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I. EXECUTIVE SUMMARY

Wildwood Lake is located in Sections 21 and 22 of Nunda Township (T.33N, R.2W) in Cheboygan County, Michigan and was created around 1962. The lake surface area is approximately 227.4 acres (Michigan Department of Natural Resources, 2001) and may be classified as a man-made lake (impoundment) with a large, shallow littoral zone. Wildwood Lake has a maximum depth of 18.0 feet and a mean depth of approximately 6.23 feet. Wildwood Lake has a lake perimeter of approximately 5.79 miles (Lakeshore Environmental, Inc., 2008). In addition, the lake is 0.96 miles (in length) at its longest dimension (Michigan Department of Natural Resources, 2001) and is therefore capable of producing sizeable waves during high-wind events. The volume of the lake is estimated to be approximately 1,391.2 acre-feet of water. The dam is located at the southwest corner of the lake. Three areas, located at the north and east end of the lake, including Bradley Creek drain to the lake. Wildwood Lake eventually drains into Lance Lake which empties into the Sturgeon River. Recent limnological surveys of the lake indicate that the lake is eutrophic, with moderate Secchi disk transparency, elevated nutrients such as nitrogen and phosphorus, and abundant exotic and native aquatic macrophyte and algae growth.

Eurasian milfoil (*Myriophyllum spicatum*; Figure 1) was introduced to the United States in the 1950's and has progressed to many of Michigan's inland lakes. Currently, it exists in over 33 of the United States. Shallow lakes with moderate to high water transparency and boat access sites (such as Wildwood Lake) are most vulnerable to Eurasian milfoil infestation. Eurasian milfoil is among the first species to germinate in lakes after the ice melts, and quickly forms a dense surface canopy that reduces the necessary light for more favorable, native aquatic plant species. Eurasian milfoil reproduces by seed and fragmentation and may even hybridize with native milfoil species if present in the lake. Due to the presence of abundant native milfoils in Wildwood Lake, the hybridization process has occurred to a significant degree. Eurasian milfoil is also capable of overwintering under winter ice, although a fair amount of the previous seasonal vegetation does decay. Rigorous lake management approaches such as the use of systemic herbicides (mainly Triclopyr OTF®) used on July 12, 2010 to control 35 acres of Eurasian milfoil in Wildwood Lake were successful, with minimal re-growth of the Eurasian milfoil by late summer of 2010. It is impossible to predict the probability of milfoil growth for 2011;

however, the treatment area should be significantly less as only 4.0 acres of sparse milfoil growth was noted during the September 5, 2010 survey.

Figure 1. Eurasian milfoil (*Myriophyllum spicatum L.*) with lateral branches and seed head. © *Superior Photique, 2007.*

Watershed inputs of nutrients through road and impervious surface runoff, septic tank leachate, lawn fertilizers, and storm drains may be contributing excess nutrients to Wildwood Lake. Excessive nutrients both saturate the sediment and water column of the lake and act as continual sources for emergent and submersed macrophytes. Watershed management plan strategies which implement BMP's are needed to ensure long-term improvement of the lake. These BMP's will continue to be presented to the riparians around Wildwood Lake as they become available.

In summary, lake improvement strategies for Wildwood Lake should include both within-lake and watershed components. Cooperation among the riparian residents, lake association, and the township is critical for success of the lake management program.

