large areas of aquatic plants in Door County waters must be done with input from those who use the system. The Wisconsin Department of Natural Resources (WDNR) is given responsibility for coordinating this task. Permits to use aquatic herbicides for aquatic plant management are issued by WDNR. A permit to cut and harvest plants is not required in Wisconsin. Rare and endangered species, however, are protected. WDNR has been working with groups interested in managing plants in Door County and they have been willing participants in this effort.

In recent years the dense growth of obnoxious aquatic plants in the waters of Sturgeon Bay has created a serous problem for recreational boaters (both sail and motor) and is therefore affecting the economic stability of marinas and other seasonal facilities in our community.

Statistics prove that tourism is one of our community's leading industries. It has been documented that sport fishing, alone, brings in $6,200,000 a year. Also benefiting from useable waters are motels, hotels, bait shops, grocery stores, retail stores, restaurants, etc.

The littoral blanket of weeds that cover our waters in July and August has become a harbor of filth and disease due to the entrapment of dead wildlife such as ducks, birds, rats, and fish. These dead carcasses become a horrible bed of stench and bacteria polluting and infesting our swimming waters.

In 1985 a group of property owners, with shore frontage, organized a volunteer committee chartered under the name of the Sturgeon Bay Harbor Imp. Comm., Inc. This organization contracted with a commercial harvester to selectively harvest weeds along their waterfronts. The project was deemed successful and developed a wealth of scientific information. After a period of 4 years, it became apparent that the scope of the problem was overwhelming. At that time our Mayor, Mr. Norb Schachtner, acknowledged our effort and appointed a weed study group.

The weed study committee has found ample evidence that the weed problem is severely inhibiting use of the Sturgeon Bay waters and most surely, will have an adverse effect on our tourism industry. This in turn will affect and erode our economic stability.

The weed study committee has recommended that chemical treatment is NOT a desirable nor acceptable means of eradicating aquatic weeds. We also recognize the need to create weed "islands or beds" and that not all weeds are considered obnoxious.

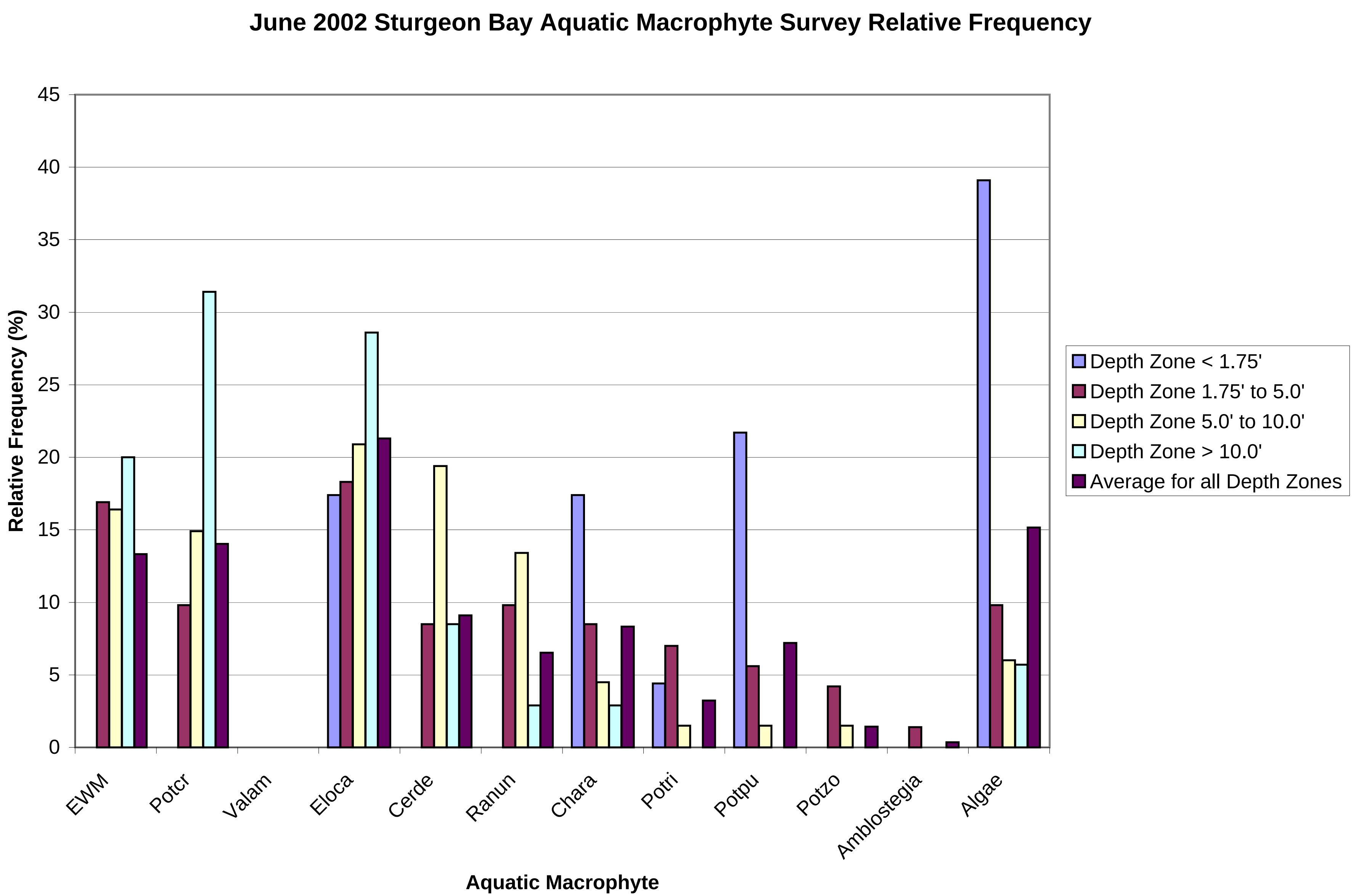
It is therefore requested that a recon study of the waters of Sturgeon Bay to investigate problems created by obnoxious aquatic plants be initiated (as soon as possible.) Weed Committee, Dennis Jordan 1990.

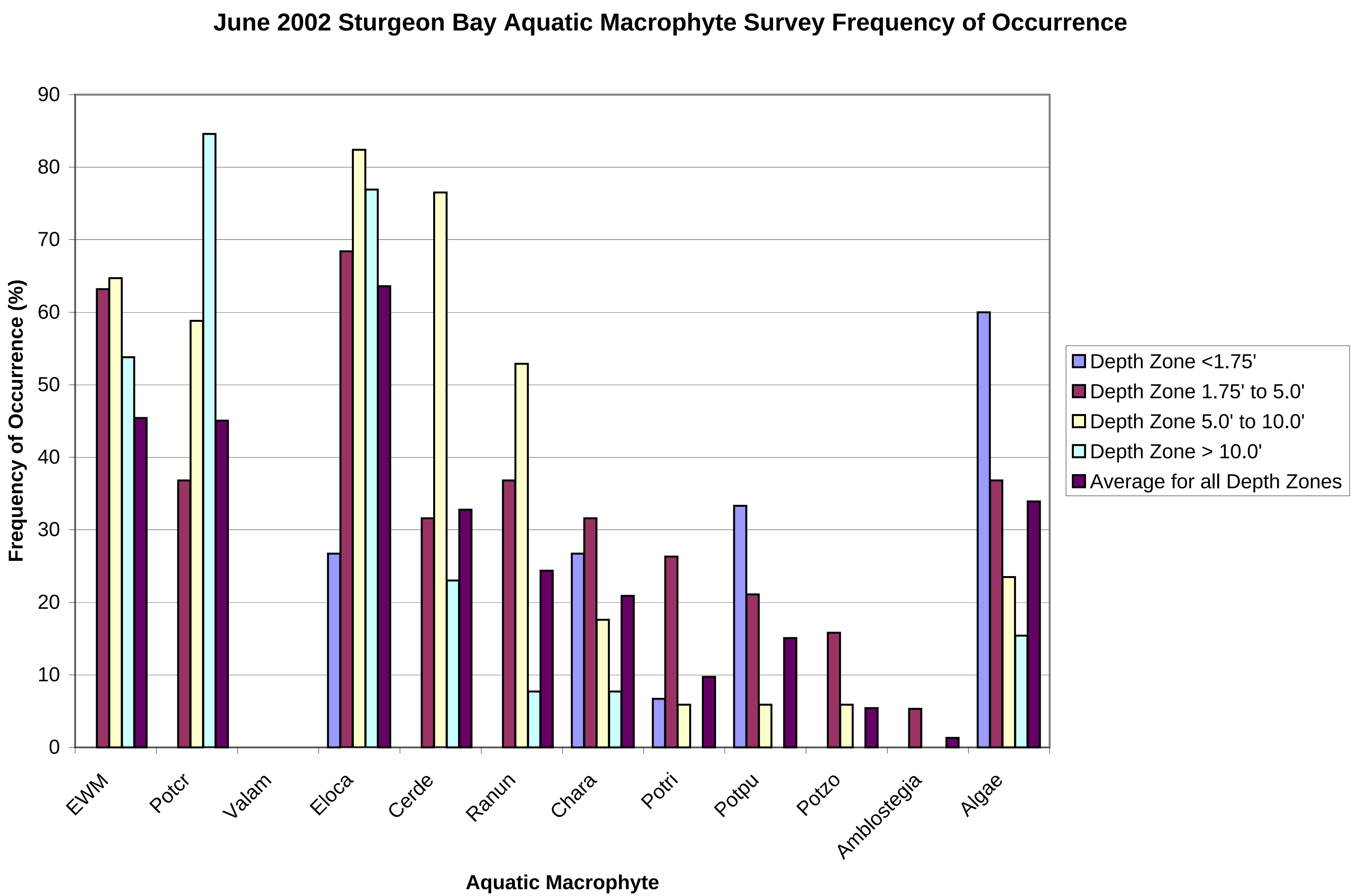
Problems and perceptions are similar for Little Sturgeon and Sawyer Harbor.

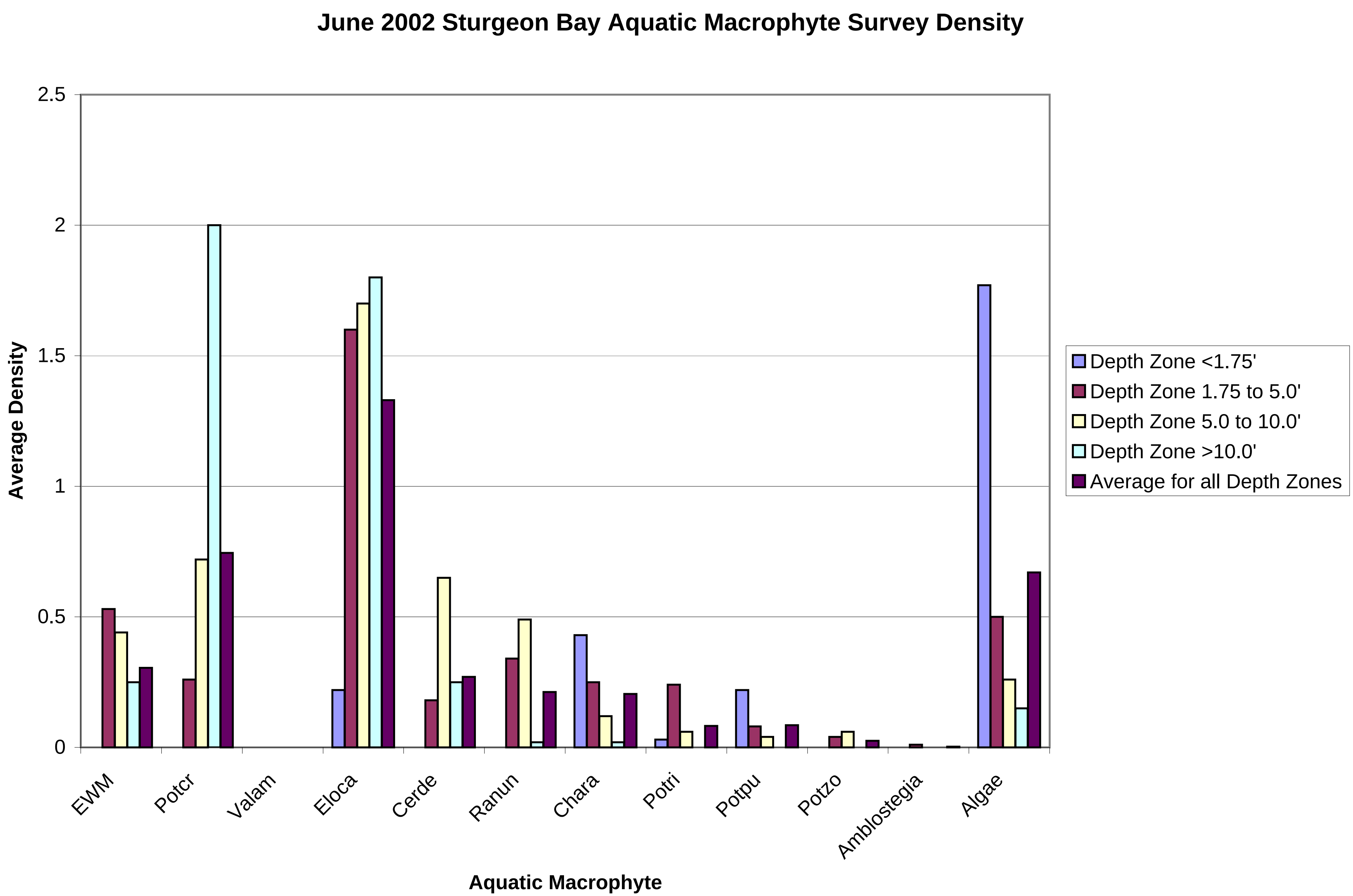
Inventory And Forecast Of Conditions

The State is beginning a cost share program to provide lake groups the opportunity to develop a plan. Outlying waters of Door County will qualify provided the sponsors have been organized for at least one year. The sponsors are asked to apply for the grant to the WDNR District Office. Grants will be made starting in late November 1990. The next application deadline is February 1, 1991 to qualify for grants made April 1. The City of Sturgeon Bay and Little Sturgeon Property Owners Assoc. have been working with DNR to determine if and when the need may arise to apply. The Sawyer Harbor group needs better organization to qualify. The grant may provide the sponsors with needed funds to go into the next phase in the Corps Aquatic Plant Control program, preparation of the design memorandum. It may also provide a method for gathering information to evaluate the success of the project. There is a need for more detailed qualification and quantification of aquatic plants in the three areas. Some work has been done by a private group, the Sturgeon Bay Harbor Imp. Comm. A brief survey was conducted in May, by DNR to document problems in Little Sturgeon (Rasman, WDNR May 1990).

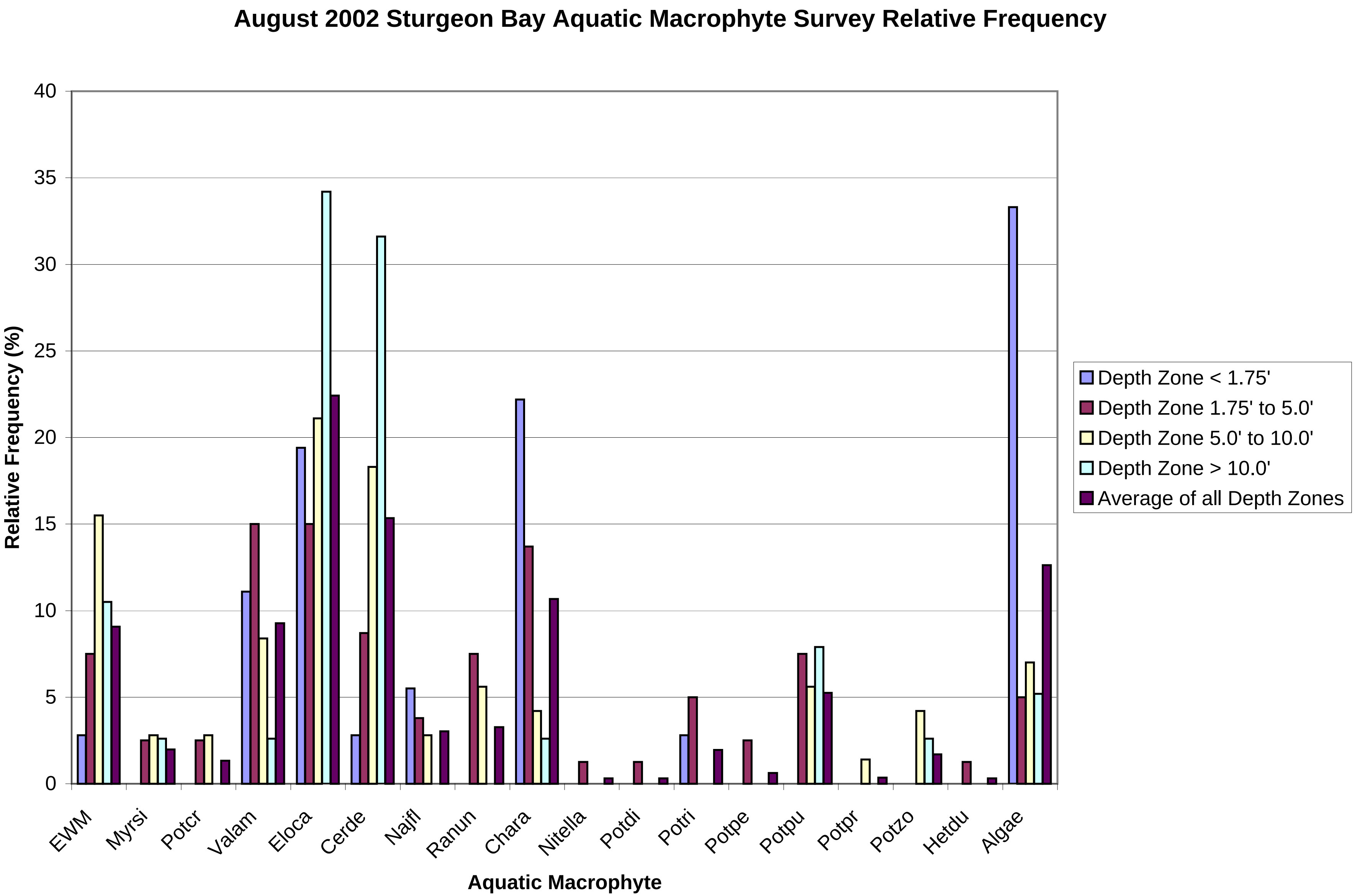
The cost for managing plants varies significantly from one method to another, with a lot of the cost depending on the individual situation.


June 2002 Sturgeon Bay Aquatic Macrophyte Survey Relative Frequency
Relative Frequency (%)
45
40
35
30
25
20
15
10
5
0
EWM
Potcr
Valam
Eloca
Cerde
Ranun
Chara
Potri
Potpu
Potzo
Amblostegia
Algae
Aquatic Macrophyte
Depth Zone < 1.75'
Depth Zone 1.75' to 5.0'
Depth Zone 5.0' to 10.0'
Depth Zone > 10.0'
Average for all Depth Zones

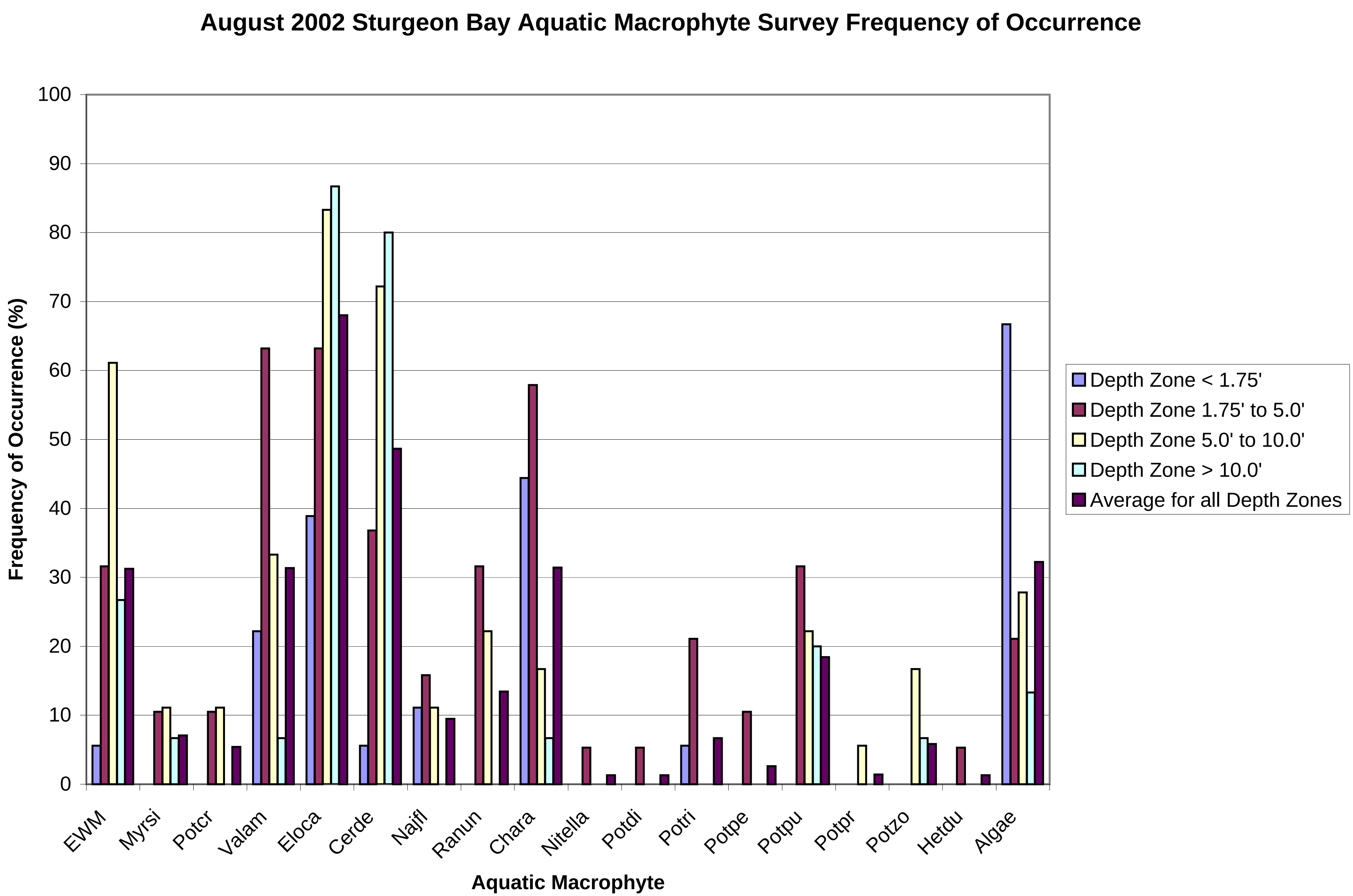

June 2002 Sturgeon Bay Aquatic Macrophyte Survey Frequency of Occurrence
Frequency of Occurrence (%)
0
10
20
30
40
50
60
70
80
90
EWM
Potcr
Valam
Eloca
Cerde
Ranun
Chara
Potri
Potpu
Potzo
Amblostegia
Algae
Aquatic Macrophyte
Depth Zone <1.75'
Depth Zone 1.75' to 5.0'
Depth Zone 5.0' to 10.0'
Depth Zone > 10.0'
Average for all Depth Zones

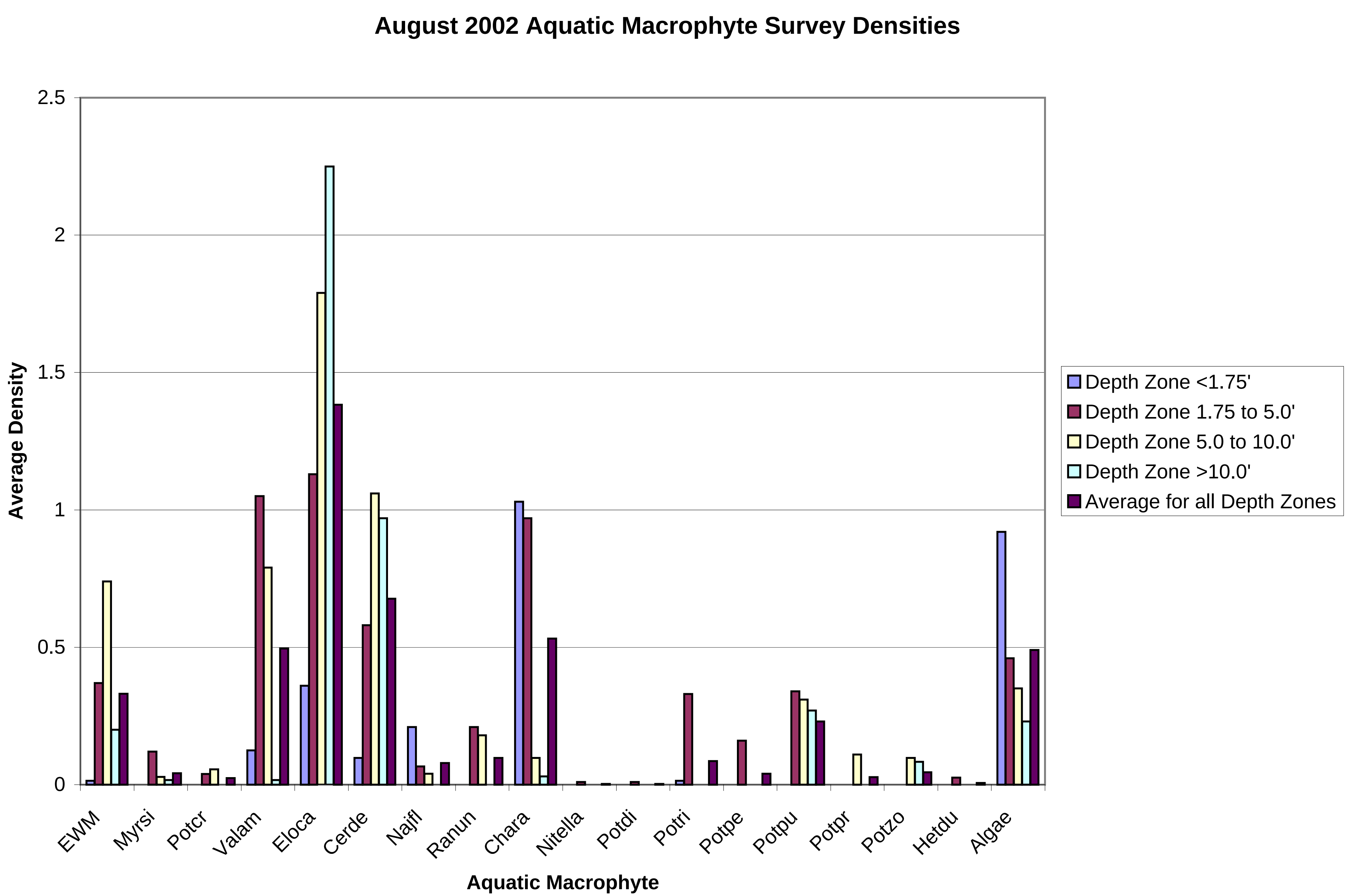


June 2002 Sturgeon Bay Aquatic Macrophyte Survey Density
Average Density
2.5
2
1.5
1
0.5
0
EWM
Potcr
Valam
Eloca
Cerde
Ranun
Chara
Potri
Potpu
Potzo
Amblostegia
Algae
Aquatic Macrophyte
Depth Zone <1.75'
Depth Zone 1.75 to 5.0'
Depth Zone 5.0 to 10.0'
Depth Zone >10.0'
Average for all Depth Zones



August 2002 Sturgeon Bay Aquatic Macrophyte Survey Relative Frequency
Relative Frequency (%)
0
5
10
15
20
25
30
35
40
EWM
Myrsi
Potcr
Valam
Eloca
Cerde
Najfl
Ranun
Chara
Nitella
Potdi
Potri
Potpe
Potpu
Potpr
Potzo
Hetdu
Algae
Aquatic Macrophyte
Depth Zone < 1.75'
Depth Zone 1.75' to 5.0'
Depth Zone 5.0' to 10.0'
Depth Zone > 10.0'
Average of all Depth Zones


August 2002 Sturgeon Bay Aquatic Macrophyte Survey Frequency of Occurrence
Frequency of Occurrence (%)
0
10
20
30
40
50
60
70
80
90
100
EWM
Myrsi
Potcr
Valam
Eloca
Cerde
Najfl
Ranun
Chara
Nitella
Potdi
Potri
Potpe
Potpu
Potpr
Potzo
Hetdu
Algae
Aquatic Macrophyte
Depth Zone < 1.75'
Depth Zone 1.75' to 5.0'
Depth Zone 5.0' to 10.0'
Depth Zone > 10.0'
Average for all Depth Zones


August 2002 Aquatic Macrophyte Survey Densities
Average Density
2.5
2
1.5
1
0.5
0
EWM
Myrsi
Potcr
Valam
Eloca
Cerde
Najfl
Ranun
Chara
Nitella
Potdi
Potri
Potpe
Potpu
Potpr
Potzo
Hetdu
Algae
Aquatic Macrophyte
Depth Zone <1.75'
Depth Zone 1.75 to 5.0'
Depth Zone 5.0 to 10.0'
Depth Zone >10.0'
Average for all Depth Zones

Sturgeon Bay - 2002 Aquatic Macrophyte Survey **(June summary for <1.75' depth zone)**
survey dates: June 5-8, 2002

	Species Density Rating											
	EWM	Potcr	Valam	Eloca	Cerde	Ranun	Chara	Potri	Potpu	Potzo	Amblostegia ?	Algae
Transect Z4B												
depth zone <1.75'				3/3					3/3			
Transect Z4A												
depth zone <1.75'				4/4					1/1			
Transect Z5A												
depth zone <1.75'				3/3					4/4			
Transect Z1A												
depth zone <1.75'				3/3					4/4			
Transect Z1B												
depth zone <1.75'	**No Vegetation**											
Transect Z3A												
depth zone <1.75'	**No Vegetation**											
Transect Z3B												
depth zone <1.75'												4/12
Transect C1A												
depth zone <1.75'												4/11
Transect C1B												
depth zone <1.75'												4/11
Transect G21												
depth zone <1.75'												4/17
Transect CP1												
depth zone <1.75'												4/12
Transect SP1												
depth zone <1.75'												4/12
Transect "Further South of Quarry"												
depth zone <1.75'							1/1					4/14
Transect "South of Quarry"												
depth zone <1.75'							2/2					4/11
Transect SW1												
depth zone <1.75'							4/12					
Transect SW2												
depth zone <1.75'	**No Vegetation**											
Transect SW3												
depth zone <1.75'							4/11	2/2	1/1			
Transect SW4												
depth zone <1.75'												4/6
Frequency of Occurrence =(# of depth intervals along the transects in which species occurrs / Total # of [sites; (depth intervals)] w/veg)	0	0	0	4/15 = 26.7	0	0	4/15 = 26.7	1/15 = 6.7	5/15 = 33.3	0	0	9/15 = 60
Relative Frequency= Frequency/sum of Freq	0	0	0	26.7/153.4 = 17.4	0	0	26.7/153.4 = 17.4	6.7/153.4 = 4.4	33.3/153.4 = 21.7	0	0	60/153.4 = 39.1
Sum of Frequences = 153.4	0	0	0		0	0					0	
Sum of Densities	0	0	0	13	0	0	26	2	13	0	0	106
Average Density = Sum of density ratings for species / # of [sites; (depth intervals)] w/ veg	0	0	0	13/60 = 0.22	0	0	26/60 = 0.43	0.03	0.22	0	0	1.77
# of depth intervals along the transects in which species occurrs	0	0	0	4	0	0	4	1	5	0	0	9
Total number of depth intervals (along the transects) sampled = 18 with 4 rake subsamples each = 72												
Total number of depth intervals (along the transects) sampled in which vegetation occurs = 15 with 4 rake subsamples each = 60												
Transect Z2A was omited; because, it was dredged and no depths > 1.75' existed												

Sturgeon Bay - 2002 Aquatic Macrophyte Survey (**June summary for 1.75 to 5.0' depth zone**)
survey dates: June 5-8, 2002

	Species Density Rating											
	EWM	Potcr	Valam	Eloca	Cerde	Ranun	Chara	Potri	Potpu	Potzo	Amblostegia ?	Algae
Transect Z2A												
depth zone 1.75 to <5.0'	3/3	1/1		4/8	1/1	3/6					1/1	1/1
Transect Z4B												
depth zone 1.75 to <5.0'	4/5	1/1		4/14								
Transect Z4A												
depth zone 1.75 to <5.0'	4/8	1/1		4/10	1/1	1/1						
Transect Z5A												
depth zone 1.75 to <5.0'	4/5	4/4		4/11		1/5						
Transect Z1A												
depth zone 1.75 to <5.0'	1/1			4/8			3/3	3/3	3/3			
Transect Z1B												
depth zone 1.75 to <5.0'		3/3		4/13	1/1			2/2				
Transect Z3A												
depth zone 1.75 to <5.0'	4/4			4/15		3/6	1/1					
Transect Z3B												
depth zone 1.75 to <5.0'	4/4	2/2		4/12	4/4	4/4						
Transect C1A												
depth zone 1.75 to <5.0'		4/8		4/14	4/6	3/3						
Transect C1B												
depth zone 1.75 to <5.0'	1/1						3/3					4/9
Transect G21												
depth zone 1.75 to <5.0'	1/1											4/13
Transect CP1												
depth zone 1.75 to <5.0'	1/1											4/4
Transect SP1												
depth zone 1.75 to <5.0'												2/4
Transect "Further South of Quarry"												
depth zone 1.75 to <5.0'												2/3
Transect "South of Quarry"												
depth zone 1.75 to <5.0'							1/1					3/4
Transect SW1												
depth zone 1.75 to <5.0'	2/2			4/8			3/4	3/6	1/1	1/1		
Transect SW2												
depth zone 1.75 to <5.0'				2/2				3/3	1/1			
Transect SW3												
depth zone 1.75 to <5.0'				3/3				4/4	1/1	1/1		
Transect SW4												
depth zone 1.75 to <5.0'	4/5			4/4	1/1	1/1	4/7			1/1		
Frequency of Occurrence =(# of depth intervals along the transects in which species occurs / Total # of [sites; (depth intervals)] w/veg)	12/19 = 63.2	7/19 = 36.8	0	13/19 = 68.4	6/19 = 31.6	7/19 = 36.8	6/19 = 31.6	5/19 = 26.3	4/19 =21.1	3/19 = 15.8	1/19 = 5.3	7/19 = 36.8
Relative Frequency= Frequency/sum of Freq	16.9	9.8	0	18.3	8.5	9.8	8.5	7	5.6	4.2	1.4	9.8
Sum of Frequencies = 373.7												
Sum of Densities	40	20	0	122	14	26	19	18	6	3	1	38
Average Density = Sum of density ratings for species / # of [sites; (depth intervals)] w/ veg	40/76 =0.53	20/76 = 0.26	0	122/76 = 1.6	14/76 = 0.18	26/76 = 0.34	19/76 = 0.25	18/76 = 0.24	6/76 = 0.08	3/76 = 0.04	1/76 = 0.01	38/76 = 0.5
# of depth intervals along the transects in which species occurrs	12	7	0	13	6	7	6	5	4	3	1	7
Total number of depth intervals (along the transects) sampled = 19												
Total number of depth intervals (along the transects) sampled in which vegetation occurs = 19												

Sturgeon Bay - 2002 Aquatic Macrophyte Survey **(June, summary for depth zones > 10)**

survey dates: June 5-8, 2002

	Species Density Rating											
	EWM	Potcr	Valam	Eloca	Cerde	Ranun	Chara	Potri	Potpu	Potzo	Amblostegia ?	Algae
Transect Z2A												
depth zone >10.0'		4/12		4/5								3/3
Transect Z4B												
depth zone >10.0'		4/14		4/9		1/1						
Transect Z4A												
depth zone >10.0'	2/2	4/4		4/13								
Transect Z5A												
depth zone >10.0'	2/2	3/4		4/17								
Transect Z1A												
depth zone >10.0'	2/2	4/4		4/12								
Transect Z1B												
depth zone >10.0'		3/4		4/11								
Transect Z3A												
depth zone >10.0'	2/2	4/16		4/4								
Transect Z3B												
depth zone >10.0'		4/18										
Transect C1A												
depth zone >10.0'		4/12		3/8								
Transect C1B												
depth zone >10.0'					4/5							4/5
Transect G21												
depth zone >10.0'	1/1	4/12		3/7	3/5							
Transect CP1												
depth zone >10.0'	3/3						1/1					
Transect SP1												
depth zone >10.0'	1/1	3/5		4/9	2/3							
Transect "Further South of Quarry"												
depth zone >10.0'	No Vegetation											
Transect "South of Quarry"												
depth zone >10.0'	No Vegetation											
Frequency of Occurrence =(# of depth intervals along the transects in which species occurs / Total # of [sites; (depth intervals)] w/veg)	7/13 = 53.8	11/13 = 84.6	0	10/13 = 76.9	3/13 = 23	1/13 = 7.7	1/13 = 7.7	0	0	0	0	2/13 = 15.4
Relative Frequency= Frequency/sum of Freq	53.8/269.1 = 20	84.6/269.1 = 31.4	0	28.6	8.5	2.9	2.9					5.7
Sum of Frequencies = 269.1												
Sum of Densities	13	105	0	95	13	1	1	0	0	0	0	8
Average Density = Sum of density ratings for species / # of [sites; (depth intervals)] w/ veg	0.25	2	0	1.8	0.25	0.02	0.02	0	0	0	0	0.15
# of depth intervals along the transects in which species occurs	7	11	0	10	3	1	1	0	0	0	0	2
Total number of depth intervals (along the transects) sampled = 15 with 4 rake samples each = 60												
Total number of depth intervals (along the transects) sampled in which vegetation occurs = 13 with 4 rake samples each = 52												

Sturgeon Bay - 2002 Aquatic Macrophyte Survey (**June summary for 5-10' depth zone**)
survey dates: June 5-8, 2002

	Species Density Rating											
	EWM	Potcr	Valam	Eloca	Cerde	Ranun	Chara	Potri	Potpu	Potzo	Amblostegia ?	Algae
Transect Z2A												
depth zone 5.0' to <10.0'	1/1	2/4		4/5	2/2	1/1						3/5
Transect Z4B												
depth zone 5.0' to <10.0'		4/12		4/8								
Transect Z4A												
depth zone 5.0' to <10.0'	4/6			4/13	1/1	2/3						
Transect Z5A												
depth zone 5.0' to <10.0'	4/6	1/1		4/15	1/1							
Transect Z1A												
depth zone 5.0' to <10.0'	3/3	4/16		4/10								
Transect Z1B												
depth zone 5.0' to <10.0'				4/12	4/4							
Transect Z3A												
depth zone 5.0' to <10.0'	1/1	2/2		4/11	3/3	2/2						
Transect Z3B												
depth zone 5.0' to <10.0'	3/3	4/4		4/14	3/3	1/1						
Transect C1A												
depth zone 5.0' to <10.0'	1/1	4/7		4/13	4/7	4/5						
Transect C1B												
depth zone 5.0' to <10.0'					3/5							4/7
Transect G21												
depth zone 5.0' to <10.0'	1/1				2/4	3/3	4/6					4/5
Transect CP1												
depth zone 5.0' to <10.0'				1/1			1/1					1/1
Transect SP1												
depth zone 5.0' to <10.0'	1/1			3/5	1/2							
Transect "Further South of Quarry"												
depth zone 5.0' to <10.0'	No Vegetation											
Transect "South of Quarry"												
depth zone 5.0' to <10.0'	1/1											
Transect SW1												
depth zone 5.0' to <10.0'		1/1		2/2	2/2	3/6						
Transect SW2 - no depths > 5.0'												
Transect SW3												
End of Transect (Deepest point) 5'				4/4	1/1	1/1		4/4	3/3	4/4		
Transect SW4												
depth zone 5.0' to <10.0'	4/6	2/2		3/3	4/9	4/11	1/1					
Frequency of Occurrence =(# of depth intervals along the transects in which species occurs / Total # of [sites; (depth intervals)] w/veg)	11/17 = 64.7	10/17 = 58.8	0	14/17 = 82.4	13/17 = 76.5	9/17 = 52.9	3/17 = 17.6	1/17 = 5.9	1/17 = 5.9	1/17 = 5.9	0	4/17 = 23.5
Relative Frequency= Frequency/sum of Freq	16.4	14.9	0	20.9	19.4	13.4	4.5	1.5	1.5	1.5	0	6
Sum of Frequencies = 394.1												
Sum of Densities	30	49	0	116	44	33	8	4	3	4	0	18
Average Density = Sum of density ratings for species / # of [sites; (depth intervals)] w/ veg	0.44	0.72	0	1.7	0.65	0.49	0.12	0.06	0.04	0.06		0.26
# of depth intervals along the transects in which species occurs	11	10	0	14	13	9	3	1	1	1	0	4
Total number of depth intervals (along the transects) sampled = 18 with 4 rake subsamples each = 72												
Total number of depth intervals (along the transects) sampled in which vegetation occurs = 17 with 4 rake subsamples each = 68												

Sturgeon Bay - 2002 Aquatic Macrophyte Survey (June 5-8, 2002)

Transect Name	Species Density Rating																			Substrate						Location	
survey dates: June 5-8, 2002	Algae	Cerde	Chara	Elodea	EWM	Fine leaved	Milfoil	Native Milfoil	Najas	Nitella	Pithophora	Potamo	Pot rich	Pot pus	Potzo	Crispus	Ranucnc	Sparganium	Valam	*Silt*	*Sand*	*Gravel*	*Cobbles*	*Boulders*	*Zebra Mussels*	Start of Transect	End of Transect
Transect #1 Z3A																										N44° 49.576	N44° 49.473
depth zone <1.75'	NO VEGETATION																									Sand/No Veget.	In front of pipe outfall
depth zone 1.75 to <5.0'			1	15	4												2									Sand	
depth zone 5.0' to <10.0'		3		11	1											2	2			X	X						
depth zone >10.0'				4	2											16				X							
Transect #2 Z3B																											
depth zone <1.75'	12																									N44° 49.698'	N44° 49.592
depth zone 1.75 to <5.0'		4		12	4											2	4										
depth zone 5.0' to <10.0'		3		14	3											4	1										
depth zone >10.0'																18											
Transect #3 Z1A																											
depth zone <1.75'				3		4																				N44° 49.313'	N44° 49.063'
depth zone 1.75 to <5.0'			3	8	1	3							3								X						
depth zone 5.0' to <10.0'				10	3											16				X	X						
depth zone >10.0'				12	2											4				X							
Transect #4 Z1B																											
depth zone <1.75'	NO VEGETATION																			X						N44° 49.384'	N44° 49.273'
depth zone 1.75 to <5.0'		1		13									2			3				X	X						
depth zone 5.0' to <10.0'		4		12																X	X						
depth zone >10.0'				8												7											
Transect #5 Z2A																											
depth zone <1.75'																										N44° 49.49'	N44° 49.579'
depth zone 1.75 to <5.0'	1	1		8	3											1	6										
depth zone 5.0' to <10.0'	5	2		5	1											4	1									Inside Marina	
depth zone >10.0'	3			5												12											
Transect #6 Z4B																											
depth zone <1.75'				3		3															100%					N44° 49.377	N44° 49.438'
depth zone 1.75 to <5.0'				14	5											1											
depth zone 5.0' to <10.0'				8												12											
depth zone >10.0'				9												14	1										
Transect #7 Z4A																											
depth zone <1.75'				4		1																				N44° 49.288'	N44° 49.307'
depth zone 1.75 to <5.0'		1		10	8											1	1			X	X						
depth zone 5.0' to <10.0'		1		13	6												3										
depth zone >10.0'				13	2											4					X						
Transect #8 Z5A																											
depth zone <1.75'				3		4																				N44° 49.085'	N44° 49.138'
depth zone 1.75 to <5.0'				11	5											4	5			X	X						
depth zone 5.0' to <10.0'		1		15	6											1											
depth zone >10.0'				17	2											4					X						
Transect #9 C1A																											
depth zone <1.75'	11																									N44° 49.976'	N44° 49.971
depth zone 1.75 to <5.0'		6		14												8	3										
depth zone 5.0' to <10.0'		7		13	1											7	5										
depth zone >10.0'				8												12				90%	5%						
Transect #10 C1B																											
depth zone <1.75'	11																									N44° 49.938'	N44° 49.964'
depth zone 1.75 to <5.0'	9		3		1																						
depth zone 5.0' to <10.0'	7	5																									
depth zone >10.0'	5	5																			80%						
Transect #11 SW1																											
depth zone <1.75'			12																							N44° 52.776	N44° 52.98'
depth zone 1.75 to <5.0'			4	8	2	1							6		1												
depth zone 5.0' to <10.0'		2		2												1	6										
depth zone >10.0'																											
Transect #12 SW2																											
depth zone <1.75'																										N44° 52.833'	N44° 53.075'
depth zone 1.75 to <5.0'				2		1							3														
depth zone 4'5"		1		2									1		4		3										
depth zone >10.0'																											
Transect #13 SW3																											
depth zone <1.75'			11			1							2													N44° 53.217'	N44 53.106'
depth zone 1.75 to <5.0'				3		1							4		1												
depth zone 5.0' to <10.0'		1		4		3							4		4		1										
depth zone >10.0'																											
Transect #14 SW4																											
depth zone <1.75'	2																									N44 53.172' N	N44° 53.101'
depth zone 1.75 to <5.0'		1	7	4	5										1		1										
depth zone 5.0' to <10.0'		9	1	3	6											2	11										
depth zone >10.0'																											
Transect #15 G21																											
depth zone <1.75'	17																									N44° 50.207'	N44° 50.184'
depth zone 1.75 to <5.0'	18				1																						
depth zone 5.0' to <10.0'	5	4	6		1												3										
depth zone >10.0'		5		7	1											12											
Transect #16 GP1																											
depth zone <1.75'	12																									N44° 50.768'	N44° 50.812'
depth zone 1.75 to <5.0'	4				1																						
depth zone 5.0' to <10.0'	1		1	1																							
depth zone >10.0'			1		3																						
Transect #17 SP1																											
depth zone <1.75'	12																									N44° 51.069'	N44° 51.112'
depth zone 1.75 to <5.0'	4																										
depth zone 5.0' to <10.0'		2		5	1																						
depth zone >10.0'		3		9	1											5											
Transect #18 S. of Quarry																											
depth zone <1.75'	11		2																							N44° 53.640'	N44° 53.566'
depth zone 1.75 to <5.0'	4		1																								
depth zone 5.0' to <10.0'					1																						
depth zone >10.0'	NO	VEGETATION																									
Transect #19 Further S.ofQuarry																											
depth zone <1.75'	14		1																							N44° 53.185'	N44°53.145'
depth zone 1.75 to <5.0'	3																										
depth zone 5.0' to <10.0'	NO VEGETATION																										
depth zone >10.0'	NO VEGETATION																										

