



An Update on the Bio-Engineering at Island Lake

In 2010, Progressive AE conducted a series of studies on Island Lake to assess the lake condition. The results of these studies were compiled and discussed in “Island Lake Improvement Plan Report”, January 2011, by Progressive AE (attached). One area of concern discussed in the report was the erosion of the two islands in the middle of the lake. The report discusses the problems caused by the erosion and recommends bio-engineering or “soft armoring” to stabilize the islands and prevent further erosion.

The bio-engineering of the islands consists of two major activities: (1) the installation of bio-degradable engineering materials to stabilize the islands and prevent further erosion, and (2) planting of native vegetation to establish plants and root structure that will further stabilize the islands. The report from Progressive AE makes many recommendations for these activities, including the need to reduce the overall populations of birds on the islands in order to address soil acidity that would prevent plants from growing.

On April 13, 2011, the Island Lake Improvement Board held a Hearing of Practicability at the Bloomfield Township offices to discuss the implementation of this project. The minutes from that meeting are attached. The Island Lake Improvement Board voted unanimously to move forward with the project to stabilize islands through bio-engineering.

On October 24, 2011, the MDEQ issued a permit for all bio-engineering activities on Island Lake (attached).

On March 19, 2012, LakePro began working on the islands (and other areas of the lake) to install bio-engineering materials. For the proper installation of the bio-logs (coir logs) around the islands, the first step of the work was to remove woody debris from around the shoreline of the islands. In the early days of our project, we removed only nests that were inactive and in the area we were working.

We installed the bio-logs & erosion control blankets, put down seed mix, and planted live plants. Once the birds fully returned the islands, the only work that was done was inspection of the bio-engineering materials and watering of the new vegetation on the islands.

Once the birds left the islands for the season, we resumed our work and removed the rest of the woody debris from around and on top of the islands. We also planted the spruce trees in order to establish some larger plants. Spruce trees were selected specifically because they do not normally provide nesting habitat to Egrets and Cormorants.

Future work on the islands will involve regular inspection of the bio-engineering materials, supplemental plantings as necessary, and watering of the plants during the summer. Reducing the bird populations is vital to the success of this project because the birds can destroy the bio-engineering





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materials, kill the new vegetation, and acidify the soil to prevent future plant growth. However, Egrets and Cormorants that create new nests on the islands will not be disturbed during the summer. Once they leave for the season, the nests will be removed to discourage their return. Nests in the woody structure surrounding the islands will not be touched.

One other item is that the islands are owned by Kirk in the Hills and they have approved all of the work that has/will be undertaken. I understand that residents around the lake may take issue with the work being done, but the decision ultimately belongs to the church and funding comes from the Lake Board and the Kirk.

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*Lake Manager for Island Lake
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Complete Water Management





Island Lake Improvement Plan Report

Prepared for:

Island Lake Improvement Board
4200 Telegraph Road
Bloomfield Hills, MI 48302

Prepared by:

Progressive AE
1811 4 Mile Road, NE
Grand Rapids, MI 49525-2442
616/361-2664

January 2011

Project No: 61880101

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Introduction

Island Lake is located in Sections 17 and 18 of Bloomfield Township in Oakland County (Figure 1). In April of 2010, Progressive AE was retained by the Island Lake – Lake Board to conduct a lake improvement feasibility study. The objective of the study was to develop and define an improvement plan for Island Lake. The purpose of this report is to discuss study findings, conclusions, and recommendations.

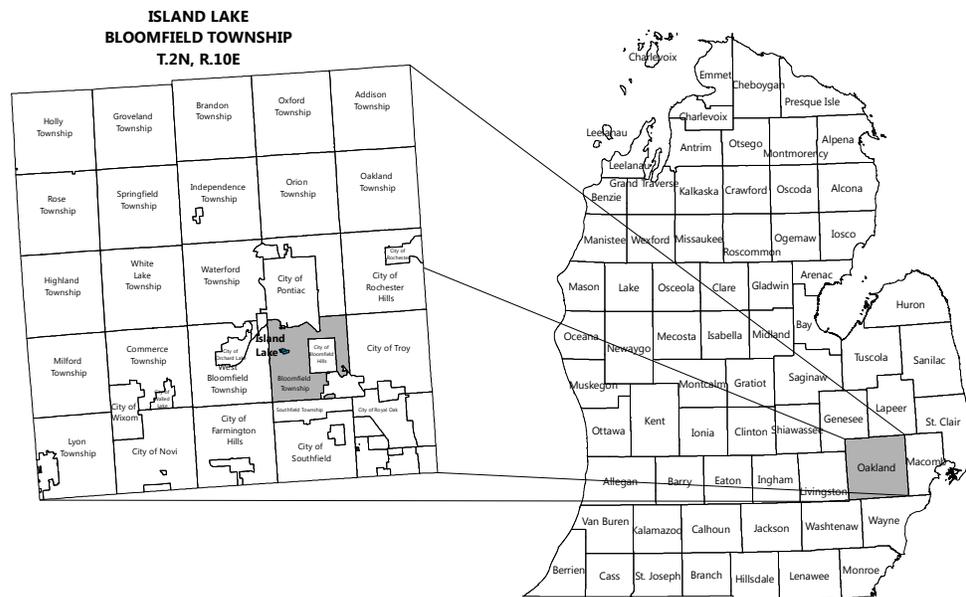
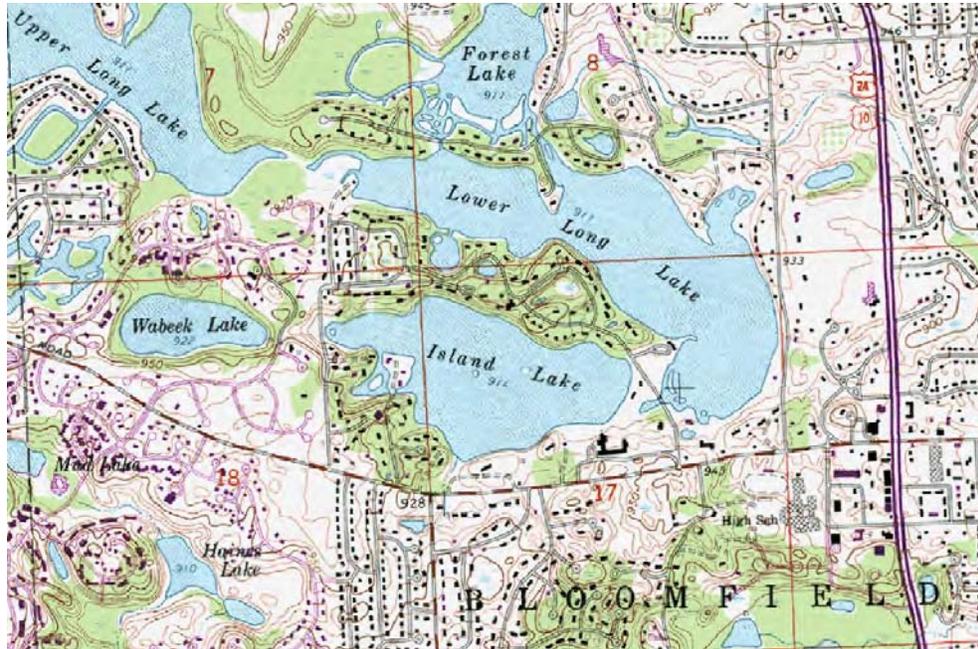
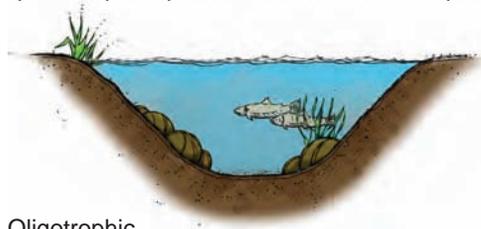


Figure 1. Project location map.

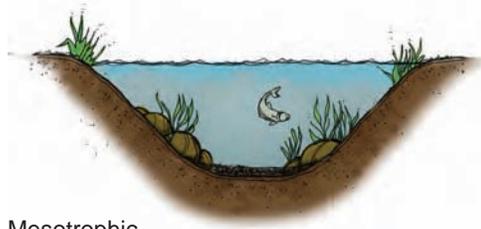
Physical, Chemical, and Biological Characteristics

Lake water quality is determined by a unique combination of processes that occur both within and outside of the lake. In order to make sound management decisions, it is necessary to have an understanding of the current physical, chemical, and biological condition of the lake, and the potential impact of drainage from the surrounding watershed.

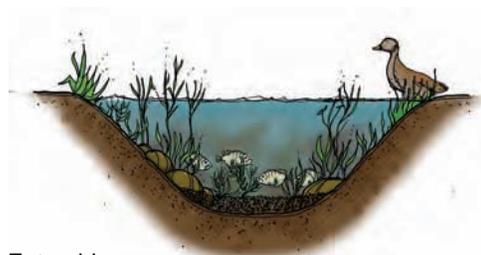
Scientists classify lakes as **oligotrophic, mesotrophic, or eutrophic** (Figure 2). Oligotrophic lakes are generally deep and clear with little aquatic plant growth. These lakes maintain sufficient dissolved oxygen in the cool, deep bottom waters during late summer to support cold water fish such as trout and whitefish. By contrast, eutrophic lakes are generally shallow, turbid, and support abundant aquatic plant growth. In deep eutrophic lakes, the cool bottom waters usually contain little or no dissolved oxygen. Therefore, these lakes can only support warm water fish such as bass and pike. Lakes that fall between these two extremes are called mesotrophic lakes.



Oligotrophic



Mesotrophic



Eutrophic

Figure 2. Lake classification.

Under natural conditions, most lakes will ultimately evolve to a eutrophic state as they gradually fill with sediment and organic matter transported to the lake from the surrounding watershed. As the lake becomes shallower, the process accelerates. When aquatic plants become abundant, the lake slowly begins to fill in as sediment and decaying plant matter accumulate on the lake bottom. Eventually, terrestrial plants become established and the lake is transformed to a marshland. The aging process in lakes is called "**eutrophication**" and may take anywhere from a few hundred to several thousand years, generally depending on the size of the lake and its watershed. The natural lake aging process can be greatly accelerated if excessive amounts of sediment and nutrients (which stimulate aquatic plant growth) enter the lake from the surrounding watershed. Because these added inputs are usually associated with human activity, this accelerated lake aging process is often referred to as "**cultural eutrophication**." The problem of cultural eutrophication can be managed by identifying sources of sediment and nutrient

loading (i.e., inputs) to the lake and developing strategies to halt or slow the inputs. Thus, in developing a improvement plan, it is necessary to determine the limnological (i.e., the physical, chemical, and biological) condition of the lake and the physical characteristics of the watershed as well. Methods used to study Island Lake are included in the Appendix.

ISLAND LAKE AND ITS WATERSHED

A summary of the physical characteristics of Island Lake and its watershed is provided in Table 1. Island Lake has a surface area of 111 acres, a maximum depth of 55 feet, and a mean or average depth of 13.3 feet. A map depicting approximate depth contours in Island Lake is shown in Figure 3. Island Lake contains about 1,482 acre-feet of water, a volume which would cover an area over 2.3 square miles to a depth of 1 foot. The lake has a shoreline 2.6 miles long and a shoreline development factor of 1.8. The shoreline development factor indicates the degree of irregularity in the shape of the shoreline. That is, compared to a perfectly round lake with the same surface area as Island Lake (i.e., 111 acres), the shoreline of Island Lake is 1.8 times longer because of its irregular shape.

Two small islands exist in the central portion of the lake. Both islands support substantial bird populations, a unique feature of Island Lake.

**TABLE 1
ISLAND LAKE
PHYSICAL CHARACTERISTICS**

Lake Surface Area	111 Acres
Maximum Depth	55 Feet
Mean Depth	13.3 Feet
Lake Volume	1,482 Acre-Feet
Shoreline Length	2.6 Miles
Shoreline Development Factor	1.8
Lake Elevation	914 Feet Above Sea Level
Watershed Area	283 Acres
Ratio of Lake Area to Watershed Area	1 : 2.5

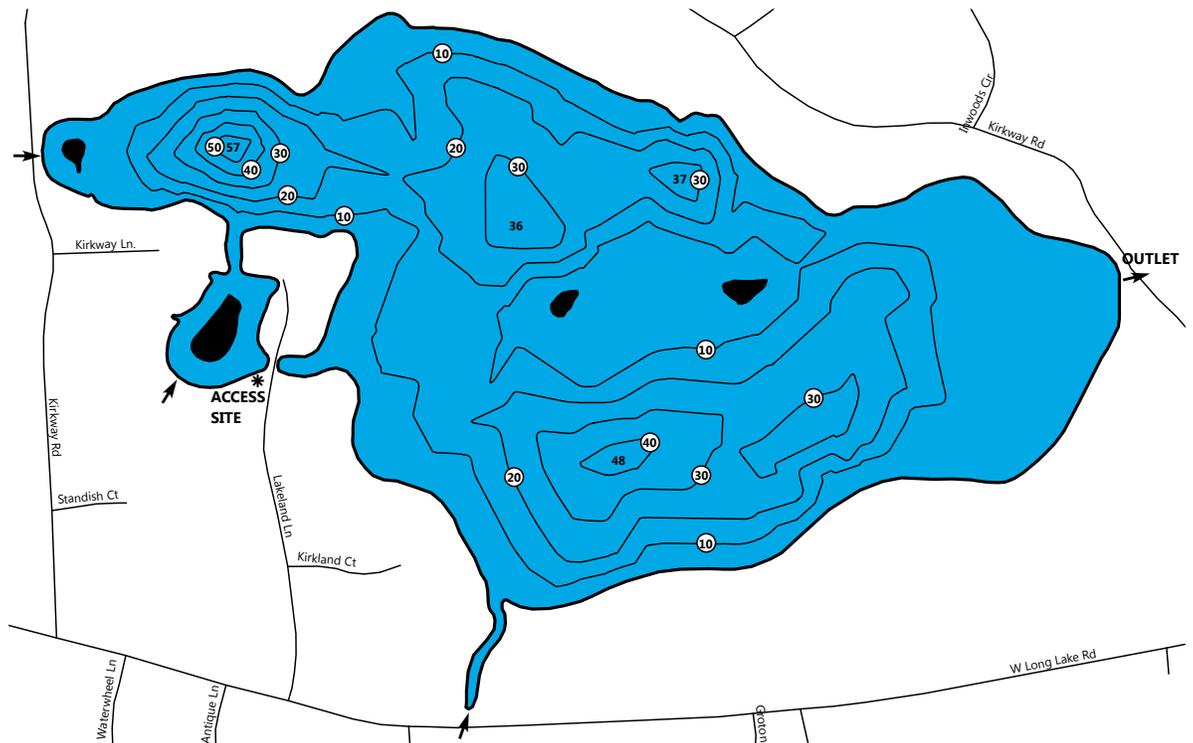


Figure 3. Island Lake depth contour map.

PHYSICAL, CHEMICAL, AND BIOLOGICAL CHARACTERISTICS

The land area surrounding a lake that drains to the lake is called its watershed or drainage basin. The Island Lake watershed is 283 acres, a land area about 2.5 times larger than the lake itself. Water enters Island Lake through three intermittent drainage ways which drain lands to the west and south of the lake (Figure 4). Most of the watershed is composed of urbanized lands, primarily residential development. Approximately 60 homes border the lake. Water flows from Island Lake over a small lake level control structure into Lower Long Lake and ultimately into the Rouge River.

