Addendum to the
Water Quality Improvement Plan
for

Lake Anita

Cass County, Iowa

Total Maximum Daily Load for:
Algae
Addendum to include Turbidity

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GENERAL REPORT SUMMARY

What is the purpose of this report?
This report serves as an addendum to the Lake Anita Water Quality Improvement Plan (WQIP), dated March 2023, which was previously prepared by the Iowa Department of Natural Resources (Iowa DNR), submitted and subsequently approved by the EPA. The WQIP addressed the Total Maximum Daily Load (TMDL) for Algae. Subsequent to the Lake Anita WQIP approval, the lake was placed on the 2024 303(d) list for a non-algal turbidity impairment. This addendum addresses the non-algal turbidity impairment. For a full discussion please see the 2023 Lake Anita WQIP entitled "*Water Quality Improvement Plan for Lake Anita, Cass County, Iowa, Total Maximum Daily load for: Algae*" dated March 2023 and approved by the EPA on April 13, 2023

What is wrong with Lake Anita?
Lake Anita is listed as impaired on the 2024 303(d) list for not supporting its primary contact recreation designated use. The impairment is due to elevated levels of non-algal turbidity, which is caused by fine sediment particles and other materials suspended in the water column.

What is causing the problem?
The amount of sediment and phosphorus transported to the lake from the surrounding watershed is sufficient to cause excessive growth of algae and excessive levels of turbidity, which reduces water clarity. Phosphorus is carried to the lake in two primary forms: (1) attached to eroded soil that is transported to the lake by rainfall runoff and stream flow, and (2) dissolved phosphorus in runoff and subsurface flow (e.g., shallow groundwater). Phosphorus and sediment within the water column and on the lake bed may become resuspended under certain conditions, which can add to algae and turbidity issues. There are no allowable discharging point sources in the Lake Anita watershed; therefore, all phosphorus loads to the lake are attributed to nonpoint sources.

Nonpoint sources are discharged in an indirect and diffuse manner, and often are difficult to locate and quantify. Nonpoint sources of phosphorus in the Lake Anita watershed include gully erosion, sheet and rill erosion from various land uses, runoff and subsurface flows from lands that receive fertilizer application, grazed pasture land, poorly functioning septic systems, manure deposited by wildlife, and particles carried by dust and wind (i.e., atmospheric deposition). A portion of the phosphorus carried to the lake eventually settles to the lake bottom and accumulates. Under certain conditions, this accumulated phosphorus can become available for algal uptake and growth through an internal recycling process.

What can be done to improve Lake Anita?
Reducing phosphorus loss from pasture and row crops and implementing or improving existing structural BMPs such as terraces, grassed waterways, and constructed sediment basins in beneficial locations will significantly reduce phosphorus loads to the lake. Increasing the trapping efficiency of the existing sediment basins may be the most cost-effective structural alternative. Attention should be given to row crops on steep slopes, where the adoption of cover crops or perennial strips may be especially beneficial. Restoring watershed hydrology to mitigate streambank and gully erosion is challenging to implement, but an effective strategy for reducing sediment and phosphorus transport. Additionally, in-lake practices such as targeted dredging may be necessary in order to address algae and turbidity concerns. Consideration should be given to rehabbing the existing ponds and wetlands in the watershed that have not been previously addressed.

TOTAL MAXIMUM DAILY LOAD (TMDL) FOR TURBIDITY

A Total Maximum Daily Load (TMDL) is required for Lake Anita by the Federal Clean Water Act. The WQIP for Lake Anita quantified the maximum amount of total phosphorus (TP) the lake can assimilate and still support primary contact recreation. The TMDL for algae will also address the turbidity impairment since both are attributed to excess nutrients, particularly phosphorus. As a result, the amendment will not revisit the allowable TP load to the lake but refer to the 2023 WQIP for allowable phosphorus loads.

For convenience, a summary of the TMDL targets presented in the 2023 Lake Anita WQIP will be provided here. For a full discussion please see the 2023 Lake Anita WQIP entitled "*Water Quality Improvement Plan for Lake Anita, Cass County, Iowa, Total Maximum Daily load for: Algae*" dated March 2023 and approved by the EPA on April 13, 2023.

