# 2025 Osakis Lake Association Monitoring Summary

## Lake Osakis at Lindberg Point, 4-Mile Hole

### Lake Osakis Overview

Lake Osakis is an important lake in the Sauk River Watershed, as it represents the headwaters of the Sauk River, a 126-mile long tributary to the Mississippi River. It is also the largest lake in the watershed. The lake falls within the North Central Hardwood Forest (NCHF) ecoregion. This is a transitional tract of land with a forested landscape to the north, leading to grassland and prairie in the south. Osakis has an average depth of 17 feet and a maximum depth of 78 feet. It has a very long residence time (average time that water spends in a waterbody) of around 5 years. The primary recreation activities supported on the lake include boating and fishing. Lake Osakis was placed on Minnesota's 303(d) Impaired Waters List (IWL) in 1998 for mercury in fish tissue, in 2004 for excessive nutrients, and 2022 for poor fish bioassessment findings. Smith, Faille, and Maple Lakes are located upstream of and drain to Lake Osakis, and these lakes are also impaired for nutrients. Being a tourist destination, the lake is highly sought out by anglers, sail boaters, and water skiers. It also has an active and supportive lake association (Osakis Lake Association) that has done volunteer monitoring and sampling on the lake consistently since 2015.


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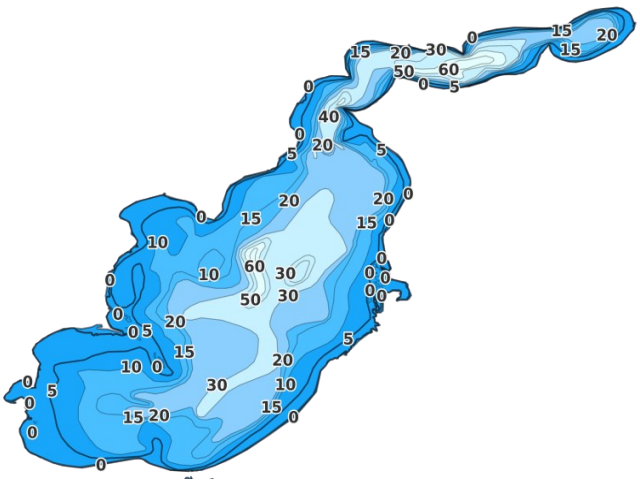
Sauk River Watershed District


**Created March 2026**

**Abi Borgerding**

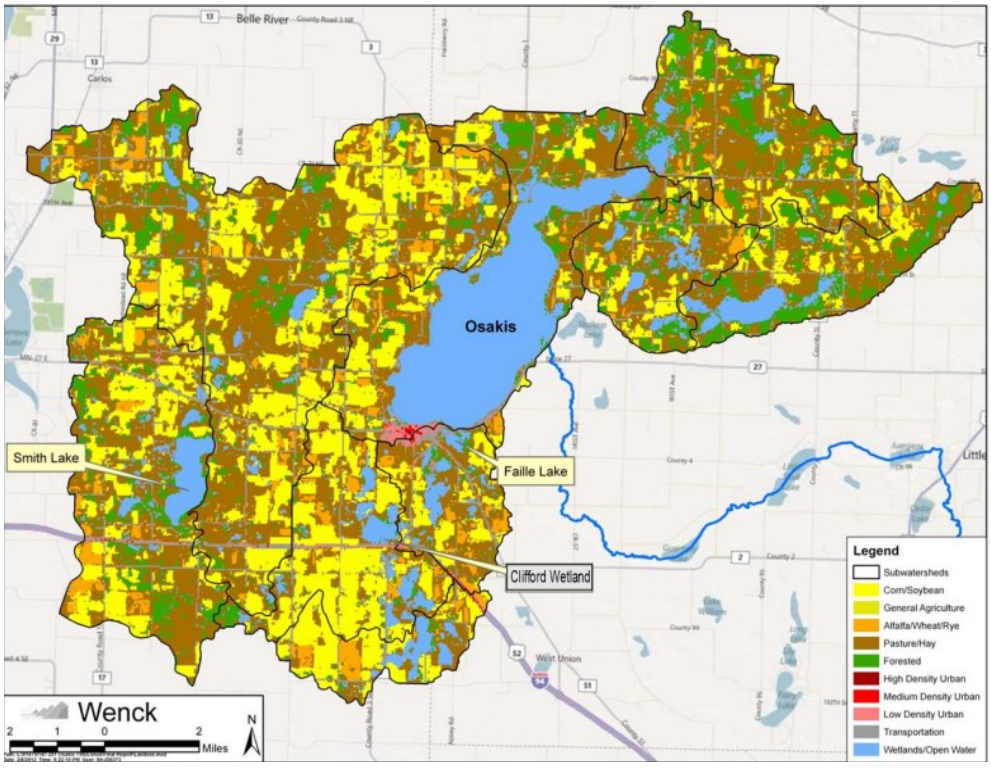
**Environmental Monitoring Manager**

# Osakis Lake Water Quality Standards & TMDL



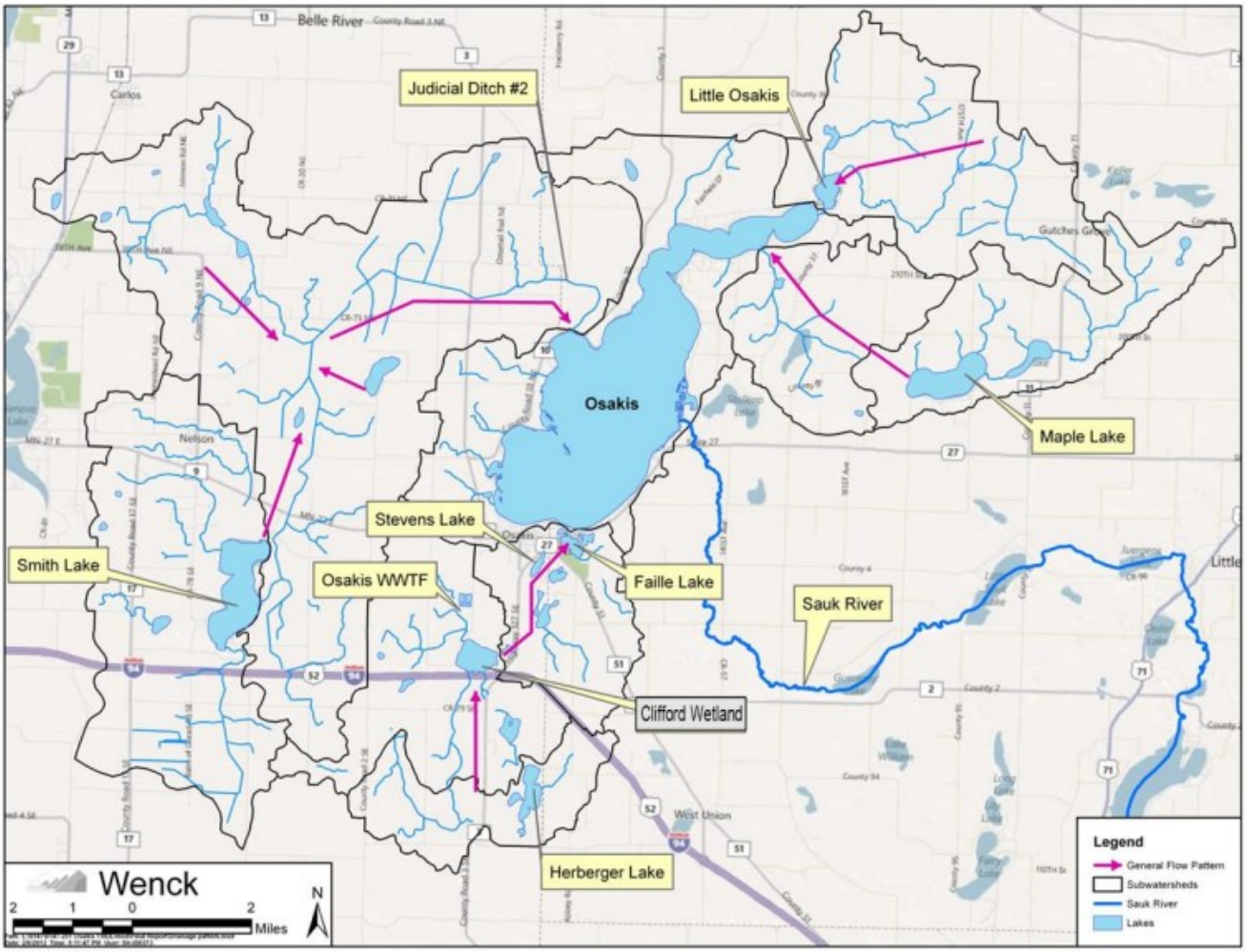
Lake Osakis is a large, deep lake with a watershed area of 88,722 acres. Despite deep spots reaching over 50 feet, about 45% of the 6,360 acre lake is shallow enough to support submerged aquatic vegetation. Lake Osakis has been considered impaired for excessive nutrients since 2004 and has undergone a Total Maximum Daily Load (TMDL) study to address its impairments. Smith, Faille, and Maple Lakes are all in the lake's watershed and drain to Lake Osakis. The purpose of the TMDL was to calculate the existing phosphorus load in the sub-watershed and the reduction amount needed for the waterbodies to meet state water quality standards (WQS). WQS are largely based on the ecoregion and designated use of the waterbody. Osakis Lake has been designated as beneficial use classification 2B by the MN Pollution Control Agency (MPCA), which specifies state standards to ensure the protection of aquatic life and recreation. The numeric water quality standards for Osakis Lake is a maximum annual average concentration of 40 µg/L for total phosphorus (TP), 14 µg/L for chlorophyll-A (chl-A), and an average greater than 4.6 feet for Secchi depth visibility (for a table of these water quality parameters, see page 4).