II. WILDWOOD LAKE IMPROVEMENT STRATEGIES-

A. Aquatic Herbicides and Algaecides

Aquatic herbicides are an effective method for the control of nuisance native and exotic macrophytes. The Natural Resources and Environmental Protection Act, P.A. 451 of 1994 (Part 33) mandates that a permit be acquired from the Michigan Department of Natural Resources and Environment (MDNRE) to all aquatic herbicide treatments. There are two broad categories of aquatic herbicides; Contact and Systemic. Systemic herbicides can be applied to various areas or to an entire system and kill the entire plant. In contrast, contact herbicides kill only the shoot portion of the plant. Algaecides also fall into the herbicide category and are effective on all types of algae including filamentous (surface), planktonic (submersed), and periphytic (submersed on aquatic plants) forms. The continued use of systemic aquatic herbicides such as Triclopyr for Wildwood Lake is recommended to maintain good control over the Eurasian Watermilfoil for the best long-term results. On July 12, 2010, approximately 35 acres of milfoil were treated with Renovate OTF® at 120 lbs/acre (Figure 2). A post-treatment survey followed on September 5, 2010. At that time, the milfoil appeared to be responding well to the Triclopyr treatment with only 4.0 acres of area with sparse milfoil noted. An additional 10 acres of contact herbicides were used to control nuisance weed and algae growth near shore and in canal areas. If algae become a nuisance during the 2011 season, then spot-treatments of chelated copper algaecides may decrease the algal population. Continued spot-treatment with Triclopyr (Renovate OTF®) at 120 lbs/acre is recommended for emerging milfoil during the 2011 season.

Figure 2. Locations of Triclopyr aquatic herbicide treatment (approximately 35 acres) on Wildwood Lake (July 12, 2010).

B. Lake Drawdown Impacts

During the fall of 2009, an initial lake drawdown was implemented on Wildwood Lake, with the goal of reducing the native exotic milfoil and nuisance native, floating-leaved pondweed growth. Initial pre-drawdown conditions consisted of 52 acres of Eurasian milfoil and approximately 20 acres of heavy floating-leaved pondweed growth (Figure 3). The lake level was brought to normal levels by spring of 2010 although minimal rainfall during the summer still maintained normal lake levels. The drawdown was very successful in the reduction of nearly 17 acres of Eurasian milfoil (as a total of 52 acres were noted during the initial lake management plan study in 2008) and also nearly 10 acres of floating-leaved pondweed (Figure 4). The drawdown process for the control of nuisance aquatic plant growth has been used over the decades with much success (Beard, 1973; Davis et al., 1964; Smith 1971). The Tennessee Valley Authority noted that a lake with a 1.83 meter depth drawdown for a time of 21-25 days during the winter season had a 90% reduction in Eurasian milfoil growth. A similar drawdown with an added 0.5 feet of drawdown depth (relative to 2010) is recommended for 2011 to further control the nuisance milfoil and pondweeds.

Figure 3. Nuisance floating-leaved pondweed growth in Wildwood Lake, Pre-drawdown, Pre-herbicide, Fall 2009.

Figure 4. Nuisance floating-leaved pondweed growth in Wildwood Lake, Post-drawdown and Post-herbicide treatment, Fall 2010. Note: Both figures 4 and 5 were taken in front of the same location on the lake.

C. Aquatic Vegetation and Algal Composition Surveys

Aquatic vegetation communities are dynamic and are composed of plants with different structural architecture. Most aquatic systems contain floating-leaved, submersed, and emergent aquatic macrophytes. These differences in aquatic plant structure enhance biodiversity of macroinvertebrates in the lake and thus offer a more diverse food source for the fishery. Repeated vegetation surveys of the lake are critical for documenting the changes in ecosystem structure that will vary with changes in water levels, nutrient concentrations, and aquatic plant control activities. Furthermore, systems such as Wildwood Lake which are infested with exotic macrophytes such as Eurasian milfoil require frequent monitoring to evaluate the progress of the selected management techniques. LEI staff were present to oversee herbicide application activities during the 2010 season and will continue to monitor those methods during 2011. In addition, a pre-treatment aquatic vegetation survey (July 12) and late summer post-treatment survey (September 5) were conducted during 2010 and will be conducted again in 2011. The recent AVAS/GPS grid survey conducted on Wildwood Lake on 12 July, 2010 revealed the presence of 2 exotic species (Table 1), including Eurasian milfoil and Purple Loosestrife (Figure 5). The current distribution of Eurasian milfoil in Wildwood Lake is shown in Figure 6. The survey also detected 13 native submersed species, 3 floating-leaved and 6 emergent species for a total of 22 species (Table 2).