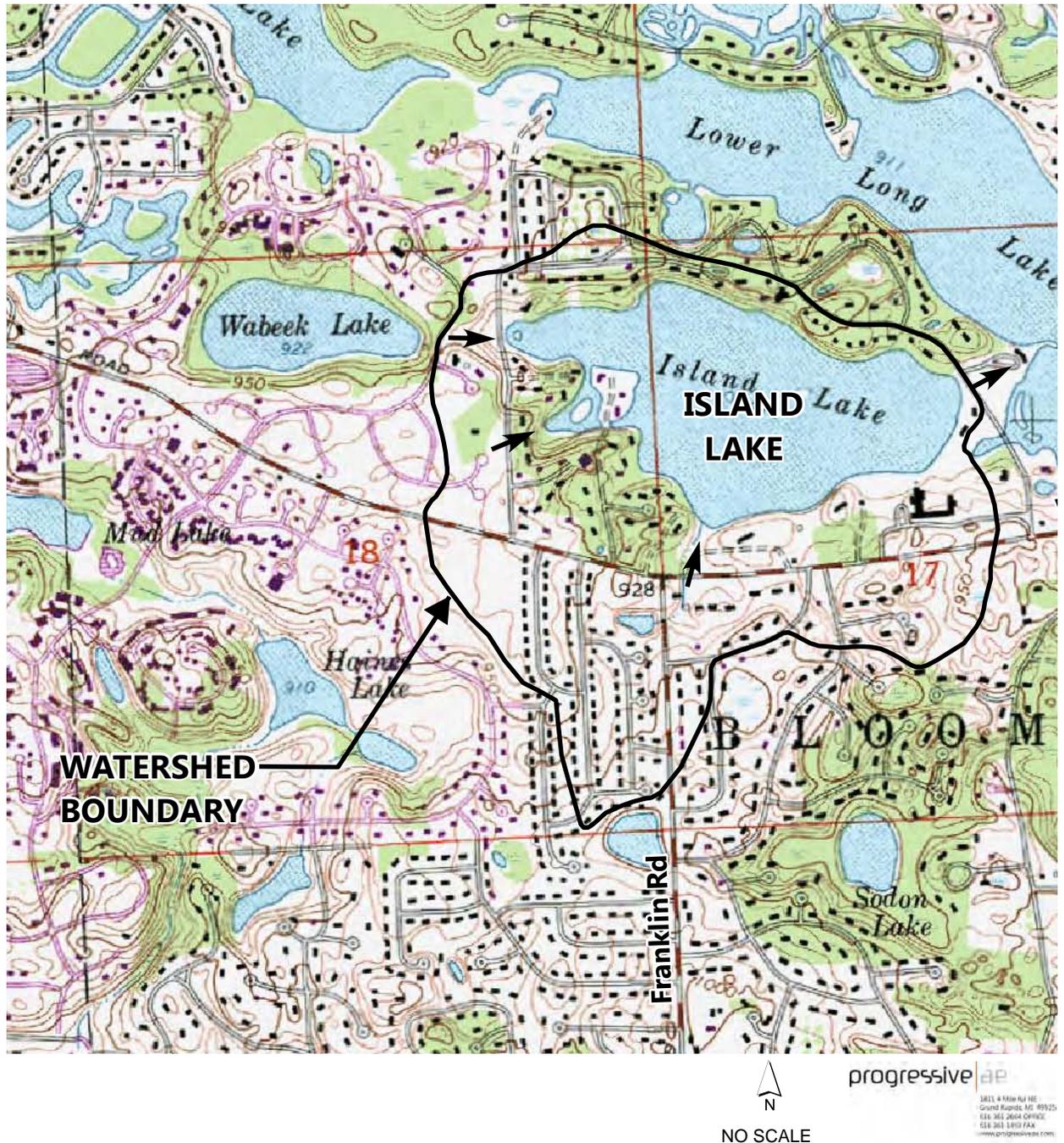


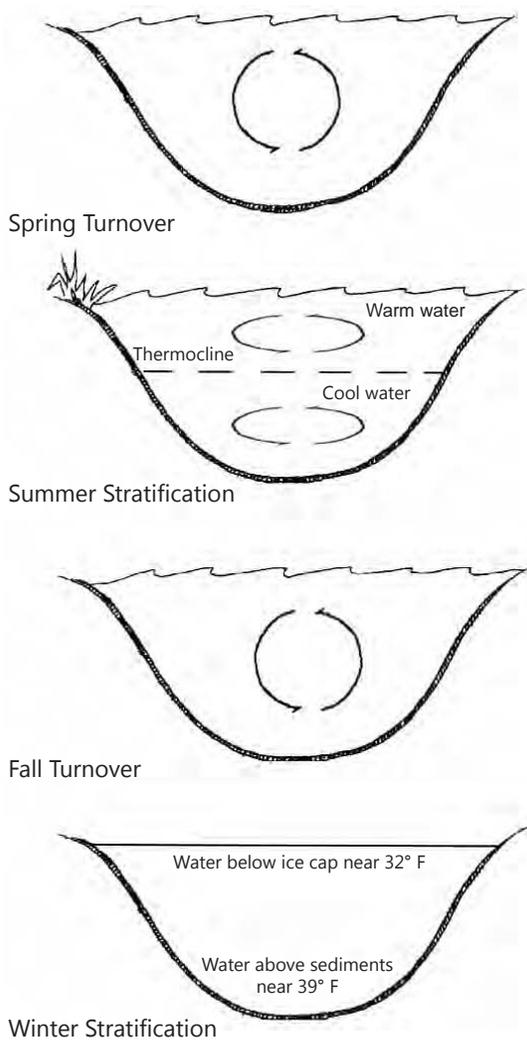
Figure 4. Island Lake watershed map.

LAKE WATER QUALITY

There are many ways to measure lake water quality, but there are a few important physical, chemical, and biological parameters that indicate the overall condition of a lake. These measurements include temperature, dissolved oxygen, total phosphorus, chlorophyll-*a*, and Secchi transparency. The latter three measures are used in classifying a lake. Other important parameters include pH, total alkalinity, and fecal coliform bacteria levels.

TEMPERATURE

Temperature is important in determining the type of organisms that may live in a lake. For example, trout prefer temperatures below 68°F. Temperature also determines how water mixes in a lake. As the ice cover breaks up on a lake in the spring, the water temperature becomes uniform from the surface to the bottom. This period is referred to as “spring turnover” because water mixes throughout the entire water column. As



the surface waters warm, they are underlain by a colder, more dense strata of water. This process is called thermal stratification. Once thermal stratification occurs, there is little mixing of the warm surface waters with the cooler bottom waters. The transition layer that separates these layers is referred to as the “thermocline.” The thermocline is characterized as the zone where temperature drops rapidly with depth. As fall approaches, the warm surface waters begin to cool and become more dense. Eventually, the surface temperature drops to a point that allows the lake to undergo complete mixing. This period is referred to as “fall turnover.” As the season progresses and ice begins to form on the lake, the lake may stratify again. However, during winter stratification, the surface waters (at or near 32°F) are underlain by slightly warmer water (about 39°F). This is sometimes referred to as “inverse stratification” and occurs because water is most dense at a temperature of about 39°F. As the lake ice melts in the spring, these stratification cycles are repeated (Figure 5). Shallow lakes do not stratify. Lakes that are 15 to 30 feet deep may stratify and destratify with storm events several times during the year.

DISSOLVED OXYGEN

An important factor influencing lake water quality is the quantity of **dissolved oxygen** in the water column. The major inputs of dissolved oxygen to lakes are the atmosphere and photosynthetic activity by aquatic plants. An oxygen level of about 5 mg/L (milligrams per liter, or parts per million) is required to support warm water fish. In lakes deep enough to exhibit thermal stratification, oxygen levels are often reduced or depleted below the thermocline once the lake has stratified. This is because

Figure 5. Lake stratification and turnover.

deep water is cut off from plant photosynthesis and the atmosphere, and oxygen is consumed by bacteria that use oxygen as they decompose organic matter (plant and animal remains) at the bottom of the lake. Bottom-water oxygen depletion is a common occurrence in eutrophic and some mesotrophic lakes. Thus, eutrophic and most mesotrophic lakes cannot support cold water fish because the cool, deep water (that the fish require to live) does not contain sufficient oxygen.

PHOSPHORUS

The quantity of **phosphorus** present in the water column is especially important since phosphorus is the nutrient that most often controls aquatic plant growth and the rate at which a lake ages and becomes more eutrophic. In the presence of oxygen, lake sediments act as a phosphorus trap, retaining phosphorus and, thus, making it unavailable for aquatic plant growth. However, if bottom-water oxygen is depleted, phosphorus will be released from the sediments and may be available to promote aquatic plant growth. In some lakes, the release of phosphorus from the bottom sediments is the primary source of phosphorus loading (or input). By reducing the amount of phosphorus in a lake, it may be possible to control the amount of aquatic plant growth. In general, lakes with a phosphorus concentration greater than 20 µg/L (micrograms per liter, or parts per billion) are able to support abundant plant growth and are classified as nutrient-enriched or eutrophic.

CHLOROPHYLL-A

Chlorophyll-a is a pigment that imparts the green color to plants and algae. A rough estimate of the quantity of algae present in lake water can be made by measuring the amount of chlorophyll-a in the water column. A chlorophyll-a concentration greater than 6 µg/L is considered characteristic of a eutrophic condition.

SECCHI TRANSPARENCY

A **Secchi disk** is often used to estimate water clarity. The measurement is made by fastening a round, black and white, 8-inch disk to a calibrated line (Figure 6). The disk is lowered over the deepest point of the lake until it is no longer visible, and the depth is noted. The disk is then raised until it reappears. The average between these two depths is the Secchi transparency. Generally, it has been found that aquatic plants can grow at a depth of approximately twice the Secchi transparency measurement. In eutrophic lakes, water clarity is often reduced by algae growth in the water column, and Secchi disk readings of 7.5 feet or less are common.

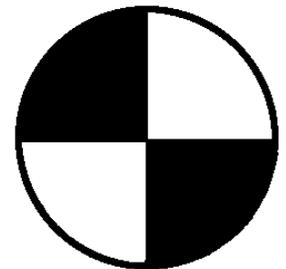


Figure 6. Secchi disk.

LAKE CLASSIFICATION CRITERIA

Ordinarily, as phosphorus inputs to a lake increase, the amount of algae will also increase. Thus, the lake will exhibit increased chlorophyll-a levels and decreased transparency. A summary of lake classification criteria developed by the Michigan Department of Natural Resources is shown in Table 2.

**TABLE 2
LAKE CLASSIFICATION CRITERIA**

Lake Classification	Total Phosphorus (µg/L) ¹	Chlorophyll-a (µg/L) ¹	Secchi Transparency (feet)
Oligotrophic	Less than 10	Less than 2.2	Greater than 15.0
Mesotrophic	10 to 20	2.2 to 6.0	7.5 to 15.0
Eutrophic	Greater than 20	Greater than 6.0	Less than 7.5

¹ µg/L = micrograms per liter = parts per billion.

pH AND ALKALINITY

pH is a measure of the amount of acid or base in water. The pH scale ranges from 0 (acidic) to 14 (alkaline or basic) with neutrality at 7. The pH of lakes generally ranges between 6 and 9 (Wetzel 1983). The concentration of gases, such as oxygen and carbon dioxide, directly influence pH. Most organisms tolerate only very narrow ranges in pH; therefore, large amounts of alkalinity are needed as natural buffers to changes in pH.

Alkalinity is the measure of the pH-buffering capacity of water. Lakes that have high alkalinity (over 100 mg/L as calcium carbonate) are able to sustain large inputs of acid with little change in pH. Addition of acid can occur naturally (e.g., during bacterial decomposition of organic material in the sediments; during natural diffusion of carbon dioxide into the surface waters), or because of pollution (acid deposition, both wet and dry fall). The ability of the lake to maintain a stable pH is crucial to the survival of its aquatic inhabitants.

SAMPLING RESULTS AND DISCUSSION

Water quality sampling was conducted in April and August of 2010 over the two deep basins of Island Lake (Figure 7). Sampling data collected during the course of study is summarized in Table 3 and Table 4.

Thermal stratification and bottom water dissolved oxygen depletion was evident in Island Lake during both the April and August sampling periods (Table 3). These data indicate that Island Lake cannot support cold-water fish species because the cool, deep bottom waters of the lake are devoid of dissolved oxygen. Thus, there is no cold-water refuge for fish during the summer months.

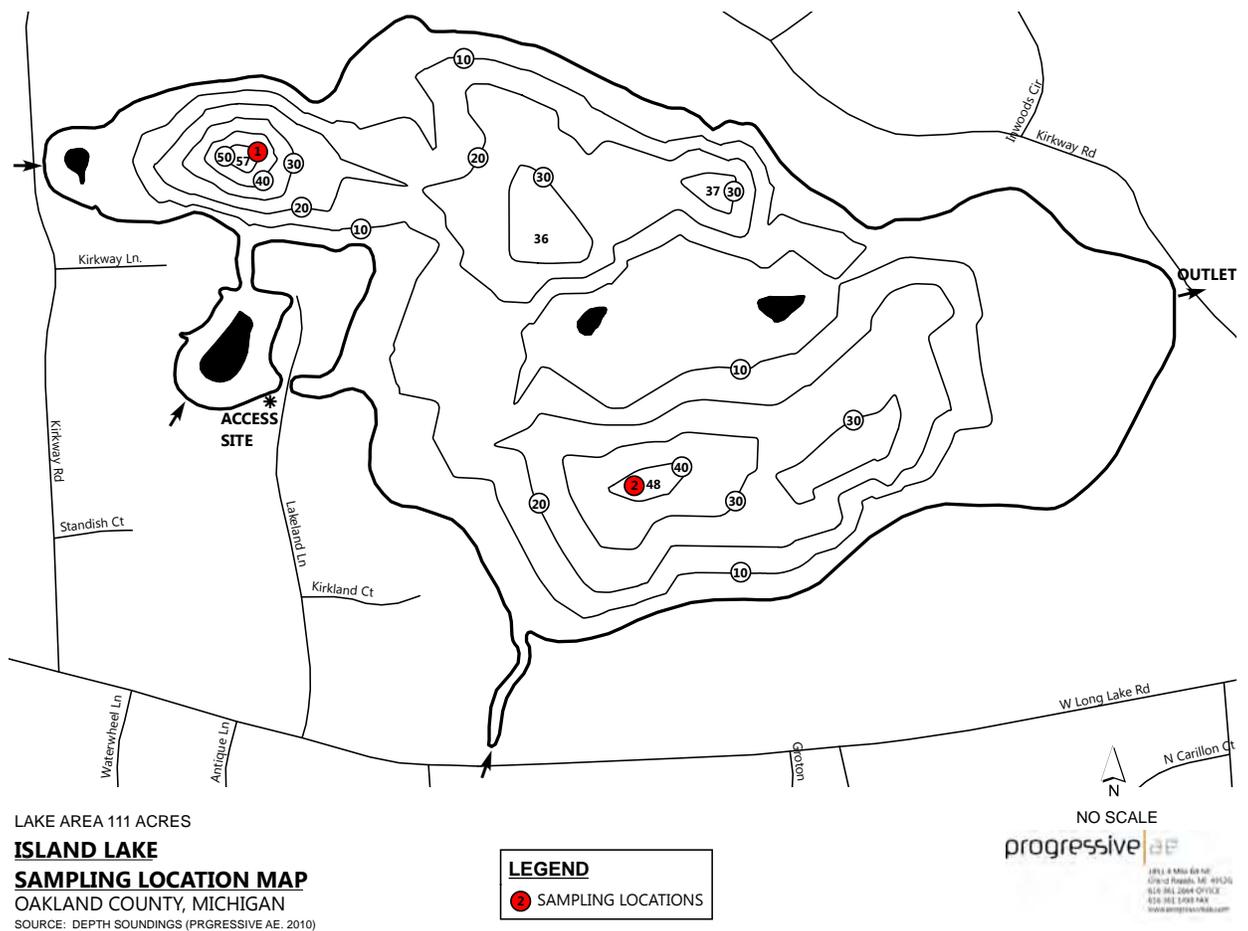


Figure 7. Island Lake sample location map.

TABLE 3
ISLAND LAKE
DEEP BASIN WATER QUALITY DATA

Date	Sample Location	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L) ¹	Total Phosphorus (µg/L) ²	pH	Chloride
22-Apr-10	1	1	58	12.4	41	9.6	162
22-Apr-10	1	10	53	11.3	52	9.5	157
22-Apr-10	1	20	46	3.2	46	8.7	155
22-Apr-10	1	30	41	0.2	103	8.4	168
22-Apr-10	1	40	40	0.0	191	8.3	174
22-Apr-10	1	55	40	0.0	217	8.1	167
22-Apr-10	2	1	59	12.8	38	9.5	170
22-Apr-10	2	10	52	12.7	44	9.4	168
22-Apr-10	2	20	46	3.9	35	8.7	164
22-Apr-10	2	30	43	0.3	136	8.4	173
22-Apr-10	2	45	42	0.1	165	8.1	183
3-Aug-10	1	1	83	9.5	12		173
3-Aug-10	1	10	79	8.1	<5		178
3-Aug-10	1	20	55	0.0	57		174
3-Aug-10	1	30	44	0.0	248		185
3-Aug-10	1	40	41	0.0	393		189
3-Aug-10	1	55	41	0.0	435		188
3-Aug-10	2	1	82	9.5	14		193
3-Aug-10	2	10	76	8.2	12		163
3-Aug-10	2	20	53	0.0	60		172
3-Aug-10	2	30	46	0.0	359		180
3-Aug-10	2	45	44	0.0	388		180

Phosphorus levels in Island Lake increased with depth and were substantially elevated in the oxygen-depleted bottom waters (Table 3). Internal release of phosphorus from the oxygen-deficient bottom sediments could be a significant source of phosphorus loading in Island Lake. The volume-weighted mean of all phosphorus samples collected is 36 parts per billion, well above the 20 parts per billion eutrophic threshold concentration.

