SUMMARY OF 2024 FIELD DATA COLLECTED IN LAKE CATHERINE, ARKANSAS

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ACRONYMS AND ABBREVIATIONS

ANOVA……..Analysis of Variance

APC&EC……..Arkansas Pollution Control and Ecology Commission

CHL…….…..…….Chlorophyll *a*

DEQ…..…..Arkansas Department of Energy and Environment Division of Environmental Quality

DO……...……...Dissolved Oxygen

MDL……...……Method Detection Limit

SD……...……Secchi Depth

SpC…….……...Specific Conductivity

TN…...……...Total Nitrogen

TP…...…….Total Phosphorus

USGS.……..United States Geological Survey

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1. INTRODUCTION

In a letter dated January 31, 2024, the Arkansas Department of Energy & Environment Division of Environmental Quality (DEQ) stated that they had received numerous complaints regarding the water quality and filamentous algal growth in Lake Catherine, specifically Spencer Bay. In this letter, DEQ requested the City of Hot Springs perform a study of water quality in Lake Catherine. This letter specified certain requirements of the water quality study, including locations, methods, and types of field data to be collected. In March 2024, the City of Hot Springs submitted to DEQ a Workplan that addressed DEQ's requirements for field data collection. In a letter dated April 9, 2024, DEQ approved the Workplan subject to several conditions, one of which was adding sample site LOUA016J. This sample site was included in all the sampling events, although the Workplan was not formally revised to reflect this addition until August 2024.

2. METHODOLOGY

2.1 Monitoring Locations

Five locations were monitored based on DEQ's study design proposal and discussions between DEQ and the City of Hot Springs in a meeting on February 28, 2024, as well as DEQ's conditional approval letter dated April 9, 2024. These monitoring locations are shown in Table 1 and Figure 1.

Table 1. Monitoring Locations in Lake Catherine.

Site Name	Location Description	Latitude	Longitude	Rationale
LOUA016N	Lake Catherine 0.5 miles upstream from Camp Couchdale	34.431194	-92.976433	Included in DEQ study design proposal
LOUA016S	Lake Catherine in Spencer Bay	34.458206	-92.974091	Included in DEQ study design proposal
LOUA016B	Lake Catherine - upper - downstream of Spencer Bay	34.457 (approx.)	-92.965 (approx.)	Discussed by City of Hot Springs and DEQ in Feb. 28 meeting
LOUA016L	Lake Catherine 0.5 miles downstream of Marina Point	34.444778	-92.947914	Included in DEQ study design proposal
LOUA016J	Lake Catherine near entrance to State Park Cove	34.439369	-92.910828	Required by DEQ Conditional Approval Letter

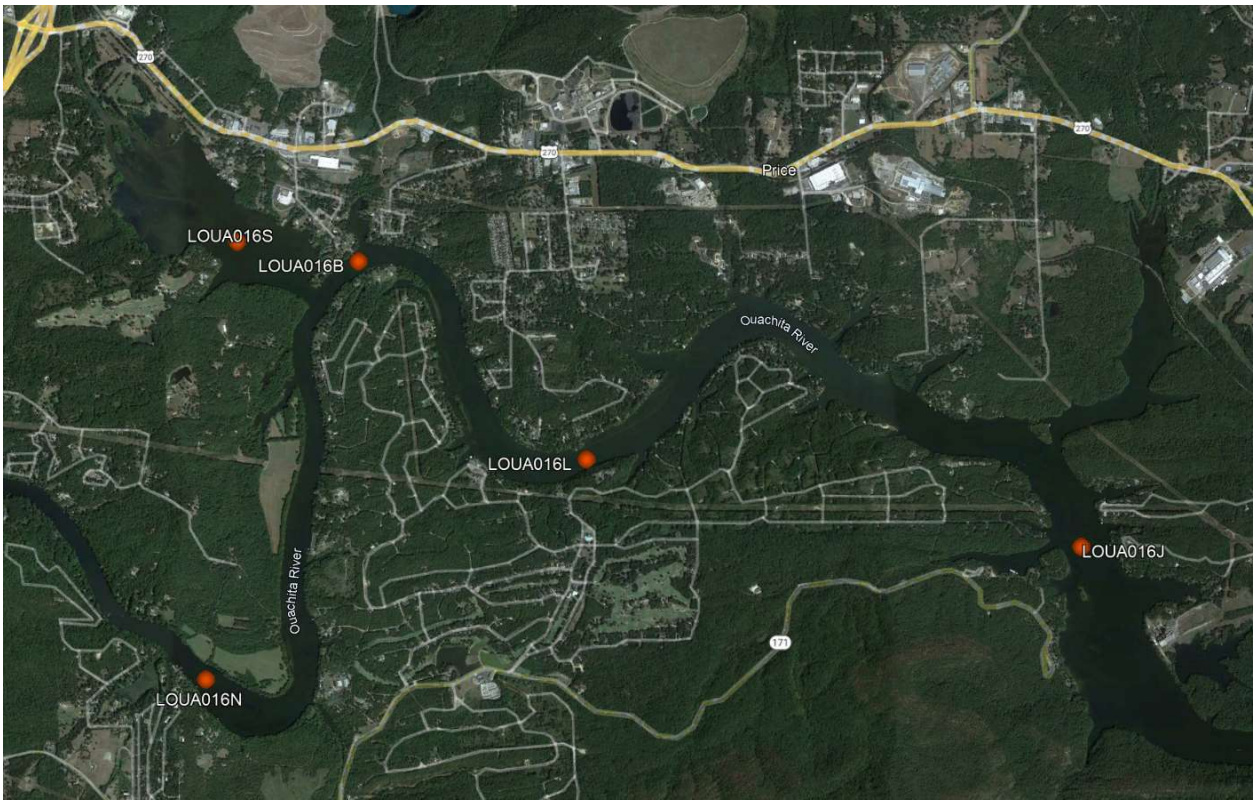

Figure 1. Field Data Collection Locations.

2.2 Water Quality

Monitoring was conducted on each of the following eight dates during 2024: April 30, May 21, June 13, July 16, August 29, September 25, October 23, and November 14. The following sampling procedures were modified from the DEQ Lake Sampling Standard Operating Procedures and Work Plan (DEQ 2023).

Vertical profiles of in situ water quality parameters were collected with a YSI ProDSS multiparameter sonde at each of the five locations in Table 1 prior to collecting samples for laboratory analysis. The ProDSS was calibrated for dissolved oxygen (DO), specific conductivity (SpC), and pH prior to and after use per factory recommended protocols. Each profile consisted of a discrete measurement just below the surface at 0.5 m depth with additional measurements at one-meter intervals beginning at one meter depth. Measured parameters included DO, temperature, SpC, and pH. Total depth and Secchi depth were recorded following each profile.

Water samples for laboratory analysis were collected via a Van Dorn sampler following measurement of in situ water quality data. Each epilimnion sample was collected from one meter below the surface, with hypolimnion samples being taken from one meter above the bottom. In Spencer Bay (LOUA016S), no hypolimnion samples or measurements were collected due to its shallow depth. Instead, a duplicate epilimnion sample was collected at LOUA016S. All samples were immediately placed on ice in an ice chest until being relinquished the same day to Eurofins Environmental Testing - Little Rock (formerly American Interplex). Each sample was analyzed for total phosphorus (TP), chlorophyll *a*, and total nitrogen (TN).

2.3 Filamentous Algae

Filamentous algae sampling procedures for Lake Catherine were modified from the subsampling method for longitudinal surveys detailed in Griggs et al. (2015). Filamentous algae sampling was conducted for each sampling event at each of the five locations in Table 1.

A transect was established at each sample location perpendicular to the bank at a horizontal distance from shore to the point where the water was 3 meters deep (average photic zone) or 50 meters from shore, whichever was less. This horizontal distance was split into 5 equidistant 1x1 m quadrates for each bank totaling 10 quadrates per monitoring location. Visual estimation of total filamentous algae cover was made within each of the ten 1x1 m quadrates. Filamentous algae was recorded as benthic, floating, or both. For transects that did not include 5 quadrates due to excessive depth, the unused plots were marked as “NA”. In quadrates where visual estimates weren’t possible due to lack of water clarity, quadrates were marked as “VDI” (for visual determination inhibited) and an additional Secchi depth was collected at mid-quadrate. When aquatic plants where visible but precluded algae estimates, “Macro” was recorded. Photos were taken at each bank.

The November sampling event occurred during lake drawdown. The length of exposed bank between the wetted width and the normal pool height was recorded. Percent coverage of filamentous algae on the shoreline of the exposed bank was estimated as an additional plot.

2.4 Incidental Sampling

While navigating between sites, any noticeable blooms of filamentous algae would be investigated per the previous methodologies if the blooming area was approximately 5 square meters (about the size of a sedan) or more.