Problem Identification

Lake Anita is a Significant Publicly Owned Lake and is protected for the following designated uses:

Primary contact recreation - Class A1
Aquatic life - Class B(LW)
Fish consumption - Class HH

The 2024 Section 305(b) Water Quality Assessment Report states that the primary contact recreation designated use for Lake Anita is assessed as "not supported" due to "Narrative criteria violation: aesthetically objectionable conditions". The 2024 assessment can be accessed at https://programs.iowadnr.gov/adbnet/Segments/1435/Assessment/2024.

Applicable Water Quality Standards

The State of Iowa Water Quality Standards (WQS) are published in the Iowa Administrative Code (IAC), Environmental Protection Rule 567, Chapter 61. Although the State of Iowa does not have numeric criteria for sediment, nutrients, or algae (chl-a), general (narrative) water quality criteria below do apply:

61.3(2) General water quality criteria. The following criteria are applicable to all surface waters including general use and designated use waters, at all places and at all times for the uses described in 61.3(1)"a."

a. Such waters shall be free from substances attributable to point source wastewater discharges that will settle to form sludge deposits.
b. Such waters shall be free from floating debris, oil, grease, scum and other floating materials attributable to wastewater discharges or agricultural practices in amounts sufficient to create a nuisance.
c. Such waters shall be free from materials attributable to wastewater discharges or agricultural practices producing objectionable color, odor or other aesthetically objectionable conditions.
d. Such waters shall be free from substances attributable to wastewater discharges or agricultural practices in concentrations or combinations which are acutely toxic to human, animal, or plant life.
e. Such waters shall be free from substances, attributable to wastewater discharges or agricultural practices, in quantities which would produce undesirable or nuisance aquatic life.

For 303(d) listing purposes, aesthetically objectionable conditions are present in a waterbody when Carlson's Trophic State Index (TSI) for the median growing season chl-a or Secchi depth exceeds 65. In order to de-list the turbidity impairment, the median growing season for chl-a TSI and Secchi depth TSI must not exceed 63 for one 303(d) listing cycle, per DNR de-listing methodology.

Problem Statement

Lake Anita is impaired because primary contact recreation is not fully supported due to violations of WQS. High levels of non-algal turbidity cause the impairment. This turbidity is the result of sediment loads from the watershed. Because sediment is laden with phosphorus, which contributes to algal blooms when non-algal turbidity is low, reductions in phosphorus loads will reduce turbidity and also prevent future algal blooms.

Interpreting Lake Anita Data

The 2024 305(b) assessment was based on results of the ambient monitoring program conducted from 2018-2022 by Iowa State University (ISU). All data was collected at the ambient monitoring location.

Carlson's Trophic State Index (TSI) was used to evaluate the relationships between TP, algae (chl-a), and transparency (Secchi depth) in Lake Anita. TSI values are not a water quality index but an index of the trophic state of the water body. However, the TSI values for Secchi depth and chl-a can be used as a guide to establish water quality improvement targets.

If the TSI values for the three parameters are the same, the relationships between the TP, algae, and transparency are strong. If the TP TSI value is higher than the chl-a TSI, it suggests there are limitations to algal growth besides phosphorus. If the Secchi depth TSI value is higher than the chl-a TSI, it suggests that non-algal factors dominate water clarity. Figure 1 is a plot of the five-year running median TSI values, the 65 TSI threshold value, and the TSI de-listing value of 63. TSI values that exceed the 303(d)-listing threshold of 65 (for chl-a and Secchi depth) are contained within the red box. Table 1 lists the Lake Anita average and median TSI values for the 2022 and 2024 305(b) assessment periods. Review of this information indicates a trend, in more recent years, that the Secchi depth TSI is greater than chl-a TSI indicating that non-algal factors dominate water clarity.

