Annual Report

Lake Lansing
Special Assessment District
2015 Annual Report

Prepared for:

Charter Township of Meridian
and
Lake Lansing Special Assessment District Advisory Committee

Prepared by:

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

January 2016

Project No: 53260102

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Table of Contents

LIST OF TABLES

LIST OF FIGURES

Executive Summary

The Lake Lansing Special Assessment District (SAD) was formed in 1998 to improve conditions in Lake Lansing. In 2007, public hearings were held and Meridian Township approved continuing the project for a ten-year period. The project includes an update of the lake and watershed management plan, water quality sampling, nuisance aquatic plant control, watershed improvements, educational programs, and grant applications. The project is overseen by the Lake Lansing SAD Advisory Committee, whose members include representatives of residents within the SAD, Meridian Township, Ingham County Parks, and the Ingham County Drain Commissioner's Office. A summary of project activities is as follows:

Water Quality Sampling: In 2015, samples were collected from Lake Lansing and from tributary streams in spring and late summer. Lake Lansing is borderline between mesotrophic (moderately productive) and eutrophic (nutrient-enriched and productive). During the 2015 sampling period, phosphorus levels were generally low with a few exceptions. Water clarity was excellent in spring and moderate in late summer. Algae growth was low in spring and late summer. Tributary streams carry only a small volume of water into Lake Lansing, and stormwater catch-basin inserts also help to reduce pollution loading.

Nuisance Aquatic Plant Control: In 2015, 28 acres of the lake were treated to control Eurasian milfoil. In mid July, 50 acres were harvested and a 37-acre harvest was conducted in mid September to control nuisance native plant growth.

Watershed Improvements: In 2015, filtration inserts were installed in two catch-basins along Perry Road south of Lake Drive.

Information and Education: Lake Lansing Property Owners Association members participated in a township-wide spring clean-up day on April 25; held their annual meeting on June 9 (Figure 1); and participated in the second annual aquatic invasive species "Landing Blitz" on June 28 and 29.

Lake Mapping: Progressive AE conducted two hydro-acoustic surveys of Lake Lansing to re-map water depth and to map aquatic vegetation bio-volume. The new depth and vegetation maps will be used to improve accuracy and efficiency of aquatic vegetation surveys.

Figure 1. Annual Lake Lansing Property Owners Association meeting, June 9, Lake Lansing Park South Pavilion.

Introduction

Lake Lansing is located in Meridian Township, Ingham County, Michigan (Figure 2). The lake is 456 acres in surface area with a maximum depth of 35 feet and a mean (average) depth of 8.7 feet. In 1998, Meridian Township established a special assessment district (SAD) under provisions of Public Act 188 of 1954 for the purposes of studying water quality, planning and implementing aquatic plant control, and developing a watershed management plan for Lake Lansing. In March of 2002, a management plan was prepared for Lake Lansing and its watershed. Public hearings were held in the summers of 2002 and 2007 to continue the management program for the lake. Ongoing management is overseen by the Lake Lansing Special Assessment District Advisory Committee (hereinafter, the Advisory Committee) with assistance from the Advisory Committee's professional consultant. The Advisory Committee includes representatives from each of the tiers in the special assessment district, Lake Lansing Property Owners Association, Meridian Township Engineering Department, Ingham County Parks Department, and Ingham County Drain Commissioner's Office. This report includes information on 2015 Lake Lansing management activities.

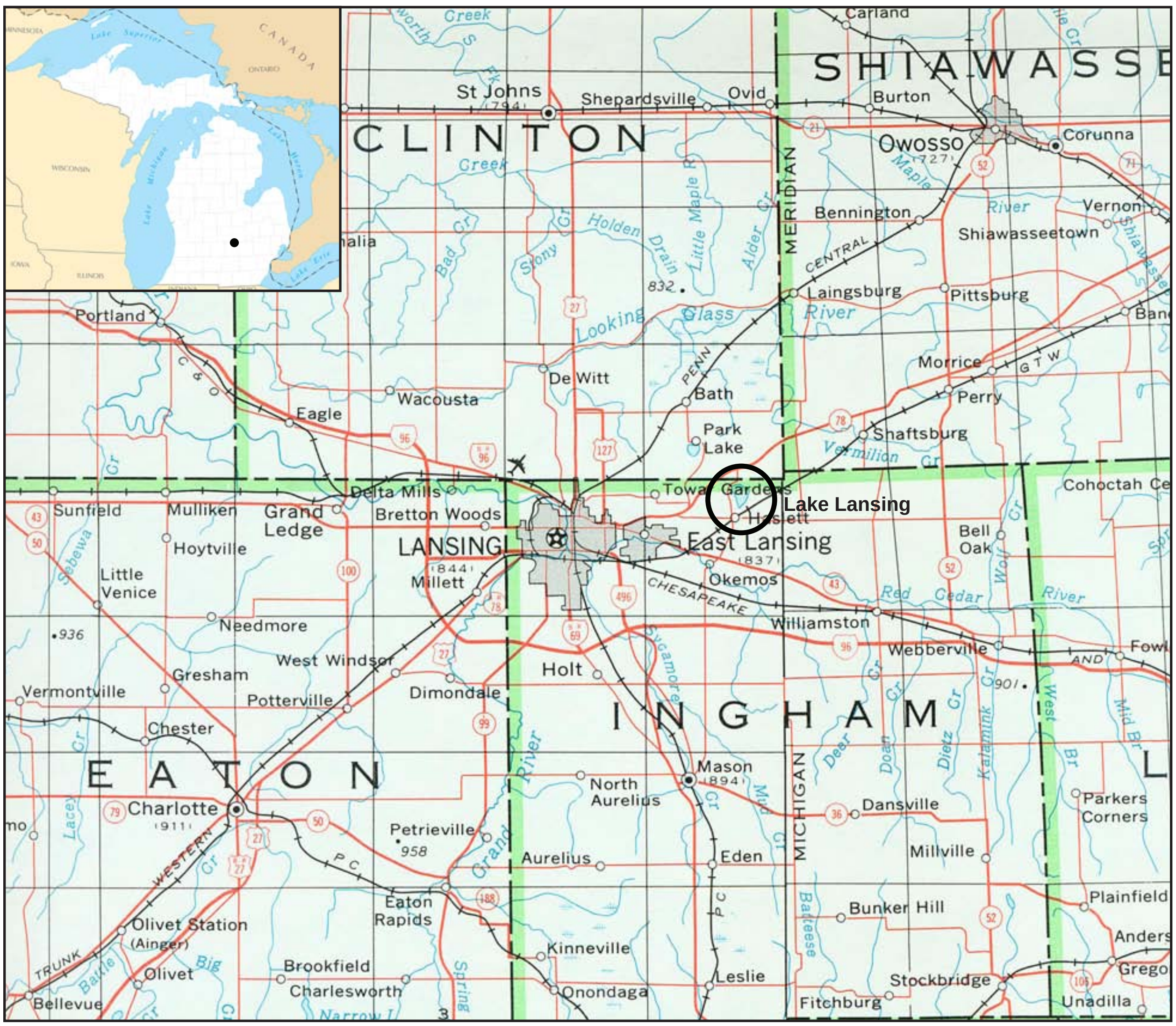


Figure 2. Lake Lansing location map. Source: United States Geological Survey.

Water Quality Sampling

Lake Water Quality

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.

Lakes are commonly classified as oligotrophic, mesotrophic, or eutrophic (Figure 3). 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.

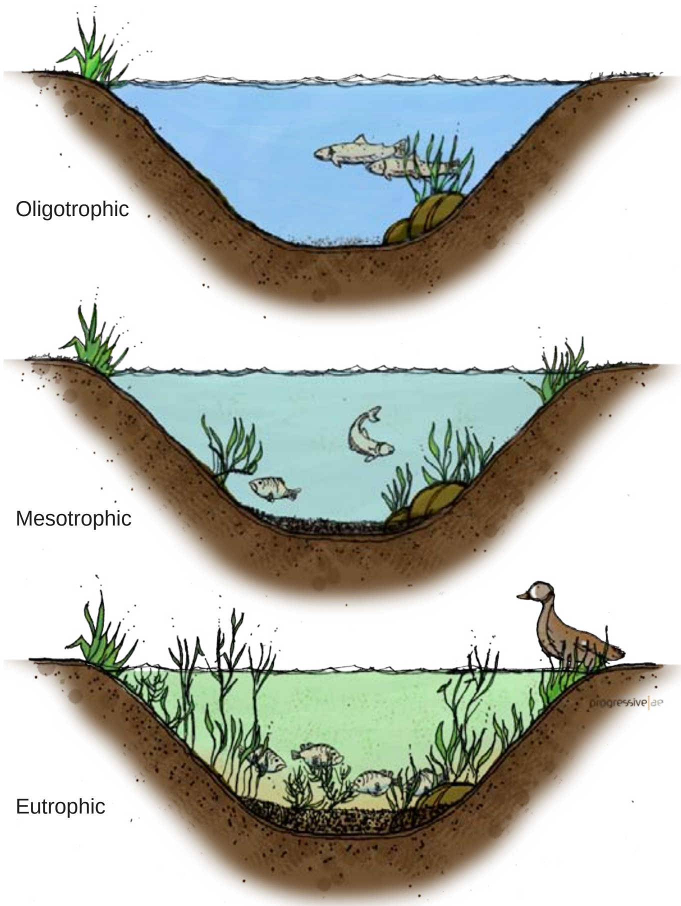


Figure 3. Lake classification.

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 management 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. Key parameters used to evaluate the limnological condition of a lake include temperature, dissolved oxygen, total phosphorus, pH and alkalinity, chlorophyll-*a*, fecal coliform bacteria, and Secchi transparency.

TEMPERATURE

Temperature is important in determining the type of organisms which 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 (Figure 4). 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.