The primary source of excessive phosphorus for Smith, Faille, and Osakis Lakes is non-point source runoff from the surrounding agricultural landscape. Over 50% of the phosphorus entering Lake Osakis comes by direct drainage to the lake.




Source: Osakis TMDL Report

# Lake Osakis, Clifford Wetland, & Faille Lake




The initial Osakis Lake Area TMDL was approved in 2013, but it did not account for an additional impaired lake in the watershed at that time, Clifford Lake. The small, shallow lake had limited available information, and development of a TMDL for Clifford Lake was postponed until additional depth and size information was obtained. Clifford Lake is the receiving water of effluent from the city of Osakis Wastewater Treatment Facility (WWTF), a point source discharge. As data was gathered, it was revealed that Clifford was much more shallow than previously indicated. It was determined in 2023 that Clifford Lake was not a lake, but actually a wetland. This led to the delisting of Clifford Lake for a nutrient impairment since wetlands in MN currently do not have water use classification protections (like with phosphorus, for example). Clifford Wetland drains into Faille Lake, which is impaired for excessive nutrients. Faille Lake then flows to Lake Osakis. Once Clifford Lake was reclassified as Clifford Wetland, the MPCA rewrote the TMDL in 2023 and recalculated Faille Lake's total phosphorus load calculations to include the effluent coming from the Osakis WWTF. Water quality monitoring in 2017 and 2018 by the MPCA showed Faille Lake was still exceeding its TP standard, but it was not showing an associated increase in chlorophyll-A concentrations or a reduction in Secchi disk visibility. Faille Lake was removed from the MN Impaired Waters List (IWL) in 2020.

# Lake Osakis 2025 Monitoring Activities

The Osakis Lake Association's (OLA) water quality sampling activities in 2025 continued at **Lindberg Point** in the "small lake" at the northern end of the lake and **4-Mile Hole**, which is in the "big lake" section of the lake in the main basin. These locations are the same intensive, routine monitoring sites the Sauk River Watershed District (SRWD) visits on a 5-year rotation. The SRWD last monitored those locations in 2022, and per the 5-year monitoring rotation, staff will return to the lake in 2027. These sites were chosen because they are at deep spots in the lake with less influence from near-shore microenvironments, and surface water at these sites is representative of ambient lake surface conditions. The deep spots in the lake are also where lake stratification and thermoclines typically occur, so oxygen and temperature depth profiles are taken with a multi-parameter probe by SRWD staff at these deep spots to assess bottom loading of nutrients and anoxic conditions.

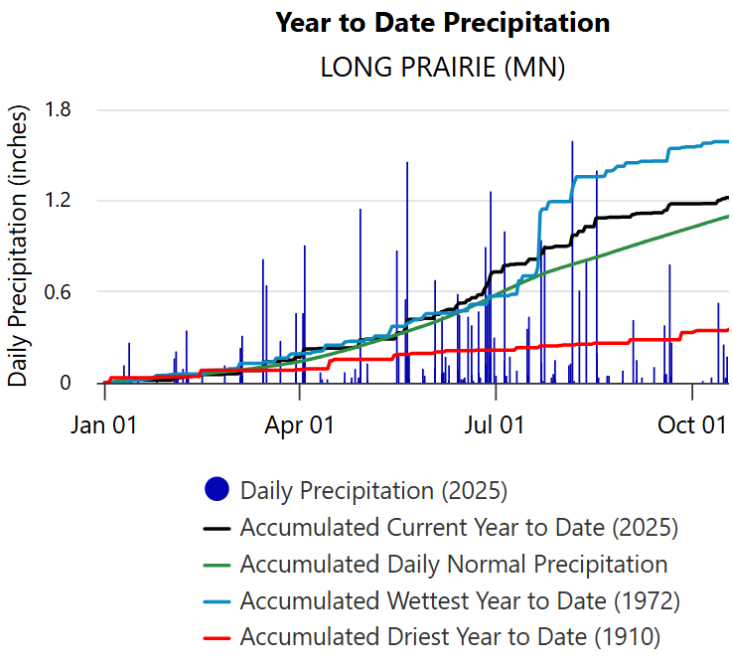
**Lake Osakis has a running ice-out date record that started back in 1867.**

It is important to note that WQS differ not only between lakes and streams, but also by ecoregion and designated use. Below is a table outlining the WQS within the Sauk River Watershed based on its beneficial use classification and ecoregion. Lake Osakis and its tributaries have been designated by the MPCA as Class 2: beneficial use for aquatic life and recreation. Most streams in the watershed, like the Sauk River, are further classified as Class 2B, which has a designated use for cool and warm water fisheries, but not protected for drinking water. Lakes, streams, and rivers throughout Minnesota are classified differently based on their designated use, and their WQS are written to protect that determined resource for future generations.

| *E. coli* Water Quality Standards for Class 2 Waters | | |
|---|---|---|
| Monthly Geometric Mean | 10% of Samples Max. | Applicable Season |
| 126 | 1260 | April 1 - October 31 |
| *Eutrophication standards for class 2B rivers and streams.* | | |
| **Substance** | **Units** | **Chronic Standard** |
| Total Suspended Solids | mg/L | less than or equal to 30 |
| Phosphorus, total | µg/L | less than or equal to 100 |
| *Deep Lakes and Reservoirs in N Central Hardwood Forest Ecoregion* | | |
| **Substance** | **Units** | **Chronic Standard** |
| Phosphorus, total | µg/L | 40 |
| Chlorophyll-a | µg/L | 14 |
| Secchi disk transparency | feet | Not less than 4.6 |
| *Shallow Lakes in North Central Hardwood Forest Ecoregion (<15 ft)* | | |
| **Substance** | **Units** | **CS** |
| Phosphorus, total | µg/L | 60 |
| Chlorophyll-a | µg/L | 20 |
| Secchi disk transparency | feet | Not less than 3.3 |

