

# **Lake Macatawa Water Quality Dashboard**

## **2017**

Prepared: February 2018

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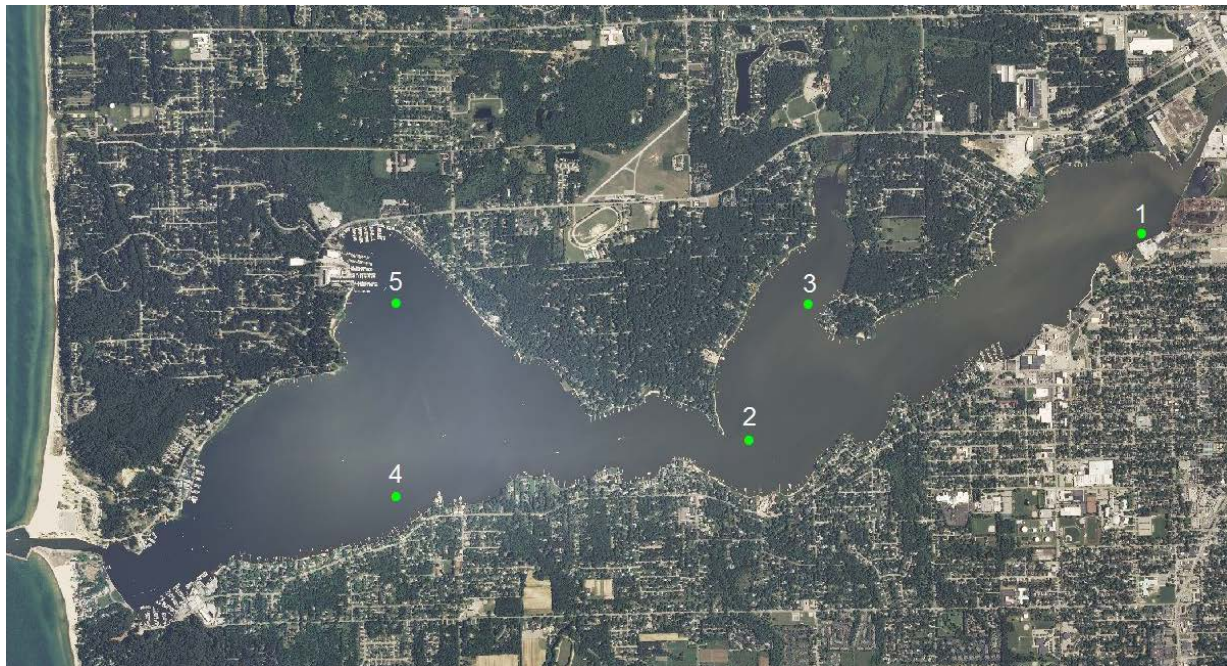


## Introduction

As part of Project Clarity, Grand Valley State University's Annis Water Resources Institute (AWRI) established a monitoring program on Lake Macatawa in 2013. The goal of the monitoring program is to evaluate and document the progress toward achieving Project Clarity's goal of improved water quality in Lake Macatawa. The monitoring program involves sampling the lake 3 times per year for a suite of biological, physical, and chemical parameters.