2.5 Analysis

2.5.1 Data Management

Multiple results reported by the lab were below method detection limits (MDL). The *2024 Integrated Water Quality Monitoring and Assessment Report* (DEQ 2024) states in Section 3.1.2.1, "data that are lower than detection limits of laboratory methods or equipment are typically represented as less than the numerical detection limit. In these cases, DEQ will use one-half the detection limit and assign that value as the numeric result of that data point." All lab results reported as below MDL were standardized to one-half the MDL for that parameter. Results that were reported by the lab with either a J flag (value above MDL but below the reporting limit) or H flag (sample was prepped or analyzed beyond the specified holding time) were retained with no adjustment. The only data that were reported with an H flag were the chlorophyll *a* data for the October sampling event.

2.5.2 Statistical Analysis

Analysis of in situ parameters used data recorded at one meter depth to coincide with the depth of epilimnion nutrient collection. A Friedman's Rank Test with a Bonferroni multiple comparisons test was used to evaluate significant differences between the monitoring locations for temperature and DO after a Shapiro-Wilk test determined the data set for these parameters did not meet the assumption of normality. A repeated measures ANOVA with a Bonferroni multiple comparisons test was used to evaluate significant differences between the monitoring locations for specific conductivity and pH.

Significant differences between monitoring locations for nutrient and chlorophyll data were evaluated via Friedman's Rank Test after a Shapiro-Wilk test determined the data sets for all three parameters did not meet the assumption of a normal distribution. A Bonferroni multiple

comparisons test was used to evaluate significant differences between the monitoring locations and depth. All statistical tests used an alpha of 0.05 to assess significance.

Filamentous algae was reported for each sampling event as average coverage for all quadrates at a monitoring location. Significant differences between monitoring locations for algal coverage was evaluated via Friedman's Rank Test with a Bonferroni multiple comparisons test, after a Shapiro-Wilk test determined the distribution of the data set did not meet the assumption of normality. An alpha of 0.05 was used to assess significance.

3. RESULTS

3.1 In Situ Water Parameters

Profile data for all five monitoring locations is presented in Appendix A. The discussion in the following paragraph applies to measurements at a depth of 1.0 meter (the same depth at which epilimnion samples were collected).

Temperature measurements at one meter depth ranged from a low of 14.1°C at LOUA016N during April to a maximum of 30.1°C at LOUA016J in July. There was no significant difference between mean temperature across the monitoring locations (F = 0.94; p = 0.45). Mean specific conductivity had a significant increase from 61.75 µS at LOUA016N to 73.0 µS at LOUA16J (F = 3.13; p = 0.026). The mean pH increased moving downstream from 6.76 at LOUA016N to 7.99 at LOUA016J (F = 3.32; p = 0.021). Nearly all (299 out of 303) of the pH values were within the range of 6.0 to 9.0 (the water quality standards). All four values that exceeded 9.0 were in the top 1.0 meter of the water column. There was no significant difference in mean DO concentrations between monitoring locations (F = 1.54; p = 0.21). However, in September, DO concentrations below 5.0 mg/L were recorded at LOUA016N, LOUA016S, and LOUA016B (1.91 mg/L, 4.26 mg/L, and 4.76 mg/L respectively). Hydropower releases from Carpenter Dam below Lake Hamilton were occurring at this time and likely influenced these DO values. The maximum DO concentration observed at one meter depth was 10.98 mg/L at LOUA016L in April. DO percent saturation values at one meter depth ranged from 20% at LOUA016N in September to 133% at LOUA016J in May. The DO percent saturation values tended to increase moving downstream; this was likely influenced by the sampling crew starting at the upstream end of the study area so that upstream locations were sampled earlier in the day than the downstream stations.

3.2 Nutrients and Chlorophyll

Eighty discrete samples were collected over the course of the study. TP values ranged from a minimum of 0.0135 mg/L (one-half MDL) to a maximum of 0.1730 mg/L (Table 2). There was no significant difference between mean TP concentrations (F = 0.467; p = 0.89). Chlorophyll *a* concentrations ranged from 0.0025 mg/L (one-half MDL) to a maximum of 1.25 mg/L (Table 3). There was no significant difference between mean chlorophyll *a* concentrations for any site or depth sampled (F = 0.837; p = 0.58). TN concentrations ranged from 0.25 mg/L (one-half MDL) to a maximum of 1.814 mg/L (Table 4). There was no significant difference between mean TN concentrations for any site or depth sampled (F = 0.693; p = 0.73).

Table 2. Total Phosphorus Concentrations (mg/L) for Each Monitoring Location.

	LOUA016N		LOUA016S		LOUA016B		LOUA016L		LOUA016J	
	Epilim.	**Hypolim.**	**Epilim.**	**Duplicate**	**Epilim.**	**Hypolim.**	**Epilim.**	**Hypolim.**	**Epilim.**	**Hypolim.**
Apr	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]
May	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]
Jun	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]
Jul	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]	0.0135[1]
Aug	0.0463[2]	0.0135[1]	0.0279[2]	0.0304[2]	0.0360[2]	0.0135[1]	0.0522[2]	0.0350[2]	0.0275[2]	0.0372[2]
Sep	0.0708[2]	0.0536[2]	0.0673[2]	0.0656[2]	0.0581[2]	0.0395[2]	0.0669[2]	0.0498[2]	0.0500[2]	0.0556[2]
Oct	0.1680	0.1330	0.0520[2]	0.0629[2]	0.0472[2]	0.0559[2]	0.0351[2]	0.0480[2]	0.0283[2]	0.0135[1]
Nov	0.0135[1]	0.0273[2]	0.0653[2]	0.0475[2]	0.0479[2]	0.0333[2]	0.0776[2]	0.0342[2]	0.0135[1]	0.0287[2]
Min	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135
Max	0.1680	0.1330	0.0673	0.0656	0.0581	0.0559	0.0776	0.0498	0.0500	0.0556
Mean	0.0441	0.0352	0.0333	0.0326	0.0304	0.0245	0.0357	0.0276	0.0217	0.0236

[1] One half of MDL
[2] Reported by laboratory with J flag (value below reporting limit but above MDL)

Table 3. Chlorophyll *a* Concentrations (mg/L) for Each Monitoring Location.

	LOUA016N		LOUA016S		LOUA016B		LOUA016L		LOUA016J	
	Epilim.	**Hypolim.**	**Epilim.**	**Duplicate**	**Epilim.**	**Hypolim.**	**Epilim.**	**Hypolim.**	**Epilim.**	**Hypolim.**
Apr	0.2510	0.0135	1.0300	1.2500	0.4360	0.0372	0.4460	0.0372	0.1730	0.2390
May	0.2000	0.0472	0.1130	0.1200	0.1300	0.0593	0.1410	0.0375	0.0727	0.2100
Jun	0.3190	0.0916	0.1710	0.1710	0.3310	0.2280	0.2630	0.1560	0.1820	0.3620
Jul	0.0196	0.0072	0.0025[1]	0.0059	0.0168	0.0025[1]	0.0118	0.0054	0.0059	0.0226
Aug	0.3470	0.0025[1]	0.0069	0.0161	0.0124	0.0025[1]	0.0174	0.0025[1]	0.0096	0.0202
Sep	0.0076	0.0101	0.0025[1]	0.0025[1]	0.0091	0.0025[1]	0.0080	0.0217	0.0126	0.0065
Oct	0.0846[3]	0.0244[3]	0.0127[3]	0.0949[3]	0.0025[13]	0.0025[13]	0.0025[13]	0.0025[13]	0.0025[13]	0.1090[3]
Nov	0.0025[1]	0.0025[1]	0.1120	0.0491	0.0186	0.0064	0.4520	0.0296	0.0100	0.0104
Min	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0065
Max	0.3190	0.0916	1.0300	1.2500	0.4360	0.2280	0.4520	0.1560	0.1820	0.3620
Mean	0.1149	0.0249	0.1813	0.2137	0.1196	0.0426	0.1677	0.0366	0.0585	0.1225

[1] One half of MDL
[2] Reported by laboratory with J flag (value below reporting limit but above MDL)
[3] Reported by laboratory with H flag (sample was prepped or analyzed beyond the specified holding time)

Table 4. Total Nitrogen Concentrations (mg/L) for Each Monitoring Location.