Figure 2 is a plot of the average and median TSI deviation values from the 2022 and 2024 305(b) assessment periods and illustrates a method for interpreting the meaning of the deviations between Carlson's TSI values for TP, Secchi depth, and chl-a. Each quadrant of the chart indicates the potential factors that may limit algal growth in a lake. A detailed description of this approach is available in A Coordinator's Guide to Volunteer Lake Monitoring Methods. If the deviation between the chl-a TSI and TP TSI is less than zero (Chl TSI < TP TSI), the data point will fall below the X-axis. This suggests phosphorus may not be the limiting factor in algal growth. The X-axis, or zero line, is related to TN:TP ratios of greater than 33:1 (Carlson, 1977). Because phosphorus is thought to become limiting at ratios greater than 10:1, TP deviations slightly below the X-axis do not necessarily indicate nitrogen limitation.

Points to the left of the Y-axis (Chl TSI < SD TSI) represent conditions in which transparency is reduced by non-algal turbidity. Points to the right reflect situations in which transparency is greater than chl-a levels would suggest, meaning that large particles, rather than fine clay particles, influence water clarity. Deviations to the right may also be caused by high zooplankton populations that feed on algae, keeping the algal populations lower than expected given other conditions. This data reinforces the previous statement that in more recent years non-algal factors dominate water clarity.