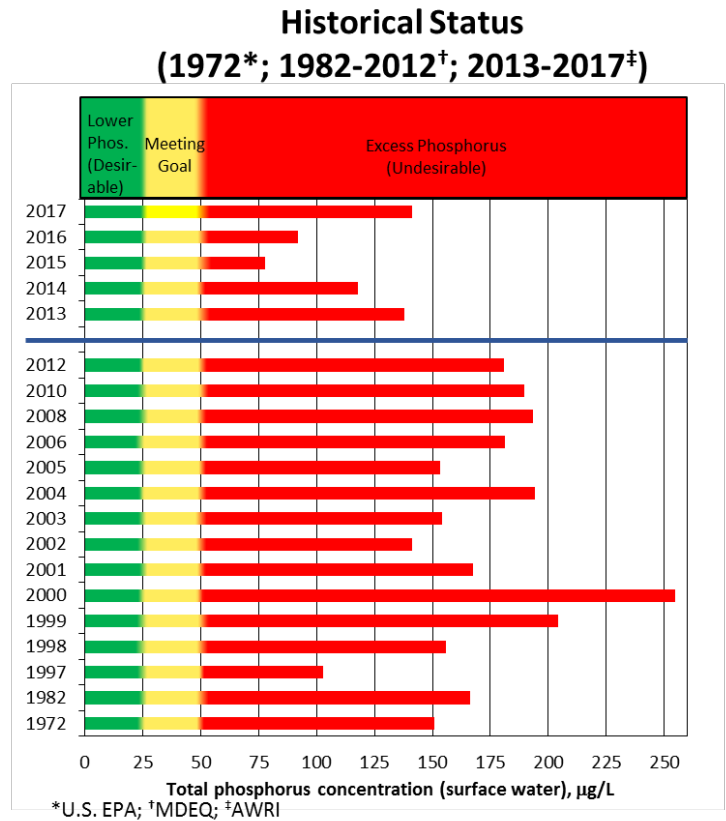
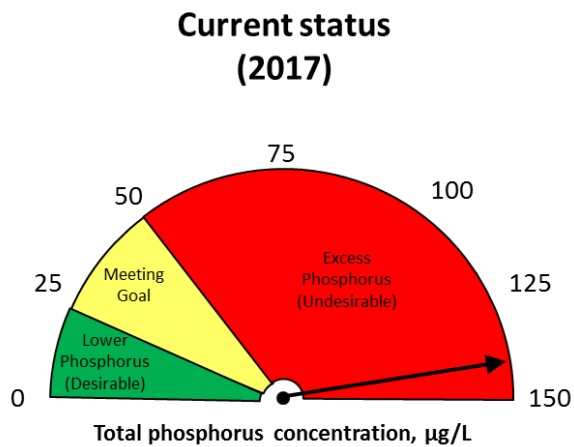
Key water quality indicators were selected from the many parameters that are monitored to create a water quality dashboard for Lake Macatawa (please see full annual report for all parameters). The goal of the dashboard is to provide a visual representation of the current status and historical trends in Lake Macatawa water quality, by rating each indicator along a scale from desirable (green) to undesirable (red) conditions. Each scale also includes a category that indicates the water quality goal for the lake is being met (yellow). The indicators that were chosen are commonly used to assess lake health: total phosphorus, chlorophyll *a*, and Secchi disk depth (water clarity). Each indicator is described in more detail below.

Historical data are included in the dashboard to facilitate comparison of current findings with past status of the selected water quality indicators. Sources for historical data include U.S. EPA (1972; STORET), Michigan Department of Environmental Quality (1982-2012; S. Holden, personal communication), and AWRI (since 2013). All current and historical data shown represent the annual average value of an indicator across Sites 1 (east basin), 2 (central basin), and 4 (west basin; see map below).



**Map of Lake Macatawa showing the 5 sampling locations (green dots) for long-term water quality monitoring. Dashboard indicators were calculated based on data from Sites 1, 2, and 4.**

# Total Phosphorus

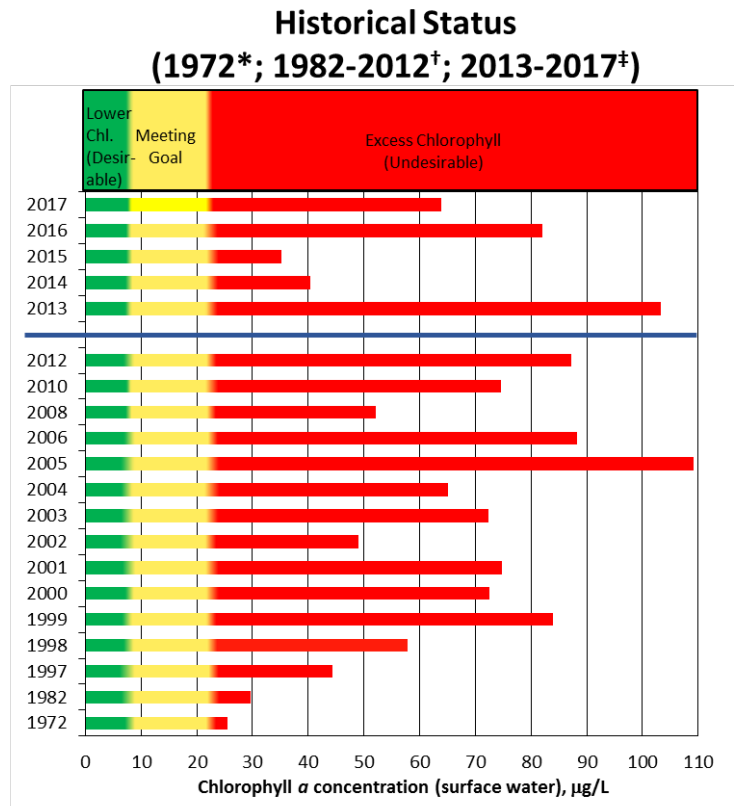
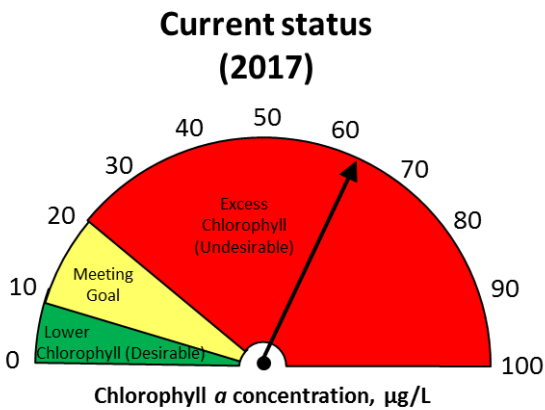