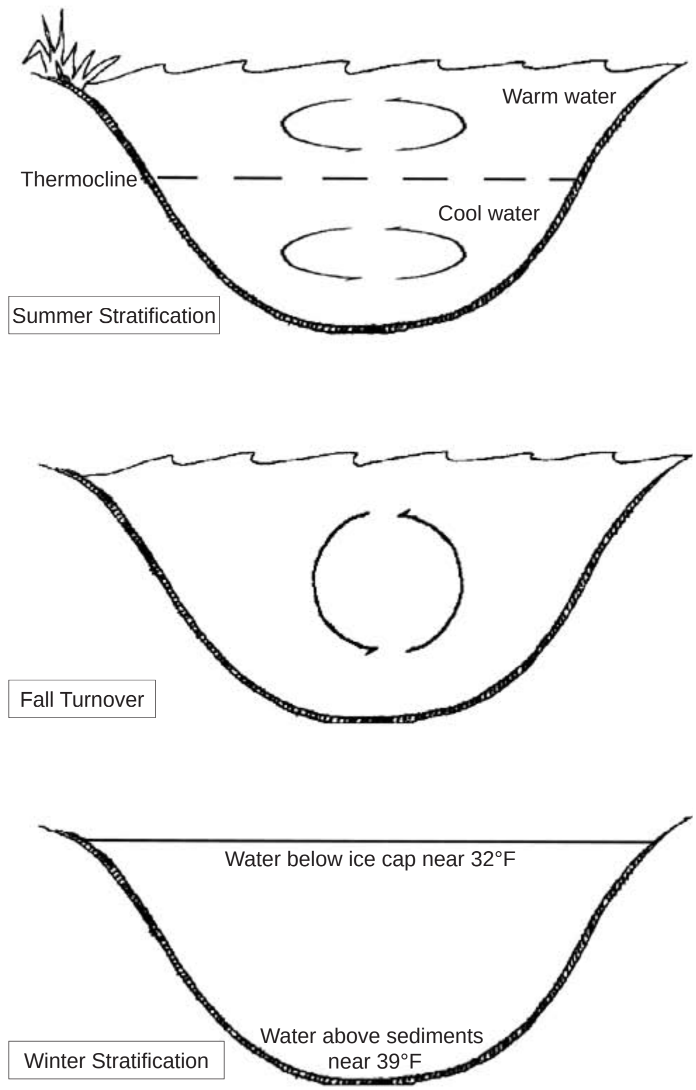


Figure 4. Seasonal thermal stratification cycles.

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 the oxygen has been consumed, in large part, 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. By reducing the availability of phosphorus in a lake, it is often possible to control the amount of aquatic plant growth. In general, lakes with a phosphorus concentration of 20 µg/L (micrograms per liter, or parts per billion) or greater are able to support abundant plant growth and are classified as nutrient-enriched or eutrophic.

Phosphorus enters the lake water either from the surrounding watershed, or from the sediments in the lake itself, or both. The input of phosphorus from the watershed is called "external loading," and from the sediments is called "internal loading." External loading occurs when phosphorus washes into the lake from sources such as fertilizers, septic systems, and eroding land. Internal loading occurs when bottom-water oxygen is depleted, resulting in a chemical change in the water near the sediments. The chemical change causes phosphorus to be released from the sediments into the lake where it becomes available as a nutrient for aquatic plants.

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 5). 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 at least 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.

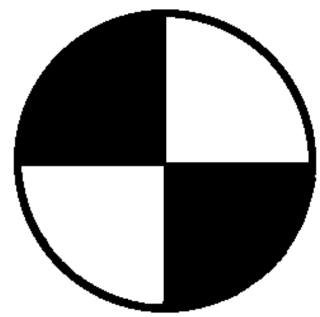


Figure 5. Secchi disk.

Ordinarily, as phosphorus inputs (both internal and external) to a lake increase, the amount of algae the lake can support 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 Environmental Quality is shown in Table 1.

TABLE 1
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 TOTAL ALKALINITY

pH is a measure of the amount of acid or base in the water. The pH scale ranges from 0 (acidic) to 14 (alkaline or basic) with neutrality at 7. The pH of most lakes in the Upper Midwest ranges from 6.5 to 9.0 (MDEQ 2012; Table 3). In addition, according to MDEQ (2013):

> While there are natural variations in pH, many pH variations are due to human influences. Fossil fuel combustion products, especially automobile and coal-fired power plant emissions, contain nitrogen oxides and sulfur dioxide, which are converted to nitric acid and sulfuric acid in the atmosphere. When these acids combine with moisture in the atmosphere, they fall to earth as acid rain or acid snow. In some parts of the United States, especially the Northeast, acid rain has resulted in lakes and streams becoming acidic, resulting in conditions which are harmful to aquatic life. The problems associated with acid rain are lessened if limestone is present, since it is alkaline and neutralizes the acidity of the water.
>
> Most aquatic plants and animals are adapted to a specific pH range, and natural populations may be harmed by water that is too acidic or alkaline. Immature stages of aquatic insects and young fish are extremely sensitive to pH values below 5. Even microorganisms which live in the bottom sediment and decompose organic debris cannot live in conditions which are too acidic. In very acidic waters, metals which are normally bound to organic matter and sediment are released into the water. Many of these metals can be toxic to fish and humans. Below a pH of about 4.5, all fish die.

The Michigan Water Quality Standard (Part 4 of Act 451) states that pH shall be maintained within the range of 6.5 to 9.0 in all waters of the state.

Alkalinity, also known as acid-neutralizing capacity or ANC, is the measure of the pH-buffering capacity of water in that it is the quantitative capacity of water to neutralize an acid. pH and alkalinity are closely linked and are greatly impacted by the geology and soil types that underlie a lake and its watershed. According to MDEQ (2012):

> Michigan's dominant limestone geology in the Lower Peninsula and the eastern Upper Peninsula contributes to the vast majority of Michigan lakes being carbonate-bicarbonate dominant [which increases alkalinity and moderates pH] and lakes in the western Upper Peninsula having lower alkalinity and thus lesser buffering capacity.

The alkalinity of most lakes in the Upper Midwest is within the range of 23 to 148 milligrams per liter, or parts per million, as calcium carbonate (MDEQ 2012; Table 3).

TABLE 3
pH AND ALKALINITY OF UPPER MIDWEST LAKES

Measurement	Low	Moderate	High
pH (in standard units)	Less than 6.5	6.5 to 9.0	Greater than 9.0
Total Alkalinity or ANC (in mg/L as $CaCO_3$[1])	Less than 23	23 to 148	Greater than 148

TOTAL SUSPENDED SOLIDS

According to MDEQ (2015):

> Total suspended solids (TSS) include all particles suspended in water which will not pass through a filter... Most people consider water with a TSS concentration less than 20 mg/L to be clear. Water with TSS levels between 40 and 80 mg/L tends to appear cloudy, while water with concentrations over 150 mg/L usually appears dirty.

1 mg/L $CaCO_3$ = milligrams per liter as calcium carbonate.

SAMPLING METHODS

Water quality sampling was conducted in the spring and late summer of 2015 at the two deep basins within Lake Lansing (Figure 6). Temperature was measured using a YSI Model 550A probe. Samples were collected at the surface, mid-depth, and just above the lake bottom with a Van Dorn bottle to be analyzed for dissolved oxygen, pH, total alkalinity, and total phosphorus. 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 and total phosphorus samples were placed on ice and transported to Progressive AE and to Prein and Newhof[1], respectively, for analysis. Total alkalinity was titrated at Progressive AE using Standard Methods procedure 2320 B, and total phosphorus was analyzed at Prein and Newhof using Standard Methods procedure 4500-P E. 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 10200 H.

Tributary monitoring was conducted in spring for the most significant storm drains and inlet streams (Figure 6). Tributary stream discharge was estimated using the U.S. Geological Survey midsection method (Buchanan and Somers 1969). Stream velocity was measured with a Pygmy Gurley flow meter. Prein and Newhof analyzed samples for total phosphorus.

Sampling Results and Discussion

Sampling results are provided in Tables 2 through 4. A graphic summary of water quality data compiled to date is shown in Figures 7 through 9 and summary statistics are included in Table 5. Historical data for Lake Lansing is contained in Appendix A.

In April of 2015, sampling was conducted during spring turnover when water temperatures were cool and dissolved oxygen was high. During the August sampling period, Lake Lansing was stratified; the lake was warm and well-oxygenated at the surface, and was cool with low oxygen at the bottom. Total phosphorus concentrations were generally low or moderate with the exception of the deepest samples in late summer which were high. The elevated bottom-water phosphorus is likely due to internal release of phosphorus from the lake sediments. However, sediment phosphorus release occurs in only a very small portion of the lake and therefore it is unlikely to be a significant loading source to Lake Lansing. pH and total alkalinity were within the moderate range for Upper Midwest lakes.

Chlorophyll-*a* levels indicate algae growth was low during both sampling periods in 2015, which has generally been the case since sampling began in 1999. Water clarity was excellent in spring and moderate in late summer. Water clarity steadily improved in Lake Lansing from 2005 through the spring of 2010, then declined until the summer of 2012 and has since been increasing (Figure 9). The improved clarity is likely related to the presence of zebra mussels which consume algae and often increase water clarity. In general, plants can grow to a depth of about twice the Secchi transparency reading. With a median Secchi transparency of 9 feet, the clarity of Lake Lansing is sufficient to allow sunlight to penetrate to about 18 feet of depth, which is over 90 percent of the lake bottom, making nearly all of Lake Lansing habitable for plant growth.

Tributary samples were collected in spring of 2015, but all tributary in-flow to Lake Lansing ceased by late summer. Phosphorus concentrations in the tributaries were moderate at Sites 1 through 3 (on the east side of the lake) but phosphorus was elevated at Perry Road. Inflow water volume (or discharge) was quite low indicating only a small quantity of phosphorus drains into Lake Lansing. Filtration inserts were installed in catch-basins along Perry Road during the summer of 2015 which should help to reduce phosphorus and sediment loading in the future.