	LOUA016N		LOUA016S		LOUA016B		LOUA016L		LOUA016J	
	Epilim.	**Hypolim.**	**Epilim.**	**Duplicate**	**Epilim.**	**Hypolim.**	**Epilim.**	**Hypolim.**	**Epilim.**	**Hypolim.**
Apr	0.652	0.250[1]	0.632	0.728	0.530	0.622	0.562	0.680	1.060	0.562
May	1.005[2]	0.339[2]	0.745[2]	0.757[2]	0.365[2]	0.337[2]	0.715[2]	0.368[2]	0.711[2]	0.385[2]
Jun	0.743[2]	0.747[2]	0.733[2]	1.375[2]	1.175[2]	0.625[2]	1.023[2]	0.749[2]	0.959[2]	0.689[2]
Jul	0.702	0.538	0.622	0.250[1]	0.534	0.250[1]	0.630	0.612	0.614	0.604
Aug	0.865[2]	1.064[2]	0.365[2]	1.082[2]	1.305[2]	0.365[2]	1.247[2]	1.236[2]	1.267[2]	1.814[2]
Sep	0.522	0.778	0.250[1]	0.778	0.644	0.730	0.658	1.580	0.730	0.892
Oct	1.480	1.430	0.838	0.866	0.934	0.810	0.920	0.736	0.894	0.780
Nov	0.953[2]	0.941[2]	1.292[2]	1.202[2]	0.927[2]	1.100[2]	1.255[2]	0.971[2]	1.069[2]	0.873[2]
Min	0.522	0.250	0.250	0.250	0.365	0.250	0.562	0.368	0.614	0.385
Max	1.480	1.430	1.292	1.375	1.305	1.100	1.255	1.580	1.267	1.814
Mean	0.865	0.761	0.685	0.880	0.802	0.605	0.876	0.867	0.913	0.825

[1] One half of reporting limit for Total Nitrogen
[2] Calculated from TKN and NO2+NO3

3.3 Filamentous Algae

Visual estimates of filamentous algae were complicated by low visibility in the water column, steep drop-offs, and aquatic plant growth. A majority of the estimates occurred within the two near-shore quadrates. Mean filamentous algae coverage ranged from 0% to 48% over the course of the monitoring period (Table 5). There was a significant difference between monitoring locations in mean filamentous algae coverage ($F = 5.196$; $p = 0.002$). LOUA016B had significantly higher filamentous algae then LOUA016N and LOUA016J. Higher filamentous algae coverage occurred at LOUA016B along the right bank in a shallow sandy area, but did not occur along the rocky shore on the left bank. This was the only location with such habitat. Shoreline photos from the August sampling event are included in Appendix B (Figures B-1 through B-10).

All filamentous algae within the quadrates was benthic and short. Additionally, no large floating algal mats or long benthic algal fibers were observed while moving between monitoring locations. A heavy rain prior to the August monitoring event dislodged submerged aquatic plants, forming floating weed mats throughout the lake. Many of the floating weed mats had attached brown algae. The only observed instance of floating filamentous algae was less than 6 inches in diameter (Figures B-11 and B-12 in Appendix B). Multiple locations beginning in mid-summer had extensive aquatic plant growth at and near the water's surface. Many of the observed aquatic plants were identified as common bladderwort (*Utricularia macrorhiza*), floating pondweed (*Potamogeton natans*), and *Elodea*. The near-shore weed beds became exposed during the November drawdown, forming large dry mats of vegetative matter (Figures B-13 and B-14 in Appendix B).

Table 5. Average Filamentous Algae Coverage (%) at Each Monitoring Location.

	LOUA016N	LOUA016S	LOUA016B	LOUA016L	LOUA016J
Apr	0[1]	0[1]	10[12]	0[12]	0[1]
May	0[1]	0[1]	10[12]	4[12]	1[1]
Jun	0[1]	7[1]	28[12]	11[12]	5[1]
Jul	3[1]	7[1]	24[12]	21[12]	1[1]
Aug	13[13]	20[13]	28[12]	17[123]	0[1]
Sep	3[13]	35[13]	38[12]	15[12]	0[1]
Oct	3[13]	0[13]	48[12]	28[12]	15[1]
Nov	0[1]	0[1]	0[12]	3[12]	0[1]
Min	0	0	0	0	0
Max	13	35	48	28	15
Mean	3	9	23	12	3

[1] One or more quadrates not estimated due to low visibility (VDI)
[2] One or more quadrates not estimated due to excessive depth (NA)
[3] One or more quadrates not estimated due to aquatic plants (Macro)

4. DISCUSSION

Temperature profiles showed the expected pattern of thermal stratification during the late spring and summer, with vertical mixing during the fall resulting in near isothermal conditions by November. Variability in specific conductivity values was small enough to be insignificant from an ecological perspective.

All four pH values that exceeded 9.0 were in the top 1.0 meter of the water column and were likely caused by photosynthesis, which increases pH by consuming dissolved carbon dioxide (Gerardi 2015). The likely source of this photosynthesis is phytoplankton since these measurements were near surface and over deep water and near the middle of the lake, far from filamentous algae and aquatic plants. Values of pH above 9.0 have been measured by the US Geological Survey (USGS) in other Arkansas lakes, including DeQueen Lake (site no. 07339450), Gillham Lake (site no. 07340450), and Dierks Lake (site no. 07340990).

Except for the September monitoring event, no DO measurements in the top one meter of the water column were below 5.0 mg/L. During the September monitoring event, hydropower releases from Carpenter Dam (Lake Hamilton) were likely the cause of low DO in the upper portion of Lake Catherine. The occurrence of hydropower releases (from lower levels of Lake Hamilton) is consistent with the pattern of steadily increasing surface temperatures in the downstream direction (17.1°C, 20.4°C, 21.9°C, and 23.7°C at LOUA016N, LOUA016B, LOUA016L, and LOUA016J, respectively). DO percent saturation values above 100% occurred at all five monitoring locations at various times. The supersaturated values measured in this study were within the ranges of values measured by the USGS in other Arkansas lakes, including Gillham Lake (site no. 07340450), Dierks Lake (site no. 07340990), Lake Maumelle (site no. 072632995), and Lake Winona (site no. 07362590).

High variability occurred in the nutrient and chlorophyll data, with multiple results below laboratory detection limits. The results did not point to a specific source of nutrient loading since there was no significant difference between monitoring locations for mean values of any of the three constituents (TP, TN, or chlorophyll *a*).

Filamentous algae estimates were limited by water clarity, excessive depth, and aquatic plant beds prohibiting visibility of the underlining substrate. No location had estimates at all ten

quadrates due to one or more of these limiting factors. All monitoring locations were found to have some filamentous algae growth with the mid lake locations having more than the upstream most or downstream most locations. More aquatic plant growth was observed in the upstream most locations than downstream locations. Since nutrient concentrations were statistically similar between monitoring locations, observed differences in growth between and within monitoring locations must be influenced by factors other than just nutrients. A few similarities became apparent during the course of the study. The quadrate nearest shore generally had less algae or plant growth than those farther from shore. Wave action on Lake Catherine may preclude growth in some areas near shore. Rocky habitat had lower algae and plant growth than softer substrates such as sand and silt. Sand and silt substrate also coincided with shallow slack water areas. Aquatic plants and algae generally did not overlap and when present, aquatic plants appear to dominate the substrate. It was also observed that a single monitoring location could have vastly different habitat on either shoreline with one side having higher growth than the other. LOUA016S, LOUA016B, and LOUA016L all had a shallow soft substrate and deeper rocky substrate shoreline. In all three locations, more growth occurred along the shallow soft shoreline. LOUA016N was soft and shallow on both shorelines and became dominated by aquatic plants by late summer. LOUA016J had rockier substrate on both shorelines and never had as much aquatic plant or filamentous algae growth as the other sites.

The photos in Appendix B from the August 29 sampling event are representative of peak algae and aquatic plant densities across the lake. These conditions were not considered by the field crew to represent “objectionable algal densities or other nuisance aquatic vegetation” that are prohibited in Arkansas Pollution Control and Ecology Commission (APC&EC) Rule 2.509. Lake Catherine does have an abundance of aquatic plants throughout the waterbody, with some filamentous algae occurring at varying degree along the shoreline. The November drawdown exposed the near shoreline areas, and it was confirmed that a majority of the vegetative biomass was aquatic plants with some algae present. It also confirmed that more vegetative biomass was present over finer substrates. These mats could be easily mistaken for algae and may be the cause of some complaints made to DEQ.

5. CONCLUSIONS

In its letter dated January 31, 2024, DEQ stated that this study should "delineate the impact the SSOs from manholes #1750 and #1748 have had on water quality in Lake Catherine". The results of this study do not point to one or more specific source(s) of nutrients as the primary cause of water quality conditions in Lake Catherine. The mean concentrations of total phosphorus, total nitrogen, and chlorophyll *a* did not show any statistically significant differences between sampling locations. Also, the locations of filamentous algae and aquatic vegetation were more dependent on habitat than nutrient sources.

In its letter dated April 9, 2024, DEQ stated that this report should "include any proactive and corrective actions the City of Hot Springs has implemented during the sampling period and an evaluation of the success of those actions". Throughout the sampling period and afterward, the City of Hot Springs has continued to work diligently to improve the wastewater collection system in accordance with their Consent Administrative Order (CAO LIS 22-007) with DEQ. Progress reports for this work are routinely submitted to DEQ by the City of Hot Springs and filed by DEQ under Enforcement Reports for NPDES Permit No. AR0033880.