Phosphorus (P) is an essential element for living organisms. In many freshwater systems, P is the element that limits algal growth. However, when it becomes too abundant, it can help stimulate undesirable algal blooms. Phosphorus comes in many forms; Total Phosphorus (TP) was chosen for the dashboard indicator. TP, as the name suggests, includes all the forms of P in the lake. Some indices use dissolved inorganic phosphorus (DIP), which is the form readily available for algal use. However, DIP can be misleading. A lake with very low DIP in the water still can have a massive algal bloom because all the DIP has been taken up by the algae.

Lake Macatawa has a history of extremely high TP concentrations (i.e., > 100 µg/L), placing it in the “hypereutrophic” trophic state. As a result of this nutrient enrichment, the State of Michigan has established an interim target TP concentration of 50 µg/L in Lake Macatawa. Thus, the TP dashboard shows the water quality goal as being met when TP concentrations are < 50 µg/L. While attaining this goal would be a significant improvement in water quality from current conditions, Lake Macatawa would still be in an impaired “eutrophic” state, which we define as TP concentration > 24 µg/L. Therefore, the TP dashboard shows the ultimate desired TP concentration as < 24 µg/L.

The current status for the total phosphorus indicator is **Undesirable**, meaning that the average TP concentration in 2017 exceeded the water quality goal. Some annual variation in TP concentration should be expected and while the increase in TP from 2016 may be discouraging, mean 2017 TP is comparable to recent years and still below the range of historic TP values observed in Lake Macatawa.

# Chlorophyll *a*



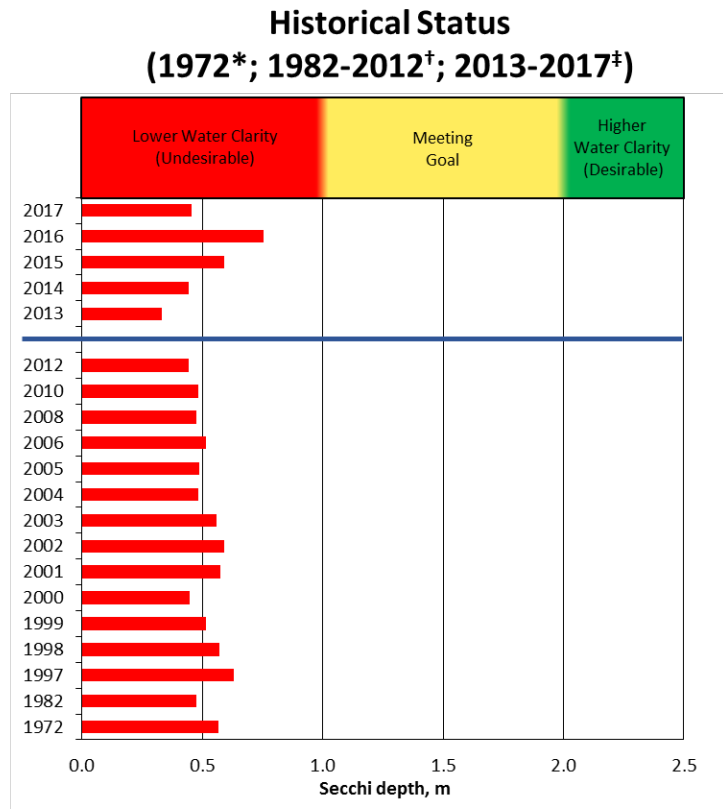
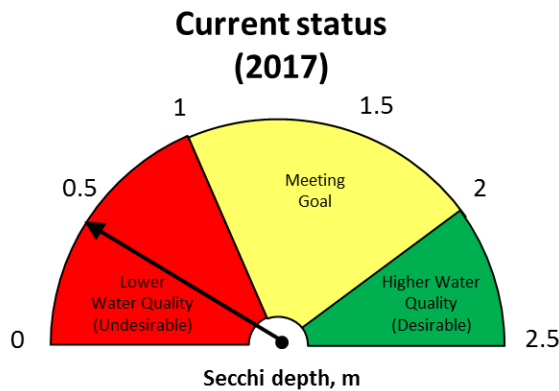
\*U.S. EPA; †MDEQ; ‡AWRI