Sturgeon Bay - 2002 Aquatic Macrophyte Survey **(August summary <1.75' depth zone)**

survey dates: August 5-9, 2002

	Species Density Rating																	
	EWM	Myrsi	Potcr	Valam	Eloca	Cerde	Najfl	Ranun	Chara	Nitella	Potdi	Potri	Potpe	Potpu	Potpr	Potzo	Hetdu	Algae
Transect Z2A - no depths < 2.0'																		
Transect Z4B																		
depth zone <1.75'					4/5				4/8									4/16
Transect Z4A																		
depth zone <1.75'					1/1				4/6									1/1
Transect Z5A																		
depth zone <1.75'					3/3				4/10									
Transect Z1A																		
depth zone <1.75'				2/2	4/4				4/14									
Transect Z1B																		
depth zone <1.75'					4/11	4/7			4/6									
Transect Z3A																		
depth zone <1.75'																		3/4
Transect Z3B																		
depth zone <1.75'					1/1													1/1
Transect C1A																		
depth zone <1.75'																		2/2
Transect C1B																		
depth zone <1.75'									4/17									4/8
Transect G21																		
depth zone <1.75'																		4/5
Transect CP1																		
depth zone <1.75'																		2/3
Transect SP1																		
depth zone <1.75'																		1/1
Transect "Further South of Quarry"																		
depth zone <1.75'																		2/2
Transect "South of Quarry"																		
depth zone <1.75'									1/1									4/11
Transect SW1																		
depth zone <1.75'				1/2					4/12									
Transect SW2																		
depth zone <1.75'				3/4	1/1		2/3											
Transect SW3																		
depth zone <1.75'	1/1			1/1			4/12					1/1						
Transect SW4																		
depth zone <1.75'																		*4/12
Frequency of Occurrence =(# of depth intervals along the transects in which species occurrs / Total # of [sites; (depth intervals)] w/veg)	1/18 = 5.6	0	0	4/18 = 22.2	7/18 = 38.9	1/18 = 5.6	2/18 = 11.1	0	8/18 = 44.4	0	0	1/18 = 5.6	0		0	0	0	12/18 = 66.7
Relative Frequency= Frequency/sum of Freq	5.6/200.1 = 2.8	0	0	11.1	19.4	2.8	5.5	0	22.2	0	0	2.8	0	0	0	0	0	33.3
Sum of Frequencies = 200.1																		
Sum of Densities	1	0	0	9	26	7	15	0	74	0	0	1	0	0	0	0	0	66
Average Density = Sum of density ratings for species / # of [sites; (depth intervals)] w/ veg	1/72 = 0.014	0	0	0.125	0.36	0.097	0.21	0	1.03	0	0	0.014	0	0	0	0	0	0.92
# of depth intervals along the transects in which species occurrs	1	0	0	4	7	1	2	0	8	0	0	1	0	0	0	0	0	12
Total number of depth intervals (along the transects) sampled = 18 with 4 rake subsamples each = 72																		
Total number of depth intervals (along the transects) sampled in which vegetation occurs = 18 with 4 rake subsamples each = 72																		

Sturgeon Bay - 2002 Aquatic Plant Survey **(August summary for depths 1.75' -5.0' depth zone)**

survey dates: August 5-9, 2002

	Species Density Rating																	
	EWM	Myrsi	Potcr	Valam	Eloca	Cerde	Najfl	Ranun	Chara	Nitella	Potdi	Potri	Potpe	Potpu	Potpr	Potzo	Hetdu	Algae
Transect Z2A																		
depth zone 1.75 to <5.0	1/2		1/2		4/9	4/10		4/7		1/1								
Transect Z4B																		
depth zone 1.75 to <5.0									4/9									4/16
Transect Z4A																		
depth zone 1.75 to <5.0	1/1			2/3	4/12			1/1	4/4					4/9				
Transect Z5A																		
depth zone 1.75 to <5.0		2/2*			4/17	2/3		2/2			1/1							
Transect Z1A																		
depth zone 1.75 to <5.0	1/1		1/1	2/2	3/4	1/2		1/1	4/11					4/10			1/2	
Transect Z1B																		
depth zone 1.75 to <5.0					4/4	3/3			2/2									
Transect Z3A																		
depth zone 1.75 to <5.0				4/13	3/3	4/12												
Transect Z3B																		
depth zone 1.75 to <5.0				2/2	4/17	4/9		4/4										4/8
Transect C1A																		
depth zone 1.75 to <5.0					*4/5	*4/5												
Transect C1B																		
depth zone 1.75 to <5.0'	3/6			4/5					4/12									
Transect G21																		
depth zone 1.75 to <5.0'	4/11	4/7																
Transect CP1																		
depth zone 1.75 to <5.0'				**1/1**			2/2		4/9									
Transect SP1																		
depth zone 1.75 to <5.0'				4/8					3/3					3/3				3/3
Transect "Further South of Quarry"																		
depth zone 1.75 to <5.0'									4/8					2/2				4/8
Transect "South of Quarry"																		
depth zone 1.75 to <5.0'	3/7			1/1	1/1				3/6									
Transect SW1																		
depth zone 1.75 to <5.0'				4/5	2/2		1/2		4/8			4/10	3/6	1/1				
Transect SW2																		
depth zone 1.75 to <5.0'				4/13	3/6		1/1	1/1				3/3						
Transect SW3																		
depth zone 1.75 to <5.0'				4/14	4/6							4/9	4/6	1/1				
Transect SW4																		
depth zone 1.75 to <5.0'				4/13					1/2			2/3						
Frequency of Occurrence =(# of depth intervals along the transects in which species occurrs / Total # of [sites; (depth intervals)] w/veg)	6/19 = 31.6	2/19 = 10.5	2/19 = 10.5	12/19 = 63.2	12/19 = 63.2	7/19 = 36.8	3/19 = 15.8	6/19 = 31.6	11/19 = 57.9	1/19 = 5.3	1/19 = 5.3	4/19 = 21.1	2/19 = 10.5	6/19 = 31.6	0	0	1/19 = 5.3	4/19 = 21.1
Relative Frequency= Frequency/sum of Freq	31.6/ 421.3 = 7.5%	2.5	2.5	15	15	8.7	3.8	7.5	13.7	1.26	1.26	5	2.5	7.5	0	0	1.26	5
Sum of Frequencies = 421.3																		
Sum of Densities	28	9	3	80	86	44	5	16	74	1	1	25	12	26	0	0	2	35
Average Density = Sum of density ratings for species / # of [sites; (depth intervals)] w/ veg	28/76 = 0.37	0.12	0.039	1.05	1.13	0.58	0.066	0.21	0.97	0.01	0.01	0.33	0.16	0.34	0	0	0.026	0.46
# of depth intervals along the transects in which species occurrs	6	2	2	12	12	7	3	6	11	1	1	4	2	6	0	0	1	4
Total number of depth intervals (along the transects) sampled = 19 with 4 rake subsamples each = 76																		
Total number of depth intervals (along the transects) sampled in which vegetation occurs = 19 with 4 rake subsamples each = 76																		

Sturgeon Bay - 2002 Aquatic Plant Survey (August summary for >10' depth zone)

survey dates: August 5-9, 2002

	Species Density Rating																	
	EWM	Myrsi	Potcr	Valam	Eloca	Cerde	Najfl	Ranun	Chara	Nitella	Potdi	Potri	Potpe	Potpu	Potpr	Potzo	Hetdu	Algae
Transect Z2A																		
depth zone >10.0'					4/6	3/4												
Transect Z4B																		
depth zone >10.0'		1/1*			4/13	4/6												
Transect Z4A																		
depth zone >10.0'	3/6				4/5	4/5												
Transect Z5A																		
depth zone >10.0'					4/15	1/2												
Transect Z1A																		
depth zone >10.0'					4/19	1/2												
Transect Z1B																		
depth zone >10.0'	3/3				*4/8	*2/4												
Transect Z3A																		
depth zone >10.0'	2/2			1/1	3/4	4/5												
Transect Z3B																		
depth zone >10.0'					*2/8	*2/5												
Transect C1A																		
depth zone >10.0'					*4/4	*2/2												
Transect C1B																		
depth zone >10.0'					4/18	4/6												
Transect G21																		
depth zone >10.0'					4/15	4/9												
Transect CP1																		
depth zone >10.0'					4/10									4/9				
Transect SP1																		
depth zone >10.0'					4/10	4/8										4/5		
Transect "Further South of Quarry"																		
depth zone >10.0'	1/1								2/2					2/2				4/4
Transect "South of Quarry"																		
depth zone >10.0'														3/5				4/10
Transect SW1 - no depths >10'																		
Transect SW2 - no depths >10'																		
Transect SW3 -no depths >10'																		
Transect SW4 - no depths >10'																		
Frequency of Occurrence =(# of depth intervals along the transects in which species occurrs / Total # of [sites; (depth intervals)] w/veg)	4/15 = 26.7	1/15 = 6.7	0	6.7	13/15 = 86.7	12/15 = 80	0	0	6.7	0	0	0	0	3/15 = 20	0	6.7	0	2/15 = 13.3
Relative Frequency= Frequency/sum of Freq	26.7/253.5 = 10.5%	2.6	0	2.6	34.2	31.6	0	0	2.6	0	0	0	0	7.9	0	2.6	0	5.2
Sum of Frequencies = 253.5																		
Sum of Densities	12	1	0	1	135	58	0	0	2	0	0	0	0	16	0	5	0	14
Average Density = Sum of density ratings for species / # of [sites; (depth intervals)] w/ veg	0.2	0.017	0	0.017	2.25	0.97	0	0	0.03	0	0	0	0	0.27	0	0.083	0	0.23
# of depth intervals along the transects in which species occurrs	4	1	0	1	13	12	0	0	1	0	0	0	0	3	0	1	0	2
Total number of depth intervals (along the transects) sampled = 15 with 4 rake subsamples = 60																		
Total number of depth intervals (along the transects) sampled in which vegetation occurs = 15 with 4 rake subsamples = 60																		

Sturgeon Bay - 2002 Aquatic Plant Survey (August summary for 5'-10' depth zone)
survey dates: August 5-9, 2002

	Species Density Rating																	
	EWM	Myrsi	Potcr	Valam	Eloca	Cerde	Najfl	Ranun	Chara	Nitella	Potdi	Potri	Potpe	Potpu	Potpr	Potzo	Hetdu	Algae
Transect Z2A																		
depth zone 5.0' to <10.0'	2/2		3/3		3/3	4/11		1/1										
Transect Z4B																		
depth zone 5.0' to <10.0'		1/1*			4/4	4/9										1/1		4/6
Transect Z4A																		
depth zone 5.0' to <10.0'	4/7				4/12	4/10												
Transect Z5A																		
depth zone 5.0' to <10.0'	4/10		1/1		4/14	4/8												
Transect Z1A																		
depth zone 5.0' to <10.0'	2/2				4/18	1/1												
Transect Z1B																		
depth zone 5.0' to <10.0'	3/5				4/12	3/7												
Transect Z3A																		
depth zone 5.0' to <10.0'	2/2				4/15	4/10												
Transect Z3B																		
depth zone 5.0' to <10.0'	4/5				4/6	4/6												
Transect C1A																		
depth zone 5.0' to <10.0'					*4/5	*2/2												
Transect C1B																		
depth zone 5.0' to <10.0'	4/10			4/7	3/3	1/1			2/3									3/5
Transect G21																		
depth zone 5.0' to <10.0'	2/2				4/11	1/1			1/2					4/5				2/2
Transect CP1																		
depth zone 5.0' to <10.0'	2/2			4/11	4/4		2/2							4/9				
Transect SP1																		
depth zone 5.0' to <10.0'					4/12	4/9										4/5		
Transect "Further South of Quarry"																		
depth zone 5.0' to <10.0'									2/2					2/2				4/8
Transect "South of Quarry"																		
depth zone 5.0' to <10.0'	4/6	1/1		2/2														3/4
Transect SW1																		
depth zone 5.0' to <10.0'				4/8			1/1	1/1							4/8			
Transect SW2 - no depths > 5'																		
Transect SW3																		
End of Transect (Deepest point) 5'				4/13	4/7			4/10						4/6		1/1		
Transect SW4																		
depth zone 5.0' to <10.0'				4/16	3/3	1/1		1/1										
Frequency of Occurrence =(# of depth intervals along the transects in which species occurrs / Total # of [sites; (depth intervals)] w/veg)	11/18 = 61.1	2/18 = 11.1	11.1	6/18 = 33.3	15/18 = 83.3	13/18 = 72.2	11.1	4/18 = 22.2	3/18 = 16.7	0	0	0	0	22.2	1/18 = 5.6	16.7	0	5/18 = 27.8
Relative Frequency= Frequency/sum of Freq	61.1/394.4 = 15.5%	2.8	2.8	8.4	21.1	18.3	2.8	5.6	4.2	0	0	0	0	5.6	1.4	4.2	0	7
Sum of Frequencies = 394.4																		
Sum of Densities	53	2	4	57	129	76	3	13	7	0	0	0	0	22	8	7	0	25
Average Density = Sum of density ratings for species / # of [sites; (depth intervals)] w/ veg	0.74	0.028	0.056	0.79	1.79	1.06	0.04	0.18	0.097	0	0	0	0	0.31	0.11	0.097	0	0.35
# of depth intervals along the transects in which species occurs	11	2	2	6	15	13	2	4	3	0	0	0	0	4	1	3	0	5
Total number of depth intervals (along the transects) sampled = 18 with 4 rake subsamples each = 72																		
Total number of depth intervals (along the transects) sampled in which vegetation occurs = 18 with 4 rake subsamples each = 72																		

Sturgeon Bay - 2002 Aquatic Macrophyte Survey(August 5-9, 2002)

Transect Name	Species Density Rating																			Substrate						Location	
survey dates: August 5-9, 2002	Algae	Cerde	Chara	Elodea	EWM	Het Du	Milfoil	Native Milfoil	Najas/Nalas	Nitella	Pot pec	Pot Div	Pot rich	Pot pus	Potzo	Crispus	Ranucnc	Pot Prae	Valam	Silt	Sand	Gravel	Cobbles	Boulders	Zebra Mussels	Start of Transect	End of Transect
Transect #1 Z2A																										N44° 49.485'	
depth zone <1.75'																				60%	20%		20%				
depth zone 1.75 to <5.0'		10		9			2			1						2	7			60%	20%		20%				
depth zone 5.0' to <10.0'		11|7		3|8			2			1				1		3|1				90%	10%						
depth zone >10.0'		4		6																						N44° 49.590'	
Transect #2 Z4A																											
depth zone <1.75'	1		6	1																	80%	20%				N44° 49.219	
depth zone 1.75 to <5.0'			4	12	1		1								9		1		3	70%	30%						
depth zone 5.0' to <10.0'		10		12	7															80%	20%						
depth zone >10.0'		5		5	6															80%	20%					N44° 49.291'	
Transect #3 Z4B																											
depth zone <1.75'	16		8	6																40%	60%					N44° 49.367'	
depth zone 1.75 to <5.0'	16		9																	40%	60%						
depth zone 5.0' to <10.0'	6	9		4			1								1					30%	70%						
depth zone >10.0'		6		13			1													60%	40%					N44° 49.413'	
Transect #4 Z5A																											
depth zone <1.75'			10	3																	70%	20%	10%			N44° 49.076'	
depth zone 1.75 to <5.0'		3		17			2					1		1			2			30%	70%						
depth zone 5.0' to <10.0'		8		14	10															60%	40%						
depth zone >10.0'		2		15																70%	30%					N44° 49.140'	
Transect #5 SP1																											
depth zone <1.75'	1																					5%	80%	15%		N44° 51.064	
depth zone 1.75 to <5.0'	3		3											3					8			5%	80%	15%			
depth zone 5.0' to <10.0'		9		12											5					40%	20%		40%				
depth zone >10.0'		8		10											5					40%	20%		40%			N44° 51.068'	
Transect #6 S.of Quarry																											
depth zone <1.75'	11		1																		5%	5%	85%	5%		N44° 53.670'	
depth zone 1.75 to <5.0'			6	1	7														1		15%	30%	50%	5%			
depth zone 5.0' to <10.0'	4				6			1											2		15%	20%	60%	5%			
depth zone >10.0'	10													5							5%	10%	80%	5%		N44° 53.564	
Transect #7 Further S. of Quarry																											
depth zone <1.75'	2																				5%	10%	80%	5%		N44° 53.187'	
depth zone 1.75 to <5.0'	8		8											2							5%	10%	80%	5%			
depth zone 5.0' to <10.0'	8		2											2							5%	10%	80%	5%			
depth zone >10.0'	4		2		1									2								15%	80%	5%		N44° 53.157'	
Transect #8 C1A																											
depth zone <1.75'	2																						20%	80%		N44° 49.981'	
depth zone 1.75 to <5.0'		5		5																40%	40%		20%				
depth zone 5.0' to <10.0'		2		5																40%	40%		20%				
depth zone >10.0'		2		4																30%	30%		40%				
Transect #9 Z3A																											
depth zone <1.75'	4																				90%	5%	5%			N44° 49.579'	
depth zone 1.75 to <5.0'			12	3															13	20%	80%						
depth zone 5.0' to <10.0'		10		15	2															40%	60%						
depth zone >10.0'		5		4	2											1				50%	50%					N44° 49.471'	
Transect #10 Z3B																											
depth zone <1.75'	1			1																	15%	75%	10%			N44° 49.698'	
depth zone 1.75 to <5.0'	8	9		17													4		2	40%	60%						
depth zone 5.0' to <10.0'		6		6	5															50%	50%						
depth zone >10.0'		5		8																60%	40%					N44° 49.617'	
Transect #11 SAW1																											
depth zone <1.75'			12																2		35%	30%	25%	10%		N44° 52.777'	
depth zone 1.75 to <5.0'			8	2					2		6		10	1	4				5	50%	50%						
depth zone 5.0' to <10.0'									1								1	8	8	50%	50%					N44° 52.963'	
depth zone >10.0'																											
Transect #12 SAW2																											
depth zone <1.75'				1					3										4		10%	20%	70%			N44° 52.821'	
depth zone 1.75 to <5.0'				6					1				3				1		13	50%	50%						
depth zone 4-4'-5"				6					2						2		8		14	40%	60%					N44° 53.028'	
depth zone >10.0'																											
Transect #13 SAW3																											
depth zone <1.75'					1				12				1						1	20%	65%	5%	5%	5%		N44° 53.219'	
depth zone 1.75 to <5.0'				6							6		9	1					14	50%	50%						
depth zone 5.0' to 5'3"				7										6	1		10		13	60%	40%						
depth zone >10.0'																										N44° 53.061'	
Transect #14 SAW4																											
depth zone <1.75'	20																				5%	15%	40%	40%		N44° 53.172'	
depth zone 1.75 to <5.0'			2										3						13	50%	50%						
depth zone 5.0' to <10.0'		1		3															16	50%	50%					N44° 53.068'	
depth zone >10.0'																	1										
Transect #15 Z1A																											
depth zone <1.75'			14	4															2	30%	70%					N44° 49.312'	
depth zone 1.75 to <5.0'		2	11	4	1	2								10		1	1		2	40%	60%						
depth zone 5.0' to <10.0'		1		18	2															40%	60%						
depth zone >10.0'		2		19																50%	50%					N44° 48.963'	
Transect #16 Z1B																											
depth zone <1.75'		7	6	11																60%	40%					N44° 49.385'	
depth zone 1.75 to <5.0'		3	2	4																70%	30%						
depth zone 5.0' to <10.0'		7		12	5															70%	30%						
depth zone >10.0'		4		8	3															80%	20%					N44° 49.290'	
Transect #17 CP-1																											
depth zone <1.75'	3																						40%	60%		N44° 50.762'	
depth zone 1.75 to <5.0'			9						2										1		80%		20%				
depth zone 5.0' to <10.0'				4	2				2					9					11		95%		5%				
depth zone >10.0'				10										9						50%	50%					N44° 50.778'	
Transect #18 C1B																											
depth zone <1.75'	8		17																		30%	10%	50%	10%		N44° 49.930'	
depth zone 1.75 to <5.0'			12		6														5		20%	15%	35%		30%		
depth zone 5.0' to <10.0'	9	1	3	3	10														7	15%	70%				15%		
depth zone >10.0'		6		18																50%	50%					N44° 49.954'	
Transect #19 G21																											
depth zone <1.75'	5																				5%	5%	90%			N44° 50.221'	
depth zone 1.75 to <5.0'					11														7		25%	25%	50%				
depth zone 5.0' to <10.0'	2	1	2	11	2									5							20%	60%	20%				
depth zone >10.0'		9		15																	50%	50%				N44° 50.262'	

NORTHERN LAKE SERVICE, INC.
Analytical Laboratory and Environmental Services
400 North Lake Avenue - Crandon, WI 54520
Ph: (715)-478-2777 Fax: (715)-478-3060

ANALYTICAL REPORT

WDNR Laboratory ID No. 721026460
WDATCP Laboratory Certification No. 105 000330
EPA Laboratory ID No. WI00034

Printed: 08/09/02 Code: S

Client: Northern Environmental Technologies Inc (Waupun)
Attn: Clint Wendt
1203 Storbeck Drive
Waupun,WI 53963

Project: STB08-3100-0574

NLS Project: 67847

NLS Customer: 86616

W1 NLS ID: 286767

Ref. Line 1 COC 56608 W1 Matrix: SW
Collected: 07/19/02 12:30 Received: 07/23/02
Notes: Noncompliance: Sample(s) received beyond EPA holding time for: Nitrite.

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Alkalinity, tot. as CaCO3 (unfiltered)	170	mg/L	2	2.2	7.9	07/29/02	EPA 310.1	721026460
Chloride, as Cl (unfiltered)	14	mg/L	10	5.0	5.0	07/24/02	EPA 300.0	721026460
~~Nitrogen, ammonia~~ as N (unfiltered) Ammonia	[0.039]	mg/L	1	0.025	0.075	07/29/02	EPA 350.1	721026460
~~Nitrate as~~ N, corr. for NO2 (unfilt) Nitrate	ND	mg/L	1	0.075*	0.075*	07/26/02	EPA 353.2	721026460
~~Nitrogen,~~ nitrite as N Nitrite	0.0050	mg/L	1	0.0030*	0.0030*	07/24/02	SM 4500NO2B	721026460
~~Nitrogen, Kjeldahl as~~ N (unfiltered) TKN	0.55	mg/L	1	0.10	0.37	08/06/02	EPA 351.2	721026460
Phosphorus, tot. as P Total Phosphorus	0.054	mg/L	1	0.0070*	0.0070*	07/25/02	EPA 365.2	721026460
Phosphorus, tot. dis. as P Total dissolved Phosphorus	0.056	mg/L	1	0.0070*	0.0070*	07/31/02	EPA 365.2	721026460
Sulfate, as SO4 (unfiltered) Sulfate	16	mg/L	10	5.0	5.0	08/06/02	EPA 300.0	721026460
Lab filtration	yes		-			07/26/02	NA	721026460

W2 NLS ID: 286768

Ref. Line 2 COC 56608 W2 Matrix: SW
Collected: 07/19/02 12:55 Received: 07/23/02
Notes: Noncompliance: Sample(s) received beyond EPA holding time for: Nitrite.

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Alkalinity, tot. as CaCO3 (unfiltered)	130	mg/L	2	2.2	7.9	07/29/02	EPA 310.1	721026460
Chloride, as Cl (unfiltered)	24	mg/L	10	5.0	5.0	07/24/02	EPA 300.0	721026460
Nitrogen, ammonia as N (unfiltered)	0.12	mg/L	1	0.025	0.075	07/29/02	EPA 350.1	721026460
Nitrate as N, corr. for NO2 (unfilt)	ND	mg/L	1	0.075*	0.075*	07/26/02	EPA 353.2	721026460
Nitrogen, nitrite as N	0.0080	mg/L	1	0.0030*	0.0030*	07/24/02	SM 4500NO2B	721026460
Nitrogen, Kjeldahl as N (unfiltered)	0.54	mg/L	1	0.10	0.37	08/06/02	EPA 351.2	721026460
Phosphorus, tot. as P	0.041	mg/L	1	0.0070*	0.0070*	07/25/02	EPA 365.2	721026460
Phosphorus, tot. dis. as P	0.040	mg/L	1	0.0070*	0.0070*	07/31/02	EPA 365.2	721026460
Sulfate, as SO4 (unfiltered)	17	mg/L	10	5.0	5.0	08/06/02	EPA 300.0	721026460
Lab filtration	yes		-			07/26/02	NA	721026460

W3 NLS ID: 286769

Ref. Line 3 COC 56608 W3 Matrix: SW
Collected: 07/19/02 13:25 Received: 07/23/02
Notes: Noncompliance: Sample(s) received beyond EPA holding time for: Nitrite.

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Alkalinity, tot. as CaCO3 (unfiltered)	110	mg/L	2	2.2	7.9	07/29/02	EPA 310.1	721026460
Chloride, as Cl (unfiltered)	15	mg/L	10	5.0	5.0	07/24/02	EPA 300.0	721026460
Nitrogen, ammonia as N (unfiltered)	[0.063]	mg/L	1	0.025	0.075	07/29/02	EPA 350.1	721026460
Nitrate as N, corr. for NO2 (unfilt)	ND	mg/L	1	0.075*	0.075*	07/26/02	EPA 353.2	721026460
Nitrogen, nitrite as N	0.010	mg/L	1	0.0030*	0.0030*	07/24/02	SM 4500NO2B	721026460
Nitrogen, Kjeldahl as N (unfiltered)	0.45	mg/L	1	0.10	0.37	08/06/02	EPA 351.2	721026460
Phosphorus, tot. as P	0.030	mg/L	1	0.0070*	0.0070*	07/25/02	EPA 365.2	721026460
Phosphorus, tot. dis. as P	0.030	mg/L	1	0.0070*	0.0070*	07/31/02	EPA 365.2	721026460
Sulfate, as SO4 (unfiltered)	18	mg/L	10	5.0	5.0	08/06/02	EPA 300.0	721026460
Lab filtration	yes		-			07/26/02	NA	721026460

NORTHERN LAKE SERVICE, INC.
Analytical Laboratory and Environmental Services
400 North Lake Avenue - Crandon, WI 54520
Ph: (715)-478-2777 Fax: (715)-478-3060

ANALYTICAL REPORT

WDNR Laboratory ID No. 721026460
WDATCP Laboratory Certification No. 105 000330
EPA Laboratory ID No. WI00034

Printed: 08/09/02 Code: S

NLS Project: 67847
NLS Customer: 86616

Client: Northern Environmental Technologies Inc (Waupun)
Attn: Clint Wendt
1203 Storbeck Drive
Waupun,WI 53963

Project: STB08-3100-0574

W4 NLS ID: 286770
Ref. Line 4 COC 56608 W4 Matrix: SW
Collected: 07/19/02 13:46 Received: 07/23/02
Notes: Noncompliance: Sample(s) received beyond EPA holding time for: Nitrite.

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Alkalinity, tot. as CaCO3 (unfiltered)	110	mg/L	2	2.2	7.9	07/29/02	EPA 310.1	721026460
Chloride, as Cl (unfiltered)	11	mg/L	10	5.0	5.0	07/24/02	EPA 300.0	721026460
Nitrogen, ammonia as N (unfiltered)	0.19	mg/L	1	0.025	0.075	07/29/02	EPA 350.1	721026460
Nitrate as N, corr. for NO2 (unfilt)	0.19	mg/L	1	0.075*	0.075*	07/26/02	EPA 353.2	721026460
Nitrogen, nitrite as N	0.0040	mg/L	1	0.0030*	0.0030*	07/24/02	SM 4500NO2B	721026460
Nitrogen, Kjeldahl as N (unfiltered)	[0.28]	mg/L	1	0.10	0.37	08/06/02	EPA 351.2	721026460
Phosphorus, tot. as P	0.035	mg/L	1	0.0070*	0.0070*	07/25/02	EPA 365.2	721026460
Phosphorus, tot. dis. as P	0.042	mg/L	1	0.0070*	0.0070*	07/31/02	EPA 365.2	721026460
Sulfate, as SO4 (unfiltered)	18	mg/L	10	5.0	5.0	08/06/02	EPA 300.0	721026460
Lab filtration	yes		-			07/26/02	NA	721026460

W5 NLS ID: 286771
Ref. Line 5 COC 56608 W5 Matrix: SW
Collected: 07/19/02 14:10 Received: 07/23/02
Notes: Noncompliance: Sample(s) received beyond EPA holding time for: Nitrite.

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Alkalinity, tot. as CaCO3 (unfiltered)	120	mg/L	2	2.2	7.9	07/29/02	EPA 310.1	721026460
Chloride, as Cl (unfiltered)	15	mg/L	10	5.0	5.0	07/24/02	EPA 300.0	721026460
Chlorophyll, all species	see attached		-			08/07/02	SM 10200H	721026460
Nitrogen, ammonia as N (unfiltered)	0.11	mg/L	1	0.025	0.075	07/29/02	EPA 350.1	721026460
Nitrate as N, corr. for NO2 (unfilt)	0.15	mg/L	1	0.075*	0.075*	07/26/02	EPA 353.2	721026460
Nitrogen, nitrite as N	0.012	mg/L	1	0.0030*	0.0030*	07/24/02	SM 4500NO2B	721026460
Nitrogen, Kjeldahl as N (unfiltered)	0.97	mg/L	1	0.10	0.37	08/06/02	EPA 351.2	721026460
Phosphorus, tot. as P	0.086	mg/L	1	0.0070*	0.0070*	07/25/02	EPA 365.2	721026460
Phosphorus, tot. dis. as P	0.095	mg/L	1	0.0070*	0.0070*	07/31/02	EPA 365.2	721026460
Sulfate, as SO4 (unfiltered)	19	mg/L	10	5.0	5.0	08/06/02	EPA 300.0	721026460
Lab filtration	yes		-			07/26/02	NA	721026460

Values in brackets represent results greater than the LOD but less than or equal to the LOQ and are within a region of "Less-Certain Quantitation". Results greater than the LOQ are considered to be in the region of "Certain Quantitation". LOD and LOQ tagged with an asterisk(*) are considered Reporting Limits.

LOD = Limit of Detection
LOQ = Limit of Quantitation
ND = Not Detected
1000 ug/L = 1 mg/L
DWB = Dry Weight Basis
NA = Not Applicable
%DWB = (mg/kg DWB) / 10000
MCL = Maximum Contaminant Levels for Drinking Water Samples

Reviewed by: R. T. Kr

Authorized by:
R. T. Krueger
President

Northern Lake Service, Inc.
Chlorophyll Results

Customer: Northern Environmental Technologies Inc (Waupun)
Project: STB08-3100-0574

Sample	Description	CC a	Pheo a	TC a	TC b	TC c
286771	W5	83	2.8	88	0.0*	0.83

CC a = Corrected Chlorophyll a
Pheo a = Pheophytin a
TC a = Trichromatic Chlorophyll a
TC b = Trichromatic Chlorophyll b
TC c = Trichromatic Chlorophyll c
Units = ug/L

*: The complex calculations used to differentiate the various chlorophyll species magnify error at low concentrations and sometimes produce negative values, which are reported as 0.0 on this report.

SAMPLE COLLECTION AND CHAIN OF CUSTODY RECORD

Wisconsin Lab Cert. No. 721026460

NORTHERN LAKE SERVICE, INC.

Analytical Laboratory and Environmental Services

400 North Lake Avenue • Crandon, WI 54520-1298

Tel: (715) 478-2777 • Fax: (715) 478-3060

NO. 56608

CLIENT	Northern Environmental
ADDRESS	1203 Storbeck Drive
CITY	Waupun
STATE	WI
ZIP	53963
PROJECT DESCRIPTION / NO.	STB 08-3100-0574
QUOTATION NO.	
CONTACT	Clint Wendt
PHONE	(920) 324-8600
PURCHASE ORDER NO.	
FAX	(920) 324-8023

MATRIX:
SW = surface water
WW = waste water
GW = groundwater
TIS = tissue
AIR = air
DW = drinking water
SOIL = soil
SED = sediment
PROD = product
SL = sludge
OTHER

USE BOXES BELOW: Indicate Y or N if GW Sample is field filtered.
Indicate G or C if WW Sample is Grab or Composite.

ANALYZE PER ORDER OF ANALYSIS

ITEM NO.	NLS LAB. NO.	SAMPLE ID	COLLECTION DATE	COLLECTION TIME	MATRIX		Alkalinity	Chloride	Chlorophyll	Ammonia	Nitrate	Nitrite	TKN	Total Phosphorus	Total Diss. Phosphorus	Sulfate		COLLECTION REMARKS
1.	286767	W1	7/19/02	12:30	H_2O (GW)		X	X	X	X	X	X	X	X	X	X		
2.	286768	W2		12:55														
3.	286769	W3		13:25														
4.	286770	W4		13:46														
5.	286771	W5		14:10			X	X	X	X	X	X	X	X	X	X		
6.																		
7.																		
8.																		
9.																		
10.																		

ONE SAMPLE PER LINE

COLLECTED BY (signature) Clint Wendt	CUSTODY SEAL NO. (IF ANY)	DATE/TIME 7/19/02
RELINQUISHED BY (signature) Clint Wendt	RECEIVED BY (signature)	DATE/TIME
DISPATCHED BY (signature) [signature]	METHOD OF TRANSPORT	DATE/TIME
RECEIVED AT NLS BY (signature) [signature]	DATE/TIME 7/23/02 10:15	CONDITION On ice
COOLER # 48-12	TEMP.	

REMARKS & OTHER INFORMATION: Per Clint W. [illegible] 7/24/02 [illegible]

WDNR FACILITY NUMBER:

E-MAIL ADDRESS: cwendt@northernenvironmental.com

REPORT TO: Northern Environmental

INVOICE TO: Northern Environmental

PRESERVATIVE:
NP = no preservative
S = sulfuric acid
N = nitric acid
Z = zinc acetate
M = methanol
OH = sodium hydroxide
HA = hydrochloric & ascorbic acid
H = hydrochloric acid

IMPORTANT:
1. TO MEET REGULATORY REQUIREMENTS, THIS FORM **MUST** BE COMPLETED IN DETAIL AND INCLUDED IN THE SHIPPER CONTAINING THE SAMPLES DESCRIBED.
2. PLEASE USE ONE LINE PER SAMPLE, **NOT** PER BOTTLE.
3. RETURN THIS FORM WITH SAMPLES - CLIENT MAY KEEP PINK COPY. Per Client tot phos & tot disphos. DMW 7/23/02
4. PARTIES COLLECTING SAMPLE, LISTED AS REPORT TO AND LISTED AS INVOICE TO AGREE TO STANDARD TERMS & CONDITIONS ON REVERSE.

NORTHERN LAKE SERVICE, INC.
Analytical Laboratory and Environmental Services
400 North Lake Avenue - Crandon, WI 54520
Ph: (715)-478-2777 Fax: (715)-478-3060

ANALYTICAL REPORT

WDNR Laboratory ID No. 721026460
WDATCP Laboratory Certification No. 105 000330
EPA Laboratory ID No. WI00034

Printed: 08/27/02 Code: S

Client: Northern Environmental Technologies Inc (Waupun)
Attn: Clint Wendt
1203 Storbeck Drive
Waupun,WI 53963

NLS Project: 68233

NLS Customer: 86616

Project: Sturgeon Bay Samples

101 NLS ID: 288137
Ref. Line 1 COC 56874 101 Matrix: SW
Collected: 08/07/02 07:00 Received: 08/08/02

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Alkalinity, tot. as CaCO3 (unfiltered)	120	mg/L	2	2.2	7.9	08/12/02	EPA 310.1	721026460
Chloride, as Cl (unfiltered)	14	mg/L	10	5.0	5.0	08/14/02	EPA 300.0	721026460
Chlorophyll, all species	see attached		-			08/26/02	SM 10200H	721026460
Nitrogen, ammonia as N (unfiltered)	0.13	mg/L	1	0.025	0.075	08/13/02	EPA 350.1	721026460
Nitrate as N, corr. for NO2 (unfilt)	ND	mg/L	1	0.075*	0.075*	08/15/02	EPA 353.2	721026460
Nitrogen, nitrite as N	ND	mg/L	1	0.0030*	0.0030*	08/08/02	SM 4500NO2B	721026460
Nitrogen, Kjeldahl as N (unfiltered)	0.40	mg/L	1	0.10	0.37	08/15/02	EPA 351.2	721026460
Phosphorus, tot. as P	0.023	mg/L	1	0.0070*	0.0070*	08/15/02	EPA 365.2	721026460
Phosphorus, tot. dis. as P	ND	mg/L	1	0.0070*	0.0070*	08/20/02	EPA 365.2	721026460
Sulfate, as SO4 (unfiltered)	20	mg/L	10	5.0	5.0	08/14/02	EPA 300.0	721026460
Lab filtration	yes		-			08/08/02	NA	721026460

102 NLS ID: 288138
Ref. Line 2 COC 56874 102 Matrix: SW
Collected: 08/07/02 07:15 Received: 08/08/02

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Alkalinity, tot. as CaCO3 (unfiltered)	79	mg/L	2	2.2	7.9	08/12/02	EPA 310.1	721026460
Chloride, as Cl (unfiltered)	12	mg/L	10	5.0	5.0	08/14/02	EPA 300.0	721026460
Chlorophyll, all species	see attached		-			08/26/02	SM 10200H	721026460
Nitrogen, ammonia as N (unfiltered)	ND	mg/L	1	0.025	0.075	08/13/02	EPA 350.1	721026460
Nitrate as N, corr. for NO2 (unfilt)	ND	mg/L	1	0.075*	0.075*	08/15/02	EPA 353.2	721026460
Nitrogen, nitrite as N	ND	mg/L	1	0.0030*	0.0030*	08/08/02	SM 4500NO2B	721026460
Nitrogen, Kjeldahl as N (unfiltered)	0.41	mg/L	1	0.10	0.37	08/15/02	EPA 351.2	721026460
Phosphorus, tot. as P	0.017	mg/L	1	0.0070*	0.0070*	08/16/02	EPA 365.2	721026460
Phosphorus, tot. dis. as P	ND	mg/L	1	0.0070*	0.0070*	08/20/02	EPA 365.2	721026460
Sulfate, as SO4 (unfiltered)	20	mg/L	10	5.0	5.0	08/14/02	EPA 300.0	721026460
Lab filtration	yes		-			08/08/02	NA	721026460

103 NLS ID: 288139
Ref. Line 3 COC 56874 103 Matrix: SW
Collected: 08/07/02 07:30 Received: 08/08/02

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Alkalinity, tot. as CaCO3 (unfiltered)	110	mg/L	2	2.2	7.9	08/12/02	EPA 310.1	721026460
Chloride, as Cl (unfiltered)	13	mg/L	10	5.0	5.0	08/14/02	EPA 300.0	721026460
Chlorophyll, all species	see attached		-			08/26/02	SM 10200H	721026460
Nitrogen, ammonia as N (unfiltered)	[0.028]	mg/L	1	0.025	0.075	08/13/02	EPA 350.1	721026460
Nitrate as N, corr. for NO2 (unfilt)	ND	mg/L	1	0.075*	0.075*	08/15/02	EPA 353.2	721026460
Nitrogen, nitrite as N	[0.0030]	mg/L	1	0.0030*	0.0030*	08/08/02	SM 4500NO2B	721026460
Nitrogen, Kjeldahl as N (unfiltered)	0.44	mg/L	1	0.10	0.37	08/15/02	EPA 351.2	721026460
Phosphorus, tot. as P	0.029	mg/L	1	0.0070*	0.0070*	08/16/02	EPA 365.2	721026460
Phosphorus, tot. dis. as P	ND	mg/L	1	0.0070*	0.0070*	08/20/02	EPA 365.2	721026460
Sulfate, as SO4 (unfiltered)	19	mg/L	10	5.0	5.0	08/14/02	EPA 300.0	721026460
Lab filtration	yes		-			08/08/02	NA	721026460

NORTHERN LAKE SERVICE, INC.
Analytical Laboratory and Environmental Services
400 North Lake Avenue - Crandon, WI 54520
Ph: (715)-478-2777 Fax: (715)-478-3060

ANALYTICAL REPORT

WDNR Laboratory ID No. 721026460
WDATCP Laboratory Certification No. 105 000330
EPA Laboratory ID No. WI00034

Printed: 08/27/02 Code: S

Client: Northern Environmental Technologies Inc (Waupun)
Attn: Clint Wendt
1203 Storbeck Drive
Waupun,WI 53963

NLS Project: 68233

NLS Customer: 86616

Project: Sturgeon Bay Samples

104 NLS ID: 288140
Ref. Line 4 COC 56874 104 Matrix: SW
Collected: 08/07/02 07:45 Received: 08/08/02

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Alkalinity, tot. as CaCO3 (unfiltered)	120	mg/L	2	2.2	7.9	08/12/02	EPA 310.1	721026460
Chloride, as Cl (unfiltered)	14	mg/L	10	5.0	5.0	08/14/02	EPA 300.0	721026460
Chlorophyll, all species	see attached		-			08/26/02	SM 10200H	721026460
Nitrogen, ammonia as N (unfiltered)	[0.026]	mg/L	1	0.025	0.075	08/13/02	EPA 350.1	721026460
Nitrate as N, corr. for NO2 (unfilt)	ND	mg/L	1	0.075*	0.075*	08/15/02	EPA 353.2	721026460
Nitrogen, nitrite as N	0.0070	mg/L	1	0.0030*	0.0030*	08/08/02	SM 4500NO2B	721026460
Nitrogen, Kjeldahl as N (unfiltered)	0.47	mg/L	1	0.10	0.37	08/15/02	EPA 351.2	721026460
Phosphorus, tot. as P	0.031	mg/L	1	0.0070*	0.0070*	08/15/02	EPA 365.2	721026460
Phosphorus, tot. dis. as P	ND	mg/L	1	0.0070*	0.0070*	08/20/02	EPA 365.2	721026460
Sulfate, as SO4 (unfiltered)	19	mg/L	10	5.0	5.0	08/14/02	EPA 300.0	721026460
Lab filtration	yes		-			08/08/02	NA	721026460

105 NLS ID: 288141
Ref. Line 5 COC 56874 105 Matrix: SW
Collected: 08/07/02 08:00 Received: 08/08/02

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Alkalinity, tot. as CaCO3 (unfiltered)	110	mg/L	2	2.2	7.9	08/12/02	EPA 310.1	721026460
Chloride, as Cl (unfiltered)	14	mg/L	10	5.0	5.0	08/14/02	EPA 300.0	721026460
Chlorophyll, all species	see attached		-			08/26/02	SM 10200H	721026460
Nitrogen, ammonia as N (unfiltered)	ND	mg/L	1	0.025	0.075	08/13/02	EPA 350.1	721026460
Nitrate as N, corr. for NO2 (unfilt)	ND	mg/L	1	0.075*	0.075*	08/15/02	EPA 353.2	721026460
Nitrogen, nitrite as N	0.0050	mg/L	1	0.0030*	0.0030*	08/08/02	SM 4500NO2B	721026460
Nitrogen, Kjeldahl as N (unfiltered)	0.67	mg/L	1	0.10	0.37	08/15/02	EPA 351.2	721026460
Phosphorus, tot. as P	0.031	mg/L	1	0.0070*	0.0070*	08/15/02	EPA 365.2	721026460
Phosphorus, tot. dis. as P	ND	mg/L	1	0.0070*	0.0070*	08/20/02	EPA 365.2	721026460
Sulfate, as SO4 (unfiltered)	20	mg/L	10	5.0	5.0	08/14/02	EPA 300.0	721026460
Lab filtration	yes		-			08/08/02	NA	721026460

106 NLS ID: 288142
Ref. Line 6 COC 56874 106 Matrix: SW
Collected: 08/07/02 08:15 Received: 08/08/02

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Alkalinity, tot. as CaCO3 (unfiltered)	110	mg/L	2	2.2	7.9	08/12/02	EPA 310.1	721026460
Chloride, as Cl (unfiltered)	13	mg/L	10	5.0	5.0	08/14/02	EPA 300.0	721026460
Chlorophyll, all species	see attached		-			08/26/02	SM 10200H	721026460
Nitrogen, ammonia as N (unfiltered)	[0.035]	mg/L	1	0.025	0.075	08/13/02	EPA 350.1	721026460
Nitrate as N, corr. for NO2 (unfilt)	ND	mg/L	1	0.075*	0.075*	08/15/02	EPA 353.2	721026460
Nitrogen, nitrite as N	0.0060	mg/L	1	0.0030*	0.0030*	08/08/02	SM 4500NO2B	721026460
Nitrogen, Kjeldahl as N (unfiltered)	0.49	mg/L	1	0.10	0.37	08/15/02	EPA 351.2	721026460
Phosphorus, tot. as P	0.031	mg/L	1	0.0070*	0.0070*	08/15/02	EPA 365.2	721026460
Phosphorus, tot. dis. as P	ND	mg/L	1	0.0070*	0.0070*	08/20/02	EPA 365.2	721026460
Sulfate, as SO4 (unfiltered)	18	mg/L	10	5.0	5.0	08/14/02	EPA 300.0	721026460
Lab filtration	yes		-			08/08/02	NA	721026460

NORTHERN LAKE SERVICE, INC.
Analytical Laboratory and Environmental Services
400 North Lake Avenue - Crandon, WI 54520
Ph: (715)-478-2777 Fax: (715)-478-3060

ANALYTICAL REPORT

WDNR Laboratory ID No. 721026460
WDATCP Laboratory Certification No. 105 000330
EPA Laboratory ID No. WI00034

Printed: 08/27/02 Code: S

Client: Northern Environmental Technologies Inc (Waupun)
Attn: Clint Wendt
1203 Storbeck Drive
Waupun,WI 53963

NLS Project: 68233

NLS Customer: 86616

Project: Sturgeon Bay Samples

107 NLS ID: 288143
Ref. Line 7 COC 56874 107 Matrix: SW
Collected: 08/07/02 09:00 Received: 08/08/02

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Alkalinity, tot. as CaCO3 (unfiltered)	110	mg/L	2	2.2	7.9	08/12/02	EPA 310.1	721026460
Chloride, as Cl (unfiltered)	11	mg/L	10	5.0	5.0	08/14/02	EPA 300.0	721026460
Chlorophyll, all species	see attached		-			08/26/02	SM 10200H	721026460
Nitrogen, ammonia as N (unfiltered)	ND	mg/L	1	0.025	0.075	08/13/02	EPA 350.1	721026460
Nitrate as N, corr. for NO2 (unfilt)	0.20	mg/L	1	0.075*	0.075*	08/15/02	EPA 353.2	721026460
Nitrogen, nitrite as N	ND	mg/L	1	0.0030*	0.0030*	08/08/02	SM 4500NO2B	721026460
Nitrogen, Kjeldahl as N (unfiltered)	[0.18]	mg/L	1	0.10	0.37	08/15/02	EPA 351.2	721026460
Phosphorus, tot. as P	[0.0070]	mg/L	1	0.0070*	0.0070*	08/15/02	EPA 365.2	721026460
Phosphorus, tot. dis. as P	ND	mg/L	1	0.0070*	0.0070*	08/20/02	EPA 365.2	721026460
Sulfate, as SO4 (unfiltered)	20	mg/L	10	5.0	5.0	08/14/02	EPA 300.0	721026460
Lab filtration	yes		-			08/08/02	NA	721026460

108 NLS ID: 288144
Ref. Line 8 COC 56874 108 Matrix: SW
Collected: 08/07/02 09:15 Received: 08/08/02

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Alkalinity, tot. as CaCO3 (unfiltered)	120	mg/L	2	2.2	7.9	08/12/02	EPA 310.1	721026460
Chloride, as Cl (unfiltered)	14	mg/L	10	5.0	5.0	08/14/02	EPA 300.0	721026460
Chlorophyll, all species	see attached		-			08/26/02	SM 10200H	721026460
Nitrogen, ammonia as N (unfiltered)	ND	mg/L	1	0.025	0.075	08/13/02	EPA 350.1	721026460
Nitrate as N, corr. for NO2 (unfilt)	ND	mg/L	1	0.075*	0.075*	08/15/02	EPA 353.2	721026460
Nitrogen, nitrite as N	0.0050	mg/L	1	0.0030*	0.0030*	08/08/02	SM 4500NO2B	721026460
Nitrogen, Kjeldahl as N (unfiltered)	0.41	mg/L	1	0.10	0.37	08/15/02	EPA 351.2	721026460
Phosphorus, tot. as P	0.025	mg/L	1	0.0070*	0.0070*	08/15/02	EPA 365.2	721026460
Phosphorus, tot. dis. as P	ND	mg/L	1	0.0070*	0.0070*	08/20/02	EPA 365.2	721026460
Sulfate, as SO4 (unfiltered)	20	mg/L	10	5.0	5.0	08/14/02	EPA 300.0	721026460
Lab filtration	yes		-			08/08/02	NA	721026460

109 NLS ID: 288145
Ref. Line 9 COC 56874 109 Matrix: SW
Collected: 08/07/02 09:30 Received: 08/08/02

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Alkalinity, tot. as CaCO3 (unfiltered)	180	mg/L	2	2.2	7.9	08/12/02	EPA 310.1	721026460
Chloride, as Cl (unfiltered)	33	mg/L	10	5.0	5.0	08/14/02	EPA 300.0	721026460
Chlorophyll, all species	see attached		-			08/26/02	SM 10200H	721026460
Nitrogen, ammonia as N (unfiltered)	ND	mg/L	1	0.025	0.075	08/13/02	EPA 350.1	721026460
Nitrate as N, corr. for NO2 (unfilt)	0.22	mg/L	1	0.075*	0.075*	08/15/02	EPA 353.2	721026460
Nitrogen, nitrite as N	0.014	mg/L	1	0.0030*	0.0030*	08/08/02	SM 4500NO2B	721026460
Nitrogen, Kjeldahl as N (unfiltered)	0.75	mg/L	1	0.10	0.37	08/15/02	EPA 351.2	721026460
Phosphorus, tot. as P	0.048	mg/L	1	0.0070*	0.0070*	08/15/02	EPA 365.2	721026460
Phosphorus, tot. dis. as P	ND	mg/L	1	0.0070*	0.0070*	08/20/02	EPA 365.2	721026460
Sulfate, as SO4 (unfiltered)	18	mg/L	10	5.0	5.0	08/14/02	EPA 300.0	721026460
Lab filtration	yes		-			08/08/02	NA	721026460

NORTHERN LAKE SERVICE, INC.
Analytical Laboratory and Environmental Services
400 North Lake Avenue - Crandon, WI 54520
Ph: (715)-478-2777 Fax: (715)-478-3060

ANALYTICAL REPORT

WDNR Laboratory ID No. 721026460
WDATCP Laboratory Certification No. 105 000330
EPA Laboratory ID No. WI00034

Printed: 08/27/02 Code: S

Client: Northern Environmental Technologies Inc (Waupun)
Attn: Clint Wendt
1203 Storbeck Drive
Waupun,WI 53963

NLS Project: 68233

NLS Customer: 86616

Project: Sturgeon Bay Samples

110 NLS ID: 288146
Ref. Line 10 COC 56874 110 Matrix: SW
Collected: 08/07/02 09:45 Received: 08/08/02

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Alkalinity, tot. as CaCO3 (unfiltered)	110	mg/L	2	2.2	7.9	08/12/02	EPA 310.1	721026460
Chloride, as Cl (unfiltered)	13	mg/L	10	5.0	5.0	08/14/02	EPA 300.0	721026460
Chlorophyll, all species	see attached		-			08/26/02	SM 10200H	721026460
Nitrogen, ammonia as N (unfiltered)	ND	mg/L	1	0.025	0.075	08/13/02	EPA 350.1	721026460
Nitrate as N, corr. for NO2 (unfilt)	ND	mg/L	1	0.075*	0.075*	08/15/02	EPA 353.2	721026460
Nitrogen, nitrite as N	0.0060	mg/L	1	0.0030*	0.0030*	08/08/02	SM 4500NO2B	721026460
Nitrogen, Kjeldahl as N (unfiltered)	0.40	mg/L	1	0.10	0.37	08/15/02	EPA 351.2	721026460
Phosphorus, tot. as P	0.024	mg/L	1	0.0070*	0.0070*	08/15/02	EPA 365.2	721026460
Phosphorus, tot. dis. as P	ND	mg/L	1	0.0070*	0.0070*	08/20/02	EPA 365.2	721026460
Sulfate, as SO4 (unfiltered)	19	mg/L	10	5.0	5.0	08/14/02	EPA 300.0	721026460
Lab filtration	yes		-			08/08/02	NA	721026460

Values in brackets represent results greater than the LOD but less than or equal to the LOQ and are within a region of "Less-Certain Quantitation". Results greater than the LOQ are considered to be in the region of "Certain Quantitation". LOD and LOQ tagged with an asterisk(*) are considered Reporting Limits.