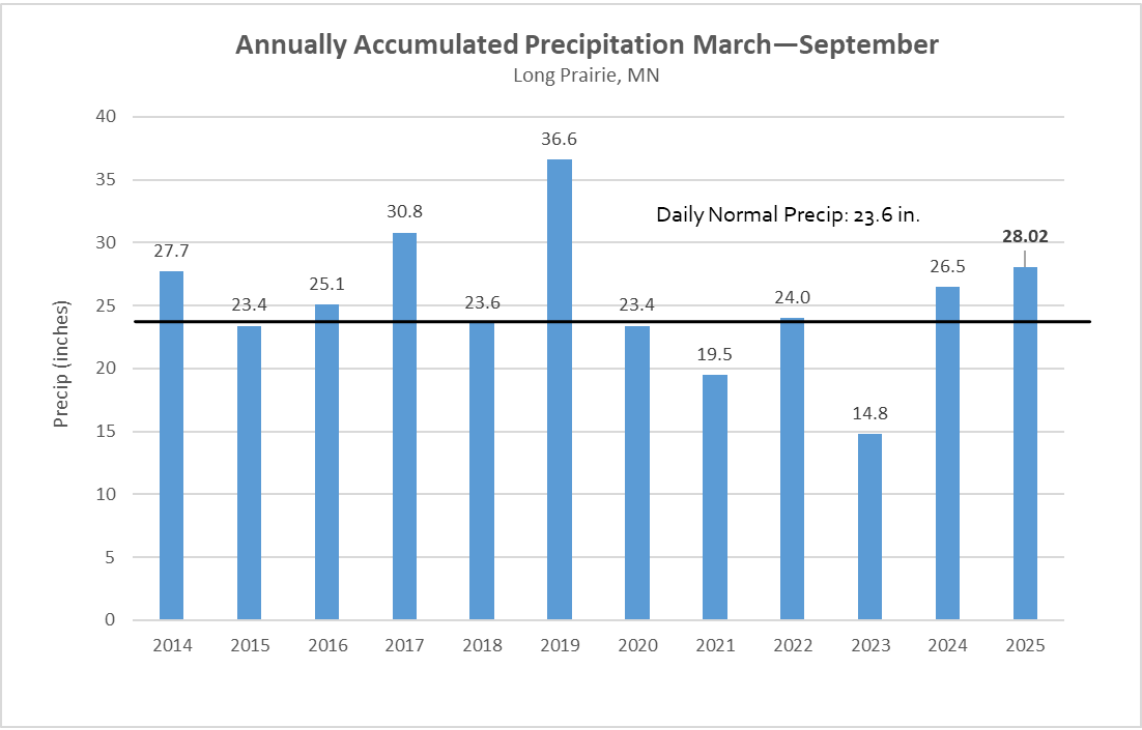
# 2025 Precipitation Near Lake Osakis

Precipitation events during the 2025 sampling season near Long Prairie, the closest long term precipitation monitoring site to Lake Osakis, show a wet spring and summer. The graph to the right shows the accumulated rainfall received in 2025 from January through September (black line). A "normal" amount of rainfall for this region (green line) from March—September is **~23.6 inches**. Even though 2025 started in drought conditions that persisted from the previous fall, rainfall during the growing season made up for that. The ice-out date by year in Lake Osakis is also trending 4.8 days earlier per century.

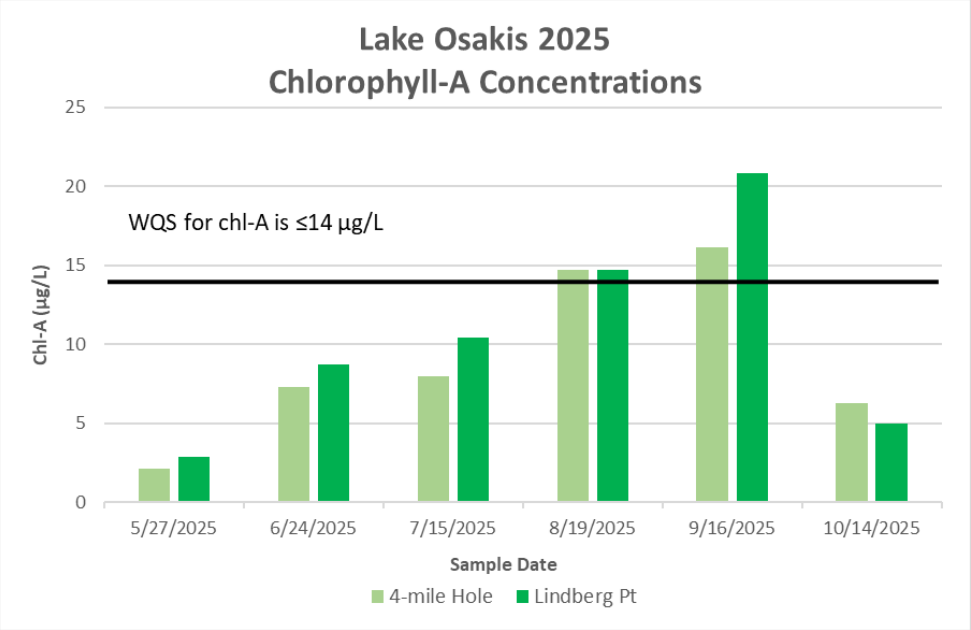



Source: the National Oceanic and Atmospheric Administration (NOAA)

The graph below shows annual precipitation since 2014 from March through September. 2025 was the wettest year since 2019 and rose above the daily normal precipitation. 2023 remains the driest year for this time period. After another dry January and February, March came in like a lion with a blizzard on the 4th-5th. A rain system also came through the area on March 14th-15th, dumping just over an inch of rain in 48 hours. By early July, 63% of Minnesota was free of any drought designation with June being quite a wet month. As can be seen in the graph below, the total accumulated precipitation for the 2025 monitoring season was **28.02 inches** (4.4 inches above average).