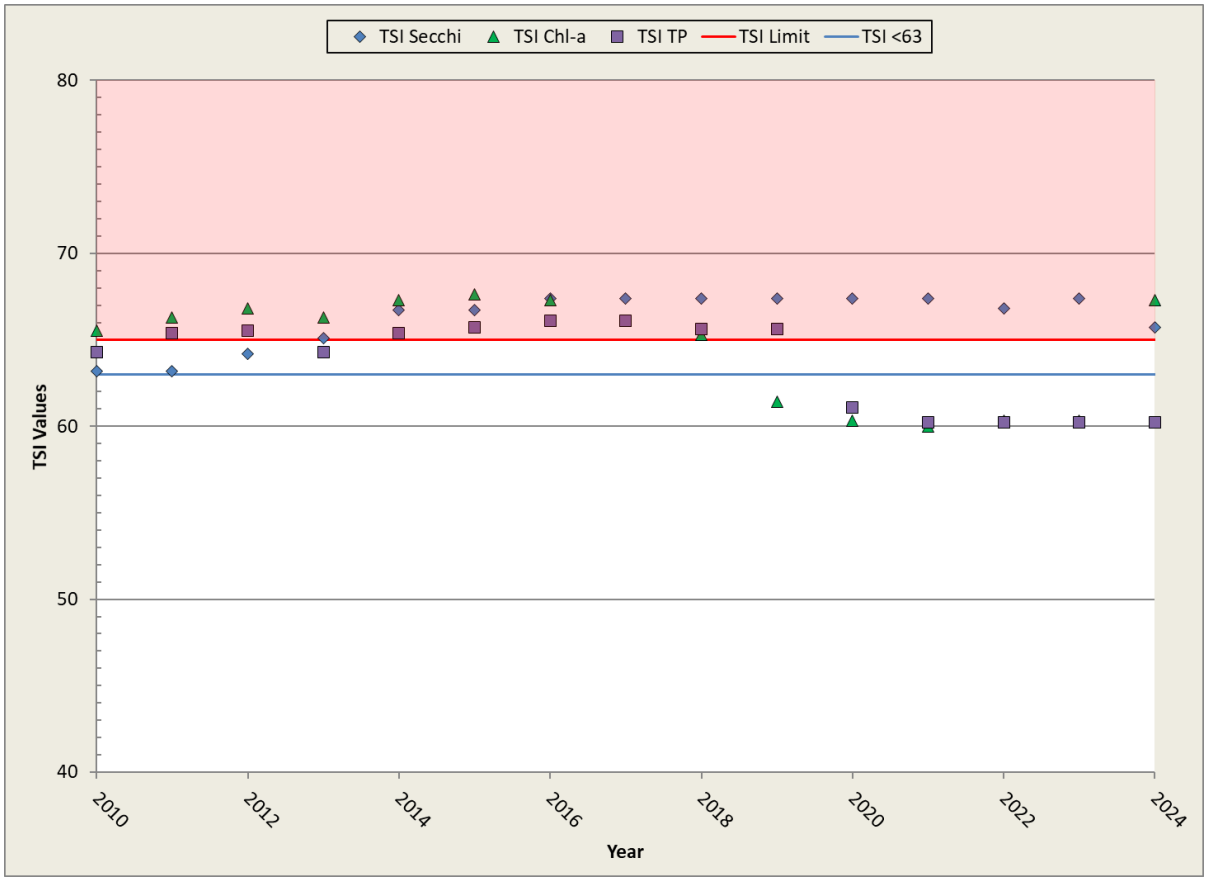

Figure 1. Five-Year Running Median TSI Values.

Table 1. Average and Median TSI Values for 2022 and 2024 Assessment Periods.

	Secchi Depth	Chl-a	Total Phosphorus
2022 Average TSI Values	64	57	59
2022 Median TSI Values	67	60	61
2024 Average TSI Values	63	60	57
2024 Median TSI Values	67	60	60

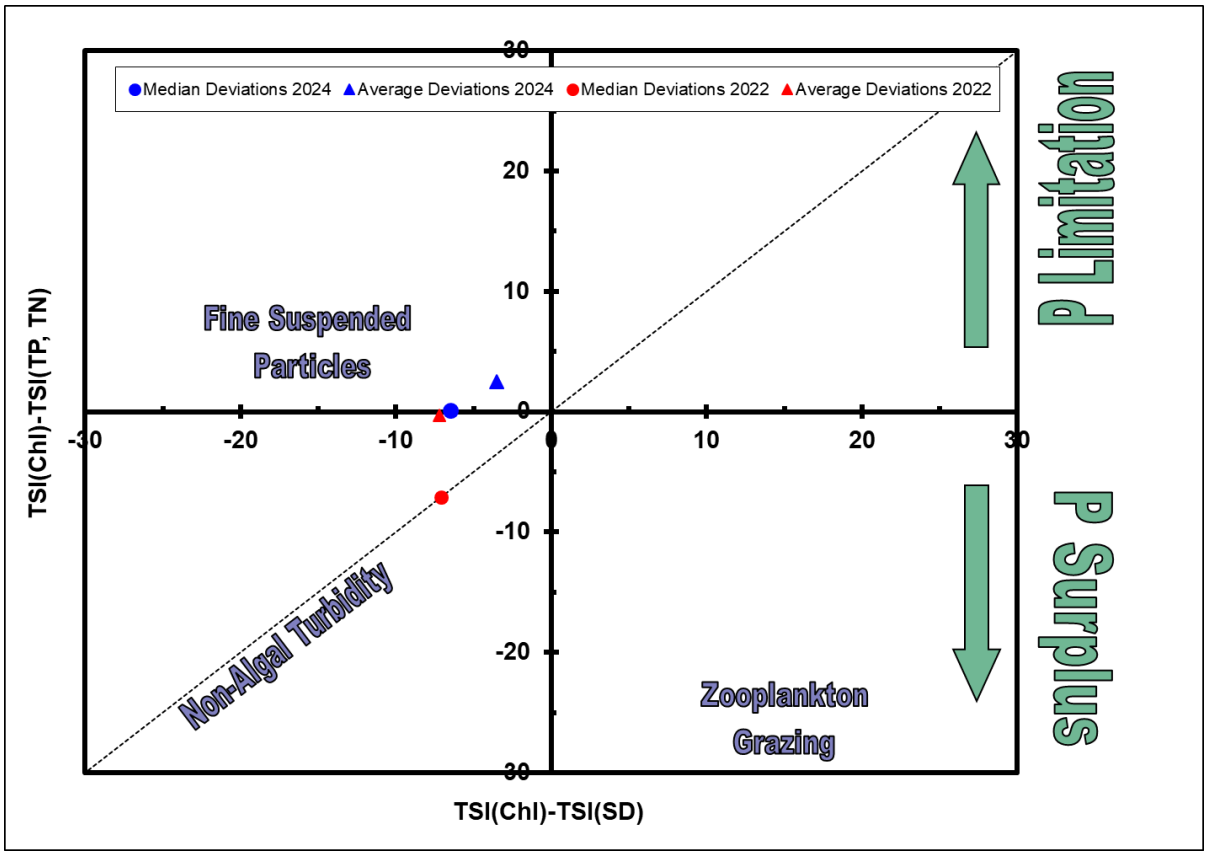

Figure 2. Average and Median TSI Deviation Values from 2022 and 2024 Assessment Periods.