LOD = Limit of Detection LOQ = Limit of Quantitation ND = Not Detected 1000 ug/L = 1 mg/L
DWB = Dry Weight Basis NA = Not Applicable %DWB = (mg/kg DWB) / 10000
MCL = Maximum Contaminant Levels for Drinking Water Samples

Reviewed by: 2/.27x

Authorized by:
R. T. Krueger
President

Northern Lake Service, Inc.
Chlorophyll Results

Customer: Northern Environmental Technologies Inc (Waupun)
Project: Sturgeon Bay Samples

Sample	Description	CC a	Pheo a	TC a	TC b	TC c
288137	101	6.1	0.41	6.6	0.24	0.38
288138	102	1.4	0.07	1.5	0.08	0.0*
288139	103	8.2	0.0*	8.4	0.18	0.058
288140	104	5.7	0.29	6.1	0.12	0.0*
288141	105	8.9	0.0*	8.9	0.36	0.38
288142	106	6.4	0.0*	6.3	0.16	0.23
288143	107	0.84	0.14	0.95	0.18	0.0*
288144	108	7.3	0.83	8.1	0.5	0.47
288145	109	12	1	13	0.58	0.41
288146	110	4.3	0.1	4.5	0.29	0.0*

CC a = Corrected Chlorophyll a
Pheo a = Pheophytin a
TC a = Trichromatic Chlorophyll a
TC b = Trichromatic Chlorophyll b
TC c = Trichromatic Chlorophyll c
Units = ug/L

*: The complex calculations used to differentiate the various chlorophyll species magnify error at low concentrations and sometimes produce negative values, which are reported as 0.0 on this report.

SAMPLE COLLECTION AND CHAIN OF CUSTODY RECORD

Wisconsin Lab Cert. No. 721026460

NORTHERN LAKE SERVICE, INC.

Analytical Laboratory and Environmental Services

400 North Lake Avenue · Crandon, WI 54520-1298

Tel: (715) 478-2777 · Fax: (715) 478-3060

NO. 56874

STB 08 3100 0574

CLIENT	Northern Environmental / Sturgeon Bay
ADDRESS	1203 Storbeck Drive
CITY / STATE / ZIP	Waupun / WI / 53963
PROJECT DESCRIPTION / NO.	Sturgeon Bay Samples
QUOTATION NO.	
CONTACT	Clint Wendt
PHONE	(920) 324 8600
PURCHASE ORDER NO.	STB 08 3100 0574
FAX	(920) 324 3023

MATRIX:
SW = surface water
WW = waste water
GW = groundwater
TIS = tissue
AIR = air
DW = drinking water
SOIL = soil
SED = sediment
PROD = product
SL = sludge
OTHER

USE BOXES BELOW: Indicate Y or N if GW Sample is field filtered.
Indicate G or C if WW Sample is Grab or Composite.

ANALYZE PER ORDER OF ANALYSIS

ONE SAMPLE PER LINE

ITEM NO.	NLS LAB. NO.	SAMPLE ID	COLLECTION DATE	COLLECTION TIME	MATRIX		Alkalinity	Chloride	Chlorophyll	Ammonia	Nitrate	Nitrite	TKN	total Phosphorus	total Diss. Phosphorus	Sulfate		COLLECTION REMARKS
1.	288137	101	08/07/02	7:00 AM	SW/H_2O(2)		X	X	X	X	X	X	X	X	X	X		
2.	288138	102	08/07/02	7:15 AM	SW/H_2O(2)													
3.	288139	103	08/07/02	7:30 AM	SW/H_2O(2)													
4.	288140	104	8/7/02	7:45 AM	SW/H_2O(2)													
5.	288141	105	8/7/02	8:00 AM	SW/H_2O(2)													
6.	288142	106	8/7/02	8:15 AM	SW/H_2O(2)													
7.	288143	107	8/7/02	9:00 AM	SW/H_2O(2)													
8.	288144	108	8/7/02	9:15 AM	SW/H_2O(2)													
9.	288145	109	8/7/02	9:30 AM	SW/H_2O(2)													
10.	288146	110	8/7/02	9:45 AM	SW/H_2O(2)		X	X	X	X	X	X	X	X	X	X	X	

COLLECTED BY (signature)	CUSTODY SEAL NO. (IF ANY)	DATE/TIME 08/07/02 10:30 AM
RELINQUISHED BY (signature)	RECEIVED BY (signature) R. R. Dirkes-Dunham	DATE/TIME 08/07/02 2:40 PM
DISPATCHED BY (signature)	METHOD OF TRANSPORT	DATE/TIME

REPORT TO: Clint Wendt, Northern Environmental

INVOICE TO: Northern Environmental

RECEIVED AT NLS BY (signature)	DATE/TIME 8-8-02 11:55	CONDITION on ice	TEMP.
COOLER # 48 120	REMARKS & OTHER INFORMATION DM		
	WDNR FACILITY NUMBER	E-MAIL ADDRESS	

PRESERVATIVE:
NP = no preservative
S = sulfuric acid
N = nitric acid
Z = zinc acetate
M = methanol
OH = sodium hydroxide
HA = hydrochloric & ascorbic acid
H = hydrochloric acid

IMPORTANT:
1. TO MEET REGULATORY REQUIREMENTS, THIS FORM MUST BE COMPLETED IN DETAIL AND INCLUDED IN THE SHIPPER CONTAINING THE SAMPLES DESCRIBED.
2. PLEASE USE ONE LINE PER SAMPLE, NOT PER BOTTLE.
3. RETURN THIS FORM WITH SAMPLES - CLIENT MAY KEEP PINK COPY.
4. PARTIES COLLECTING SAMPLE, LISTED AS REPORT TO AND LISTED AS INVOICE TO AGREE TO STANDARD TERMS & CONDITIONS ON REVERSE.

DUPLICATE COPY

NORTHERN LAKE SERVICE, INC.
Analytical Laboratory and Environmental Services
400 North Lake Avenue - Crandon, WI 54520
Ph: (715)-478-2777 Fax: (715)-478-3060

ANALYTICAL REPORT

WDNR Laboratory ID No. 721026460
WDATCP Laboratory Certification No. 105 000330
EPA Laboratory ID No. WI00034

Printed: 08/14/02 Code: S

NLS Project: 68125

NLS Customer: 86616

Client: Northern Environmental Technologies Inc (Waupun)
Attn: Clint Wendt
1203 Storbeck Drive
Waupun,WI 53963

Project: STB 08-3100-0574

Strawberry (330) NLS ID: 287725
Ref. Line 1 COC 56873 Strawberry (330) Matrix: SW
Collected: 07/31/02 00:00 Received: 08/03/02

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Nitrogen, ammonia as N (unfiltered)	ND	mg/L	1	0.025	0.075	08/06/02	EPA 350.1	721026460
Nitrogen, NO2 + NO3 as N (unfiltered)	0.38	mg/L	1	0.075*	0.075*	08/08/02	EPA 353.2	721026460
Phosphorus, tot. as P	0.054	mg/L	1	0.0070*	0.0070*	08/13/02	EPA 365.2	721026460

Strawberry (331) NLS ID: 287726
Ref. Line 2 COC 56873 Strawberry (331) Matrix: SW
Collected: 07/31/02 00:00 Received: 08/03/02

DRAIN PIPE

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Nitrogen, ammonia as N (unfiltered)	ND	mg/L	1	0.025	0.075	08/06/02	EPA 350.1	721026460
Nitrogen, NO2 + NO3 as N (unfiltered)	1.1	mg/L	1	0.075*	0.075*	08/08/02	EPA 353.2	721026460
Phosphorus, tot. as P	0.022	mg/L	1	0.0070*	0.0070*	08/13/02	EPA 365.2	721026460

Strawberry (326) NLS ID: 287727
Ref. Line 3 COC 56873 Strawberry (326) Matrix: SW
Collected: 07/31/02 00:00 Received: 08/03/02

SAMUELSONS

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Nitrogen, ammonia as N (unfiltered)	[0.075]	mg/L	1	0.025	0.075	08/06/02	EPA 350.1	721026460
Nitrogen, NO2 + NO3 as N (unfiltered)	0.83	mg/L	1	0.075*	0.075*	08/08/02	EPA 353.2	721026460
Phosphorus, tot. as P	0.031	mg/L	1	0.0070*	0.0070*	08/13/02	EPA 365.2	721026460

Strawberry (325) NLS ID: 287728
Ref. Line 4 COC 56873 Strawberry (325) Matrix: SW
Collected: 07/31/02 00:00 Received: 08/03/02

Little Creek

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Nitrogen, ammonia as N (unfiltered)	0.14	mg/L	1	0.025	0.075	08/06/02	EPA 350.1	721026460
Nitrogen, NO2 + NO3 as N (unfiltered)	0.78	mg/L	1	0.075*	0.075*	08/08/02	EPA 353.2	721026460
Phosphorus, tot. as P	0.11	mg/L	1	0.0070*	0.0070*	08/13/02	EPA 365.2	721026460

Strawberry (324) NLS ID: 287729
Ref. Line 5 COC 56873 Strawberry (324) Matrix: SW
Collected: 07/31/02 00:00 Received: 08/03/02

Big Creek

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Nitrogen, ammonia as N (unfiltered)	ND	mg/L	1	0.025	0.075	08/06/02	EPA 350.1	721026460
Nitrogen, NO2 + NO3 as N (unfiltered)	4.6	mg/L	5	0.38*	0.38*	08/08/02	EPA 353.2	721026460
Phosphorus, tot. as P	0.028	mg/L	1	0.0070*	0.0070*	08/13/02	EPA 365.2	721026460

..HERN LAKE SERVICE, INC.
..alytical Laboratory and Environmental Services
400 North Lake Avenue - Crandon, WI 54520
Ph: (715)-478-2777 Fax: (715)-478-3060

ANALYTICAL REPORT

WDNR Laboratory ID No. 721026460
WDATCP Laboratory Certification No. 105 000330
EPA Laboratory ID No. WI00034

Printed: 08/14/02 Code: S

Client: Northern Environmental Technologies Inc (Waupun)
Attn: Clint Wendt
1203 Storbeck Drive
Waupun,WI 53963

NLS Project: 68125

NLS Customer: 86616

Project: STB 08-3100-0574

Values in brackets represent results greater than the LOD but less than or equal to the LOQ and are within a region of "Less-Certain Quantitation". Results greater than the LOQ are considered to be in the region of "Certain Quantitation". LOD and LOQ tagged with an asterisk(*) are considered Reporting Limits.

LOD = Limit of Detection
LOQ = Limit of Quantitation
ND = Not Detected
1000 ug/L = 1 mg/L
DWB = Dry Weight Basis
NA = Not Applicable
%DWB = (mg/kg DWB) / 10000
MCL = Maximum Contaminant Levels for Drinking Water Samples

Reviewed by: Thomas R Prickle

Authorized by:
R. T. Krueger
President

JULY WATER WEED HARVESTING INFORMATION

Date	Area Cut	# Loads	Fish Type	Ave. Cut Depth	Curly Leaf Pond	Milfoil	Coontail	Water Buttercup	Elodea	Others	Comments
					% of Cutter Load	%	%	%	%	%	
7/1/02	Mooring #2 Utopia Circle to Bayview Bridge	22	None	5'- 0"	5	5			90		Big chang in weeds being harvested from curley leaf to eloda.
7/1/02	Floaters- Stone Harbor Quarter Deck	1	None	1/2 Dock pick up 1/2 Cutter @ 12" - 18"	50	50					
7/1/02	Mooring #1 SBYC to Quarter Deck Marina	13	None	5' - 0"	10				90		See note item #1
7/2/02	Floaters- PBI slips, PJ slips	1	None	15" - 18"	50	5			40	5	
7/2/02	Mooring #2 Utopia Circle to Bayview Bridge	14	None	5' - 0"	5				90	5	See note item #1
7/2/02	Mooring #1 SBYC to Quarter Deck Marina	8	None	5' - 0"	5				90	5	See note item #1
7/2/02	Floaters- Memorial Drive 8th to 12th Avenue	1	None	15" - 18"	40				50	10	

JULY WATER WEED HARVESTING INFORMATION

Date	Area Cut	# Loads	Fish Type	Ave. Cut Depth	Curly Leaf Pond	Milfoil	Coontail	Water Buttercup	Elodea	Others	Comments
					% of Cutter Load	%	%	%	%	%	
7/3/02	Tacoma Beach Road Bay View Bridge East Floaters	32	Bull Heads Sunfish	18"	< 1	< 1	< 1		98		Heavy floater concentration and Elodea growth
7/8/02	Tacoma Beach										Didn't work (storm)
7/8/02	Mooring # 2 Floaters in Channel	45	None	5'-0"		< 1	< 1		95	< 3	
7/8/02	Mooring # 1 Floaters in Channel	34	None	5'-0"		< 1	< 1		95	< 3	
7/8/02	Floaters Stone Harbor Marina	2	None	18"					99	1	
7/8/02	Floaters Quarter Deck Marina	4	None	18"					99	1	
7/8/02	Bayview Bridge West Channel for Sail Boats (approx 1/16 mile from bridge) 7.3 * I.1 and 7.4 * I.2	4	None	5'-0"					99	1	

JULY WATER WEED HARVESTING INFORMATION

Date	Area Cut	# Loads	Fish Type	Ave. Cut Depth	Curly Leaf Pond	Milfoil	Coontail	Water Buttercup	Elodea	Others	Comments
					% of Cutter Load	%	%	%	%	%	
7/9/02	Floaters Channel Tacoma Beach Mooring # 2	33	None	2'-0" to 5'-0"		< 1	< 5		90	< 5	
7/9/02	Floaters Sawyer Launch Mooring # 1 Quarter Deck, Stone Harbor Channel	38	None	2'-0" to 5'-0"		< 1	< 5		90	< 5	
710/2002	Floaters Sawyer Launch	3	None	18" to 4'-0"					99	< 1	
7/10/02	Floaters Quarter Deck Marina	8	None	18" to 3'			< 1		95	< 5	
7/10/02	Bay View Bridge West to Asher Lagoon Floaters	30	None	18" to 3'-0"			< 5		95	< 1	
710/2002	Mooring # 1 Floaters	12	None	5'-0"					99	< 1	
7/10/02	Mooring #2 Floaters	4	None	5'-0"					99	< 1	

JULY WATER WEED HARVESTING INFORMATION

Date	Area Cut	# Loads	Fish Type	Ave. Cut Depth	Curly Leaf Pond	Milfoil	Coontail	Water Buttercup	Elodea	Others	Comments
					% of Cutter Load	%	%	%	%	%	
7/10/02	PBI Memorial Drive Heavy Floaters & Cutting	10	None	3'-0" to 5'-0"					99	< 1	
7/11/02	SBYC Marina Floaters	4	None	18" to 3'-0"			< 5		90	< 5	
7/11/02	Stone Harbor Floaters Harbor Club Floaters	4	None	Dock Pick Up					99	< 1	
7/11/02	Quarter Deck Floaters	3	None	Dock Pick Up			< 1		95	< 5	
7/11/02	Mooring # 1	8	None	5'-0"					98	< 3	Mostly floaters hung up on buoys
7/11/02	Tacoma Beach Road Access Channel "A" & "B"	27	None	3' to 5'		< 1	1		95	< 4	
7/11/02	Memorial Drive @ Utopia Circle Sail Boat by Ben Larsons	8	None	3' to 5'	2				98		

JULY WATER WEED HARVESTING INFORMATION

Date	Area Cut	# Loads	Fish Type	Ave. Cut Depth	Curly Leaf Pond	Milfoil	Coontail	Water Buttercup	Elodea	Others	Comments
					% of Cutter Load	%	%	%	%	%	
7/12/02	SBYH Lift Wells "C" Dock Entrance	1	None	18" to 3'-0"			< 1		99	< 1	
7/12/02	Harbor Club Floaters Dock Pick Up	2	None				< 1	< 1	98	< 1	
7/12/02	Stone Harbor Floaters	3	None	Dock Pick Up			< 1		98	< 2	
7/12/02	Quarter Deck Floaters	2	None	Dock Pick Up			<1		98	< 2	
7/12/02	Tacoma Beach Access Channel "B"	24	Bull Heads Sunfish	18" to 5'-0"			1	2	95	< 3	
7/12/02	Tacoma Beach Floater Dock Face out approx 200'	18	None	18" to 36"			1	2	95	< 3	
7/12/02	Floaters SBYC to Michigan Street Bridge	2	None	3'-0" to 5'-0"			< 1	1	98	< 1	

JULY WATER WEED HARVESTING INFORMATION

Date	Area Cut	# Loads	Fish Type	Ave. Cut Depth	Curly Leaf Pond	Milfoil	Coontail	Water Buttercup	Elodea	Others	Comments
					% of Cutter Load	%	%	%	%	%	
7/15/02	Harbor Club, Stone Harbor Dock Pick-Up	1	None	Dock Pick Up			< 1		98	< 2	
7/15/02	Floaters Mooring # 2 Leathem Smith	2	None	15" to 24"			< 1		99	< 1	
7/15/02	Weed Bed off of Utopia Circle West of Mooring # 2	6	None	3'-0" to 5'-0"		< .5	< 1		98	< 1	
7/15/02	Tacoma Beach Floaters	15	Sunfish Bull Heads	15" - 24"			1		98	1	
7/15/02	Tacoma Beach Channel "C"	21	Small Perch Bull Heads Sunfish Rock Bass	24" to 5'-0"			1		98	1	Some Northern Milfoil noted
7/15/02	Floaters Memorial Drive 8th Ave West to PBI Docks	25	Bull Heads Crabs	15" to 24"					98	2	

Mooring at SBYH

Point ID	Input Latitude		Input Longitude	
	Deg	Min	Deg	Min
75	44	49.59	87	22.42
76	44	49.55	87	22.45
77	44	49.53	87	22.46
78	44	49.50	87	22.41
79	44	49.48	87	22.34
80	44	49.45	87	22.25
81	44	49.45	87	22.21
82	44	49.47	87	22.17
83	44	49.50	87	22.18
84	44	49.55	87	22.26
85	44	49.56	87	22.30
86	44	49.57	87	22.35
87	44	49.59	87	22.39

Leathern Smith Mooring

Point ID	Input Latitude		Input Longitude	
	Deg	Min	Deg	Min
25	44	49.19	87	21.16
26	44	49.23	87	21.12
27	44	49.24	87	21.13
28	44	49.27	87	21.19
29	44	49.30	87	21.26
30	44	49.32	87	21.32
31	44	49.34	87	21.37
32	44	49.39	87	21.43
33	44	49.40	87	21.47
34	44	49.41	87	21.51
35	44	49.40	87	21.56
36	44	49.39	87	21.63
37	44	49.37	87	21.62
38	44	49.34	87	21.56
39	44	49.31	87	21.49
40	44	49.26	87	21.39
41	44	49.24	87	21.33
42	44	49.22	87	21.29
43	44	49.20	87	21.23
44	44	49.19	87	21.19

Tacoma Beach Channels

Point ID	Input Latitude		Input Longitude	
	Deg	Min	Deg	Min
A1	44	49.01	87	20.96
A2	44	48.99	87	20.98
A3	44	48.97	87	21.01
A4	44	48.95	87	21.04
A5	44	48.91	87	21.03
A6	44	48.93	87	20.99
A7	44	48.96	87	20.96
A8	44	48.98	87	20.93
B9	44	49.07	87	21.03
B10	44	49.04	87	21.08
B11	44	49.03	87	21.11
B12	44	49.01	87	21.14
B13	44	49.02	87	21.18
B14	44	49.04	87	21.16
B15	44	49.06	87	21.14
B16	44	49.07	87	21.13
C17	44	49.12	87	21.19
C18	44	49.10	87	21.22
C19	44	49.09	87	21.24
C20	44	49.08	87	21.25
C21	44	49.08	87	21.30
C22	44	49.10	87	21.28
C23	44	49.11	87	21.27
C24	44	49.13	87	21.26

Bridge to DNR

Point ID	Input Latitude		Input Longitude	
	Deg	Min	Deg	Min
51	44	49.21	87	21.40
52	44	49.24	87	21.47
53	44	49.26	87	21.52
54	44	49.28	87	21.59
55	44	49.30	87	21.63
56	44	49.31	87	21.67
57	44	49.33	87	21.71
58	44	49.35	87	21.76
59	44	49.37	87	21.81
60	44	49.39	87	21.86
61	44	49.42	87	21.94
62	44	49.44	87	21.99
63	44	49.47	87	22.05
64	44	49.51	87	22.14
65	44	49.56	87	22.25
66	44	49.61	87	22.36
67	44	49.64	87	22.43
68	44	49.67	87	22.50
69	44	49.71	87	22.58
70	44	49.73	87	22.62
71	44	49.74	87	22.66
72	44	49.72	87	22.69
73	44	49.71	87	22.73
74	44	49.70	87	22.76

Leathern Smith Channel

Point ID	Input Latitude		Input Longitude	
	Deg	Min	Deg	Min
45	44	49.32	87	21.41
46	44	49.34	87	21.40
47	44	49.35	87	21.39
48	44	49.36	87	21.41
49	44	49.35	87	21.42
50	44	49.33	87	21.44

Weed Bed (Memorial Drive)

Point ID	Input Latitude		Input Longitude	
	Deg	Min	Deg	Min
16	44		87	
17	44		87	
18	44		87	
19	44		87	
20	44		87	
21	44		87	
22	44		87	
23	44		87	
24	44		87	
25	44		87	
26	44		87	
27	44		87	
28	44		87	
29	44		87	
30	44		87	
31	44		87	
32	44		87	
33	44		87	
34	44		87	
35	44		87	
36	44		87	
37	44		87	
38	44		87	
39	44		87	
40	44		87	
41	44		87	

Channel #1 (Memorial Drive)

Point ID	Input Latitude		Input Longitude	
	Deg	Min	Deg	Min
42	44	49.58	87	22.14
43	44	49.61	87	22.14
44	44	49.63	87	22.14
45	44	49.65	87	22.14
46	44	49.66	87	22.10
47	44	49.64	87	22.10
48	44	49.61	87	22.11
49	44	49.60	87	22.11
50	44	49.58	87	22.12

Channel #2 (Memorial Drive)

Point ID	Input Latitude		Input Longitude	
	Deg	Min	Deg	Min
51	44	49.52	87	21.98
52	44	49.54	87	21.97
53	44	49.56	87	21.96
54	44	49.58	87	21.94
55	44	49.59	87	21.94
56	44	49.58	87	21.91
57	44	49.56	87	21.92
58	44	49.53	87	21.93
59	44	49.52	87	21.94
60	44	49.50	87	21.95

Channel #3 (Memorial Drive)

Point ID	Input Latitude		Input Longitude	
	Deg	Min	Deg	Min
61	44	49.45	87	21.86
62	44	49.47	87	21.84
63	44	49.52	87	21.82
64	44	49.55	87	21.80
65	44	49.54	87	21.77
66	44	49.51	87	21.78
67	44	49.49	87	21.79
68	44	49.44	87	21.81

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:	13-Jun-02
COLLECTED BY:	Hunter/Tanner
WEATHER (sunny, overcast, partly cloudy, etc.)	Overcast
WIND (direction, est. speed)	East at 5 mph

LOCATION Longitude	**Latitude**	**TIME**	**SECCHI DISK down/up (feet)**	**WATER DEPTH (feet)**	**SUBSTRATE TYPE (circle one)**				**TEMP. (fahrenheit)**	**SAMPLE DEPTH (feet)**	**NITRATE (mg/l)**	**PHOSPHATE (mg/l)**	**OTHER**		**MAJOR PLANT SPECIES**	**GENERAL NOTES & COMMENTS (significant fish, noteworthy items)**
													Alkalinity	**pH**		
N 44°49.13	W087°21.34	10:45	L/W	7 ft.	muck	silt	sand	gravel	58°	1 ft.	0.5	5	120	9	Curley Leaf Pond	Weed bed began at depth of 3.5 ft. from surface
			3 ft.						58°						Elodea	Near Bay View Brigde off Tacoma Beach
N 44°49.16	W087°21.27	11:07	6 ft.	22 tt.	muck	**silt**	sand	gravel	58°	1 ft.	0	5				Channel between Bay View Bridge and navigation
			6 ft.						58°							markers
N 44°49.23	W087°20.88	11:26	L/W	3 ft. 6 in.	muck	silt	sand	gravel	64°	1 ft.	0	5			Elodea, Curley Leaf Pond, and	Weed began at depth of 2 ft. from surface
									62°						some Eurasian	Big Creek area
N 44°49.11	W087°20.74	11:41	V/B	3 ft. 6 in.	**muck**	silt	sand	gravel	62°	1 ft.	0	5			Sparse Elodea	Water somewhat cloudy
									62°							Big Creek area
N 44°49.20	W087°21.36	2:02	7 ft. 6 in.	26 ft. 6 in.	muck	**silt**	sand	gravel	59°	1 ft.	0.5	5				Channel under Bay View Bridge
			7 ft. 6 in.						59°							
N 44°49.35	W087°20.77	2:28	V/B	1 ft. 6 in.	muck	**silt**	sand	gravel	65°	1 ft.	1	10	200	9	Unidentified weed	Water viibly dingy / numerous mature carp
									65°							Big Creek area
N 44°48.87	W087°20.85	2:53	V/B	4 ft.	**muck**	silt	sand	gravel	64°	1 ft.	0	25			Elodea, Eurasian, and Curley	Very sunny! / Perch (2-3 in.)
									64°						Leaf Pond	East Tacoma Beach
N 44°48.81	W087°20.69	3:15	6 ft. 6 in	10 ft.	muck	**silt**	sand	gravel	62°	1 ft.	0.5	10				Very sunny!
			6 ft. 6 in						57°							Straberry Estates Channel
N 44°48.73	W087°20.75	3:25	6 ft. 6 in	10 ft. 6 in.	muck	**silt**	sand	gravel	62°	1 ft.	0	20			Curley Leaf Pond	Very sunny!
			6 ft. 6 in						59°							Straberry Estates Marina
N 44°48.79	W087°20.81	3:43	V/B	3 ft.	muck	**silt**	sand	gravel	64°	1 ft.	0	30	120	9		Very sunny!
									64°							East Tacoma Beach
N 44°48.99	W087°20.63	4:00	V/B	3 ft. 6 in.	**muck**	silt	sand	gravel	61°	1 ft.	0.5	10			Patchy Elodea	Sunny
									61°							Zenith Street
N 44°48.79	W087°21.07	4:39	L/W	4 ft. 6 in.	**muck**	silt	sand	gravel	64°	1 ft.	0	5			Elodea	Sunny; weed bed began at depth of 3 ft. 6 in. from
									63°							surface

WEATHER STATION (NORTHERN TO COMPLETE)	
TEMP	________________
PRESSURE	________________
PRECIP	________________
WIND	________________

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:	14-Jun-02
COLLECTED BY:	Hunter / Tanner
WEATHER (sunny, overcast, partly cloudy, etc.)	Slight fog and cloudy, rain all night and into the morning
WIND (direction, est. speed)	North North-East at 5 mph

LOCATION Long.	**Lat.**	**TIME**	**SECCHI DISK down/up (feet)**	**WATER DEPTH (feet)**	**SUBSTRATE TYPE (circle one)**				**TEMP. (fahrenheit)**	**SAMPLE DEPTH (feet)**	**NITRATE (mg/l)**	**PHOSPHATE (mg/l)**	**OTHER**		**MAJOR PLANT SPECIES**	**GENERAL NOTES & COMMENTS (significant fish, noteworthy items)**
													Alkalinity	**pH**		
N 44°49.64	W087°22.59	8:00	3 ft.	**11 ft.**	muck	silt	sand	gravel		1 ft.					Curley Leaf Pond	Excessive floaters; large tug and barge passed through at
			3 ft.													5:00 AM
N 44°49.73	W087°22.25	10:55	V/B	2 ft.	**muck**	silt	sand	gravel	62°	1 ft.	0	5	100	8		Right in front of drain pipe just east of Starr's house
									62°							
N 44°49.73	W087°22.25	11:05	/		muck	silt	sand	gravel	67°	From Drain	0	5	20	6.5		City street drain pipe / Ambered colored water
																Drain pipe just east of Starr's house
N 44°49.44	W087°21.50	11:37	1 ft.	1 ft. 6 in.	muck	**silt**	sand	gravel	62°	1 ft.	0	5	110	8.5	Same unidentified weed found in	Cloudy water / Sediment visibly stirred at mouth
			1 ft.												Big Creek	Mouth of Little Creek
N 44°49.37	W087°20.78	12:00	V/B	2 ft.	muck	**silt**	sand	gravel	64°	1 ft.	2	3	240	9	Unidentified weed	Sediment visibly stirred at mouth / water amber in color
									64°							Mouth of Big Creek
N 44°49.30	W087°22.23	12:28	V/B	2 ft.	muck	silt	sand	**gravel**	61°	1 ft.	2	3	200	8.5		Samuelson Creek mouth in Purves Lagoon
									61°							
N 44°49.30	W087°22.23	12:40	V/B	6 in.	muck	silt	**sand**	gravel	61°	Surface	2	3	200	8.5		Samuelson Creek itself, upstream 40 ft. from previous site
									61°							
			/		muck	silt	sand	gravel	58°	1 ft.						
									58°							

WEATHER STATION (NORTHERN TO COMPLETE)	**TEMP**	________________
	PRESSURE	________________
	PRECIP	________________
	WIND	________________

STURGEON BAY FIELD DATA COLLECTION FORM

DATE: 18-Jun-02
COLLECTED BY: Hunter Propsom / Tanner/ Mike Eukert
WEATHER (sunny, overcast, partly cloudy, etc.) No clouds
WIND (direction, est. speed) East approximately 5 - 10 mph

LOCATION Long.	Lat.	TIME	SECCHI DISK down/up (feet)	WATER DEPTH (feet)	SUBSTRATE TYPE (circle one)				TEMP. (fahrenheit)	SAMPLE DEPTH (feet)	NITRATE (mg/l)	PHOSPHATE (mg/l)	OTHER Alkalinity	OTHER pH	MAJOR PLANT SPECIES	GENERAL NOTES & COMMENTS (significant fish, noteworthy items)
N 44 49.34'	W 087 22.22'	1:33	5'-7", 5'-2"	7'-2"	muck	silt	sand	gravel	72/70	1'	1	12	220	9	Curly Leaf, some Elodea	Dingy brown water
N 44 49.23'	W 087 21.25'	1:55	8'-9", 8'-0"	11'-8"	muck	silt	sand	gravel	68/66	1'	0	12			Curly Leaf	water amber in color
N 44 49.30'	W 087 20.77'	2:10	2'-6", 2'-3"	3'-2"	muck	silt	sand	gravel	74	1'	0	10	100	9	Curly leaf, and uknown weed	Water very stirred up and brown in color w/ numerous carp
N 44 48.89'	W 087 20.98'	2:30	V/B	3'-10"	muck	silt	sand	gravel	71/71	1'	0	10	100	9	Elodea and some E.M.	water is amber colored
N 44 49.52'	W 087 22.43'	3:36	6', 6'	8'	muck	silt	sand	gravel	70/70	1'	0.5	10			Elodea, some curly leaf	SBYH end of E dock
N 44 49.44'	W 087 22.43'	3:50	V/B	6'	muck	silt	sand	gravel	72/72	1'	1	10			Elodea, curly leaf	Sewage plant out, water amber colored (visible scum/algae on surface)
N 44 49.43'	W 087 22.13'	400	6', 6' (lost in weeds)	9'	muck	silt	sand	gravel	70/70	1'	0	5			Curly Leaf, some elodea	W Purves Lagoon
N 44 49.27'	W 087 21.79	4:14	4', 4' (lost in weeds)	6.5'	muck	silt	sand	gravel	69/69	1'	0	10			Elodea	Across bay from E. Memorial Dr.
N 44 49.17'	W 087 21.42'	4:35	9', 9' (lost in weeds)	9.5'	muck	silt	sand	gravel	71/69	1'	0	10	100	9	Elodea	Under Bayview Bridge
N 44 49.32'	W 087 21.39'	4:50	.5', 4.5' (lost in weeds	8'-6"	muck	silt	sand	gravel	72/72	1'	0	5			Elodea	Leathem Smith mooring area
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								

WEATHER STATION (NORTHERN TO COMPLETE)

TEMP ____________________
PRESSURE ____________________
PRECIP ____________________
WIND ____________________

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:	18-Jun-02
COLLECTED BY:	Hunter Propson / Matt Brown
WEATHER (sunny, overcast, partly cloudy, etc.)	No Clouds
WIND (direction, est. speed)	Wind (Southeast) Approximately 10 mph

LOCATION Long.	Lat.	TIME	SECCHI DISK down/up (feet)	WATER DEPTH (feet)	SUBSTRATE TYPE (circle one)				TEMP. (fahrenheit)	SAMPLE DEPTH (feet)	NITRATE (mg/l)	PHOSPHATE (mg/l)	OTHER		MAJOR PLANT SPECIES	GENERAL NOTES & COMMENTS (significant fish, noteworthy items)
													Alkalinity	pH		
N 44 49.92'	W 087 23.07'	9:28	V/B	14'-8"	muck	silt	sand	gravel	62/62	1'	0	15			Curly Leaf	Clear Water
N 44 49.88'	W 087 23.11'	9:43	V/B	2'3"	muck	silt	sand	gravel	62	1'	0	15				Green Scum on Bottom attached to rocks
N 44 50.14'	W 087 23.25'	9:54	V/B	2'6"	muck	silt	sand	gravel	63	1'	0	5				Green Scum on Bottom attached to rocks
N 44 50.48'	W 087 23.64'	10:03	11'-6", 10'6"	17'-4"	muck	silt	sand	gravel	63/62	1'	0.5	10				Water was murky and green in color
N 44 50.64'	W 087 23.23'	10:15	11'9", 11'6"	21'-4"	muck	silt	sand	gravel	62/62	1'	0.5	10	110	8.5	N/A	N/A
N 44 50.70'	W 087 23.18'	10:24	V/B	5'3"	muck	silt	sand	gravel	63	1'	0	15			Elodea, some E.M.	Spotted 4 Gobes while taking test
N 44 50.49'	W 087 23.81'	10:45	V/B	4'-1"	muck	silt	sand	gravel	66/66	1'	0	10			Elodea, Curly Leaf, scarse E.M.	Smallmouth bass
N 44 49.91'	W 087 23.03'	11:12	V/B	9'-9"	muck	silt	sand	gravel	65/63	1'	0	5			Curly Leaf, Elodea	Schools of Aelwife, murky brown water
N 44 49.91'	W 087 23.03'	1:08	7'-0", 6'-4"	10'-8"	muck	silt	sand	gravel	67/66	1'	0.5	12				Next to Roen Salvage

WEATHER STATION (NORTHERN TO COMPLETE)	**TEMP**	________________________
	PRESSURE	________________________
	PRECIP	________________________
	WIND	________________________

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:	19-Jun-02
COLLECTED BY:	Hunter / Mike
WEATHER (sunny, overcast, partly cloudy, etc.)	Overcast
WIND (direction, est. speed)	South-East at 20 mph

LOCATION Long.	Lat.	TIME	SECCHI DISK down/up (feet)	WATER DEPTH (feet)	SUBSTRATE TYPE (circle one)				TEMP. (fahrenheit)	SAMPLE DEPTH (feet)	NITRATE (mg/l)	PHOSPHATE (mg/l)	OTHER Alkalinity	pH	MAJOR PLANT SPECIES	GENERAL NOTES & COMMENTS (significant fish, noteworthy items)
N 44°49.78	W087°22.50	12:55	9 ft. 6 in.	15 ft. 3 in.	muck	silt	sand	gravel	70°	1ft.	0	5	100	9		By the Ryerson
			8 ft. 10 in.						68°							
N 44°49.86	W087°23.31	1:30	V/B	6 in.	muck	silt	sand	**gravel**	59°	1ft.	3	5	240	7		Otumba Beach strom drain
N 44°49.86	W087°23.35	1:45	V/B	4 in.	muck	silt	**sand**	gravel	64°	1ft.	2.5	5	240	8.5		Otumba Beach storm drain on other side
N 44°49.88	W087°23.19	2:04	V/B		muck	silt	sand	gravel	58°	From Drain	3	5	240	8.5	Green Scum	Storm Drain - Bridge Port
N 44°49.88	W087°23.15	2:16	V/B	3 ft. 6 in.	muck	silt	sand	**gravel**	67°	1ft.	0.5	5	120	9	Green Scum	Storm Drain - Bridge Port (near light)
N 44°49.86	W087°23.13	2:36	V/B		muck	silt	sand	gravel	57°	From Drain	2	5	240	7	Green Scum	Storm Drain -Bridge Port (cortyard)
			/		muck	silt	sand	gravel								

WEATHER STATION (NORTHERN TO COMPLETE)

TEMP ______________________
PRESSURE ______________________
PRECIP ______________________
WIND ______________________

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:	19-Jun-02
COLLECTED BY:	Doug / Tanner
WEATHER (sunny, overcast, partly cloudy, etc.)	Hazy (not quite overcast)
WIND (direction, est. speed)	South-East at 15-20 mph

LOCATION Long.	Lat.	TIME	SECCHI DISK down/up (feet)	WATER DEPTH (feet)	SUBSTRATE TYPE (circle one)				TEMP. (fahrenheit)	SAMPLE DEPTH (feet)	NITRATE (mg/l)	PHOSPHATE (mg/l)	OTHER Alkalinity	OTHER pH	MAJOR PLANT SPECIES	GENERAL NOTES & COMMENTS (significant fish, noteworthy items)
N 44°49.91	W087°22.91	9:48	8 ft.	16 ft. 6 in.	muck	**silt**	sand	gravel	66°	0	0	5				Harbor Club wall parallel to bridge
			8 ft.						66°							
N 44°49.91	W087°23.03	10:05	6 ft.	8 ft.	muck	**silt**	sand	gravel	67°	1 ft.	0	5	120	8.5		Inside Harbor Club (1st Dock)
			6 ft.						67°							
N 44°49.86	W087°23.31	10:25	V/B	1 ft.	muck	silt	**sand**	gravel	61°	1 ft.	2	5	240	7		Otumba Beach drainage pipe
									61°							
N 44°49.86	W087°23.31	10:36	V/B	1 ft.	muck	silt	**sand**	gravel	66°	1 ft.	0	5	120	8.5		Otumba Beach
									66°							
N 44°50.00	W087°22.78	10:56	V/B	5 ft.	muck	**silt**	sand	gravel	68°	1 ft.	0	10			Elodea and Curley Leaf	Stone Harbor Marina
									68°							
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								

WEATHER STATION
(NORTHERN TO COMPLETE)

TEMP ____________________
PRESSURE ____________________
PRECIP ____________________
WIND ____________________

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:	20-Jun-02
COLLECTED BY:	Dylan & Tanner
WEATHER (sunny, overcast, partly cloudy, etc.)	Partyly Cloudy
WIND (direction, est. speed)	Southeast 10 mph

LOCATION long	Lat	TIME	SECCHI DISK down/up (feet)	WATER DEPTH (feet)	SUBSTRATE TYPE (circle one)				TEMP. (fahrenheit)	SAMPLE DEPTH (feet)	NITRATE (mg/l)	PHOSPHATE (mg/l)	OTHER		MAJOR PLANT SPECIES	GENERAL NOTES & COMMENTS (significant fish, noteworthy items)
													Alkalinity	pH		
N 44 48.82'	W 087 20.99'	9:44	V/B	4'	muck	silt	sand	gravel	66/66	1'	0	10	120	9		East Tacoma Beach
N 44 48.78'	W 087 20.77	10:00	V/B	3'	muck	silt	sand	gravel	64/64	1'	0.5	10				Strawberry Creek Estates breakwall
N 44 49.00'	W 087 21.17'	10:14	V/B	3.5'	muck	silt	sand	gravel	67/67	1'	0	3				Mid Tacoma Beach
N 44 49.12	W 087 21.37	10:26	2', 2' (lost in weeds)	5'	muck	silt	sand	gravel	66/66	1'	0	10			Elodea, Eurasian Mil	W Tacoma / wind switch to SW, 5 to 10 mph
N 44 49.56'	W 087 22.67'	11:19	V/B	2'	muck	silt	sand	gravel	64/64	1'	0	5				Inlet between SBYH and Roen Salvage
N 44 49.66'	W 087 22.34'	11:31	11.5'	20.5'	muck	silt	sand	gravel	64	1'	0	10				Channel in front of Yacht Club

*NOTE: 400 foot cruise ship passed through approximately 9:00 A.M.