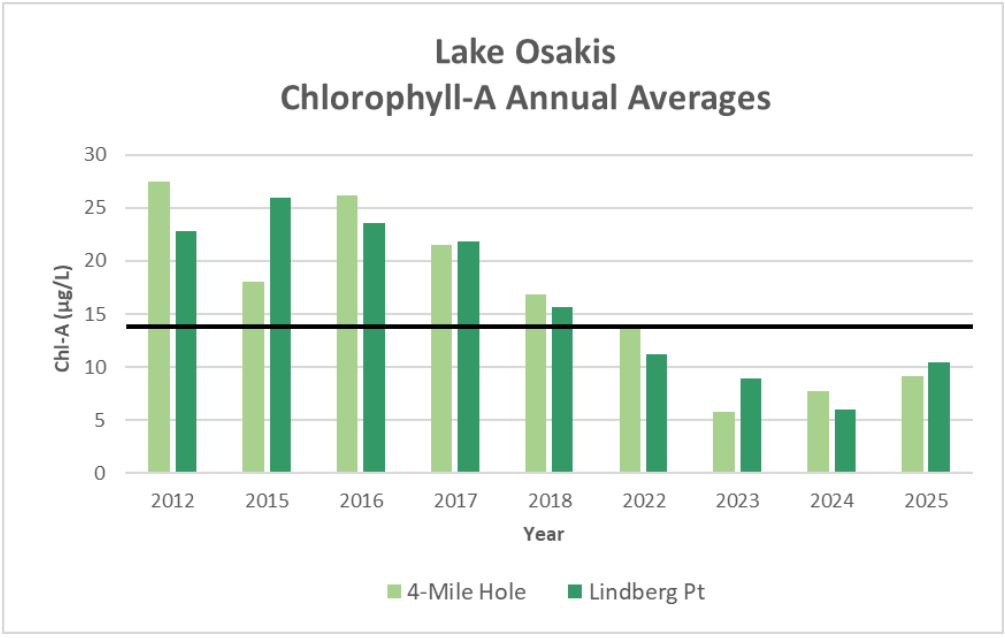


# 2025 Water Quality at 4-Mile Hole & Lindberg Point

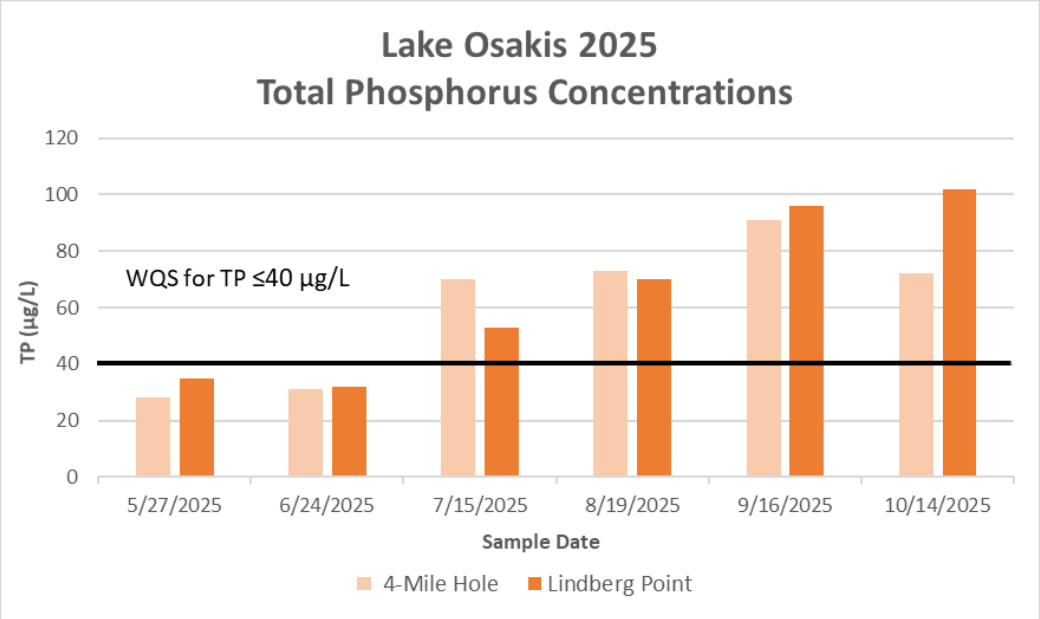



The above graph contains each 2025 chlorophyll-A (chl-A) sample result for both sites on Lake Osakis. Chl-A is a measure of algae growth. These samples were taken from the first 6 feet of lake surface water, which is the expected range for light penetration and algae production. Both of the sites only exceeded the chl-A WQS of <14 µg/L twice, this happening in August and September. As is typical, algae growth steadily increased throughout the summer, then came back down in October. 4-Mile Hole had the lower overall average at **9.1 µg/L**, and Lindberg Point was only slightly higher with an average of **10.4 µg/L**.

The bottom graph shows the annual average chl-A concentrations for both sites. It appears that chl-A concentrations have been decreasing in Lake Osakis since 2012, with a slight uptick in 2025. The annual averages have continued to remain below the WQS since 2022. Each year's climate conditions vary, and in response, the chl-A concentrations can vary from month-to-month and year-to-year. Long term data collection is necessary to accurately identify trends. Thankfully, there is a long history of water quality monitoring on Lake Osakis.

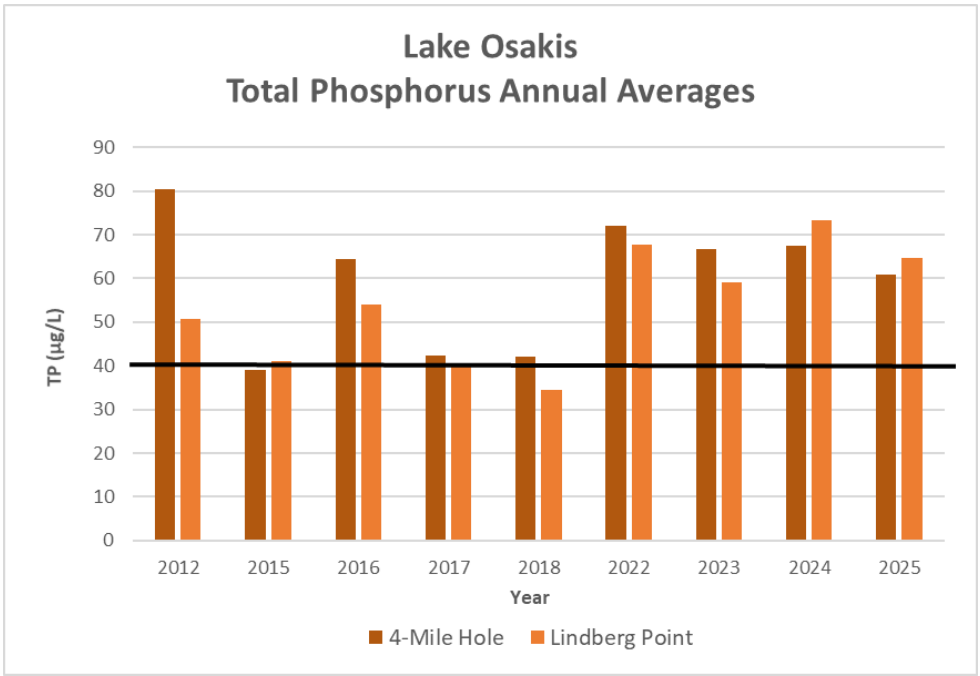


# 2025 Water Quality Cont.

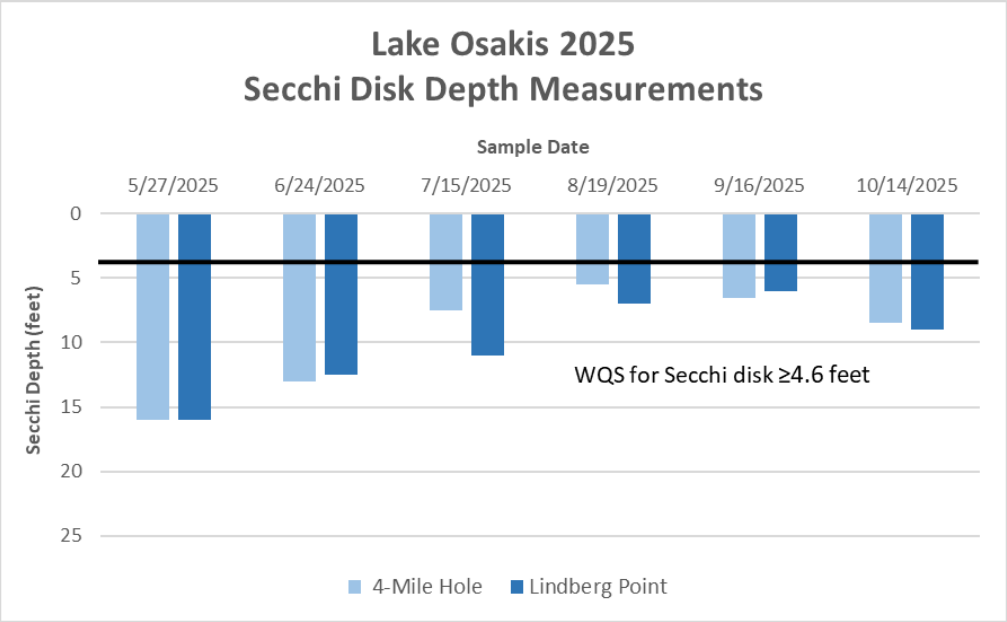



The TP samples in 2025 started off encouraging and below the WQS of <40 µg/L, but concentrations crept up throughout the season. The highest result was 102 µg/L at Lindberg Point in October. There is not a significant difference between the two sampling sites. The annual average at 4-Mile Hole was **60.8 µg/L**, while at Lindberg Point was **64.7 µg/L**, which are both above the WQS.

The graph below contains the annual average TP concentrations at both sites from 2012 to 2025. Note that there is no data from years 2019 to 2021. There is not a clear trend over the years, but the 2025 averages at both sites are lower than the 2024 averages. For Lindberg Point, there have consistently been slight increases in the TP averages.