Macrophyte Species and Code	***Common Name***	***Plant Growth Form***
Myriophyllum spicatum, 1	Eurasian Watermilfoil	Submersed; Rooted
Lythrum salicaria, 43	Purple Loosestrife	Emergent

Table 1. Exotic aquatic macrophyte species found in and around Wildwood Lake (September 5, 2010)

Figure 5. Purple Loosestrife (*L. salicaria*)

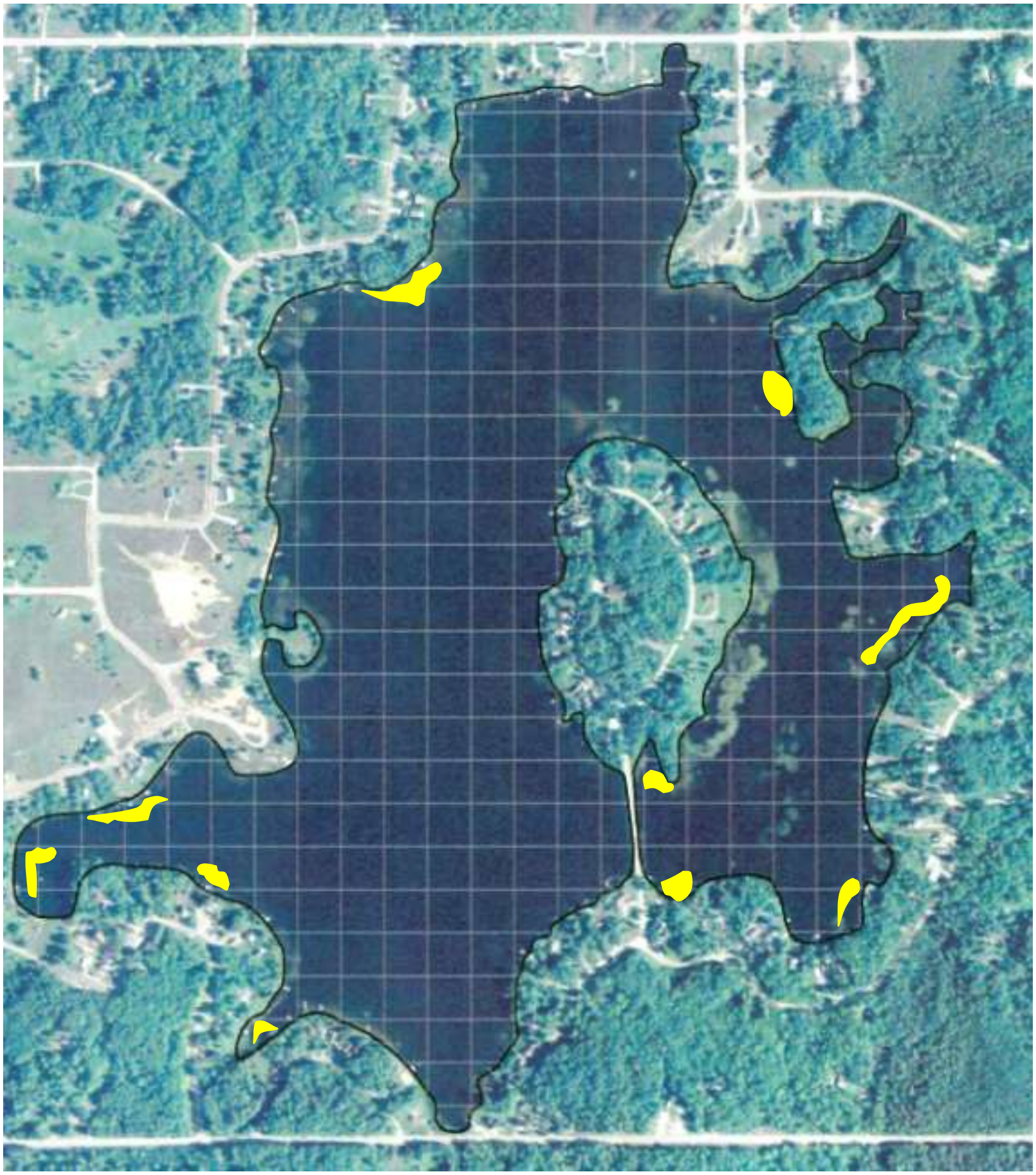

Figure 6. Post-treatment 2010 locations of Eurasian milfoil in Wildwood Lake (September 5, 2010).