WEATHER STATION (NORTHERN TO COMPLETE)	**TEMP**	________________
	PRESSURE	________________
	PRECIP	________________
	WIND	________________

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:	20-Jun-02
COLLECTED BY:	Hunter & Mike
WEATHER (sunny, overcast, partly cloudy, etc.)	Overcast
WIND (direction, est. speed)	SW (10 mph)

LOCATION Long.	Lat.	TIME	SECCHI DISK down/up (feet)	WATER DEPTH (feet)	SUBSTRATE TYPE (circle one)				TEMP. (fahrenheit)	SAMPLE DEPTH (feet)	NITRATE (mg/l)	PHOSPHATE (mg/l)	OTHER Alkalinity	pH	MAJOR PLANT SPECIES	GENERAL NOTES & COMMENTS (significant fish, noteworthy items)
N 44 48.90'	W 087 20.74'	1:20	V/B	12'-6"	muck	silt	sand	gravel	62/62	1'	0.5	3	100	8.5	N/A	1st green can going towards channel, water - aqua green
N 44 48.70'	W 087 20.78'	1:40	V/B	10'-7"	muck	silt	sand	gravel	66/66	1'	0	3	120	9	Curly Leaf	Strawberry Creek Estates (In Marina)
N 44 49.07'	W 087 20.75'	2:05	L/W	5'-2"	muck	silt	sand	gravel	68	1'	0	5	80	9	Curly Leaf, Elodea, E. M.	Weed bed in front of Big Creek
			4'-4"													
N 44 49.26'	W 087 20.79'	2:21	V/B	3'-7"	muck	silt	sand	gravel	70	1'	0	4	110	9	E.M., Elodea, Curly Leaf	Entrance of Big Creek, water is amber in color
N 44 49.37'	W 087 21.40'	2:40	L/W	5'-6"	muck	silt	sand	gravel	70/69	1'	0.5	5	120	9	Curly Leaf, Elodea	Water stirred, brown in color, Leathem Dock
			5'-3"													
N 44 49.37'	W 087 21.52'	3:05	L/W	9'-2"	muck	silt	sand	gravel	67/67	1'	0	5	120	9	Curly Leaf, Elodea	Leathem mooring area
			5'-6"													

WEATHER STATION
(NORTHERN TO COMPLETE)

TEMP ____________________
PRESSURE ____________________
PRECIP ____________________
WIND ____________________

Sturgeon Bay Field Data Collection Form

DATE: 21-Jun-02
COLLECTED BY: Hunter / Mike
WEATHER (sunny, overcast, partly cloudy, etc.) Mostly Cloudy
WIND (direction, est. speed) (West-Northwest)

LOCATION Long.	Lat	TIME	SECCHI DISK down/up (feet)	WATER DEPTH (feet)	SUBSTRATE TYPE (circle one)				TEMP. (fahrenheit)	SAMPLE DEPTH (feet)	NITRATE (mg/l)	PHOSPHATE (mg/l)	OTHER Alkalinity	OTHER pH	MAJOR PLANT SPECIES	GENERAL NOTES & COMMENTS (significant fish, noteworthy items)
N 44 49.53'	w 087 22.39'	8:00	L/W	9'-2"	muck	silt	sand	gravel	64/64	1'	0	3	120	8.5	Elodea	Mooring - SBYH
			6'-4"													
N 44 49.52'	W 087 22.29'	8:15	V/B	12'-3"	muck	silt	sand	gravel	64/64	1'	0	2	80	8.5	Elodea, Curly Leaf	Mooring - SBYH, in front of Quarterdeck Marina
N 44 49.47'	W 087 22.19'	8:30	L/W	9'-5"	muck	silt	sand	gravel	64/64	1'	0	0	80	9	Curly Leaf, Elodea	Mooring - SBYH, in front of Purves Lagoon
			8'-1"													
N 44 49.34'	W 087 21.95'	8:50	L/W	10'-4"	muck	silt	sand	gravel	66/65	1'	0	4	80	9	Curly Leaf, Elodea	Halfway between Ashers and Channel
			9'-1"													
N 44 49.26'	W 087 21.84'	9:05	L/W	7'-0"	muck	silt	sand	gravel	66/66	1'	0	4	80	9	Elodea, Curly Leaf, E.M.	Floating docks, down from Asher's
			6'-4"													
N 44 49.38'	W 087 21.62'	9:55	L/W	10'3"	muck	silt	sand	gravel	66/65	1'	0	4	120	9	Curly Leaf	Halfway between Peterson's and canal
			8'-6"													
N 44 49.45'	W 087 21.88'	10:16	12'-6", 11'-6"	20'-8"	muck	silt	sand	gravel	63/62	1'	0	2	120	9	None	Right by Red Can, corner to Utopia Circle
			/		muck	silt	sand	gravel								

WEATHER STATION (NORTHERN TO COMPLETE)
TEMP ____________________
PRESSURE ____________________
PRECIP ____________________
WIND ____________________

STURGEON BAY FIELD DATA COLLECTION FORM

DATE: 24-Jun-02
COLLECTED BY: Hunter Propson / Dylan Watkins
WEATHER (sunny, overcast, partly cloudy, etc.) Sunny, but hazy
WIND (direction, est. speed) ____________________

LOCATION long.	lat.	TIME	SECCHI DISK down/up (feet)	WATER DEPTH (feet)	SUBSTRATE TYPE (circle one)				TEMP. (fahrenheit)	SAMPLE DEPTH (feet)	NITRATE (mg/l)	PHOSPHATE (mg/l)	OTHER		MAJOR PLANT SPECIES	GENERAL NOTES & COMMENTS (significant fish, noteworthy items)
													Alkalinity	pH		
N 44 49.24'	W 087 20.79'	8:05	2'-5", 2'-3"	2'-5"	muck	silt	sand	gravel	75/75	1'	0	5	240	9	Buttercup	Day after heavy rain, hazy, no stirred water
N 44 49.35'	W 087 20.80'	8:14	V/B	2'-3"	muck	silt	sand	gravel	75/75	1'	0	4	180	9	None	Day after havy rain, hazy
N 44 49.27'	W 087 20.97'	8:20	V/B	3'-3"	muck	silt	sand	gravel	72/72	1'	0	3	120	9	None	Day after heavy rain, hazy
N 44 49.11'	W 087 20.80'	8:36	4'4", 4'-0"		muck	silt	sand	gravel	72/72	1'	0	5	80	9	Curly Leaf	Same as above
N 44 49.02'	W 087 20.81'	8:50	10'-5", 10'-0"	18'-05"	muck	silt	sand	gravel	66/64	1'	0	5	120	9	None	Murky water next to clear water, canal water never murky but today
																Current flowing towards lake
N 44 48.80'	W 087 20.90'	9:08	V/B		muck	silt	sand	gravel	72/72	1'	0	4	120	9	Indeter	Rust colored water
N 44 49.18'	W 087 21.36'	9:38	10', 10'-6"	15'-0"	muck	silt	sand	gravel	63/62	1'	0	4	80	9	None	Murky Water
N 44 49.70'	W 087 22.69'	10:05	12', 11'	26'-0"	muck	silt	sand	gravel	66/65	1'	0.5	15	120	8	None	CG cutter went through, clear weather
N 44 49.72'	W 087 22.25'	10:29	Lost in weeds @ 6'	6'-10"	muck	silt	sand	gravel	68/68	1'	0	5	120	9	Hedia (10" tall)	Clear looking water
N 44 49.35'	w 087 20.74'	1:20	V/B	2'-6"	muck	silt	sand	gravel	80	1'	1	10	200	9	Grassy unknown weeds	Murky brown water, Big Creek mouth
N 44 48.97'	W 087 20.70'	1:41	L/W	7'-6"	muck	silt	sand	gravel	68/68	1'	0	4	100	9	Curly Leaf, Elodea	Edge of channel, big navigational marker
			5'-10"													
N 44 48.77'	W 087 20.41'	2:01	11'-0", 10'1"	18'-1"	muck	silt	sand	gravel	69/68	1'	0	4	120	8.5	None	By Red Marker, near canal
N 44 49.87	W 087 23.10'	2:52	N/A	N/A	muck	silt	sand	gravel	72	1'	2	15	240	7	Algae	Storm dDrain, edge of bridge port, tests right from drain
N 44 49,89'	W 087 23.20'	3:04	N/A	N/A	muck	silt	sand	gravel	70	1'	2	30	240	7	Algae	Storm drain, edge of Bridgeport, tests right from drain
N 44 49.86	W 087 23.31'	3:15	/		muck	silt	sand	gravel	61	1'	0	15	180	7		Storm Drain by Beach (Otumba)
N 44 49.56'	W 087 22.67'	3:50	V/B	1'-6"	muck	silt	sand	gravel	70	1'	0	5	80	7		SBYH Dock - Near Roen Salvage, water stirred & brown
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								

WEATHER STATION (NORTHERN TO COMPLETE)

TEMP ____________________
PRESSURE ____________________
PRECIP ____________________
WIND ____________________

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:	25-Jun-02
COLLECTED BY:	Hunter / Matt
WEATHER (sunny, overcast, partly cloudy, etc.)	Partly Cloudy
WIND (direction, est. speed)	South-Southwest

LOCATION Long.	**Lat.**	**TIME**	**SECCHI DISK down/up (feet)**	**WATER DEPTH (feet)**	**SUBSTRATE TYPE (circle one)**				**TEMP. (fahrenheit)**	**SAMPLE DEPTH (feet)**	**NITRATE (mg/l)**	**PHOSPHATE (mg/l)**	**OTHER**		**MAJOR PLANT SPECIES**	**GENERAL NOTES & COMMENTS (significant fish, noteworthy items)**
													Alkalinity	**pH**		
N 44 50.79'	W 087 23.58'	8:24	14'-4", 13'-7"	21'-8"	muck	silt	sand	gravel	64/63	1'	0	3	120	8.5	None	By Navigational can
N 44 51.57'	W 087 24.23'	8:50	17'-6", 16'-9"	34'-7"	muck	silt	sand	gravel	64/62	1'	0	5	120	8.5	None	Off Potawotomi Park land marker
N 44 51.46'	W 087 24.26'	9:05	/		muck	silt	sand	gravel	51	1'	0	15	240	7.5	None	Spring or well off Potawatomi Park
N 44 51.38'	W 087 24.23'	9:20	V/O	2'-0"	muck	silt	sand	gravel	68	1'	0	15	110	8.5	Milfoil, Rock algae	Near shoreline of Pot Park
N 44 51.45'	W 087 23.59'	9:37	V/B	8'-2"	muck	silt	sand	gravel	70/70	1'	0	5	100	8.5	None	The Flats
N 44 51.03'	W 087 22.98'	10:04	V/B	6'-0"	<u>muck</u>	silt	sand	gravel	76/72	1'	0.5	10	120	9	Curly Leaf, Algae	Wama Lama

WEATHER STATION
(NORTHERN TO COMPLETE)

TEMP ____________________
PRESSURE ____________________
PRECIP ____________________
WIND ____________________

STURGEON BAY FIELD DATA COLLECTION FORM

DATE: 1-Jul-02
COLLECTED BY: Jason / Matt
WEATHER (sunny, overcast, partly cloudy, etc.) Sunny / Hot
WIND (direction, est. speed) ____________________

LOCATION Long.	Lat.	TIME	SECCHI DISK down/up (feet)	WATER DEPTH (feet)	SUBSTRATE TYPE (circle one)				TEMP. (fahrenheit)	SAMPLE DEPTH (feet)	NITRATE (mg/l)	PHOSPHATE (mg/l)	OTHER Alkalinity	pH	MAJOR PLANT SPECIES	GENERAL NOTES & COMMENTS (significant fish, noteworthy items)
N 44°49.34	W 87°22.23	1:01 PM	4.5 ft	6.7 ft	muck	silt	sand	gravel	80°	1 ft.	0	5	160	9	Milfoil	99° (humid and clear)
			4 ft													
N 44°49.41	W 87°22.23	1:15	V/B	3.1 ft	**muck**	silt	sand	gravel	80°	1 ft.	0	22.5	160	8.5	None	
									80°							
N 44°49.88	W 87°23.02	1:38	V/B	7.8 ft	muck	silt	sand	gravel	80°	1 ft.	0	2.5	120	9	Elodea	Very Hot!
									78°							
N 44°49.91	W 87°23.32	1:55	V/B	6.3 ft	**muck**	silt	sand	gravel	78°	1 ft.	0	5	120	9	Indeterminate	
									78°							
N 44°50.54	None	2:23	10.5 ft	18 ft	muck	silt	sand	gravel	76°	1 ft.	0	22.5	110	9	Elodea	
			10 ft						76°						Curley Leaf	
N 44°49.85	W 87°22.99	2:40	3 ft	4.5 ft	**muck**	silt	sand	gravel	80°	1 ft.	0	22.5	120	9	None	Fire boat left port
									76°							
N 44°49.17	W 87°21.44	4:07	V/B	6.7 ft	**muck**	silt	sand	gravel	84°	1 ft.	0	15	80	>9	Elodea	Big wake from a boat
									82°						Milfoil	
N 44°49.33	W 87°20.77	5:30	V/B	2.5 ft	**muck**	silt	sand	gravel	90°	1 ft.	0	5	120	>9	None	East wind
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								

WEATHER STATION (NORTHERN TO COMPLETE)
TEMP ____________________
PRESSURE ____________________
PRECIP ____________________
WIND ____________________

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:	3-Jul-02
COLLECTED BY:	Tanner / Rick / Tony
WEATHER (sunny, overcast, partly cloudy, etc.)	Sunny / Hot (90 Plus)
WIND (direction, est. speed)	NW light 5 mph

LOCATION Long.	Lat.	TIME	SECCHI DISK down/up (feet)	WATER DEPTH (feet)	SUBSTRATE TYPE (circle one)				TEMP. (fahrenheit)	SAMPLE DEPTH (feet)	NITRATE (mg/l)	PHOSPHATE (mg/l)	OTHER Alkalinity	OTHER pH	MAJOR PLANT SPECIES	GENERAL NOTES & COMMENTS (significant fish, noteworthy items)
N 44°49.087	W 87°21.339	2:44 PM	V/B	4 ft	muck	**silt**	sand	gravel	80.3°	1 ft.	0	5	120	9	Elodea, Curly Leaf	
									80°						Some Coontail	
N 44°49.119	W 87°21.256	3:02	8 ft	11 ft	muck	**silt**	sand	gravel	78.5°	1 ft.	0	10			Elodea	Wind switch to the East
			8 ft												Some Curley Leaf	
					muck	silt	sand	gravel								
					muck	silt	sand	gravel								
					muck	silt	sand	gravel								
					muck	silt	sand	gravel								
					muck	silt	sand	gravel								
					muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								

WEATHER STATION
(NORTHERN TO COMPLETE)

TEMP ____________________
PRESSURE ____________________
PRECIP ____________________
WIND ____________________

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:	5-Jul-02
COLLECTED BY:	Matt Brown / Tanner Pinney
WEATHER (sunny, overcast, partly cloudy, etc.)	Sunny
WIND (direction, est. speed)	North wind at 5-10 mph

LOCATION Long.	Lat.	TIME	SECCHI DISK down/up (feet)	WATER DEPTH (feet)	SUBSTRATE TYPE (circle one)				TEMP. (fahrenheit)	SAMPLE DEPTH (feet)	NITRATE (mg/l)	PHOSPHATE (mg/l)	OTHER Alkalinity	pH	MAJOR PLANT SPECIES	GENERAL NOTES & COMMENTS (significant fish, noteworthy items)
N 44°47.58	W087°18.76	6:15 AM	5 ft.	16 ft. 6 in.	muck	silt	sand	gravel	80°	1 ft.	0	2.5	150	8.5	NONE	Far East of channel
			5 ft.						76°							Notable West to East current
N 44°47.47	W087°18.75	6:32 AM	V/B	10 ft. 6 in.	muck	silt	**sand**	gravel	58°	1 ft.	0	5	80	8.5	NONE	Lake Michigan around break wall
									56°							
N 44°47.85	W087°19.00	6:46 AM	5 ft. 6 in.	22 ft.	muck	silt	sand	gravel	81°	1 ft.	0	5			NONE	Mid channnel
			5 ft. 6 in.						74°							
N 44°48.68	W087°20.18	7:25 AM	V/B	1 ft. 6 in.	muck	silt	**sand**	gravel	80°	1 ft.	0	5			NONE	New construction; no black cloth for erosion control
N 44°52.24	W087°23.82	8:54 AM	V/B	13 ft.	muck	silt	sand	gravel	78°	1 ft.	0	5			NONE	Flats
									74°							Wind switched to the NE at 10-15 mph
N 44°53.95	W087°24.23	9:21 AM	15 ft.	28 ft.	muck	silt	sand	gravel	77°	1 ft.	0	5	150	8	NONE	North Green Bay mouth
			15 ft.						72°							
N 44°53.98	W087°24.79	9:36 AM	15 ft.	52 ft.	muck	silt	sand	gravel	77°	1 ft.	0	5			NONE	Middle Green Bay mouth
			15 ft.						62°							
N 44°53.61	W087°25.97	10:04 AM	15 ft.	40 ft.	muck	silt	sand	gravel	60°	1 ft.	0	5	120	8	NONE	South Green Bay mouth near the light house
			15 ft.						56°							
N 44°53.09	W087°25.13	10:20 AM	9 ft.	19 ft.	muck	silt	sand	gravel	78°	1 ft.	0	5			NONE	West of Sawyer Harbor mouth
			9 ft.						66°							
N 44°53.10	W087°25.66	10:36 AM	4 ft. 6 in.	6 ft. 6 in.	muck	**silt**	sand	gravel	79°	1 ft.	0	10			Wild Celery / Coontail	Inside Sawyer Harbor
			4 ft. 6in.						79°							

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:	5-Jul-02
COLLECTED BY:	Matt Brown / Tanner Pinney
WEATHER (sunny, overcast, partly cloudy, etc.)	Sunny
WIND (direction, est. speed)	North wind at 5-10 mph

LOCATION Long.	Lat.	TIME	SECCHI DISK down/up (feet)	WATER DEPTH (feet)	SUBSTRATE TYPE (circle one)				TEMP. (fahrenheit)	SAMPLE DEPTH (feet)	NITRATE (mg/l)	PHOSPHATE (mg/l)	OTHER Alkalinity	pH	MAJOR PLANT SPECIES	GENERAL NOTES & COMMENTS (significant fish, noteworthy items)
N 44°52.85	W087°26.36	10:53 AM	V/B	2 ft. 6 in.	**muck**	silt	sand	gravel	78°	1 ft.	0	5	180	9	Lilly Pads / Buttercup	Idewild Creek mouth
									78°						Curly Leaf Pond / Wild Celery	Water was cloudy
N 44°52.75	W087°25.71	11:15 AM	V/B	2 ft.	muck	silt	sand	**gravel**	80°	1 ft.	0	5			Curly Leaf Pond	Inside Sawyer Harbor
															Wild Celery	Water was considerably clearer than above
N 44°52.66	W087°25.27	11:32 AM	10 ft.	15 ft.	muck	silt	sand	gravel	78°	1 ft.	0	5			NONE	East Sawyer Harbor mouth
			10 ft.						69°							Water noticalby clearer in comparision to Idewild Creek
N 44°49.87	W087°23.03	12:30 PM	5 ft.	8 ft.	muck	**silt**	sand	gravel	80°	1 ft.	0	10	120	9	Recently sprayed marina	Inside Harbor Club Marina
			5 ft.						78°							
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								

WEATHER STATION (NORTHERN TO COMPLETE)	**TEMP** ________
	PRESSURE ________
	PRECIP ________
	WIND ________

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:

COLLECTED BY:

WEATHER (sunny, overcast, partly cloudy, etc.)

WIND (direction, est. speed)

LOCATION Long.	Lat.	TIME	SECCHI DISK down/up (feet)	WATER DEPTH (feet)	SUBSTRATE TYPE (circle one)				TEMP. (fahrenheit)	SAMPLE DEPTH (feet)	NITRATE (mg/l)	PHOSPHATE (mg/l)	OTHER Alkalinity	OTHER pH	MAJOR PLANT SPECIES
N 44°48.521	W 87°20.192	1:30 PM	V/B	2.5 ft	muck	silt	sand	gravel	72.7°	1 ft	0	10	120	9	Buttercup ?
N 44°47.566	W 87°18.745	1:53	V/B	7.7 ft	muck	silt	**sand**	gravel	65.9°	1 ft	0	10	100	7.5	None
N 44°47.915	W 87°19.184	2:09	V/B	21 ft	muck	silt	sand	gravel	66.2°	1 ft	0	10			None
N 44°48.431	W 87°21.006	2:25	Lost in Weeds	4 ft	**muck**	silt	sand	gravel	73.2°	1 ft	0	10			Elodea, Some Eurasian Milfoil
N 44°49.168	W 87°21.435	2:35	5.5 ft	7 ft	**muck**	silt	sand	gravel	72.8°	1 ft	0	10			None
			5.5 ft												
N 44°49.549	W 87°22.362	2:48	5 ft	9.5 ft	**muck**	silt	sand	gravel	72.8°	1 ft	0	10	120	9	None
			5 ft												
			/		muck	silt	sand	gravel							
			/		muck	silt	sand	gravel							
			/		muck	silt	sand	gravel							
			/		muck	silt	sand	gravel							

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:
COLLECTED BY:
WEATHER (sunny, overcast, partly cloudy, etc.)
WIND (direction, est. speed)

LOCATION		TIME	SECCHI DISK down/up (feet)	WATER DEPTH (feet)	SUBSTRATE TYPE (circle one)				TEMP. (fahrenheit)	SAMPLE DEPTH (feet)	NITRATE (mg/l)	PHOSPHATE (mg/l)	OTHER		MAJOR PLANT SPECIES
Long.	Lat.												Alkalinity	pH	
			/		muck	silt	sand	gravel							
			/		muck	silt	sand	gravel							
			/		muck	silt	sand	gravel							
			/		muck	silt	sand	gravel							
			/		muck	silt	sand	gravel							
			/		muck	silt	sand	gravel							

WEATHER STATION
(NORTHERN TO COMPLETE)
TEMP
PRESSURE
PRECIP
WIND

24-Jul-02
Hunter / Tanner
Sunny
East approx. 10 mph
GENERAL NOTES & COMMENTS
(significant fish, noteworthy items)
Mouth of Strawberry Creek
Far East channel (lake mouth)
Mid channel (between bay and lake)
Water is exceptionally clear!
East Tacoma Beach
Braumeisters house (near Bayview Bridge)
Mooring area by SBYH

24-Jul-02
Hunter / Tanner
Sunny
East approx. 10 mph

GENERAL NOTES & COMMENTS (significant fish, noteworthy items)

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:	25-Jul-02
COLLECTED BY:	Hunter / Tanner
WEATHER (sunny, overcast, partly cloudy, etc.)	Overcast
WIND (direction, est. speed)	S SE approx. 10-15 mph

LOCATION Long.	Lat.	TIME	SECCHI DISK down/up (feet)	WATER DEPTH (feet)	SUBSTRATE TYPE (circle one)				TEMP. (fahrenheit)	SAMPLE DEPTH (feet)	NITRATE (mg/l)	PHOSPHATE (mg/l)	OTHER Alkalinity	OTHER pH	MAJOR PLANT SPECIES	GENERAL NOTES & COMMENTS (significant fish, noteworthy items)
N 44°49.516	W 87°21.726	9:00 AM	V/B	7 ft	muck	**silt**	sand	gravel	68.6°	1 ft	0.5	5			Elodea, Some Coontail	East Memorial Drive
N 44°49.722	W 87°22.298	9:15	4 ft	5ft	muck	**silt**	sand	gravel	68.7°	1 ft	0	5	150	8.5	None	West Memorial Drive
N 44°49.902	W 87°22.750	9:25	8.5 ft	22 ft	muck	silt	sand	gravel	68.7°	1 ft	0	5			None	In front of Palmer Johnson's
			8.5 ft													
N 44°49.532	W 87°22.467	10:13	7 ft	9 ft	muck	**silt**	sand	gravel	68.2°	1 ft	0.5	10			None	Mooring area in front of SBYH
			7 ft													
N 44°49.931	W 87°23.166	11:21	Lost in Weeds	12 ft	muck	silt	sand	gravel	68.3°	1 ft	0	5			Elodea on bottom	East of Dunlap's Reef
			at 8 ft													
N 44°51.726	W 87°24.393	11:46	13 ft	33 ft	muck	silt	sand	gravel	66°	1 ft	0	3				Green channel marker #27 on South side of bay
			13 ft													
N 44°51.458	W 87°24.240	11:57	12.5 ft	18 ft	muck	silt	sand	gravel	67.6°	1 ft	0	5	150	8		Hills Point
			12.5 ft													
N 44°49.698	W 87°22.726	12:21 PM	8 ft	14 ft	muck	silt	sand	gravel	67.4°	1 ft	0	5				In front of DNR building
			8 ft													
N 44°49.650	W 87°22.091	12:32	V/B	5 ft	muck	silt	sand	gravel	68.7°	1 ft	0	5				
			/		muck	silt	sand	gravel								

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:	25-Jul-02
COLLECTED BY:	Hunter / Tanner
WEATHER (sunny, overcast, partly cloudy, etc.)	Overcast
WIND (direction, est. speed)	S SE approx. 10-15 mph

LOCATION Long.	**Lat.**	**TIME**	**SECCHI DISK down/up (feet)**	**WATER DEPTH (feet)**	**SUBSTRATE TYPE (circle one)**				**TEMP. (fahrenheit)**	**SAMPLE DEPTH (feet)**	**NITRATE (mg/l)**	**PHOSPHATE (mg/l)**	**OTHER**		**MAJOR PLANT SPECIES**	**GENERAL NOTES & COMMENTS (significant fish, noteworthy items)**
													Alkalinity	**pH**		
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								

WEATHER STATION (NORTHERN TO COMPLETE)	**TEMP**	____________
	PRESSURE	____________
	PRECIP	____________
	WIND	____________

STURGEON BAY FIELD DATA COLLECTION FORM

DATE: 26-Jul-02
COLLECTED BY: Matt / Hunter
WEATHER (sunny, overcast, partly cloudy, etc.) Sunny
WIND (direction, est. speed) S SW at 3-5 mph

LOCATION Long.	Lat.	TIME	SECCHI DISK down/up (feet)	WATER DEPTH (feet)	SUBSTRATE TYPE (circle one)				TEMP. (fahrenheit)	SAMPLE DEPTH (feet)	NITRATE (mg/l)	PHOSPHATE (mg/l)	OTHER Alkalinity	pH	MAJOR PLANT SPECIES	GENERAL NOTES & COMMENTS (significant fish, noteworthy items)
N 44°49.688	W 87°22.212	8:28 AM	5 ft	5.5 ft	**muck**	silt	sand	gravel	66.9°	1 ft	0	5	100	9	Elodea	Memorial Drive
			5 ft													Clear skies; day after rain
N 44°49.334	W 87°21.979	8:44	V/B	3 ft	**muck**	silt	sand	gravel	66.9°	1 ft	0	10				Asher's house near Pervis Lagoon
N 44°49.036	W 87°21.155	8:52	V/B	5 ft	**muck**	silt	sand	gravel	66.0°	1 ft	0	10		9	Indeterminate	Tacoma Beach Rd.
N 44°49.188	W 87°20.837	8:58	V/B	2.5 ft	**muck**	silt	sand	gravel	68.0°	1 ft	0	10	160		Elodea, Wild Celery	Big Creek
N 44°47.596	W 87°18.752	9:21	10 ft	20.5 ft	muck	silt	sand	gravel	64.6°	1 ft	0	10				Channel between break walls
			10 ft													
N 44°48.674	W 87°20.201	9:46	Lost in weeds	4.5 ft	muck	silt	sand	gravel	67.3°	1 ft	0.5	5	120	8.5	Elodea	Cove Road
			at 3.5 ft													
N 44°49.907	W 87°23.322	10:23	V/B	7.5 ft	muck	silt	sand	gravel	67.1°	1 ft	0.5	15			Eurasian Milfoil	Otumba Beach
N 44°52.990	W 87°26.004	10:55	V/B	5 ft	muck	silt	sand	gravel	73.1°	1 ft	0.5	10	120	9	Eurasian Milfoil, Buttercup, Wild Celery	Sawyer Harbor
																Unidentified plant species
N 44°53.974	W 87°24.636	11:14	14.5 ft	46.5 ft	muck	silt	sand	gravel	70.1°	1 ft	0	15				Quarter mile off Murphy Park
			14 ft													
N 44°49.777	W 87°22.477	11:43	9.5 ft	16 ft	muck	silt	sand	gravel	67.1°	1 ft	0.5	20	150	8		Near Ryerson towards Memorial Drive
			9 ft													
N 44°49.445	W 87°22.201	11:55	V/B	8.5 ft	muck	silt	sand	gravel	67.9°	1 ft	0.5	5				Channel to Purvis Lagoon
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								

WEATHER STATION (NORTHERN TO COMPLETE)
TEMP ____________________
PRESSURE ____________________
PRECIP ____________________
WIND ____________________

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:	29-Jul-02
COLLECTED BY:	Hunter / Tanner
WEATHER (sunny, overcast, partly cloudy, etc.)	Overcast (sprinkling) rained during the night
WIND (direction, est. speed)	W SW <5 mph

LOCATION Long.	**Lat.**	**TIME**	**SECCHI DISK down/up (feet)**	**WATER DEPTH (feet)**	**SUBSTRATE TYPE (circle one)**				**TEMP. (fahrenheit)**	**SAMPLE DEPTH (feet)**	**NITRATE (mg/l)**	**PHOSPHATE (mg/l)**	**OTHER**		**MAJOR PLANT SPECIES**	**GENERAL NOTES & COMMENTS (significant fish, noteworthy items)**
													Alkalinity	**pH**		
N 44°49.942	W 87°23.090	8:57 AM	9 ft	12.5 ft	muck	silt	sand	gravel	71.7°	1 ft	0	3				North of Otumba
			9 ft													
N 44°50.134	W 87°23.529	9:10	9 ft	16.0 ft	muck	silt	sand	gravel	72.3°	1 ft	0	3			Elodea	South of Dunlap's Reef
			9 ft													
N 44°50.722	W 87°23.884	9:34	V/B	5.5 ft	muck	silt	sand	**gravel**	72.7°	1 ft	0	3			Eurasian Milfoil	In front of Blake Peterson's house
N 44°51.096	W 87°24.094	9:45	V/B	7.5 ft	**muck**	silt	sand	gravel	73.1°	1 ft	0	3	140	8.5	Possible algae bloom?	East end of Pot Park
N 44°52.827	W 87°26.350	10:26	1.5 ft	2.0 ft	muck	**silt**	sand	gravel	78.7°	1 ft	0	3	120	9	Water Celery	Mouth of Idewild Creek
			1.5 ft													Very murky water
N 44°52.690	W 87°23.007	11:00	V/B	5.5 ft	muck	silt	sand	**gravel**	74.6°	1 ft	0	3				The Flats
																Note: GPS coor. not as far North as previous?
N 44°51.619	W 87°23.404	11:16	V/B	7.5 ft	muck	silt	**sand**	gravel	73.5°	1 ft	0	10				The Flats (East end)
																Note: GPS coor. farther West than previous?
N 44°48.511	W 87°20.200	1:22	V/B	1.5 ft	muck	**silt**	sand	gravel	75.0°	1 ft	0	20	200	9	Curley Leaf, Buttercup (?)	Sunny
N 44°49.493	W 87°20.853	1:41	V/B	1.5 ft	muck	**silt**	sand	gravel	77.8°	1 ft	2	20	(solid) 240	9	Buttercup (?), Milfoil, Curley Leaf	Up the the mouth of Big Creek
N 44°50.114	W 87°23.219	2:20	V/B	2.5 ft	muck	silt	sand	**gravel**	73.7°	1 ft	0	10			Elodea	Just East of Dunlap's Reef
N 44°49.924	W 87°23.316	2:32	V/B	7.0 ft	muck	silt	**sand**	gravel	73.9°	1 ft	0	3				In front of Otumba
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								

WEATHER STATION (NORTHERN TO COMPLET

TEMP	____________
PRESSURE	____________
PRECIP	____________
WIND	____________

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:	30-Jul-02
COLLECTED BY:	Matt / Hunter
WEATHER (sunny, overcast, partly cloudy, etc.)	Sunny
WIND (direction, est. speed)	SW at 5 mph

LOCATION Long.	Lat.	TIME	SECCHI DISK down/up (feet)	WATER DEPTH (feet)	SUBSTRATE TYPE (circle one)				TEMP. (fahrenheit)	SAMPLE DEPTH (feet)	NITRATE (mg/l)	PHOSPHATE (mg/l)	OTHER Alkalinity	OTHER pH	MAJOR PLANT SPECIES	GENERAL NOTES & COMMENTS (significant fish, noteworthy items)
N 44°49.620	W 87°22.375	8:12 AM	10.5 ft	22.0 ft	muck	silt	sand	gravel	73.3°	1 ft	0	15	110	9	None	Channel in front of SBYH
			10.5 ft													Clear and hot!
N 44°49.604	W 87°22.356	8:20	9 ft	21.0 ft	muck	silt	sand	gravel	73.4°	1 ft	0	10			None	Channel in front of SBYH mooring
			9 ft													Clouded with sediment or algae (green in color)
N 44°49.667	W 87°22.483	8:39	10 ft	24.0 ft	muck	silt	sand	gravel	73.5°	1 ft	0	15	120	9	None	Middle of channel in front of A dock at Yacht Harbor
			10 ft													Clouded with sediment or algae (green in color)
N 44°49.530	W 87°22.408	8:57	8 ft	8.5 ft	muck	**silt**	sand	gravel	73.4°	1 ft	0	5			Coontail	SBYH mooring
			8 ft													Clouded with sediment or algae (green in color)
N 44°52.811	W 87°24.251	9:24	13.5 ft	32.0 ft	muck	silt	sand	gravel	75.3°	1 ft	0	15	80	9	None	Middle of bay between Sawter Harbor and Radio Towers
			13 ft													Clouded with sediment or algae (green in color)
N 44°53.582	W 87°24.847	9:43	11 ft	41.0 ft	muck	silt	sand	gravel	75.2°	1 ft	0	15	100	9	None	Bell nav. marker off Cabots Point
			10.5 ft													Clouded with sediment or algae (green in color)
N 44°51..569	W 87°24.268	9:57	12 ft	32.0 ft	muck	silt	sand	gravel	75.8°	1 ft	0	15	120	9	Algae bloom ?	Nav. marker #27 near Hills Point
			11.5 ft													Clouded with sediment or algae (green in color)
N 44°49.659	W 87°22.333	10:32	9.5 ft	11.0 ft	muck	silt	sand	gravel	74.2°	1 ft	0	15			None	Memorial Drive
			8.5 ft													Clouded with sediment or algae (green in color)
N 44°49..545	W 87°22.155	10:37	8.5 ft	23.0 ft	muck	silt	sand	gravel	74.1°	1 ft	0	20			None	Channel in front of Purvis Lagoon entrance
			8 ft													Clouded with sediment or algae (green in color)

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:	30-Jul-02
COLLECTED BY:	Matt / Hunter
WEATHER (sunny, overcast, partly cloudy, etc.)	Sunny
WIND (direction, est. speed)	SW at 5 mph

LOCATION Long.	Lat.	TIME	SECCHI DISK down/up (feet)	WATER DEPTH (feet)	SUBSTRATE TYPE (circle one)				TEMP. (fahrenheit)	SAMPLE DEPTH (feet)	NITRATE (mg/l)	PHOSPHATE (mg/l)	OTHER Alkalinity	pH	MAJOR PLANT SPECIES	GENERAL NOTES & COMMENTS (significant fish, noteworthy items)
N 44°49.431	W 87°21.952	10:43	8.5 ft	16.5 ft	muck	silt	sand	gravel	74.1°	1 ft	0	15			None	Channel in front of Asher's
			8 ft													Clouded with sediment or algae (green in color)
N 44°49.280	W 87°21.584	10:48	7.5 ft	19.0 ft	muck	silt	sand	gravel	73.7°	1 ft	0	20			None	Channel in front of Leathem Smith
			7 ft													Clouded with sediment or algae (green in color)
N 44°49.942	W 87°23.271	1:56 PM	13 ft	15 ft	muck	silt	sand	gravel	76.6°	1 ft	0	20			Elodea	Near Otumba Beach
			12.5 ft													
N 44°50.316	W 87°23.535	2:09	11 ft	17 ft	muck	silt	sand	gravel	75.5°	1 ft	0	20			Indeterminate	North of Duluth Ave.
			10.5 ft													
N 44°48.959	W 87°20.704	2:46	7 ft	16.5 ft	<u>**muck**</u>	silt	sand	gravel	75.0°	1 ft	0	20	120	9	Indeterminate	Nav. marker #12
			7 ft													
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								

WEATHER STATION (NORTHERN TO COMPLETE)	**TEMP** ____________
	PRESSURE ____________
	PRECIP ____________
	WIND ____________

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:	8/1/2002
COLLECTED BY:	Jason / Tanner
WEATHER (sunny, overcast, partly cloudy, etc.)	Partly cloudy / overcast
WIND (direction, est. speed)	SE 10mph

LOCATION Lat	**dep**	**TIME**	**SECCHI DISK down/up (feet)**	**WATER DEPTH (feet)**	**SUBSTRATE TYPE (circle one)**				**TEMP. (fahrenheit)**	**SAMPLE DEPTH (feet)**	**NITRATE (mg/l)**	**PHOSPHATE (mg/l)**	**OTHER Alkalinity**	**pH**	**MAJOR PLANT SPECIES**	**GENERAL NOTES & COMMENTS (significant fish, noteworthy items)**
N 44° 50.791	W 87° 23.274	1:30pm	V/B	4.5 ft	muck	silt	**sand**	gravel	76.3°	1.0 ft	0	5			Celery Cody	In front of
																Sunset beach
N 44° 51.442	W 87° 23.210	1:45pm	V/B	5.8 ft	muck	silt	**sand**	gravel	76.0°	1.0 ft	0	5				E part of
																flats
N 44°50.434	W 87° 23.072	2:03 PM	10.0 ft / 10.0 ft	22.5ft	muck	silt	sand	gravel	75.9°	1.0 ft	0	3				In front of
																Bay Ship
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								

WEATHER STATION		
(NORTHERN TO COMPL	**TEMP**	____________________
	PRESSURE	____________________
	PRECIP	____________________
	WIND	____________________

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:	5-Aug-02
COLLECTED BY:	Tanner / Hunter / Matt
WEATHER (sunny, overcast, partly cloudy, etc.)	Hazy
WIND (direction, est. speed)	N NE 10MPH

LOCATION Lat	dep	TIME	SECCHI DISK down/up (feet)	WATER DEPTH (feet)	SUBSTRATE TYPE (circle one)				TEMP. (fahrenhei	SAMPLE DEPTH (feet)	NITRATE (mg/l)	HOSPHAT (mg/l)	OTHER Alkalinity	pH	MAJOR PLANT SPECIES	GENERAL NOTES & COMMENTS (significant fish, noteworthy items)
N 44° 49.548	W 87° 22.505	1:38 PM	6.0 ft / 6.0 ft	8.0 ft	muck	silt	sand	gravel	74.0°	1.0 ft	0	5	120	8.5		In front of
																SBYC
N 44° 49.713	W 87° 22.382	1:45 PM	L/W @	7.5 ft	muck	**silt**	sand	gravel	73.6°	1.0 ft	0	10			Elodea	W Memorial
			6ft													Drive
N 44° 49.700	W 87° 22.260	2:00 PM	7.0 ft / 7.0 ft	12.0 ft	muck	**silt**	sand	gravel	73.4°	1.0 ft	0	10				Memorial E
																of Starr's
N 44° 52.709	W 87° 23.879	9:08 AM	8.5 ft / 8.5 ft	16.0 ft	muck	silt	sand	gravel	73.7°	1.0 ft	0	10				Mild flats
N 44° 53.081	W 87°26.136	9:42 AM	V/B	3.5 ft	**muck**	silt	sand	gravel	77.3°	1.0 ft	0	10			Water Celery	Sawyer
															Buttercup?	Harbor
N 44° 49.661	W 87° 22.233	10:08 AM	V/B	7.5 ft	muck	**silt**	sand	gravel	72.1°	1.0 ft	0	12			Coontail	Memorial Dr
																Wind change W 10 MPH
N 44° 49.326	W 87° 20.792	10:48 AM	V/B	1.5 ft	muck	**silt**	sand	gravel	77.3v	1.0 ft	0	5	180	8.5	Coontail	Big Creek Mouth
															Water Celery	Cloud change to heavy
N 44° 47.514	W 87° 18.449	11:24 AM	V/B	20 ft	muck	silt	sand	gravel	65.5°	1.0 ft	0	3				Lake Michigan (N of Channel)
																Wind change NE at 10 MPH
N 44° 47.480	W 87° 18.741	11:30 AM	V/B	9.0 ft	muck	silt	**sand**	gravel	68.5°	1.0 ft	0	5				Lake Mighigan
																S of Channel
N 44° 49.255	W 87° 22.031	12:02 PM	3.0 ft / 3.0 ft	5.5 ft	muck	**silt**	sand	gravel	75.1°	1.0 ft	0.5	10	180	8.5		Inside Purves Lagoon
N 44° 48.504	W 87° 20.204	12:23PM	V/B	1.5 ft	muck	**silt**	sand	gravel	75.7°	1.0 ft	0	10			Elodea	Mouth of Strawberry Creek
															Buttercup?	
N 44° 51.459	W 87° 24.246	1:18 PM	V/B	9.0 ft	muck	silt	sand	gravel	74.0°	1.0 ft	0	5				Off shore W Pot Park by rusty stones
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								

WEATHER STATION (NORTHERN TO COMPLE	
TEMP	
PRESSURE	
PRECIP	
WIND	

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:	6-Aug-02
COLLECTED BY:	Matt / Hunter
WEATHER (sunny, overcast, partly cloudy, etc.)	Cool, mid 60's
WIND (direction, est. speed)	N NW 5-10 MPH

LOCATION Lat	dep	TIME	SECCHI DISK down/up (feet)	WATER DEPTH (feet)	SUBSTRATE TYPE (circle one)				TEMP. (fahrenhei	SAMPLE DEPTH (feet)	NITRATE (mg/l)	PHOSPHATE (mg/l)	OTHER Alkalinity	pH	MAJOR PLANT SPECIES	GENERAL NOTES & COMMENTS (significant fish, noteworthy items)
N 44° 50.675	W 87° 23.351	8:15 AM	6.0 ft / 6.0 ft	20.2 ft	muck	silt	sand	gravel	72.1°	1.0 ft	0	5	150	9	None	
N 44° 50.496	W 87° 23.460	8:35 AM	9.0 ft / 9.0 ft	13.0 ft	muck	silt	sand	gravel	71.9°	1.0 ft	0	5			None	
N 44° 50.370	W 87° 23.631	8:53 AM	9.5ft / 8.5 ft	11.0 ft	muck	silt	sand	gravel	71.9°	1.0 ft	0	5			Ind	
N 44° 50.272	W 87° 23.133	9:02 AM	8.0 ft / 7.0 ft	25.5 ft	muck	silt	sand	gravel	72.3°	1.0 ft	0	5			None	
N 44° 50.051	W 87° 23.175	9:19 AM	8.5 ft / 8.0 ft	10.4 ft	muck	silt	sand	gravel	72.1°	1.0 ft	0	10			Elodea	
N 44° 49.919	W 87° 23.295	9:36 AM	V/B	4.1 ft	muck	silt	sand	gravel	72.5°	1.0 ft	0	10	120	9	Milfoil	
N 44° 49.872	W 87° 22.696	9:46 AM	7.5 ft / 7.0 ft	20.2 ft	muck	silt	sand	gravel	72.4°	1.0 ft	0	8			None	
N 44° 49.762	W 87° 22.746	9:58 AM	7.0 ft / 6.5 ft	20.2 ft	muck	silt	sand	gravel	72.6°	1.0 ft	0	3			None	
N 44° 49.739	W 87° 22.360	10:07	V/B	6.0 ft	muck	**silt**	sand	gravel	72.6°	1.0 ft	0	10			Milfoil, Coontail	
N 44° 49.711	W 87° 22.288	10:15 AM	V/B	5.1 ft	muck	**silt**	sand	gravel	72.3°	1.0 ft	0	10	120	9.0 ft	Coontail, Milfoil, and	
															Elodea	
N 44° 49.519	W 87° 21.783	10:48 AM	V/B	4.5 ft	muck	silt	sand	gravel	71.4°	1.0 ft	0	10			Wild Celery, Milfoil	Near Utopia Circle
N 44° 49.482	W 87° 21.893	11:04 AM	6.5 ft / 6.5 ft	11.5 ft	muck	silt	sand	gravel	72.7°	1.0 ft	0	7.5	120	9	None	Near Channel off # 6 Naviational Marker
N 44° 49.389	W 87° 22.002	11:25 AM	5.5 ft / 5.5 ft	8 ft	**muck**	silt	sand	gravel	72.7°	1.0 ft	0	10			Coontail	In front of Purves Lagoon
N 44° 48.525	W 87° 20.042	12:15 PM	5 ft / 4.5 ft	11.2 ft	muck	**silt**	sand	gravel	72.8°	1.0 ft	0	15	110	9	None	Cove Road near Channel entrance
N 44° 48.559	W 87° 20.080	12:30 PM	V/B	4.5 ft	muck	silt	sand	gravel	73.4°	1.0 ft	0	7.5			Unidentified weed	Cove Road- close to shore
															Buttercup	
N 44° 48.931	W 87° 20.554	12:50 PM	V/B	4.5 ft	muck	silt	sand	gravel	73.4°	1.0 ft	0	7.5			Wild Celery, Buttercup	Wind Increase Approx (10-15 mph)
															Elodea, Milfoil	Cove Road- near nav. marker
N 44° 48.866	W 87° 20.791	1:07 PM	4.5 ft / 4.5 ft	5 ft	muck	**silt**	sand	gravel	73.0°	1.0 ft	0	5			Wild Celery, Milfoil	Tacoma Beach near Strawberry Creek
															Coontail	
N 44° 49.150	W 87° 21.391	1:33PM	5.0 ft / 5.0 ft	7 ft	muck	**silt**	sand	gravel	73.4°	1.0ft	0	10			Curly Leaf Elodea	Memorial Drive near Bay View Bridge
N 44° 49.305	W 87° 21.307	1:44 PM	5.5 ft / 5.0 ft	7 ft	muck	silt	sand	gravel	73.2°	1.0 ft	0	10			Elodea	Memorial Drive near Bay View Bridge
															Coontail	
N 44° 49.347	W 87° 21.546	1:54 PM	7.0 ft / 6.5 ft	10.5 ft	muck	silt	sand	gravel	73.2°	1.0 ft	0	15			Elodea	Lathem Smith Mooring

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:	7-Aug-02
COLLECTED BY:	Tanner / Jason
WEATHER (sunny, overcast, partly cloudy, etc.)	Partly Cloudy
WIND (direction, est. speed)	

LOCATION Lat	**dep**	**TIME**	**SECCHI DISK down/up (feet)**	**WATER DEPTH (feet)**	**SUBSTRATE TYPE (circle one)**				**TEMP. (fahrenheit)**	**SAMPLE DEPTH (feet)**	**NITRATE (mg/l)**	**PHOSPHATE (mg/l)**	**OTHER**		**MAJOR PLANT SPECIES**	**GENERAL NOTES & COMMENTS (significant fish, noteworthy items)**
													Alkalinity	**pH**		
N 44° 49.258	W 87° 22.025	10:42 AM	2.0 ft / 2.0 ft	8.0 ft	muck	silt	sand	gravel	73.1°	1.0ft	0	5	200	9		Inside Purves Lagoon
																Green alge on surface
N 44° 49.355	W 87° 22.025	10:59 AM	5.5 ft / 5.5 ft	7.5 ft	muck	silt	sand	gravel	72.8°	1.0 ft	0	15			Serious Alge, Growth on surface	Quarterdeck, left well
															Elodea at bottom,	
N 44° 49.524	W 87° 21.684	11:16 AM	V/B	2.5 ft	muck	silt	sand	gravel	72.1°	1.0 ft	0	10			Elodea, Water Celery	E Memorial Drive
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:	7-Aug-02
COLLECTED BY:	Tanner / Jason
WEATHER (sunny, overcast, partly cloudy, etc.)	Partly Cloudy
WIND (direction, est. speed)	

LOCATION Lat	dep	TIME	SECCHI DISK down/up (feet)	WATER DEPTH (feet)	SUBSTRATE TYPE (circle one)				TEMP. (fahrenheit)	SAMPLE DEPTH (feet)	NITRATE (mg/l)	PHOSPHATE (mg/l)	OTHER		MAJOR PLANT SPECIES	GENERAL NOTES & COMMENTS (significant fish, noteworthy items)
													Alkalinity	pH		
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								
			/		muck	silt	sand	gravel								

WEATHER STATION (NORTHERN TO COMPLETE)	**TEMP**	
	PRESSURE	
	PRECIP	
	WIND	

STURGEON BAY FIELD DATA COLLECTION FORM

DATE:		08/07/02
COLLECTED BY:		Jason / Tanner / Rick
Weather	(sunny, overcast, partly cloudy, etc.)	Sunny, Very calm
Wind	(direction, est. speed)	Very Light N Wind

LOCATION Lat	**dep**	**Sample #**	**TIME**	**SECCHI DISK down/up (feet)**	**WATER DEPTH (feet)**	**TEMP. (fahrenheit)**	**SAMPLE DEPTH (feet)**	**GENERAL NOTES & COMMENTS (significant fish, noteworthy items)**
N 44° 53.364	W 87° 25.036	101	6:38 AM	9 ft / 9 ft	41 ft	68.5°	1.0 ft	Off Sherwood Point
N 44° 52.874	W 87° 26.270	102	7:01 AM	V/B	2.4 ft	70.1°	1.0 ft	Buttercup Weed, and white light floating matter on surface, other fairly thick growth. Idlewild Creek
N 44° 50.593	W 87° 23.371	103	7:28 AM	6.5 ft/ 6.5 ft	22.9 ft	71.3°	1.0 ft	Wind has picken up to 3-5 MPH from N Bay Ship
N 44° 50.075	W 87° 23.315	104	7:40 AM	7 ft / 7 ft	10 ft	71.7°	1.0 ft	South of Dunlap Reef, Alge, Floating Weeds
N 44° 49.659	W 87° 22.519	105	7:59 AM	5 ft / 5 ft	23.8 ft	71.5°	1.0 ft	Middle of Canal in front of Roehn Salvage
N 44° 49.574	W 87° 22.217	106	8:06 AM	5 ft / 5 ft	21.8 ft	71.4°	1.0 ft	NE wind < 5 MPH In front of Quarterdeck Marina
N 44° 47.481	W 87° 18.473	107	8:30 AM	16 ft	22.2 ft	67.2°	1.0 ft	Coast Guard Station 1-2 Foot Waves
N 44° 48.515	W 87° 20.183	108	8:57 AM	V/B	1.7 ft	68.0°	1.0 ft	Boat Traffic Strawberry Creek Mouth, Heavy Vegetiaton
N 44° 49.3969	W 87° 20.795	109	9:15 AM	V/B	2 ft	70.6°	1.0 ft	Big Creek, Light NE wind partly cloudy
N 44° 49.418	W 87° 21.509	110	9:32 AM	V/B	2.2 ft	71.0°	1.0 ft	Little Creek Not as noticeable alge
				/				
				/				
				/				
				/				
				/				
				/				
				/				
				/				
				/				
				/				
				/				

STB -0574

University of Wisconsin–Madison/Extension

Soil & Plant Analysis Laboratory
Soil Science Department
5711 Mineral Point Road
Madison, Wisconsin 53705-4453
Phone (608) 262-4364
FAX (608) 263-3327
http://uwlab.soils.wisc.edu

College of Agricultural and Life Sciences

Date: August 12, 2002
Lab No. 6512
Acct. No. 557719

Chain of Custody Record No. 15102

TO: Northern Environmental
1203 Storbeck Drive
Waupun, WI 53963

FROM: John D. Parsen, Lab Manager
Soil & Plant Analysis Lab

RE: 2 seaweed tissue samples and 5 soil samples submitted July 23, 2002

We have enclosed analyses of your samples. We have also faxed them.
If you have any questions please let us know.