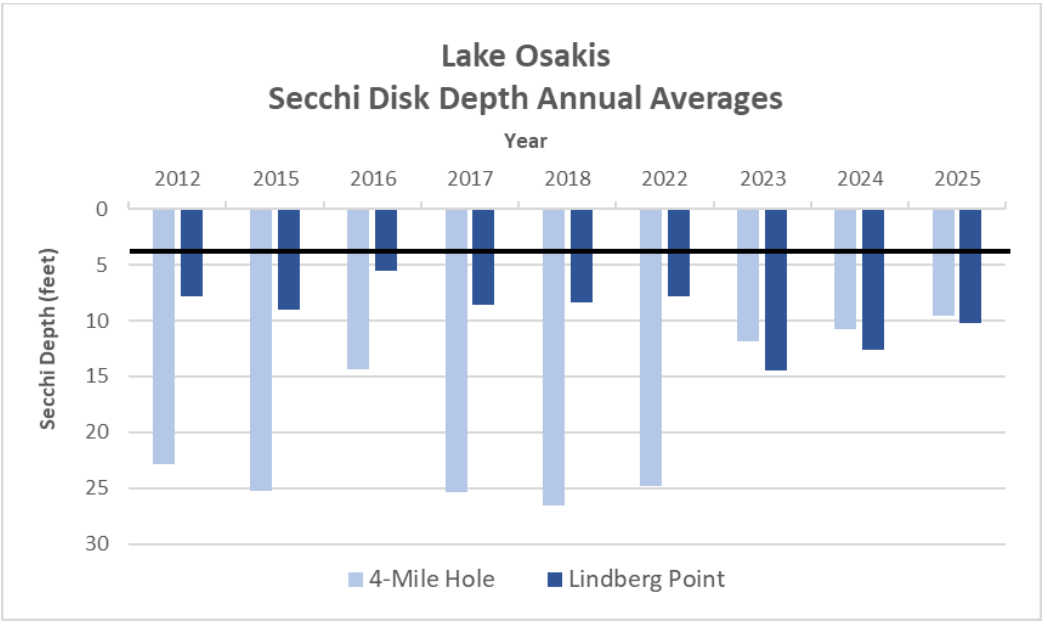


# 2025 Water Quality Cont.




The graph above shows that all of the Osakis Secchi disk depth measurements met the WQS of >4.6 feet in 2025. The average Secchi disk measurement for the year was **9.5 feet** at 4-Mile Hole and **10.3 feet** at Lindberg Point. As a reminder, higher results are desirable since Secchi depth is a measure of water clarity. As the season progresses, it is common for Secchi disk depth readings to decline, which can be seen in the graph above.

The bottom graph shows the annual average Secchi disk depths since 2012. For both sites, there have been slight decreases in Secchi depth averages since 2023. However, each annual average has been above the WQS since 2012, and there have been much lower averages at Lindberg Point in the past.



# Carlson Trophic State Index

To better understand the interaction of phosphorus, chlorophyll-A, and Secchi disk visibility on lake water quality, the Carlson Trophic State Index (TSI) was chosen a good assessment tool. The Carlson TSI is designed to indicate how much biomass (plants, animals, and bacteria) a waterbody can sustain and measures the abundance of nutrients available, called the trophic state, of a waterbody. The word *trophic* is Greek and means nourishment or food. More available nutrients means the waterbody will likely have more problems with algae and aquatic plant overgrowth. The index consists of a scale ranging from 0 to 100+ and is used as a predictor of poor water quality conditions. Under the Carlson TSI scale, water bodies may be classified as follows:

**Oligotrophic**: TSI 0 - 40, Clear water, good oxygen conditions, limited nutrients available, deep or shallow lake. From the Greek "oligos" meaning few, scant.

**Mesotrophic**: TSI 40 - 50, Moderately clear water but increased chance of low oxygen conditions in shallow lakes. From the Greek "meso" meaning middle, moderate.

**Eutrophic**: TSI 50 - 70, Moderately clear to cloudy water, with a high chance of low oxygen conditions in the summer, extensive plant growth, and potential algal scum. From the Greek "eu" meaning well, plenty.

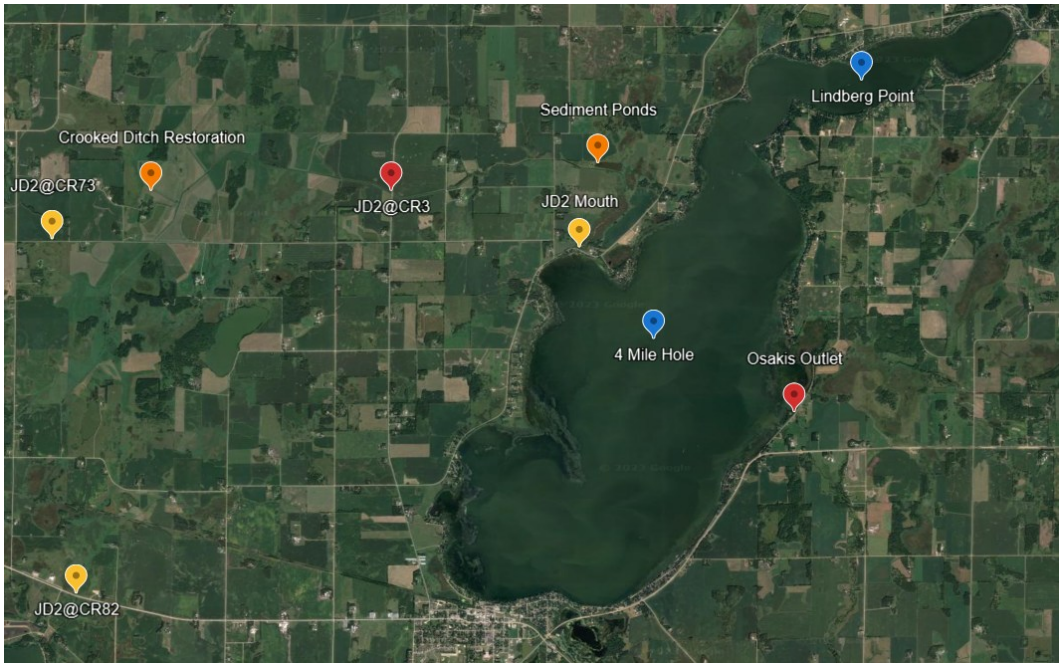
**Hypereutrophic**: TSI 70+, Dense plant growth, heavy algal blooms and scum possible, low oxygen conditions, fish kill possible. From the Greek "hyper" meaning over much.

The table below contains the calculated Carlson TSI scores for Lindberg Point and 4-Mile Hole since 2012. These scores are calculated using the annual average chlorophyll-A and TP concentrations, and the annual average Secchi disk measurement for each sampling year. 4-Mile Hole remained the same as 2024's score at **53**, and Lindberg Point increased slightly to **54** in 2025. The annual average TSI scores for both 4-Mile Hole and Lindberg Point are in the *eutrophic* category, which indicates that nutrients are plentiful in Lake Osakis. The common TSI range for our North Central Hardwood Forest ecoregion is a TSI between 46 to 58, which Lake Osakis falls within. TSI scores in 2025 are comparable to results in past years and are mostly holding steady. There have been higher TSI scores in the past for both sites.

| Year | 4-Mile Hole TSI | Lindberg Pt TSI |
|---|---|---|
| 2012 | 54 | 57 |
| 2015 | 49 | 55 |
| 2016 | 55 | 59 |
| 2017 | 50 | 55 |
| 2018 | 49 | 53 |
| 2022 | 51 | 56 |
| 2023 | 51 | 51 |
| 2024 | 53 | 52 |
| 2025 | 53 | 54 |