¹ mg/L = milligrams per liter = parts per million.

² µg/L = micrograms per liter = parts per billion.

PHYSICAL, CHEMICAL, AND BIOLOGICAL CHARACTERISTICS

The pH measurements in Island Lake were within ranges commonly observed in southern Michigan lakes. The pH readings were higher in the surface waters and lower in the anaerobic bottom waters of the lake (Table 3). pH is strongly influenced by the amount of carbon dioxide in the water column. In the surface water, carbon dioxide is used by plants during photosynthesis which increases the pH. In the anaerobic bottom waters, bacterial respiration produces carbon dioxide which dissolves in the water and forms a weak acid (carbonic acid) that decreases pH. Alkalinity readings in Island Lake are high indicating the lake is well-buffered and has a high capacity to neutralize acids without dramatic shifts in pH.

Chloride is a chemical constituent that is relatively benign in most lakes. Michigan's chloride standard states that surface water used as a public drinking water supply shall not exceed 125 parts per million. USEPA's ambient water criteria to protect aquatic life is 230 parts per million for chronic exposure. The average chloride concentration of several hundred Michigan Lakes was 18 parts per million in a statewide survey conducted between 2001 and 2005 by the U.S. Geological Survey (Fuller and Minnerick 2008). Chloride levels in Island Lake measured during the sampling period were about 10-fold the state average (Table 3). The likely source of chloride in Island Lake is runoff of road salt. The elevated chloride levels may be creating a salinity gradient (or chemocline) that inhibits complete mixing of the lake during spring and fall turnover. Lakes in which the entire water column does not mix are referred to as "meromictic" lakes. This phenomenon could explain the lack of deep-water dissolved oxygen observed in Island Lake in April as well as the elevated deep-water phosphorus levels. Normally, during spring turnover, deep-water oxygen is replenished as the water column mixes and much of the phosphorus precipitates out of the water column. This may not have occurred in Island Lake during the spring of 2010.

Secchi transparency measurements during the April sampling period ranged from 2.8 to 3.0 feet, and from 8.5 to 9.0 feet in August (Table 4). During the April sampling, chlorophyll-*a* values ranged from 6 to 8 parts per billion indicating significant algae growth was occurring the open waters of the lake. In August, chlorophyll-*a* levels were slightly reduced and ranged from 2 to 6 parts per billion. The reduced algae growth in the water column in August likely contributed to the increased transparency measured in the lake at that time.

Based on the data collected and presented herein, Island Lake would be classified as eutrophic in that it has elevated total phosphorus levels, intermittently high chlorophyll-*a* levels and low transparency, and dissolved oxygen depletion in the deep waters of the lake. To better evaluate baseline water quality conditions in Island Lake, a water quality monitoring program similar in scope to that completed during the course of study should be conducted on an annual basis. The annual cost of water quality monitoring would be \$3,000.

TABLE 4
ISLAND LAKE
SURFACE WATER QUALITY DATA

Date	Sample Location	Secchi Transparency (feet)	Chlorophyll- <i>a</i> ($\mu\text{g/L}$) ¹
22-Apr-10	1	3.0	8
22-Apr-10	2	2.8	6
3-Aug-10	1	9.0	6
3-Aug-10	2	8.5	2

¹ $\mu\text{g/L}$ = micrograms per liter = parts per billion.

AQUATIC PLANTS

The distribution and abundance of aquatic plants are dependent on several variables including light penetration, bottom type, temperature, water levels, and the availability of plant nutrients. The term “aquatic plants” includes both the algae and the larger aquatic plants or macrophytes. The macrophytes can be categorized into four groups: the emergent, the floating-leaved, the submersed, and the free-floating.

Aquatic plant surveys of Island Lake were conducted on May 10 and August 3, 2010. The plant surveys were performed in accordance with Department of Natural Resources and Environment (DNRE) Procedures for Aquatic Vegetation Surveys. With these procedures, the shoreline is divided into individual assessment sites and the type and relative abundance of each plant species within each assessment site is determined around the entire lake shoreline. During the May survey, plants were collected from 35 individual assessment sites around the lake and, in August, plants were collected from 40 individual assessment sites. A total of 15 species of submersed plants were observed in Island Lake during the two surveys. A listing of the species observed in the lake along with the percent frequency of each species is presented in Table 5. Percent frequency was calculated by dividing the total number of sites where a particular plant species was observed by the total number of assessment sites.

TABLE 5
ISLAND LAKE AQUATIC PLANTS

Common Name	Scientific Name	Group	Percent of Sites Where Plant Was Found	
			May 10, 2010	August 3, 2010
Eurasian milfoil	<i>Myriophyllum spicatum</i>	Submersed	97%	90%
Chara	<i>Chara</i> sp.	Submersed	91%	40%
Starry stonewort	<i>Nitellopsis obtusa</i>	Submersed		88%
Wild celery	<i>Vallisneria americana</i>	Submersed		73%
Thin-leaf pondweed	<i>Potamogeton</i> sp.	Submersed	26%	28%
Illinois pondweed	<i>Potamogeton illinoensis</i>	Submersed	11%	33%
American pondweed	<i>Potamogeton americanus</i>	Submersed		38%
Curly-leaf pondweed	<i>Potamogeton crispus</i>	Submersed	26%	5%
Large-leaf pondweed	<i>Potamogeton amplifolius</i>	Submersed		23%
Coontail	<i>Ceratophyllum demersum</i>	Submersed	3%	18%
Richardson’s pondweed	<i>Potamogeton richardsonii</i>	Submersed		20%
Naiad	<i>Najas flexilis</i>	Submersed		15%
Water stargrass	<i>Heteranthera dubia</i>	Submersed	6%	
Whitestem pondweed	<i>Potamogeton praelongus</i>	Submersed	6%	
Elodea	<i>Elodea canadensis</i>	Submersed	3%	
Big duckweed	<i>Spirodela polyrhiza</i>	Free-floating		5%
White waterlily	<i>Nymphaea odorata</i>	Floating-leaved	14%	40%
Yellow waterlily	<i>Nuphar</i> sp.	Floating-leaved		10%
Bulrush	<i>Scirpus</i> sp.	Emergent		25%
Cattail	<i>Typha</i> sp.	Emergent	11%	8%
Purple loosestrife	<i>Lythrum salicaria</i>	Emergent		15%
Iris	<i>Iris</i> sp.	Emergent		15%
Swamp loosestrife	<i>Decodon verticillatus</i>	Emergent		10%
Pickerelweed	<i>Pontederia cordata</i>	Emergent		5%
Arrowhead	<i>Sagittaria latifolia</i>	Emergent	3%	
Phragmites	<i>Phragmites australis</i>	Emergent		3%

With the exception of a few nuisance species such as Eurasian milfoil, most aquatic plants are beneficial and essential to maintaining a healthy lake (Figure 8).

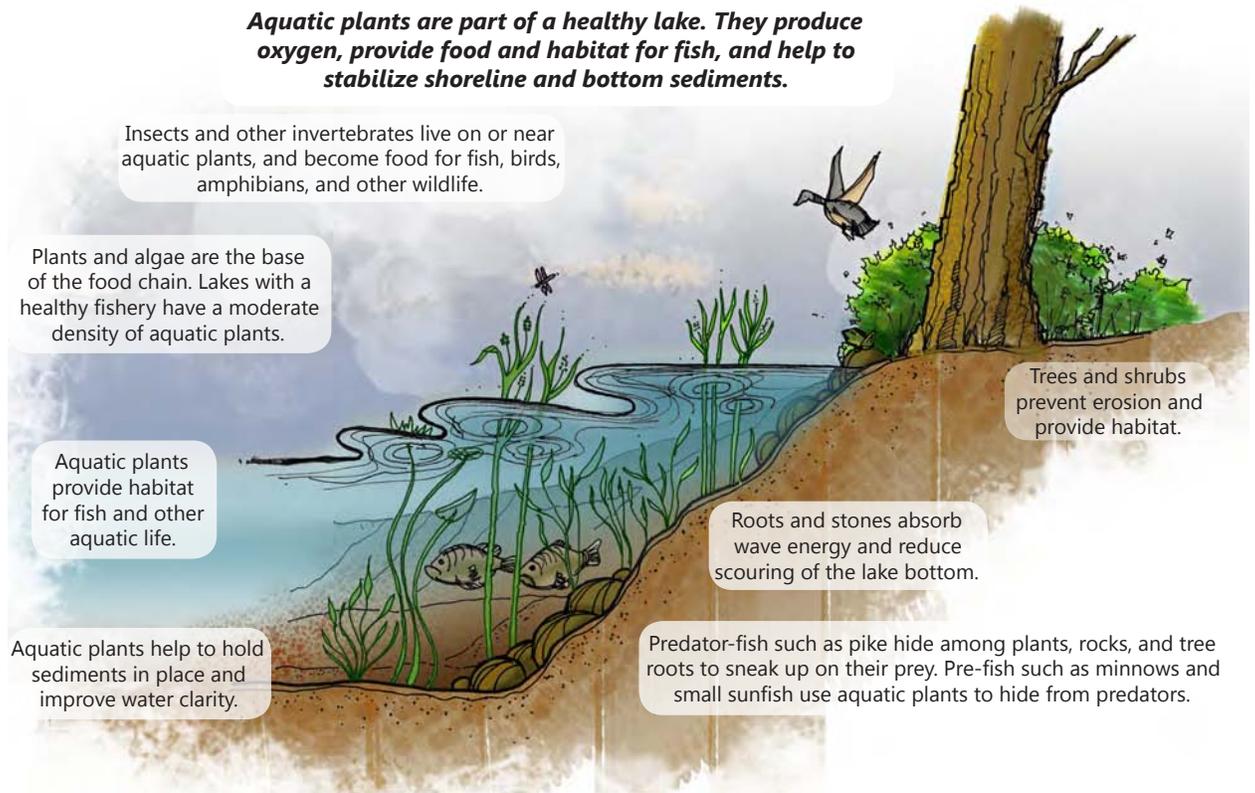


Figure 8. Aquatic plant benefits.

For example, Chara is considered a beneficial plant in that it is low-growing; it forms a net-like mat at the bottom which helps to hold sediments in place; it absorbs phosphorus and helps improve water clarity; and it provides food and habitat for fish and wildlife (Figure 9). Chara is fairly abundant in Island Lake and should not be aggressively managed.

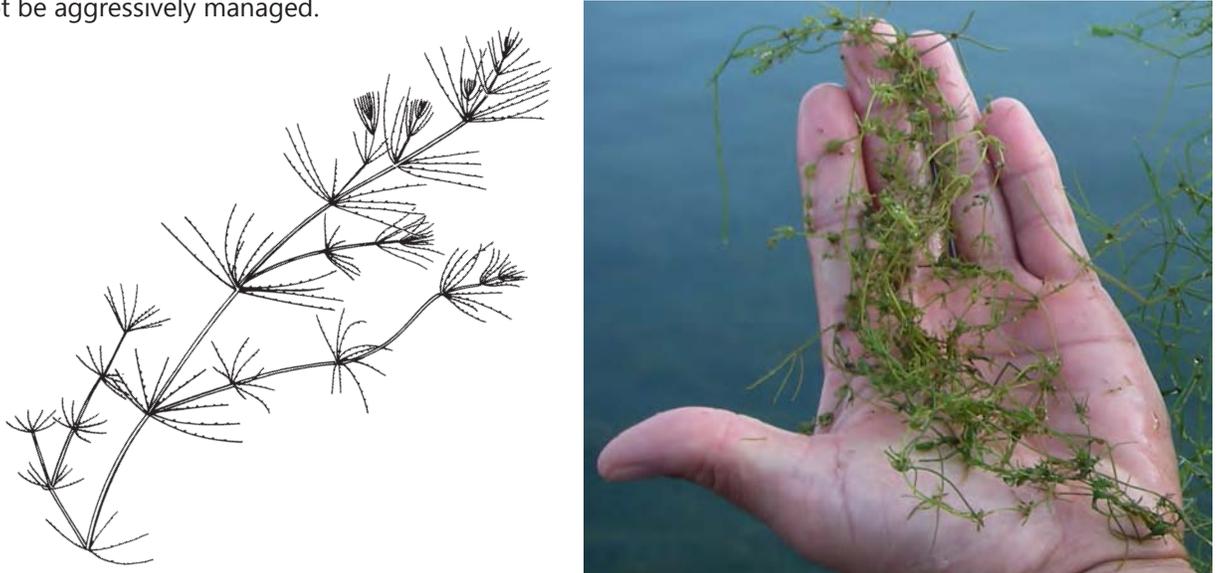


Figure 9. Chara. Aquatic plant line drawing is the copyright property of the University of Florida (Gainseville). Used with permission.

The dominant plant found in Island Lake during both plant surveys was Eurasian milfoil (Figure 10). This plant is an invasive species that, at high densities, can create nuisance conditions. Getsinger et al. (2005) described problems associated with Eurasian milfoil as follows:

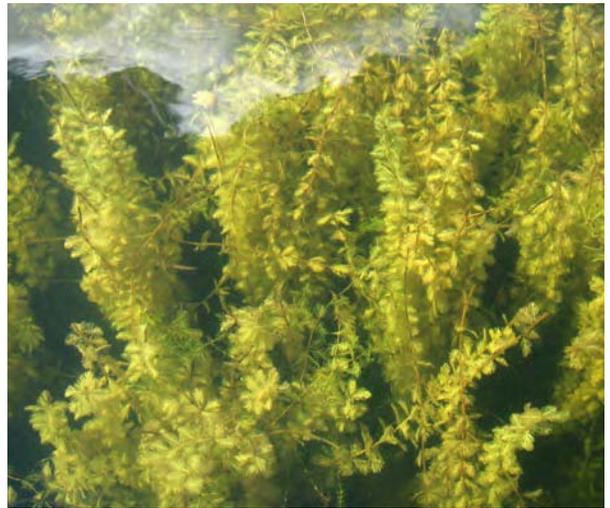


Figure 10. Eurasian milfoil.

Problems associated with this species include its aggressive displacement of native vegetation, and alteration of fish and wildlife habitat by formation of impenetrable mats with dense upper canopies that reduce light and decrease water flow. These significant changes in habitat quality quickly affect fish, wildlife, and other aquatic organisms.

Over time, Eurasian watermilfoil will out-compete or eliminate more beneficial native aquatic plants, severely reducing natural plant diversity within a lake. Eurasian watermilfoil is rarely used for food by wildlife, and can displace many aquatic plants that are valuable food sources for waterfowl, fish, and insects. Dense stands of Eurasian watermilfoil provide habitat for mosquitoes and may increase populations of some species of these insects.

Fish populations may initially experience a favorable increase when Eurasian watermilfoil first invades a site. However, the abundant and aggressive growth of this weed will counteract any short-term benefits. Its typically dense growth habit make Eurasian watermilfoil beds poor spawning areas for fish and may lead to populations of small-sized specimens. Loss of oxygen and light caused by the dense mats can also affect the characteristics of fish populations. At high densities, Eurasian watermilfoil's foliage supports a lower abundance and diversity of invertebrates to serve as fish food. While dense cover does allow high survival rates of young fish, larger predator fish lose foraging space and are less efficient at obtaining their prey. Thus dense Eurasian watermilfoil stands are reported to reduce expansion and vigor of warm-water fisheries.

The growth and senescence of dense Eurasian watermilfoil colonies also reduce water quality and water circulation, and cause lower levels of dissolved oxygen.

Another invasive plant found in Island Lake is starry stonewort (Figure 11). Starry stonewort resembles the native aquatic plant Chara. Starry stonewort has tiny, star-shaped, tan-colored reproductive structures called "bulbils" that are firm to the touch when compared to its soft branches. The presence of bulbils is one way to distinguish between starry stonewort and Chara. Unlike Chara, which is generally considered to be a beneficial plant, starry stonewort has a tendency to colonize deeper water and can form dense mats several feet thick. Starry stonewort can impede navigation and limit growth of more beneficial plants.



Figure 11. Starry stonewort.