Thank you.

JDP:jjh
Enclosure

Soil and Plant Analysis Lab
Univ. of Wisconsin-Madison
5711 Mineral Point Road
Madison, WI 53705-4453

Phone (608)262-4364
Fax (608)263-3327
http://uwlab.soils.wisc.edu/

Lab No. 6512

Acct. No. 557719

Client- Northern Environmental - Clint Wendt
Project Manager: Marty Koopman
Chain of Custody Record No. 15102

Re: 2 seaweed tissue samples and 5 soil samples submitted July 23, 2002
Results faxed and mailed: August 12, 2002

Results reported on a 'Dry weight' basis for solid samples.
Unit: ppm = mg/kg = mg/liter. 1% = 10,000 ppm.

Total Minerals

Sample ID	P ppm	K ppm	Ca ppm	Mg ppm	S ppm	Zn ppm	B ppm	Mn ppm	Fe ppm	Cu ppm	Al ppm	Na ppm
SOIL												
S1	307.58	529.45	74144.87	35304.21	1241.06	2307.73	<3	138.68	4782.24	8.97	2311.55	239.48
S2	326.74	402.77	166666.67	16655.63	3833.19	26.47	6.10	126.13	4946.22	12.94	2098.36	366.39
S3	332.51	774.02	94879.52	23476.90	2356.43	50.77	<3	209.00	6409.66	16.89	3329.69	203.93
S4	503.99	1085.91	100000.00	35224.42	2992.74	79.76	<3	318.41	10646.96	23.33	5803.74	214.07
S5	271.12	268.15	46285.14	24675.65	644.99	16.09	<3	65.66	3533.04	7.49	1448.49	110.85
SEAWEED												
C1	3625.72	5084.51	128514.06	9833.78	2680.91	52.48	<3	1465.06	3817.61	35.80	1817.91	1547.62
P1	3141.91	26312.59	36773.55	2867.25	3996.38	26.97	46.82	721.94	396.61	9.27	167.28	10831.56

Sample ID	Total N ppm	Solids %
SOIL		
S1	1501.1	61.0
S2	4763.0	39.7
S3	2502.8	40.5
S4	3573.8	38.1
S5	542.7	63.7
SEAWEED		
C1	18387.4	50.3
P1	31232.3	8.0

Northern Environmental℠
Hydrologists • Engineers • Geologists

CHAIN OF CUSTODY RECORD REQUEST FOR ANALYSIS

Page ____ of ____

No: 15102

Check office originating request

- ☐ 1214 W. Venture Ct., Mequon, WI 53092, 262-241-3133, FAX 262-241-8222
- ☐ 372 West County Road D, New Brighton, MN 55112, 651-635-9100, FAX 651-635-0643
- ☐ 954 Circle Drive, Green Bay, WI 54304, 920-592-8400, FAX 920-592-8444
- ☐ 330 South 4th Avenue, Park Falls, WI 54552, 715-762-1544, FAX 715-762-1844
- ☐ ____________
- ☒ 1203 Storbeck Drive, Waupun, WI 53963, 920-324-8600, FAX 920-324-3023
- ☐ 3211 Arnold Lane, Northbrook, IL 60062, 847-562-8577, FAX 847-562-8552
- ☐ 2222 Hwy 52 North, Ste 210, Rochester, MN 55901, 507-282-3800, FAX 507-282-3100
- ☐ 31628 Glendale Ave. Ste 100, Livonia, MI 48150, 734-422-2624, FAX 734-422-3530

Project No: Task No:

Project Location (city): Sturgeon Bay, WI

Project Manager: Marty Koopman

Sampler (name): Clint Wendt

Sampler (Signature): Clint Wendt

Sampling Date(s): 7-17-02

Reports to be Sent to: Clint Wendt

Laboratory: Mar[illegible] Soil Lab

Wisconsin DNR Certification #:

Laboratory Contact: John Parsons

Price Quote:

TURNAROUND TIME REQUIRED

☒ Normal ☐ Rush

Date Needed ____________

Sample Integrity - To be completed by receiving lab
Seal intact upon receipt ☐ yes ☐ no
Method of shipment ____________
Contents Temperature ________ °C Refrigerator No. ________

ANALYSES REQUESTED

Lab ID No.	Sample No.	Collection Date	Collection Time	No. of Containers, Size & Type	Description: Water	Description: Soil	Description: Other	Preservative	DRO (WI Modified Method)	GRO (WI Modified Method)	BETX (EPA Method 8020)	PVOC (EPA Method 8020)	VOC (EPA Method 8021)	PAH (EPA Method)	Pb (EPA Method)	Total N	Total Minerals	% Solids									
	S1	7/19/02				X										X	X	X									
	S2																										
	S3																										
	S4																										
	S5																										
	C1						X																				
	P1						X																				

Packed for Shipping by: Clint Wendt

Shipment Date: 7/22/02

Comments:

Relinquished By: Clint Wendt	Date:	Relinquished By:	Date:	Relinquished By:	Date:
Company: Northern Environmental	Time:	Company:	Time:	Company:	Time:
Received By: [illegible]	Date:	Received By:	Date:	Received By:	Date:
	Time:	Company:	Time:	Company.	Time:

Date: 4/28/03   Scenario: 1
Lake Id: Sturgeon Bay
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 20374.0 acre
Total Unit Runoff: 9.00 in.
Annual Runoff Volume: 15280.5 acre-ft
Lake Surface Area <As>: 1045.5 acre
Lake Volume <V>: 8364.2 acre-ft
Lake Mean Depth <z>: 8.0 ft
Precipitation - Evaporation: 3.9 in.
Hydraulic Loading: 17227.5 acre-ft/year
Areal Water Load <qs>: 16.5 ft/year
Lake Flushing Rate <p>: 2.06 1/year
Water Residence Time: 0.49 year
Observed spring overturn total phosphorus (SPO): 0.0 mg/m^3
Observed growing season mean phosphorus (GSM): 34 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	0.0	0.50	1.00	3.00	0.0	0	0	0
Mixed AG	12922.0	0.30	0.80	1.40	59.1	1569	4184	7321
Pasture/Grass	0.0	0.10	0.30	0.50	0.0	0	0	0
HD Urban (1/8 Ac)	2781.0	1.00	1.50	2.00	23.8	1125	1688	2251
MD Urban (1/4 Ac)	199.0	0.30	0.50	0.80	0.6	24	40	64
Rural Res (>1 Ac)	259.0	0.05	0.10	0.25	0.1	5	10	26
Wetlands	2028.0	0.10	0.10	0.10	1.2	82	82	82
Forest	1970.0	0.05	0.09	0.18	1.0	40	72	144
Barron- Quaries	215.0	0.00	0.00	0.00	0.0	0	0	0
Lake Surface	1045.5	0.10	0.30	1.00	1.8	42	127	423

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %
Sturgeon Bay WWTP	1982420.0	0.0	875.6	0.0	12.4
User Defined 2	0.0	0.0	0.0	0.0	0.0
User Defined 3	0.0	0.0	0.0	0.0	0.0
User Defined 4	0.0	0.0	0.0	0.0	0.0
User Defined 5	0.0	0.0	0.0	0.0	0.0
User Defined 6	0.0	0.0	0.0	0.0	0.0

SEPTIC TANK DATA

Description		Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)		0.30	0.50	0.80	
# capita-years	0.0				
% Phosphorous Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		0.00	0.00	0.00	0.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	6366.8	15606.3	22733.0	100.0
Total Loading (kg)	2888.0	7079.0	10311.6	100.0
Areal Loading (lb/ac-year)	6.09	14.93	21.74	
Areal Loading (mg/m^2-year)	682.58	1673.13	2437.16	
Total PS Loading (lb)	0.0	1930.4	0.0	
Total PS Loading (kg)	0.0	875.6	0.0	
Total NPS Loading (lb)	6273.6	13396.1	21800.2	
Total NPS Loading (kg)	2845.7	6076.4	9888.5	

Aquatic Plant Management

Aquatic plants are a critical component in an aquatic ecosystem. Any management of an ecosystem can have negative or even detrimental effects on the whole ecosystem. Therefore, the practice of managing aquatic plants should not be taken lightly. The concept of Aquatic Plant Management (APM) is highly variable since different aquatic resource users want different things. Ideal management to one individual may mean providing prime fish habitat, for another it may be to remove surface vegetation for boating. The practice of APM is also highly variable. There are numerous APM strategies designed to achieve different plant management goals. Some are effective on a small scale, but ineffective in larger situations. Others can only be used for specific plants or during certain times of the growing season. Of course, the types of plants that are to be managed will also help determine which APM alternatives are feasible. The following paragraphs discuss the APM methods used today. The discussion is largely adopted from *Managing Lakes and Rivers, North American Lake Management Society, 2001*, supplemented with other applicable current resources and references. The methods summarized here are largely for management of rooted aquatic plants, not algae. While some methods may also have effects on nuisance algae blooms, the focus is submergent rooted aquatic macrophytes. This information is provided to allow the user to gain a basic understanding of the APM method, it is not designed to an all-inclusive APM decision-making matrix. APM alternatives can be divided into the following categories: Physical Controls, Chemical Controls, and Biological Controls.

Physical Controls

Physical APM controls include various methods to prevent growth or remove part or all of the aquatic plant. Both manual and mechanical techniques are employed. Physical APM methods include:

- Hand pulling
- Hand cutting
- Bottom barriers
- Light limitation (dyes, covers)
- Mechanical harvesting
- Hydroraking/rototilling
- Suction Dredging
- Dredging
- Drawdown

Each of these methods are described below. The costs, benefits, and drawbacks of each APM strategy are provided.

Hand Pulling: This method involves digging out the entire unwanted plant including stems and roots with a hand tool such as a spade. This method is highly selective and suitable for shallow areas for removing invasive species that have not become well established. This technique is obviously not for use on large dense beds of nuisance aquatic plants. It is best used in areas less than 3 feet, but can be used in deeper areas with divers using scuba and snorkeling equipment. It can also be used in combination with the suction dredge method. In Wisconsin, hand pulling may be completed outside a designated sensitive area without a permit but is limited to 30 feet of shoreline frontage. Removal of exotic species is not limited to 30 feet.

Advantages: This technique results in immediate clearing of the water column of nuisance plants. When a selective technique is desired in a shallow, small area, hand pulling is a good choice. It is also useful in sensitive areas where disruption must be minimized.

Disadvantages: This method is labor intensive. Disturbing the substrate may affect fish habitat, increase turbidity, and may promote phosphorus re-suspension and subsequent algae blooms.

Costs: The costs are highly variable. There is practically no cost using volunteers or lakeshore landowners to remove unwanted plants, however using divers to remove plants can get relatively expensive. Hand pulling labor can range from $400 to $500 per acre.

Hand Cutting: This is another manual method where the plants are cut below the water surface. Generally the roots are not removed. Tools such as rakes, scythes or other specialized tools are pulled through the plant beds by boat or several people. This method is not as selective as hand pulling. This method is well suited for small areas near docks and piers. Plant material must be removed from the water. In Wisconsin, hand cutting may be completed outside a designated sensitive area without a permit but is limited to 30 feet of shoreline frontage. Removal of exotic species is not limited to 30 feet.

Advantages: This technique results in immediate clearing of the water column of nuisance plants. Costs are minimal.

Disadvantages: This is also a fairly time consuming and labor intensive option. Since the technique does not remove the entire plant (leaves root system and part of plant), it may not result in long-term reductions in growth.

Costs: The costs range from minimal for volunteers using hand equipment up to over $1,000 for a hand-held mechanized cutting implement. Hand pulling labor can range from $200 to $400 per acre.

Bottom Barriers: A barrier material is applied over the lake bottom to prevent rooted aquatics from growing. Natural barriers such as clay, silt, and gravel can be used although eventually plants may root in these areas again. Artificial materials can also be used for bottom barriers and anchored to the substrate. Barrier materials include burlap, nylon, rubber, polyethylene, polypropylene, and fiberglass. Barriers include both solid and porous forms. A permit is required to place any fill or barrier structure on the substrate of a waterbody. This method is well suited for areas near docks, piers, and beaches. Periodic maintenance may be required to remove accumulated silt or rooting fragments from the barrier.

Advantages: This technique does not result in production of plant fragments. Properly installed, it can provide immediate and multiple year relief.

Disadvantages: This is a non-selective option, all plants beneath the barrier will be affected. Some materials are costly and installation is labor intensive. Other disadvantages include limited material durability, gas accumulation beneath the cover, or possible re-growth of plants from above or below the cover. Fish and invertebrate habitat is disrupted with this technique. Anchored barriers can be difficult to remove.

Costs: A 20 foot x 60 foot panel cost $265, while a 30 foot x 50 foot panel cost $375 (this does not include installation costs). Costs for materials vary from $0.15 per square foot ($ft^2$) to over $0.35/ ft^2. The costs for installation range from $0.25 to $0.50/ ft^2. Barriers can cost $20,000 to $50,000 per acre.

<u>Light Limitation:</u> Limiting the available light in the water column can prevent photosynthesis and plant growth. Dark colored dyes and surface covers have been used to accomplish light limitation. Dyes are effective in shallow water bodies where their concentration can be kept at a desired concentration and loss through dilution is less. This method is well suited for small, shallow water bodies with no outlets such as private ponds.

Surface covers can be a useful tool in small areas such as docks and beaches. While they can interfere with aquatic recreation, they can be timed to produce results and not affect summer recreation uses.

<u>Advantages:</u> Dyes are non-toxic to humans and aquatic organisms. No special equipment is required for application. Light limitation with dyes or covers method may be selective to shade tolerant species. In addition to submerged macrophyte control, it can also control the algae growth.

<u>Disadvantages:</u> The application of water column dyes is limited to shallow water bodies with no outlets. Repeated dye treatments may be necessary. The dyes may not control peripheral or shallow-water rooted plants. This technique must be initiated before aquatic plants start to grow. Covers inhibit gas exchange with the atmosphere.

<u>Costs:</u> Costs for a commercial dye and application range from $100 to $500 per acre.

<u>Mechanical Harvesting:</u> Mechanical harvesters are essentially cutters mounted on barges that cut aquatic plants at a desired depth. Maximum cutting depths range from 5 to 8 feet with a cutting width of 6.5 to 12 feet. Cut plant materials require collection and removal from the water. Conventional harvesters combine cutting, collecting, storing, and transporting cut vegetation into one piece of equipment. Transport barges and shoreline conveyors are also available to remove the cut vegetation. The cut plants must be removed from the water body. The equipment needs are dictated by severity of the aquatic plant problem. Contract harvesting services are available in lieu of purchasing used or new equipment. Trained staff will be necessary to operate a mechanical harvester. To achieve maximum removal of plant material, harvesting is usually completed during the summer months while submergent vegetation is growing to the surface. The duration of control is variable and re-growth of aquatic plants is common. Factors such as timing of harvest, water depth, depth of cut, and timing can influence the effectiveness of a harvesting operation. Harvesting is suited for large open areas with dense stands of exotic or nuisance plant species. Permits are now required in Wisconsin to use a mechanical harvester.

<u>Advantages:</u> Harvesting provides immediate visible results. Harvesting allows plant removal on a larger scale than other options. Harvesting provides flexible area control. In other words, the harvester can be moved to where it is needed and used to target problem areas. This technique has the added benefit of removing the plant material from the water body and therefore also eliminates a possible source of nutrients often released during fall decay of aquatic plants. While removal of nutrients through plant harvesting has not been quantified, it can be important in aquatic ecosystem with low nutrient inputs.

Disadvantages: Drawbacks of harvesting include: limited depth of operation, not selective within the application area, and expensive equipment costs. Harvesting also creates plant fragments, which can be a concern since certain plants have the ability to reproduce whole plants from a plant fragment (e.g. Eurasian watermilfoil). Plant fragments may re-root and spread a problem plant to other areas. Harvesting can have negative effects on non-target plants, young of year fish, and invertebrates. The harvesting will require trained operators and maintenance of equipment. Also, a disposal site or landspreading program will be needed for harvested plants.

Costs: Costs for a harvesting operation are highly variable dependant on program scale. New harvesters range from $40,000 for small machines to over $100,000 for large, deluxe models. Costs vary considerably, depending on the model, size, and options chosen. Specially designed units are available, but may cost more. The equipment can last 10 to 15 years. A grant for ½ the equipment cost can be obtained from the Wisconsin Waterways Commission and a loan can be obtained for the remaining capital investment. Operation costs include insurance, fuel, spare parts, and payroll. Historical harvesting values have been reported at $200 up to $1,500 per acre. A survey of recent Wisconsin harvesting operations reported costs to be between $100/acre and $200/acre.

A used harvester can be purchased for $10,000 to $20,000. Maintenance costs are typically higher.

Contract harvesting costs approximately $125/per hour plus mobilization to the water body. Contractors can typically harvest ¼ to ½ acre per hour for an estimated cost of $250 to $500/per acre.

Hydroraking/rototilling: Hydroraking is the use of a boat or barge mounted machine with a rake that is lowered to the bottom and dragged. The tines of the rake rip out roots of aquatic plants. Rototilling, or rotovation, also rips out root masses but uses a mechanical rotating head with tines instead of a rake. Harvesting may need to be completed in conjunction with these methods to gather floating plant fragments. This application would best be used where nuisance populations are well established and prevention of stem fragments is not critical. A permit would be required for this type of aquatic plant management and would only be issued in limited cases of extreme infestations of nuisance vegetation. In Wisconsin, this method is not looked upon favorably or at all by the WDNR.

Advantages: These methods have the potential for significant reductions in aquatic plant growth. These methods can remove the plant stems and roots, resulting in thorough plant disruption. Hydroraking/rototilling can be completed in "off season" months avoiding interference with summer recreation activities.

Disadvantages: Hydroraking/rototilling are not selective and may destroy substrate habitat important to fish and invertebrates. Suspension of sediments will increase turbidity and can possibly cause algae blooms. These methods can cause floating plant and root fragments, which may re-root and spread the problem. Hydroraking/rototilling are expensive and not likely to be permitted by regulatory agencies.

Costs: Bottom tillage costs vary according to equipment, treatment scale, and plant density. For soft vegetation costs can range from $2,000 to $4,000 per acre. For dense, rooted masses, costs can be up to $10,000 per acre. Contract bottom tillage reportedly ranges from $1,200 to $1,700 per acre (Washington Department of Ecology, 1994).

Suction Dredging: Suction dredging uses a small boat or barge with portable dredges and suction heads. Scuba divers operate the suction dredge and can target removal of whole plants, seeds, and roots. This method may be applied in conjunction with hand cutting where divers dislodge the plants. The plant/sediment slurry is hydraulically pumped to the barge through hoses carried by the diver. Its effectiveness is dependent on sediment composition, density of aquatic plants, and underwater visibility. Suction dredging may be best suited for localized infestations of low plant density where fragmentation must be controlled. A permit will be required for this activity.

Advantages: Diver suction dredging is species –selective. Disruption of sediments can be minimized. These methods can remove the plant stems and roots, resulting in thorough plant disruption and potential longer term control. Fragmentation of plants is minimized. This activity can be completed near and around obstacles such as piers or marinas where a harvester could not operate.

Disadvantages: Diver suction dredging is labor intensive and costly. Upland disposal of dredged slurry can require additional equipment and costs. Increased turbidity in the area of treatment can be a problem. Release of nutrients and other pollutants can also be a problem.

Costs: Suction dredging costs can be variable depending on equipment and transport requirements for slurry. Costs range from $5,000 per acre to $10,000 per acre.

Dredging

Sediment removal through dredging can work as a plant control technique by limiting light through increased water depth or removing soft sediments that are a preferred habitat to nuisance rooted plants. Soft sediment removal is accomplished with drag lines, bucket dredges, long reach backhoes, or other specialized dredging equipment. Dredging has had mixed results in controlling aquatic plant, however it can be highly effective in appropriate situations. Dredging is most often applied in a major restructuring of a severely degraded system. Generally, dredging is an activity associated with other restoration efforts. Comprehensive pre-planning will be necessary for these techniques and a dredging permit would be required.

Advantages: Dredging can remove nutrient reserves which result in nuisance rooted aquatic plant growth. Dredging, when completed, can also actually improve substrate and habitat for more desirable species of aquatic plants, fish, and invertebrates. It allows the complete renovation of an aquatic ecosytem. This method has the potential for significant reductions in aquatic plant growth. These methods can be completed in "off season" months avoiding interference with summer recreation activities.

Disadvantages: Dredging can temporarily destroy important fish and invertebrate habitat. Suspension of sediments usually increases turbidity significantly and can possibly releases nutrients causing algae blooms. Dredging is extremely expensive and requires significant planning. Dredged materials may contain toxic materials (metals, PCBs). Dredged material transportation and disposal of toxic materials are additional management considerations and are potentially expensive. It could be difficult and costly to secure regulatory permits and approvals.

Costs: Dredging costs depend upon the scale of the project and many other factors. It is generally an extremely expensive option.

Drawdown: Water level drawdown exposes the plants and root systems to prolonged freezing and drying to kill the plants. It can be completed any time of the year, however is generally more effective in winter, exposing the lake bed to freezing temperatures. If there is a water level control structure capable of drawdown, it can be an in-expensive way to control some aquatic plants. Aquatic plants vary in their susceptibility to drawdown, therefore, accurate identification of problem species is important. Drawdown is often used for other purposes of improving waterfowl habitat or fishery management, but sometimes has the added benefit of nuisance rooted aquatic plant control. This method can be used in conjunction with a dredging project to excavate nutrient-rich sediments. This method is best suited for use on reservoirs or shallow man-made lakes. A drawdown would require regulatory permits and approvals.

Advantages: A drawdown can result in compaction of certain types of sediments and can be used to facilitate other lake management activities such as dam repair, bottom barrier, or dredging projects. Drawdown can significantly impact populations of aquatic plants that propagate vegetatively. It is inexpensive.

Disadvantages: This method is limited to situations with a water level control structure. Pumps can be used to de-water further if ground water seepage is not significant. This technique may also result in the removal of beneficial plant species. Drawdowns can decrease bottom dwelling invertebrates and overwintering reptiles and amphibians. Drawdowns can affect adjacent wetlands, alter downstream flows, and potentially impair well production. Drawdowns and any water level manipulation are often highly controversial since shoreline landowners access and public recreation are limited during the drawdown. Fish populations are vulnerable during a drawdown due to over-harvesting by fisherman in decreased water volumes.

Costs: If a suitable outlet structure is available then costs should be minimal. If dewatering pumps would be required or additional management projects such as dredging are completed, additional costs would be incurred. Other costs would include recreational losses and perhaps loss in tourism revenue.

Chemical Controls

Using chemical herbicides to kill nuisance aquatic plants is the oldest APM method. However, past pesticides uses being linked to environmental or human health problems have led to public wariness of chemicals in the environment. Current pesticide registration procedures are more stringent than in the past. While no chemical pesticide can be considered 100 percent safe, federal pesticide regulations are based on the premise that if a chemical is used according to its label instructions it will not cause adverse environmental or human health effects.

Chemical herbicides for aquatic plants can be divided into two categories, systemic and contact herbicides. Systemic herbicides are absorbed by the plant, translocated throughout the plant, and are capable of killing the entire plant, including the roots and shoots. Contact herbicides kill the plant surface in which in comes in contact, leaving roots capable of re-growth. Aquatic herbicides exist under various trade names, causing some confusion. Aquatic herbicides include the following:

- Endothall Based Herbicide
- Diquat Based Herbicide
- Fluridone Based Herbicide
- 2-4 D Based Herbicide
- Glyophosate Based Herbicide
- Triclopyr Based Herbicide
- Phosphorus Precipitation

Each of these methods are described below. The costs, benefits, and drawbacks of each chemical APM alternative are provided.

Endothall Based Herbicide: Endothall is a contact herbicide, attacking a wide range of plants at the point of contact. The chemical is not readily transferred to other plant tissue, therefore regrowth can be expected and repeated treatments may be needed. It is sold in liquid and granular forms under the trade names of Aquathol K, Aquathol, or Hydrothol. Hydrothol is also an algaecide. Most endothall products break down easily and do not remain in the aquatic environment. Endothall products can result in plant reductions for a few weeks to several months. Multi-season effectiveness is not typical. A permit is required for use of this herbicide.

Advantages: Endothall products work quickly and exhibit moderate to highly effective control of floating and submersed species. This herbicide has limited toxicity to fish at recommended doses.

Disadvantages: The entire plant is not killed when using endothall. Endothall is non-selective in the treatment area. High concentrations can kill fish easily. Water use restrictions (time delays) are necessary for recreation, irrigation, and fish consumption after application.

Costs: Costs vary with treatment area and dosage. Average costs for chemical application range between $400 and $700 per acre.

Diquat Based Herbicide: Diquat is a fast-acting contact herbicide effective on a broad spectrum of aquatic plants. It is sold under the trade name of Reward. Diluted forms of this product are also sold as private label products. Since Diquat binds to sediments readily, its effectiveness is reduced by turbid water. Multi-season effectiveness is not typical. A permit is required for use of this herbicide.

Advantages: Diquat works quickly and exhibit moderate to highly effective control of floating and submersed species. This herbicide has limited toxicity to fish at recommended doses.

Disadvantages: The entire plant is not killed when using diquat. Diquat is non-selective in the treatment area. Diquat can be inactivated by suspended sediments. Diquat is sometimes toxic to zooplankton at the recommended dose. Limited water used restrictions (water supply, agriculture, and contact recreation) are required after application.

Costs: Costs vary with treatment area and dosage. A general cost estimate for treatment is between $200 and $500 per acre.

Fluoridone Based Herbicide: Fluoridone is a slow-acting systemic herbicide, which is effectively absorbed and translocated by both plant roots and stems. Sonar is the trade name and it is sold in liquid or granular form. Fluoridone requires a longer contact time and demonstrates delayed toxicity to target plants. Eurasian watermilfoil is more sensitive to fluoridone than other aquatic plants. This allows a semi-selective approach when low enough doses are used. Since the roots are also killed, multi-season effectiveness can be achieved. It is best applied during the early growth phase of the plants. A permit is required for use of this herbicide.

Advantages: Fluoridine is capable of killing roots, therefore producing a longer lasting effect than other herbicides. A variety of emergent and submersed aquatics are susceptible to this herbicide. Fluoridine can be used selectively, based on concentration. A gradual killing of target plants limits severe oxygen depletion from dead plant material. It has demonstrated low toxicity to aquatic fauna such as fish and invertebrates. 3 to 5 year control has been demonstrated. Extensive testing have shown that, when used according to label instructions, it does not pose negative health affects.

Disadvantages: Fluoridine is a very slow-acting herbicide sometimes taking up to several months for visible effects. It requires a long contact time. Fluoridine is extremely soluble and mixable, therefore, not effective in flowing water situations or for treating a select area in a large open lake. Impacts on non-target plants are possible at higher doses. Time delays are necessary on use of the water (water supply, irrigation, and contact recreation) after application.

Costs: Costs vary with treatment area and dosage. Treatment costs range from $500 to $2,000 per acre.

2,4-D Based Herbicide: 2,4-D-based herbicides are sold in liquid or granular forms under various trade names. It is a systemic herbicide that affects broad leaf plants. It has been demonstrated effective against Eurasian watermilfoil, but it may not work on many aquatic plants. Since the roots are also killed, multi-season effectiveness may be achieved. It is best applied during the early growth phase of the plants. Visible results are evident within 10 to 14 days. A permit is required for use of this herbicide.

Advantages: 2,4-D is capable of killing roots, therefore producing a longer lasting effect than some other herbicides. It is fairly fast and somewhat selective, based on application timing and concentration. 2,4-D containing products are moderately to highly effective on a few emergent, floating, or submersed plants.

Disadvantages: 2,4-D can have variable toxicity effects to aquatic fauna, depending on formulation and water chemistry. 2,4-D lasts only a short time in water, but can be detected in sediments for months after application. Time delays are necessary on use of the water (agriculture and contact recreation) after application. The label does not permit use of this product in water used for drinking, irrigation, or livestock watering.

Costs: Costs vary with treatment area and dosage. Treatment costs range from \$300 to \$800 per acre.

Glyophosate Based Herbicide: Glyophosate has been categorized as both a contact and a systemic herbicide. It is applied as a liquid spray and is sold under the trade name Rodeo or Pondmaster. It is a non-selective, broad based herbicide effective against emergent or floating leaved plants, but not submergents. It's effectiveness can be reduced by rain. A permit is required for use of this herbicide.

Advantages: Glyophoshate is moderately to highly effective against emergent and floating-leaf plants resulting in rapid plant destruction. Since it is applied by spraying plants above the surface, the applicator can apply it selectively to target plants. Glyophosate dissipates quickly from natural waters, has a low toxicity to aquatic fauna, and carries no restrictions or time delays for swimming, fishing, or irrigation.

Disadvantages: Glyophoshate is non-selective in the treatment area. Wind can dissipate the product during the application reducing it's effectiveness and cause damage to non-target organisms. Therefore, spray application should only be completed when wind drift is not a problem. This compound is highly corrosive, therefore storage precautions are necessary.

Costs: Costs average \$500 to \$1,000 per acre depending on the scale of treatment.

Triclopyr Based Herbicide: Triclopyr is a systemic herbicide. It is registered for experimental aquatic use in selected areas only. It is applied as a liquid spray or injected into the subsurface as a liquid. Triclopyr has shown to be an effective control to many floating and submersed plants. It has been demonstrated to be highly effective against Eurasian watermilfoil, having little effect on valued native plants such as pondweeds. Triclopyr is most effective when applied during the active growth period of younger plants.

Advantages: This herbicide is fast acting. Triclopyr can be used selectively since it appears more effective against dicot plant species, including several difficult nuisance plants. Testing has demonstrated low toxicity to aquatic fauna.

Disadvantages: At higher doses, there are possible impacts to non-target species. There is a time delay of 30 days for fish consumption from treated areas. This herbicide is experimental for aquatic use and restrictions on use of the treated water are not yet certain.

Biological Controls

There has been recent interest in using biological technologies to control aquatic plants. This concept stems from a desire to use a "natural" control and reduce expenses related to equipment and/or chemicals. While use of biological controls is in its infancy, potentially useful technologies have been identified and show promise for integration with physical and chemical APM strategies. Several biological controls that are in use or are under experimentation include the following:

- Herbivorous Fish
- Herbivorous Insects
- Plant Pathogens
- Native Plants

Each of these methods are described below. The costs, benefits, and drawbacks of each biologic APM method are provided.

Herbivorous Fish: A herbivorous fish such as the non-native grass carp can consume large quantities of aquatic plants. These fish have high growth rates and a wide range of plant food preferences. Stocking rates and effectiveness will depend on many factors including climate, water temperature, type and extent of aquatic plants, and other site-specific issues. Sterile (triploid) fish have been developed resulting in no reproduction of the grass carp and population control. This technology has demonstrated mixed results and is most appropriately used for lake-wide, low intensity control of submersed plants. Some states do not allow stocking of herbivorous fish. In Wisconsin, stocking of grass carp is prohibited.

Advantages: This technology can provide multiple years of aquatic plant control from a single stocking. Compared to other long-term aquatic plant control techniques such as bottom tillage or bottom barriers, costs may be relatively low.

Disadvantages: Sterile grass carp exhibit distinct food preferences, limiting their applicability. Grass carp may feed selectively on the preferred plants, while less preferred plants, including milfoil, may increase. The effects of using grass carp may not be immediate. Overstocking may result in an impact on non-target plants or eradication of beneficial plants, altering lake habitat. Using grass carp may result in algae blooms and increased turbidity. If precautions are not taken (i.e. inlet and outlet control structures to prevent fish migration) the fish may migrate and have adverse effects on non-target vegetation.

Costs: Costs can range from $50/acre to over $2,000/acre, at stocking rates of 5 fish/acre to 200 fish/acre.

Herbivorous Insects: Non-native and native insect species have been used to control rooted plants. Using herbivorous insects is intended to selectively control target species. These aquatic larvae of moths, beetles, and thrips use specific host aquatic plants. Several non-native species have been imported under USDA approval and used in integrated pest management programs, a combination of biological, chemical, and mechanical controls.
These non-native insects are being used in southern states to control nuisance plant species and appear climate-limited, their northern range being Georgia and North Carolina. While successes have been demonstrated, non-native species have not established themselves for solving biological problems, sometimes creating as many problems as they solve. Therefore, government agencies prefer alternative controls.

Native insects such as the larvae of midgeflies, caddisflies, beetles, and moths may be successful APM controls in northern states. Recently however, the native aquatic weevil *Euhrychiopsis lecontei* has received the most attention. This weevil has been associated with native northern water milfoil. The weevil can switch plant hosts and feed on Eurasian watermilfoil, destroying it's growth points. While the milfoil weevil is gaining popularity, it is still experimental.

Advantages: Herbivorous insects are expected to have no negative effects on non-target species. The insects have shown promise for long term control when used as part of integrated aquatic plant management programs. The milfoil weevils do not use non-milfoil plants as hosts.

Disadvantages: Natural predator prey cycles indicate that incomplete control is likely. An oscillating cycle of control and re-growth is more likely. Fish predation may complicate controls. Large numbers of milfoil weevils may be required for a dense stand and can be expensive. The weevil leaves the water during the winter, may not return to the water in the spring, and are subject to bird predation in their terrestrial habitat. Application is manual and extremely time consuming. Introducing any species, especially non-native ones, into an aquatic ecosystem may have undesirable effects. Therefore, it is extremely important to understand the life cycles of the insects and the host plants.

Costs: Reported costs of herbivorous insects rang from $300/acre to $3,000/acre.

Specifically, the native milfoil weevils cost approximately $1.00 per weevil. It is generally considered appropriate to use 5 to 7 weevils per stem. Dense stands of milfoil may contain 1 to 2 million stems per acre. Therefore, costs of this new technology are currently prohibitive.

Plant Pathogens: Using a plant pathogen to control nuisance aquatic plants has been studied for many years, however still remains largely experimental. Fungi are the most common pathogens, while bacteria and viruses have also been used. There is potential for highly specific plant applications.

Advantages: Plant pathogens may be highly species specific. They may provide substantial control of a nuisance species.

Disadvantages: Pathogens are experimental. The effectiveness and longevity of control is not well understood. Possible side effects are also unknown.

Costs: These techniques are experimental therefore a supply of specific products and costs are not established.

Native Plants: This method involves removing the nuisance plant species through chemical or physical means and re-introducing seeds, cuttings, or whole plants of desirable species. Success has been variable. When using seeds, they need to be planted early enough to encourage the full growth and subsequent seed production of those plants. Transplanting mature plants may be a better way to establish seed producing populations of desirable aquatics. Recognizing that a healthy, native, desirable plant community may be resistant to infestations of nuisance species, planting native plants should be encouraged as an APM alternative. Non-native plants can not be translocated.

Advantages: This alternative can restore native plant communities. It can be used to supplement other methods and potentially prevent future needs for costly repeat APM treatments.

Disadvantages: While this appears to be a desirable practice, it is experimental at this time and there are not many well documented successes. Nuisance species may eventually again invade the areas of native plantings. Careful planning is required to ensure that the introduced species do not themselves become nuisances. Hand planting aquatic plants is labor intensive.

Costs: Costs can be highly variable depending on the selected native species, numbers of plants ordered, and the nearest dealer location.

Aquatic Plant prevention

The phrase "an ounce of prevention is worth a pound of cure" certainly holds true for APM. Prevention is the best way to avoid nuisance aquatic plant growth. Prevention of the spread of invasive aquatic plants must also be achieved. Inspecting boats, trailers, and live wells for live aquatic plant material is the best way to prevent nuisance aquatic plants from entering a new aquatic ecosystem. Protecting the desirable native plant communities is also often important to maintain a healthy aquatic ecosystem and preventing the spread of nuisance aquatics once they are present.

Prolific growth of nuisance aquatic plants can be prevented by limiting nutrient (i.e. phosphorus) inputs to the water body. Aeration or phosphorus precipitation can achieve controls of in-lake cycling of phosphorus, however if there are additional outside sources of nutrients, these methods will be largely ineffective in controlling algae blooms or intense aquatic macrophyte infestations. Watershed management activities to control nutrient laden storm water runoff are critical to controlling excessive nutrient loading to the water bodies. Nutrient loading can be prevented/minimized by the following:

- Shoreline buffers
- Using non-phosphorus fertilizers on lawns
- Settling basins for storm water effluents

WISCONSIN DEPT. OF NATURAL RESOURCES

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Jim Doyle, Governor
Scott Hassett, Secretary
Ronald W. Kazmierczak, Regional Director

Northeast Region Headquarters
1125 N. Military Ave., P.O. Box 10448
Green Bay, Wisconsin 54307-0448
Telephone 920-492-5800
FAX 920-492-5913
TTY 920-492-5912

April 8, 2003

Andrew Depies, Bob Bordeau, Rick Yadicka
City of Sturgeon Bay
P.O. Box 47
Sturgeon Bay, WI 54235

Subject: Aquatic Plant Managament Plan

Dear City of Sturgeon Bay staff:

The department would like to begin by identifying some of the preliminary results from the survey conducted during 2002 and integrate this with other data to develop a management plan that balances recreational access issues with habitat protection issues.

To start with, there are several issues that need to be considered in the development of an approved strategy that will guide future permit activities for herbicides and harvesting. Mapping of the different use areas, critical habitat, aquatic plant sensitive areas, and active management areas is a critical step in documenting management strategies and conveying them to the public to allow for their informed input into the decision making process. It is important all user groups be informed and allowed to provide feed back into management decisions. Historically feed back from different user groups fell on different ears. The City of Sturgeon Bay often had to deal with the difficult process of educating different user groups about the value of certain habitat areas when dealing with recreational boaters complaints that expressed their dislike of much if any aquatic plants within the City limits . While the fishermen more often expressed their concerns about protecting critical habitat areas to the DNR. A balanced approach must try to balance the two by providing critical navigational access channels and protecting the remaining critical habitat and aquatic plant sensitive areas.

Because of the national importance and recognition of the recreational fishery in the Sturgeon Bay area and its importance to the local economy, efforts should attempt to inform this broader user base of the existing management strategies and their importance and allow for their proper feed back into the decision making process. Print media and conservtion groups such as In-Fisherman, Fishing Facts, Wisconsin Outdoors, BASS, Walleyes for Tomorrow, Muskies inc., and other conservation groups as they are identified should be contacted and allowed to help in the education process if they are willing.

The following maps are a critical element in the development of an effective aquatic plant management plan.

The **map of sensitive areas** -- Designating an area as a sensitive area or as critical habitat does not prevent or eliminate potential consideration of treatment or removal; but, should limit them to what is absolutely necessary for minimal navigational access **(map #1). A detailed discussion of the importance of these sensitive areas will be provided in two DNR companion documents. The first will be "Sturgeon Bay Lake Sensitive Area Survey Report and Management Guidelines" with the**

seciond being "Guidelines For Protecting, Maintaining, and Understanding Lake Sensitive Areas and Critical Habitat".

Map of approved priority navigational channels (mechanical harvesting)

Map of approved areas for chasing floaters (Main Shipping Channel & approved navigational channels)

Map of approved herbicide treatments (Inside of Marinas docks & piers)

Map of "Use Conflict Areas". Areas for consideration of increased protection of habitat ecosystem functional values (Mooring areas that occur within sensitive areas). The City should consider the importance of the sensitive areas which provide critical habitat within a several hundred meters of the Hwy 54/42 bridge. The location of limited mooring areas provides mooring for a few boat users; but, the harvesting activities associated with the mooring areas results in the direct mortality of perch and the subesquent destruction of critical habitat for spawning, nursery areas, and forage and baitfish production. The scarcity of high quality aquatic plant habitat within the Green Bay ecosystem increases the importance of protecting habitat within Sturgeon Bay; one of the few areas that support adequate aquatic plant densities to be a viable Perch spawning and nursery area. In discussions with City staff it appears that they are aware of other areas outside of the designated sensitive areas that may be more suitable for mooring and will look into the possability of moving the existing mooring areas near the Hwy 54/42 bridge through attrition to mooring areas outside of the sensitive areas and use conflict area.

Historic fish surveys and information from the Cities harvesting crew support the importance of the aquatic plant habitat within the areas designated near the Hwy 54/42 bridge. Local perch fishermen also concentrate a great deal of effort in these productive areas. Other gamefish species such as Northern Pike, Muskie, Bass, and Walleye also benefit from these areas as nurseries and as forage fish and invertebrate production areas.

Removal or treatment of vegetation immediately in front of private developed shorelines (<100' from shore) should be done only at the request and approval of the private landowner. It was brought to my attention by some of the landowners that they did not want the City removing vegetation and fish habitat in front of their properties; if, it was to be done they would rather do it by hand on a limited basis.

If it is feasible to hand pull or rake an area, herbicides or mechanical harvesting should not be used. Both Mechanical removal permit applications and herbicide permit applications require the applicant to consider if hand pulling or raking is feasible on an area. If they are feasible the herbicide or mechanical removal should be denied; in favor of a less destructive/invasive method.

With this in mind **(please refer to map #?)** the City should not automatically be pursueing removal of vegetation within near shore areas in front of private property owners within the City limits not essential for public navigation.

The decision on wether or not vegetation should be removed from in front of private property should be left to the individual landowner. **Removal or treatment of aquatic vegetation must be confined to in front of developed shorelines in response to a written request from the private landowner which must be confirmed or requested annually. Before the city initiates removal of vegetation in front of private properties they should do both of the following. First they should provide the landowner with an informational handout explaining the benefits of protecting habitat and the critical habitat**

needs and sensitive areas identified by the DNR. Removal of vegetation in front of private docks should always be accomplished by hand pulling or raking if site conditions (firm substrates that allow for easy wading) allow for easy raking or hand pulling. A hand raking or hand pulling feasability determination must be made and substantiated in writing on all herbicide and mechanical permits request forms. If hand raking or hand pulling is not feasible then and only then can a permit for mechanical or herbicides be considered for approval. Special allowance are made for handicapped and elderly who could not physically perform hand raking or pulling if similar professional services are not available in the area. Herbicides and mechanical harvesting should usually be used for deeper water areas in main navigational access channels, not in front of private docks where hand pulling or raking can be easily done and demonstrated as effective.

If the landowner still wants to pursue removal they shoud provide the City a request letter annually for the specific removal or treatment.

If the city wants to try to assist private individuals with removal of vegetation in front of their private property by mechanical harvesting or treating it with herbicides the City shall provide a letter which lists the positive and negative consequences of the removal or herbicide treatment and allow them to make a decision for the habitat in front of their own property. This informational letter must include the importance of designated sensitive areas with maps and location of property under consideration for removal or treatment. Landowners should not be led to believe that the removal or herbicide treatment is for the benefit of the environment. Habitat fragmentation, cumulative loss and degradation, combined with the additive impacts exotics are placing on the Lake Michigan food chain make each additional impact a greater threat to ecosystem health and should be carefully considered before implementing and must be emphasized in any balanced plan.

Many actions directed at aquatic plants are done under the title exotic species control. In some situations drastic actions are warranted; because of the ability to control a population before it becomes well established. Unfortunately for the Green Bay, Sturgeon Bay, Lake Michigan ecosystem control of curly-leaf pondweed or Eurasion Water Milfoil populations is unlikely. Drastic actions can greatly impact local ecology; while the widespread presence of these exotics insures rapid recolonization of any area localized control efforts are attempted. Localized control efforts for these exotics can have a profound impact on the native species which have to utilize an area. While the exotics are often found in an area that historically provided critical spawning and nursery habitat it does not mean that the exotic species are not providing similar habitat functions. As native fish and invertebrate species are attracted and utilize these areas the impacts of control efforts must be considered. Repeated efforts that only provide minor supression of growth form while substantially impacting spawning success of our native fisheries such as Perch, walleye, bass, and pike in critical habitat areas should not be a regualrly annually repeated process. This is especially true during the early parts of the year when spawning and fry are present. This time of the year usually covers from April through mid to late June when fry are relatively immobile and can be heavily impacted by mechanical harvesting and herbicides.

The designated sensitive areas within Sturgeon Bay provide critical spawning and nursury habitat for perch which have suffered serious population declines in the last decade increasing the importance of striking a balance in management strategies.

Needed changes from 2002 permit:

I. Must allow for chasing floaters within main shipping channel and designated priority navaigational access channles; but, chasing floaters in other areas not identified in the harvesting permit is not allowed.

II. If moderate numbers of gamefish **(>2 dozen?Mike should we enumerate this?)**, even young of the year perch, are encountered in a specific area and habitat type harvesting should be haulted and the Department notified that the city has encountered a high use area for gamefish and harvesting was haulted for the specific area. A report of the area and the fish encountered should be provided to the Department within 48 hours. This may be more of a case for early June activities; but, it must be carefully monitored and reported; so, that the management plan can integrate the value of the area. Once activities are haulted in a specific area because of fishery concerns harvesting should not be resumed until Department staff have determined there is no longer a need to protect the given area and habitat (seasonal use patterns). Department staff may decide to supervise the initial return of harvesting activities to the specific area to insure potential impacts to the fishery and habitat is minimized.

The plan needs to clearly discuss the influence and changes that may and will occur as water levels on Lake Michigan begin to return to normal elevations. The concept of flucatuating water levels and their influence and the need for an adaptive management strategy must be emphasized. Additional aquatic plant surveys should be conducted to update the plan as necessary as water levels change.