1 Prein and Newhof Environmental and Soils Laboratory, 3260 Evergreen, NE, Grand Rapids, MI.

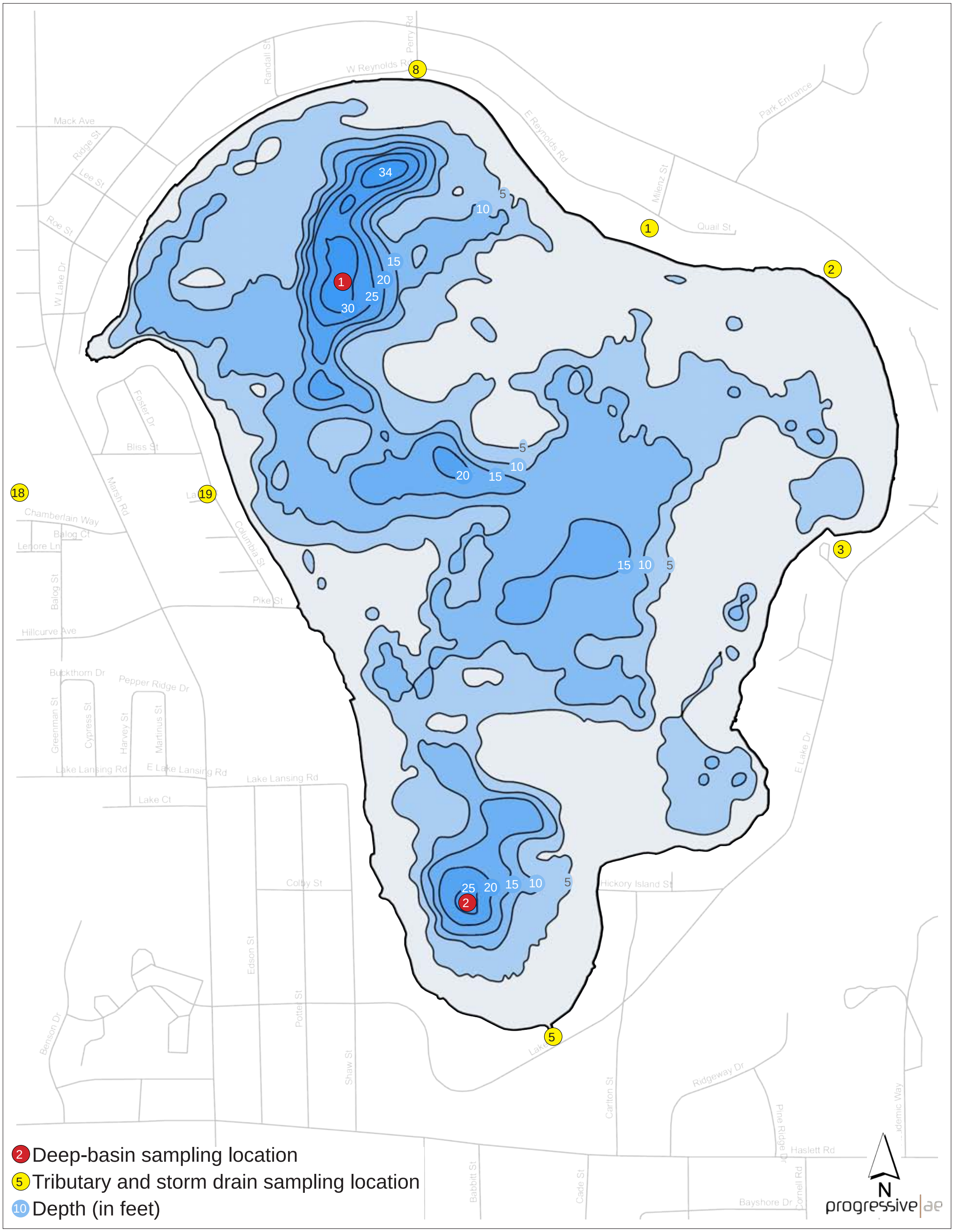


Figure 6. Lake Lansing sampling location map.

TABLE 2
LAKE LANSING
2015 DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)[1]	Total Phosphorus (µg/L)[2]	pH (S.U.)[3]	Total Alkalinity (mg/L $CaCO_3$)[4]
14-Apr-15	1	1	52	11.1	10	8.1	145
14-Apr-15	1	15	51	11.4	8	8.0	141
14-Apr-15	1	30	51	11.0	7	8.1	135
14-Apr-15	2	1	51	11.2	<5	8.1	136
14-Apr-15	2	11	51	11.0	8	8.1	137
14-Apr-15	2	22	48	8.6	35	8.1	137
26-Aug-15	1	1	71	7.6	<5	9.1	110
26-Aug-15	1	15	71	7.8	<5	9.0	112
26-Aug-15	1	30	60	1.5	40	8.3	160
26-Aug-15	2	1	71	7.5	<5	8.9	108
26-Aug-15	2	12	71	7.6	<5	8.9	111
26-Aug-15	2	24	58	0.6	172	8.0	178

TABLE 3
LAKE LANSING
2015 SURFACE WATER QUALITY DATA

Date	Station	Secchi Transparency (feet)	Chlorophyll-*a* (µg/L)[4]
14-Apr-15	1	15.5	0
14-Apr-15	2	14.5	1
26-Aug-15	1	9.0	0
26-Aug-15	2	9.0	0

1 mg/L = milligrams per liter = parts per million.
2 µg/L = micrograms per liter = parts per billion.
3 S.U. = standard units.
4 mg/L $CaCO_3$ = milligrams per liter as calcium carbonate.

TABLE 4
LAKE LANSING
2015 STORM DRAIN MONITORING DATA

Date	Number	Name	Discharge (cfs)[1]	Total Phosph. (µg/L)[2]	Total Solids (mg/L)[3]	Total Suspended Solids (mg/L)[3]
14-Apr-15	1	Barnhart	0.4	22	277	<4
14-Apr-15	2	Milliman	0.4	19	280	<4
14-Apr-15	3	Wallace	0.9	18	313	<4
14-Apr-15	5	South End	0			
14-Apr-15	8	Perry Road	0.1	112	590	14
14-Apr-15	18	Marshall Upstream	0			
14-Apr-15	19	Marshall Downstream	0			

TABLE 5
LAKE LANSING
SUMMARY STATISTICS (1999-2015)[4]

	Total Phosphorus (µg/L)[2]	Chlorophyll-*a* (µg/L)[2]	Secchi Transparency (feet)
Mean	35	1	9.7
Standard deviation	56	2	3.7
Median	20	1	9.0
Minimum	5	0	4.3
Maximum	364	9	19.5
Number of samples	191	60	60

Summary statistics indicate Lake Lansing is borderline between mesotrophic (moderately productive) and eutrophic (nutrient-enriched and productive). Phosphorus levels range from moderate to high with the median phosphorus concentration at the eutrophic threshold of 20 parts per billion. Bottom-water oxygen is reduced, and water clarity appears to fluctuate with the zebra mussel population. Rooted plant growth in Lake Lansing is moderate to dense, and algae growth is generally moderate or low, thus it would appear that phosphorus is more readily used by rooted plants in the lake rather than algae.

1 cfs = cubic feet per second.
2 µg/L = micrograms per liter = parts per billion.
3 mg/L = milligrams per liter = parts per million.
4 Summary statistics include data from sampling stations 1 and 2 only. Historically, samples were also collected from two additional stations near the shoreline, but only deep basin data is included in this analysis.

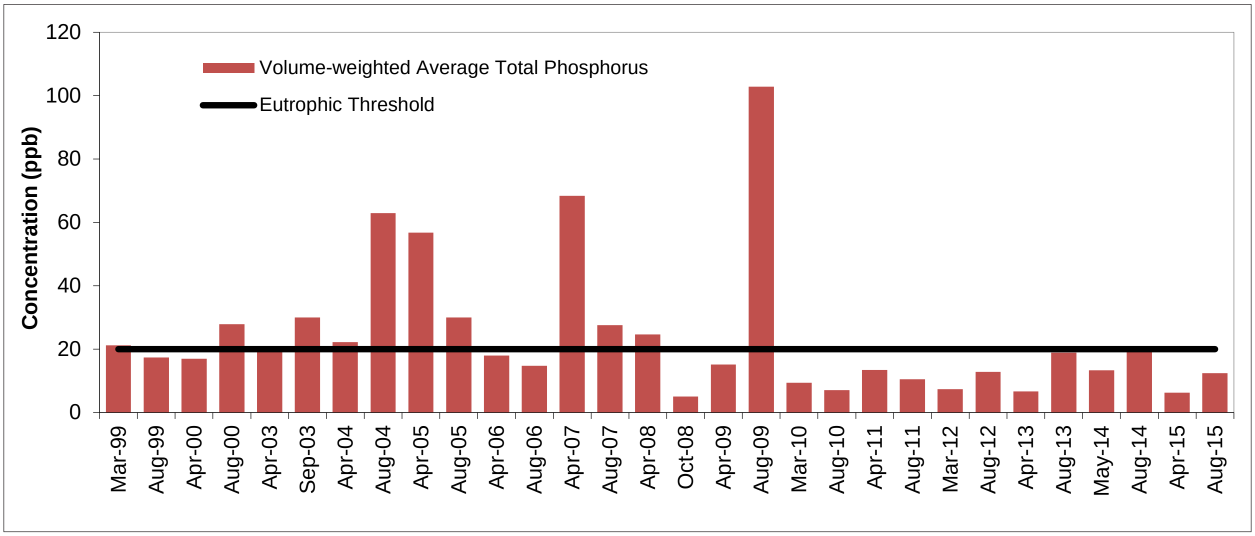


Figure 7. Volume-weighted average total phosphorus concentrations, 1999-2015.