6. REFERENCES

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APPENDIX A
IN SITU PROFILE DATA

LOUA016N

Depth	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
				Temperature (°C)				
0.5	17.0	21.3	25.2	26.5	26.1	17.1	17.2	17.4
1	14.2	18.3	25.2	25.5	26.2	17.1	17.3	17.4
2	14.1	15.5	21.8	18.6	18.8	17.1	17.3	17.4
3	13.9	15.3	20	18.2	17.9	17.1	17.3	17.4
4	13.8	15.1	19.5	17.6	17.2	17.1	17.3	17.4
5	13.9	15.0	19.5	17.5	17.1	17.1	17.3	
6	13.8	15.0	19.4		17.1		17.2	
7	13.8	15.0						
				Specific Conductivity (µS)				
0.5	57	61	61	65	87	54	68	57
1	54	59	61	64	77	54	68	57
2	54	56	60	57	57	54	68	56
3	54	54	59	55	55	54	68	56
4	54	53	58	55	55	54	68	56
5	54	53	58	55	55	54	68	
6	54	53	57		55		65	
7	54	53						
				pH (NU)				
0.5	6.63	6.91	6.24	7.31	7.41	6.46	6.92	6.64
1	6.61	6.88	6.3	7.10	7.40	6.42	6.75	6.60
2	6.54	6.83	6.34	6.94	6.33	6.4	6.74	6.60
3	6.56	6.74	6.33	6.84	6.47	6.38	6.76	6.60
4	6.54	6.67	6.29	6.75	6.53	6.36	6.77	6.60
5	6.54	6.63	6.27	6.62	6.54	6.34	6.78	
6	6.52	6.61	6.23		6.54		6.80	
7	6.61	6.59						
				Dissolved Oxygen (mg/L)				
0.5	8.58	8.54	8.89	8.53	9.07	2.28	8.25	7.71
1	7.37	7.73	8.77	8.12	8.98	1.91	8.04	7.56
2	7.23	6.76	8.52	4.81	4.19	1.87	8.01	7.51
3	7.17	6.02	6.33	3.92	3.35	1.84	7.96	7.45
4	7.09	6.69	4.68	3.75	3.21	1.84	7.95	7.42
5	7.08	5.73	4.35	3.7	3.18	1.82	7.96	
6	7.07	5.72	4.37		3.15		7.49	
7	7.06	5.72						

	Dissolved Oxygen Percent Saturation (%)							
0.5	90%	98%	110%	108%	114%	24%	87%	82%
1	73%	83%	108%	101%	113%	20%	85%	80%
2	71%	69%	98%	52%	46%	20%	85%	79%
3	70%	61%	71%	42%	36%	19%	84%	79%
4	69%	67%	52%	40%	34%	19%	84%	79%
5	70%	58%	48%	39%	33%	19%	84%	
6	69%	58%	48%		33%		79%	
7	69%	58%						
	Total Depth (m)							
	7.25	7.2	6.2	5.25	6.25	5.1	6.75	4.0

LOUA016S

Depth	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
				Temperature (°C)				
0.5	21.4	26.3	27.3	30.0	28.2	22.9	18.6	16.5
1	21.3	26.3	27.4	30.0	28.3	20.3	18.6	16.6
2	17.8	20.9	24.5	24.3	24.7	19.7	18.6	16.5
3		18.9	21.1			18.5		
				Specific Conductivity (µS)				
0.5	69	67	65	72	82	71	70	70
1	69	67	65	70	82	61	70	70
2	70	62	64	66	71	60	68	70
3		60	61			57		
				pH (NU)				
0.5	6.33	7.02	6.97	8.66	8.49	6.73	7.32	7.03
1	6.30	6.98	7.00	8.28	8.67	6.30	7.37	7.00
2	6.28	6.95	6.94	7.73	7.48	6.23	7.39	6.78
3		6.81	6.73			6.20		
				Dissolved Oxygen (mg/L)				
0.5	10.30	9.31	9.17	9.16	8.91	7.53	10.21	8.85
1	9.73	9.41	9.11	9.46	8.36	4.26	10.13	8.08
2	5.77	7.98	5.84	9.88	7.87	3.39	9.72	7.65
3		6.69	1.75			2.52		
				Dissolved Oxygen Percent Saturation (%)				
0.5	118%	117%	117%	123%	116%	89%	111%	92%
1	111%	118%	117%	127%	109%	48%	110%	84%
2	62%	91%	71%	120%	96%	38%	105%	79%
3		73%	20%			27%		
				Total Depth (m)				
	2.25	3.0	3.0	2.5	2.8	3.2	2.8	2.0

LOUA016B

Depth	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
				Temperature °C				
0.5	21.4	24.8	27.3	28.7	27.8	20.4	18.6	17.0
1	21.1	24.5	27.3	28.7	27.7	20.5	18.6	17.1
2	19.6	19.0	23.8	26.0	24.3	19.6	18.5	17.0
3	16.6	18.5	21.4	21.7	21.8	18.9	18.4	17.0
4	14.5	18.1	20.5	19.1	19.3	18.4	18.0	17.0
5	14.3	17.9	20	19.0	18.9	17.8	17.5	17.0
6	14.2	17.7	19.6	18.8	18.4	17.7	17.3	17.0
7	14.2	17.6	19.5	18.7	18.2	17.7	17.2	17.0
8	14.2	17.4	19.3	18.7	18.2	17.7	17.0	17.1
9		17.3		18.7	18.2		17.0	
10				18.7	18.2			
				Specific Conductivity µS				
0.5	66	69	68	73	80	62	80	64
1	66	59	66	73	79	61	79	67
2	67	59	65	87	71	58	71	72
3	57	59	58	62	67	57	67	72
4	55	59	57	58	59	55	59	78
5	53	59	56	58	58	55	58	83
6	53	58	56	57	57	55	57	89
7	53	58	55	57	57	55	57	111
8	53	58	55	57	57	55	57	150
9		58		57	57		57	
10				57	57			
				pH (NU)				
0.5	7.88	7.02	7.58	7.95	9.14	6.74	7.51	7.01
1	7.98	6.96	7.58	7.96	8.89	6.49	7.48	6.80
2	7.73	6.96	7.36	7.52	7.65	6.39	7.45	6.70
3	7.46	6.92	7.21	7.34	7.26	6.32	7.39	6.63
4	7.71	6.88	7.07	7.16	7.05	6.29	7.27	6.59
5	7.10	6.83	6.94	7.03	7.01	6.27	7.15	6.56
6	7.05	6.80	6.86	6.92	6.98	6.24	7.09	6.53
7	6.96	6.77	6.79	6.83	6.98	6.23	7.00	6.54
8	6.9	6.71	6.67	6.77	6.98	6.37	6.92	6.55
9		6.69		6.72	6.97		6.96	
10				6.87	6.96			

				Dissolved Oxygen (mg/L)				
0.5	10.81	9.41	9.82	9.27	9.83	6.01	10.70	6.93
1	10.84	8.89	9.75	9.25	9.77	4.76	10.69	6.01
2	10.03	8.11	8.16	8.38	8.50	3.93	10.50	5.50
3	8.32	7.67	6.17	6.03	6.65	3.31	10.04	5.24
4	7.64	7.57	5.01	5.00	4.75	2.43	9.14	5.05
5	7.21	7.51	4.13	4.48	4.10	2.24	8.74	5.02
6	7.10	7.42	3.79	4.33	3.87	2.12	8.75	5.08
7	7.13	7.02	3.64	4.19	3.74	2.08	8.07	4.75
8	7.00	6.76	3.44	4.18	3.73	2.06	7.63	4.31
9		6.69		4.16	3.70		7.29	
10				4.11	3.70			
				Dissolved Oxygen Percent Saturation (%)				
0.5	124%	115%	126%	122%	127%	68%	116%	73%
1	124%	108%	125%	121%	126%	54%	116%	63%
2	111%	89%	98%	105%	103%	43%	114%	58%
3	87%	83%	71%	70%	77%	36%	108%	55%
4	76%	81%	56%	55%	52%	26%	98%	53%
5	71%	80%	46%	49%	45%	24%	93%	53%
6	70%	79%	42%	47%	42%	23%	92%	53%
7	70%	75%	40%	46%	40%	22%	85%	50%
8	69%	72%	38%	45%	40%	22%	80%	45%
9		71%		45%	40%		76%	
10				45%	40%			
				Total Depth (m)				
	8.5	9.0	8.2	10.2	10.5	8.6	9.5	8.1