Mike Toneys and fisheries staff – we could also identify course rock rubble habitat that is important for spawning and worthy of protecting when considering stormwater runoff impacts, shoreline buffers, other sources of sediment laden runoff pollution, and impacts from existing and proposed solid piers and dredging. This should be included in the larger management plan and maybe the sensitive areas and critical habitat maps.

Management Alternatives & Guidance

I. Harvesting

A. Harvestors can be only operated in approved areas as denoted on permit map
B. Harvesting can be only conducted to mid depth and no harvesting shall take place in water depths shallower than 2 feet. If cutter heads make contact with the bottom and a sediment ploom becomes visible harvesting must be haulted. If contact with bottom occurred while cutter head was at a depth of 4' cutter head must be raised to a depth no greater than 2'. If the cutter head makes repeated contact with the bottom you will be in violation of your permit and may be cited and potentially loose the privaledges associated with the existing permit.
C. If game fish are encountered during a harvesting run all harvesting operations within the immediate area (defined?) shall be haulted. A report of what species and numbers were encountered and the exact location GPS coordinates Lat /Long should be filled out and provided to the Department. Before harvesting can resume the local DNR aquatic plant manager should consult with fisheries staff and determine when harvesting can resume. The local DNR aquatic plant manager should accompany harvestor operators to assess if seasonal use concerns still exist and merit continued protection within the identified area.

II. Herbicide Treatments

A. Systemic herbicides should not be used within Sturgeon Bay; because, of the difficulty in maintaining adequate contact times.

B. Use of copper containg algacides should be confined to locations and times were documented cases of nuisance algae exist. Label instruction list appropriate target species and herbicides can not be used for species not listed on their specific label. Even though labels may allow for mixing of reward with cutrine; cutrine can only be used were listed target species occur at nuisance levels.

III. Mapping of non-point source problem areas

IV. Development of an integrated stormwater management plan

V. Restoration of shoreline buffers

VI. Protection of other critical habitat areas: Coarse rock rubble spawning areas for walleye, smallmouth bass spawning areas, wetland northen pike spawning areas in tributaries and ditches.

VII. Restoration and protection of impervious surfaces and undeveloped green space. There should be an emphasis placed on planning efforts to map and characterize the percent forested land use and wetlands for all subwatersheds. Watersheds with less than 30% forested land use or a 50% reduction in historic wetlands should begin developing an integrated plan to restore and maintain adequate percentages to insure healthy watershed hydrologies which do not overwhelm existing stream channels. Adequate percentages of forested land use and wetlands reduce nonpoint source runoff pollutants while maintaining the overall ecological health of watersheds and helps insure development is accomplished in a manor which balances human needs with the environment.

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Scott McCallum, Governor
Darrell Bazzell, Secretary
Ronald W. Kazmierczak, Regional Director

Sturgeon Bay Service Center
110 S. Neenah Ave.
Sturgeon Bay, Wisconsin 54235
Telephone 920-746-2860
FAX 920-746-2863

January 8, 2003

Tony Depies, Bob Bordeau, Rick Yadicka
City of Sturgeon Bay
P.O. Box 47
Sturgeon Bay, WI 54235

Subject: Aquatic Plant Management Plan

Dear City of Sturgeon Bay Staff:

The department would like to begin by identifying some of the preliminary results from the survey conducted during 2002 and integrate this with other data and the cooperative efforts of Northern Environmental to develop a management plan that balances recreational access issues with habitat protection issues.

To start with, there are several issues that need to be considered in the development of an approved strategy that will guide future permit activities for herbicides and harvesting.

The **map of aquatic plant habitat sensitive areas** within Sturgeon Bay **(see modifications/ additions to the 1/6/2003 map provided by Northern Environmental)** -- Designating an area as a sensitive area or as critical habitat does not prevent or eliminate potential consideration of treatment or removal; but, should limit them to what is absolutely necessary for minimal navigational access **(map #1).**

The Map of aquatic plant habitat sensitive areas within Green Bay. This map is important to provide perspective on how limited similar types of aquatic plant beds are within the Green Bay ecosystem and emphasizes the importance of protecting one of the few remaining areas with this kind of high quality habitat that is important to the rest of the Bay. (See Mike Toneys for his copy of the Green Bay fish habitat use areas). Note much of the similar habitat that used to exist on the west side of Green Bay has been eliminated because of extensive sediment additions from the tributary streams. These sediments are unstable and shift making it difficult to establish extensive aquatic plant beds.

Map of approved priority navigational channels for mechanical harvesting and associated NR 109 permit requirements. Map of approved areas for chasing floaters could be differentiated from the previous areas on the same map by color (Main Shipping Channel & approved navigational channels)

Map of approved herbicide treatments (Inside of commercial Marinas docks & piers)

Limit Mooring / Reduce by Attrition

Conflicting Use Areas (Mooring Area #2)- for consideration of increased protection of habitat ecosystem functional values (Mooring areas that occur within sensitive areas or degrade historic sensitive areas and fragment and reduce the overall habitat quality of the remaining parts). The City should consider the importance of the sensitive areas which provide critical habitat within a several hundred meters of the Hwy 54/42 bridge. The location of limited mooring areas provides mooring for a few boat users; but, the harvesting activities associated with the mooring areas results in the direct mortality of perch and the subesquent destruction of critical habitat for spawning, nursery areas, and forage and baitfish production. There are literally thousands of people nationally that know and appreciate the outstanding fisheries we have in Sturgeon Bay and Green Bay. These fisheries are of significant economic importance to the local economy. The Department would encourage the City to hold informational meetings and publish informational articles that would encourage an open dialog with more of the public on this and other controversial issues. (Contact In-Fishermen to provide an informatioanl article soliciting input from the broader use group of fishermen and various fisheries groups?)

Considerations for Navigational Access Channels in front of Private Property

See the draft map produced by Northern Environmental on 1/6/2003 for background and orientation for the following discussion.

Navigational access channels 1, 2, and 3 located between PBI dock & slips and Leathem Smith Marina should only be cut at the request of the private shoreline landowners. A similar situation exists for the navigational access channels A, B, and C located between Bay View Bridge and Strawberry Creek Estates Marina.

Removal or treatment of vegetation immediately in front of private developed shorelines (<100 yards from shore) should be done only at the request and approval of the private landowner. It was brought to my attention by some of the landowners that they did not want the City removing vegetation and fish habitat in front of their properties; if, it was to be done they would rather do it by hand on a limited basis to protect habitat and water quality.

For this reason side channels or navigational access channels (1, 2, & 3, and A, B, & C should be done only if the riparian property owners request that it be done. At this point and time I would eliminate them from the map as is and begin an educational effort to make riparian landowners aware of the benefits of protecting the habitat. If after providing the appropriate educational materials and meetings they still would like side channels cut you can modify the permit map as needed. Each side channel should be able to reach 4-6 continous properties if requested. If only a single individual requests a side channel widths should be kept to 30' wide. If multiple continous property owners desire a common side channel the width may be increased to 50' with a slightly wider mouth near the docks to provide access to the channel. If situations arise that can't be handled with these allowances please contact the Department and we will work through this with you. Requests for these side channels should be in writing from the perspective landowners. The request for these channels should be confirmed in writing each year by each property owner. This insures that improper removal from in front of someones property does not occur if it has changed ownership.

If it is feasible to hand pull or rake an area, herbicides or mechanical harvesting should not be used. Both Mechanical removal permit applications and herbicide permit applications require the applicant to consider if hand pulling or raking is feasible on an area. If they are feasible the herbicide or mechanical removal should be denied; in favor of a less destructive/invasive method.

Removal or treatment of aquatic vegetation must be confined to in front of developed shorelines.

If the city wants to try to assist private individuals with removal of vegetation in front of their private property by mechanical harvesting or treating it with herbicides the City shall provide a letter which lists the positive and negative consequences of the removal or herbicide treatment and allow them to make a decision for the habitat in front of their own property. This informational letter must include the importance of designated sensitive areas with maps and location of property under consideration for removal or treatment. Landowners should not be led to believe that the removal or herbicide treatment is for the benefit of the environment. Habitat fragmentation, cumulative loss and degradation, combined with the additive impacts exotics are placing on the Lake Michigan food chain make each additional impact a greater threat to ecosystem health and should be carefully considered before implementing and must be emphasized in any balanced plan or presentation. Removal of vegetation in front of private docks should always be accomplished by hand pulling or raking if at all possible on as limited basis as is needed to provide navigational access. Herbicides and mechanical harvesting should usually be used for deeper water areas in main navigational access channels, not in front of private docks where hand pulling or raking can be easily done and demonstrated as effective.

Many actions directed at aquatic plants are done under the auspices of exotic species control. In some situations drastic actions are warranted; because of the ability to control a population before it becomes well established. Unfortunately for the Green Bay, Sturgeon Bay, Lake Michigan ecosystem control of curly-leaf pondweed or Eurasion Water Milfoil populations is unlikely. Drastic actions can greatly impact local ecology; while the widespread presence of these exotics insures rapid recolinization of any area localized control efforts are attempted. Localized control efforts for these exotics can have a profound impact on the native species which have to utilize an area. While the exotics are often found in an area that historically provided critical spawning and nursery habitat it does not mean that the exotic species are not providing similar habitat functions. As native fish and invertebrate species are attracted and utilize these areas the impacts of control efforts must be considered. Repeated efforts that only provide minor supression of growth form while substantially impacting spawning success of our native fisheries such as Perch, walleye, bass, and pike in critical habitat areas should not be a regularly annually repeated process. This is especially true during the early parts of the year when spawning and fry are present. This time of the year usually covers from April through mid to late June when fry are relatively immobile and can be heavily impacted by mechanical harvesting and herbicides.

Needed changes from 2002 permit:

I. Must allow for chasing floaters within main shipping channel; but, chasing floaters in other areas not identified in the harvesting permit is not allowed.

II. If moderate numbers of gamefish **(>dozen?Mike should we enumerate this?)**, even young of the year perch, are encountered in a specific area and habitat type harvesting should be halted and the Department notified that the city has encountered a high use area for gamefish and harvesting was halted for the specific area. A report of the area and the fish encountered should be provided to the Department within 48 hours. This may be more of a case for early June activities; but, it must be carefully monitored and reported; so, that the management plan can integrate the value of the area. Once activities are halted in a specific area because of fishery concerns harvesting should not be resumed until Department staff have determined there is no longer a need to protect the given area and habitat (seasonal use patterns). Department staff may decide to supervise the initial return of harvesting activities to the specific area to insure potential impacts to the fishery and habitat is minimized.

The plan needs to clearly discuss the influence and changes that may and will occur as water levels on Lake Michigan begin to return to normal elevations. The concept of fluctuating water levels and their influence and the need for an adaptive management strategy must be emphasized. Additional aquatic plant surveys should be conducted to update the plan as necessary as water levels change.

Mike Toneys and fisheries staff – we could also identify course rock rubble habitat that is important for spawning and worthy of protecting when considering stormwater runoff impacts, shoreline buffers, other sources of sediment laden runoff pollution, and impacts from existing and proposed solid piers and dredging. This should be included in the larger management plan and maybe the sensitive areas and critical habitat maps. Northern Environmental should contact Mike Toneys if they would like further information about fisheries data. A fall fish survey was conducted in 2002 and additional spring fyke net and other survey data have been collected in past years. Much of this was used to help in designation of sensitive areas.

General Exotics Management Considerations

With the widespread establishment of Eurasion Water Milfoil (EWM) and Curly-leaf Pondweed in Sturgeon Bay, Green Bay, and much of Lake Michigan it is unlikely that small localized treatments or removals will result in any effective control of the exotics population. With this in mind we need to consider that attempts to eliminate the exotic from a relatively small area can have profound effects on the fish and invertebrates utilizing the area. With much of the historic high quality native aquatic plant habitats co-occupied with EWM and Curly-leaf Pondweed the native fisheries have become dependent upon these areas to provide critical habitat during particularly sensitive time of the year. Spawning and nursery areas are of particular importance during the early times of the year (April through June).

If these exotics weren't so widespread and you were trying to reduce the spread of the exotic you could do early season removal to reduce turion developoment therebye reducing potential expansion; but, since it is so well established the relief you get from early season removals will be minimal and offset by all the surrounding areas that will go untreated. However, early season harvesting does pose a serious threat to critical ecosystem functional values such as spawning and nursery areas.

Management Alternatives & Guidance

I. Harvesting

A. Harvestors can be only operated in approved areas as denoted on permit map. All harvestor operators must have read and understood the permit and attachments before they can operate any harvesting equipment and they must be capable of explaining the permit requirements as laid out in the permit. Continued operation of harvesting equipment not in accordance to the conditions of the permit places the operator, the supervisors, and the city in violation of their permit and may result in fines or loss of permit privledges.

B. Harvesting can be only conducted to mid depth and no harvesting shall take place in water depths shallower than 2 feet. If cutter heads make contact with the bottom and a sediment ploom becomes visible harvesting must be haulted. If contact with bottom occurred while cutter head was at a depth of 4' cutter head must be raised to a depth no greater than 2'. If the cutter head makes repeated contact with the bottom you will be in violation of your permit and may be cited and potentially loose the privledges associated with the existing permit.

C. If numerous **(define numerous)** game fish are encountered during a harvesting run all harvesting operations within the immediate area **(defined?)** shall be haulted. A report of what species and numbers were encountered and the exact location GPS coordinates Lat /Long should be filled out and provided to the Department. Before harvesting can resume the local DNR aquatic plant manager should consult with fisheries staff and determine when harvesting can resume. The local DNR aquatic plant manager and fisheries staff should accompany harvestor operators to assess if seasonal use concerns still exist and merit continued protection within the identified area before resuming normal harvesting operations within the identified arae.

D. If possible the local DNR aquatic plant manager and fisheries staff should accompany harvestor operators the first few days they begin harvesting each year to assess each area for potential fishery impacts. → Mike Toney$ Cahow through 2003

II. Herbicide Treatments

A. Systemic herbicides should not be used within Sturgeon Bay; because, of the difficulty in maintaining adequate contact times.

B. Use of copper containg algacides should be confined to locations and times were documented cases of nuisance algae exist. Label instruction list appropriate target species and herbicides can not be used for species not listed on their specific label. Even though labels may allow for mixing of reward with cutrine; cutrine can only be used were listed target species occur at nuisance levels as listed on the cutrine label.

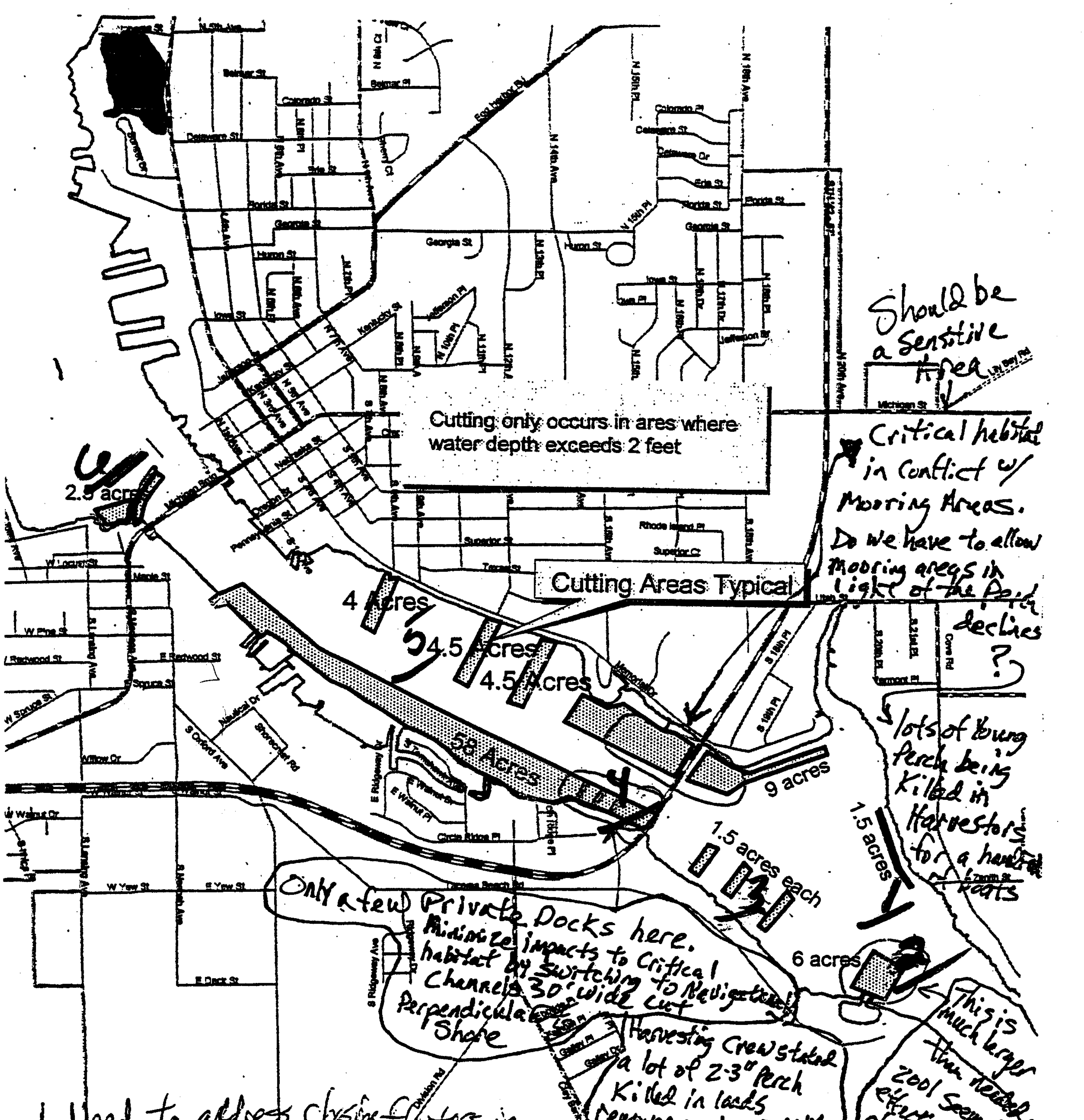
III. Mapping of non-point source problem areas

IV. Development of an integrated stormwater management plan

V. Restoration of shoreline buffers

VI. Protection of other critical habitat areas: Coarse rock rubble spawning areas for walleye, smallmouth bass spawning areas, wetland northen pike spawning areas in tributaries and ditches.

VII. Restoration and protection of impervious surfaces and undeveloped green space. There should be an emphasis placed on planning efforts to map and characterize the percent forested land use and wetlands for all subwatersheds. Watersheds with less than 30% forested land use or a 50% reduction in historic wetlands should begin developing an integrated plan to restore and maintain adequate percentages to insure healthy watershed hydrologies which do not overwhelm existing stream channels. Adequate percentages of forested land use and wetlands reduce nonpoint source runoff pollutants while maintaining the overall ecological health of watersheds and helps insure development is accomplished in a manor which balances human needs with the environment.



1. Need to address chasing floaters in Main Navigational Channel → provide language in 2003 permit to allow.
2. Need to address halting any harvesting when encountering numerous fish as on June 3rd-5th even in approved areas → We are going to use incidental information from harvesting reports to identify fishery

Fall 2002

Fish Survey

By

Mike Toneys

Previous Surveys available in S.B. Office from Tim Kroeff

9-4-02

PAGE 1 of 3

Cove Rd. #1 300 yds 730–740 10 min. Shocked

Bullhead – 卌 卌 卌 卌 卌 II (27)

Sunfish – II (2)

Y. Perch – 卌 II (7)

P. Seed – I (1)

Carp – I (1)

0.7 Perch/min

STRAWBERRY CK. ESTATES #2 745–756 11 min. shocked

Bullhead – 卌 卌 卌 III (18)

P. Seed – 卌 卌 卌 (9)

P. Seed YOY – 1 (1)

DRUM – 1 (1)

Ch. Cat – 1 (1)

Y. Perch – IIII (4)

.36 Perch/min

Carp – II (2)

SMB – 1 (1)

Giz. Shad – 20 (20)

NP – 1 (1) NP YOY – 1 (1)

TAHCOMA BEACH #3 757–817 20 mins shocked

P. Seed – 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 III 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 (148)

Bullhead – 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 (95)

Y. Perch – 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 (95)

Carp – 卌 卌 I (11)

SMB – II (2)

Giz. Shad – IIII (4)

Wh. Sucker – 1 (1)

Y. Perch 卌 卌 卌 卌 卌 卌 卌 卌 卌 II (47)

4.1 Perch/min

Bullhead 卌 卌 II (12)

Bowfin – II (2)

most Perch Yearlings

Burmiesters =4 817-822 - 5 min. Shocked

Giz. Shad - ||| 3
Wh. Sucker - |||| 5
R. Seed - |||| |||| | 11
Bullhead - ||| 3
Y. Perch - |||| 4

0.8 Perch/MIN

Memorial Drive =5 831-856 25 min. Shocked

Giz. Shad - , 25, 114, 17,
Y. Perch - 53
Wh. Sucker - ||| 3
Bullhead - 90
P. Seed - 53 R.Seed YOY - , 15, Lots
SMB - || 2
Drum - |||| ||| 8
Carp - |||| |||| 9
Bowfin - ||| 3
P. Seed - 81
Bullhead - 31
RockBass - | 1

2.1 Perch/MIN

Page 3 of 3

9-4-02

RR TRESLE =6   905-914   9 min Shocking

G.Z. Shad - ~~||||~~ ~~||||~~ ~~||||~~ || 17

Rock Bass - | 1

Bullhead - || 2

P. Seed - ~~||||~~ 5

0 Perch

SMB - | 1

Wh. Suckers

Shocker Setting

9.5 - 10.5 amps

Volts 175

Duty Cycle 25

Pulse rate 50

GUIDELINES FOR PROTECTING, MAINTAINING, AND UNDERSTANDING LAKE SENSITIVE AREAS AND CRITICAL HABITAT

A companion document to better help understand lakes sensitive area reports

James M. Cahow
Water Resources Biologist
DNR, Northern Region, Barron

Richard R. Cornelius
Fisheries Biologist
DNR, Northern Region, Barron

TABLE OF CONTENTS

GUIDELINES FOR PROTECTING, MAINTAINING, AND UNDERSTANDING LAKE SENSITIVE AREAS AND CRITICAL HABITAT

This document was originally designed to be used in conjunction with specific lake sensitive area survey reports; **but it can also be useful to other parties interested in protecting lakes by helping them understand important factors which affect water quality and lake ecosystem health**. This document will concentrate on several main areas within the lake and its' shoreline areas that can be protected or restored to maintain water quality and lake ecosystem health. These main areas include aquatic plant sensitive areas, shoreline land use and lakeshore buffers, gravel and coarse rock rubble habitat, large woody debris, and various water regulations and zoning concerns.

This document will not attempt to deal with land use problems that do not fall within the immediate shoreline areas; although it should be recognized that lakes may have problems that occur in these outlying areas of their watershed resulting in significant nutrient and sediments additions that threaten the overall health of the lake ecosystem and should be dealt with through land acquisition and subsequent deed restrictions and implementation of non-point source control best management practices.

UNDERSTANDING AQUATIC PLANT SENSITIVE AREAS

The importance of aquatic plant communities are frequently under appreciated and their importance to a lake's ecosystem health misunderstood. This is often evident by the way people refer to aquatic plant habitat as problem weeds or weed beds. A weed by definition is a plant that is out of place or a plant of no value. The vast majority of native aquatic plants grow where they should be growing based on available light (water clarity & light penetration), water depth, and bottom substrate or soils and are not out of place and as previously stated are extremely important for the proper functioning of a healthy lake ecosystem and are an integral part of the biotic integrity. Aquatic plants (macrophytes & algae) are the primary energy source upon which the rest of the lakes food chain is based and dependent upon. Fisheries are dependent upon them for cover, spawning habitat, important habitat and cover for fingerlings and young of the year, critical habitat for aquatic insects and other important food or forage species (minnows). They also serve an important function in reducing the shoreline erosion associated with wave action while stabilizing sediments in place, and aquatic plants lock up available phosphorus which would otherwise be available to drive undesirable algae blooms.

Aquatic plants also provide many important functional values for wildlife: Loons require aquatic vegetation for their nests, and waterfowl and furbearers require aquatic vegetation for food and cover. Songbirds, shoreline waterbirds, frogs and other amphibians, reptiles, and a host of other wildlife require aquatic vegetation for some critical need throughout different life cycles.

Use of Aquatic Herbicides

Because the potential ecological risks associated with aquatic herbicide applications are so high, most aquatic herbicide applications must be approved through the DNR permitting system and the application must be completed by a DATCP certified aquatic herbicide applicator. Those herbicides that don't require a DNR permit are often inappropriate for the existing site conditions or species present resulting in potential impacts without real nuisance relief.

The herbicides that don't require a permit are resticted to granular or pellatized forms and usually will only work in a narrow set of environmental conditions. If the site conditions include much of any fine floculant sediments effectiveness can be dramatically reduced or eliminated. Many of these herbicides will work on only a limited number of species which may not even occur on the site increasing the importance of having a qualified applicator capabale of identifying the species present and the site conditions which can limit herbicide effectiveness. In the long run most people would be far better off trying to limit vegetation by hand pulling or raking and if these are not feasible contacting a DATCP certified aquatic herbicide applicator to have them assess the different control methods suitable for the site.

In most cases aquatic herbicide applications should be discouraged because:

I. Less invasive or less destructive methods of control are feasible for the site and may include one or more of the following: mechanical harvesting, hand pulling, hand raking, hand cutting, and nutrient controls within the watershed. All too often herbicide treatments are conducted adjacent to private docks in situations where hand pulling or raking were easily a viable option and should have been the only allowable practice.

Before taking action a careful assessment of existing conditions should be conducted and should include: importance of existing habitat areas, actual needs for clearing of aquatic plant habitat (navigational access does not require removal of all vegetation; only a reduction in density), and consideration of the cumulative impacts of removing aquatic plant habitat or treating it and the organisms living in it or around it with herbicides.

II. Can result in an overall reduction or fragmentation of important native aquatic plant habitat.

III. Creates openings in areas that should be colonized by native aquatic plant species. These openings provide increased opportunities for exotic species to become established in the lake and once established provide opportunities for their expansion.

IV. Results in direct and indirect mortality of sensitive or intolerant immobile species such mussels and other invertebrates. Some treatments can also result in the gradual build up of copper in the lake bed sediments to the point of being toxic to aquatic organisms. Several lakes in Northwestern Wisconsin have already reached or are approaching copper concentrations or levels that would be toxic or considered a lethal dose to 50% (LD50) of selected aquatic organisms exposed to similar concentrations under laboratory conditions. A serious problem that needs to be carefully considered is that copper does not break down, and it continues to build in concentration in the lake bed sediments with each subsequent treatment containing copper.

If people are going to treat aquatic plants they must understand that the available phosphorus will be expressed in larger plants or algae. Any attempts to suppress the expression of the available phosphorus will usually be very short term (7 days). It is difficult to justify adding toxic chemicals which do not break down and continue to build up towards toxic levels with each subsequent treatment. For this reason aquatic herbicide treatments containing copper should be restricted to exceptional circumstances and not used on a regularly reoccurring basis.

V.

If the average landowner width is 100' or less and the minimum effective herbicide treatment width of 30' is applied by most shoreline property owners around a lake, the cumulative impacts of the treatment could eliminate or seriously impact greater than 30% of the available habitat. This reduction in available habitat can result in an even greater percentage reduction in the overall fish populations for the lake. Elimination of habitat in even a small percentage of a lake, especially in critical habitat areas, can cause the collapse of a fishery.

V. Aquatic plants lock up available phosphorus which would otherwise be available to drive undesirable algae blooms.

VI. Aquatic plants serve an important function in reducing the shoreline erosion associated with wave action while stabilizing sediments in place.

VII. Aquatic plant management staff routinely hear complaints from shoreline property owners who expected their contracted aquatic herbicide application to eliminate all of the vegetation from the treatment area for a significant portion of the summer period. Most aquatic herbicides are effective on only a portion of the total aquatic plant community at a given site (species selective).

Free-floating species such as coon tail (*Ceratophyllum* sp.) and duckweed (*Lemna* sp.) also often drift back into treated areas with the next pervasive wind, eliminating the benefits they had expected from the chemical treatment. Other species such as Elodea, curly-leaf pondweed, milfoil, and other species easily fragment at times of the year and also drift into treatment areas eliminating or reducing the benefits of the previous treatment.

Hand raking or pulling near docks and in front of private developed properties eliminates the guess work out of what will be removed or eliminated when compared to expensive herbicide treatments with health concerns, use restrictions, and limited effectiveness.

Recent changes affecting mechanical removal and hand pulling of aquatic vegetation

Prior to the passing of Senate Bill 55 in September 2001, mechanical removal of aquatic plants was unregulated provided the lake bottom was not disturbed, the cut plants were removed from the lake and not allowed to drift free, and the plants cut and removed did not include rice or those that are a part of a floating bog mat.

As exotic species, such as Eurasion Water Milfoil, expand their distribution within the state, more opportunities for spreading these exotics will occurr. The risk of an exotic becoming established in a new lake is dramatically increased if the native species of aquatic plants that normally occupy a specific habitat type have been eliminated or reduced. When exotics are introduced into an area they have to find a suitable location to become established. If all the suitable growing sites are occupied by native species the exotic will have a much more difficult time establishing a reproducing population.

The Department has recently developed the necessary administrative rules within NR 109 to comply with the legislative mandates of SB 55. These focus on protecting native aquatic plant habitat to reduce the risk of exotic species invasions, while also recognizing the importance of protecting and maintaining the native aquatic plant habitat and the functions it performs in maintaining overall lake health. These rules limit shoreline removals of aquatic plant habitat without a permit to less than a 30' width; with the restrictions that this 30' width also include docks and other human activity areas that result in the loss or degradation of aquatic plant habitat.

If individual shoreline owners would like to consider removing vegetation by hand pulling or raking in widths greater than 30' they must apply for an aquatic plant management permit with their local DNR aquatic plant management specialist. It is unlikely that the Department will approve many alterations beyond the standard 30' width because of the concerns related to: creating more areas devoid of native vegetation which increases opportunities for possible colonization sites for exotics, cumulative losses of overall habitat, and the fragmentation and degradation that impairs the remaining habitat.

Summary of management recommendations for the protection and restoration of aquatic plant communities

The following management recommendations provide some basic concepts that can be used or implemented to insure the long term health of aquatic plant communities and the overall health of lakes ecosystems.

1. Prohibit chemical treatment of aquatic plants accept under extenuating circumstances such as:
   A. The habitat to be treated is a dominant feature in the lake and the cumulative treatment of small areas will not reduce the overall percentage of coverage from historic coverages.
   B. There is no other management alternative that will work to clear necessary navigational access channels identified in a Department approved management plan (post 2000)
   C. Treatment will not result in a loss of critical habitat
   D. It can be shown that chemical treatment will result in an improvement to the overall health of the ecosystem.
   E. a serious use problem clearly exists
2. Discourage mechanical harvesting of aquatic plants in most circumstances. Clear only Department approved NR 109 permitted navigational channels 20'-30' wide. If small areas adjacent to docks are to be cleared of vegetation hand raking or pulling should be used if at all possible. Please consider the cumulative impacts if everyone was to duplicate the actions you take on your property around the rest of the lake.
3. Educate lake users about the value and importance of native aquatic plant habitats. Lake districts and associations should try to educate new property owners as soon as possible about the value of critical habitat and the laws associated with protecting lakes and lake front property.
4. Apply aggressive erosion control measures to all bare soil areas
5. **Protect** existing natural plant cover in upland areas within at least a 50'-60' corridor of the waters edge and **reestablish** an **effective buffer** of natural plant cover where it has been eliminated. This corridor or buffer is an important component in protecting water quality and habitat against eutrophication and sedimentation and provides critical habitat for our shoreline species of wildlife. Lake districts and associations should try to educate new property owners as soon as possible about the value of **shoreline buffers** and the laws associated with protecting lakes and lake front property.
6. Encourage the strict enforcement of existing zoning

regulations and encourage their strengthening and uniform enforcement.

7. Provide follow through and feed back with public officials when it comes to waivers and variances of existing zoning regulations and building codes
8. Encourage the requirement of mandatory erosion control plans for all building permits that require ground breaking
9. Filling, dredging, or other shoreline or littoral zone alterations covered by chapter 30, Wisconsin Statutes, should be prohibited unless there is clear evidence that such an alteration would benefit the lake's ecosystem.
10. Lake districts should carefully consider the value of purchasing shallow water bays with extensive aquatic plant communities to insure that future development does not result in an impact or a loss of this valuable habitat.

SHORELINE LANDUSE AND LAKESHORE BUFFERS

The impacts that can result from shoreline development can be greatly reduced if done carefully with respect to the many important functional values that must exist to maintain a healthy lakes ecosystem. Natural shoreline vegetation provides important protection for lake water quality as well as ecosystem health and should be maintained for at least a 50-60' buffer strip adjacent to any waterbody. If shorelines have a steeper gradient than 10-15% the buffer strip width should be increased. Access corridors through this buffer zone are restricted by most county zoning regulations. Restrictions usually prevent the clearing of woody vegetation and mowing to no more than a 30' width of the shoreline. Property owners that care about the health of their lake's ecosystem can go a step further by reducing the clearing of vegetation to a narrow foot path. The best design for a foot path is an irregular trail that does not go in a direct line to the lake but has irregular meanders much like a stream with small berms and humps to prevent runoff from flowing directly down the path and preventing the path from become an area of concentrated flow for the direct delivery of sediments and nutrients.

The importance of maintaining the zone of no disturbance of the natural vegetation along the lake shoreline is important for several reasons. As land is cleared and developed irregular surface areas are lost, leveled, and filled in by earth moving equipment, reducing infiltration and increasing runoff. The natural spongy layer of decaying leaves and plant matter is also removed further reducing infiltration and increasing runoff. Soil porosity is also decreased, decreasing infiltration and increasing runoff. As we lose or simplify the layers present (trees, shrubs, and unmowed herbaceous ground cover) in the shoreline areas we decrease the layers present for the interception of rainfall; each layer present reduces the energy and volume of rainfall striking the grounds surface thereby reducing what is available for the mobilization and transport of sediments and nutrients from the ground's surface to the lake. The greater the volume of runoff the more energy available for the transport of nutrients and sediments from surrounding land uses into the lake to drive algae blooms and bury important shoreline habitats.

Shoreline buffers also increase the build up of leaf litter forming a spongy layer to absorb more precipitation and runoff reducing the amount of sediment and nutrients reaching the lake and negatively impacting water quality and habitat. The denser unmowed vegetation also filters sediments and nutrients from runoff.

Each of these three layers (trees, shrubs, and herbaceous ground cover) provide different important habitat components for different life cycle requirements of various wildlife. If any one layer is missing the ability of certain wildlife species to survive may be compromised. Leaving wider areas of uncut vegetation (Buffer Zones) increases the likelihood that adequate habitat will exist for many species of songbirds, who are at risk from the loss of this valuable lake shoreline habitat. Furbearers, raptors, frogs, deer, and other wildlife also benefit from these wider natural areas.

The aesthetic perspective also needs to be evaluated. Everyone likes to look out and see the lake, but very few people like to look at an intensively developed shoreline that reminds them of the urban yards and hectic pace they were trying to get away from. Maintaining the natural wild character of a lake should be the highest priority guiding any development activities. Both man and wildlife will lose if the natural character is allowed to be manipulated to the point our lakeshores begin to resemble urban yards and lawns. This emphasizes the importance of insuring that development is done carefully to maintain as many of the important functional values that the natural undeveloped shoreline had.

The restoration of a naturally vegetated buffer for at least 50'-60' from waters edge should be a very high priority for properties that have been cleared or converted. As previously stated a healthy buffer includes the native trees, shrubs, and herbaceous ground cover that would naturally have existed on a given site or location. The native species can usually be identified by looking at undeveloped shoreline areas.

Summary of management recommendations for the protection and restoration of natural vegetative shoreline buffers

1. Educate landowners about the importance of a healthy lakeshore buffer
2. Encourage the strict enforcement of existing zoning regulations and encourage their strengthening and uniform enforcement.
3. Provide follow through and feed back with public officials when it comes to waivers and variances of existing zoning regulations and building codes
4. Encourage the requirement of mandatory erosion control plans for all building permits that require ground breaking
5. Provide direct oversight of all building crews and insure that as little as possible of the natural plant cover is disturbed during the construction phases.
6. Utilize only the native indigenous species for shoreline buffer restoration efforts and carefully consider site limitations (soil type, soil moisture regime, and shade preferences of plantings) when selecting appropriate species. Restoration efforts should follow a least disturbance scenario; by first halting mowing within at least the shoreline buffer zone (35' back from the waters edge and with no more than 30' width of the shoreline cleared for access purposes; landowners that care about the health of their lake ecosystem are encouraged to go beyond the minimum requirements of the law and increase buffer width and decrease the length of shoreline cleared of vegetation for access). It is important to remember that any ground breaking activities increases the opportunity for transport of sediments and nutrients into the lake; especially within the lakeshore buffer zone.

   Landowners should expect that initial recovery of the natural vegetation within the ground cover layer may take one or two full growing seasons, after halting mowing activities. Vegetation can usually re-establish it's self from the natural seed bank available within the existing soils and from the seeds and rootstalks of adjacent plant communities. Plug plantings of the native herbaceous groundcover species can be used to achieve adequate density and diversity if recovery appears to be sparse in successive years. Supplemental plantings to establish adequate densities for the tree and shrub layer will have to be used in most situations.

The native species that should be used to restore the lakeshore buffer in order to provide the proper habitat and water quality protection functions necessary to insure a healthy Northern Wisconsin lake ecosystem are available through County Land and Water Resources District Conservation staff, please refer to the list of contact names and numbers at the end of this document.

ZONING AND REGULATION CONSIDERATIONS FOR LAKE PROTECTION

Filling, dredging, or other shoreline or littoral zone alterations covered by chapter 30, Wisconsin Statutes, should be prohibited unless there is clear evidence that such an alteration would benefit the lake's ecosystem. Sea-walls should not be used and sand blankets should not be allowed in almost all situations. Rock rip-rap should be used only when anchoring difficult shorelines with problematic erosion which can not be handled with just restoration of the native vegetation. If questions arise or problem areas exist lakeshore property owners should call their local DNR water regs staff for assistence or to report a problem area which may be negatively impacting lake water quality or habitat. A list of locally available technical assistence contact names and phone numbers is provided at the end of this document for easy reference.

County shoreland and wetland zoning regulations apply to the areas within 1000 feet of lakes, ponds, and flowages and within 300 feet of rivers, streams, and creeks. The intent of zoning regulations is to promote wise land use planning while allowing careful development around our precious surface water resources. Most of the counties in northwestern Wisconsin now have lakes classifications which require or prescribe certain setbacks for all structures and the maintainence or re-establishment of shoreline buffers to protect water quality and habitat needs. Most of them **as a minimum** allow for reasonable use of shoreline areas by allowing a

30' wide access/viewing corridor through the buffer. The remainder of the lot from the waters edge back 35'should be restored to a natural condition with trees, shrubs, and unmowed herbacious ground cover including various grasses, sedges, forbs, and wildflowers. On more sensitive lakes county classifications may require or prescribe a wider buffer width and lakeshore property owners are encouraged to contact their **local county conservationist** and determine what the specific requirements are for shoreline buffers on their lake. A list of locally available technical assistence contact names and phone numbers is provided at the end of this document for easy reference.

In all cases during development, the maintenance of a naturally vegetated buffer zone is critical to preserve a healthy lake ecosystem. In situations where the vegetation has been removed or altered landowners are encouraged to reestablish a buffer zone composed of the natural plant communities that belong there. For technical assistence in restoring your shoreline buffer please contact your local county conservationist or county shoreline BPM technician using the names and numbers provided at the end of this document. This ensures that you not only get water quality protection, but you also get the important functional values that the native plants provide for food and cover for shoreline species of wildlife dependent upon them.

EROSION CONTROL DURING LOT DEVELOPMENT

This is one area that can have a dramatic effect on water quality and habitat if it is not done correctly. The volume of sediments and nutrients that can be transported to a lake during the construction phase can equal the amount that would normally have only come off from the same parcel of land over a period of hundreds of years. The compounding effect of this nutrient load can have a dramatic effect on long term lake water quality. By following some basic rules during the construction phase we can keep most of these sediments and nutrients in place and prevent them from becoming a part of the lakes internal nutrient cycle that could cause a shift from a clear lake to one that has ample nutrients to drive extensive algae blooms each year.

Adequate soil erosion control measures and their proper maintenance during construction are very important and should become a very high priority for individual property owners. Lake association members could play an active part in reaching property owners before the damage is done or minimizing impacts by identifying active sites that need erosion control measures and contacting property owners to encourage proper implementation of erosion control measures. County zoning staff and officials need public support to get more effective zoning regulations on the books. Public support needs to be expressed if adequate county staff are to be hired to meet the increasing demands that are being placed on them by expanding development. As is most counties suffer from inadequate staff to deal with existing work demands. Mandatory erosion control plans should be a requirement for all building permits that will involve ground breaking. This needs to be coupled with adequate staff to insure that erosion control plans are being followed and properly implemented and that erosion control measures are properly maintained. More recently county governments have begun to deal with these difficult issues.

Until county wide erosion control ordinances can be established it is strongly recommended that individuals require contractors to develop erosion control plans prior to the initiation of any construction, then the landowner should ensure that it is adequate. Aggressive follow through after construction has begun is also important to insure erosion control practices are properly implemented and maintained.

By giving erosion control careful consideration prior to construction serious impacts to our lakes and streams can be minimized or avoided entirely. Yards can be designed with subtle burms to divert runoff into internally drained areas or into constructed depressions to allow sediments and nutrients to settle out and be trapped before reaching our streams and lakes. Silt screen fences, properly installed during construction can protect against "sheet" runoff. Other erosion control methods are required on steep slopes or difficult sites. Your county land conservation staff or DNR technical support can provide expert advice about erosion control.

Protect all top soil piles by properly locating them away from drainage ways and as far away from the lake as possible. Surround them with a ring of silt screen fence while also seeding them down with an annual rye grass to provide additional stabilization until they are needed.

Never divert rainfall runoff from driveways, roofs, or access roads directly to the lake through draintiles, culverts, or waterways. Instead, divert runoff into internally drained areas, constructed depressions to allow for settling of sediments and nutrients, or at least into a thickly vegetated site that will provide some degree of filtration and infiltration of runoff.

Management recommendations for constructions site erosion control

1. Minimize disturbance of natural plant communities within shoreline areas (50'-60' from waters edge) so they can continue to act as a buffer protecting lake water quality by filtering runoff and providing for infiltration before it reaches the lake.

2. Provide direct oversight of the construction crew during development. Insure that clearing of vegetation is kept to the minimum needed to accomplish the desired construction and avoid any disturbances within at least 50'-60' of any shoreline

   A. Insure that silt screen fences are installed and maintained.
   B. Apply mulch to all bare soil areas that may be exposed to precipitation during none work hours, and especially make sure mulch is applied before weekends. Purchase and use excelsior erosion control mats and other products where necessary.
   C. Provide coarse gravel and crushed rock cover for all areas that have regular heavy equipment traffic, i.e. driveways. Keep all vehicle traffic confined to these protected road surfaces.
   D. Include landscape designs for the protection of water quality i.e., such as holding ponds and depressions which provide for the opportunity to capture and hold runoff while maximizing infiltration and allowing sediments and nutrients to settle out.
   E. Try to eliminate or minimize areas of concentrated flow by reducing the surface area draining through a single path or channel and encouraging flow over multiple paths into depressional areas through the use of berms and other best management practices (BMPs).

3. Report serious erosion control problems that aren't being dealt with in a timely manner; before, they can result in significant impacts to water quality and habitat.

PROTECTION OF GRAVEL AND COARSE ROCK RUBBLE HABITAT

Gravel and coarse rock rubble free of silt and sediments are critical to the successful reproduction of some walleye stocks. Gravel and coarse rock rubble free of silt and sediments are also critical to the survival of different components of the aquatic food chain that supports a healthy lake ecosystem, including aquatic insects, crayfish, and other forage or food species. The greatest threat to these critical habitats is shoreline development that is not accomplished in a manner that maintains an adequate buffer of undisturbed land and does not implement and maintain proper erosion control measures. This buffer is particularly important during ground breaking and construction of lake shoreline areas, because it traps sediments and nutrients within the vegetation and irregular surface areas and small depressions preventing them from reaching the lake and driving algae blooms or burying important habitat.

Summary of management recommendations for the protection of rock rubble *walleye spawning* habitat

1. Educate landowners about the importance of a healthy lakeshore buffer (filter out sediments)
2. Encourage the strict enforcement of existing zoning regulations and encourage their strengthening and uniform enforcement.
3. Provide follow through and feed back with public officials when it comes to waivers and variances of existing zoning regulations and building codes
4. Encourage the requirement of a mandatory erosion control plan for all building permits that require ground breaking
5. Provide direct oversight of all building crews and insure that as little as possible of the natural plant cover is disturbed during the construction phases.
6. Do not use sand blankets to convert natural bottom types to sterile beach sand.
7. Filling, dredging, or other shoreline or littoral zone alterations covered by chapter 30, Wisconsin Statutes, should be prohibited unless there is clear evidence that such an alteration would benefit the lake's ecosystem.

MAINTENANCE OF LARGE WOODY DEBRIS

Large woody debris or trees should be left in the lake as they naturally collapse and fall into the lake. Large woody debris is often overlooked for its importance in providing critical fish habitat. Species such as largemouth bass require some sort of cover to successfully nest and rear offspring. Bluegills and other species also benefit from the presence of large woody debris. The conversion or removal of natural plant cover within a 50'-60' corridor of the lake reduces or eliminates completely the opportunity for the replacement of large woody debris as well as other important functional areas important the any lake's ecosystem health and should be discouraged. The way we look at large woody debris should in the context of its importance to the health of the lake ecosystem. Preformulated perceptions drawn from urban experiences or practices used in urban areas can be very destructive to the way natural environments function in a complex interconnected fashion. A shoreline ringed with fallen trees should not be looked at as untidy or unkempt but one that is providing important habitat for fish and wildlife. Fishermen have recognized for decades that fallen trees are often some of the best habitat to fish for bass and panfish. This emphasizes the need to re-assess our value system and begin leaving them for important habitat. Fisheries managers in recent years have begun to increase their educational efforts in this particular area but still have a majority of the public to reach with this important message.

Management recommendations for woody debris

1. Educate lake shore owners about the value of allowing trees to fall into the lake naturally in order to provide valuable habitat for fish and wildlife.
2. Encourage lake shore property owners to become involved in the long term planning for woody debris on their property. Plant young trees for the replacement of older trees.

USE OF FERTILIZERS ON LAKE SIDE LAWNS

From a water quality standpoint lawn fertilizers are a recognizable source of nutrients that property owners can eliminate or control through proper application. More is not better. Landowners are also encouraged to strongly consider the consequences of having a large lawn that extends into the recommended buffer area (within 50'- 60' of the lakeshore). By reducing your lawn size you not only reduce the amount of sediments and nutrients entering the lake you also provide important habitat necessary to support Wisconsin's wildlife species dependent upon this important shoreline habitat that is quickly disappearing in the face of increasing development pressures. Another benefit to decreasing lawn size is the reduction in work load necessary to maintain it; hence you can spend more time relaxing and enjoying your property.

If you feel the need to fertilize your lawn have your soil tested for phosphorus and potassium levels. When applying fertilizers consider the need to have soil phosphorus levels at the maximum recommended level. By applying fertilizers at a lesser rate you can still enhance your lawn without the increased risk of having excess drain into the lake to drive undesirable algae blooms. Remember that fertilizer suppliers are in the business to sell chemicals. The recommended bag application rates are often too high. Get advice from your county or university extension offices and remind them that you are applying the fertilizers to a lakeshore lawn and do not want to over-apply.