In addition to nuisance submersed species, an emergent species called Phragmites was observed bordering Island Lake (Figure 12). Phragmites is an aggressive-growing, exotic emergent plant that is infesting Michigan's coastal areas, wetlands, and lake shores. Plants can exceed 15 feet in height and obstruct shoreline views and uses. Phragmites can greatly reduce the diversity of desirable native plants and reduce wildlife habitat.



Figure 12. Phragmites.

Phragmites is a perennial plant that is dormant during the winter months. Primary growth occurs during mid-summer with flowering and seed dispersal in late summer and fall. Besides seed dispersal, Phragmites can also spread through the expansion of underground stems called rhizomes. In fact, much of the plant's biomass is underground. Rhizomes can

exceed 60 feet in length, grow several feet per year, and readily grow into new plants when fragmented. Phragmites roots can penetrate the ground several feet and the plant can survive in relatively dry uplands as well as shallow wetlands. However, water depths greater than a few inches typically inhibit Phragmites seed germination.

Eurasian milfoil, starry stonewort, and possibly Phragmites are the primary nuisance species that should be targeted for control in Island Lake. Plant surveys using the state survey procedures discussed herein should be performed in spring and late summer each year to evaluate the overall effectiveness of plant control activities. The cost to conduct annual plant surveys and to prepare a brief report of findings would be \$3,500 per year.

Lake Improvement Alternatives

INTRODUCTION

Study findings indicate that Island Lake is eutrophic and has phosphorus levels sufficient to sustain abundant aquatic plant growth. Currently, substantial infestations of the invasive, nuisance species Eurasian milfoil and starry stonewort occur in Island Lake. In order to effectively manage Island Lake over the long term, steps should be taken in concert with in-lake improvements to reduce watershed pollution inputs. Watershed issues of primary concern include phosphorus fertilizer runoff and loss of shoreland habitat.

AQUATIC PLANT CONTROL

Although an overabundance of undesirable plants can limit recreational use and enjoyment of a lake, it is important to realize that aquatic plants are a vital component of aquatic ecosystems. They produce oxygen during photosynthesis, provide food and habitat for fish and other organisms, and help stabilize shoreline and bottom sediments. The objective of a sound aquatic plant control program is to remove plants only from problem areas where nuisance growth is occurring. Under no circumstance should an attempt be made to remove all plants from the lake.

Mechanical harvesting (i.e., plant cutting and removal) and chemical herbicide treatments are methods commonly employed to control aquatic plant growth (Figures 13 and 14). For large-scale aquatic plant control, harvesting may be advantageous over herbicide treatments since plants removed from the lake will not sink to the lake bottom and add to the buildup of organic sediments. In addition, some nutrients contained within the plant tissues are removed with the harvested plants. With the use of herbicides, treated plants die back and decompose on the lake bottom while bacteria consume dissolved oxygen reserves in the decomposition process. Since the plants are not removed from the lake, sediment buildup on the lake bottom continues, often creating a bottom substrate ideal for future aquatic plant growth. However, if used sparingly or for selective control of nuisance species such as Eurasian milfoil, herbicides can provide effective control with minimal environmental impacts.



Figure 13. Mechanical harvesting.



Figure 14. Aquatic herbicide treatments.

It should be noted, however, that attempts to control certain plant types by harvesting alone may not be entirely effective. Since it is not economically feasible to mechanically harvest planktonic (i.e., free-floating) algae in a lake, herbicides, such as copper sulfate and chelated copper products, are often utilized to control nuisance algae growth. However, copper treatments for algae control are generally short-lived. If nutrients are available and weather and other conditions are favorable, nuisance algae can regrow rapidly. Given that algae treatments are short-lived and copper accumulates in lake sediment, aggressive and frequent treatments for

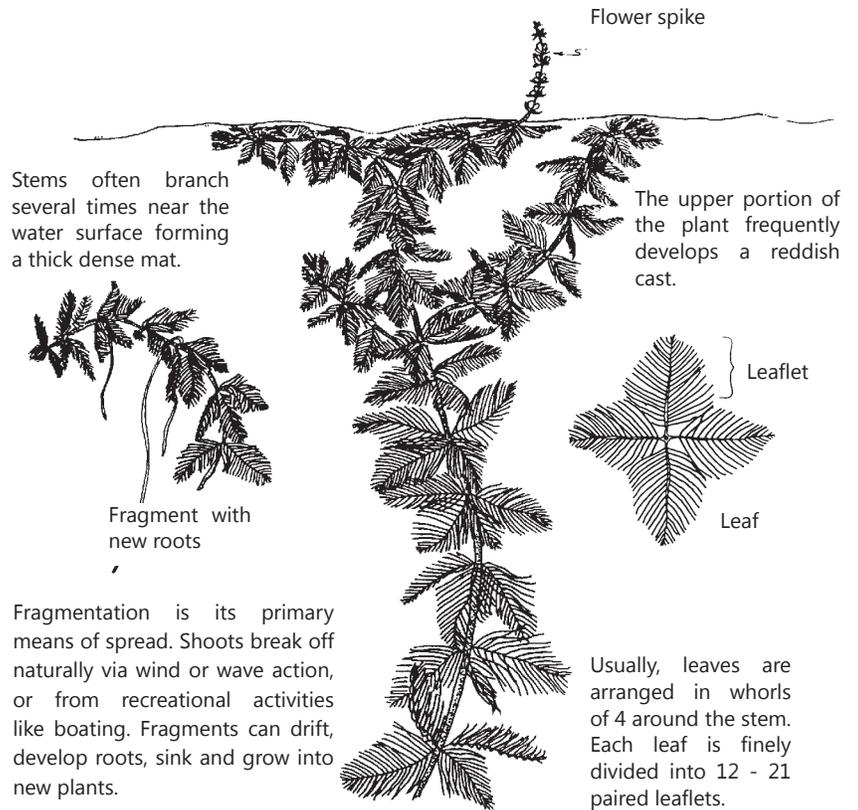


Figure 15. Eurasian milfoil (*Myriophyllum spicatum*).

algae control are generally ill-advised. Harvesting is not recommended for the control of Eurasian milfoil due to the fact that this plant may proliferate and spread via vegetative propagation (small pieces break off, take root, and grow) if the plant is cut (Figure 15). In general, season-long control of Eurasian milfoil is best achieved through the use of systemic herbicides rather than contact herbicides. Systemic herbicides are taken up by the plant and move to the root system. Systemic herbicides generally take several weeks to kill the targeted plant. Contact herbicides only kill the portion of the plant that comes into contact with the herbicide. While contact herbicides work quickly (in a few days time), the root system of the plant remains viable. Given the propensity of Eurasian milfoil to grow rapidly, systemic herbicides are generally preferred over contact herbicides for Eurasian milfoil control.

In Michigan, Part 33, Aquatic Nuisance Control, of the Natural Resources and Environmental Protection Act, PA 451 of 1994, requires that a permit be acquired from the DNRE before any herbicides are applied to inland lakes. The permit will include a list herbicides that are approved for use in the lake, respective dose rates, use restrictions, and will show specific areas in the lake where treatments are allowed.

In recent years, considerable research has been conducted on the biological control of Eurasian milfoil. This approach currently focuses on the introduction of an aquatic weevil, *Euhrychiopsis lecontei*, (Figure 16) that feeds almost exclusively on Eurasian milfoil. Weevils are native to the United States and Canada, and populations have been observed in Michigan lakes. However, control of Eurasian milfoil generally requires that large numbers of weevils be stocked to augment natural



Figure 16. Milfoil weevil.

Photo courtesy of Tom Alwin and Michigan State University Department of Fisheries and Wildlife

populations. Weevils do not eradicate Eurasian milfoil, and the overall biomass of Eurasian milfoil in the lake may not decline substantially as a result of weevil stocking (Cofrancesco et al. 2004). Rather, the boring action of weevil larvae can cause the plant to lose buoyancy and drop to the bottom. By preventing the formation of a dense canopy at the water surface, weevils can help to control the primary nuisance characteristic of Eurasian milfoil. However, as is the case with most biological controls, it is not possible to predict with certainty how effective weevils may be in controlling milfoil in a particular lake. Weevil and Eurasian milfoil populations can be expected to fluctuate up and down over time. In some lakes, fish predation can impact weevil populations. In lakes with high numbers of sunfish (*Lepomis* spp.), adult weevil density can be substantially reduced (Ward and Newman 2006). With weevils, adult longevity is important to end-of-summer population size (Ward and Newman 2006). Fish predation, which directly affects adult longevity, may be an important factor limiting weevil success (Newman 2004). Weevil stocking for Eurasian milfoil control in Island Lake is not recommended at this time.

Given the abundance of Eurasian milfoil in Island Lake, it is recommended that consideration be given to spot-treating Eurasian milfoil beds with systemic herbicides. Herbicide treatments for Eurasian milfoil control generally work best when conducted early in the growing season (i.e., May or early June) when the plants are actively growing. Over the course of a growing season, approximately 50 acres of Island Lake could require treatments for Eurasian milfoil control. Assuming a cost of \$400 per acre to treat Eurasian milfoil with a systemic herbicide, the annual cost of herbicide treatments in Island Lake would be \$20,000.

Another alternative to control the infestation of Eurasian milfoil in Island Lake would be a whole-lake treatment with a herbicide called fluridone (trade name Sonar). Fluridone is a systemic herbicide that, at low doses, selectively controls Eurasian milfoil while not significantly impacting desirable native plant species. In accordance with DNRE permit requirements, fluridone is applied in what is called a "6-bump-6" treatment. With this approach, fluridone is applied at an initial concentration of 6 parts per billion. About two weeks after the initial treatment, the concentration of fluridone in the lake is measured and the lake is treated again to bring the concentration back up to 6 parts per billion. The initial fluridone application is generally scheduled for late April or early May. At the low dose rates permitted, fluridone is slow-acting. It takes several weeks for the Eurasian milfoil to be noticeably impacted. Although the response to fluridone is initially slow, Eurasian milfoil is generally controlled the entire year of treatment and is greatly reduced the following year as well. As part of the approval process for the use of fluridone, the DNRE requires that a three-year lake management plan be prepared and submitted along with the standard herbicide treatment permit application.

In addition to the information required for the management plan, the DNRE requires a detailed aquatic plant survey of the lake in the year before the treatment, monitoring of treatment dose and aquatic plants during the year of treatment, and follow-up plant surveys in the second and third year after the treatment. With each plant survey, the type and relative abundance of each species throughout the lake are mapped using the previously described protocol developed by the DNRE. This data is used to document the need for a fluridone treatment and to assess treatment impacts. The estimated cost to conduct a whole-lake Sonar® treatment of Island Lake and to prepare the required lake management plan is \$20,000.

In conjunction with herbicide applications, consideration should also be given to the harvesting of vegetation where plants (other than Eurasian milfoil) are growing at nuisance densities in Island Lake. The primary plant that should be targeted for harvesting in Island Lake is starry stonewort. Harvesting operations should focus on developed shoreline areas and/or areas where plant growth is impeding navigation or recreation. It should be noted that Chara competes with planktonic algae for nutrients available in the lake. Excessive harvesting of vegetation (especially Chara) in Island Lake could inadvertently increase the

growth of planktonic algae. To the extent possible, harvesting operations adjacent to the islands should be minimized. Submersed vegetation around the islands creates a natural buffer that dissipates wave energy and helps prevent erosion. Vegetation in this area also absorbs some of the nutrient load from the island's bird population. Assuming two harvests of 35 acres are performed at a cost of \$600 per acre, the annual cost of harvesting in Island Lake would be \$42,000.

A final note, recent research indicates that Eurasian milfoil has begun to hybridize with native milfoil species. Moody and Les (2007) documented that invasive milfoil hybrids are widely dispersed across the northern portion of the United States and appear to be widespread in Michigan (Sturtevant et al. 2009). There is concern that these hybrid milfoils may grow more aggressively, and exhibit increased tolerance to herbicidal and biological control measures (Moody and Les 2007). Studies are underway to address these concerns and to better document the impact of hybrid milfoil. Milfoil samples collected and analyzed as part of this study found that hybrid milfoil does exist in Island Lake. The management implications of this finding are unclear at this time.

ISLAND STABILIZATION

The two islands in Island Lake have become a sanctuary and nesting area for a variety of bird species including egrets, cormorants, and herons (Figure 17). The concentration of birds on the islands has denuded much of the vegetation and appears to be greatly accelerating erosion of the islands. As part of the study, a field assessment of the island was conducted and alternatives to help stabilize the islands were evaluated. At this time, it appears that a bioengineering approach would provide the most cost-effective and environmentally sound way to help stem the accelerated erosion process on the islands.



Figure 17. Island Lake island.

Bioengineering is a technique whereby plant materials and special construction techniques are used to control erosion. Given the concentration of birds on the islands, construction would best be conducted in late summer or early fall when lake water levels are usually lowest and the bird population on the islands is diminished.

To maintain a more natural appearance of the islands, soft armoring, such as bio-logs (coir logs) is recommended. Bio-logs are interwoven coconut fibers filled with a growing medium that are bound together with biodegradable netting and are shaped like a log (Figure 18). They come either pre-vegetated or non-vegetated. Non-vegetated bio-logs are planted with lake edge plantings by hand, or the area behind the bio-log can be filled and planted. The bio-log provides temporary protection to the existing shoreline while new vegetation

is allowed adequate time to become established.

In the case of the west island, the bio-logs could be placed at the water's edge. Since the east island has existing buttonbush in shallow water ringing the island, it is recommended that the bio-log be located on the outside of the buttonbush (Figure 18). This may help the buttonbush become even more established and allow other vegetation to fill in on the shoreline behind the buttonbush.

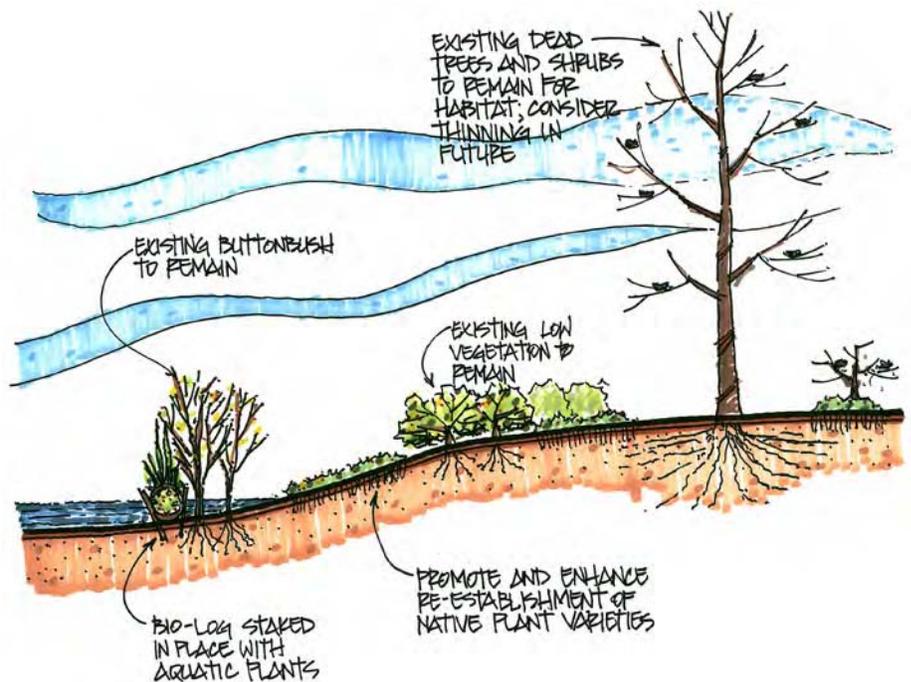


Figure 18. Bioengineering schematic.

The use of bio-logs will provide erosion control at the perimeter of the islands, which should allow the existing vegetation to spread even further. To supplement this, additional plugs/plants should be added to existing bare areas above the water line at a 12-inch to 24-inch spacing. Ground covers/vines would be preferable, as they would form more of a mat and possibly discourage an increased bird population. Virginia creeper or limber honeysuckle are possible varieties that could be used, to be consistent with the existing vegetation. In addition, other plants that tolerate wet conditions and acidic soils are trailing arbutus, checkerberry wintergreen and cranberry. These, too, should provide a low, matted ground cover.

Over time, it may be advisable to attempt to reduce the number of birds that inhabit the island during warmer weather in order to address the acidity of the soils. Hazing cannot be done, as both the egrets and great blue herons are protected species once they've nested. However, destruction of nests once the birds have migrated for the year or the use of visual bird deterrents, such as mylar tape, may discourage repopulation of the islands. Selective thinning of woody plants may also make some areas less desirable for nesting while still providing root systems necessary for erosion control.