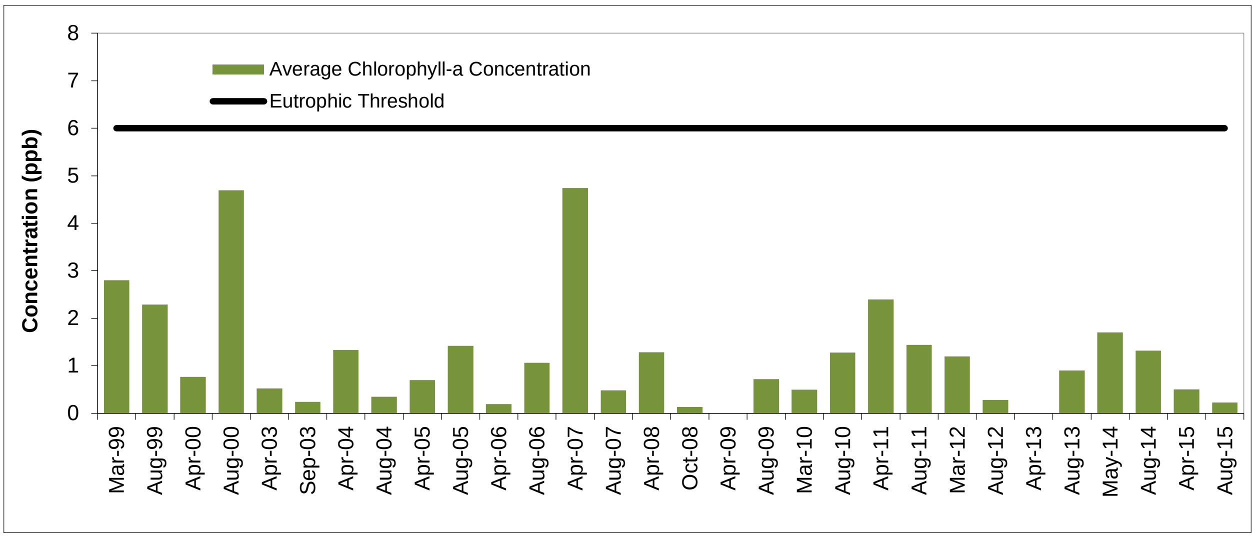


Figure 8. Average chlorophyll-*a* concentrations, 1999-2015.

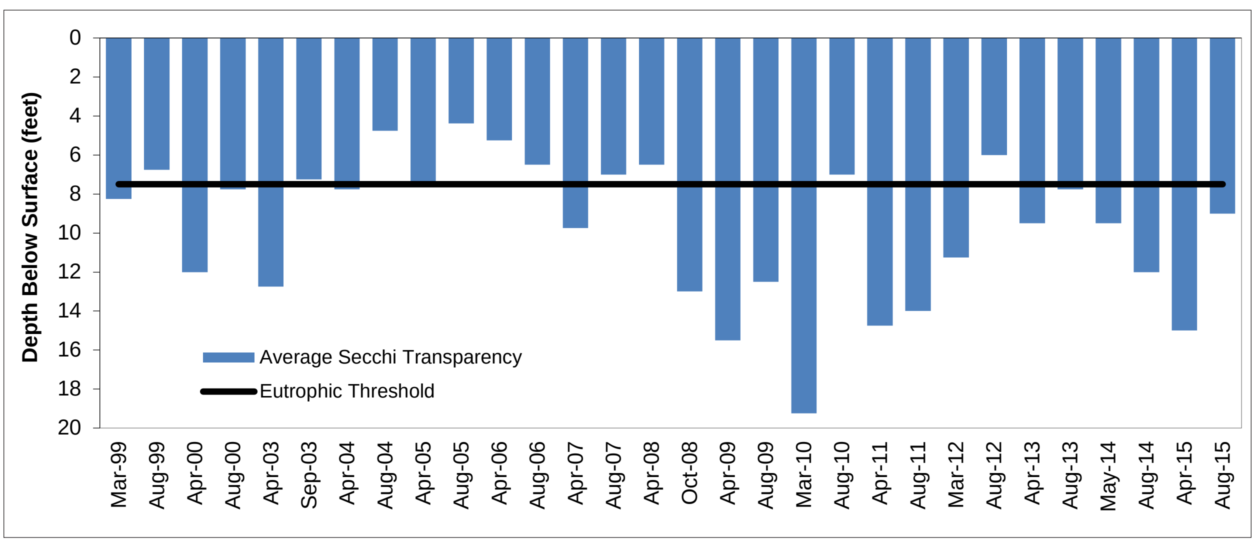


Figure 9. Average Secchi transparency measurements, 1999-2015.

Nuisance Aquatic Plant Control

The focus of the plant control program in Lake Lansing is control of exotic (i.e., non-native) plants such as Eurasian milfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*), and control of native plants that reach nuisance densities. In 2015, 28 acres of the lake were treated to control Eurasian milfoil. In mid July, 50 acres were harvested and a 37-acre harvest was conducted in mid September to control nuisance native plant growth.

On August 26, the lake was surveyed using the Department of Environment Quality's *Procedures for Aquatic Vegetation Surveys*. With these procedures, the type and relative abundance of all plants species present in the lake are evaluated. Lake Lansing was segmented into 70 survey sites and the type and density of plants at each site was recorded (Table 6).

TABLE 6
LAKE LANSING AQUATIC PLANT FREQUENCY AND DENSITY
AUGUST 26, 2015

		Number of Survey Sites Where Plant Was Found by Density			
Common Name	**Scientific Name**	**Rare**	**Sparse**	**Common**	**Dense**
Wild celery	*Vallisneria americana*		36	24	2
Chara	*Chara* sp.		36	16	
Thin-leaf pondweed	*Potamogeton* sp.		45	4	
Large-leaf pondweed	*Potamogeton amplifolius*	1	35	4	
Eurasian milfoil	*Myriophyllum spicatum*	6	28	4	
Sago pondweed	*Stuckenia pectinata*	3	20	9	
Flat-stem pondweed	*Potamogeton zosteriformis*	1	23		
Elodea	*Elodea canadensis*	1	18	5	
Cattail	*Typha* sp.		3	2	8
Yellow waterlily	*Nuphar* sp.		4	3	
Whitestem pondweed	*Potamogeton praelongus*	4	2		
Water stargrass	*Heteranthera dubia*	1	5		
Naiad	*Najas* sp.	1	3		
Floating-leaf pondweed	*Potamogeton natans*		3		
White waterlily	*Nymphaea odorata*		3		
Pickerelweed	*Pontederia cordata*		2	1	
Starry stonewort	*Nitellopsis obtusa*		3		
Purple loosestrife	*Lythrum salicaria*	1	1		
Swamp loosestrife	*Decodon verticillatus*		1		

During the August survey, nineteen aquatic plant species were found. Wild celery, Chara, thin-leaf pondweed, and large-leaf pondweed were the most common submersed plants. In addition to Eurasian milfoil, starry stonewort was another non-native plant found in Lake Lansing. The plant has become a severe nuisance plant in many Michigan lakes but, so far, growth has been moderate in Lake Lansing. Starry stonewort looks like a rooted plant but is actually an algae, similar in appearance to the native plant Chara (Figure 10). However, unlike Chara, starry stonewort can grow in mats several feet thick which can impede navigation, recreational use, and may impact fish spawning habitat. It will be important to monitor and control the spread of starry stonewort in the future.

Figure 10. Chara (left) and starry stonewort (right).

Watershed Improvements

In recent years, several storm drain modifications have been implemented to reduce watershed pollution inputs. In 2015, filtration inserts were installed in two catch-basins along Perry Road south of Lake Drive (Figures 11 and 12). The inserts consist of a metal frame with heavy yet porous fabric through which the stormwater flows, thus removing sediment and other pollutants. Paving of the Meridian Township portion of Perry Road, which was completed in 2014, reduced the amount of sediment entering the storm sewer system. However, paving will not eliminate all sediment transport, thus the filtration inserts will help to further reduce inputs to Lake Lansing.

Figure 11. Perry Road catch-basin near Lake Drive.

Figure 12. Perry Road catch-basin near Reynolds Road.

Information and Education

The Lake Lansing Property Owners Association (LLPOA) and the Lake Lansing Advisory Committee participated in several educational efforts in 2015.

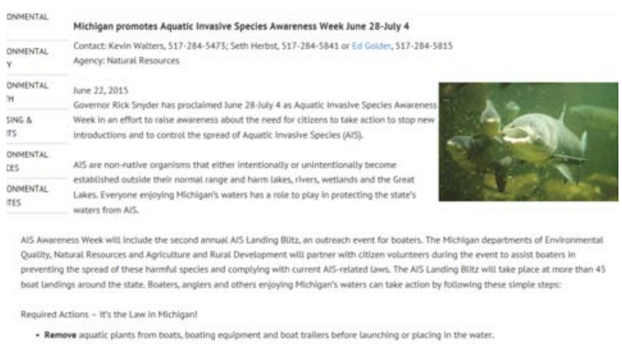
April 25: LLPOA members participated in a township-wide spring clean-up day that included trash pickup on the shoulders of Lake Drive.

June 9: LLPOA annual meeting at the Lake Lansing South Park pavilion. Information was presented to lake residents on invasive species, nuisance aquatic plant control, and watershed management (Figure 13).

Figure 13. LLPOA annual meeting.

June 28 and 29: Landing Blitz. LLPOA members participated in the second annual aquatic invasive species “Landing Blitz” coordinated by the Michigan Departments of Environmental Quality (MDEQ), Natural Resources (MDNR), and Agriculture and Rural Development (MDARD) . The Landing Blitz is a collaborative outreach campaign to raise awareness about preventing the spread of aquatic invasive species (AIS) through recreational boating and related activities. Volunteer partners delivered consistent messaging about preventing the introduction and spread of AIS from the movement of watercraft and equipment between water bodies at both public and private boating access sites throughout the state (Figures 14 and 15).

Figure 14. Public access site boat washing.



Michigan promotes Aquatic Invasive Species Awareness Week June 28-July 4

Contact: Kevin Walters, 517-284-5473; Seth Herbst, 517-284-5841 or Ed Golder, 517-284-5815
Agency: Natural Resources

June 22, 2015
Governor Rick Snyder has proclaimed June 28-July 4 as Aquatic Invasive Species Awareness Week in an effort to raise awareness about the need for citizens to take action to stop new introductions and to control the spread of Aquatic Invasive Species (AIS).

AIS are non-native organisms that either intentionally or unintentionally become established outside their normal range and harm lakes, rivers, wetlands and the Great Lakes. Everyone enjoying Michigan's waters has a role to play in protecting the state's waters from AIS.

AIS Awareness Week will include the second annual AIS Landing Blitz, an outreach event for boaters. The Michigan departments of Environmental Quality, Natural Resources and Agriculture and Rural Development will partner with citizen volunteers during the event to assist boaters in preventing the spread of these harmful species and complying with current AIS-related laws. The AIS Landing Blitz will take place at more than 45 boat landings around the state. Boaters, anglers and others enjoying Michigan's waters can take action by following these simple steps:

Required Actions – It's the Law in Michigan!