Macrophyte Species and Code	***Common Name***	***Plant Growth Form***	***Relative Density***
Chara vulgaris (macroalga), 3	Muskgrass	Submersed; Rooted	Common
Stuckenia pectinatus, 4	Sago Pondweed	Submersed; Rooted	Sparse
Potamogeton zosteriformis, 5	Flatstem Pondweed	Submersed; Rooted	Sparse
Potamogeton gramineus, 7	Variable-leaved Pondweed	Submersed; Rooted	Sparse
Potamogeton illinoensis,10	Illinois Pondweed	Submersed; Rooted	Sparse
Potamogeton amplifolius, 11	Large-leaf Pondweed	Submersed; Rooted	Common
Potamogeton natans,13	Floating-leaf Pondweed	Submersed; Rooted	Common
Myriophyllum sibiricum, 17	Northern Watermilfoil	Submersed; Rooted	Sparse
Elodea canadensis, 21	Common Waterweed	Submersed; Rooted	Common
Ceratophyllum demersum, 20	Coontail	Submersed; Non-rooted	Sparse
Utricularia vulgaris, 21	Bladderwort	Submersed; Non-rooted	Sparse
Najas guadalupensis, 25	Southern Naiad	Submersed; Rooted	Common
Potamogeton foliosus, 29	Small-leaf Pondweed	Submersed; Rooted	Sparse
Eleocharis acicularis, 27	Spikerush	Emergent	Sparse
Nymphaea odorata, 30	White Waterlily	Floating-Leaved	Sparse
Nuphar variegata, 31	Yellow Waterlily	Floating-Leaved	Sparse
Brasenia schreberi, 32	Watershield	Floating-Leaved	Common
Typha latifolia, 39	Cattails	Emergent	Common
Scirpus acutus, 40	Bulrushes	Emergent	Sparse
Iris sp., 44	Iris	Emergent	Sparse
Decodon verticillatus, 42	Swamp Loosestrife	Emergent	Sparse
Polygonum amphibium, 48	Water Smartweed	Emergent	Sparse

Table 2. Native aquatic macrophyte species found in and around Wildwood Lake (July and September, 2010).

In addition to the aquatic vegetation analyses, algal community composition was assessed in the main open waters of Wildwood Lake. Algal genera from composite water samples collected over the Deep Basins of Wildwood Lake in July of 2010 were analyzed under a compound bright field microscope. The genera present included the Chlorophyta (green algae): *Chlorella* sp., *Ulothrix* sp., *Rhizoclonium* sp., *Haematococcus* sp., *Euglena* sp., *Spirogyra* sp., *Pediastrum* sp., *Gleocystis* sp., *Pandorina* sp., *Actinastrum* sp., *Ankistrodesmus* sp., *Volvox* sp., *Dictyosphaerium* sp., *Radiococcus* sp., *Cryptomonas* sp., *Cladophora* sp., *Spirogyra* sp., and *Chloromonas* sp. The Cyanophyta (blue-green algae): *Microcystis* sp., *Gleotrichia* sp., and *Gleocapsa* sp.; the Bascillariophyta (diatoms*):* *Eunotia* sp., *Navicula* sp., *Cymbella* sp., *Rhoicosphenia* sp., *Gomphonema* sp., *Fragilaria* sp., *Synedra* sp., *Asterionella* sp., *Nitzschia* sp., and *Tabellaria* sp. The aforementioned species indicate a diverse algal flora and represent a relatively balanced freshwater ecosystem, capable of supporting a strong zooplankton community in favorable water quality conditions. Blue-green algae such as *Microcystis* sp., is capable of producing microtoxins (Rinehart et al. 1994) that can cause neurologic or hepatic (liver) dysfunction in animals or humans if ingested in large quantities. Blue-green blooms are usually visible as a bluish tinted surface “scum layer” on lake waters when they are a threat and these areas should be avoided when obvious surface layer blooms are present. The waters of Wildwood Lake are rich in the Chlorophyta (both filamentous and planktonic green algae), which are indicators of good water quality and also support a robust fishery. During the 2010 season, an intense bloom of the filamentous green algae, *Rhizoclonium*, produced large masses of dense mats that colonized the open waters and canal areas (Figure 7). The growth of filamentous algae is a function of significantly warmer water temperatures.