Bioengineering work on the islands would require a permit from the DNRE under provisions of Part 301, Inland Lakes and Streams, of the Natural Resources and Environmental Protection Act, PA 451 of 1994. An estimate of probable costs to implement bioengineering erosion controls on the islands is presented in Table 6.

TABLE 6
ISLAND LAKE ISLAND STABILIZATION - ESTIMATE OF PROBABLE COSTS

Work Item	Estimated Cost
Mobilization and Site Preparation	\$4,000
Bioengineering (Bio-logs with plugs)	\$30,000
Groundcover Plantings	\$15,000
Site Engineering, Bidding, Construction Observation	\$12,000
Approvals and Permits	\$2,200
Contingency (15%)	\$9,400
Total	\$72,600

LAKE ALUM TREATMENT

Alum is a compound that can be added to water to help control internal cycling or loading of phosphorus in a lake. Alum is typically applied with specialized computer-metered, GPS-guided application vessel (Figure 19). As previously discussed, phosphorus loading can be categorized into two sources: internal and external. If internal recycling of phosphorus is of major significance in a lake, removal of external loadings such as fertilizer runoff may have very little effect on the eutrophic or fertilized condition of the lake.

In some lakes, phosphorus can be transported internally through physical and chemical means. If the water lying just above the sediments is devoid of oxygen, phosphorus will be released (from the sediments) into the water column. From there, phosphorus can be moved upward through a hydro-physical process called vertical entrainment. When a strong unidirectional wind blows across the lake for several days, water actually begins to pile up on the lee end of the lake. The accumulated water sinks to the stratified thermocline layer and slides back toward the opposite end of the lake. If the prevailing wind stops, the surface continues to rock back and forth for several days. This "see-saw" type of movement occurs not only on the surface but to an even greater extent in the thermally stratified waters beneath. Material from the bottom will be picked up on the down side of the see-saw, then is moved upward as the cool, dense bottom waters rock upward again.



Figure 19. Alum application barge.

Phosphorus can be redistributed in this manner to the upper regions of the lake where it will be available for uptake by plants (Wetzel 1983). Phosphorus can also be released from anaerobic bottom water during the periods of spring and fall turnover.

There are many compounds that can bind with phosphorus and remove it from the water column. Alum, an aluminum sulfate and/or sodium aluminate compound, is optimal for use in lake treatments in that it continues to bind phosphorus under anaerobic conditions and under most pH ranges encountered in natural waters. Two methods may be used to reduce phosphorus availability with alum. One is to add it to the lake surface in a concentration that is only slightly higher than the ambient phosphorus concentration.

The alum-phosphorus compound forms a heavy floc, which sinks to the bottom; thus, the nutrient is no longer available for algal growth. The other technique involves adding alum at a higher dose rate to restrict phosphorus release from the sediments and, thus, reducing internal loading. Both techniques have been employed in many lakes across the country with good to excellent results (Cooke et al. 1986). However, for long-term control of internal phosphorus recycling, the higher dose rate is required. It has been demonstrated that, at higher dose levels, up to 90 percent removal of phosphorus can be expected with continued low nutrient levels for up to 15 years after treatment (Cooke et al. 1986).

Not all lakes are good candidates for alum treatments. Alum is not suitable for shallow lakes that do not exhibit stratification during the summer months. This is due to the fact that frequent mixing allows for constant renewal of the nutrient supply to the upper productive regions of the lake despite the addition of alum (Knauer and Garrison 1980). In addition, there may be an inherent trade-off in water quality with the use of alum. Because water clarity will improve, often dramatically, when phosphorus is removed, the increased light penetration can be a stimulus for increased macrophyte (large aquatic plant) growth. In other words, it may be possible to trade an algae problem for a macrophyte problem since rooted plants may still extract phosphorus from the sediments. Also, lakes receiving excessive phosphorus loadings from external (i.e., watershed) sources may not be good candidates for an alum treatment in that the longevity of the alum treatment may be greatly reduced.

Preliminary study findings indicate that internal loading of phosphorus may be a significant phosphorus source in Island Lake. An alum treatment of Island Lake should not be considered until a comprehensive watershed management effort has been initiated and until additional water quality monitoring has been performed to evaluate the magnitude of internal phosphorus loading. While an alum treatment could significantly improve water quality conditions, additional data is needed to determine if alum would, in fact, be a viable lake improvement alternative for Island Lake. An alum treatment of Island Lake would require approvals from the DNRE and considerable water quality monitoring data and support documentation. A preliminary cost estimate to conduct an alum treatment of Island Lake is \$160,000.

LAKE AERATION

Aeration is a management technique that involves introducing dissolved oxygen into a lake. Aeration is used to reduce the potential for fish kills resulting from dissolved oxygen depletion or to reduce the potential for internal phosphorus release, or both. Aeration can reduce internal phosphorus release by creating conditions that promote the precipitation of phosphorus from the water column. There are two types of aeration systems: Total (i.e., whole-lake) aerators, and hypolimnetic (i.e., bottom-water) aerators. Whole-lake aeration is accomplished by placing compressed air diffuser boxes on the lake bottom, or by mechanical pumping. With whole-lake aeration, the lake is often destratified and the entire water column is mixed. Once destratified, a lake becomes nearly isothermal (i.e., the same temperature) surface to bottom.

In lakes that sustain a cold water fishery, whole-lake aeration may be a problem in that it will eliminate cold-water habitat. However, this may not be a constraint if management of a warm water fishery is the objective. Warming of the waters in a lake can also be problematic in that it can increase biological oxygen demand at the lake bottom.

Hypolimnetic or bottom-water aeration systems are designed to operate without disrupting thermal stratification. These systems generally pump water from the bottom of the lake, oxygenate it at the surface, and return the oxygenated water back to the lake bottom.

LAKE IMPROVEMENT ALTERNATIVES

The effects of artificial aeration on lake water quality and biota are mixed (Cooke et al. 1993). In theory, aeration should create conditions within a lake that promote the precipitation of phosphorus; calcium, iron, and other compounds bind with phosphorus, and remove it from the water column. However, in practice, this is not always the case (Beduhn 1994; Cooke et al. 1993). In some lakes, algae biomass and phosphorus levels showed no change or increased following aeration-induced circulation (Cooke et al. 1993). In some instances, declines in nuisance blue-green algae have been reported as the result of aeration, however, this effect appears to be more the result of the physical mixing of the water column than reduced phosphorus levels (Jungo et al. 2001).

The overall effectiveness and success of aeration is dependent on several variables including lake morphometry (i.e., size and shape), the relative magnitude of internal phosphorus loading versus external (i.e., watershed) loading, and the specific objectives of the aeration project (e.g., fishery management, control of nuisance algae blooms, etc.). With respect to reducing algae growth and phosphorus levels, which would be the primary objectives of aeration in Island Lake, aeration results have been highly variable (Cooke et al. 1993). Given the results of aeration are not consistent or predictable, aeration is not recommended as a lake management technique for Island Lake.

WATERSHED MANAGEMENT

Lake water quality is often a reflection of land use activities in the watershed. In general, lakes such as Island Lake that are located in highly urbanized areas, tend to have poorer water quality compared to lakes in less developed areas. In more urbanized watersheds, many of the natural areas that allow rain waters to infiltrate have been replaced by roof tops, roads, driveways, and other hard surfaces. Now, rather than infiltrating, storm water runs off these hard surfaces, often carrying fertilizer, oil, road salt and other pollutants to the lake. Adverse impacts often associated with urbanization include increased aquatic plant growth, diminished fisheries, and poor water quality. Sampling performed during the course of study indicates that Island Lake has elevated nutrient levels. In order for in-lake improvements to be effective over the long term, watershed pollution inputs to Island Lake must be reduced to the extent practical.

In a recent nationwide assessment conducted by the US Environmental Protection Agency, loss of shoreland habitat was found to be the greatest stressor of the nation's lakes (USEPA 2009). Lakes with poor shoreland habitat were three times more likely to be in poor biological condition. Several states, such as Maine, Minnesota, and Wisconsin have adopted state-wide shoreland zoning regulations. These regulations establish uniform setbacks for homes and structures, restrictions on certain uses in shorelands, and require shoreland vegetation be preserved to the extent practical (Figure 20). In Michigan there are no state-wide shoreland regulations for lakes, and most watershed management initiatives are voluntary.

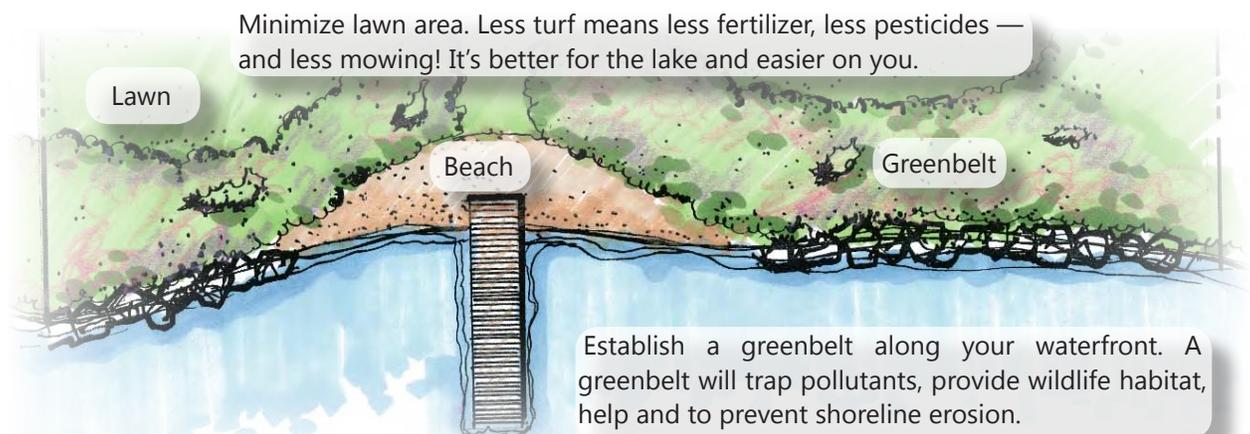
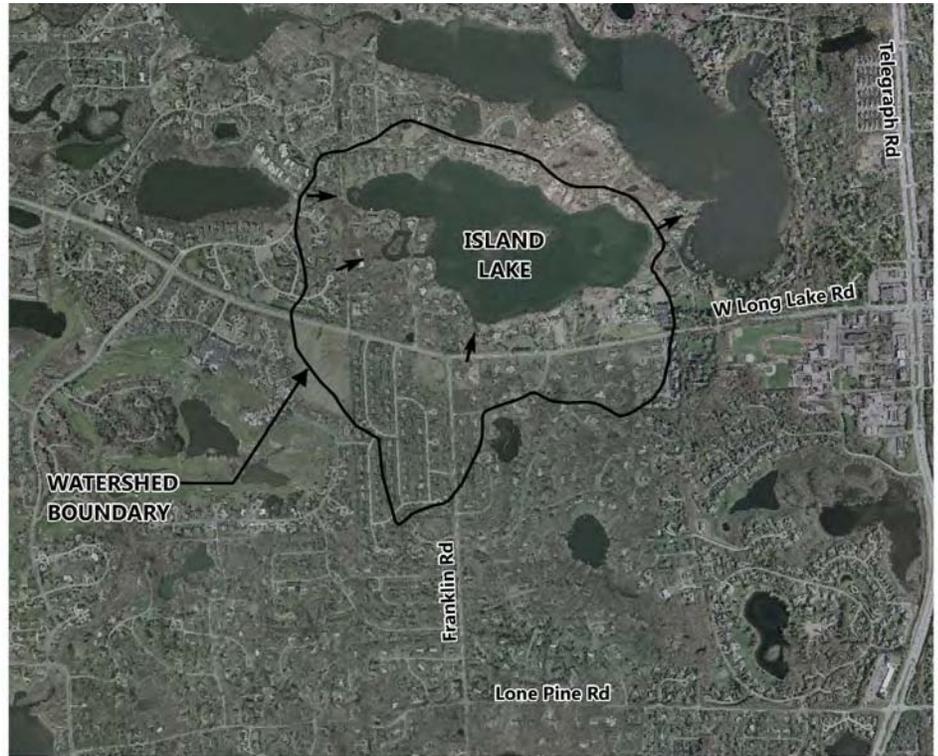


Figure 20. Shoreline management.

LAKE IMPROVEMENT ALTERNATIVES

The watershed area that drains to Island Lake is relatively small. Direct drainage to the lake occurs from the shorelands immediately adjacent to the lake and from off-lake areas to the south and west of the lake (Figure 21). A concerted effort by area landowners to curtail the use of lawn fertilizers containing phosphorus and to restore vegetative buffers along the shoreline could, in time, improve water quality and reduce the costs of ongoing in-lake maintenance.



ISLAND LAKE
WATERSHED AERIAL PHOTOGRAPHY
OAKLAND COUNTY, MICHIGAN
SOURCE: WATERSHED BOUNDARY PROVIDED BY MICHIGAN DEPARTMENT ENVIRONMENTAL QUALITY

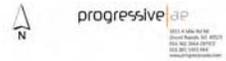


Figure 21. Island Lake Watershed Aerial.

Additional water quality benefits could accrue if the drainage from the south portion of the watershed (Figure 22) was provided additional filtration before entering Island Lake. One way this could be accomplished would be to allow vegetation to become established in the channel at the south end of the lake. By assimilation nutrients and sediment, this vegetation would act as a bio-filter and help reduce nutrient loading to Island Lake. To this



Figure 22. Island Lake South Channel.

end, it is recommended that vegetation be planted along both sides of the channel from west Long Lake Road to the confluence of the channel with the lake, a distance of approximately 500 feet. Vegetation types could include a combination of cattails, irises, pickerel weed and lily pads. The estimate of costs to establish plantings on both sides of the channel would be \$24 per lineal foot or \$24,000 total.

Given that most watershed initiatives are voluntary, information and education is often key to effective watershed management. For example, many lake residents are not aware that a single pound of phosphorus in the lake can generate 500 pounds of aquatic plants, and lawn fertilizers are a common source of phosphorus input to lakes. Once lake residents are provided this information, they could make appropriate decisions regarding proper lawn care.



Figure 23. Island Lake Guidebook.

As part of the ongoing lake improvement program for

Island Lake, it is recommended that a resource guidebook specific to Island Lake be created (Figure 23). The resource guidebook would include an historical perspective on the lake, information on the physical characteristics of the lake, information about aquatic plants and lake water quality, and specific watershed management techniques lake residents can employ to protect the lake. To be effective, the guidebook would need to be disseminated to all property owners within the Island Lake watershed. The estimated cost to prepare, publish, and mail a resource guidebook is \$12,000.

Recommended Improvement Plan

Study findings indicate that Island Lake is eutrophic and has phosphorus levels sufficient to sustain abundant aquatic plant growth. Additional water quality monitoring has been proposed to evaluate baseline water quality conditions in the lake and to evaluate the significance of internal phosphorus loading.

Currently, the invasive nuisance aquatic plants Eurasian milfoil and starry stonewort are widespread in Island Lake. A combination of herbicide treatments and mechanical harvesting is proposed to control nuisance plant growth in the lake. Herbicide treatments should focus primarily on the use of systemic herbicides to control Eurasian milfoil. Given that herbicide treatments to control planktonic algae growth are generally short-lived, such treatments should be limited. In recent years, three plant harvests have been performed annually to remove charoid algae (i.e., Chara and starry stonewort) from the lake. While heavy charoid algae growth can pose a nuisance, charoid algae competes with planktonic algae for available nutrients. Maintaining more charoid algae in Island Lake may help to improve water clarity and reduce the severity of planktonic algae blooms. In light of these considerations, harvesting should be scaled back to two harvests per year and only remove charoid algae in areas that are critical to navigation in the lake. Annual plant surveys are proposed to be conducted each spring and summer to evaluate the effectiveness of plant control activities.

The two small islands in Island Lake have become a sanctuary and nesting area for a variety of bird species including egrets, cormorants, and great blue herons. The concentration of birds on the islands has denuded much of the vegetation and appears to be greatly accelerating erosion. Bioengineering of the islands' shorelines and re-vegetation are being proposed to help stem further erosion of the islands.