- **Remove** aquatic plants from boats, boating equipment and boat trailers before launching or placing in the water.
- **Drain** live wells, bilges and all water from boats before leaving the access site.

Figure 15. Landing Blitz press release.

Lake Mapping

During 2015, Progressive AE conducted two hydro-acoustic surveys of Lake Lansing to re-map water depth (Figure 16) and to map aquatic vegetation bio-volume (Figure 17).

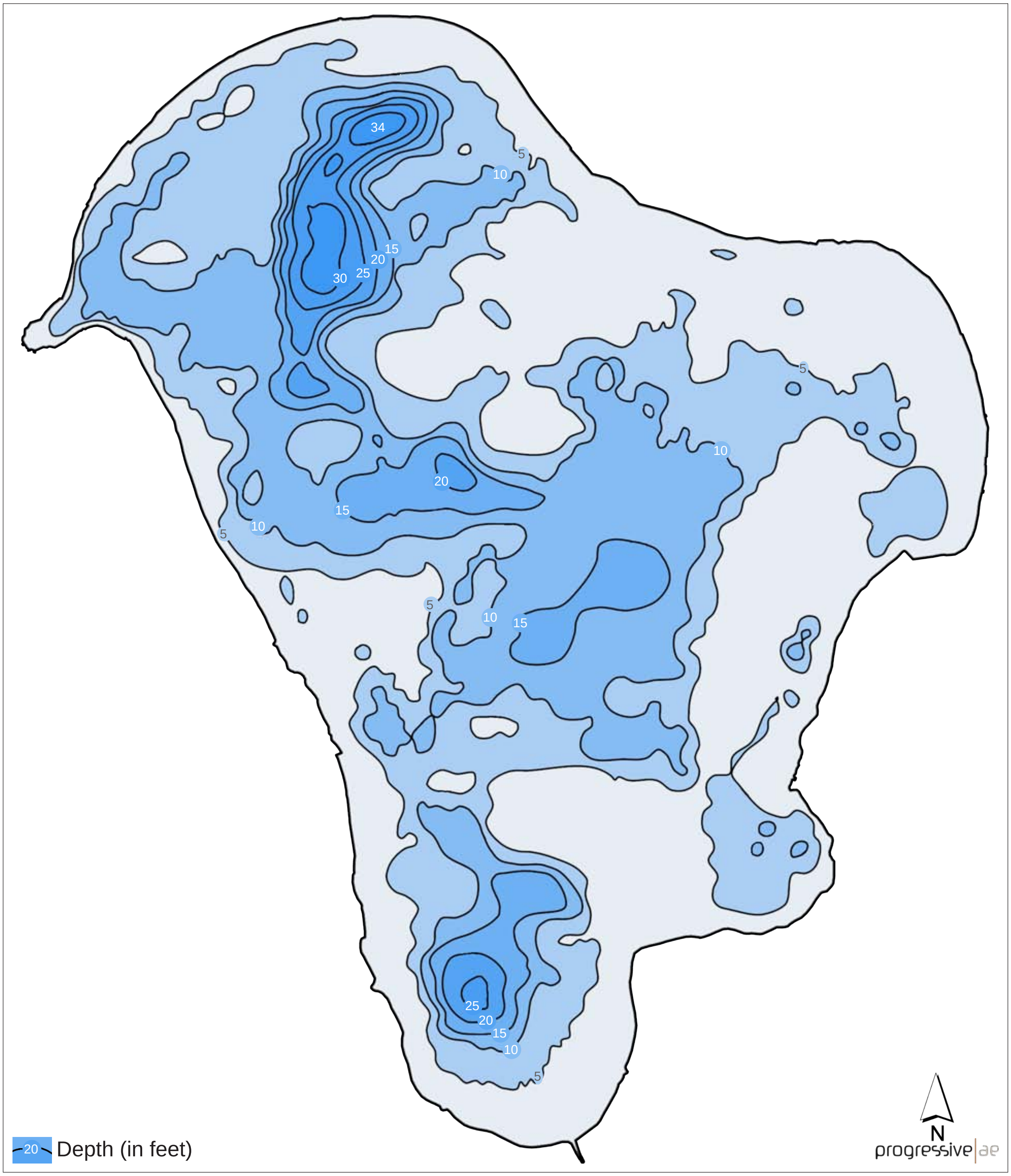


Figure 16. Lake Lansing depth contour map. Hydro-acoustic depth data collected on April 16 and 17, 2015 and processed by Navico, Inc. Lake elevation during hydro-acoustic survey: 851.92. Lake shoreline digitized from 2012 aerial orthodigital photography (Source: Microsoft).

Bio-volume is a measure of the height of plants in the water column. A bio-volume measurement of 50% indicates plants occupy one-half of the water column. The vegetation bio-volume map confirms that the majority of the Lake Lansing bottomlands are inhabitable by aquatic plants. The new depth and vegetation maps will be used to improve accuracy and efficiency of aquatic vegetation surveys.

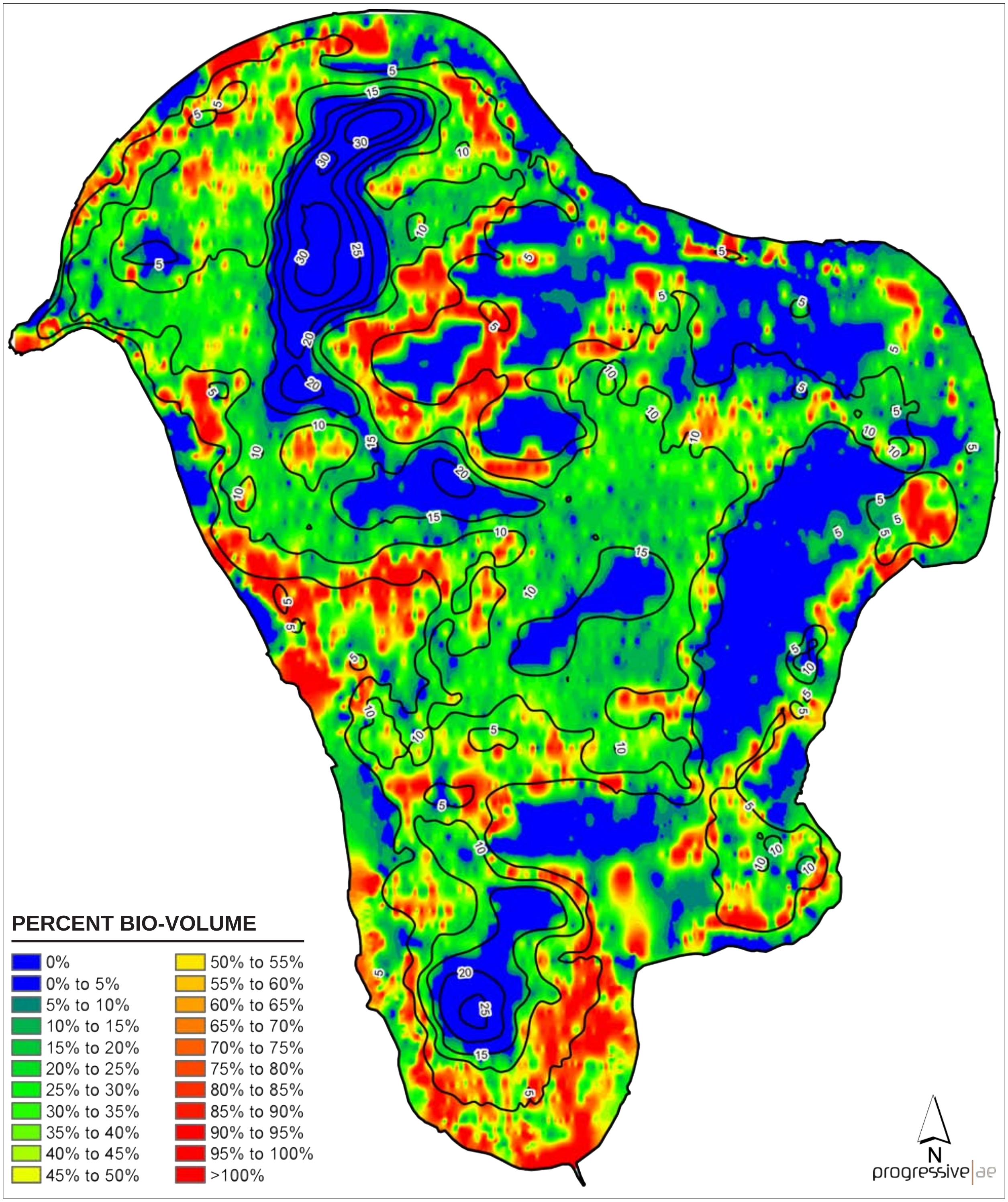


Figure 17. Lake Lansing aquatic vegetation bio-volume map. Hydro-acoustic depth data collected in September of 2015. Hydro-acoustic data processed by Navico, Inc. Lake shoreline digitized from aerial orthodigital photography (Source: USDA FSA 2014).