Figure 7. Dense mats of the green filamentous algae, *Rhizoclonium* sp.

D. Water Quality Monitoring of Wildwood Lake

The quality of water is highly variable among Michigan inland lakes, although some characteristics are common among particular lake classification types. The water quality of Wildwood Lake is affected by both land use practices and climatic events. Climatic factors (i.e. spring runoff, heavy rainfall) may alter water quality in the short term; whereas, anthropogenic (man-induced) factors (i.e. shoreline development, lawn fertilizer use) alter water quality over longer time periods. Furthermore, lake water quality helps to determine the classification of particular lakes (Table 3). Lakes that are high in nutrients (such as phosphorus and nitrogen) and chlorophyll-*a*, and low in transparency are classified as **eutrophic**; whereas those that are low in nutrients and chlorophyll-*a*, and high in transparency are classified as **oligotrophic**. Lakes that fall in between these two categories are classified as **mesotrophic**. Wildwood Lake is classified as eutrophic based on its moderate transparency and high nutrient concentrations.

Lake Trophic Status	*Total Phosphorus ($\mu g\ L^{-1}$)*	*Chlorophyll-a ($\mu g\ L^{-1}$)*	*Secchi Transparency (feet)*
Oligotrophic	< 10.0	< 2.2	> 15.0
Mesotrophic	10.0 – 20.0	2.2 – 6.0	7.5 – 15.0
Eutrophic	> 20.0	> 6.0	< 7.5

Table 3. Lake Trophic Status Classification Table (MDNRE)

Wildwood Lake Water Quality Parameters

Water quality parameters such as dissolved oxygen, water temperature, conductivity, turbidity, total dissolved solids, pH, total alkalinity, total phosphorus, total Kjeldahl nitrogen, and Secchi transparency, among others, all respond to changes in water quality and consequently serve as indicators of water quality change. These parameters are discussed below along with water quality data specific to Wildwood Lake (Tables 4-6). Water quality data was collected on July 12, 2010.

Dissolved Oxygen

Dissolved oxygen is a measure of the amount of oxygen that exists in the water column. In general, dissolved oxygen levels should be greater than 5 mg L^{-1} to sustain a healthy warm-water fishery. Dissolved oxygen concentrations in Wildwood Lake may decline if there is a high biochemical oxygen demand (BOD) where organismal consumption of oxygen is high due to respiration. Dissolved oxygen is generally higher in colder waters. Dissolved oxygen is measured in milligrams per liter (mg L^{-1}) with the use of a dissolved oxygen meter and/or through the use of Winkler titration methods. The dissolved oxygen concentrations in Wildwood Lake were normal and consistent with increased depth during the July sampling event and ranged between 1.2 – 8.0 mg L^{-1}, with concentrations relatively consistent among deep basin sampling sites. During summer months, dissolved oxygen at the surface is generally higher due to the exchange of oxygen from the atmosphere with the lake surface, whereas dissolved oxygen is lower at the lake bottom due to decreased contact with the atmosphere and increased biochemical oxygen demand (BOD) from microbial activity. A decline in dissolved oxygen may cause increased release rates of phosphorus

(P) from Wildwood Lake bottom sediments if dissolved oxygen levels drop to near zero milligrams per liter.

Water Temperature

The water temperature of lakes varies within and among seasons and is nearly uniform with depth under winter ice cover because lake mixing is reduced when waters are not exposed to wind. When the upper layers of water begin to warm in the spring after ice-off, the colder, dense layers remain at the bottom. This process results in a "thermocline" that acts as a transition layer between warmer and colder water layers. During the fall season, the upper layers begin to cool and become denser than the warmer layers, causing an inversion known as "fall turnover". In general, lakes with deep basins will stratify and experience turnover cycles. Water temperature is measured in degrees Celsius (ºC) or degrees Fahrenheit (ºF) with the use of a submersible thermometer. The July water temperatures of Wildwood Lake demonstrated nearly isothermic conditions between the surface and bottom, since the sampling period occurred during a very warm season. Late summer water temperatures ranged between 80.1ºF at the surface and 76.7 ºF at the lake bottom among both deep basin sampling locations.