TMDL Target

General Description of the Pollutant

The 2024 305(b) assessment attributes poor water quality in Lake Anita to turbidity. From the 2023 Lake Anita WQIP, modeling indicates that a TP reduction of 53% is needed to achieve TSI values of 63 or less for Secchi depth and chl-a. However, modeling also indicates that to achieve the desired result of TP reduction that Secchi depth is the controlling parameter over chl-a. This would also suggest that water clarity is influenced more from non-algal turbidity than algal turbidity.

Table 2 was copied from the 2023 Lake Anita WQIP and reports the simulated chl-a, TP, and Secchi depth at the ambient monitoring location for both existing and target conditions. The Secchi depth TSI target of 63 complies with the narrative "free from aesthetically objectionable conditions" criterion. Meeting this target will result in delisting Lake Anita if attained in one 303(d) listing cycle, per Iowa DNR de-listing methodology. Note that TP values in Table 2 are not TMDL targets. Rather, they represent in-lake water quality resulting from TP load reductions required to obtain the chl-a and Secchi depth TSI targets in Lake Anita.

Table 2[3]. Existing and Target Water Quality (Ambient Monitoring Location).

Parameter	2006-2021[1]	2016-2020[2]	TMDL Target Conditions
Secchi Depth (meter)	0.69	0.6	0.8
TSI (Secchi Depth)	65	67	63
Chlorophyll-a (µg/L)	35.0	20.6	27.1
TSI (Chlorophyll-a)	65	60	63
TP (µg/L)	64.0	52	44.6
TSI (TP)	64	61	59

[1]Modeled Period, Median Values.
[2]2022 Assessment/Listing Cycle Values.
[3]This table copied from the 2023 Lake Anita WQIP.

The allowable in-lake Secchi depth target of 63 was translated to the TP loading by performing water quality simulations using the BATHTUB model. Based on these models the allowable annual loading capacity for TP is 1,225.1 lbs/year and the allowable maximum daily load is 10.5 lbs/day.

Waterbody Pollutant Loading Capacity (TMDL)
The TMDL establishes a Secchi depth TSI target of 63 or less using analyses of existing water quality data and Carlson's trophic state index methodology. The allowable TP loading capacity was developed by performing water quality simulations using the BATHTUB model.

Decision Criteria for WQS Attainment
The narrative criteria in the water quality standards require that Lake Anita support primary contact for recreation. The metrics for WQS attainment for de-listing the impairments are a chl-a TSI and Secchi depth TSI of 63 or less for one 303(d) listing cycle.

Pollution Source Assessment
Existing Load
Using STEPL and BATHTUB to simulate annual average conditions between 2006-2021, the annual TP load to Lake Anita was estimated to be 2,580.1 lbs/yr.

Identification of Pollutant Sources
The existing TP load to Lake Anita is entirely from nonpoint sources of pollution and natural background sources. Sources that would contribute to non-algal turbidity are the same as those contributing to the phosphorus load as described in the 2023 WQIP.

TMDL Summary

The following general equation represents the total maximum daily load (TMDL) calculation and its components:

$$TMDL = LC = \sum WLA + \sum LA + MOS$$

Where:
TMDL = total maximum daily load
LC = loading capacity
Σ WLA = sum of wasteload allocations (point sources)
Σ LA = sum of load allocations (nonpoint sources)
MOS = margin of safety (to account for uncertainty)

Once the loading capacity, wasteload allocations, load allocations, and margin of safety have all been determined for the Lake Anita watershed, the general equation above can be expressed for the Lake Anita algae TMDL.