Appendix A
Lake Lansing
Historical Water Quality Data

TABLE A1
LAKE LANSING
1999-2013 DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)[1]	Total Phosphorus (µg/L)[2]	pH (S.U.)[3]	Total Alkalinity (mg/L $CaCO_3$)[4]
29-Mar-99	1	1	44	12.9	20	8.4	124
29-Mar-99	1	5	44	11.9			
29-Mar-99	1	10	44	11.6			
29-Mar-99	1	15	45	12.9	20	8.3	122
29-Mar-99	1	20	45	13.4			
29-Mar-99	1	25	45	12.5			
29-Mar-99	1	30	45	13.8	22	8.3	127
29-Mar-99	2	1	45	12.2	22	8.2	127
29-Mar-99	2	6	45	13.4			
29-Mar-99	2	12	45	12.6	23	8.4	128
29-Mar-99	2	18	45	12.6			
29-Mar-99	2	23	45	12.3	23	8.2	126
29-Mar-99	3	1	44	12.6	25	7.9	130
29-Mar-99	4	1	45	12.7	27	8.4	126
11-Aug-99	1	1	73	8.0	14	8.3	114
11-Aug-99	1	5	73	8.0			
11-Aug-99	1	10	73	7.3			
11-Aug-99	1	15	72	7.4	20	8.4	116
11-Aug-99	1	20	71	6.6			
11-Aug-99	1	25	60	1.3			
11-Aug-99	1	30	58	0.8	56	7.2	172
11-Aug-99	2	1	73	8.2	17	8.4	104
11-Aug-99	2	6	73	8.4			
11-Aug-99	2	12	72	7.0	20	8.3	115
11-Aug-99	2	18	69	2.4			
11-Aug-99	2	23	57	1.1	40	7.5	130
11-Aug-99	3	1	73	8.0	22	8.5	115
11-Aug-99	4	1	74	8.1	18	8.4	118

1 mg/L = milligrams per liter = parts per million.
2 µg/L = micrograms per liter = parts per billion.
3 S.U. = standard units.
4 mg/L $CaCO_3$ = milligrams per liter as calcium carbonate.

TABLE A1 (continued)
LAKE LANSING
1999-2013 DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)[1]	Total Phosphorus (µg/L)[2]	pH (S.U.)[3]	Total Alkalinity (mg/L $CaCO_3$)[4]
17-Apr-00	1	1	50	10.9	14	8.7	132
17-Apr-00	1	5	50	10.8	24		
17-Apr-00	1	10	50	10.9	28		
17-Apr-00	1	15	50	10.8	27	8.4	133
17-Apr-00	1	20	50	10.8	19		
17-Apr-00	1	25	50	10.7	19		
17-Apr-00	1	30	50	10.8	13	8.4	130
17-Apr-00	2	1	51	10.7	11	8.4	119
17-Apr-00	2	6	51	10.6	15		
17-Apr-00	2	12	51	10.4	29	8.4	131
17-Apr-00	2	18	51	10.3	13		
17-Apr-00	2	23	51	10.6	11	8.5	127
10-Aug-00	1	1	76	7.9	25	8.8	132
10-Aug-00	1	5	76	7.7	27		
10-Aug-00	1	10	76	7.9	20		
10-Aug-00	1	15	75	7.5	20	7.9	110
10-Aug-00	1	20	72	3.5	35		
10-Aug-00	1	25	62	0.4	184		
10-Aug-00	1	30	58	0.5	71	7.6	160
10-Aug-00	2	1	76	8.4	20	8.8	143
10-Aug-00	2	6	76	8.3	20		
10-Aug-00	2	12	74	6.2	27	8.6	128
10-Aug-00	2	18	67	0.9	232		
10-Aug-00	2	24	57	1.2	93	7.6	169
7-Apr-03	1	1	41	12.2	16		
7-Apr-03	1	14	40	12.4			
7-Apr-03	1	28	41	11.8	23		
7-Apr-03	2	1	40	11.8	23		
7-Apr-03	2	9	40	11.7	28		
7-Apr-03	2	18	40	11.7	34		

1 mg/L = milligrams per liter = parts per million.
2 µg/L = micrograms per liter = parts per billion.
3 S.U. = standard units.
4 mg/L $CaCO_3$ = milligrams per liter as calcium carbonate.

TABLE A1 (continued)
LAKE LANSING
1999-2013 DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)[1]	Total Phosphorus (µg/L)[2]	pH (S.U.)[3]	Total Alkalinity (mg/L $CaCO_3$)[4]
11-Sep-03	1	1	75	8.1	28		
11-Sep-03	1	13	71	6.7	36		
11-Sep-03	1	25	64	0.0	198		
11-Sep-03	2	1	74	8.5	18		
11-Sep-03	2	11	71	8.1	41		
11-Sep-03	2	21	65	0.0	79		
12-Apr-04	1	1	47	11.9	26	8.6	123
12-Apr-04	1	15	47	11.8	32	8.6	121
12-Apr-04	1	30	47	11.6	31	8.7	122
12-Apr-04	2	1	47	12.1	17	8.7	125
12-Apr-04	2	11	47	12.1	17	8.7	120
12-Apr-04	2	22	46	11.5	27	8.6	125
30-Aug-04	1	1	73	7.3	11		
30-Aug-04	1	15	73	7.1	12		
30-Aug-04	1	30	59	1.2	39		
30-Aug-04	2	1	72	7.3	116		
30-Aug-04	2	10	72	7.3	127		
30-Aug-04	2	21	62	0.5	9		
5-Apr-05	1	1	47	10.8	71		149
5-Apr-05	1	14	46	10.4	44		149
5-Apr-05	1	28	44	10.8	37		151
5-Apr-05	2	1	47	11.0	44		137
5-Apr-05	2	11	47	10.6	44		151
5-Apr-05	2	22	44	10.6	123		154

1 mg/L = milligrams per liter = parts per million.
2 µg/L = micrograms per liter = parts per billion.
3 S.U. = standard units.
4 mg/L $CaCO_3$ = milligrams per liter as calcium carbonate.

TABLE A1 (continued)
LAKE LANSING
1999-2013 DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)[1]	Total Phosphorus (µg/L)[2]	pH (S.U.)[3]	Total Alkalinity (mg/L $CaCO_3$)[4]
26-Aug-05	1	1	75	8.5	30	9.3	106
26-Aug-05	1	14	72	7.0	30	8.8	118
26-Aug-05	1	28	57	2.3	53	8.1	169
26-Aug-05	2	1	75	9.6	30	9.4	105
26-Aug-05	2	12	72	7.1	29	9.3	126
26-Aug-05	2	23	61	0.3	29	8.9	134
3-Apr-06	1	1	46	11.4	15	8.1	125
3-Apr-06	1	15	46	8.6	12	8.2	121
3-Apr-06	1	29	45	9.3	38	8.1	125
3-Apr-06	2	1	47	9.9	22	8.2	123
3-Apr-06	2	11	46	9.8	19	8.1	125
3-Apr-06	2	22	46	10.6	22	8.4	123
11-Aug-06	1	1	75	7.0	12	8.8	108
11-Aug-06	1	15	74	5.6	23	8.6	113
11-Aug-06	1	30	64	1.7	17	7.9	130
11-Aug-06	2	1	75	7.5	11	8.8	106
11-Aug-06	2	12	72	6.8	21	8.7	104
11-Aug-06	2	24	65	1.1	47	7.8	130

1 mg/L = milligrams per liter = parts per million.
2 µg/L = micrograms per liter = parts per billion.
3 S.U. = standard units.
4 mg/L $CaCO_3$ = milligrams per liter as calcium carbonate.

TABLE A1 (continued)
LAKE LANSING
1999-2013 DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)[1]	Total Phosphorus (µg/L)[2]	pH (S.U.)[3]	Total Alkalinity (mg/L $CaCO_3$)[4]
16-Apr-07	1	1	42	12.9	73	8.1	128
16-Apr-07	1	15	43	12.6	60	7.9	128
16-Apr-07	1	30	42	10.5	67	8.0	125
16-Apr-07	2	1	43	10.9	63	8.0	128
16-Apr-07	2	11	43	11.1	73	7.9	130
16-Apr-07	2	22	43	12.0	64	7.9	127
30-Aug-07	1	1	77	8.8	19	9.1	127
30-Aug-07	1	14	74	6.7	23	8.7	128
30-Aug-07	1	28	58	0.5	35	8.1	148
30-Aug-07	2	1	77	8.4	37	9.0	124
30-Aug-07	2	12	76	8.2	31	8.9	121
30-Aug-07	2	23	60	0.2	39	7.9	142
7-Apr-08	1	1	50	11.0	28	8.4	139
7-Apr-08	1	15	49	11.2	30	8.3	135
7-Apr-08	1	30	48	11.5	19	8.3	137
7-Apr-08	2	1	48	11.4	20	8.3	135
7-Apr-08	2	12	48	11.3	23	8.3	138
7-Apr-08	2	24	46	11.5	23	8.2	135
14-Oct-08	1	1	63	9.4	<5	9.2	112
14-Oct-08	1	15	60	9.3	<5	9.2	113
14-Oct-08	1	30	58	7.0	<5	8.8	116
14-Oct-08	2	1	62	9.3	<5	9.2	111
14-Oct-08	2	12	61	9.6	<5	9.2	109
14-Oct-08	2	24	59	8.5	<5	9.0	108

1 mg/L = milligrams per liter = parts per million.
2 µg/L = micrograms per liter = parts per billion.
3 S.U. = standard units.
4 mg/L $CaCO_3$ = milligrams per liter as calcium carbonate.

TABLE A1 (continued)
LAKE LANSING
1999-2013 DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)[1]	Total Phosphorus (µg/L)[2]	pH (S.U.)[3]	Total Alkalinity (mg/L $CaCO_3$)[4]
14-Apr-09	1	1	46	11.3	29	9.3	123
14-Apr-09	1	16	46	11.3	6	9.3	123
14-Apr-09	1	32	46	9.4	<5	9.3	123
14-Apr-09	2	1	47	11.5	<5	9.3	124
14-Apr-09	2	13	47	11.5	<5	9.3	123
14-Apr-09	2	26	47	11.4	14	9.3	125
26-Aug-09	1	1	74	8.1	20	8.6	115
26-Aug-09	1	16	74	8.3	20	8.5	112
26-Aug-09	1	32	73	1.6	208	7.7	115
26-Aug-09	2	1	74	7.8	274	8.4	106
26-Aug-09	2	10	74	8.0	6	8.5	113
26-Aug-09	2	20	71	2.5	16	8.1	119
30-Mar-10	1	1	46	10.6	6	8.1	127
30-Mar-10	1	15	44	11.0	14	7.8	129
30-Mar-10	1	30	44	10.8	6	7.5	128
30-Mar-10	2	1	45	11.2	12	7.9	128
30-Mar-10	2	12	44	10.3	11	7.9	130
30-Mar-10	2	24	43	10.7	6	7.9	129
31-Aug-10	1	1	78	8.6	<5	8.2	125
31-Aug-10	1	15	75	7.3	<5	8.3	125
31-Aug-10	1	30	58	1.1	327	7.3	160
31-Aug-10	2	1	77	9.4	<5	8.2	120
31-Aug-10	2	12	74	8.4	<5	8.3	124
31-Aug-10	2	24	59	0.5	26	6.9	176

1 mg/L = milligrams per liter = parts per million.
2 µg/L = micrograms per liter = parts per billion.
3 S.U. = standard units.
4 mg/L $CaCO_3$ = milligrams per liter as calcium carbonate.