Conductivity

Conductivity is a measure of the amount of mineral ions present in the water, especially those of salts and other dissolved inorganic substances. Conductivity generally increases as the amount of dissolved minerals and salts in a lake increases, and also increases as water temperature increases. Conductivity is measured in microsiemens per centimeter ($\mu S\ cm^{-1}$) with the use of a conductivity probe and meter. Conductivity values for Wildwood Lake were low and consistent among sampling sites and similar to most healthy inland lakes in Michigan. Conductivity was consistent among sites and ranged between 280 $\mu S\ cm^{-1}$ and 321 $\mu S\ cm^{-1}$ for late summer water samples among the three sites. Baseline parameter data such as conductivity are important to measure the possible influences of land use activities (i.e. road salt influences) on Wildwood Lake over a long period of time, or to trace the origin of a substance to the lake in an effort to reduce pollutant loading.

Turbidity

Turbidity is a measure of the loss of water transparency due to the presence of suspended particles. The turbidity of water increases as the number of total suspended particles increases. Turbidity may be caused from erosion inputs, phytoplankton blooms, stormwater discharge, urban runoff, re-suspension of bottom sediments, and by large bottom-feeding fish such as carp. Particles suspended in the water column absorb heat from the sun and raise the water temperature. Since higher water temperatures generally hold less oxygen, shallow turbid waters are usually lower in dissolved oxygen. Turbidity is measured in Nephelometric Turbidity Units (NTU's) with the use of a turbimeter. The World Health Organization (WHO) requires that drinking water be less than 5 NTU's; however, recreational waters may be significantly higher than that. The turbidity of Wildwood Lake was low and ranged from 0.2 – 0.9 NTU's during the sampling event. The lake bottom is predominately sandy/marl substrate with some silt, which increases the turbidity values near the lake bottom.

pH

pH is the measure of acidity or basicity of water. The standard pH scale ranges from 0 (acidic) to 14 (alkaline), with neutral values around 7. Most Michigan lakes have pH values that range from 6.5 to 9.5. Acidic lakes (pH < 7) are rare in Michigan and are most sensitive to inputs of acidic substances due to a low acid neutralizing capacity (ANC). pH is measured with a pH electrode and pH-meter in Standard Units (S.U). The pH of Wildwood Lake water ranged from 6.8 – 7.8 during the late summer sampling. It is not uncommon for lakes in the northern region of Michigan to possess pH values slightly lower than those of southern lakes due to the underlying geological features which help determine pH. From a limnological perspective, Wildwood Lake is considered "slightly basic" on the pH scale.

Total Alkalinity

Total alkalinity is the measure of the pH-buffering capacity of lake water. Lakes with high alkalinity (> 150 mg L^{-1} of $CaCO_3$) are able to tolerate larger acid inputs with less change in water column pH.

Many Michigan lakes contain high concentrations of $CaCO_3$ and are categorized as having "hard" water. Total alkalinity is measured in milligrams per liter of $CaCO_3$ through an acid titration method. The total alkalinity of Wildwood Lake is considered "moderate" (< 150 mg L^{-1} of $CaCO_3$), and indicates that the water is slightly alkaline. Total alkalinity ranged from 120-148 mg L^{-1} of $CaCO_3$ during the late summer sampling. Total alkalinity may change on a daily basis due to the re-suspension of sedimentary deposits in the water and respond to seasonal changes due to the cyclic turnover of the lake water.