Chlorophyll *a* is the green pigment found in photosynthetic plants and algae. Measuring chlorophyll *a* is a relatively simple way to estimate the amount of algal biomass present in lake water, although it has some limitations. First, chlorophyll *a* does not provide information on the type of algae present (e.g., is it a harmful species or not?). Second, chlorophyll concentrations can change depending upon environmental conditions, such as light or nutrient level. Finally, chlorophyll *a* concentrations may be low due to very active predation by grazers, so the measurement may give an underestimate of how much algal biomass would otherwise be present.

Lake Macatawa has a history of excess algal biomass and high chlorophyll *a* concentrations, typically exceeding the “hypereutrophic” threshold commonly used by MDEQ (22 µg/L) in its assessments of the lake. The chlorophyll *a* dashboard shows that the concentration will meet the water quality goal once it is < 22 µg/L. Although meeting the chlorophyll *a* goal would be a significant improvement in water quality, Lake Macatawa would still be categorized as “eutrophic” (i.e., > 7 µg/L chlorophyll *a*). Thus, the chlorophyll *a* dashboard shows that the ultimate desired chlorophyll *a* concentration is < 7 µg/L.

The current status for the chlorophyll *a* indicator is **Undesirable**, meaning that the average chlorophyll *a* concentration in 2017 exceeded the water quality goal. While 2017 mean chlorophyll concentrations declined from those in 2016, levels are still extremely high.