TABLE A1 (continued)
LAKE LANSING
1999-2013 DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)[1]	Total Phosphorus (µg/L)[2]	pH (S.U.)[3]	Total Alkalinity (mg/L $CaCO_3$)[4]
13-Apr-11	1	1	52	11.3	15	8.6	112
13-Apr-11	1	15	51	11.0	7	8.6	113
13-Apr-11	1	30	51	11.0	20	8.6	118
13-Apr-11	2	1	51	10.8	17	8.5	117
13-Apr-11	2	13	51	10.7	<5	8.5	116
13-Apr-11	2	26	50	11.0	8	8.5	119
22-Aug-11	1	1	76	7.9	9	8.7	97
22-Aug-11	1	15	76	6.9	<5	8.5	107
22-Aug-11	1	30	59	4.8	40	8.1	112
22-Aug-11	2	1	76	7.8	13	8.6	99
22-Aug-11	2	11	75	7.8	8	8.2	106
22-Aug-11	2	22	61	4.1	32	8.0	97
19-Mar-12	1	1	59	10.4	10	8.5	108
19-Mar-12	1	15	49	12.3	8	8.6	113
19-Mar-12	1	30	46	10.3	<5	8.4	119
19-Mar-12	2	1	57	11.6	<5	8.6	105
19-Mar-12	2	11	49	12.3	<5	8.6	114
19-Mar-12	2	22	45	11.6	<5	8.5	105
16-Aug-12	1	1	74	8.8	12	9.0	115
16-Aug-12	1	15	72	6.0	13	8.5	118
16-Aug-12	1	30	56	0.3	364	7.7	146
16-Aug-12	2	1	75	8.8	6	9.0	115
16-Aug-12	2	11	72	6.0	9	8.5	117
16-Aug-12	2	22	67	2.1	73	7.9	122

1 mg/L = milligrams per liter = parts per million.
2 µg/L = micrograms per liter = parts per billion.
3 S.U. = standard units.
4 mg/L $CaCO_3$ = milligrams per liter as calcium carbonate.

TABLE A1 (continued)
LAKE LANSING
1999-2013 DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)[1]	Total Phosphorus (µg/L)[2]	pH (S.U.)[3]	Total Alkalinity (mg/L $CaCO_3$)[4]
22-Apr-13	1	1	48	11.1	<5	8.0	113
22-Apr-13	1	15	47	9.5	<5	8.0	114
22-Apr-13	1	30	47	11.0	<5	7.9	112
22-Apr-13	2	1	48	11.6	<5	8.0	114
22-Apr-13	2	12	47	11.5	<5	8.0	118
22-Apr-13	2	24	46	10.5	<5	7.9	109
13-Aug-13	1	1	73	8.0	8	8.9	115
13-Aug-13	1	15	73	7.6	<5	9.0	113
13-Aug-13	1	30	54	3.7	90	8.3	131
13-Aug-13	2	1	72	7.8	23	9.1	114
13-Aug-13	2	10	73	7.7	30	9.0	114
13-Aug-13	2	20	58	2.8	68	8.2	134
1-May-14	1	1	55	10.7	12	8.5	123
1-May-14	1	15	55	9.9	<5	8.5	125
1-May-14	1	30	54	11.3	<5	8.5	131
1-May-14	2	1	54	10.8	<5	8.9	130
1-May-14	2	12	54	9.9	<5	8.7	128
1-May-14	2	24	53	11.7	<5	8.6	128
14-Aug-14	1	1	74	8.1	21	8.8	103
14-Aug-14	1	15	74	8.4	16	8.8	102
14-Aug-14	1	30	58	0.6	173	7.8	147
14-Aug-14	2	1	74	8.2	15	8.7	91
14-Aug-14	2	12	74	8.3	18	8.7	102
14-Aug-14	2	24	58	0.0	331	7.5	157

1 mg/L = milligrams per liter = parts per million.
2 µg/L = micrograms per liter = parts per billion.
3 S.U. = standard units.
4 mg/L $CaCO_3$ = milligrams per liter as calcium carbonate.

TABLE A2
LAKE LANSING
1999-2014 SURFACE WATER QUALITY DATA

Date	Station	Secchi Transparency (feet)	Chlorophyll-*a* (μg/L)[1]
29-Mar-99	1	9.0	3.8
29-Mar-99	2	7.5	1.8
29-Mar-99	3	5.0	2.8
29-Mar-99	4	5.0	
11-Aug-99	1	7.0	3.8
11-Aug-99	2	6.5	0.8
11-Aug-99	3	7.0	1.1
11-Aug-99	4	6.0	1.3
17-Apr-00	1	13.5	1.1
17-Apr-00	2	10.5	0.5
10-Aug-00	1	8.5	2.9
10-Aug-00	2	7.0	6.5
07-Apr-03	1	13.5	1.1
07-Apr-03	2	12.0	0
11-Sept-03	1	7.0	0.5
11-Sept-03	2	7.5	0
12-Apr-04	1	8.0	1
12-Apr-04	2	7.5	2
30-Aug-04	1	4.5	1
30-Aug-04	2	5.0	0
5-Apr-05	1	8.0	1
5-Apr-05	2	7.0	0
26-Aug-05	1	4.3	2
26-Aug-05	2	4.5	1

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

TABLE A2 (continued)
LAKE LANSING
1999-2014 SURFACE WATER QUALITY DATA

Date	Station	Secchi Transparency (feet)	Chlorophyll-*a* (µg/L)[1]
3-Apr-06	1	5.5	0
3-Apr-06	2	5.0	0
11-Aug-06	1	6.0	1
11-Aug-06	2	7.0	1
10-Apr-07	1	10.0	0
10-Apr-07	2	9.5	9
30-Aug-07	1	6.5	1
30-Aug-07	2	7.5	0
7-Apr-08	1	6.0	1
7-Apr-08	2	7.0	2
14-Oct-08	1	12.5	0
14-Oct-08	2	13.5	0
14-Apr-09	1	13.0	0
14-Apr-09	2	18.0	0
26-Aug-09	1	12.0	1
26-Aug-09	2	13.0	0
30-Mar-10	1	19.5	1
30-Mar-10	2	19.0	0
31-Aug-10	1	7.0	2
31-Aug-10	2	7.0	1
13-Apr-11	1	13.5	3
13-Apr-11	2	16.0	2
22-Aug-11	1	14.0	0
22-Aug-11	2	14.0	3
19-Mar-12	1	11.0	1
19-Mar-12	2	11.5	2
16-Aug-12	1	6.0	0
16-Aug-12	2	6.0	1

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

TABLE A2 (continued)
LAKE LANSING
1999-2014 SURFACE WATER QUALITY DATA

Date	Station	Secchi Transparency (feet)	Chlorophyll-*a* (µg/L)[1]
22-Apr-13	1	9.5	0
22-Apr-13	2	9.5	0
13-Aug-13	1	8.5	0
13-Aug-13	2	7.0	1
1-May-14	1	10.0	2
1-May-14	2	9.0	2
14-Aug-14	1	12.0	1
14-Aug-14	2	12.0	2

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

TABLE A3
LAKE LANSING
1999-2014 STORM DRAIN MONITORING DATA

Date	Number	Name	Discharge (cfs)[1]	Total Phosphorus (μg/L)[2]	*E. coli* per 100 mL[3]
22-Apr-99	1	Barnhart		51	120
22-Apr-99	2	Milliman			40
22-Apr-99	3	Wallace		71	280
22-Apr-99	5	South End			460
22-Apr-99	7	Condos		100	60
22-Apr-99	7b	Condos Upstream			10
22-Apr-99	8	Perry Road			320
22-Apr-99	9	Carlton		43	80
22-Apr-99	14	Mack Street		190	34,000
12-Apr-00	1	Barnhart	0.1		4
12-Apr-00	2	Milliman	1.1		12
12-Apr-00	3	Wallace	0.03		4
12-Apr-00	8	Perry Road	0		3
12-Apr-00	9	Carlton	0		2
12-Apr-00	11	New Condos	0		19
23-Apr-00	1	Barnhart		65	
23-Apr-00	2	Milliman		41	60
23-Apr-00	3	Wallace		23	40
23-Apr-00	5	South End		53	50
23-Apr-00	8	Perry Road		44	110
23-Apr-00	9	Carlton		16	60
23-Apr-00	11	New Condos			10
10-Apr-03	1	Barnhart	0	249	25
10-Apr-03	2	Milliman	1.2	92	20
10-Apr-03	3	Wallace	2.2	50	21
10-Apr-03	5	South End	0	77	9
10-Apr-03	8	Perry Road	0.04	71	91

1 cfs = cubic feet per second.
2 μg/L = micrograms per liter = parts per billion.
3 mL = milliliters.

TABLE A3 (continued)
LAKE LANSING
1999-2014 STORM DRAIN MONITORING DATA

Date	Number	Name	Discharge (cfs)[1]	Total Phosphorus (µg/L)[2]	*E. coli* per 100 mL[3]
12-Apr-04	1	Barnhart	0.2	36	14
12-Apr-04	2	Milliman	0.4	34	23
12-Apr-04	3	Wallace	0.2	53	<1
12-Apr-04	5	South End	0	44	<1
12-Apr-04	8	Perry Road	0	165	<1
11-May-04	1	Barnhart	4.8	131	249
11-May-04	2	Milliman	1.3	109	157
11-May-04	3	Wallace	0.8	203	816
11-May-04	5	South End	0.7	161	99
11-May-04	8	Perry Road	0.4	195	2,420
29-Jun-04	1	Barnhart	0.9	164	15
29-Jun-04	2	Milliman	0		
29-Jun-04	3	Wallace	0.1	29	62
29-Jun-04	5	South End	0		
29-Jun-04	8	Perry Road	0		
5-Apr-05	1	Barnhart	1.4	141	<1
5-Apr-05	2	Milliman	1.2	62	27
5-Apr-05	3	Wallace	1.2	55	16
5-Apr-05	5	South End	0.5	214	14
5-Apr-05	7	Condos	0		
5-Apr-05	8	Perry Road	0		
5-Apr-05	14	Mack Avenue	0		

1 cfs = cubic feet per second.
2 µg/L = micrograms per liter = parts per billion.
3 mL = milliliters.