Total Phosphorus

Total phosphorus (TP) is a measure of the amount of phosphorus (P) present in the water column. Phosphorus is the primary nutrient necessary for abundant algae and aquatic plant growth. Lakes which contain greater than 20 µg L^{-1} of TP are defined as eutrophic or nutrient-enriched. TP concentrations are usually higher at increased depths due to higher release rates of P from lake sediments under low oxygen (anoxic) conditions. Phosphorus may also be released from sediments as pH increases. Total phosphorus is measured in micrograms per liter (µg L^{-1}) with the use of a chemical autoanalyzer. Mean surface total phosphorus (TP) concentrations for the Wildwood Lake Deep Basin sampling sites (based on the n = 3 Deep Basin sites) during spring were < 0.020 mg L^{-1}. Total phosphorus concentrations at the bottom depths among the three Deep Basin sites averaged < 0.050 mg L^{-1}., with the highest value recorded at Deep Basin 3.

Total Kjeldahl Nitrogen

Total Kjeldahl Nitrogen (TKN) is the sum of nitrate (NO_3^-), nitrite (NO_2^-), ammonia (NH_4^+), and organic nitrogen forms in freshwater systems. Much nitrogen (amino acids and proteins) also comprises the bulk of living organisms in an aquatic ecosystem. Nitrogen originates from atmospheric inputs (i.e. burning of fossil fuels), wastewater sources from developed areas (i.e. runoff from fertilized lawns), agricultural lands, septic systems, and from waterfowl droppings. It also enters lakes through groundwater or surface drainage, drainage from marshes and wetlands, or from precipitation (Wetzel, 2001). In lakes with an abundance of nitrogen (N: P > 15), phosphorus may be the limiting nutrient for phytoplankton and aquatic macrophyte growth. Alternatively, in lakes with low nitrogen concentrations (and relatively high phosphorus), the blue-green algae populations may increase due to the ability to fix nitrogen gas from atmospheric inputs. Lakes with a mean TKN value of 0.66 mg L^{-1} may be classified as oligotrophic, those with a mean TKN value of 0.75 mg L^{-1} may be classified as mesotrophic, and those with a mean TKN value greater than 1.88 mg L^{-1} may be classified as eutrophic. Wildwood Lake contained highly variable values for TKN (= 0.50 – 1.00 mg L^{-1}).

Secchi Transparency

Secchi transparency is a measure of the clarity or transparency of lake water, and is measured with the use of an 8-inch diameter standardized Secchi disk. Secchi disk transparency is measured in feet (ft) or meters (m) by lowering the disk over the shaded side of a boat around noon and taking the mean of the measurements of disappearance and reappearance of the disk. Elevated Secchi transparency readings allow for more aquatic plant and algae growth. Eutrophic systems generally have Secchi disk transparency measurements less than 7.5 feet due to turbidity caused by excessive planktonic algae growth. The Secchi transparency of Wildwood Lake averaged 9.0 feet over the three deep basins during the 2010 sampling period. This transparency is adequate to allow abundant growth of algae and aquatic plants in the majority of the littoral zone of the lake. Secchi transparency is variable and depends on the amount of suspended particles in the water (often due to windy conditions of lake water mixing) and the amount of sunlight present at the time of measurement.

Total Suspended and Dissolved Solids

Total Suspended Solids (TSS) is the measure of the amount of suspended particles in the water column. Particles suspended in the water column absorb heat from the sun and raise the water temperature. Total suspended solids is often measured in mg L^{-1} and analyzed in the laboratory. The lake bottom contains many fine sediment particles which are easily perturbed from winds and wave turbulence. Spring values would likely be higher due to increased watershed inputs from spring runoff and/or increased planktonic algal communities. In addition, Total Dissolved Solids (TDS) is a measure of the amount of inorganic and organic solids dissolved in the lake water that may cause a stained color or increase conductivity. The concentration of TSS in Wildwood Lake during the late summer sampling events ranged from < 2.0 mg L^{-1} to < 15.0 mg L^{-1}. Total Suspended Solids were highest at the lake bottom in Deep Basin #1.Total dissolved solids averaged between 43.5 mg L^{-1} and 67.2 mg L^{-1}. The acceptable standard for drinking water is 100 mg L^{-1}.