LOUA016L

Depth	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
				Temperature (°C)				
0.5	21.1	25.5	27.3	28.9	27.8	21.9	18.5	17.4
1	20.8	24.5	27.3	28.9	27.7	21.9	18.5	17.4
2	17.5	20.1	26.8	24.3	24.8	21.8	18.4	17.3
3	15.7	19.0	21.8	21.8	22.6	21.8	18.3	17.4
4	15.5	18.9	20.8	21.1	20.3	21.6	18.2	17.3
5	14.8	18.0	19.7	20.1	19.6	20.0	18.1	17.3
6	14.4	17.3	19.5	19.4	19.3	18.5	18.0	17.2
7	14.3	16.6	19.2	18.9	19.2	18.1	17.6	17.2
8	14.2	16.6	19.0	18.8	18.5	17.8	17.3	17.2
9	14.2	16.0	18.8	18.7	18.4	17.8	17.1	17.2
10	14.2	15.9	18.6	18.6		17.7	17.0	17.2
11		15.8		18.6		17.8	16.9	17.1
12		15.7					16.8	
13		15.7					16.8	
				Specific Conductivity (µS)				
0.5	66	70	66	78	80	70	70	82
1	66	67	66	78	81	70	70	80
2	67	67	71	82	75	70	71	81
3	71	75	87	87	70	71	72	80
4	72	74	84	84	68	71	71	80
5	71	65	84	123	69	71	72	80
6	69	65	93	106	73	71	68	80
7	67	67	89	83	107	79	66	80
8	66	73	83	79	111	78	64	80
9	67	73	80	77	113	79	63	79
10	67	72	80	76		79	63	76
11		72		76		78	62	75
12		72					62	
13		72					62	
				pH (NU)				
0.5	8.27	7.05	7.90	8.37	9.14	7.08	7.49	6.75
1	8.11	7.02	7.90	8.38	9.25	6.95	7.46	6.69
2	7.80	7.305	7.62	8.02	8.19	6.99	7.33	6.66
3	7.55	6.99	7.38	7.39	7.39	6.95	7.26	6.64
4	7.39	6.93	7.16	7.19	7.12	6.93	7.19	6.62
5	7.30	6.87	6.97	7.05	7.04	6.71	7.15	6.58
6	7.21	6.81	6.88	6.98	7.02	6.55	7.02	6.57

7	7.14	6.78	6.76	6.82	6.98	6.51	6.93	6.55
8	7.03	6.74	6.70	6.76	6.97	6.53	6.83	6.56
9	6.86	6.73	6.62	6.72	6.97	6.53	6.90	6.55
10	6.85	6.71	6.57	6.65		6.53	6.89	6.55
11		6.69		6.59		6.53	6.85	6.54
12		6.67					6.83	
13		6.65					6.84	
				Dissolved Oxygen (mg/L)				
0.5	11.10	9.72	9.92	9.47	9.83	8.12	10.72	7.32
1	10.98	9.37	9.99	9.56	10.2	7.99	10.75	6.61
2	8.96	8.31	9.21	10.38	9.91	7.84	10.46	6.38
3	8.13	7.87	5.37	6.68	7.96	7.38	10.21	6.27
4	7.63	7.38	4.21	5.50	5.73	7.31	9.88	6.10
5	7.31	7.38	3.67	4.73	4.83	5.10	9.01	5.78
6	7.12	6.78	3.43	4.39	4.83	3.62	8.75	5.70
7	7.04	6.79	3.02	4.01	3.99	2.44	8.01	5.65
8	6.97	6.74	2.81	3.87	3.73	2.24	7.49	5.60
9	7.01	6.28	2.41	3.68	3.67	2.19	7.31	5.61
10	6.94	6.21	2.23	3.46		2.16	7.01	5.48
11		6.21		3.36		2.14	6.54	5.39
12		6.05					6.29	
13		6.00					6.24	
				Dissolved Oxygen Percent Saturation (%)				
0.5	127%	120%	127%	125%	128%	94%	116%	77%
1	124%	114%	128%	126%	129%	93%	116%	70%
2	95%	93%	117%	126%	113%	91%	113%	67%
3	83%	86%	62%	77%	63%	85%	110%	66%
4	78%	81%	48%	63%	47%	84%	106%	64%
5	73%	79%	41%	53%	41%	57%	97%	61%
6	71%	72%	38%	48%	38%	39%	94%	60%
7	70%	71%	33%	44%	33%	26%	85%	60%
8	69%	70%	31%	42%	30%	24%	79%	59%
9	69%	65%	26%	40%	26%	23%	77%	59%
10	69%	64%	24%	38%		23%	74%	58%
11		64%		36%		23%	68%	57%
12		62%					66%	
13		61%					65%	
				Total Depth (m)				
	10.3	13.3	10.5	11.0	9.75	11.6	13.1	11.5

LOUA016J

Depth	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Temperature (°C)								
0.5	21.5	25.7	27.2	30.1	27.6	23.7	20.0	17.6
1	21.1	25.7	27.2	30.1	27.4	23.7	20.0	17.6
2	20.3	21.9	24.4	28.0	24.8	22.2	18.6	17.6
3	17.5	19.3	21.8	23.5	23.0	19.4	18.5	17.6
4	16.1	18.89	20.0	20.1	21.4	19.3	18.5	17.6
5	15.8	18.2	19.9	20.0	21.1	18.9		
6		17.8	19.8	19.6	20.5			
Specific Conductivity (µS)								
0.5	63	68	61	76	84	77	78	75
1	64	68	62	76	84	77	78	75
2	65	70	76	80	84	77	79	75
3	69	74	85	75	84	81	79	74
4	70	73	95	87	81	84	79	74
5	71	74	93	95	77	89		
6		74	91	100	77			
pH (NU)								
0.5	8.23	7.25	8.04	8.57	9.12	8.03	7.04	6.83
1	8.29	7.33	8.22	8.62	9.00	7.81	7.03	6.75
2	8.15	7.40	8.01	7.53	7.38	7.07	7.05	6.65
3	7.70	7.41	7.63	7.52	7.03	6.73	7.08	6.58
4	7.56	7.28	7.39	7.38	6.96	6.60	7.03	6.56
5	7.43	7.19	7.19	7.24	6.94	6.57		
6		7.08	7.02	7.08	6.93			
Dissolved Oxygen (mg/L)								
0.5	10.83	9.92	10.18	9.32	9.94	9.92	8.58	6.68
1	11.10	10.13	10.30	9.47	10.27	9.90	8.58	5.64
2	11.02	11.26	10.99	7.41	8.66	7.93	9.03	5.34
3	9.20	11.30	6.71	9.18	5.83	4.50	8.64	5.13
4	7.73	10.20	4.01	6.15	4.22	3.84	8.23	5.07
5	7.55	9.26	3.38	4.79	3.44	3.44		
6		8.51	3.18	4.21	3.00			

	Dissolved Oxygen Percent Saturation (%)							
0.5	124%	123%	130%	125%	128%	119%	96%	71%
1	127%	126%	132%	127%	132%	119%	96%	60%
2	124%	130%	133%	96%	106%	92%	98%	57%
3	98%	124%	78%	110%	69%	50%	94%	55%
4	80%	111%	45%	69%	48%	42%	89%	54%
5	77%	100%	38%	53%	39%	38%		
6		91%	35%	47%	34%			
	Total Depth (m)							
	5.25	6.0	6.75	6.75	6.5	5.4	4.0	4.0

Secchi Depths (m) for All Monitoring Locations

	LOUA016N	**LOUA016S**	**LOUA016B**	**LOUA016L**	**LOUA016J**
Apr	1.60	0.75	1.20	1.00	1.50
May	1.06	1.14	1.67	1.21	1.50
Jun	1.44	1.52	1.15	1.37	1.82
Jul	0.91	1.00	0.91	1.21	1.28
Aug	0.97	1.18	1.03	1.06	1.21
Sep	2.10	1.00	1.20	1.06	1.30
Oct	1.20	0.75	1.50	1.06	1.80
Nov	1.47	0.91	1.00	1.32	1.60
Min	0.91	0.75	0.91	1.00	1.21
Max	2.10	1.52	1.67	1.37	1.82
Mean	1.34	1.03	1.20	1.16	1.50

APPENDIX B
PHOTOS FROM AUGUST AND NOVEMBER SAMPLING EVENTS

Figure B-1. LOUA016N right bank 8/29/2024

Figure B-2. LOUA016N left bank 8/29/2024

Figure B-3. LOUA016S right bank 8/29/2024

Figure B-4. LOUA016S left bank 8/29/2024

Figure B-5. LOUA016B right bank 8/29/2024

Figure B-6. LOUA016B left bank 8/29/2024

Figure B-7. LOUA016L right bank 8/29/2024

Figure B-8. LOUA016L right bank 8/29/2024

Figure B-9. LOUA016J right bank 8/29/2024

Figure B-10. LOUA016J right bank 8/29/2024

Figure B-11. Floating aquatic plants with brown algae 8/29/2024

Figure B-12. Floating aquatic plants with filamentous algae 8/29/2024

Figure B-13. Mat of aquatic plants exposed by lake drawdown 11/14/2024

Figure B-14. Dried aquatic plants exposed by lake drawdown 11/14/2024

2024 Data Collected in Lake Catherine on behalf of City of Hot Springs -- Total P, Chlorophyll a, Total N
Data are described in report titled "Summary of 2024 Field Data Collected in Lake Catherine, Arkansas", dated February 24, 2025 (revised)