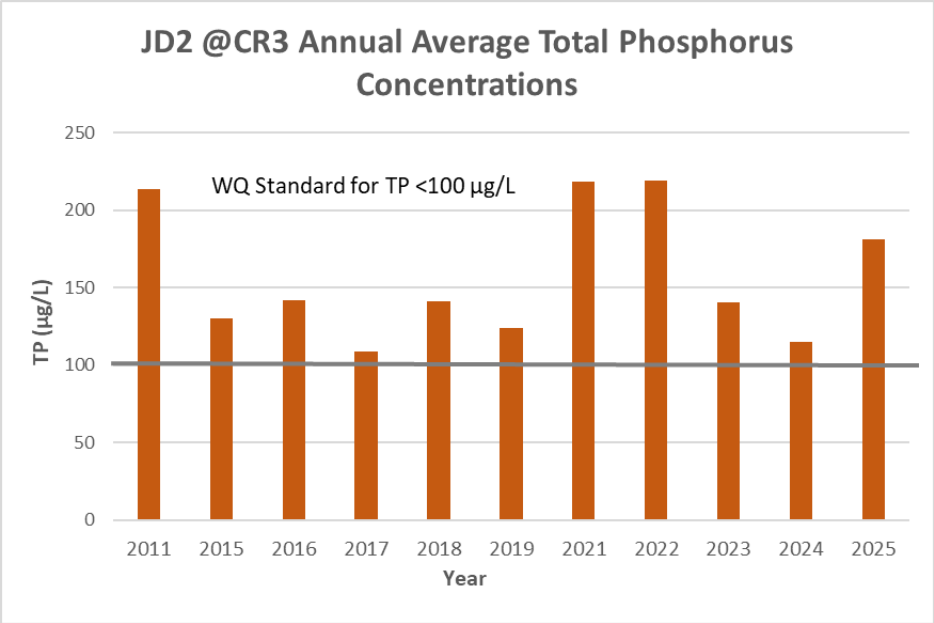
# Lake Osakis Watershed Monitoring History

SRWD, MPCA, and DNR have monitored many locations on Lake Osakis and its tributaries for water quality and aquatic life. Judicial Ditch #2 (JD2) is a 37 mile-long public drainage network that flows from east of Smith Lake and outlets into Lake Osakis. JD2 ditch drains around 45% of the Lake Osakis watershed area. Due to the flat landscape in the Crooked Lake area that JD2 flows through, water quality samples and flow monitoring have been difficult. Monitoring has been affected by high lake levels reversing the flow in the ditch (backwater effect), limited ditch access locations, no-flow in summer, and dense aquatic vegetation. The map below shows a number of monitoring locations the SRWD no longer uses (yellow markers), the sites that we still operate today (red markers), select water quality projects in the region (orange markers), and the lake sampling locations (blue markers). The table below explains more about the monitoring sites.



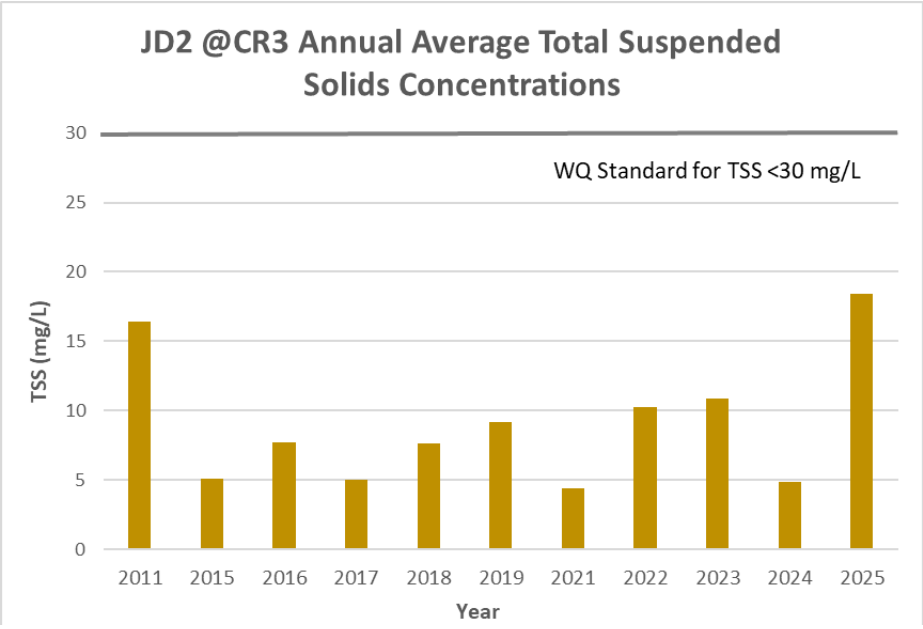

| Site | Status |
|---|---|
| **JD2@CR82** | Site active in 2018 only. MPCA staff reviewed the weekly sample and flow data collected at this site during the 2018 monitoring season and found the site unsuitable for data collection. It was recommended that this site not be monitored in the future unless site conditions change. |
| **JD2@CR73** | Site last active in 2018 and was uninstalled after Osakis Lake Area TMDL project was completed. Site is no longer being monitored at this time as JD2 @CR3 is adequate. Site was also not conducive to ideal data collection that would produce reliable results. |
| **JD2@CR3** | Site active from 2011 - Present. Dense submerged aquatic plants affect water levels in the channel by creating mass that displaces the water. Weekly flows are collected when dense vegetation is present. |
| **JD2 Mouth** | Site active from 2016 - 2018. Discontinued due to how close this site was to the lake. There was commonly a backwater effect from the lake or stagnant water due to the relatively flat slope leading to Lake Osakis. Sampling and flow measurements were not reliable due to these problematic conditions. |
| **Osakis Outlet** | Active site since 1989, located at the outlet of Lake Osakis and the beginning of the Sauk River. Long-term monitoring equipment cannot be deployed due to outlet design, so a staff gauge is used. |

# Monitoring on Judicial Ditch 2 at CR3

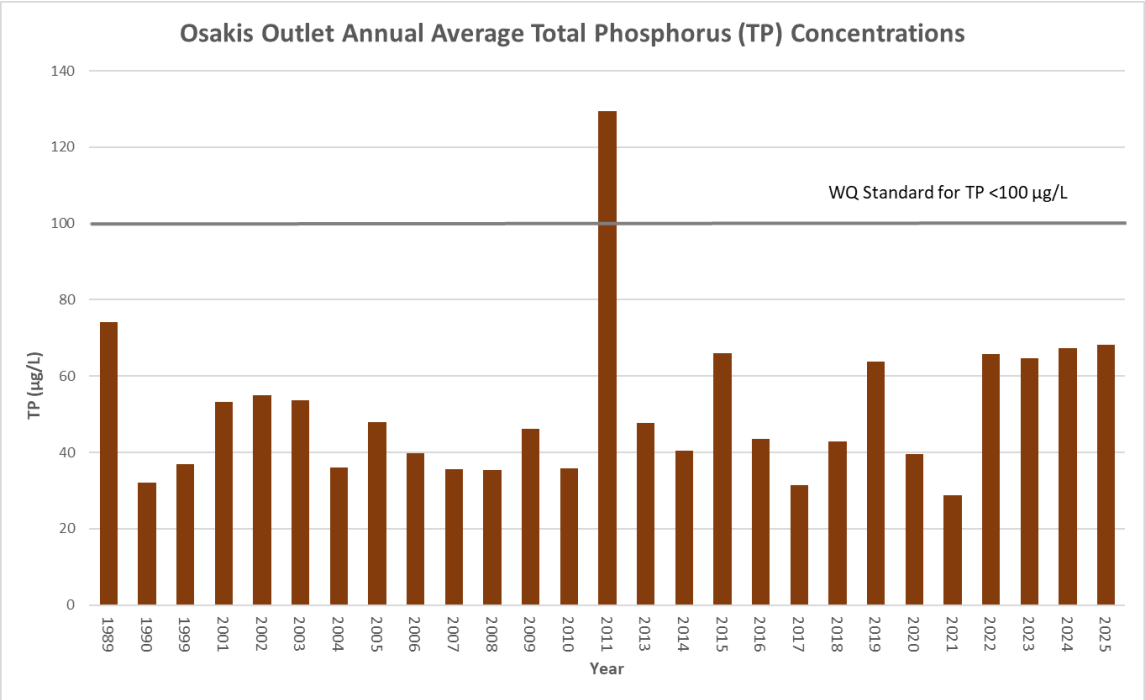



The annual average total phosphorus (TP) concentrations at Judicial Ditch #2 (JD2) at County Road 3 are presented in the graph above. Results date back to 2011, then for the past 10 years (excluding 2020). Each TP annual average is above the WQS of <100 µg/ L. There was a slight increase in the 2025 average compared to the prior year. The 2025 average was **181.2 µg/ L**.