Never burn brush or leaves, especially along the lakeshore, in road ditches, or in drainage ways that drain into the lake. The ashes are very high in phosphorus and nitrogen and are soluble in rainwater. The best way to deal with leaves is to compost them. Spreading them in a wooded area that does not drain to the lake is also a good way to deal leave disposal. If neither of these is an option bag your leaves and take them to a yard waste collection site for proper disposal.

Do not remove grass clippings from lawns. They contain all the nitrogen and phosphorus your lawn needs which you will not have to replace with annual fertilizer applications. Use a mulching lawnmower it recycles the clippings into your lawn more efficiently. Never spread wood stove ashes in areas draining to the lake; instead dispose of them with your household garbage during normal refuse pickup times.

Management recommendations for fertilizer use

1. Apply fertilizers only if a soils test has determined that it is nutrient

deficient and add less than the maximum recommended.

2. The use of a low phosphorus content fertilizers or no-phosphorus fertilizers is strongly recommended if the fertilizer is to be applied on lakeshore property.

SEPTIC SYSTEM MAINTENANCE AND NECESSARY REPLACEMENT OF OLD FAILING SYSTEMS

Failing septic systems can pose a significant threat to water quality, especially when large portions of shoreline are developed and when the overall percentage of a lakes watershed is dominated by lakeshore properties. Septic systems that are older then 20 years should be looked at to insure that the filtration field is properly functioning and that waste is not perching above the drain field and entering the lake directly without adequate filtration of nutrients and other components. There is no specific rule that septic systems have to be evaluated to determine if they are functioning properly, unless there is a complaint filed.

It is generally recommended that you have your septic system pumped of the normal sludge buildup every two to three years. This sludge removal is essential for maintaining the absorptive capacity of your drainfield.

Inspect your system regularly for surfacing effluent around the drainfield. Are there wet areas or strong odors? Do the drains in your home seem to work properly or are they sluggish? Do they make noisy gurgling sounds? If your septic system has any of these systems you should have it inspected by a licensed installer.

Never make any changes to your sanitary system or wastewater piping. This work must be done by a licensed installer. It is not only dangerous to health and human safety, as well as water quality, it is also illegal and can result in fines or penalties.

Avoid using a garbage disposal with private septic systems. Put kitchen scraps in a compost pile if at all possible; otherwise, as a last resort put them in with your household garbage. Limit the use washing machines, if possible. Laundry washwater is high in lint, synthetic fibers, and pet hair all of which can cause premature failure of your drainfield. Use a commercial laundry if possible or if you are a weekend resident with a lakeshore septic system wait until you return to your midweek residence with public water and sewer.

A septic system is only intended to break down organic wastes. Never put solvents, furniture stripping solutions, degreasers, petroleum compounds, oil based paints and stains, or other chemicals into your sanitary system.

Diverting sink and shower drains (so called gray water) to lawns and other properties adjacent to the lake will not only impact lake water quality it is also illegal. Gray water must be run through your septic system to allow for the proper filtration of pollutants. There are no exceptions to this without first obtaining necessary permits.

Lakes Technical Assistance Contact Information List

Barron County:

County Conservationist: Dale Hansen – 715/ 537-6315
DNR Water Regulations: Dan Harrington – 715/ 822-3590 ext. #108
DNR Water Resources Biologist: Jim Cahow – 715/537-5046

Bayfield County (In Part):

County Conservationist: Diane Dalton – 715/682-7187 ext. #3
DNR Water Regulations:John Spangberg – 715/682-2923
DNR Water Resources Biologist: Jim Cahow – 715/537-5046

Burnett County:

County Conservationist: Dave Ferris – 715/349-2185

DNR Water Regs: Ed Slaminski – 715/635-4097
DNR Water Resources Biologist: Jim Cahow – 715/537-5046

Douglas County (In Part):
County Conservationist: Diane Dalton – 715/682-7187 ext #3
DNR Water Regs: John Spangberg – 715/685-2923
DNR Water Resources Biologist: Jim Cahow – 715/537-5046

Polk County:
County Conservationist: Jeff Timmons – 715/485-8631
DNR Water Regs: Dan Harrington – 715/822-3590 ext. 108
DNR Water Resources Biologist: Jim Cahow – 715/537-5046

Sawyer County (In Part):
County Conservationist: Dale Olson – 715/ 634-6463
DNR Water Regs: Jon Kleist – 715/532-3911
DNR Water Resources Biologist: Jim Cahow – 715/537-5046

Washburn County:
County Conservationist: Craig Conroy – 715/468-2666
DNR Water Regs: Ed Slaminski – 715/635-4097
DNR Water Resources Biologist: Jim Cahow – 715/537-5046

Shortcuts: go

Site Map | Contact the DNR | What's New? | Newsroom | Events

SEARCH DNR: go

MN DNR Home > Assistance > In your backyard > Shoreland management > Aquatic plant management guide >

Value of aquatic plants

Aquatic plants are a natural part of most lake communities and provide many benefits to fish, wildlife, and people. In lakes, life depends?directly or indirectly--on water plants. They are the primary producers in the aquatic food chain, converting the basic chemical nutrients in the water and soil into plant matter, which becomes food for all other life.

Aquatic plants serve many important functions:

Provide fish food
More food for fish is produced in areas of aquatic vegetation than in areas where there are no plants. Insect larvae, snails, and freshwater shrimp thrive in plant beds. Sunfish--Minnesota's most sought-after game fish--eat aquatic plants in addition to aquatic insects and crustaceans.

Offer fish shelter
Plants provide shelter for young fish. Because bass, sunfish, and yellow perch usually nest in areas where vegetation is growing, certain areas of lakes are protected and posted by the DNR as fish spawning areas during spring and early summer. Northern pike use aquatic plants, too, by spawning in marshy and flooded areas in early spring.

Improve water clarity and quality
Certain water plants, like bulrushes, can absorb and break down polluting chemicals. Nutrients used by aquatic plants for growth are not available to algae. This reduces algae abundance improving water clarity. Aquatic plants also maintain water clarity by preventing the re-suspension of bottom sediments. Algae, which thrive on dissolved nutrients, can become a nuisance when too many submerged water plants are destroyed.

Protect shorelines and lake bottoms
Aquatic plants, especially rushes and cattails, dampen the force of waves and help prevent shoreline erosion. Submerged aquatic plants also weaken wave action and help stabilize

RELATED PAGES:

Aquatic plant management guide

Main page

Aquatic plant management regulations

Aquatic plant stewardship

Factors influencing aquatic plant abundance

Permits to control aquatic plants

Required permits

Problem aquatic plants

Value of aquatic plants

Where aquatic plants grow

Aquatic Plant Management Program

Shoreland management

Main page

Aquatic plant guide

Restore Your Shore

Shoreland management guide

The Water's Edge (brochure) PDF

bottom sediment.

Provide food and shelter for waterfowl
Many submerged plants produce seeds and tubers (roots), which are eaten by waterfowl. Bulrushes, sago pondweed, wild celery, and wild rice are especially important duck foods. Submerged plants also provide habitat to many insect species and other invertebrates that are, in turn, important foods for brooding hens and migrating waterfowl.

Improve aesthetics
The visual appeal of a lakeshore often includes aquatic plants, which are a natural, critical part of a lake community. Plants such as water lilies, arrowhead, and pickerelweed have flowers or leaves that many people enjoy.

Provide economic value
As a natural component of lakes, aquatic plants support the economic value of all lake activities. Minnesota has a huge tourism industry centered on lakes and the recreation they support. Residents and tourists spend more than $1.5 billion each year to hunt, fish, camp, and watch wildlife on and around the state's lakes. The wild rice harvesting industry alone is worth at least $2 million to Minnesota's economy.

Shoreland Habitat Restoration Project sign PDF - download an example of the sign art to use in creating signs for your projects.

What every water gardener and shoreline restorer should know about harmful exotic aquatic plants PDF (973Kb)

Back to top

Main Categories: Outdoor Activities | Regulations, Licenses, Permits | Natural Resources | Education & Safety | About the DNR | Maps | Publications | Employment | Volunteering | Technical & Financial Assistance | Public Input

---

Sensitive Area Designation Surveys

Sensitive area designation surveys are designed to identify and protect important fish and wildlife habitat. The surveys can also be used as a tool for lake protection. Sensitive area designation surveys are an integrated approach to resource management, utilizing the expertise of many DNR resource managers. Resource experts identify locations around a lake which are critical to the future health and balance of the lake's ecosystem. Sensitive area surveys provide lake organizations, shoreline property owners, county zoning officials, DNR personnel, and other interested individuals with specific management recommendations that can be used to help protect these areas and improve the overall health of lakes.

Sensitive areas are often located in areas that consist of:

- terrestrial vegetation
- aquatic/wetland vegetation
- gravel/rubble lake substrate
- woody cover

These areas provide water quality benefits to the lake and provide habitat that is necessary for seasonal and/or life stage requirements of fish, invertebrates and wildlife. Aquatic and terrestrial plants also help to reduce shoreline erosion. A 'designated sensitive area' alerts interested individuals such as DNR personnel, county zoning personnel and lake associations that the area contains critical habitat vital to sustaining a healthy lake ecosystem and/or features an endangered plant or animal. In these areas permit reviews and decisions regarding activities that may impact the resource are reviewed closely by management personnel. Information presented in a sensitive area report may discourage certain permits from being approved within these sites or may require specific conditions for approval.

On August 23, 2001 a sensitive area survey was conducted on Big Portage Lake in Vilas County. A total of 13 sensitive areas were designated on this 600 acre lake. Many of the sites were selected because of large aquatic plant beds, quality fish habitat beneficial to both game and non-game species, and quality wildlife habitat. Copies of the Big Portage Lake Sensitive Area Designation Report, and data collected to compile the report, can be obtained from the Rhinelander DNR Service Center.

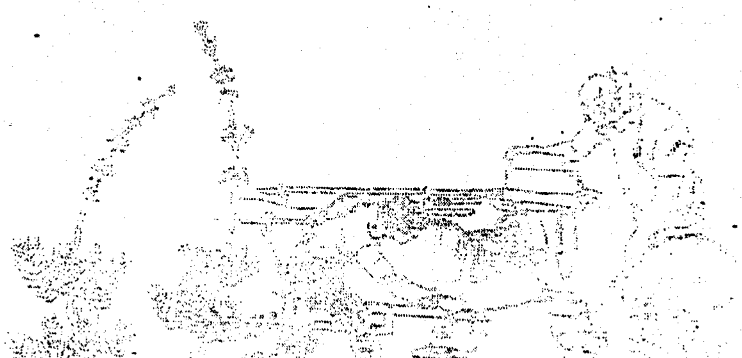
The DNR has scheduled two other sensitive area designation surveys that will be conducted in Vilas County in August of 2002. At this time, North/South Twin and White Sand Lake are scheduled to have surveys completed on them. For more information regarding sensitive area designations you may contact Jennifer Wudi at 715-365-8937.

Bureau of Fisheries Management and Habitat Protection-DNR
107 Sutliff Ave
Rhinelander, WI

WISCONSIN DEPT. OF NATURAL RESOURCES

Wisconsin Department of Natural Resources

The Facts...
On Eurasian Water Milfoil



The Dilemma:

Exotic species disrupt the stability of natural ecosystems and threaten biodiversity. An exotic species of special concern for lake users is Eurasian water milfoil. Eurasian water milfoil was introduced into North America and has spread to lakes across the nation. This exotic plant has invaded lakes in 35 states and in 3 Canadian provinces. In Wisconsin, the plant can be found in at least 235 sites in 43 of the state's 72 counties.

Eurasian water milfoil replaces native aquatic plant communities and forms thick underwater beds of tangled stems and vast mats of vegetation at the water's surface. These dense beds cause loss of plant diversity, degrade water quality, and may reduce habitat for fish, invertebrates and wildlife. They also hinder boating, swimming and fishing. Many lake organizations and local governments devote much of their lake management budgets to control this exotic plant. Eurasian water milfoil is an affliction that costs the citizens of Wisconsin millions of dollars in plant control and lost tourism revenue annually.

How Does it Spread:

This prolific plant doesn't spread well by seeds. It spreads by shoots and runners that creep along the bed of lakes or rivers. New plants also grow from small fragments transported from lake to lake. Commonly it's transported by boats and trailers but could also be transported on SCUBA gear, water skis or waterfowl. Eurasian water milfoil has become a successful invader primarily by means of its stem fragments. A single fragment can take root and form a new colony.

Eurasian water milfoil is most successful in waters disturbed by cultural developments such as shoreline construction, watershed runoff, aquatic nuisance control activities or heavy boat traffic. Eurasian water milfoil also has a competitive advantage in lakes that are stressed by pollution. It has difficulty becoming established in lakes with healthy populations of native plants. A healthy lake ecosystem and preservation of native plants is protection against a Eurasian water milfoil invasion.

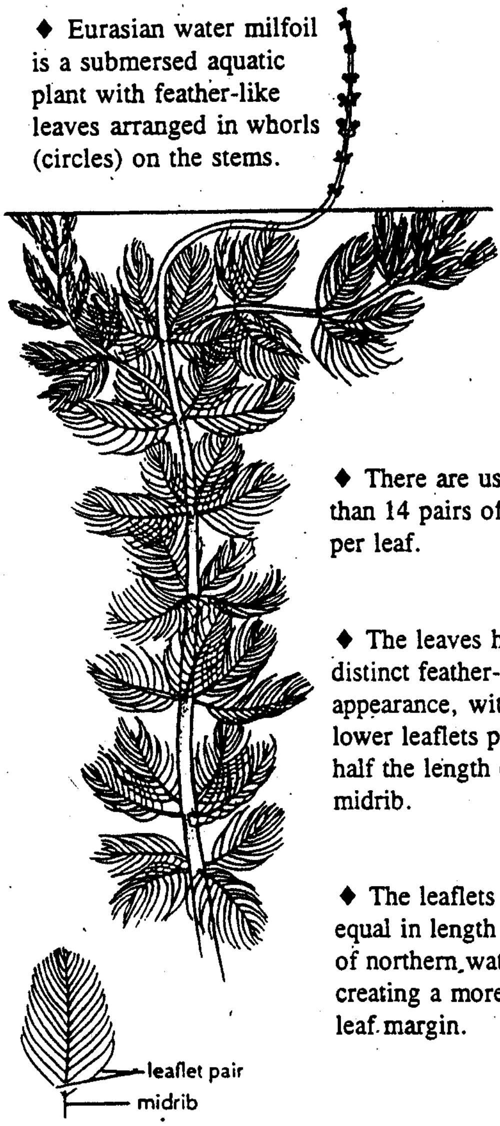
Recognizing Eurasian Water Milfoil (*Myriophyllum spicatum*):

Eurasian water milfoil is one of eight water milfoil species found in Wisconsin and the only one that is not native. The most common native water milfoil in Wisconsin lakes is northern water milfoil (*Myriophyllum sibiricum*). It bears a strong resemblance to Eurasian water milfoil but it is not prone to the rapid growth and canopy formation that make Eurasian water milfoil a nuisance.

It is important to be able to distinguish Eurasian water milfoil from other similar aquatic plants. The native plants provide valuable habitat for fish and invertebrates without obstructing recreational uses of lakes. Healthy beds of native plants also reduce the risk of Eurasian water milfoil successfully invading our state's waters.

The following description and illustration should help you recognize Eurasian water milfoil.

♦ Eurasian water milfoil is a submersed aquatic plant with feather-like leaves arranged in whorls (circles) on the stems.



♦ There are usually more than 14 pairs of leaflets per leaf.

♦ The leaves have a distinct feather-like appearance, with the lower leaflets pairs about half the length of the midrib.

♦ The leaflets are more equal in length than those of northern water milfoil, creating a more uniform leaf margin.

♦ Stem tips are tassel-like. No winter buds are formed.

♦ Branching is abundant in water 3-10 feet deep.

Before attempting any management of milfoil plants, please contact your regional DNR office for confirmation of your identification and recommendations of management alternatives.

The Solution:

There are three key elements to the control of exotic plants:

I. Removing the plant:
Early detection of Eurasian water milfoil growth is critical in stopping the plant from becoming a widespread problem in a lake. The best chance to halt these non-native invaders is when they first appear on the scene. Eurasian water milfoil often appears near boat landings and at disturbed sites.

New colonies are best removed before they expand. **Hand pulling** and removal from the water is a simple and effective control method for small areas. Harvesting, **raking** or **screening the bottom** also works well. Milfoil can be effectively treated with selective chemicals early in the summer before plants flower. A permit is required from the DNR for chemical treatment or bottom screening. Whole-lake **herbicide treatment** is not generally permitted because of the potential to disrupt lake ecosystems by eliminating both exotic and beneficial native plants.

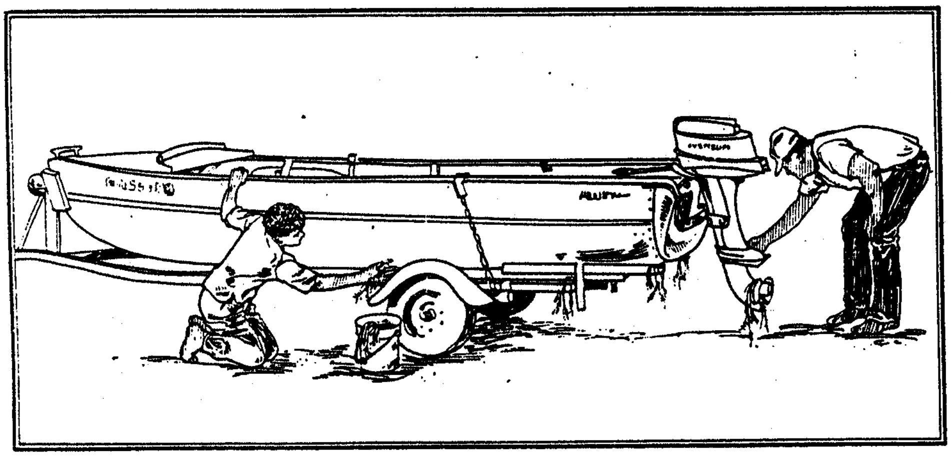
For lakes dominated with beds of milfoil, control efforts must be focused on reducing its spread. **Mechanical harvesting** can open areas for boating and swimming and cut fish cruising lanes. Harvesting can encourage growth of native plants while removing milfoil canopies that limit native plant growth.

New research is underway to explore **biological control** of Eurasian water milfoil. A small aquatic insect (*Euhrychiopsis lecontei*), a weevil native to Wisconsin, shows particular promise. It has demonstrated a preference for Eurasian water milfoil over native plants. It was first associated with milfoil decline in Vermont. More recently scientists have found it in lakes in Wisconsin, Minnesota and Illinois where milfoil decline has occurred. The distribution and natural history of this weevil is being studied and tests are being conducted to determine the role it could play in milfoil control.

II. Stopping the Transport:

Studies suggest that Eurasian water milfoil is moved from lake to lake by small fragments transported on objects used in a lake. Commonly it is transported by boats and trailers but it could be transported by fishing equipment, live wells or water toys.

- **Remove all aquatic plant fragments** when leaving the water and before launching in another lake or river. Plants should be disposed of on high, dry ground where there is no danger of them establishing a new colony.
- Help **establish a plant disposal station** at boat landings for plant fragments that are removed from watercraft.
- Carefully **inspect any equipment** that enters the lake: boats, motors, anchors, bait buckets and trailers.



- **Learn to recognize** Eurasian water milfoil. Regularly monitor boat landings, marinas and inlets for the first sign of invasion. Report new invasions to your local DNR office.
- **Be sure all boat landings are posted** with Eurasian water milfoil signs that describe the plant and instruct boaters to remove all plant fragments from their boats and trailers.
- Work with your local lake association to **develop an aquatic plant management and protection plan** for your lake, including contingency plans in case Eurasian water milfoil is found in the lake. Help others understand the benefits of native plants and use discretion in their control.
- **Organize a volunteer program** to meet boaters at your lake's access areas, pass out milfoil literature, explain the threat this plant poses to Wisconsin's lakes, and help boaters remove and dispose of plants.
- Ask your local lake organization about their milfoil volunteer alert program or **start a lake organization** if one doesn't exist.
- **Share this pamphlet** and your knowledge with others.

III. Building Awareness of the Problem

Citizens and lake communities are the cornerstones of the struggle against the spread of non-native plants and animals. State aquatic biologists can monitor only a small number of Wisconsin's lakes each year. Citizen watches must play a role in finding and responding to new infestations with appropriate actions. Lake management organizations, the DNR and UWEX can work to educate citizens about Eurasian water milfoil.

- **Pamphlets and bumper stickers** explaining how to identify and remove milfoil from boats, trailers and motor propellers can be handed out at bait shops, boat landings, highway rest areas and marinas.

Why Should I Help?

Our waterways are the pride of Wisconsin and belong to all of us.

Because of the vast number of lakes, ponds, rivers and streams in Wisconsin, citizen involvement in plant monitoring and removal of exotics is crucial in preventing the spread of Eurasian water milfoil. Our waterways are the pride of Wisconsin and belong to all of us. Your participation in Eurasian water milfoil control and prevention is essential to the successful control of this nuisance plant.

Wisconsin Waters with EWM (2/96)

COUNTY	WATER BODY NAME
Adams	Arkdale (Millpond), Arrowhead (Manchester), Camelot, Goose, Jordan (Long), Mason, Parker, Peppermill (Beaver Pond), Sherwood (Deer Lodge), Wolf
Barron	Beaver Dam
Bayfield	Superior-Washburn Harbor
Columbia	Lazy (Fall R Millpond), Park, Silver, Spring
Dane	Crystal, Fish, Kegonsa, Mendota, Monona, Waubesa, Wingra
Dodge	Fox
Door	Clark, Forestville Flowage, Kangaroo, Lake Michigan-Moonlight Bay, North Bay, Rowley Bay, Sturgeon Bay Ship Canal
Florence	Twin Falls Flowage
Fond du Lac	Forest, Kettle Moraine (Round), Mauthe (Moon), Wolf
Forest	Metonga
Grant	Jones Slough
Green	Beckman, Zanders
Green Lake	Green (Big Green), Little Green, Puckaway
Iowa	Twin Valley
Jefferson	Blue Spring, Ripley, Rock, Rome Mill Pond, Lower Spring
Juneau	Castle Rock, Petenwell
Kenosha	Camp, Center, East Flowage, George, Hooker, Shangrila-Benet (Paschen), Benedict, Elizabeth (South Twin), Mary (Marie), Lilly (Leaone), Paddock, Powers, Silver
Kewaunee	Alaska (East & West), Heidmann (Bolt), Krohns, Shea
La Crosse	Mississippi River
Manitowoc	Carstens (Carsten), Cedar, Hartlaub, Horseshoe, Pigeon, Rockville Flowage, Tuma (Ording), Wilke
Marathon	Big Eau Pleine River (T26N R6E S14) & Reservoir, Mayflower (Sunflower), Wisconsin River below Wausau Lake Dam
Marinette	High Falls Reservoir, Mary, Peshtigo Flowage, Thunder
Marquette	Birch (Moon), Buffalo, Comstock, Emery (Emerald, Richards), Ennis (Muir), Mason, Montello, Neenah (Oxford Millpond), School Section, Sharon, Spring (East), White
Milwaukee	Greenfield Park Lagoon (Milwaukee), Hollen Park Lagoon (Milwaukee), Mitchell Park Lagoon (Milwaukee)
Oconto	Machickanee Flowage (Stiles)
Oneida	Manson, Rainbow Flowage
Outagamie	Black Otter (Hortonville)
Ozaukee	Pit
Polk	Long Trade
Portage	Dubay, Emily, McDill Pond, Pacawa, Springville Pond, Wisconsin River Flowage #3-Stevens Point
Racine	Bohner, Browns, Eagle, Rockland, Tichigan, Waubeesee (Minister), Wind
Richland	Lee (Cazenovia Millpond), Long (T08N R02E S13)
Rock	Gibbs (Big Spring), Storrs
Sauk	Delton, Devils, Dutch Hollow, Long (T08 R05E S02), Mirror, White Mound, Wisconsin
Sawyer	Chippewa (Chippewa Flowage), Round (Big Round)
Shawano	Beaulieu, Big, Grass, Koonz, Pine, Red Lower (Weed Dam Pond), Red Upper (Gresham Pond), Shawano, Washington (Mud), White Clay, Wolf River Pond
Sheboygan	Crooked, Crystal, Little Elkhart, Random, Sheboygan River
St. Croix	Mallalieu, Little Falls
Vilas	Big Sand, Catfish, Duck, Eagle (T40N R10E S22), Otter, Scattering Rice, Voyageur (Smile-A-While), Watersmeet, Yellow Birch
Walworth	Army (East Troy), Beulah, Booth, Cravath, Delavan, Geneva, Green (Lauderdale), Ivanhoe (Ryan), Lorraine (Lake #9), Lulu, Middle (Lauderdale), Mill Lake (Lauderdale), Potter, Rice (Lower Whitewater), Silver, Tombeau, Tripp (Trapp), Turtle, Wandawega (Otter), Whitewater (Bass, Kettle), Whitewater Creek
Washburn	Nancy
Washington	Allenton Marsh, Bark & Bark River, Big Cedar, Erler, Five, Friess (Fries), Gilbert, Green, Little Cedar, Pike, Silver (Paradise Valley), Wallace
Waukesha	Ashippun, Beaver, Big Muskego, Cornell (T8N R18E S31, Mud), Crooked, Dutchman (Ladl), Eagle Spring (Eagle), Forest, Fowler, Genesee (Lower), Genesee (Middle), Golden, Henrietta, Hunters, Keesus, Kelly (Wpa Cranberry), Lac La Belle, Little Muskego, Moose, Nagawicka, Nashotah (Upper & Lower), Nemahbin (Upper & Lower), New Berlin Quarry Pond, North, Oconomowoc (& Upper), Okauchee, Pewaukee (Auer Bay), Pine, Pretty, Roxy Pond (Mukwonago Park), School Section, Silver, Spring (T6N R17E S03-Dousman), Unnamed (T06N R2OE S18-02), Utica, Waterville
Waupaca	Pigeon, School Section, Silver (T23N R11E S14), White
Waushara	Alpine, Big Hills (Hills), Big Twin (Twin), Flynns Quarry, Gilbert, Irogami (Fish), Kristine, Kusel (Koosel), Napowan (Funk), Pearl, Round (T20N R11E S35), Silver (T18N R11E S07), Spring, Wild Rose Millpond
Winnebago	Butte Des Morts, Poygan, Winnebago
Wood	Hemlock Creek

COUNTY	MILFOIL NO LONGER FOUND (per extensive APM survey)
Iowa	Cox Hollow Lake

For further information, contact your regional DNR Office:

Northern Region-West
Box 309
Spooner, WI 54801
715/635-2101

Northern Region-Central
Box 818
Rhinelander, WI 54501
715/362-7616

West-Central Region
Box 4001
Eau Claire, WI 54702
715/839-3700

South-Central Region
3911 Fish Hatchery Rd.
Madison, WI 53711
608/275-3266

North-East Region
Box 10448
Green Bay, WI 54307
414-492-5800

South-East Region
PO Box 12436
Milwaukee, WI 53212
414-263-8500

or contact the UW-Extension Lakes Program, CNR-UWSP, 1900 Franklin St., Stevens Point WI 54481 [715-346-2116]

Wisconsin Lakes Partnership

Wisconsin Dept. of Natural Resources

Wisconsin Association of Lakes

PUBL WR-463-96-REV

Curlyleaf Pondweed

by Susan Borman, WDNR - Western District Aquatic Botanist

Curlyleaf pondweed (*Potamogeton crispus* L.) is a cool water specialist. This non-native aquatic plant developed very successful adaptations for surviving low temperature water in its native range of northern Europe and Asia. It has proven to be a strong competitor with native species in Wisconsin lakes and streams, particularly in the spring and early summer when it gets a head start on the local competition.

The first confirmed specimen of curlyleaf pondweed in the United States was collected in Delaware in the mid-1800's. By the turn of the century, it had spread along the east coast from Virginia to Canada, and by the 1930's it was established in the Midwest. Currently, curlyleaf pondweed is found throughout the lower 48 states.

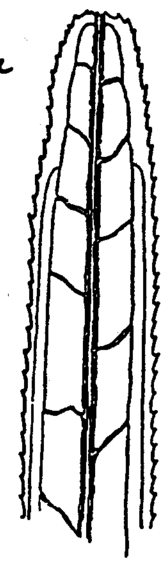
Description

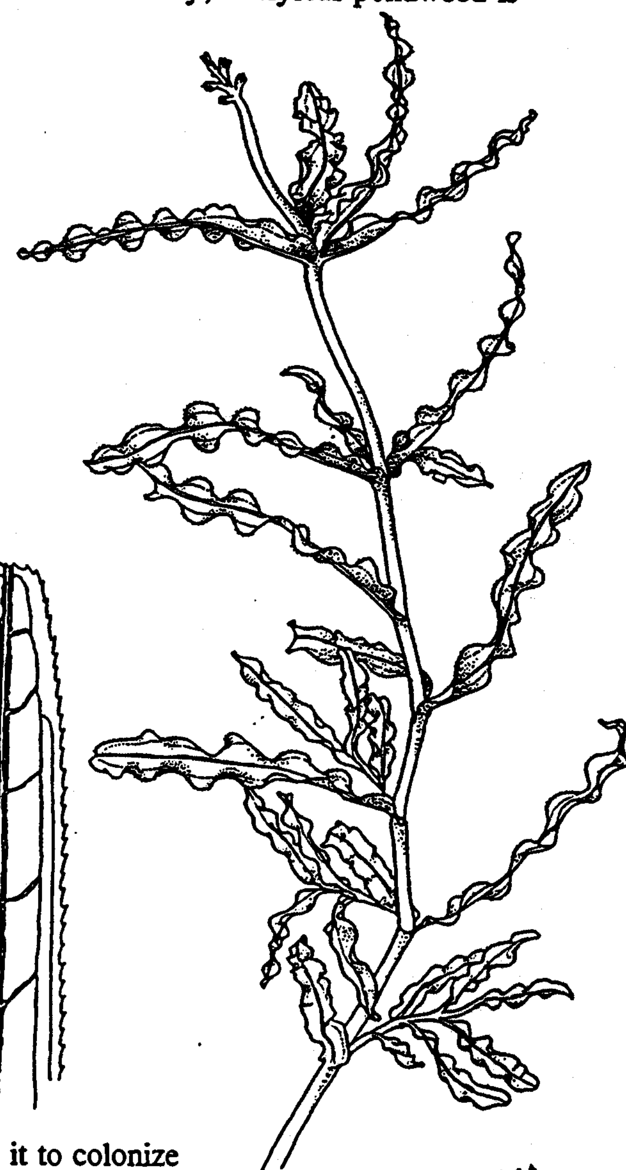
Although curlyleaf pondweed is a submersed aquatic plant, the spaghetti-like stems often reach the surface by mid-June. The oblong leaves attach directly to the stem in an alternate pattern. Margins of the leaves are wavy and finely-toothed creating an overall leaf-texture that is "crispy." In the spring, curlyleaf produces flower spikes that stick up above the water surface. The small flowers are arranged in a dense terminal spike on a curved 1-2 inch stalk. By June, thin-walled nutlets (*achenes*) are mature on the stalks and may serve as duck food or drop to the sediment.

Habitat

Curlyleaf is considered a deep water plant, but will also colonize shallow areas. In a lake where it is dominant, a curlyleaf bed may start in 1 to 2 feet of water and extend out to a depth of 10 to 12 feet or more. It has a competitive advantage over many native species at disturbed sites because it can tolerate low light conditions, both in the summer during algal blooms and under ice and snow cover in the winter. It has been found growing under 20 inches of ice and a heavy blanket of snow.

leaf margin





summer foliage

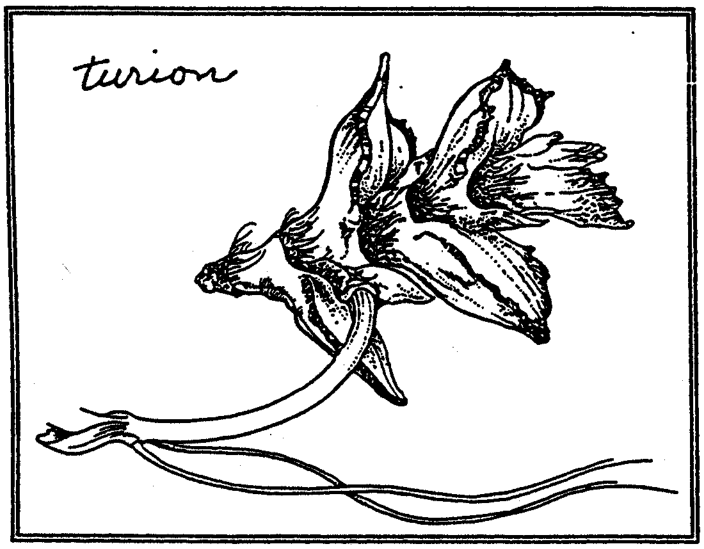
The strong rhizome anchoring system of curlyleaf allows it to colonize a number of challenging sites from lakeshores with wave action to streams with moderate velocity. Curlyleaf can grow on a variety of sediment types but is most successful on fine sediments enriched with organic matter.

Curlyleaf pondweed seeds play a relatively small role in reproduction compared to their vegetative winter buds (*turion*). These turions look like small brown pine cones and are produced in great numbers by mid-summer on shortened branchlets along the stem. Studies of curlyleaf beds in lakes have shown as many as 1,600 turions in just a square yard plot. The germination rate for these turions is high, ranging from 60 to 80%.

Special Adaptations

The cool water adaptations of curlyleaf set it apart from other Wisconsin aquatic plants. It is actively growing under the ice while most plants are dormant, but dies back in mid-July when other aquatic plants are just reaching their peak growth for the year.

The life cycle of curlyleaf is triggered by changes in water temperature. Warming waters in May stimulate growth of the spring foliage which has wider leaves than the winter growth and a reddish brown cast with wavy leaf margins. During the spring, flowers and fruit are produced. As water temperatures rise in early July, curlyleaf prepares for late summer dormancy. By August, the majority of curlyleaf stems and leaves have decayed and dropped a carpet of sharp-angled turions on the sediment.



These turions lie dormant until the water begins to cool in September. When the water temperatures fall to about 75° F the turions germinate to produce winter foliage. The winter curlyleaf growth has flat, blue-green leaves that are narrower, softer and more translucent than the summer leaves. The plant grows and photosynthesizes under the ice and when the water warms up in the spring the summer growth cycle starts over.

Significance in Aquatic Community

Curlyleaf provides habitat for fish and invertebrates in winter and spring when most other plants are reduced to rhizomes and winter buds. However, the mid-summer curlyleaf decay creates a sudden loss of habitat and releases a surge of nutrients into the water column that can trigger algal blooms and create turbid water conditions. In waters that have a diversity of other aquatic plants, the breakdown of curlyleaf may not be a problem. However, in situations where curlyleaf is dominant the summer die-off can lead to habitat disturbance and degraded water quality.

Living with Curlyleaf Pondweed

Curlyleaf provides food for ducks and valuable winter and spring habitat for fish and invertebrates. But these values can be overshadowed by big summer die-off when curlyleaf dominates a plant population. Selective control of curlyleaf stands and protection or restoration of native species can lead to a balanced plant population. Protecting water quality will also help keep curlyleaf in check because it has a competitive advantage over native plants when water clarity is reduced.

Wisconsin's New Aquatic Plant Laws

In September 2001, new laws were passed that represent some of the most significant changes to Wisconsin aquatic plant management to come along in decades.

Wisconsin State Statutes s. 23.24, relating to aquatic plants, requires the Department of Natural Resources (DNR) to establish a program to:

- Protect and develop diverse and stable communities of aquatic plants.
- Regulate how aquatic plants are managed.
- Provide education and conduct research on invasive aquatic plants.

A second law, s. 30.715 Wis. Stats., prohibits the launching of boats or boating equipment or trailers in navigable water if the person has reason to believe that the boat, boat trailer, or boating equipment has any aquatic plants or zebra mussels attached.

Major Changes

- A permit will be needed for the removal and harvesting of aquatic plants.
- Mechanical harvesting will require a permit.
- The launching of boats or boating equipment in navigable waters is prohibited if there is reason to believe the equipment has aquatic plants or zebra mussels attached.
- Manual cutting and raking will be exempt from the permit requirement if the area of plant removal is no more than 30 feet along the shoreline and any piers, boatlifts, swim rafts, and other recreational and water use devices are located within that 30 feet.

What are the next steps?

As a result of these changes, the Department of Natural Resources is drafting a new set of rules to manage aquatic plants. An Emergency Rule was adopted by the DNR in Spring 2002 to provide a permit program as required by the new legislation to regulate cutting and harvesting, planting aquatic plants, and any other methods of plant control. The final version of the Administrative Rule numbered and titled NR 109, "Aquatic Plants: Introduction, Manual Removal, and Mechanical Control Regulations" is open for public comment until August 23, 2002 during the public hearing period. ***The DNR is seeking input from lake organizations, aquatic plant service providers and individuals interested in protecting our valuable aquatic plant communities.*** **Written Comments on NR 109 may be sent to Frank Koshere, WDNR, 1401 Tower Ave, Superior, WI 54880.**

What is proposed in the new rule?

Wisconsin Administrative Code s. NR 109 will create a permit program for introducing aquatic plants, manual removal, and mechanical cutting and harvesting. As proposed in an early draft:

- Manual cutting and raking will be exempted from a permit if the area of plant removal is a single area with a maximum width of no more than 30' along the shoreline provided that any piers, boatlifts, swim rafts, and other recreational and water use devices are located within the 30' zone. All cut plants must be removed from the water.
- Mechanical harvesting will require a permit. Initially permits will be issued annually, and after completion of an approved Aquatic Plant Management Plan, permits may be issued for multiple years.

- Other methods of plant control and plantings and introductions will require a permit.

The permit may specify the quantity of plants, the species, the locations, the methods, the times, and disposal methods for managing aquatic plants. Fees will be established based on size of the proposed project. Proposed fees range from $30 to a maximum of $300, based on the size of the project. Manual removal by a riparian owner in an area 30 feet wide or less will not require a permit or fee.

What is regulated?
The law allows DNR to designate plants as "invasive plants," such as Eurasian Water Milfoil, Curly Leaf Pondweed, and Purple Loosestrife. No person may intentionally introduce these plants. In addition, anyone cutting plants of any species must remove them.

Also, the Boat Launch Law makes it illegal to launch watercraft or associated equipment if there may be aquatic plants or zebra mussels attached. Fines under both laws are established at $200 for first time violations, and for second violations may go from $700 - $2000 or include prison, and the courts have the ability to order restoration.

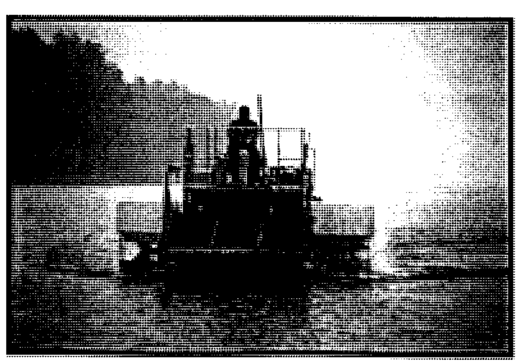
Who is affected?
Anyone involved in aquatic plant control should be aware that a permit may be needed. The main exemption is for small-scale manual removal by riparian property owners which covers an area no larger than 30' along the shoreline. Lake associations, lake districts, contractors for cutting and harvesting, lake management consultants, persons planning plant restoration projects, groups proposing water draw downs for plant control, or others managing, controlling, or planting aquatic plants should be aware of final rule development as these activities will be regulated.

All persons are covered by the boat launch law.

Stay tuned!
This is a new law and actions to implement it will continue after completion of NR 109 which regulates introductions, manual removal and mechanical cutting. The next step will be to revise NR 107- Aquatic Plant Management, which currently deals specifically with chemical controls, to include updated requirements from the legislation. Revisions to NR 107 will cover chemical control, biological control, and other aquatic pest management methods. The current rules and the new NR 109 will continue in effect until a more comprehensive rule revision is undertaken.

Aquatic plants have finally become a recognized resource in Wisconsin. The loss of natural shorelines and the effects of invasive species have made us more aware of the important benefits plants share in providing fish, wildlife, and invertebrate habitat, and in protecting shores from erosion, loss of aesthetics, and maintaining water quality. These changes will help conserve native plants and their beneficial role on lakes, and will help to better manage problem and invasive plants.

Wisconsin Lakes Partnership



STOP AQUATIC HITCHHIKERS!

Protect Your Waters

Hitchhikers Impacts Prevention Resources News Activities About Us
Contact Us
FAQ

Protect Your Waters and Stop Aquatic Hitchhikers!

Stop Aquatic Hitchhikers!
Clean all recreational equipment.

Welcome to a site for recreational users who want to help stop aquatic nuisance species. As Americans, we love to spend time on the water. Protecting these resources is an important part of our overall enjoyment. A concern we must all address is the spreading of harmful plants, animals and other organisms. These aquatic nuisance species can hitch a ride on our clothing, boats, and items used in the water. When we go to another lake or stream, the nuisance species can be released. And, if the conditions are right, these introduced species can become established and create drastic results.

So what can we do? By following a simple procedure each time we leave the water, we can stop aquatic hitchhikers. Knowing which waters contain nuisance hitchhikers is not as important ---- as doing the procedure every time we leave any lake, stream or coastal area. (Click on the links for details on what to do.)

Simple Procedure

- Remove any visible mud, plants, fish or animals before transporting equipment
- Eliminate water from equipment before transporting
- Clean and dry anything that came in contact with water (Boats, trailers, equipment, clothing, dogs, etc.)
- Never release plants, fish or animals into a body of water unless they came out of that body of water.

Become Informed and Take Action!
We can also become more informed about this issue. As recreational users, history has shown we will take action if informed. We will work to protect our environment if we know what to do. This site is designed to help us learn about the aquatic hitchhiker issue. Navigate through this site to get:

- The latest news about this growing problem
- Detailed procedures to prevent the transport of nuisance species
- Impacts caused by these species
- Facts about some of the more common hitchhikers
- Resources and ideas for you or your club to get involved with prevention efforts
- Support materials to further your understanding of and involvement with the Aquatic Hitchhiker problem.

Why Is This Important? Because these hitchhikers can:

- Reduce game fish populations
- Ruin boat engines and jam steering equipment
- Make lakes/rivers unusable by boaters and swimmers
- Dramatically increase the operating costs of drinking water plants, power plants, dam maintenance, and industrial processes
- Reduce native species
- Degrade ecosystems
- Affect human health
- Reduce property values
- Affect local economies of water-dependent communities.

Clarification of Terms
For the purposes of this campaign and the related materials, Aquatic Hitchhikers are defined as non-native, harmful aquatic plants, animals or microscopic organisms that can readily be transported to other waters via popular recreational activities. Also, different terms will be used interchangeably throughout the campaign to describe aquatic hitchhikers. These terms include: *aquatic nuisance species, ANS, aquatic invasive species*

News
Check ou
the Stop
Campaig
Aquatic H

Test your
species k
Wants To
game.

Recreati
Boating, I
Waterfow
or Snorke
Seaplane
Watercra
Harvestin

Con
Zebra Mu
Disease,
Round G

Video Cl
Asia
M
(I

E-Mail N
Stop Aq
news. I

E-Mail S

and non-native, harmful aquatic species. Campaign sponsors use these multiple terms to facilitate a better understanding about the issue and to assist with the ease of your reading.

Home Search Link to Us Site Map

The Stop Aquatic Hitchhikers web site is part of the ANS Task Force public awareness campaign and is sponsored by the U.S. Fish and Wildlife Service and the U.S. Coast Guard.

Machine Harvesting of Aquatic Plants

Mechanical harvesting cuts nuisance aquatic plants below the water surface and removes them from the lake. It is just one method of aquatic plant control which could be incorporated into a lake use management plan.

The following sections discuss mechanical harvesting, how it fits into lake use planning, plant disposal, costs, and the advantages and disadvantages of this plant management technique.

Before a mechanical harvester is used or purchased, it should be evaluated not only for its cutting capability but also for its ability to remove or gather the cut plants. To prevent regrowth, it is often necessary to gather wind-blown fragments along the shore using rakes and pitchforks in conjunction with harvesting.

Description of Method

The typical harvester is a low-draft barge with a horizontal and two vertical cutter bars. Hydraulic conveyors hoise the cut aquatic plants onto the deck of the barge. Two to eight tons of wet plants can be stored on the harvester, depending on its size. The plants are unloaded using a conveyor on the shore.

Where Machine Harvesting Works Best

Harvesting is successful in producing temporary relief from nuisance aquatic plants. It is suited for most rooted and some floating plants, but cannot control swimmer's itch or algae. Harvesters generally work best in open, unobstructed areas of the lake where the water is two to six feet deep.

Harvesting should be approached as a selective technique used to create boat lanes and open spaces, not as a clear cutting operation of aquatic plants in a lake. A clear cutting approach to harvesting can cause serious habitat disturbance because plant beds support fish and aquatic insect life. It has been estimated that up to thirty percent of a lake's juvenile fish population can be removed because of clear cutting operations.

Before embarking upon any harvesting operation, prepare a lake-use plan examining the lake, its uses, its ecosystem, and the surrounding watershed. A combination of techniques may be needed to provide the most effective plant management. As an example, a mechanical harvester could be used to clear a boating channel, handpulling and raking could be used for the beach area, and fiberglass screens could be used around piers. A lake use plan would define lake uses and integrate these various treatment techniques. Spawning areas, wetlands and wildlife areas are not recommended for treatment.

When harvesting is done to create boating or navigation channels the use of the area can be enhanced by adequate marking of the open channels. Official marking buoys will force boat traffic through the cut area, minimizing the regrowth problem. Buoys should meet set standards and be placed only after obtaining a permit through your local conservation warden.

Plant Disposal

Aquatic plant fences can be used in connection with harvesting to prevent cut plant fragments from drifting and blowing around the lake. The fences are rooted plants that have grown to the surface of the water. At the end of the day plant fragments are collected within these fences. Openings should be left in the plant fences to permit boat travel.

By removing the cut plants from the lake you not only remove nutrients but you also prevent plants from decomposing in the water. Due to their high nutrient content, harvested aquatic plants should not be piled along the lakeshore and left to continue fertilizing the lake. Instead, they should be transported to a site where they can be used as mulch, soil conditioner, or fertilizer. Transporting the plants to the site where they will be used can be a large percentage of the total harvesting cost.

Since the aquatic plants are rich in nutrients, farmers or gardeners are often willing to accept the plants and in some cases may even buy the plants from the harvester contractor. Aquatic plants compare favorably with cow manure as a source of nutrients (2.5% nitrogen, 0.6% phosphorus, and 2.3% potassium) and can add valuable organic matter to the soil.

Aquatic plants that have been harvested should not be hauled to the local landfill. Many counties in Wisconsin are now hauling organic materials to separate sites to compost and recycle due to the limited amount of landfill pace left. Proper advertising and work with local officials will ensure that the plants you harvest from your lake are being incorporated into the soil or disposed of properly.

For more information about plant disposal, consult the factsheet entitled, "What To Do With Harvested Aquatic Plants."

When to Harvest

Generally one to two harvests in the same area during the summer are recommended for most aquatic plant species. Assuming no fish spawning is occurring, the first cutting should be done about mid-June with the second cutting in mid-July. The first cutting should avoid any fish spawning areas in the lake. By mid-June most fish are done spawning.