Expressed as the allowable annual average, which is helpful for water quality assessment and watershed management:

$$TMDL = LC = \sum WLA(0\ lbsTP/year) + \sum LA(1102.6\ lbsTP/year + MOS(122.5\ lbsTP/year) = \mathbf{1225.1\ lbsTP/year}$$

Expressed as the maximum daily load:

$$TMDL = LC = \sum WLA(0\ lbsTP/day) + \sum LA(9.4\ lbsTP/day + MOS(1.1\ lbsTP/day) = \mathbf{10.5\ lbsTP/day}$$

Table 3. Water Quality Data, From 2006-2023.

Source	Date	Secchi (m)	Chl-a (µg/L)	TP (µg/L)	Secchi TSI	Chl-a TSI	TP TSI
ISU	5/30/2006	1.15	34.0	44.0	58.0	65.2	58.7
ISU	6/26/2006	0.90	17.9	49.0	61.5	58.9	60.2
ISU	8/1/2006	0.75	62.9	77.0	64.1	71.2	66.7
SHL	4/23/2007	2.10	16.0	60.0	49.3	57.8	63.1
ISU	5/29/2007	1.25	54.6	62.0	56.8	69.8	63.6
ISU	6/25/2007	1.17	17.9	58.0	57.7	58.9	62.7
SHL	7/9/2007	0.60	51.0	70.0	67.4	69.2	65.4
ISU	7/30/2007	0.45	73.2	80.0	71.5	72.7	67.3
SHL	9/10/2007	0.80	34.0	80.0	63.2	65.2	67.3
SHL	5/12/2008	1.20	42.0	80.0	57.4	67.3	67.3
SHL	7/7/2008	1.10	43.0	70.0	58.6	67.5	65.4
ISU	6/9/2009	1.80	12.0	29.7	51.5	55.0	53.0
ISU	7/13/2009	0.80	38.0	65.0	63.2	66.3	64.3
ISU	8/6/2009	0.40	35.0	76.0	73.2	65.5	66.6
ISU	6/16/2010	0.80	35.0	47.8	63.2	65.5	59.9
ISU	8/3/2010	0.40	48.0	76.0	73.2	68.6	66.6
ISU	9/16/2010	0.60	27.0	62.7	67.4	62.9	63.8
ISU	6/15/2011	2.10	14.0	52.4	49.3	56.5	61.2
ISU	8/2/2011	0.60	55.0	71.4	67.4	69.9	65.7
ISU	9/13/2011	0.70	49.0	81.4	65.1	68.8	67.5
ISU	6/13/2012	1.00	23.0	42.1	60.0	61.4	58.0
ISU	8/1/2012	0.40	76.0	87.5	73.2	73.1	68.6
ISU	9/11/2012	0.60	42.0	138.9	67.4	67.3	75.2
ISU	6/12/2013	1.20	14.0	50.7	57.4	56.5	60.7
ISU	7/31/2013	1.00	39.0	43.8	60.0	66.5	58.6
ISU	9/11/2013	0.50	77.0	80.0	70.0	73.2	67.3
TMDL	4/16/2014			50.0			60.5
TMDL	4/17/2014		11.0	40.0		54.1	57.3
TMDL	4/29/2014		2.0	50.0		37.4	60.5
TMDL	5/13/2014		4.0	40.0		44.2	57.3
TMDL	5/27/2014		11.0	50.0		54.1	60.5