In order to effectively manage Island Lake over the long term, steps should be taken to reduce watershed pollution inputs. Watershed issues of primary concern include lawn fertilizer runoff and loss of shoreland habitat. As part of the ongoing lake improvement program for Island Lake, it is recommended that a resource guidebook specific to Island Lake be created. The resource guidebook would include an historical perspective on the lake, information on the physical characteristics of the lake, information about aquatic plants and lake water quality, and specific watershed management techniques lake residents can employ to protect the lake. The guidebook would be disseminated to all property owners in the Island Lake watershed.

Additional water quality benefits would accrue if the drainage from the south portion of the watershed was filtered before entering Island Lake. This could be accomplished by establishing vegetation along and within the drainage channel tributary at the south end of the lake.

An estimate of costs to implement the recommended improvement plan for Island Lake over a three-year period is presented in Table 7. In accordance with Part 309, Inland Lake Improvements, of the Natural Resources and Environmental Protection Act, PA 451 of 1994, public hearings must be held to determine if there is support to proceed with the recommended improvements and the collection of special assessments to finance the improvements. Surplus funds that have accrued from the current project are proposed to be used to reduce the costs of the proposed three-year improvement project.

TABLE 7
ISLAND LAKE IMPROVEMENT PLAN PROPOSED BUDGET (2012 – 2014)

Improvement	Annual Cost
Nuisance Aquatic Plant Control	\$62,000
Aquatic Plant Surveys	\$3,500
Water Quality Monitoring	\$3,000
Homeowners' Guidebook	\$4,000
Islands Stabilization	\$24,200
Channel Bioengineering	\$8,000
Administration/Contingencies (10%)	\$10,500
Total	\$115,200

Appendix Study Methods

Study Methods

Lake and Watershed Physical Characteristics

The map depicting approximate depth contours in Island Lake was created by taking approximately 236 discrete depth soundings at geo-referenced points across the lake during multiple field surveys performed in the summer of 2010. The points then were exported to computer software called Microstation (Geopak) that was used to triangulate the data and create approximate depth contours within the lake. Lake volume was calculated using GeoPak three-dimensional modeling based on the digitized contours.

Lake Water Quality

Temperature was measured using a YSI Model 550A probe. Samples were collected with a Van Dorn sampler to be analyzed for dissolved oxygen, pH, total alkalinity, total phosphorus, and chloride. Dissolved oxygen samples were fixed in the field and then transported to Progressive AE for analysis using the modified Winkler method (Standard Methods Procedure 4500-O C). pH was measured in the field using a YSI EcoSense pH meter. Total alkalinity was titrated at Progressive AE using Standard Methods Procedure 2320.B. Total phosphorus and chloride were analyzed at Prein and Newhof¹ using Standard Methods Procedure 4500-P E and 4110, respectively. In addition to the depth-interval samples at each deep basin, Secchi transparency was measured and composite chlorophyll-*a* samples were collected from the surface to a depth equal to twice the Secchi transparency. Chlorophyll-*a* samples were analyzed by Prein and Newhof using Standard Methods Procedure 10200H.

Aquatic Plant Surveys

Aquatic plant surveys were conducted in accordance with DNRE Procedures For Aquatic Vegetation Surveys.

¹ 3260 Evergreen Dr NE, Grand Rapids, MI 49525

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**ISLAND LAKE-LAKE BOARD
SPECIAL ASSESSMENT DISTRICT (S.A.D.) 285**

PUBLIC HEARING OF PRACTICABILITY

WEDNESDAY, APRIL 13, 2011 – 4:00 P.M.

Meeting at Bloomfield Township Hall

PRESENT: David Payne, Bloomfield Twp. Supervisor, Chairperson
Jan Roncelli, Bloomfield Twp. Clerk, Secretary/Treasurer
Harold Barry, Riparian Representative (Past)
Ned Greenberg, Riparian Representative
Shelley Taub, Oakland County Commissioner
Jacy Garrison, Oakland County Water Resources Commissioner's Office
Mark Roberts, Attorney, Secrest Wardle

ALSO PRESENT: Noah Mehalski, Environmental Specialist, Bloomfield Township
Pete Filpansick, LakePro

ABSENT: None

I. Board Picture for Website

II. Call Meeting to Order

Chairperson Payne called the meeting to order at 4:03 p.m.

III. Sign-In Sheet

25 attendees completed the Sign-In Sheet.

IV. Presentation of Posted Meeting Notice

Supervisor Payne advised that notices for this meeting had been posted in the Township vestibule and also at the Oakland County Water Resources Commission Office.

V. Appoint Ned Greenberg as New Island Lake – Lake Board Riparian

Supervisor Payne said that the he was pleased to have had Riparian Barry on the board and the reason why lake boards work is due to the efforts of residents such as he.

Clerk Roncelli read the resolution in honor of Riparian Barry.

MOTION by Taub and SUPPORT by Garrison to ADOPT the Resolution in Honor of Harold Barry.

RESOLUTION IN HONOR OF HAROLD BERRY

WHEREAS, Harold Berry, a Bloomfield Township resident, has served as Riparian Representative for the Island Lake Lake Board for eight years since 2003; and

WHEREAS, the Township appreciates the strong working relationship with the Island Lake Lake Board sustained by Harold and his dedication to managing the Island Lake projects; and

WHEREAS, we appreciate Harold's participation on the Forest Lake, Island Lake, and Upper Long Lake Property Owners Association (POH); and

WHEREAS, we are grateful for his strong commitment to maintaining the beauty of Island Lake; and

WHEREAS, we admire Harold's foresight in establishing an advisory committee to assist him with the Island Lake tasks;

WHEREAS, we truly regret his retirement from the position of Riparian Representative to the Island Lake Lake Board, but wish him continued success in his businesses, Berry Investment Company and Berry Trico Group, and good health.

NOW, THEREFORE BE IT RESOLVED, that the past and present members of the Island Lake Lake Board and the residents of Island Lake HONOR Harold Berry for his years of service and contributions to enhancing Island Lake in Bloomfield Township.

BE IT KNOWN to all reading this Resolution that it was adopted by the Island Lake Lake Board on April 15, 2011, and included in the minutes as a permanent record.

Ayes: Unanimous

RESOLUTION DECLARED ADOPTED.

Riparian Barry introduced and nominated Ned Greenberg to replace him as Riparian Representative for the Island Lake – Lake Board.

MOTION by Taub and SUPPORT by Garrison to ACCEPT the Nomination of Ned Greenberg for Riparian Representative of the Island Lake – Lake Board.

Ayes: Unanimous

VI. Old Business

- A. Approved Minutes of April 8, 2010 as printed.
- B. Approve invoices paid by the Township since the last meeting.

MOTION by Garrison and SUPPORT by Taub to APPROVE Invoices Paid by the Township Since the Last Meeting In the Amount of \$73,203.30.

Ayes: Unanimous

- C. Preapprove bill issued to the Township for legal ads in the *Observer Eccentric Newspaper* for the Notice of Determination published after the meeting.

MOTION by Taub and SUPPORT by Greenberg to PREAPPROVE bill issued to the Township for legal ad for Notice of Determination publication.

Ayes: Unanimous

VII. New Business

- A. Open Hearing of Practicability

Chairperson Payne opened the Hearing of Practicability at 4:09 p.m.

- B. Purpose of Hearing of Practicability

Chairperson Payne explained to the audience that the purpose of the hearing is to listen to the report from the expert (Pete Filpansick, LakePro) and also to give the audience and those affected an opportunity to voice their opinions and ask questions.

VIII. Documentation of Proper Notification for Public Hearing

- A. Affidavits verifying publication of ads published on March 20, 2011 and April 10, 2011 for the Hearing of Practicability.
- B. First class mailing to each individual property owner in the 285 Special Assessment District was mailed on March 31, 2011.

IX. Hearing of Practicability – Island Lake Improvement Plan

Pete Filpansick, LakePro, reviewed the study and Improvement Plan that was completed last year by Progressive AE.

The study looked at water quality, which for the most part is good. It also looked at the dissolved oxygen readings, which is important for plants and fish. The readings were good in the spring, but later in the year they dropped, but none were alarming.

Island Lake was also found to be high in the nutrients of phosphorus and nitrogen. These chemicals can come from old septic, fertilizers, animal droppings, etc. A lot of these nutrients were found to be coming from the South Kirkway area. Bioengineering may help with this problem by placing plants by the source. This vegetation would be slow growing emergent plants that are native and would be placed in the margins of the lake. The plants are proven to be beneficial, but it will take time for them to grow and improve the surroundings.

Erosion of the two islands in Island Lake is another problem. The concentration of birds on the islands is destroying much of the vegetation, which appears to be greatly accelerating the erosion of the land. Progressive AE evaluated the best ways to stabilize the land and found that a bioengineering approach would provide the most cost-effective and environmentally friendly way to help slow the erosion process of the islands. Bio-logs would be placed along the shoreline and will provide temporary protection while new vegetation is allowed adequate time to become established. Construction will be performed in the late summer/early fall when water levels are usually low and the bird population is diminished.

Mechanical weed harvesting is currently performed on the lake by Inland Lakes. It is important to continue with this method since plants are removed from the lake and will not sink to the bottom and add to the buildup of sediment. Chemical treatment is also effective to control nuisance species such as Eurasian Milfoil and has minimal environmental impacts.

Other lake management options were considered for Island Lake such as aeration and mechanical harvesting reduction. Aeration was not recommended as a technique because results are not consistent or predictable. And, reducing the number of mechanical harvestings from three to two would allow harmful plants, such as Eurasian Milfoil, to far outnumber beneficial vegetation.

Supervisor Payne advised the audience that the purpose of this Hearing and the approval to conduct the study of Island Lake is

because lakes change over time and the board wanted to make sure that all is being done to beautify the lake. The intention is not to change the assessment for residents. Reserve funds will be used to pay for the difference between assessments collected and additional expenses.

X. Open Hearing of Practicability for Public Comment

Supervisor Payne opened the floor for public comment at 4:29 p.m.

A. Letters received

Clerk Roncelli advised that no letters or emails had been received.

B. Open floor for public comment

The following people addressed the Board with questions and/or comments:

Edward Treisman, 3857 Lakeland Ln.
Edward Mayne, 1445 Kirkway Rd.
Rochelle Simon, 3975 Kirkland Ct.
Mary Pardi, 1433 Kirkway Rd.

C. Close Hearing of Practicability.

Chairperson Payne closed the Hearing of Practicability at 4:44 p.m.

XI. Resolution

Chairperson Payne advised that board members have copies of the proposed budget for the revised project and it meets the requirements of Island Lake's current assessment roll.

**ISLAND LAKE
PROPOSED 2011 EXPENSES
4/1/11-3/31/12**

Permits	\$ 800
Water Quality Analysis and Vegetation Surveys	\$ 3,090
Weed Harvesting	\$47,000
Systemic Herbicide Treatments	\$10,000
Channel Bio-Engineering	\$10,000
Island Reconstruction	\$15,000
3-year Management Plan	\$ 2,500
Homeowners Education	\$ 1,000
Legal and Mailing	<u>\$ 600</u>
Total	\$ 89,990

MOTION by Greenberg and SUPPORT by Taub to ADOPT the Island Lake Resolution.

**STATE OF MICHIGAN
COUNTY OF OAKLAND
ISLAND LAKE – LAKE BOARD**

SPECIAL ASSESSMENT DISTRICT NO. 285

**RESOLUTION APPROVING REVISED PROJECT
UNDER CURRENT ASSESSMENT ROLL**

RECITATIONS:

The Island Lake – Lake Board, having retained Progressive AE to prepare the engineering study and economic report as required by MCL §324.30909, and pursuant to the authority given in MCL §324.30908, has determined to consider the revised lake improvement project recommended by the engineering study (The Revised Project) as authorized under MCL §324.30902(1).

A 2009 - 2011 assessment roll for the special assessment district has been established, namely, the property referenced as the Lake Board District (Exhibit 1), which is to be benefited by The Revised Project.

Plans for The Revised Project, and an estimate of the total cost of The Revised Project in the amount not to exceed \$115,200.00, have been prepared and notice has been given according to law to the owners of property in the Island Lake - Lake Board District with respect to a hearing for the purpose of presenting any objections to the engineering study and economic report regarding the proposed Revised Project.

The hearing was conducted consistent with the Notice, following which the Lake Board has determined to proceed with The Revised Project under the current special assessment.

NOW THEREFORE, BE IT RESOLVED AS FOLLOWS:

1. That the engineering study and economic report is determined to be sufficient.
2. That the Lake Board shall proceed with The Revised Project.
3. The plans prepared for The Revised Project and the cost estimate are approved.
4. The 2009 – 2011 assessment roll for the District shall consist of the Lake Board District, described in Exhibit 1, against which 100 percent of the cost of The Revised Project shall be assessed.
5. The duration of the Special Assessment District's assessment roll shall be through 2011.

Ayes: Unanimous

CERTIFICATION

It is hereby certified that the foregoing Resolution is a true and accurate copy of the Resolution adopted by the Island Lake - Lake Board at a meeting duly called and held on the 13th day of April 2011.

XII. Adjourn meeting

The Public Hearing of Practicability adjourned at 4:47 p.m.

Island Lake – Lake Board

Jan Roncelli, Lake Board Secretary/Treasurer



**MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER RESOURCES DIVISION
PERMIT**

ISSUED TO:

Island Lake Improvement Board
Attn: Bloomfield Township
PO Box 489
Bloomfield Hills, MI 48303

Permit No.	11-63-0142-P
Issued	October 24, 2011
Extended	
Revised	
Expires	February 10, 2017

This permit is being issued by the Michigan Department of Environmental Quality (MDEQ) under the provisions of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA), and specifically:

- | | |
|---|---|
| <input checked="" type="checkbox"/> Part 301, Inland Lakes and Streams | <input type="checkbox"/> Part 315, Dam Safety |
| <input type="checkbox"/> Part 325, Great Lakes Submerged Lands | <input type="checkbox"/> Part 323, Shorelands Protection and Management |
| <input type="checkbox"/> Part 303, Wetlands Protection | <input type="checkbox"/> Part 353, Sand Dunes Protection and Management |
| <input type="checkbox"/> Part 31, Floodplain/Water Resources Protection | |

Permission is hereby granted, based on permittee assurance of adherence to State of Michigan requirements and permit conditions, to:

Permitted Activity:

Plant native wetland vegetation in two areas totaling 0.15 acre, and along a third area along 350 feet of shoreline. Install a total of 600 feet of coir logs around two islands on Island Lake planted with native wetland vegetation.

All work shall be in accordance with DEQ approved plans and the conditions of this permit.

Water Course Affected: Island Lake

Property Location: Oakland County, Bloomfield Township, Section 17
Subdivision, Lot Town/Range 2N, 10E Property Tax No.

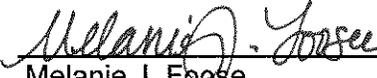
Authority granted by this permit is subject to the following limitations:

- A. Initiation of any work on the permitted project confirms the permittee's acceptance and agreement to comply with all terms and conditions of this permit.
- B. The permittee, in exercising the authority granted by this permit, shall not cause unlawful pollution as defined by Part 31 of the NREPA.
- C. This permit shall be kept at the site of the work and available for inspection at all times during the duration of the project or until its date of expiration.
- D. All work shall be completed in accordance with the plans and specifications submitted with the application and/or plans and specifications attached hereto.
- E. No attempt shall be made by the permittee to forbid the full and free use by the public of public waters at or adjacent to the structure or work approved herein.
- F. It is made a requirement of this permit that the permittee give notice to public utilities in accordance with Act 53 of the Public Act of 1974 and comply with each of the requirements of that act.
- G. This permit does not convey property rights in either real estate or material, nor does it authorize any injury to private property or invasion of public or private rights, nor does it waive the necessity of seeking federal assent, all local permits, or complying with other state statutes.
- H. This permit does not prejudice or limit the right of a riparian owner or other person to institute proceedings in any circuit court of this state when necessary to protect his rights.
- I. Permittee shall notify the MDEQ within one week after the completion of the activity authorized by this permit, by completing and forwarding the attached preaddressed postcard to the office addressed thereon.
- J. This permit shall not be assigned or transferred without the written approval of the MDEQ.