Table 2. Total Phosphorus Concentrations (mg/L) for Each Monitoring Location

	LOUA016N		LOUA016S		LOUA016B		LOUA016L		LOUA016J	
	epi	hypo	epi	dup	epi	hypo	epi	hypo	epi	hypo
Apr	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135
May	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135
Jun	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135
Jul	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135
Aug	0.0463	0.0135	0.0279	0.0304	0.0360	0.0135	0.0522	0.0350	0.0275	0.0372
Sep	0.0708	0.0536	0.0673	0.0656	0.0581	0.0395	0.0669	0.0498	0.0500	0.0556
Oct	0.1680	0.1330	0.0520	0.0629	0.0472	0.0559	0.0351	0.0480	0.0283	0.0135
Nov	0.0135	0.0273	0.0653	0.0475	0.0479	0.0333	0.0776	0.0342	0.0135	0.0287
Min	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135	0.0135
Max	0.1680	0.1330	0.0673	0.0656	0.0581	0.0559	0.0776	0.0498	0.0500	0.0556
Mean	0.0441	0.0352	0.0333	0.0326	0.0304	0.0245	0.0357	0.0276	0.0217	0.0236

Shading: = one half of method detection limit (MDL)
= reported by lab with J flag (value below reporting limit but above MDL)

F=0.4674 p=0.891

Table 3. Chlorophyll a Concentrations (mg/L) for Each Monitoring Location

	LOUA016N		LOUA016S		LOUA016B		LOUA016L		LOUA016J	
	epi	hypo	epi	dup	epi	hypo	epi	hypo	epi	hypo
Apr	0.2510	0.0135	1.0300	1.2500	0.4360	0.0372	0.4460	0.0372	0.1730	0.2390
May	0.2000	0.0472	0.1130	0.1200	0.1300	0.0593	0.1410	0.0375	0.0727	0.2100
Jun	0.3190	0.0916	0.1710	0.1710	0.3310	0.2280	0.2630	0.1560	0.1820	0.3620
Jul	0.0196	0.0072	0.0025	0.0059	0.0168	0.0025	0.0118	0.0054	0.0059	0.0226

Aug	0.0347	0.0025	0.0069	0.0161	0.0124	0.0025	0.0174	0.0025	0.0096	0.0202
Sep	0.0076	0.0101	0.0025	0.0025	0.0091	0.0025	0.0080	0.0217	0.0126	0.0065
Oct	0.0846	0.0244	0.0127	0.0949	0.0025	0.0025	0.0025	0.0025	0.0025	0.1090
Nov	0.0025	0.0025	0.1120	0.0491	0.0186	0.0064	0.4520	0.0296	0.0100	0.0104
Min	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0065
Max	0.3190	0.0916	1.0300	1.2500	0.4360	0.2280	0.4520	0.1560	0.1820	0.3620
Mean	0.1149	0.0249	0.1813	0.2137	0.1196	0.0426	0.1677	0.0366	0.0585	0.1225

Shading: = one half of method detection limit (MDL) F=0.8369 p=0.584

= reported by lab with J flag (value below reporting limit but above MDL)

= reported by lab with H flag (sample was prepped or analyzed beyond the specified holding time)

= one half of method detection limit (MDL) AND reported by lab with H flag

Table 4. Total Nitrogen Concentrations (mg/L) for Each Monitoring Location

	LOUA016N		LOUA016S		LOUA016B		LOUA016L		LOUA016J	
	epi	hypo	epi	dup	epi	hypo	epi	hypo	epi	hypo
Apr	0.652	0.250	0.632	0.728	0.530	0.622	0.562	0.680	1.060	0.562
May	1.005	0.339	0.745	0.757	0.365	0.337	0.715	0.368	0.711	0.385
Jun	0.743	0.747	0.733	1.375	1.175	0.625	1.023	0.749	0.959	0.689
Jul	0.702	0.538	0.622	0.250	0.534	0.250	0.630	0.612	0.614	0.604
Aug	0.865	1.064	0.365	1.082	1.305	0.365	1.247	1.236	1.267	1.814
Sep	0.522	0.778	0.250	0.778	0.644	0.730	0.658	1.580	0.730	0.892
Oct	1.480	1.430	0.838	0.866	0.934	0.810	0.920	0.736	0.894	0.780
Nov	0.953	0.941	1.292	1.202	0.927	1.100	1.255	0.971	1.069	0.873
Min	0.522	0.250	0.250	0.250	0.365	0.250	0.562	0.368	0.614	0.385
Max	1.480	1.430	1.292	1.375	1.305	1.100	1.255	1.580	1.267	1.814
Mean	0.865	0.761	0.685	0.880	0.802	0.605	0.876	0.867	0.913	0.825

Shading: = one half of reporting limit for Total Nitrogen F=0.6925 p=0.731

= calculated from one half the MDL for TKN plus reported value of NO2+NO3

= calculated from reported value of TKN plus one half of MDL for NO2+NO3

= calculated from one half of MDL for TKN plus one half of MDL for NO2+NO3

= calculated as reported value of TKN plus reported value of NO2+NO3

2024 Data Collected in Lake Catherine on behalf of City of Hot Springs -- Filamentous Algae Observations
Data are described in report titled "Summary of 2024 Field Data Collected in Lake Catherine, Arkansas", dated February 24, 2025 (revised)

Table 5. Average Filamentous Algae Coverage (%) at Each Monitoring Location.

	LOUA016N	LOUA016S	LOUA016B	LOUA016L	LOUA016J
Apr	0	0	10	0	0
May	0	0	10	4	1
Jun	0	7	28	11	5
Jul	3	7	24	21	1
Aug	13	20	28	17	0
Sep	3	35	38	15	0
Oct	3	0	48	28	15
Nov	0	0	0	3	0
Min	0	0	0	0	0
Max	13	35	48	28	15
Mean	3	9	23	12	3

VDI = Quadrate not estimated due to low visibility
NA = Quadrate not estimated due to excessive depth
Macro = Quadrate not estimated due to aquatic plants

		LOUA016N		LOUA016S		LOUA016B		LOUA016L		LOUA016N	
Month	Quadrate	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank
APR	1	0	0	0	0	0	10	VDI	0	0	0
APR	2	0	0	VDI	0	VDI	20	VDI	0	0	0
APR	3	VDI	VDI	VDI	VDI	NA	VDI	VDI	NA	VDI	VDI
APR	4	VDI	VDI	VDI	VDI	NA	VDI	VDI	NA	VDI	NA
APR	5	VDI	VDI	VDI	VDI	NA	VDI	VDI	NA	VDI	NA
APR	Mean	0		0		10		0		0	

		LOUA016N		LOUA016S		LOUA016B		LOUA016L		LOUA016N	
Month	Quadrate	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank
MAY	1	0	0	0	0	0	20	5	5	0	5
MAY	2	0	0	VDI	0	0	30	0	5	0	0
MAY	3	VDI	VDI	VDI	VDI	NA	0	VDI	NA	0	0
MAY	4	VDI	VDI	VDI	VDI	NA	VDI	VDI	NA	VDI	NA
MAY	5	VDI	VDI	VDI	VDI	NA	VDI	VDI	NA	VDI	NA
MAY	Mean	0		0		10		4		1	

		LOUA016N		LOUA016S		LOUA016B		LOUA016L		LOUA016N	
Month	Quadrate	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank
JUN	1	0	0	10	0	15	10	5	10	0	0
JUN	2	0	0	10	VDI	35	30	10	20	20	0
JUN	3	VDI	VDI	VDI	VDI	NA	50	VDI	NA	VDI	VDI
JUN	4	VDI	VDI	VDI	VDI	NA	VDI	VDI	NA	VDI	VDI
JUN	5	VDI	VDI	VDI	VDI	NA	VDI	VDI	NA	VDI	NA
JUN	Mean	0		7		28		11		5	

		LOUA016N		LOUA016S		LOUA016B		LOUA016L		LOUA016N	
Month	Quadrate	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank
JUL	1	0	5	10	0	20	5	10	30	5	0
JUL	2	VDI	5	10	VDI	30	40	15	30	0	0
JUL	3	VDI	VDI	VDI	VDI	NA	VDI	VDI	NA	0	VDI
JUL	4	VDI	VDI	VDI	VDI	NA	VDI	VDI	NA	VDI	VDI
JUL	5	VDI	VDI	VDI	VDI	NA	VDI	VDI	NA	VDI	NA
JUL	Mean	3		7		24		21		1	

		LOUA016N		LOUA016S		LOUA016B		LOUA016L		LOUA016N	

Month	Quadrate	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank
AUG	1	0	10	VDI	20	30	10	10	20	0	0
AUG	2	20	20	VDI	20	40	20	VDI	20	0	0
AUG	3	VDI	VDI	VDI	VDI	NA	40	VDI	NA	VDI	VDI
AUG	4	VDI	VDI	VDI	VDI	NA	VDI	VDI	NA	VDI	VDI
AUG	5	VDI	VDI	VDI	VDI	NA	VDI	VDI	NA	VDI	NA
AUG	Mean	13		20		28		17		0	