Source	Date	Secchi (m)	Chl-a (µg/L)	TP (µg/L)	Secchi TSI	Chl-a TSI	TP TSI
TMDL	6/9/2014		45.0	90.0		67.9	69.0
ISU	6/18/2014	0.68	59.0	73.5	65.6	70.6	66.1
TMDL	6/24/2014		22.0	50.0		60.9	60.5
TMDL	7/8/2014		16.0	60.0		57.8	63.1
TMDL	7/23/2014		42.0	80.0		67.3	67.3
TMDL	8/5/2014		130.0	80.0		78.4	67.3
ISU	8/6/2014	0.63	66.2	70.1	66.7	71.7	65.4
TMDL	8/20/2014		120.0	740.0		77.6	99.4
TMDL	9/2/2014		86.0	320.0		74.3	87.3
ISU	9/16/2014	0.50	97.4	133.7	70.0	75.5	74.7
TMDL	9/30/2014		140.0	110.0		79.1	71.9
TMDL	10/15/2014		9.0	70.0		52.2	65.4
ISU	6/17/2015	2.50	9.0	24.9	46.8	52.2	50.5
ISU	8/5/2015	0.50	70.0	80.0	70.0	72.3	67.3
ISU	9/15/2015	0.50	65.0	110.3	70.0	71.6	71.9
ISU	6/14/2016	1.70	23.0	40.9	52.4	61.4	57.6
ISU	8/2/2016	0.50	80.0	98.9	70.0	73.6	70.4
ISU	9/11/2016	0.60	36.0	94.5	67.4	65.8	69.7
ISU	6/6/2017	1.60	20.0	22.5	53.2	60.0	49.0
ISU	7/25/2017	0.60	30.0	77.3	67.4	64.0	66.8
ISU	8/28/2017	0.40	1.7	76.6	73.2	35.5	66.7
ISU	6/5/2018	1.00	6.0	34.6	60.0	48.2	55.2
ISU	7/25/2018	0.50	86.0	70.9	70.0	74.3	65.6
ISU	8/30/2018	0.80	33.0	61.3	63.2	64.9	63.5
ISU	6/11/2019	1.68	0.6	10.0	52.6	25.6	37.3
ISU	7/31/2019	0.53	16.5	10.0	69.1	58.1	37.3
ISU	9/8/2019	0.43	4.0	119.8	72.2	44.2	73.1
ISU	6/3/2020	1.50	16.4	24.8	54.2	58.0	50.4
ISU	7/20/2020	0.60	44.4	52.0	67.4	67.8	61.1
ISU	9/23/2020	0.50	20.6	37.0	70.0	60.3	56.2
ISU	6/2/2021	2.2	8.7	24.0	49.0	51.9	49.9
ISU	7/27/2021	0.6	42.2	54.0	66.8	67.3	61.6
ISU	9/13/2021	0.5	53.0	49.0	69.3	69.5	60.2
ISU	6/21/2022	1.6	15.7	40.0	53.2	57.6	57.3
ISU	8/9/2022	0.6	101.4	68.0	67.4	75.9	65.0
ISU	9/19/2022	0.9	50.7	55.0	61.5	69.1	61.9
ISU	6/21/2023	2.2	8.1	27.0	48.8	51.1	51.6
ISU	8/8/2023	0.5	81.7	55.0	69.3	73.8	61.9
ISU	9/18/2023	0.6	25.3	56.0	67.4	62.3	62.2
ISU	6/25/2024	1.18	2.1	27.0	57.7	38.1	51.6
ISU	8/15/2024	1.18	75.6	41.0	57.7	73.0	57.7

Source	Date	Secchi (m)	Chl-a (µg/L)	TP (µg/L)	Secchi TSI	Chl-a TSI	TP TSI
ISU	9/30/2024	0.68	56.3	54.0	65.7	70.1	61.6
Average	--	0.94	41.3	74.5	62.9	63.1	62.9
Median	--	0.70	35.5	60.0	65.1	65.6	63.1

PUBLIC PARTICIPATION

Public involvement is important in the Total Maximum Daily Load (TMDL) process since it is the land owners, tenants, and citizens who directly manage land and live in the watershed that determine the water quality in Lake Anita.

Public Meeting

A virtual on-line presentation was prepared to present the results of the TMDL. A link to the presentation can be located on the Iowa DNR's website at https://www.iowadnr.gov/environmental-protection/water-quality/watershed-improvement/watershed-planning/water-quality-improvement-plans. The presentation will be available for viewing through the public comment period.

Public Comments

A press release was issued on May 29, 2025 to begin a 30-day public comment period which will end on June 30, 2025. All comments received by the DNR during the 30-day public notice period will be attached.