Cost

The largest expense for this method is typically the initial cost of the harvester, which can range between $20,000 and $80,000. To reduce this cost, several lake districts in Wisconsin share a harvester. Additional costs such as unloading systems, trailers and trucks can add to the cost. Operating costs can be quite variable, but generally average around several thousand dollars per year with labor comprising from 20 percent to 65 percent of the total operating costs unless the time and labor is being volunteered.

Contract harvesting is an option for lake groups or municipalities without access to a harvester. Contract harvester costs from a DNR study on Devil's Lake in Sauk County were estimated to be $85/hour in 1987. Contracting harvesting has the advantages of lower short-term costs and less need for a support network (program administration, storage buildings, crews, maintenance, etc.). Moreover, lake managers are not locked into a set control strategy. Potential problems include less conscientious plant collection, potential unacceptable harvesting performance and uncertain availability of the harvester when needed.

Regulations

A state permit is not required in Wisconsin for harvesting, but the law requires the removal of the plant fragments from the water.

Advantages of Mechanical Harvesting

- Harvesting alleviates public concern about potential toxicity that may occur with chemical treatment methods.
- Harvesting frees area for immediate use.
- Control can be directed at specific areas or used selectively to create channels.
- Proper collection of plants removes essential plant nutrients from the water.
- Harvested plants have value as mulch, fertilizer, and soil conditioner.

Disadvantages of Mechanical Harvesting

- Harvesting does not correct the cause of the abundant plant problem.
- Harvesting may have to be repeated during a season for effective control since the root systems are not removed during harvesting.
- Harvesting can produce plant fragments which can re-root if not removed from the lake (old harvesters are often less effective than newer ones at controlling this problem).
- Shoreline cleanup using rakes and pitchforks needs to accompany harvesting operations to insure removal of plant fragments.
- Large harvesters cannot operate close to docks and piers.
- Harvesting may remove fish; avoid times of fish spawning and nursery areas.
- Harvesting can be noisy and disturb bird life.
- Harvesting can be over-used leaving little habitat for fish, waterfowl, and aquatic insects.
- Harvesting alters plant community composition; it may remove desirable plant species along with undesirable ones.

Who to Call

For more information, contact the UW-Extension Lakes Management Program, College of Natural Resources, University of Wisconsin, Stevens Point WI 54481 or DNR Lake Management Program, Box 7921, Madison WI 53707.

Wisconsin Lakes Partnership

Wisconsin Dept. of Natural Resources

University of Wisconsin Extension

Wisconsin Association of Lakes

PUBL-WR-201 88
August 1988

What To Do With Harvested Aquatic Plants

Cut plant fragments, by law, must be removed from the water for the following reasons:

- Fragments of certain plants can re-root and form new beds of aquatic plants; so instead of solving a problem you've compounded it.

- Harvested plants, if not removed from the water, add nutrients to the lake as they decompose which fertilize the other plants in the lake.

- Unharvested plants can cause navigation hazards for boaters.

- Decomposing plant fragments can deplete dissolved oxygen in the water.

Plants that have been harvested can be piled away from shore and allowed to dry for a few days. Cut plants will have an odor until dried out. Many people find the odor unpleasant. To minimize this and to speed up the drying process, spread the plants thinly in a sunny spot with good air circulation.

After drying, the plants will weigh substantially less and are more easily handled. The plants then can be composted or mulched, making an excellent soil conditioner and adding to soil fertility. Farmers or gardeners are often willing to accept the plants, and in some cases may even buy the plants from the harvester contractor. Aquatic plants compare favorably with cow manure as a source of nutrients (2.5% nitrogen, 0.6% phosphorus, and 2.3% potassium) and can add valuable organic matter to the soil. Transporting the plants to the site where they will be used often turns out to be a large percentage of the total harvesting cost.

Haul the plant off the shoreline. Nutrients leaching from aquatic plants piled along the lake-shore will fertilize the lake. If you do not have a garden, neighbors with gardens who do not have lake-front property often will gladly take the plants.

Aquatic plants that have been harvested should not be hauled to the local landfill. Many counties in Wisconsin are now hauling organic materials to compost sites because landfill space is becoming limited. Proper advertising and work with local officials will ensure that plants you harvest from your lake become incorporated into the soil or disposed of properly.

How to Use Aquatic Plants

Mulch

To use aquatic plants as a mulch, let them dry out for three to four days before tilling them into the soil.

Compost

Here's a recipe for aquatic plant compose for your garden:

Step 1. Dry harvested plants on a wooden pallet, any elevated area of soil, or a drying rack for about 24 hours. This reduced the moisture content and makes the plants easier to handle.

Step 2. If desired, construct a 3-by-3 foot chicken wire or wooden compost bin to contain the composted material.

Step 3. Remove grass and sod cover from the composting area to allow materials to be in direct contact with soil microorganisms.

Step 4. Layer materials in the following way for best results:

1st layer: three to four inches of chopped brush or other coarse material on top of the soil surface. This allows air circulation around the base of the heap.

2nd layer: six to eight inches of aquatic plants, mixed kitchen scraps, leaves, grass clippings, sawdust, etc. Materials should be sponge damp and produce no water droplets when squeezed.

3rd layer: one inch of soil serves as an inoculant by adding microorganisms to the heap.

4th layer: two to three inches of manure provide the nitrogen needed by microorganisms. Sprinkle lime, wood ash, and/or rock phosphate over the layer of manure to reduce the heap's acidity. Add water if the manure is dry.

5th layer: Repeat steps one to four until the bin is almost full. Top off the heap with a four to six inch layer of straw, scoop out a basin at the top to catch rain water.

A properly made heap will reach temperatures of 140°-160° F in four to five days. At this time, you'll notice the pile settling, a good sign that your compost heap is working properly.

After five to six weeks, fork the materials into a new pile, turning the outside of the old heap into the center of the new pile. If only turned this one time, the compost should be ready for use in three to four months. To make compost faster, turn the pile more often. Check the internal temperature regularly; when it decreases substantially (usually after about a week), turn the pile. Compost is ready when it is dark brown, crumbly and earthy-smelling.

For more information about composting, write to the Department of Natural Resources, Bureau of Solid Waste Management, Box 7921, Madison WI 53707 for the following free publications:

Backyard Composting Made Easy

Home Composting

Rediscover Composting: a natural waste recycler

Lake Management Program
Wisconsin Department of Natural Resources
University of Wisconsin Extension, UWSP

PUBL-WR-203 88
August 1988

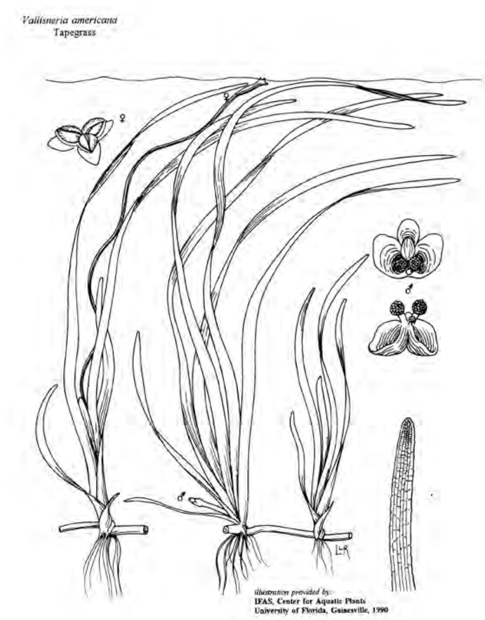
SHORELINE LANDOWNER NAVIGATION ACCESS FORM

Please complete the following:

Name	
Address	
Phone	

The Aquatic Plant Management (APM) Program requires that a shoreline landowner be aware of the value of aquatic plants and consider manual removal of aquatic plants prior to requesting navigational access channel to private piers or docks. Please read the following:

Value of Aquatic Plants



Aquatic plants are vital to the health of a water body. Unfortunately, much too often, people refer to all rooted aquatic plants as weeds and their ultimate goal is to eradicate them. However, aquatic plants play a key role in the ecology of a lake system. Aquatic plants provide important food and shelter for fish, wildlife and invertebrates. Without aquatic plants, the aquatic food chain can be disrupted harming fish populations. Aquatic plants also improve water quality by protecting shorelines and the lake bottom.

Aquatic plants can become a nuisance, however, when native and exotic plant species occupy large portions of a water body. Excessive aquatic plant growth can negatively affect navigational and recreational activities. When "managing" aquatic plants, it is important to maintain a well-balanced, stable, and diverse aquatic plant community that contain high percentages of desirable native vegetation.

Additional information about the value of aquatic plants is available in the Sturgeon Bay Resource Inventory and Aquatic Plant Management Plan, which is available in the local library. Sources for additional information about aquatic plants are included in the references section of this report. Information is also available on the Sturgeon Bay Aquatic Plant Management Program Website: http://www.northernenvironmental/sturgeonbay under the technical information link. Links to other sources of information about aquatic plants are also provided on this website.

Manual Removal

The APM Program requires a shoreline landowner to evaluate if hand pulling or raking is feasible prior to requesting an access channel to their pier or dock. A private shoreline landowner can complete manual removal of aquatic plants in a 30-foot wide corridor for swim rafts and navigational access to piers without a permit.

OVER

SHORELINE LANDOWNER NAVIGATION ACCESS FORM

	YES	NO
I have read the information provided above and understand the value of aquatic plants, however I still desire the City to provide a navigational channel to navigable water	___	___
I have evaluated the feasibility of manual aquatic plant removal. It is not feasible to remove plants manually, therefore I am requesting a navigational access channel.	___	___

Reason manual removal is not feasible: ____

Signature	
Date	

Please return this completed form to:

Sturgeon Bay Department of Public Works
Aquatic Plant Management Program
Attention: Shoreline Landowner Access
834 North 14th Avenue
Sturgeon Bay, WI 54235

Upon receipt of this form, the APM Program staff will issue you a placard marker to place at the end of your dock indicating that you have completed the appropriate steps. To facilitate timely response for your access, the City recommends delivering the form to the above address in person. Multi-use priority navigational channels take precedent over private channel access.

It is important to note that the City is confined to the requirements of the APM Permit issued by the WDNR and cannot complete aquatic plant removal for aesthetic reasons. A navigational need must be demonstrated.

OVER

STURGEON BAY APM
SPECIAL CONDITION
REQUEST FORM

Date:________________________

To: Wisconsin Department of Natural Resources APM Coordinator,
Name____

From: Sturgeon Bay APM Program Manager
Name____

Location
(Description and GPS Reading if possible)
____
____

Description of Problem requiring Special Condition Request
____
____
____
____
____
____

Please call us at (920) 746-7912 to discuss the special condition or to arrange for an inspection of the situation requiring a special condition

______ The APM Staff may proceed with the "Special Condition" requiring navigational access or assistance

______ I need to visit the situation prior to issuing an approval. The following time and date works for me_______________________________

Please fax this form to (920) 746-2906 within 24 hours

.

STURGEON BAY APM
SPECIAL CONDITION
REQUEST FORM

Date________________________

To:_________________________

From:______________________

Location (Location and GPS Reading if possible)____

Description of Problem requiring special condition____
____
____

Please call _______________________ at (920)__________________ to discuss the special condition or to arrange for an inspection of the situation requiring a special condition

______ The APM Staff may proceed with the "Special Conditon" requiring navigational access or assistance

______ I need to visit the situation prior to issuing an approval. The following time and date works for me_____________________________

Please fax this form to (920) 747-2906 within 24 hours

Sturgeon Bay Aquatic Plant Management Documentation Record

Date:__________________________________
Operator:_______________________________
Harvester:______________________________

MANAGEMENT AREA			MANAGEMENT FOR	Time	Fish Present?	Bottom Encountered?	Aquatic Plants harvested?	Noteworthy Observations
Description	Coordinates (if available lat/long or UTM)		Multi-use Channel = M/U Mooring Area = MOOR Shoreline Access Request = REQ Special Condition = SC		YES/NO/TYPE	YES/NO/DEPTH	Types / loads	

Stormie's Clean Water Tips

Cleaning Up Stormwater Runoff

What is stormwater runoff? It is the rain and melting snow that flows off streets, rooftops, lawns, and farmland. The flowing water carries salt, sand, soil, pesticides, fertilizers, leaves and grass clippings, oil, litter, and many other pollutants into nearby waterways. Since these pollutants are washed off a wide area and cannot be traced to a single source, they are called nonpoint source or runoff pollutants.

Storm Sewers – Rivers Beneath Our Feet

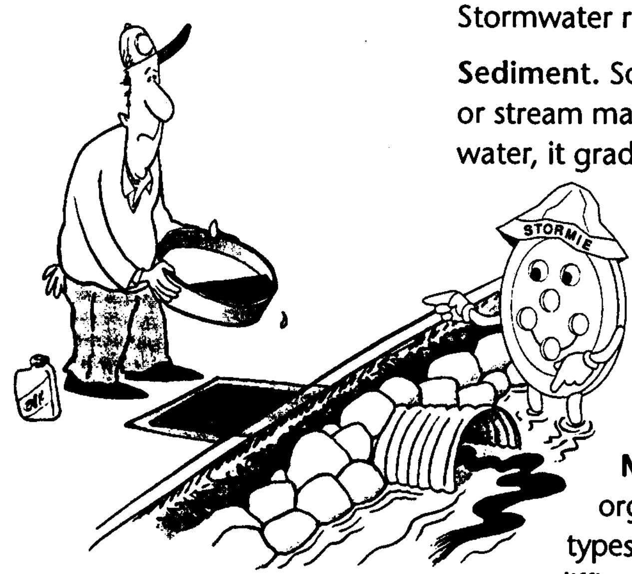
In developed areas, much of the land surface is covered by buildings and pavement which do not allow water to soak into the ground. Instead, storm sewers are used to carry the large amounts of runoff from these roofs and paved areas to nearby waterways.

Storm sewers are simply pipes laid underground, often below streets. Inlets or drains located along curbs and in parking areas collect the runoff, which then flows to nearby streams or lakes. A common misconception is that water running off streets goes into a sewage treatment plant. It does not. In fact, stormwater usually receives no treatment. Water that runs off lawns, streets, and parking lots flows directly into lakes and streams.

Stormwater is Not Clean Water

Stormwater runoff carries pollutants that seriously harm our waters:

Sediment. Soil particles washed off constuction sites or farm fields into a lake or stream make the water cloudy or turbid. When sediment settles out of the water, it gradually fills in the stream or lake bed.



Did you know that oil dumped into the storm sewer pollutes our water?

Phosphorus. This nutrient, often attached to soil particles, fuels the growth of algae and aquatic weeds. These plants are important in providing habitat for fish and wildlife. However, rapid and excessive growth of algae and aquatic plants can degrade water quality and interfere with swimming, boating and fishing.

Micro-organisms. Bacteria, viruses and other disease causing organisms make waterways unsafe for swimming, wading and other types of recreation. Some of these organisms, notably Cryptosporidium, are difficult to remove through water treatment and may endanger people who depend on drinking water supplies drawn from lakes or streams.

Toxic chemicals. Motor oil, lead from gas and auto exhaust, zinc from roof drains and tires, and pesticides in stormwater runoff may kill aquatic organisms or impair their health, growth or ability to reproduce.

The Goals of Urban Stormwater Programs are to:

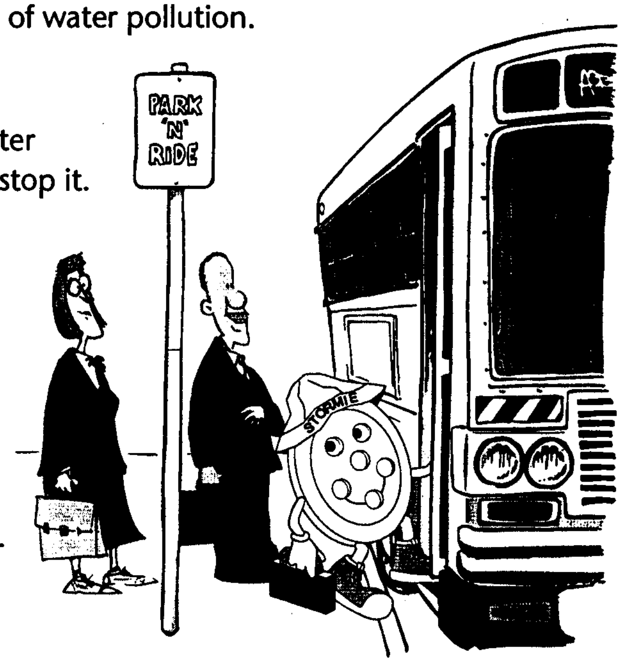
- Slow down water, decreasing its ability to cause erosion and carry pollutants.
- Reduce the amount of runoff by encouraging water to soak into ground.
- Prevent pollution by reducing the use of toxic chemicals, controlling erosion and by covering outdoor storage piles.
- Remove pollutants by routing runoff through settling ponds, grass filter strips or other treatment devices.

Federally mandated stormwater permits require many industries and cities to control stormwater runoff. Even communities without stormwater permits require erosion controls on constuction sites and better stormwater management in new development.

Federal laws also require all farmers who participate in federal programs to develop farm conservation plans that help control cropland erosion, barnyard runoff and other sources of water pollution.

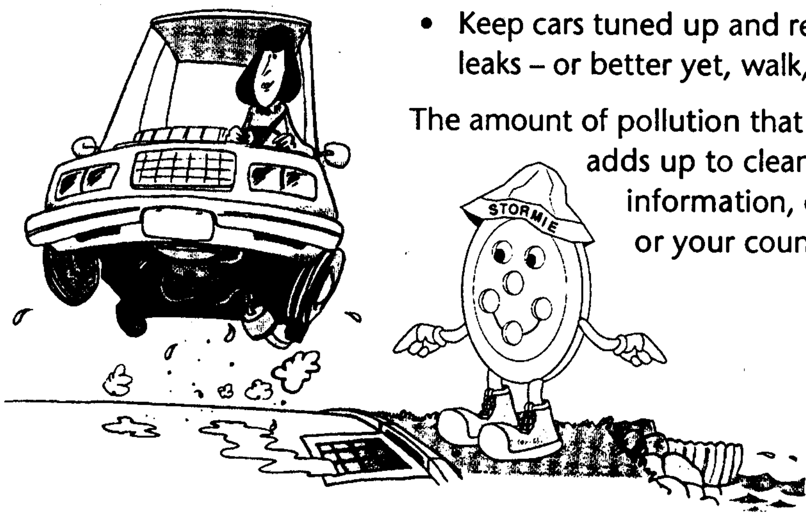
We Can All Help!

Each of us contributes to stormwater pollution and each of us can help stop it. Here are some ways you can help:



- Keep pesticides, oil, leaves and other pollutants off streets and out of storm drains.
- Divert roof water to lawns or gardens where it can safely soak in.
- Clean up pet waste – bury it or flush in down the toilet.
- Keep cars tuned up and repair leaks – or better yet, walk, bike or take the bus.

The amount of pollution that you stop may seem small, but together it all adds up to cleaner water for everyone to enjoy. For more information, contact the Department of Natural Resources or your county Extension or Land Conservation office.



This publication is available from county UW-Extension offices or from Extension Publications, 630 W. Mifflin St., Madison, WI 53703. (608) 262-3346.

A publication of the University of Wisconsin–Extension in cooperation with the Wisconsin Department of Natural Resources.

Author: Carolyn Johnson, UW–Extension.

Editing and design by the Environmental Resources Center, University of Wisconsin–Extension.

Printed on recycled paper

GWQ016 Cleaning Up Stormwater Runoff

DNR WT-532-99

R-09-99-10M-20-S

Why Protect Shoreland Areas?

Whether you own waterfront property or simply enjoy visiting lakes, rivers, or streams, you probably know that certain development activities can have adverse effects on water quality. Careful use of land surrounding our lakes and streams is essential to protect one of Wisconsin's greatest natural assets — clean water. Good water quality is also necessary for numerous wildlife species, and for providing us with recreational opportunities such as fishing, boating and swimming. Protecting our many surface waters is also essential to our economy because our waterways attract businesses, homeowners, and vacationers. Shoreland zoning plays a major role in helping us protect the quality and the natural scenic beauty of Wisconsin's surface waters by promoting appropriate land use surrounding our lakes, streams and rivers.

Land Use and Construction Activities Affected by Shoreland Zoning

Each Wisconsin county has zoning ordinance provisions which protect water resource values: water quality, recreation and navigation, fish and wildlife habitat, and natural scenic beauty. County ordinances must have standards that meet or exceed the minimum state standards contained in Chapter NR 115, Wisconsin Administrative Code. These standards include:

- Setbacks for structures from waterways and property lines
- Minimum lot sizes and land division review
- Controls on cutting shoreline vegetation
- Standards for earth moving activities
- Protection for wetlands
- Regulation of septic systems and wells
- Restrictions on improvements to older structures that don't meet the shoreland standards

What's Inside?

- *What Areas are Affected by Shoreland Zoning? (jurisdictional map)*
- *Useful Tips for the Waterfront Property Buyer/Owner*
- *Resource List*

Illustrations by Jim McEvoy
PUBL-WZ-009 94

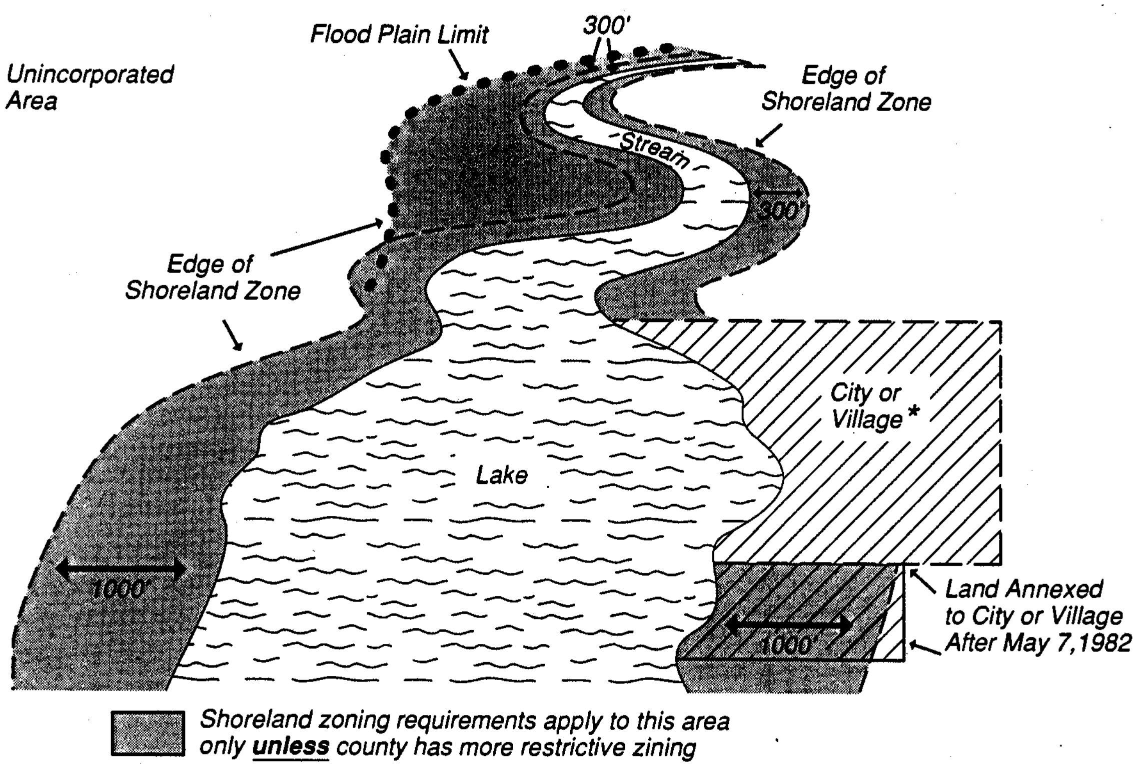
WISCONSIN DEPARTMENT OF NATURAL RESOURCES

PRINTED ON RECYCLED PAPER

PRINTED WITH SOY INK

Which Areas Are Affected By Shoreland Zoning?

All shorelands in unincorporated areas and all shorelands annexed to a city or village after May 7, 1982.



*Cities and villages are required to zone **wetlands** within the shoreland. Contact your zoning administrator.*

Definitions

Shoreland Zone — The shoreland zone is located within 1,000 feet of the ordinary high water mark (OHWM) of a "navigable" lake, pond or flowage or within 300 ft. of the OHWM of a "navigable" stream or river or to the landward side of the floodplain, which ever distance is greater.

Ordinary High Water Mark — The ordinary high water mark is the boundary between upland and lake or riverbed. It is the point on the bank or shore up to which the presence and action of the water is so continuous as to leave a distinct mark either by erosion, destruction of terrestrial vegetation, or other easily recognized characteristics.

"Navigable" — Generally, a waterway is navigable if it has a bed and banks and can float a canoe at some time each year—even if only during spring floods. Even small intermittent streams that are seasonally dry may meet the test of navigability. Navigable lakes and streams are public waterways protected by law for all citizens.

Unincorporated Areas — Lands lying outside of incorporated cities or villages.

Tips for the Waterfront Property Owner/Purchaser

If you are thinking of buying shoreland property or if you are considering remodeling, landscaping, or building on lands within the shoreland zone (See map on opposite page), this section provides information about many of the activities that may be regulated. Because some counties' shoreland protection standards go beyond the state minimum requirements that are described in this brochure, contact your local zoning office for specifics.

Setbacks for Buildings and other Structures from Waterways

Construction in nearshore areas often causes erosion, disturbs fish and wildlife habitat, and detracts from the natural appearance of the shoreline. In order to minimize the effects of development, local shoreland ordinances require that structures be set back from the water. Generally, you will need to place structures, including decks, a minimum of 75 feet back from the bed of the waterway.

Most county ordinances allow boathouses within the waterway setback if they meet specific construction standards. They must be used only for storing boats and related equipment and may not be built on the bed of the waterway. When there are steep slopes or unstable soil conditions, walkways and stairways necessary to access the water may be permitted within the setback. However, they must be designed with the minimum dimensions necessary to access the water. As with all shoreland development, check with your local zoning office for permit requirements.

Remodeling or Adding on to Existing Buildings

Many buildings constructed before shoreland zoning was enacted do not meet current requirements (eg. waterway setbacks, lot size, waste disposal). These buildings can be repaired and maintained, but because their presence can conflict with community goals, such as protecting natural shoreline aesthetics, habitat or water quality, local ordinances usually limit additions, alterations and expansions over the life of the structure to 50 percent of the fair market value. A permit is generally required for each change.

Vegetation Cutting

Because plant roots typically act to hold soil in place, maintaining natural vegetation on your waterfront property can help you to avoid serious erosion problems. Trees and shrubs also provide wildlife habitat, shade for fish, privacy for the property owner, and create a natural buffer that helps protect the lake or stream from erosion and sedimentation during heavy rains. Manicured lawns generally do not provide this protection. Heavy rains can carry nutrients from fertilized lawns directly into the lake. If numerous property owners apply fertilizer to their lawns, the cumulative effects can harm water quality, fish, wildlife and aesthetics. There are many attractive ways to limit shoreline cutting and still provide shoreline access and views of the water. (See resource list) Shoreland zoning ordinances specify the maximum amount of vegetation that can be cleared from the shoreline.

Grading/Earth Moving Activities

Any activity that exposes soil can cause erosion, sediment buildup and excess weedy growth in near-shore waters. The local zoning permit process helps assure that projects are designed to reduce erosion during and after the excavation. Grading activities adjacent to waterways often also require a permit from the Department of Natural Resources (DNR). Generally you'll be required to: avoid sensitive areas like wetlands and steep slopes, replant quickly, keep runoff away from exposed areas, and provide a stable slope. Depending on the specifics of the site, additional erosion control measures may be prescribed.

Protecting an Eroding Shoreline

Maintaining a good plant cover on your property can keep erosion from starting. Wetland plants also help to dissipate wave and wind action that could otherwise lead to an eroding shoreline. If you have an ongoing erosion problem, which can not be solved by use of vegetation, placing large rock or boulder rip-rap with filter material underneath along the shore is often an effective solution. Because this involves placing materials on the bed of a waterway, a DNR permit is necessary. Check with both your zoning administrator and the DNR for recommendations and permits.

Low Swampy Land

Contact the zoning office to see if the area is mapped as a wetland. Wetlands within the shoreland zone have special protection, because they help control flooding problems, serve as a filter to prevent water pollution, and provide wildlife habitat and fish spawning areas. The shoreland zoning ordinance lists the variety of uses that are permitted within wetlands in the shoreland zone. Filling, grading and draining activities are usually prohibited. For additional information see the DNR publication "Protecting Wetlands Through Local Zoning", (WZ-001), and contact your local zoning administrator. Another DNR publication, "Building Near Wetlands. The Dry Facts" provides information about Federal (U.S. Army Corps of Engineers) permits and other considerations for development near wetlands.

The Local Zoning Process

Your local zoning administrator can explain what approvals you will need before beginning your project and what application materials you will need to provide in order to ensure efficient review of your proposal. Many activities will require public notice and a public hearing. If you are denied a permit, you may appeal to your county zoning board of adjustment or in some situations, the local courts.

Resource List

- "Becoming a Lake-Front Property Owner: Tips on Buying Lake-Front Property" DNR PUBL-WR-171 88 Rev., (13 Pages)
- "Be In Tune.....To Your Lake" DNR WR-261 90, (2 pages)
- "Life on the Edge... Owning Waterfront Property, UW-Ext. (100 pages)
- "Protecting Wetlands Through Local Zoning" DNR PUBL-WZ-001 93 Rev (4 pages)
- "Rethinking Yard Care" UW-Ext. (8 pages)
- "Shoreline Plants and Landscaping" UW-Ext. GWQ014 (16 pages)
- "What is a Shoreland Buffer Zone?" DNR PUBL-WR-170 87 (2 pages)

"Life on the Edge....Owning Waterfront Property" is available through County Extension Offices or Local Zoning Offices. Other UW-Extension publications may be obtained from Cooperative Extension Publications, Room 245, 30 N. Murray Street, Madison, Wisconsin 53715 (608)262-3346.

DNR Publications are available from your local DNR area or district office

This project has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement # X995257-01-0 to the Wisconsin Department of Natural Resources. The contents of this document do not necessarily reflect the views and policies of the environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Yard Care and the Environment

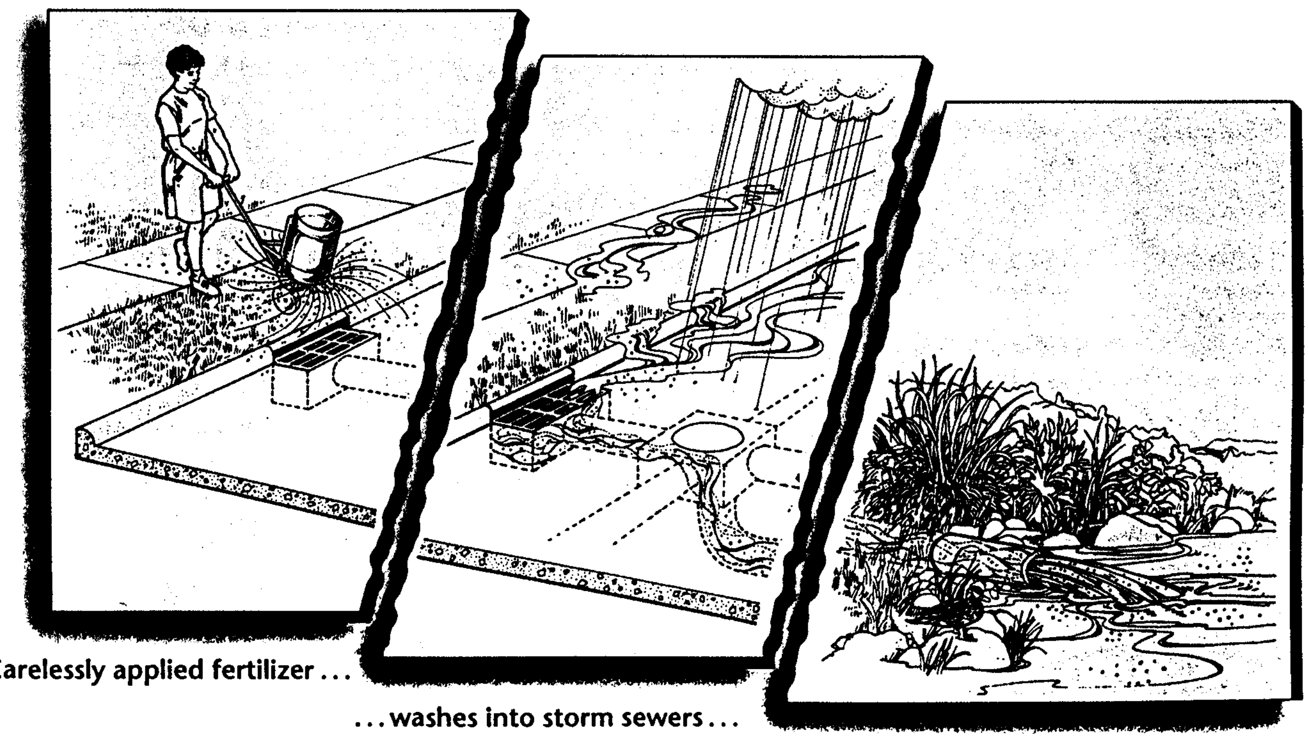
Lawn & Garden Fertilizers

Healthy lawns, trees and shrubs add to the beauty and value of a home. They also keep our lakes and streams clean by allowing rainwater to filter into the soil rather than running into storm sewers. Maintaining healthy lawns and landscape plants, however, often requires the use of fertilizers and improper fertilizer use can cause water pollution.

Many fertilizer materials, including leaves and grass clippings, contain nitrogen and phosphorus. When these nutrients wash into lakes and streams they:

- promote unsightly algae blooms and aquatic weed growth,
- lower dissolved oxygen levels in the water, and
- may release ammonia – which is toxic to fish.

This publication describes fertilizer practices that will help maintain healthy lawns and gardens, while protecting water quality in your community.



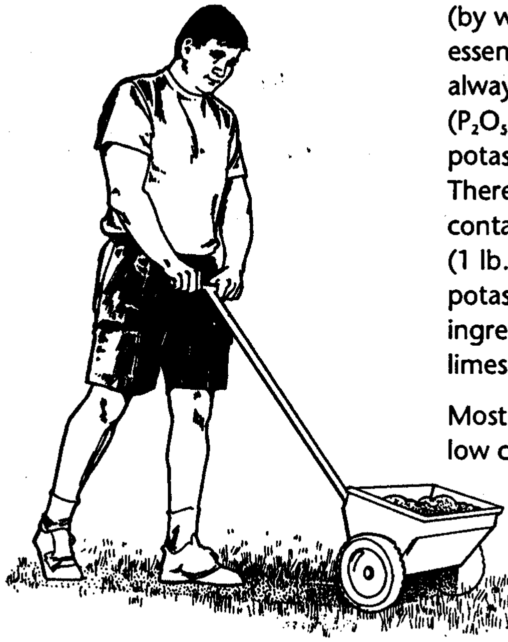
Carelessly applied fertilizer . . .

. . . washes into storm sewers . . .

. . . and flows directly into our lakes and streams.

It all adds up

Fertilizer carelessly applied on one lawn can be a waste of the homeowner's money but may otherwise seem insignificant. On hundreds or thousands of lawns, however, careless applications can add up to a major problem for local streams and lakes. For tips on efficient fertilizing, see inside . . .



It's best to test the soil before you start a fertilization program. For more information on soil testing, contact your county UW-Extension office.

FERTILIZER SELECTION

The label on a fertilizer bag has three numbers indicating the percentage (by weight) of the three nutrients most essential to healthy lawns. Nitrogen (N) is always listed first, followed by phosphate (P_2O_5), which supplies phosphorus, and potash (K_2O), which supplies potassium. Therefore, a 25 lb. bag of 25-4-5 fertilizer contains 25% (6.25 lbs.) nitrogen, 4% (1 lb.) phosphate, and 5% (1.24 lbs.) potash. The remainder is made of ingredients such as sand or ground limestone.

Most organic fertilizers contain relatively low concentrations of plant nutrients compared to synthetic fertilizers, and release nutrients more slowly. Slow-release fertilizers provide a lower concentration of nutrients over a longer period of time. Fast-release fertilizers do the opposite.

On heavy (clay) or compacted soils, fast release fertilizers are better than slow-release fertilizers. The longer a fertilizer granule remains undissolved, the greater the chances of it being washed into waterways. On sandy soils, however, nitrogen can leach through the soil into the groundwater. On these soils, slow release nitrogen is preferred. Slow release nitrogen sources provide soluble nitrogen over a period of time so there is not a large concentration of nitrogen available for leaching.

SOIL TESTS

A fertilization program should begin with a soil test. Soil tests provide specific fertilizer recommendations for your lawn and garden and can help you avoid over-application of fertilizer.

LAWN FERTILIZERS

A lawn fertilization program should begin in **early October**, not early May. Spring applications can actually harm lawns by promoting more top (leaf) growth than root growth. Shallow root systems are unable to sustain lawns through a drought or a harsh winter. Fall fertilizer applications, however, promote deep, healthy root systems and hardy lawns.

Fall fertilizer applications should be made when the average daily temperature drops to 50° F. The average daily temperature is determined by adding the daily high temperature and the daily low temperature, and dividing by two. For example, 61° F (daily high) +37° F (daily low) divided by 2 = 49° F average daily temperature.

The table below shows the timing of fertilizer applications and recommended amounts (if a soil test report is not available). It also shows the importance of grass clippings. By leaving grass clippings on the lawn, nitrogen applications can be reduced by 30-40 percent. Keep in mind that over-fertilizing and poor timing – not grass clippings – are primary reasons for thatch problems in lawns.

Nitrogen application guidelines

Time of Application[1]	Pounds of nitrogen per 1,000 square feet of lawn: Grass Clippings Removed	Grass Clippings Not Removed[2]
October 1	1.25	1.00
Late May	1.25	1.00
Late June	0.75	0.50
Late August (optional)	0.75	0.50

[1]Fall nitrogen fertilizers should be water soluble and contain nitrate or ammonia forms of nitrogen such as urea, ammonium nitrate or ammonium sulfate.

[2]Grass clippings are organic fertilizers containing 3-4% nitrogen when dry.

Note: You can use a simple calculation to determine how much fertilizer to apply to reach a recommended level of nitrogen. For example, if you want to apply 1.00 lb. of nitrogen using 25-4-5 fertilizer, divide 1.00 by 25 percent (or .25). The answer is 4. In this case, to get the recommended 1.00 pound of nitrogen, apply 4 lbs. of the fertilizer mixture per 1,000 sq. ft. of lawn. (Of course, you also need to determine the size of the lawn.)

GARDENS, TREES & SHRUBS

Start with a soil test. The nutrient requirements for garden plants vary. In general, nitrogen promotes leafy top growth; phosphorus is used for root development; and potassium is necessary for winter hardiness, disease resistance, and general plant durability. Specific recommendations can be found in publications available at your county UW-Extension office.

Healthy trees and shrubs in will-drained, fertile soils do not require annual fertilizer applications. If they appear unhealthy, the problem may be caused by insects, disease, or weather. Fertilizers should be applied when trees and shrubs are growing poorly and the problem cannot be traced to other causes. If plants do not respond, the problem may be soil-related.

In general, trees and shrubs should be fertilized when they are dormant, in late fall or early spring. Fertilizing in early fall stimulates growth that might be killed in winter, providing an entrance for insects and disease organisms. Similarly, fertilizing in late spring stimulates growth that depletes stored food supplies and weakens the plant. (However, if trees and shrubs are stressed by environmental conditions, fertilizer should be applied in June.)

When planting gardens, trees or shrubs, cover the bare soil with a mulch to prevent erosion, and sweep (don't wash) soil off paved areas. Phosphorus is often attached to soil particles. When these particles are washed into lakes or streams the phosphorus stimulates excess weed and algae growth.

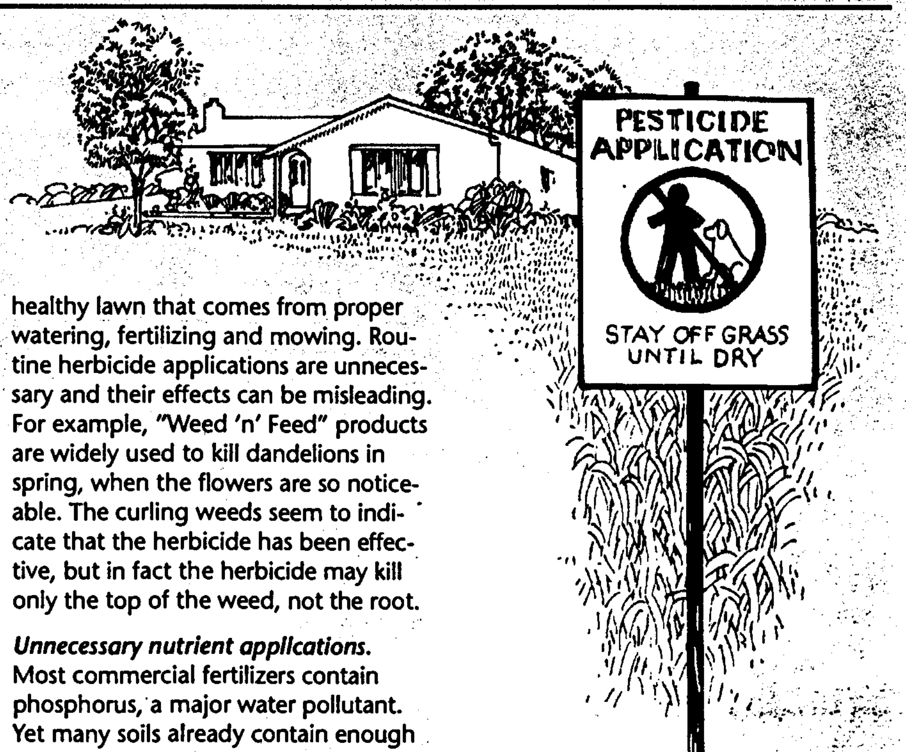
Healthy gardens, trees and shrubs add beauty and value to a home, allow stormwater to soak into the ground and help filter impurities from the water.

A Note of Caution on Fertilizer-Pesticide Combinations

Many homeowners and lawn care companies routinely combine fertilizer and pesticides in a series of applications throughout the spring, summer and fall. These multi-step programs are promoted as the sure and easy path to the perfect lawn. The pressure to have a perfect lawn, however, has clouded a number of issues and literally mixed ingredients that should be kept separate. Areas of caution include:

Routine insecticide applications. Most insects found on a lawn are beneficial, and insecticides can harm these beneficial insects, as well as birds, pets and people. Research in Wisconsin indicates that only about one lawn in 200 will need an insecticide application in a given year. Even on lawns where harmful insects exist, natural controls or better lawn care practices will reduce the threat. For example, chinch bugs can be pests during a dry year, but proper watering (or even a good rain) can minimize their effects.

Routine herbicide applications. Weeds are not the cause of an unhealthy lawn, they are the result. The best defense against weeds is a thick healthy lawn that comes from proper watering, fertilizing and mowing. Routine herbicide applications are unnecessary and their effects can be misleading. For example, "Weed 'n' Feed" products are widely used to kill dandelions in spring, when the flowers are so noticeable. The curling weeds seem to indicate that the herbicide has been effective, but in fact the herbicide may kill only the top of the weed, not the root.



Unnecessary nutrient applications. Most commercial fertilizers contain phosphorus, a major water pollutant. Yet many soils already contain enough phosphorus for a healthy lawn. This underscores the need for a soil test before applying fertilizers. Low-phosphorus or phosphorus-free fertilizers can provide nutrients while avoiding the threat to water quality.

In short, applying unneeded pesticides and nutrients in a generic, multi-step fertilizer program can be expensive for the homeowner and harmful to the environment.

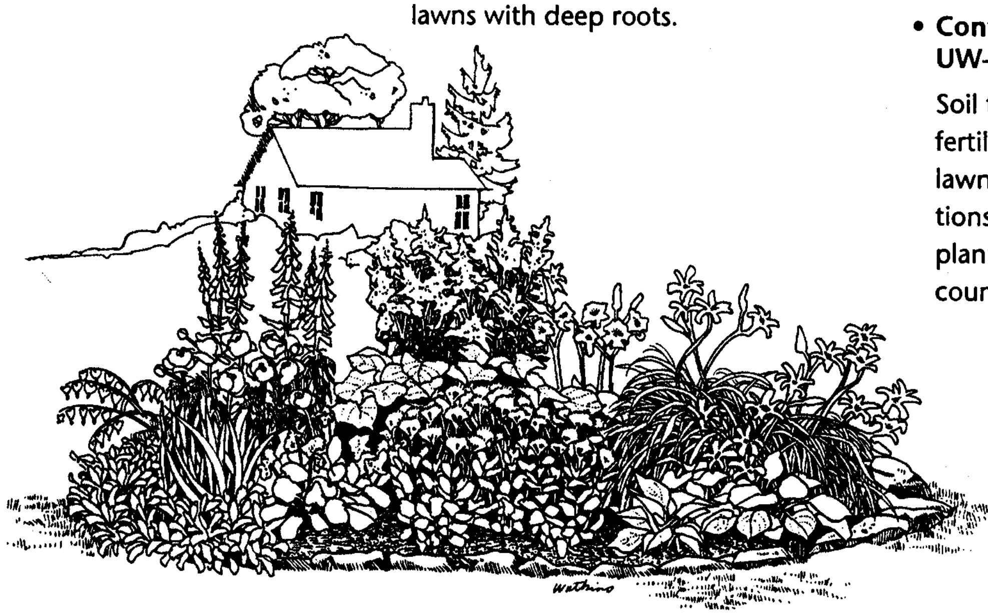
A good fertilization program promotes healthy plants that are more resistant to drought, insects and diseases. Healthy plants can also out-compete weeds and filter pollutants carried by runoff water. Indiscriminate use of fertilizers, however, can damage plants and pollute lakes and streams. To maintain a healthy lawn and garden and protect our water resources, remember:

- **Test the soil.**

  Before planting a garden or fertilizing your lawn, have the soil tested. A soil test takes the guesswork out of fertilization.

- **Fertilize lawns in the fall.**

  Fall fertilization promotes healthy lawns with deep roots.



- **Healthy trees and shrubs do not require an annual fertilizer application.**

  Overfertilized shrubs, in fact, will produce more growth and require more pruning.

- **Sweep all fertilizers, soil, and vegetation off paved surfaces.**

  Fertilizers, soil particles, grass clippings and leaves contain nitrogen and phosphorus which can cause nuisance weed and algae growth if washed through storm sewers into nearby waterways. In addition, decomposing leaves and grass clippings can rob streams and lakes of oxygen.

- **Contact your county UW-Extension office.**

  Soil testing information and fertilizer recommendations for lawns and gardens, and suggestions for selecting the right plants, are available at your county UW-Extension office.

This publication is available from county UW-Extension offices or from Extension Publications, 630 W. Mifflin St., Madison, WI 53703. (608) 262-3346.

A publication of the University of Wisconsin–Extension in cooperation with the Wisconsin Department of Natural Resources.

Authors: Gary Korb and James Hovland, UW-Extension, and Steven Bennett.

Illustrations: Carol Watkins

Editing and design by the Environmental Resources Center, University of Wisconsin–Extension.

Printed on recycled paper

GWQ002 Lawn & Garden Fertilizers

DNR WT-528-99

R-09-99-10M-30-S