TABLE A3 (continued)
LAKE LANSING
1999-2014 STORM DRAIN MONITORING DATA

Date	Number	Name	Discharge (cfs)[1]	Total Phosphorus (µg/L)[2]	*E. coli* per 100 mL[3]
27-Apr-05	1	Barnhart	0.5	58	17
27-Apr-05	2	Milliman	2.3	39	98
27-Apr-05	3	Wallace	0.7	45	29
27-Apr-05	5	South End	0	45	91
27-Apr-05	7	Condos	0		
27-Apr-05	8	Perry Road	0	78	17
28-Mar-06	1	Barnhart	1.8	24	40
28-Mar-06	2	Milliman	0.9	19	11
28-Mar-06	3	Wallace	0.2	19	4
28-Mar-06	5	South End	0	35	1
28-Mar-06	8	Perry Road	0	48	99
3-Apr-06	1	Barnhart	0.5	33	54
3-Apr-06	2	Milliman	1.0	31	3
3-Apr-06	3	Wallace	0.2	21	41
3-Apr-06	5	South End	0	48	
3-Apr-06	8	Perry Road	0	79	
27-Apr-06	1	Barnhart	0.1	51	82
27-Apr-06	2	Milliman	0.1	63	24
27-Apr-06	3	Wallace	0.1	13	199
27-Apr-06	5	South End	0	86	1
27-Apr-06	8	Perry Road	0	27	26
12-Sep-06	1	Barnhart	0		
12-Sep-06	2	Milliman	0		
12-Sep-06	3	Wallace	0		
12-Sep-06	5	South End	0	21	34
12-Sep-06	8	Perry Road	0	336	525

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TABLE A3 (continued)
LAKE LANSING
1999-2014 STORM DRAIN MONITORING DATA

Date	Number	Name	Discharge (cfs)[1]	Total Phosphorus (µg/L)[2]	*E. coli* per 100 mL[3]
26-Mar-07	1	Barnhart	1.4	61	7
26-Mar-07	2	Milliman	2.6	80	12
26-Mar-07	3	Wallace	1.6	56	10
26-Mar-07	5	South End	0.9	77	21
26-Mar-07	8	Perry Road	0	99	866
10-Apr-07	1	Barnhart	1.2	62	1
10-Apr-07	2	Milliman	0.7	75	4
10-Apr-07	3	Wallace	0.4	61	8
10-Apr-07	5	South End	0	115	11
10-Apr-07	8	Perry Road	0	80	16
16-Apr-07	1	Barnhart		85	
16-Apr-07	2	Milliman		63	
16-Apr-07	3	Wallace		62	
16-Apr-07	5	South End	0	87	
16-Apr-07	8	Perry Road	0	87	
30-Aug-07	1	Barnhart	0		
30-Aug-07	2	Milliman	0		
30-Aug-07	3	Wallace	0		
30-Aug-07	5	South End	0	281	42
30-Aug-07	8	Perry Road	0	178	249

1 cfs = cubic feet per second.
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TABLE A3 (continued)
LAKE LANSING
1999-2014 STORM DRAIN MONITORING DATA

Date	Number	Name	Discharge (cfs)[1]	Total Phosphorus (µg/L)[2]	*E. coli* per 100 mL[3]
7-Apr-08	1	Barnhart	0.6	62	6
7-Apr-08	2	Milliman	0.8	37	11
7-Apr-08	3	Wallace	1.4	23	26
7-Apr-08	5	South End	0	37	11
7-Apr-08	8	Perry Road	0	59	33
14-Apr-08	1	Barnhart		14	22
14-Apr-08	2	Milliman	1.4	16	15
14-Apr-08	3	Wallace	2.4	5	23
14-Apr-08	5	South End		16	6
14-Apr-08	8	Perry Road	0	23	16
12-May-08	1	Barnhart	0.7	61	26
12-May-08	2	Milliman	0.8	46	326
12-May-08	3	Wallace	0.3	6	205
12-May-08	5	South End	0	110	53
12-May-08	8	Perry Road	0	69	147
12-May-08	18	Marshall Upstream	0	67	461
12-May-08	19	Marshall Downstream	0		
14-Oct-08	1	Barnhart	0.1	123	33
14-Oct-08	2	Milliman	0	276	108
14-Oct-08	3	Wallace	0	83	12
14-Oct-08	5	South End	0	526	91
14-Oct-08	8	Perry Road	0	134	194
14-Oct-08	18	Marshall Upstream	0	276	206
14-Oct-08	19	Marshall Downstream	0	5	37

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TABLE A3 (continued)
LAKE LANSING
1999-2014 STORM DRAIN MONITORING DATA

Date	Number	Name	Discharge (cfs)[1]	Total Phosphorus (µg/L)[2]	*E. coli* per 100 mL[3]
14-Apr-09	1	Barnhart	0.2	<5	16
14-Apr-09	2	Milliman	0.4	5	10
14-Apr-09	3	Wallace	0.4	<5	50
14-Apr-09	5	South End	0.2	14	1
14-Apr-09	8	Perry Road	0	25	41
14-Apr-09	14	Mack Avenue	0	146	81
14-Apr-09	18	Marshall Upstream	0	111	345
14-Apr-09	19	Marshall Downstream	0	76	28
20-Aug-09	1	Barnhart		37	290.9
20-Aug-09	2	Milliman		349	
20-Aug-09	3	Wallace		38	
20-Aug-09	5	South End		137	
20-Aug-09	8	Perry Road		27	78.5
20-Aug-09	18	Marshall Upstream		94	2419.2
20-Aug-09	19	Marshall Downstream		<5	
23-Oct-09	20	Meadowbrook Sub Ashbrook Dr		<5	
23-Oct-09	21	Perry Road between county line and Ashbrook Dr		374	

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TABLE A3 (continued)
LAKE LANSING
1999-2014 STORM DRAIN MONITORING DATA

Date	Site	Name	Discharge (cfs)[1]	Total Phos. (µg/L)[2]	Total Solids (mg/L)[3]	Total Susp. Solids (mg/L)
30-Mar-10	1	Barnhart		27	392	<4
30-Mar-10	2	Milliman	0.5	21	336	<4
30-Mar-10	3	Wallace	0.6	9	316	<4
30-Mar-10	5	South End	0	32	360	<4
30-Mar-10	8	Perry Road	0	33	452	14
6-Apr-10	20	Meadowbrook Sub.		98		
7-Apr-10	20	Meadowbrook Sub.		37	228	7.27
7-Apr-10	21	Perry Road between county line and Ashbrook		54		
16-Sep-10	20	Meadowbrook Sub.		583		24
22-Sep-10	20	Meadowbrook Sub.		162		10
22-Sep-10	22	Perry Road Buried Manhole #107		218		20
13-Apr-11	1	Barnhart	1.6	67		
13-Apr-11	2	Milliman	0.6	26		
13-Apr-11	3	Wallace	0.6	33		
13-Apr-11	5	South End	0	92		
13-Apr-11	8	Perry Road	0	30		
22-Aug-11	1	Barnhart	0	9980		
22-Aug-11	2	Milliman	0	166		
22-Aug-11	3	Wallace	0			
22-Aug-11	5	South End	0	1260		
22-Aug-11	8	Perry Road	0	38		
22-Aug-11	18	Marshall Upstream				
22-Aug-11	19	Marshall Downstream				

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3 mg/L = milligrams per liter.

TABLE A3 (continued)
LAKE LANSING
1999-2014 STORM DRAIN MONITORING DATA

Date	Site	Name	Discharge (cfs)[1]	Total Phos. (μg/L)[2]	Total Solids (mg/L)[3]	Total Susp. Solids (mg/L)
19-Mar-12	1	Barnhart	0.4	100	836	28
19-Mar-12	2	Milliman	1.6	25	192	<4
19-Mar-12	3	Wallace	0.2	20	524	<4
19-Mar-12	5	South End	0	56	488	5
19-Mar-12	8	Perry Road	0	56	580	6
19-Mar-12	18	Marshall Upstream	0			
19-Mar-12	19	Marshall Downstream	0			
16-Aug-12	1	Barnhart	0			
16-Aug-12	2	Milliman	0			
16-Aug-12	3	Wallace	0			
16-Aug-12	5	South End	0			
16-Aug-12	8	Perry Road	0			
16-Aug-12	18	Marshall Upstream	0			
16-Aug-12	19	Marshall Downstream	0			
18-Apr-13	1	Barnhart	1.4	69	204	<4
18-Apr-13	2	Milliman	2	52	196	5
18-Apr-13	3	Wallace	1.9	32	208	<4
18-Apr-13	5	South End	1.9	57	180	<4
18-Apr-13	8	Perry Road	0.5	96	480	31
18-Apr-13	18	Marshall Upstream	0.03	178	292	13
18-Apr-13	19	Marshall Downstream	0	69	380	8

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3 mg/L = milligrams per liter.

TABLE A3 (continued)
LAKE LANSING
1999-2014 STORM DRAIN MONITORING DATA

Date	Site	Name	Discharge (cfs)[1]	Total Phos. (µg/L)[2]	Total Solids (mg/L)[3]	Total Susp. Solids (mg/L)
1-May-14	1	Barnhart	0.2	69	300	<4
1-May-14	2	Milliman	0.3	45	312	7
1-May-14	3	Wallace	0.7	24	344	<4
1-May-14	5	South End	0	85	452	8.8
1-May-14	8	Perry Road	0	113	860	12.8
1-May-14	18	Marshall Upstream	0	37	520	14.4

1 cfs = cubic feet per second.
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3 mg/L = milligrams per liter.

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