Oxidative Reduction Potential

The oxidation-reduction potential (E_h) of lake water describes the effectiveness of certain atoms to serve as potential oxidizers and indicates the degree of reductants present within the water. In general, the Eh level (measured in millivolts) decreases in anoxic (low oxygen) waters. Low E_h values are therefore indicative of reducing environments where sulfates (if present in the lake water) may be reduced to hydrogen sulfide (H_2S). Decomposition by microorganisms in the hypolimnion may also cause the E_h value to decline with depth during periods of thermal stratification. The E_h (ORP) values for Wildwood Lake ranged between 67.6 mV and 118.2 mV from the surface to the bottom within the lake, and thus were within a normal range for meso-eutrophic lakes.

Depth ft	***Water Temp ºF***	***DO mg L^{-1}***	***pH S.U.***	***Cond. µS cm^{-1}***	***Turb. NTU***	***ORP mV***	***Total Kjeldahl Nitrogen mg L^{-1}***	***Total Alk. mgL^{-1} $CaCO_3$***	***Total Phos. mg L^{-1}***
0	81.5	8.1	7.0	289	0.4	97.2	< 0.50	125	< 0.020
8	79.0	8.0	7.1	284	0.7	80.1	< 1.00	148	< 0.050

Table 4. Wildwood Lake Water Quality Parameter Data Collected over Deep Basin 1 on July 12, 2010.

Depth ft	***Water Temp ºF***	***DO mg L^{-1}***	***pH S.U.***	***Cond. µS cm^{-1}***	***Turb. NTU***	***ORP mV***	***Total Kjeldahl Nitrogen mg L^{-1}***	***Total Alk. mgL^{-1} $CaCO_3$***	***Total Phos. mg L^{-1}***
0	80.1	7.0	6.8	280	0.3	113.3	< 0.50	145	< 0.020
9	79.0	7.1	6.6	282	0.9	97.3	< 0.50	130	< 0.050

Table 5. Wildwood Lake Water Quality Parameter Data Collected over Deep Basin 2 on July 12, 2010.

Depth ft	***Water Temp ºF***	***DO mg L^{-1}***	***pH S.U.***	***Cond. µS cm^{-1}***	***Turb. NTU***	***ORP mV***	***Total Kjeldahl Nitrogen mg L^{-1}***	***Total Alk. mgL^{-1} $CaCO_3$***	***Total Phos. mg L^{-1}***
0	81.3	7.5	7.7	311	0.4	118.2	< 0.50	135	< 0.020
14	76.7	1.2	7.8	321	0.9	67.6	< 0.50	120	< 0.050

Table 6. Wildwood Lake Water Quality Parameter Data Collected over Deep Basin 3 on July 12, 2010.

E. Watershed Management Education and Implementation

Many point and non-point sources are responsible for nutrient loads to aquatic systems. Many of the homes surrounding Wildwood Lake currently utilize septic systems which can contribute nutrients to groundwater that eventually enter the lake. In addition, some residential lawns are regularly enriched with fertilizers that contain P. Many counties within Michigan are introducing P bans and P-free fertilizers and dishwashing detergents are becoming more available. Storm drains may also contribute nutrients to aquatic systems; however, if nutrient sources are dramatically reduced in proximity to the drains, the effluent is generally not nutrient-enriched and not a threat to the system. Riparian zone (shoreline) vegetation should also be preserved to act as a filter of nutrients that originate in the watershed and eventually enter the lake. In addition, areas with high erosion risk (Figure 8) should be stabilized with vegetation or structural materials to decrease nutrient and sediment loading to the lake. It is recommended that an annual spring septic pump out day be established for all year-long residential homes which immediately border Wildwood Lake and that long-term connection to the sewer line is recommended.

Figure 8 Shoreline areas with steep slope and unvegetated sand contributes to nutrient and sediment loading in Wildwood Lake due to erosion (Photo taken September 5, 2010).

III. 2011 Proposed Wildwood Lake Management Budget

Improvement Strategy	Estimated Cost
Aquatic Herbicide Treatments (30 acres@$525 per acre)	$21,050
MDNRE permit ($800)-Algaecides/Contacts	
15 acres@ $300 per acre	
Consulting Fees	$6,000
(Administration, surveys, sampling)	
Contingency (10%)	$2,705
Total 2011 Program Cost	$29,755

Table 9. Wildwood Lake proposed lake management costs for 2011. Note: Contingency budget may also be allocated to drawdown fees.