The graph below shows the annual average total suspended solids (TSS) concentration at JD2. Each annual average has fallen well below the WQS of <30 mg/L, but the 2025 average was the highest in this dataset. The 2025 annual average came out to be **18.4 mg/L**. Major precipitation events and the amount of winter snowpack affects TSS and TP levels, so long term and frequent sampling is essential to account for these variables.

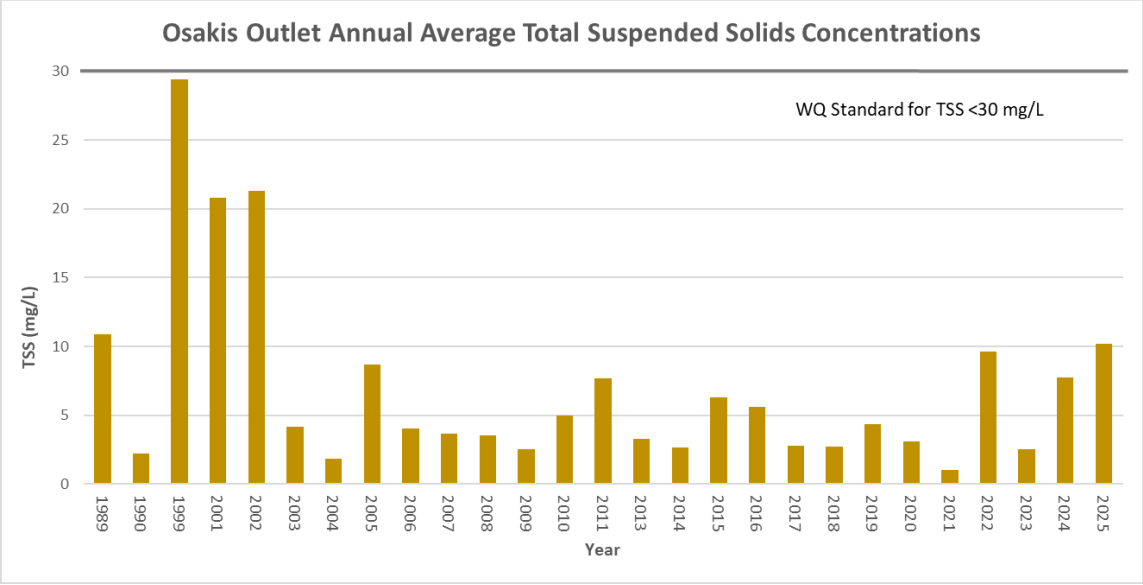


# Monitoring at Osakis Outlet




The above graph presents the annual average TP concentrations at Osakis Lake outlet. This site has a strong dataset that extends back to 1989. The data shows a slight upward trend in average TP over time, but the WQS of <100 µg/ L was exceeded only once (in 2011) since 1989. The 2025 annual average was **68.1 µg/ L**.

In the graph below are the annual average total suspended solids (TSS) concentrations at Osakis Outlet. An obvious decreasing trend can be seen. All annual averages since 1989 were below the TSS WQS of <30 mg/L. The 2025 annual average was **10.2 mg/L,** which is a slight increase from the 2024 average. The intensity of precipitation events and amount of winter snowpack greatly affect TSS and TP levels.



# 2025 Monitoring Summary

Taking all of the 2025 data into account, there were both encouraging and concerning results. The 2025 monitoring season had an abundance of precipitation, which allows for more nonpoint source pollution and watershed runoff. The total accumulated precipitation from March-September last year was 28.02", which is 4.4" above average. It did help that the winter of 2024-25 experienced good ice coverage, which is ideal for weed suppression and not allowing algae to take off early. As for the lake results, **chl-A** levels only exceeded the WQS twice for each site in 2025. Both 4-Mile Hole and Lindberg Point had annual averages for chl-A that were below the WQS. Compared to past years, there is a noticeable decreasing trend in chl-A averages, but there was a slight increase in 2025 from 2024 averages. For **TP**, sample results were over the WQS the majority of the year, and the annual averages were over the WQS at both sites. However, there was a slight decrease in TP averages compared to the 2024 averages. Lake Osakis historically has had high TP levels, which is representative of a lake that receives input from both a drainage system network and a highly-developed surrounding shoreland. Looking at clarity, measured by **Secchi disk depth**, readings were deeper than the WQS of >4.6 feet on each sampling day for both sites. The 2025 annual averages for Secchi depth at both sites were slightly below the 2024 averages, and there is a slight declining trend in clarity since 2015. Carlson TSI scores were both in the eutrophic category, with 4-Mile Hole at 53 and Lindberg Point at 55.

The Osakis Area TMDL specifies that a 41% reduction in phosphorus is needed to meet the phosphorus WQS. It also reports that 58% of phosphorus loading in the lake comes from the surrounding watershed, which includes public drainage systems and the direct shoreline watershed. Additionally, habitat restoration projects are needed along the Osakis shoreline and in the creeks and ditches flowing to Lake Osakis to address aquatic life impairments. Restoration modeling of the JD2 drainage area indicate that utilizing best management practices (BMPs) alone will not be enough to reduce nutrients and meet WQS. It will require larger capital improvement projects, particularly those that reduce external phosphorus loading, to adequately address Lake Osakis' nutrient impairments. Maintaining long-term monitoring data allows for annual variations in weather, temperature, and rainfall to be accounted for. The longer and more frequently data collection occurs on a waterbody, the stronger the dataset is for water quality assessments.

Battle Point Park, 05.23.2024

# What is a Rock Arch Rapids?

As some may know, the current outlet of Lake Osakis, where the Sauk River begins, is controlled by a weir or "low head" dam structure. The weir was constructed in 1996 and contains a double-box concrete culvert under County Road 37. A few years ago, the Osakis Lake Association (OLA) started exploring what installing a rock arch rapids at the outlet would look like. Lake Osakis has drastically fluctuating water levels, which is something this outlet modification would address. The goals of the project are to maintain the existing water elevation (it will not raise or lower the ordinary high water level), improve native fish passage, create a stable and low-maintenance outlet, and reduce lake level fluctuations.

A preliminary design was completed by Houston Engineering in January of 2025, and the total cost estimate is $433,500. The current design of the outlet shows that the rock arch rapids structure would indeed maintain water levels on the lake for longer in the season, and it would allow for more flow capacity to handle high water levels. In other words, the lake bounce would not be as severe. The project was proposed as a possibility at the May 2025 OLA Annual Meeting. As for funding the project, the Judicial Ditch #2 Drainage Authority, with assistance from Houston Engineering, applied for and received a MN Department of Natural Resources grant called the Conservation Partners Legacy. This grant covers 90% of the project cost and requires a 10% local match. The OLA has committed to contribute $30,000 for the local match, leaving $13,350 to cover the rest of the match requirement. The current goal is to begin construction in fall of 2026.

So, what is a **rock arch rapids**? It is a riffle design of large boulders arranged in a line of curved "steps" that gradually lower the water level as it flows downstream. They are commonly constructed at lake outlets and/or where dams are located. The design is meant to maintain the water level of the upstream lake while allowing for fish passage and reducing erosion impacts caused by dams. This will help restore and maintain habitat for fish, aquatic plants, and macroinvertebrates. A major benefit of this outlet style is that it requires little to no maintenance once in place, unlike conventional, outdated dams and weirs. A rock arch rapids will also return the channel to a more natural state, as it will look similar to natural river rapids. It is more safe than a low head dam since the rock arches eliminate the dangerous churning hydraulic undertows that dams create.