- K. Failure to comply with conditions of this permit may subject the permittee to revocation of permit and criminal and/or civil action as cited by the specific state act, federal act, and/or rule under which this permit is granted.
- L. Work to be done under authority of this permit is further subject to the following special instructions and specifications:
1. All vegetation shall be native to Michigan and shall not include any non-native species, cultivars or hybrids.
 2. All work shall be completed in accordance with the attached plans and the terms and conditions of this permit.
 3. Prior to the initiation of any permitted construction activities, a siltation barrier shall be constructed immediately down gradient of the construction site. Siltation barriers shall be specifically designed to handle the sediment type, load, water depth, and flow conditions of each construction site throughout the anticipated time of construction and unstable site conditions. The siltation barrier shall be maintained in good working order throughout the duration of the project. Upon project completion, the accumulated materials shall be removed and disposed of at an upland (non-wetland, non-floodplain) site. The siltation barrier shall then be removed in its entirety and the area restored to its original configuration and cover.
 4. All raw areas resulting from the permitted construction activity shall be promptly and effectively stabilized with sod and/or seed and mulch (or other technology specified by this permit or project plans) in a sufficient quantity and manner to prevent erosion and any potential siltation to surface waters or wetlands.
 5. Authority granted by this permit does not waive permit requirements under Part 91, Soil Erosion and Sedimentation Control, of the NREPA, or the need to acquire applicable permits from the County Enforcing Agent (CEA). To locate the Soil Erosion Program Administrator for your county visit www.deq.state.mi.us/sesca/.
 6. No fill, excess soil, or other material shall be placed in any wetland or surface water area not specifically authorized by this permit, its plans, and specifications.
 7. Excess soil materials from the project shall not be deposited in wetlands or surface water without first securing a permit under Part 303, Wetlands Protection, of the NREPA or other applicable statute. Prior to the initiation of any permitted construction activity, a silt fence shall be installed along the entire route of the disturbed wetland area and maintained in good working order until permanent stabilization and re-vegetation of all disturbed areas has occurred. The silt fence shall be removed after re-vegetation. All excess soil material shall be placed on an upland location and then seeded and mulched to prevent erosion into waters, floodplain, or wetlands.
 8. The permittee is cautioned that grade changes resulting in increased runoff onto adjacent property is subject to civil damage litigation.
 9. In issuing this permit, the MDEQ has relied on the information and data that the permittee has provided in connection with the permit application. If, subsequent to the issuance of this permit, such information and data prove to be false, incomplete, or inaccurate, the MDEQ may modify, revoke, or suspend the permit, in whole or in part, in accordance with the new information.
 10. The permittee shall indemnify and hold harmless the State of Michigan and its departments, agencies, officials, employees, agents and representatives for any and all claims or causes of action arising from acts or omissions of the permittee, or employees, agents, or representatives of the permittee, undertaken in connection with this permit. This permit shall not be construed as an indemnity by the State of Michigan for the benefit of the permittee or any other person.
 11. Noncompliance with these terms and conditions, and/or the initiation of other regulated activities not specifically authorized by this permit shall be cause for the modification, suspension, or revocation of this permit, in whole or in part. Further, the MDEQ may initiate criminal and/or civil proceedings as may be

deemed necessary to correct project deficiencies, protect natural resource values, and secure compliance with statutes.

12. If any change or deviation from the permitted activity becomes necessary, the permittee shall request, in writing, a revision of the permitted activity and/or mitigation plan from the MDEQ. Such revision requests shall include complete documentation supporting the modification and revised plans detailing the proposed modification. Proposed modifications must be approved, in writing, by the MDEQ prior to being implemented.
13. This permit may be transferred to another person upon written approval of the MDEQ. The permittee must submit a written request to the MDEQ to transfer the permit to the new owner. The new owner must also submit a written request to accept transfer of the permit. The new owner must agree, in writing, to accept all conditions of the permit. A single letter signed by both parties which includes all the above information may be provided to the MDEQ. The MDEQ will review the request and if approved, will provide written notification to the new owner.
14. This permit is being issued for the maximum time allowed under Part 301, Inland Lakes and Streams and Part 303, Wetlands Protection, of the Natural Resources and Environmental Protection Act, PA 451 of 1994, as amended, including all permit extensions allowed under the administrative rules R 281.813 and R 281.923. Therefore, no extensions of this permit will be granted. Initiation of the construction work authorized by this permit indicates the permittee's acceptance of this condition. The permit, when signed by the MDEQ, will be for a five-year period beginning at the date of issuance.
15. The staff person who has reviewed this application for permit is Melanie J. Foose, Water Resources Division, Department of Environmental Quality, and can be reached by e-mail at foosem@michigan.gov, by phone at 586-753-3866, or by mail at 27700 Donald Court, Warren, Michigan 48092.

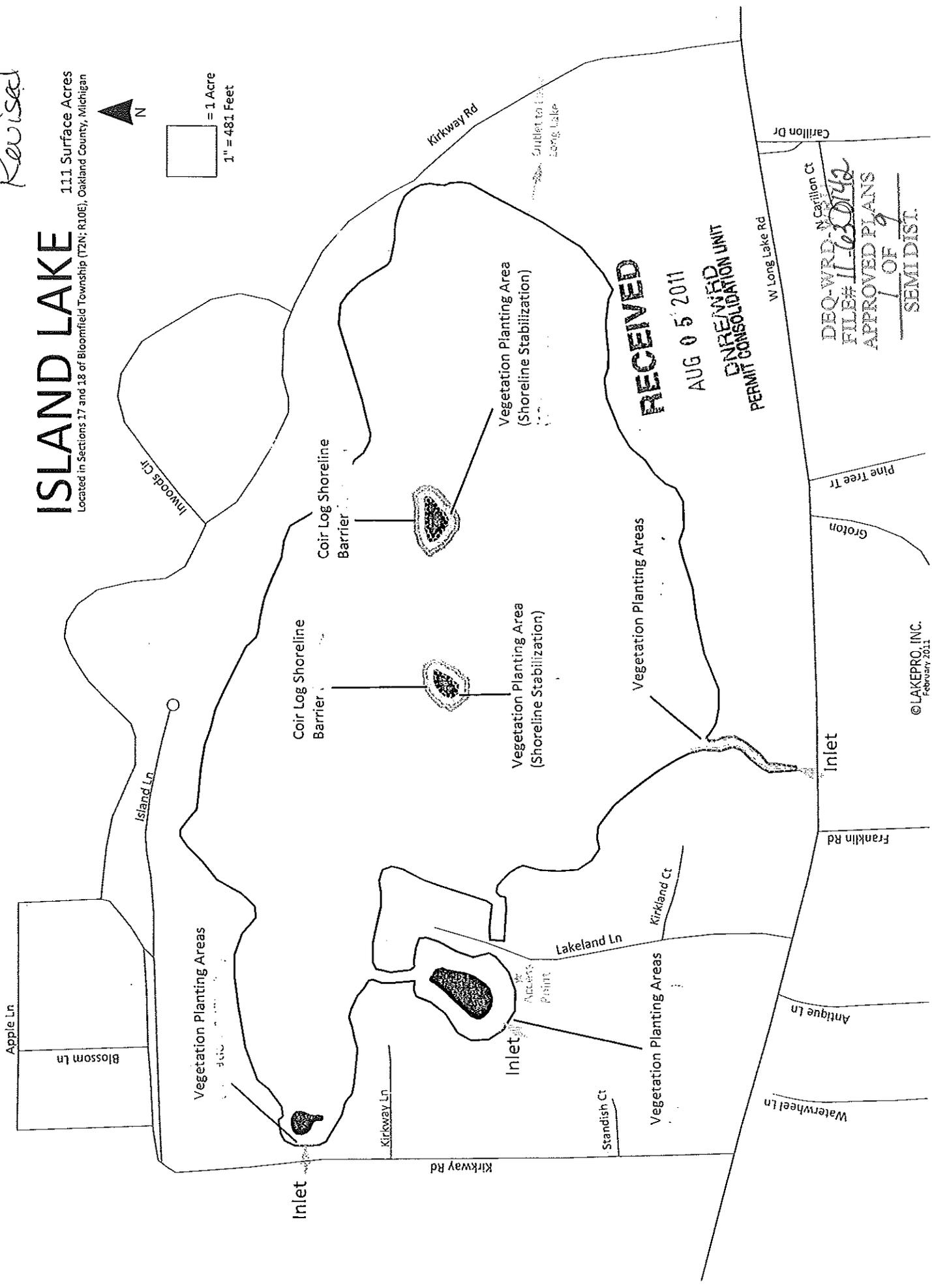
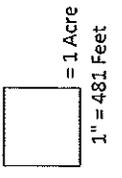
By: 
Melanie J. Foose
Water Resources Division
586-753-3866

cc: Bloomfield Township Clerk
Mr. Rick DeVisch, Oakland County Water Resources Commission
Mr. Peter Filpansick, LakePro, Inc.
Dr. William Larsen, DEQ
Ms. Bev Hague, Michigan Administrative Hearing System (MAHS)

Revised

ISLAND LAKE

111 Surface Acres
Located in Sections 17 and 18 of Bloomfield Township (72N; R10E), Oakland County, Michigan



RECEIVED

AUG 05 2011

DEFERRED
PERMIT CONSOLIDATION UNIT

DIQ-WRD-N Carillon Ct
FILE# 11-63019
APPROVED PLANS
1 OF 9
SEMI DIST.

© LAKEPRO, INC.
February 2011

West Inlet Area

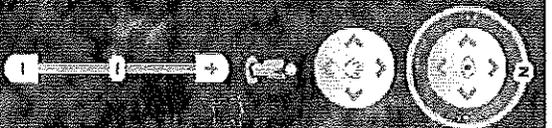
Approximately 450 square feet (0.01 Acres).

This area will be planted with White Water Lily and Common Arrowhead.

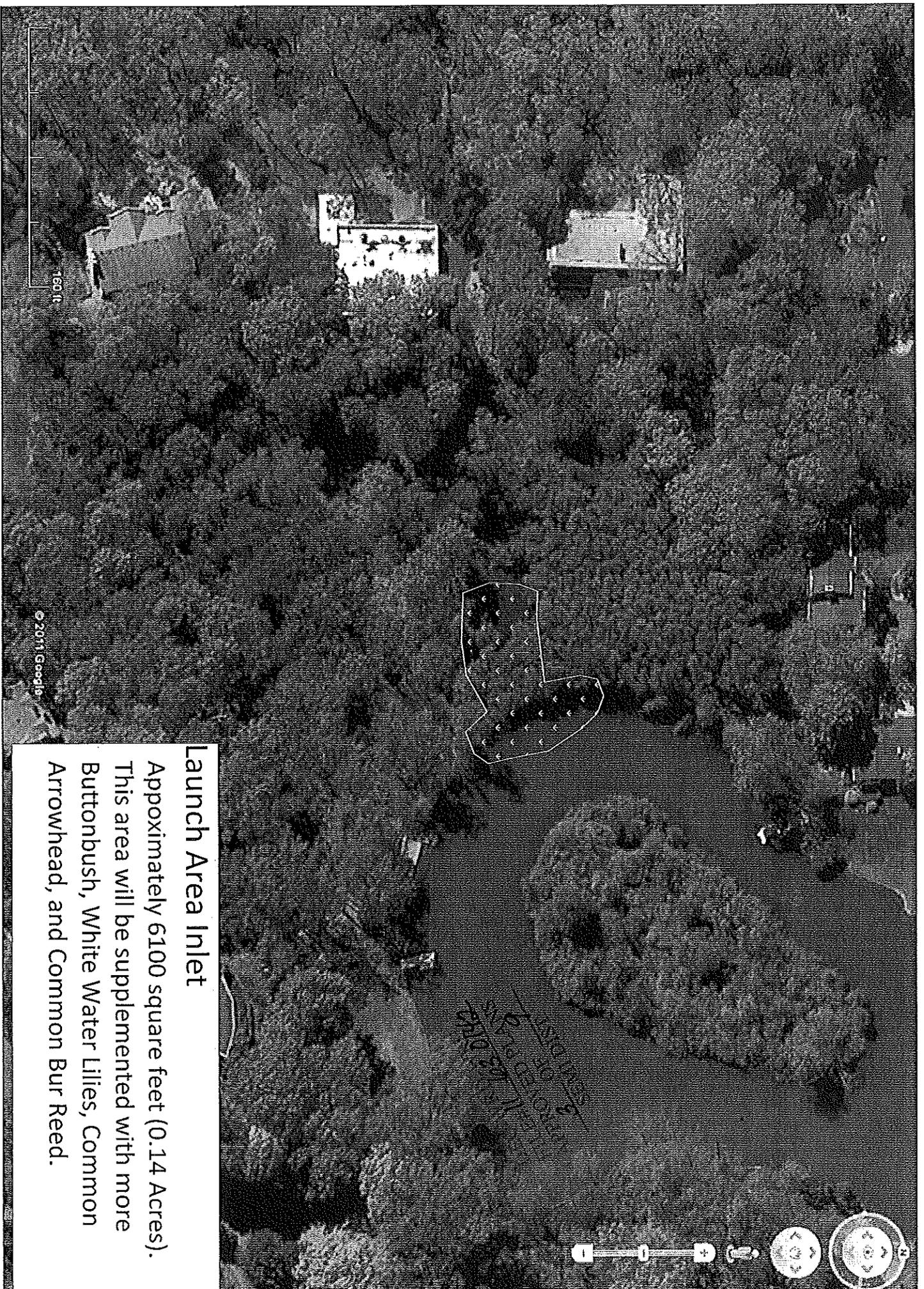


© 2011 Google

© 2010 Google



APPROXIMATELY
450 SQ. FT. OF
SEAWARD'S



Launch Area Inlet

Approximately 6100 square feet (0.14 Acres).
This area will be supplemented with more
Buttonbush, White Water Lilies, Common
Arrowhead, and Common Bur Reed.

160 ft

© 2011 Google



6100 SQ FT

Fallen timber will be removed, as needed, for proper installation of coir logs. This wood is to be used elsewhere as coarse woody structure.

Approximately 250 linear feet of shoreline around the island.

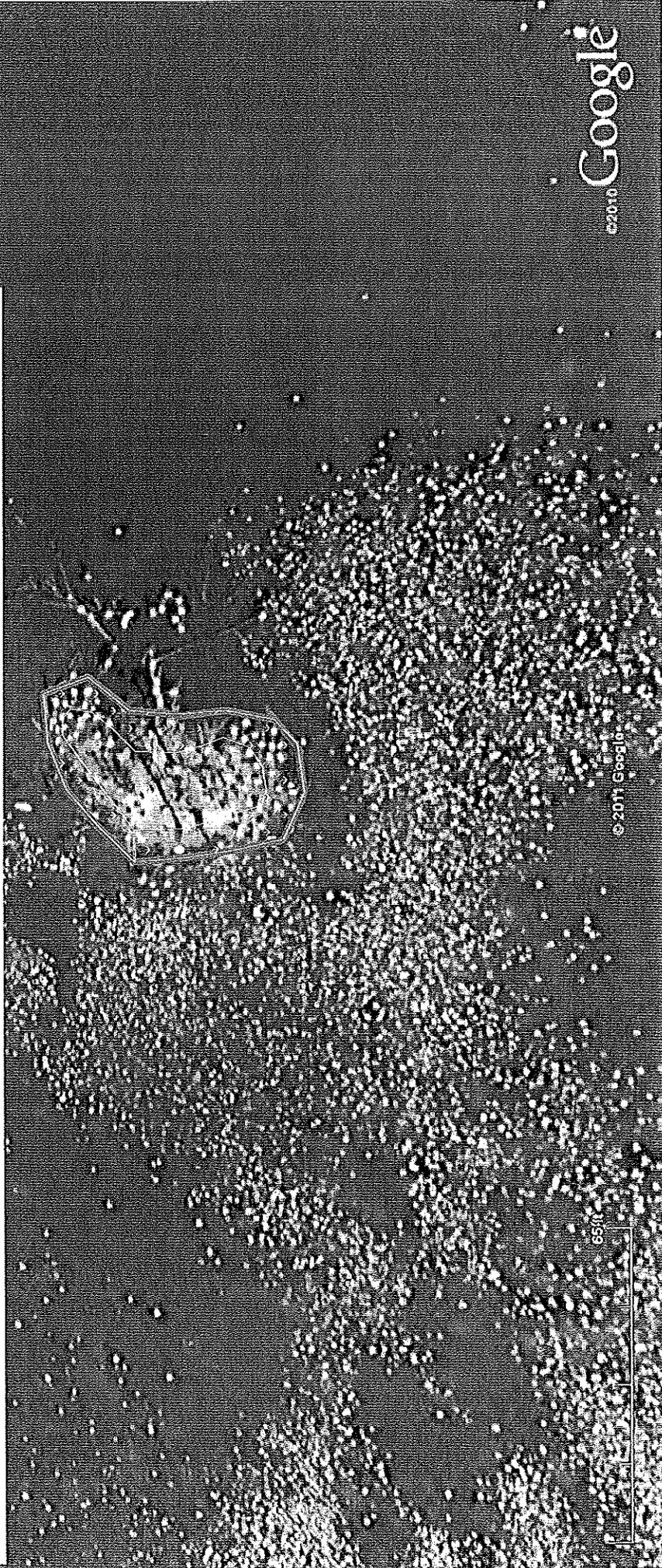
Planting will occur ~3 feet upland and <6 feet into the water.