		LOUA016N		LOUA016S		LOUA016B		LOUA016L		LOUA016N	
Month	Quadrate	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank
SEP	1	0	5	50	20	20	VDI	20	10	0	0
SEP	2	Macro	5	Macro	Macro	30	60	VDI	VDI	0	0
SEP	3	Macro	Macro	Macro	Macro	NA	40	VDI	NA	VDI	VDI
SEP	4	Macro	Macro	Macro	Macro	NA	Macro	VDI	NA	VDI	VDI
SEP	5	Macro	Macro	Macro	Macro	NA	Macro	VDI	NA	VDI	NA
SEP	Mean	3		35		38		15		0	

		LOUA016N		LOUA016S		LOUA016B		LOUA016L		LOUA016N	
Month	Quadrate	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank
OCT	1	5	0	0	0	30	60	40	20	25	0
OCT	2	Macro	Macro	Macro	VDI	30	70	50	1	25	0
OCT	3	Macro	Macro	Macro	VDI	NA	VDI	VDI	NA	VDI	25
OCT	4	Macro	Macro	Macro	VDI	NA	VDI	VDI	NA	VDI	VDI
OCT	5	Macro	Macro	Macro	VDI	NA	VDI	VDI	NA	VDI	NA
OCT	Mean	3		0		48		28		15	

		LOUA016N		LOUA016S		LOUA016B		LOUA016L		LOUA016N	
Month	Quadrate	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank	Left bank	Right bank
NOV	1	0	Macro	0	0	0	0	0	20	0	0
NOV	2	Macro	Macro	0	VDI	0	0	0	VDI	Macro	0

NOV	3	Macro	Macro	0	VDI	NA	VDI	0	NA	Macro	VDI
NOV	4	Macro	Macro	0	VDI	NA	VDI	0	NA	Macro	NA
NOV	5	Macro	Macro	VDI	VDI	NA	VDI	0	NA	Macro	NA
NOV	Mean	0		0		0		3		0	

2024 Data Collected in Lake Catherine on behalf of City of Hot Springs -- In Situ Measurements

Data are described in report titled "Summary of 2024 Field Data Collected in Lake Catherine, Arkansas", dated February 24, 2025 (revised)

DO satura

Altitude fc

LOUA016N

Depth	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
				Temperature (°C)				
0.5	17	21.3	25.2	26.5	26.1	17.1	17.2	17.4
1	14.2	18.3	25.2	25.5	26.2	17.1	17.3	17.4
2	14.1	15.5	21.8	18.6	18.8	17.1	17.3	17.4
3	13.9	15.3	20	18.2	17.9	17.1	17.3	17.4
4	13.8	15.1	19.5	17.6	17.2	17.1	17.3	17.4
5	13.9	15	19.5	17.5	17.1	17.1	17.3	
6	13.8	15	19.4		17.1		17.2	
7	13.8	15						
				Specific Conductivity (µS)				
0.5	57	61	61	65	87	54	68	57
1	54	59	61	64	77	54	68	57
2	54	56	60	57	57	54	68	56
3	54	54	59	55	55	54	68	56
4	54	53	58	55	55	54	68	56
5	54	53	58	55	55	54	68	
6	54	53	57		55		65	
7	54	53						
				pH (NU)				
0.5	6.63	6.91	6.24	7.31	7.41	6.46	6.92	6.64
1	6.61	6.88	6.3	7.1	7.4	6.42	6.75	6.6
2	6.54	6.83	6.34	6.94	6.33	6.4	6.74	6.6
3	6.56	6.74	6.33	6.84	6.47	6.38	6.76	6.6
4	6.54	6.67	6.29	6.75	6.53	6.36	6.77	6.6
5	6.54	6.63	6.27	6.62	6.54	6.34	6.78	

LOUA016S

Depth	Apr	May	Jun	Jul	Aug	Sep
				Temperature °C		
0.5	21.4	26.3	27.3	30	28.2	22.9
1	21.3	26.3	27.4	30	28.3	20.3
2	17.8	20.9	24.5	24.3	24.7	19.7
3		18.9	21.1			18.5
				Specific Conductivity µS		
0.5	69	67	65	72	82	71
1	69	67	65	70	82	61
2	70	62	64	66	71	60
3		60	61			57
				pH (NU)		
0.5	6.33	7.02	6.97	6.97	8.49	6.73
1	6.3	6.98	7	7	8.67	6.3
2	6.28	6.95	6.94	6.94	7.48	6.23
3		6.81	6.73			6.2
				Dissolved Oxygen (mg/L)		
0.5	10.3	9.31	9.17	9.16	8.91	7.53
1	9.73	9.41	9.11	9.46	8.36	4.26
2	5.77	7.98	5.84	9.88	7.87	3.39
3		6.69	1.75			2.52
				Dissolved Oxygen Percent Saturation		
0.5	118%	117%	117%	123%	116%	89%
1	111%	118%	117%	127%	109%	48%
2	62%	91%	71%	120%	96%	38%
3		73%	20%			27%

6	6.52	6.61	6.23		6.54		6.8	
7	6.61	6.59						
			Dissolved Oxygen (mg/L)					
0.5	8.58	8.54	8.89	8.53	9.07	2.28	8.25	7.71
1	7.37	7.73	8.77	8.12	8.98	1.91	8.04	7.56
2	7.23	6.76	8.52	4.81	4.19	1.87	8.01	7.51
3	7.17	6.02	6.33	3.92	3.35	1.84	7.96	7.45
4	7.09	6.69	4.68	3.75	3.21	1.84	7.95	7.42
5	7.08	5.73	4.35	3.7	3.18	1.82	7.96	
6	7.07	5.72	4.37		3.15		7.49	
7	7.06	5.72						
			Dissolved Oxygen Percent Saturation					
0.5	90%	98%	110%	108%	114%	24%	87%	82%
1	73%	83%	108%	101%	113%	20%	85%	80%
2	71%	69%	98%	52%	46%	20%	85%	79%
3	70%	61%	71%	42%	36%	19%	84%	79%
4	69%	67%	52%	40%	34%	19%	84%	79%
5	70%	58%	48%	39%	33%	19%	84%	
6	69%	58%	48%		33%		79%	
7	69%	58%						
			Total Depth (m)					
	7.25	7.2	6.2	5.25	6.25	5.1	6.75	4

Total Depth (m)					
2.25	3	3	2.5	2.8	3.2

tion equation is from Mortimer (1981) as printed in Appendix D of 1983 Corps of Engineers EM (Engineering Manual)
›r DO saturation calculations = 400 ft = 0.12192 km

LOUA016B

Oct	Nov	Depth	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
						Temperature °C				
18.6	16.5	0.5	21.4	24.8	27.3	28.7	27.8	20.4	18.6	17
18.6	16.6	1	21.1	24.5	27.3	28.7	27.7	20.5	18.6	17.1
18.6	16.5	2	19.6	19	23.8	26	24.3	19.6	18.5	17
		3	16.6	18.5	21.4	21.7	21.8	18.9	18.4	17
		4	14.5	18.1	20.5	19.1	19.3	18.4	18	17
70	70	5	14.3	17.9	20	19	18.9	17.8	17.5	17
70	70	6	14.2	17.7	19.6	18.8	18.4	17.7	17.3	17
68	70	7	14.2	17.6	19.5	18.7	18.2	17.7	17.2	17
		8	14.2	17.4	19.3	18.7	18.2	17.7	17	17.1
		9		17.3		18.7	18.2		17	
7.32	7.03	10				18.7	18.2			
7.37	7					Specific Conductivity µS				
7.39	6.78	0.5	66	69	68	73	80	62	80	64
		1	66	59	66	73	79	61	79	67
		2	67	59	65	87	71	58	71	72
10.21	8.85	3	57	59	58	62	67	57	67	72
10.13	8.08	4	55	59	57	58	59	55	59	78
9.72	7.65	5	53	59	56	58	58	55	58	83
		6	53	58	56	57	57	55	57	89
		7	53	58	55	57	57	55	57	111
111%	92%	8	53	58	55	57	57	55	57	150
110%	84%	9		58		57	57		57	
105%	79%	10				57	57			
						pH (NU)				

Depth	Apr	May	Jun
			Ter
0.5	21.1	25.5	27.3
1	20.8	24.5	27.3
2	17.5	20.1	26.8
3	15.7	19	21.8
4	15.5	18.9	20.8
5	14.8	18	19.7
6	14.4	17.3	19.5
7	14.3	16.6	19.2
8	14.2	16.6	19
9	14.2	16	18.8
10	14.2	15.9	18.6
11		15.8	
12		15.7	
13		15.7	
			Specific
0.5	66	70	66
1	66	67	66
2	67	67	71
3	71	75	87
4	72	74	84
5	71	65	84
6	69	65	93
7	67	67	89
8	66	73	83