Completed rock arch rapids at outlet of Little Birch Lake near Grey Eagle, an SRWD project

# Lake Osakis Projects

The SRWD appreciates the time and efforts of the Osakis Lake Association in 2025 and looks forward to continuing a partnership to achieve fishable and swimmable waters in Lake Osakis. Since 2022, the SRWD and OLA have been working together on the **US Army Corps of Engineers (USACE) PAS Alternatives Analysis** study on Lake Osakis and its surrounding watershed. This idea was brought about following concerns over Lake Osakis' water quality, especially in Miller Bay, and led to the formation of a project team. There has historically been water quality and habitat issues on Lake Osakis, much of it due to the drainage of the Crooked Lake Basin west of the lake. There was once a shallow "lake" or network of wetlands called Crooked Lake that eventually flowed into the Long Prairie River north of the Sauk River Watershed. In 1910, Crooked Lake was fundamentally drained due to the creation of Judicial Ditch #2 (JD2), a public drainage system network that channelized and diverted the flow of wetlands in the Crooked Lake Basin. JD2 eventually outlets into Lake Osakis at Miller Bay, meaning there is an influx of water and nutrients entering the lake from this drainage area.

The JD2 Project Team partnered with the SRWD and USACE to conduct the Alternatives Analysis study that will inform the development of a Comprehensive Plan to address the problems identified by the project team. The first task was to establish the current condition of Lake Osakis. This involved survey work, water quality and sediment sampling, and modeling. The outcome was a Lake Response Model that can predict how different management practices and conservation efforts will affect the lake and surrounding drainage area. This model will give the SRWD a better understanding of what projects would be best to implement and where to focus our attention to work towards removing Lake Osakis from the state's impaired waters list. Findings from the Alternatives Analysis will also be used to develop a Comprehensive Plan, which will be used to identify and pursue funding needs for potential project implementation.

In the meantime, OLA has been focusing on shoreline management practices and how individual lakeshore owners can reduce any negative impacts to the lake. Lawn fertilizer, shoreline erosion, and septic systems can all add unwanted nutrients to Lake Osakis.

OLA volunteers assisting with sediment sampling, 01.27.2025

You can stay up to date on the Lake Osakis Area water quality news and events by joining our Constant Contact emailing list. Sign up on our website homepage at www.srwdmn.org under **"Keep Up to Date."**

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**Abi Borgerding**
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**Sauk River Watershed District**

***Please Note:***

The data and recommendations included in this report are based on the 2025 monitoring season. Lake samples were collected by Tim Green, OLA's water quality volunteer, and all data was reviewed by the Sauk River Watershed District. This report is not a complete picture of all conditions, but built to assess specific measurements of water quality.

Contact Abi Borgerding, Environmental Monitoring Manager with the Sauk River Watershed District, with any questions or concerns regarding the information presented in this report.

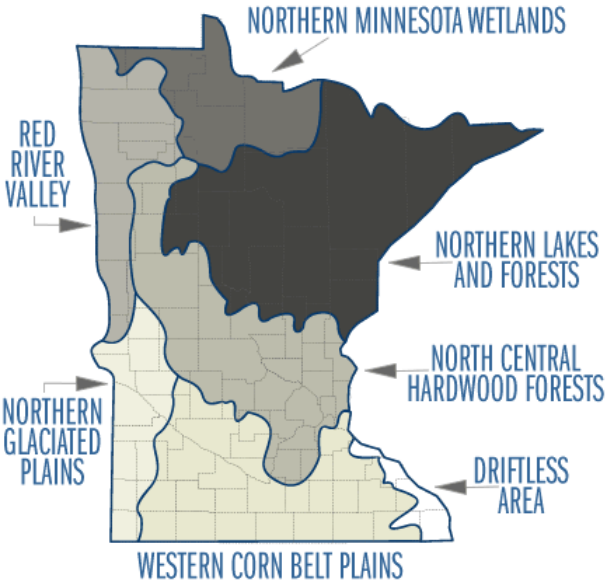
***All aerial photos taken from Google Earth, and all water quality standard information and state statistics were gathered from Minnesota Pollution Control Agency (MPCA) documents accessed Feb 2026.***

# Common Terms

**Eutrophication** - The term comes from the Greek *eutrophos*, meaning "well-nourished." Eutrophication occurs when an excess of nutrients that are usually environmentally limited enter a river or lake system and contribute to excessive plant and algae growth. Eutrophication can have quite negative impacts on aquatic communities' health. The excessive plant growth can clog up boat motors, outcompete native plants, and change the animals that are able to survive in the waterbody. When the excessive plant growth dies back and decomposes, microbes in the water break down the plant material and use up the majority of the available oxygen in the waterbody. This creates low oxygen (hypoxic) conditions and will stress and even kill aquatic animals. Additionally, water clarity and recreational suitability are greatly reduced in eutrophic conditions, and physical contact with or ingestion of the water could result in indigestion or even death.

**Point Source** and **Nonpoint Source** - These terms are used when referring to how a pollutant enters a waterbody. **Point** sources are single and identifiable locations, such as the end of a pipe, and are regulated by state and federal agencies. **Nonpoint** sources are can be rain and snow runoff, which accumulate pollutants as water drains. Places like parking lots, farmland, construction sites, and eroding streambanks are considered nonpoint sources of pollution and are harder to track, control, and regulate.

**Ecoregion** - A region defined by distinctive geography, plant and animal communities, land uses, soil profiles, and sun and moisture patterns. Ecoregions are used by the Environmental Protection Agency (EPA) and Minnesota Pollution Control Agency (MPCA) to characterize regional differences in the state and their effects on water quality. The Minnesota ecoregion Osakis Lake resides in is the North Central Hardwood Forest (NCHF). The NCHF ecoregion is a transitional zone between the predominantly forested northern lakes region and the corn belt plains in southern Minnesota. In addition to the ecoregion classification, lakes are further classified as shallow or deep, depending on the maximum and average lake depths. The size and depth of a lake influences characteristics such as water clarity, water temperature, and aquatic plant growth.



# Water Quality Monitoring Parameters

**Chlorophyll-A** (chl-A) - Chlorophyll-A is a measure of the amount of algae growing in a waterbody and can be used as an indicator of water quality. Chl-A is a comparable analysis to TSS in streams. As water warms, algae begins to grow, and the amount of growth is dependent on the amount of nutrients in the water body.

Although algae is a natural part of freshwater ecosystems, too much algae can result in decreased levels of oxygen in the waterbody and cause aesthetic problems, such as green scum and bad odors. Some algae naturally produce toxins as well and can be a public health concern in high concentrations. Waterbodies that receive septic systems discharges and agricultural and urban runoff may have high concentrations of chl-A in response to the excess nutrients. The general water quality standard for chl-A in lakes within the north central hardwood forest (NCHF) ecoregion is less than 14 µg/L.

**Total Phosphorus** (TP) - Total phosphorus is a measure of both the organic and inorganic forms of phosphorus. Organic phosphorus is not commonly found in suspension in the water column and is not as chemically available as food to bacteria and algae. Inorganic phosphorus, referred to as ortho-phosphorus, is commonly dissolved in water and is readily available to plants and animals. Phosphorus is an essential nutrient for growth but is only necessary in small concentrations to sustain life. Phosphorus can also be found in the water column and embedded in water bottom materials. Most rivers and lakes have elevated phosphorus, with point source contributions from wastewater and industrial releases, and nonpoint source contributions from agricultural fertilizers and contaminated groundwater. Minnesota is broken up into ecoregions to account for the variability in landscape, land use, and weather across the state, and each ecoregion has unique water quality standards. The Central River Nutrient Region standard for total phosphorus in JD2 and Osakis Outlet is less than 100 µg/L. The NCHF ecoregion water quality for Lake Osakis, a deep water lake, is less than 40 µg/L.

**Secchi Disk** - Water clarity is measured using a Secchi disk (also known as a transparency disk) that is lowered into the water until it can no longer be seen, and the depth of visibility is noted. Secchi disk readings are used to assess water visibility and quality. The general water quality standard for deep lake Secchi disk readings in the North Central Hardwood Forest (NCHF) ecoregion is greater than 4.6 feet (1.4 meters).