# Secchi Disk Depth (Water Clarity)



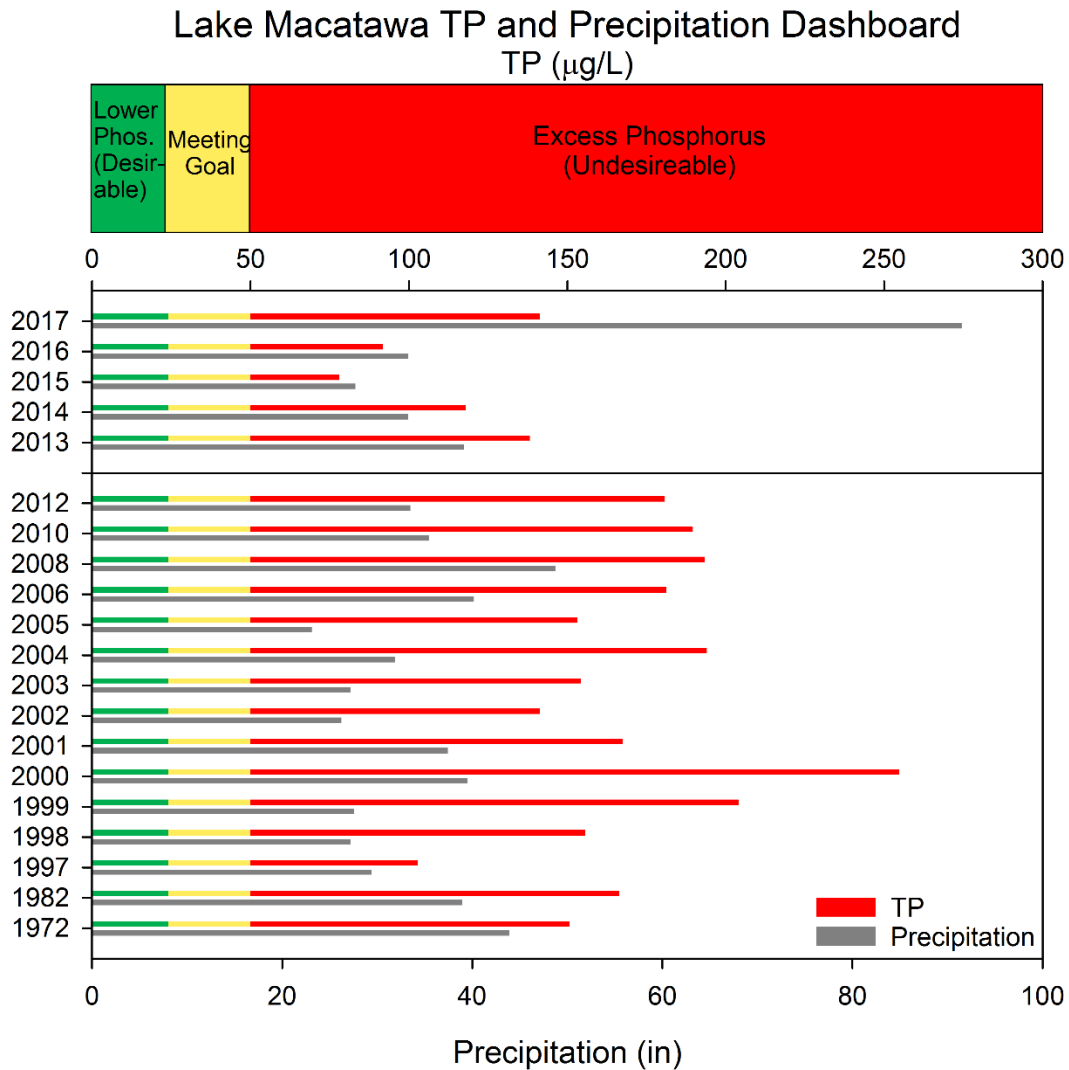
\*U.S. EPA; †MDEQ; ‡AWRI

Secchi disk depth is an estimate of water clarity. It is measured using a standard black and white disk, named after Angelo Secchi, who first used an all-white disk for marine waters in 1865. Lake ecologists modified it to black and white in the late 1800s. The Secchi disk is a simple and easy way to measure water clarity, although if waters are cloudy, the disk depth tells you nothing about why the lake is turbid (e.g., is it due to suspended algae or suspended sediment?).

Along with excess phosphorus and chlorophyll *a* concentrations, Secchi depths have historically reflected extremely impaired conditions in Lake Macatawa. Oligotrophic lakes, such as Lake Tahoe, have Secchi disk depths down to 21 m (~70 ft) or deeper. Conversely, hypereutrophic lakes, such as Lake Macatawa, typically have Secchi depths shallower than 1 m. The water clarity goal for Lake Macatawa is modest, with a Secchi depth > 1 m. Because Secchi depths between 1 and 2 m are indicative of a eutrophic state, a desirable Secchi depth is > 2 m.

The current status for the Secchi depth indicator is **Undesirable**, meaning that the average Secchi depth in 2017 was shallower (i.e., less clear) than the water quality goal. Since water clarity declined in 2017 compared to 2016, even though chlorophyll concentrations also decreased during the same time, the reduction in water clarity was likely caused by non-algal suspended particles, such as sediment.

# Total Phosphorus and Precipitation



Phosphorus concentrations in Lake Macatawa are influenced by many variables, but one of the most significant is precipitation because rain and snow events create runoff from farms and developed areas, when phosphorus can be transported to Lake Macatawa either in the dissolved form or as attached to sediment particles; precipitation also results in atmospheric deposition, which also can contribute phosphorus directly to the lake and landscape. As a consequence, it is of interest to know if annual changes in lake phosphorus concentrations are simply due to more or less precipitation.

To answer this question, we examined total phosphorus (TP) concentrations in the lake, based on data from MDEQ and AWRI (sampled 3 $\times$  per year at 3 sites), and compared them to precipitation data from the Tulip City Airport in Holland. As seen above, between 1972 and 2017, the relationship between precipitation and TP concentration in the lake was not statistically significant ( $R^2 = 0.006$ ;  $p = 0.751$ ). For example, some years have very high TP concentrations but relatively low precipitation (e.g., 2000 and

2004), whereas other years have modest levels of TP but relatively high precipitation (e.g., 2017). Interestingly, the relationship between TP and precipitation is much improved since 2013 ( $R^2 = 0.446$ ;  $p = 0.218$ ) but is still not statistically significant. This relationship is based on only 5 data points, so it should be viewed cautiously. We view these data as appropriate for screening purposes only, as the TP concentrations are single sampling events, which may miss pulses of high P concentrations after storm events.