Upland areas will be planted with "Wetland Edge Seed Mix" (attached).

Aquatic planting will include Common Bur Reed, White Water Lily, and Common Arrowhead. At the MDEQ's recommendation, Buttonbush will also be supplemented in this area.

West Island

DEQ-WRD-WRU
FILE# 11-03-0142
APPROVED PLANS
4 OF 9
SEMI DIST.



Fallen timber will be removed, as needed, for proper installation of coir logs. This wood is to be used elsewhere as coarse woody structure.

Approximately 350 linear feet of shoreline around the island.

Planting will occur ~3 feet upland and <6 feet into the water.

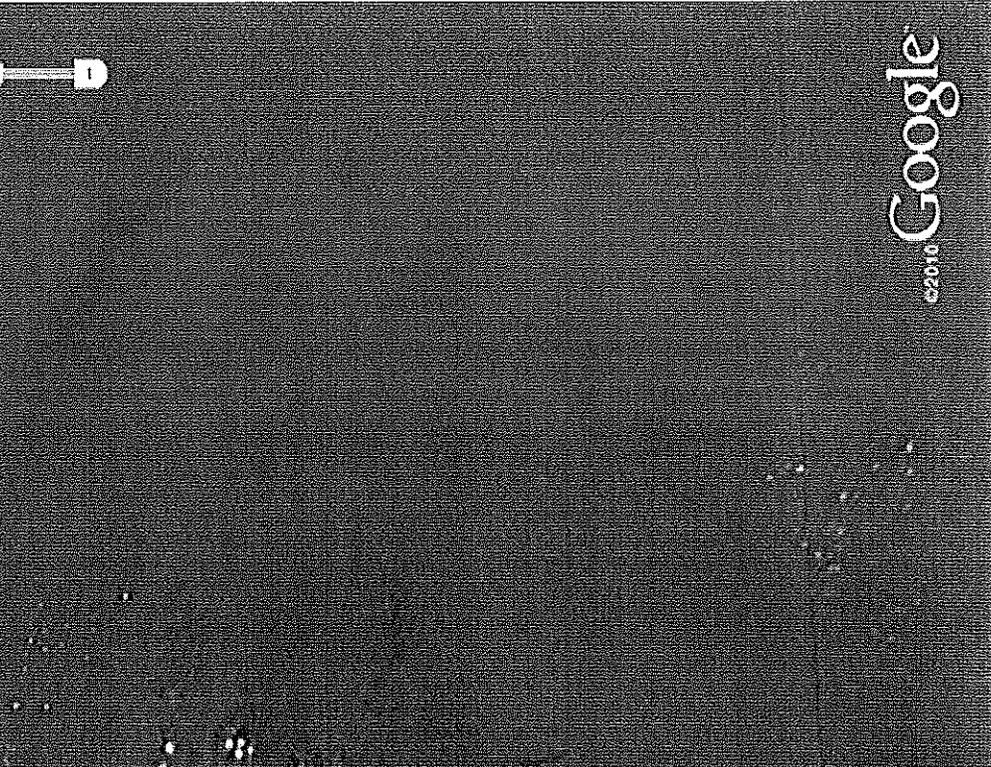
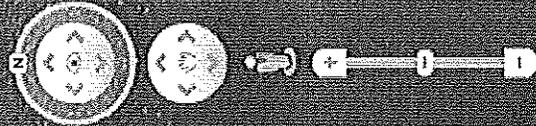
Upland areas will be planted with "Wetland Edge Seed Mix" (attached).

Aquatic planting will include Common Bur Reed, White Water Lily, and Common Arrowhead. At the MDEQ's recommendation, Buttonbush will also be supplemented in this area.

DBQ-WRD-WRY
FILE# 11-03-0142
APPROVED PLANS
5 OF 9
SEMI-**East Island**



© 2011 Google



South Inlet Area

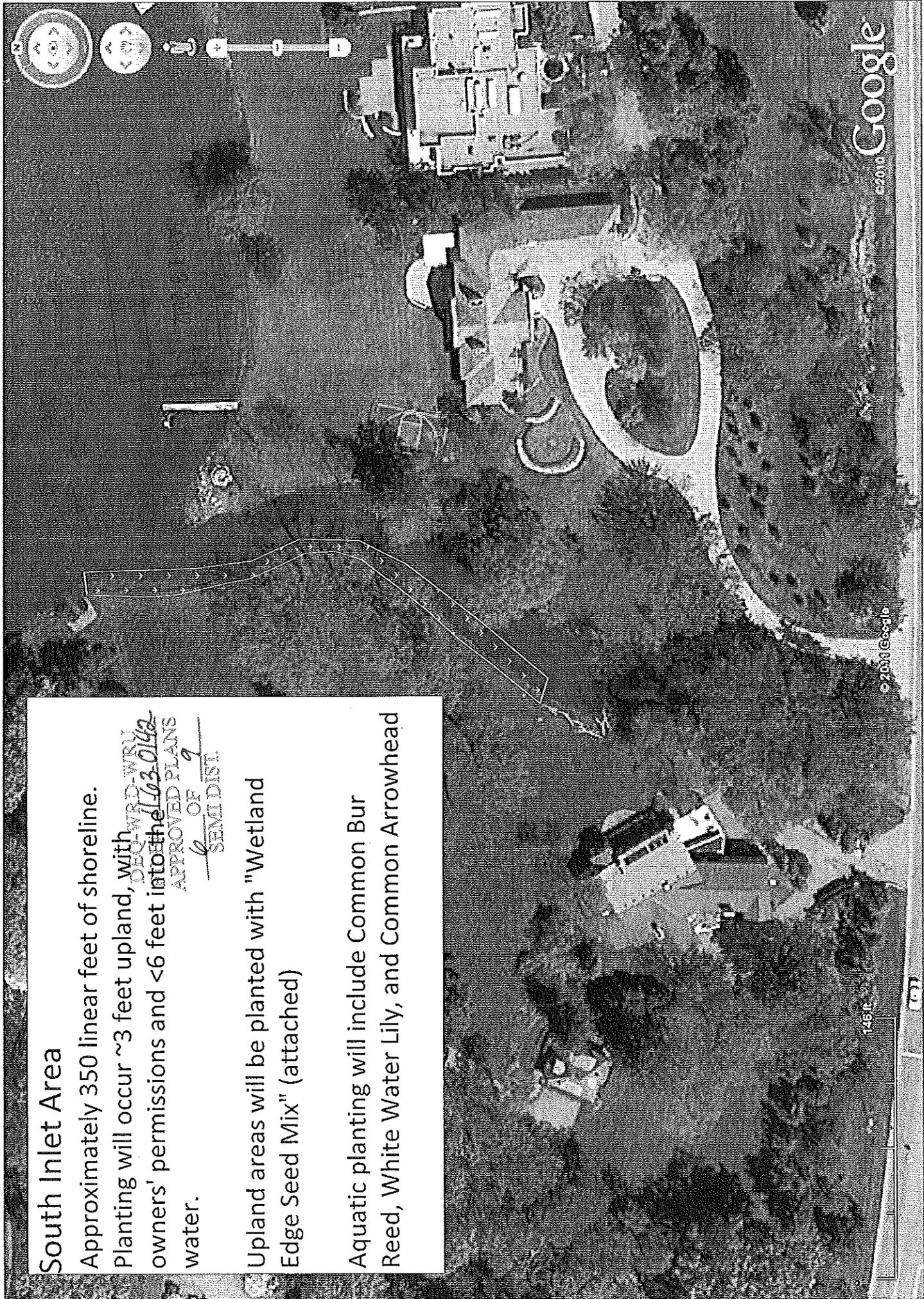
Approximately 350 linear feet of shoreline.

Planting will occur ~3 feet upland, with ^{DEC WRD WRU} ~~owners'~~ permissions and <6 feet into the ~~103.0162~~ water.

6 OF 9
SEMI-DIST.

Upland areas will be planted with "Wetland Edge Seed Mix" (attached)

Aquatic planting will include Common Bur Reed, White Water Lily, and Common Arrowhead



WETLAND EDGE SEED MIX

This is a wetland and pond-edge mix for sites with stable, saturated soil conditions and good water quality. Some species will spread to water depths of up to four inches. This seed mix includes at least 10 of 12 native permanent grass, sedge, and rush species and 7 of 20 native forb species.

Common Name	Scientific Name	Oz/Acre
Permanent Grasses / Sedges / Rushes		
<i>Carex comosa</i>	Bristly Sedge	1.00
<i>Carex cristata</i>	Crested Oval Sedge	2.00
<i>Carex frankii</i>	Bristly Cattail Sedge	6.00
<i>Carex vulpinoidea</i>	Brown Fox Sedge	3.00
<i>Eleocharis palustris</i>	Great Spike Rush	0.50
<i>Elymus virginicus</i>	Virginia Wild Rye	12.00
<i>Glyceria striata</i>	Fowl Manna Grass	1.00
<i>Ilexis crystaloides</i>	Rice Cut Grass	1.50
<i>Scirpus atrovirens</i>	Dark Green Rush	1.00
<i>Scirpus cyperinus</i>	Wool Grass	0.75
<i>Scirpus pungens</i>	Chairmaker's Rush	1.00
<i>Scirpus validus</i>	Great Bulrush	2.50
		32.25
Temporary Cover		
<i>Avena sativa</i>	Common Oat	360.00
<i>Colium multiflorum</i>	Annual Rye	100.00
		460.00
Forbs		
<i>Aconitum napellus</i>	Sweet Flag	0.50
<i>Alisma spp.</i>	Water Plantain Mix	2.00
<i>Asclepias incarnata</i>	Swamp Milkweed	1.00
<i>Aster purpureus</i>	Bristly Aster	1.00
<i>Bidens spp.</i>	Bidens Mix	2.00
<i>Eupatorium perfoliatum</i>	Common Boneset	1.00
<i>Helenium autumnale</i>	Sneezeweed	2.00
<i>Isis virginica</i>	Blue Flag	2.50
<i>Lobelia siphilitica</i>	Great Blue Lobelia	1.00
<i>Lycopus americanus</i>	Common Water Horehound	0.25
<i>Mimulus ringens</i>	Monkey Flower	1.50
<i>Penthorum sedoides</i>	Ditch Stonewort	0.50
<i>Polygonum spp.</i>	Smartweed Mix	0.50
<i>Rudbeckia laciniata</i>	Wild Golden Glow	0.75
<i>Sagittaria latifolia</i>	Common Arrowhead	2.00
<i>Senna hebecarpa</i>	Wild Senna	2.00
<i>Sparganium angustifolium</i>	Common Bur Reed	4.00
<i>Thalictrum dasycarpum</i>	Purple Meadow Rue	0.50
<i>Verbena hastata</i>	Blue Yervain	1.50
<i>Veronica spp.</i>	Ironweed Mix	2.00
		28.50

Sold in 1/4 Acre Increments

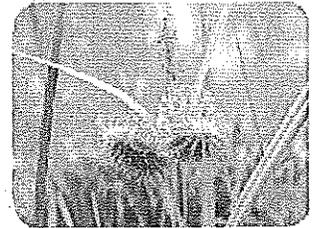
1 or More Acres	1/2 Acre	1/4 Acre
\$875 (per acre)	\$525	\$280

Apply at 32.3 PLS pounds per acre

DEC-WRD-WRTJ
 FILE# 11-103 0142
 APPROVED PLANS
 7 OF 9
 SEMI-DIST.

FEATURED SPECIES

Carex comosa Bristly Sedge Emergent Marsh Sedge



A member of the sedge family, this 2'-4' tall plant blooms in late spring to early summer. Preferring wet soils in full-to-partial sun, this long-leaved species is found in wet meadows, along lake shores, and in marshes.

Asclepias incarnata Swamp Milkweed Wet Prairie / Emergent Marsh Forb



A magnificent milkweed species that produces clusters of pink blossoms, this species prefers moist soils and full-to-partial sun. It is a favorite of native bees and wasps and is also a food source for the Monarch butterfly caterpillar. Growing to heights of 3'-5', this plant blooms from early to late summer.

Prices subject to change without notice. Visit www.JFNew.com for current pricing, terms of sale, and information on our full installation and management services.



Island Lake Restoration Projects

Plant List

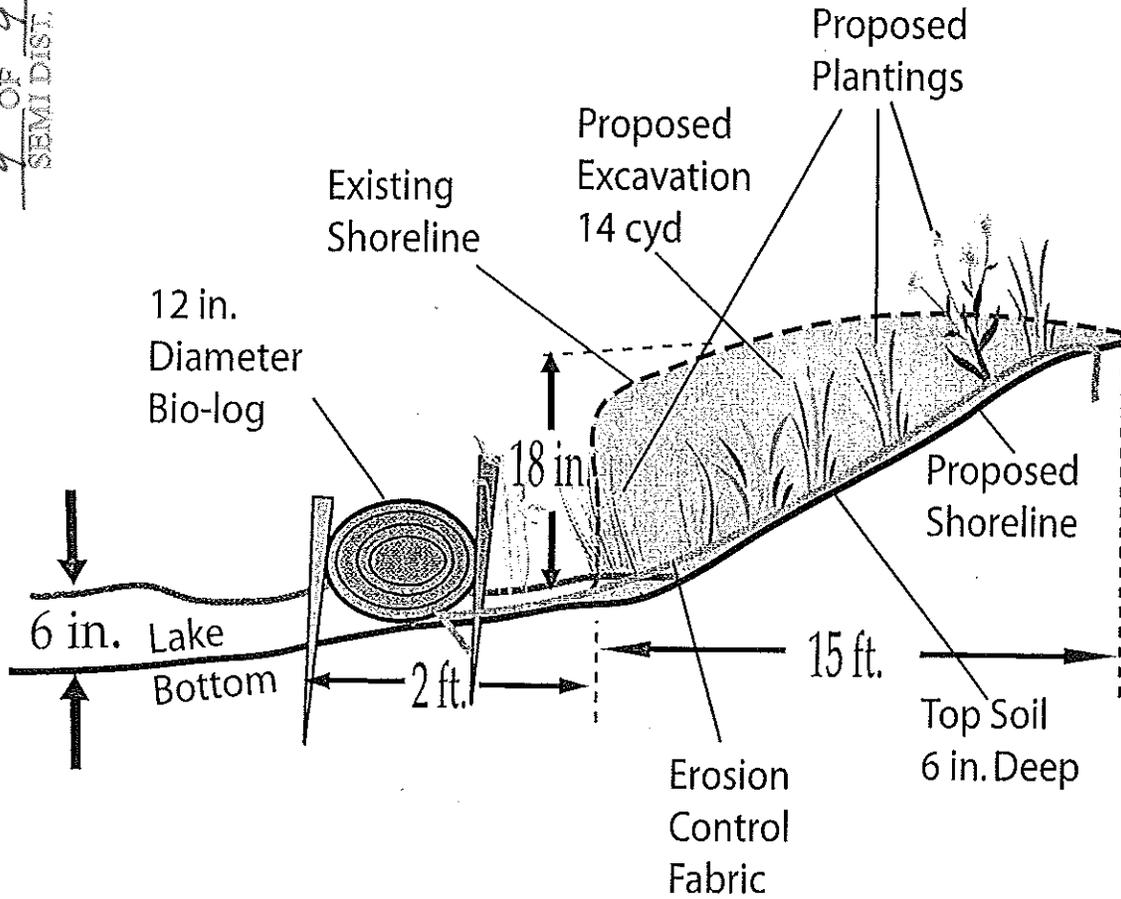
The following plants will be planted at the various bio-engineering sites. Please see maps to determine which plants will be used in which areas.

Buttonbush	<i>Cephalanthus occidentalis</i>
White Water Lily	<i>Nymphaea odorata</i>
Common Arrowhead	<i>Sagittaria latifolia</i>
Common Bur Reed	<i>Sparganium eurycarpum</i>

DEQ-WRD-WRI
 FILE# 11-63-0142
 APPROVED PLANS
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Sample Cross-Section Bioengineering

DEQ-WRD-WRU
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