2.8	2							

0.5	7.88	7.02	7.58	7.95	9.14	6.74	7.51	7.01
1	7.98	6.96	7.58	7.96	8.89	6.49	7.48	6.8
2	7.73	6.96	7.36	7.52	7.65	6.39	7.45	6.7
3	7.46	6.92	7.21	7.34	7.26	6.32	7.39	6.63
4	7.71	6.88	7.07	7.16	7.05	6.29	7.27	6.59
5	7.1	6.83	6.94	7.03	7.01	6.27	7.15	6.56
6	7.05	6.8	6.86	6.92	6.98	6.24	7.09	6.53
7	6.96	6.77	6.79	6.83	6.98	6.23	7	6.54
8	6.9	6.71	6.67	6.77	6.98	6.37	6.92	6.55
9		6.69		6.72	6.97		6.96	
10				6.87	6.96			

Dissolved Oxygen (mg/L)

0.5	10.81	9.41	9.82	9.27	9.83	6.01	10.7	6.93
1	10.84	8.89	9.75	9.25	9.77	4.76	10.69	6.01
2	10.03	8.11	8.16	8.38	8.5	3.93	10.5	5.5
3	8.32	7.67	6.17	6.03	6.65	3.31	10.04	5.24
4	7.64	7.57	5.01	5	4.75	2.43	9.14	5.05
5	7.21	7.51	4.13	4.48	4.1	2.24	8.74	5.02
6	7.1	7.42	3.79	4.33	3.87	2.12	8.75	5.08
7	7.13	7.02	3.64	4.19	3.74	2.08	8.07	4.75
8	7	6.76	3.44	4.18	3.73	2.06	7.63	4.31
9		6.69		4.16	3.7		7.29	
10				4.11	3.7			

Dissolved Oxygen Percent Saturation

0.5	124%	115%	126%	122%	127%	68%	116%	73%
1	124%	108%	125%	121%	126%	54%	116%	63%
2	111%	89%	98%	105%	103%	43%	114%	58%
3	87%	83%	71%	70%	77%	36%	108%	55%
4	76%	81%	56%	55%	52%	26%	98%	53%
5	71%	80%	46%	49%	45%	24%	93%	53%
6	70%	79%	42%	47%	42%	23%	92%	53%

9	67	73	80
10	67	72	80
11		72	
12		72	
13		72	

0.5	8.27	7.05	7.9
1	8.11	7.02	7.9
2	7.8	7.305	7.62
3	7.55	6.99	7.38
4	7.39	6.93	7.16
5	7.3	6.87	6.97
6	7.21	6.81	6.88
7	7.14	6.78	6.76
8	7.03	6.74	6.7
9	6.86	6.73	6.62
10	6.85	6.71	6.57
11		6.69	
12		6.67	
13		6.65	

Dissolv

0.5	11.1	9.72	9.92
1	10.98	9.37	9.99
2	8.96	8.31	9.21
3	8.13	7.87	5.37
4	7.63	7.38	4.21
5	7.31	7.38	3.67
6	7.12	6.78	3.43
7	7.04	6.79	3.02
8	6.97	6.74	2.81
9	7.01	6.28	2.41

7	70%	75%	40%	46%	40%	22%	85%	50%
8	69%	72%	38%	45%	40%	22%	80%	45%
9		71%		45%	40%		76%	
10				45%	40%			
				Total Depth (m)				
	8.5	9	8.2	10.2	10.5	8.6	9.5	8.1

10	6.94	6.21	2.23
11		6.21	
12		6.05	
13		6	
			Dissolved Ox
0.5	127%	120%	127%
1	124%	114%	128%
2	95%	93%	117%
3	83%	86%	62%
4	78%	81%	48%
5	73%	79%	41%
6	71%	72%	38%
7	70%	71%	33%
8	69%	70%	31%
9	69%	65%	26%
10	69%	64%	24%
11		64%	
12		62%	
13		61%	
			To
	10.3	13.3	10.5

LOUA016L

Jul	Aug	Sep	Oct	Nov
nperature (°C)				
28.9	27.8	21.9	18.5	17.4
28.9	27.7	21.9	18.5	17.4
24.3	24.8	21.8	18.4	17.3
21.8	22.6	21.8	18.3	17.4
21.1	20.3	21.6	18.2	17.3
20.1	19.6	20	18.1	17.3
19.4	19.3	18.5	18	17.2
18.9	19.2	18.1	17.6	17.2
18.8	18.5	17.8	17.3	17.2
18.7	18.4	17.8	17.1	17.2
18.6		17.7	17	17.2
18.6		17.8	16.9	17.1
			16.8	
			16.8	
Conductivity (µS)				
78	80	70	70	82
78	81	70	70	80
82	75	70	71	81
87	70	71	72	80
84	68	71	71	80
123	69	71	72	80
106	73	71	68	80
83	107	79	66	80
79	111	78	64	80

LOUA016J

Depth	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
				Temperature (°C)				
0.5	21.5	25.7	27.2	30.1	27.6	23.7	20	17.6
1	21.1	25.7	27.2	30.1	27.4	23.7	20	17.6
2	20.3	21.9	24.4	28	24.8	22.2	18.6	17.6
3	17.5	19.3	21.8	23.5	23	19.4	18.5	17.6
4	16.1	18.89	20	20.1	21.4	19.3	18.5	17.6
5	15.8	18.2	19.9	20	21.1	18.9		
6		17.8	19.8	19.6	20.5			
				Specific Conductivity (µS)				
0.5	63	68	61	76	84	77	78	75
1	64	68	62	76	84	77	78	75
2	65	70	76	80	84	77	79	75
3	69	74	85	75	84	81	79	74
4	70	73	95	87	81	84	79	74
5	71	74	93	95	77	89		
6		74	91	100	77			
				pH (NU)				
0.5	8.23	7.25	8.04	8.57	9.12	8.03	7.04	6.83
1	8.29	7.33	8.22	8.62	9	7.81	7.03	6.75
2	8.15	7.4	8.01	7.53	7.38	7.07	7.05	6.65
3	7.7	7.41	7.63	7.52	7.03	6.73	7.08	6.58
4	7.56	7.28	7.39	7.38	6.96	6.6	7.03	6.56
5	7.43	7.19	7.19	7.24	6.94	6.57		
6		7.08	7.02	7.08	6.93			
				Dissolved Oxygen (mg/L)				

77	113	79	63	79
76		79	63	76
76		78	62	75
			62	
			62	

pH (NU)				
8.37	9.14	7.08	7.49	6.75
8.38	9.25	6.95	7.46	6.69
8.02	8.19	6.99	7.33	6.66
7.39	7.39	6.95	7.26	6.64
7.19	7.12	6.93	7.19	6.62
7.05	7.04	6.71	7.15	6.58
6.98	7.02	6.55	7.02	6.57
6.82	6.98	6.51	6.93	6.55
6.76	6.97	6.53	6.83	6.56
6.72	6.97	6.53	6.9	6.55
6.65		6.53	6.89	6.55
6.59		6.53	6.85	6.54
			6.83	
			6.84	

ed Oxygen (mg/L)				
9.47	9.92	8.12	10.72	7.32
9.56	9.99	7.99	10.75	6.61
10.38	9.21	7.84	10.46	6.38
6.68	5.37	7.38	10.21	6.27
5.5	4.21	7.31	9.88	6.1
4.73	3.67	5.1	9.01	5.78
4.39	3.43	3.62	8.75	5.7
4.01	3.02	2.44	8.01	5.65
3.87	2.81	2.24	7.49	5.6
3.68	2.41	2.19	7.31	5.61

0.5	10.83	9.92	10.18	9.32	9.94	9.92	8.58	6.68
1	11.1	10.13	10.3	9.47	10.27	9.9	8.58	5.64
2	11.02	11.26	10.99	7.41	8.66	7.93	9.03	5.34
3	9.2	11.3	6.71	9.18	5.83	4.5	8.64	5.13
4	7.73	10.2	4.01	6.15	4.22	3.84	8.23	5.07
5	7.55	9.26	3.38	4.79	3.44	3.44		
6		8.51	3.18	4.21	3			

Dissolved Oxygen Percent Saturation								
0.5	124%	123%	130%	125%	128%	119%	96%	71%
1	127%	126%	132%	127%	132%	119%	96%	60%
2	124%	130%	133%	96%	106%	92%	98%	57%
3	98%	124%	78%	110%	69%	50%	94%	55%
4	80%	111%	45%	69%	48%	42%	89%	54%
5	77%	100%	38%	53%	39%	38%		
6		91%	35%	47%	34%			

Total Depth (m)							
5.25	6	6.75	6.75	6.5	5.4	4	4

3.46		2.16	7.01	5.48
3.36		2.14	6.54	5.39
			6.29	
			6.24	
ygen Percent Saturation				
125%	128%	94%	116%	77%
126%	129%	93%	116%	70%
126%	113%	91%	113%	67%
77%	63%	85%	110%	66%
63%	47%	84%	106%	64%
53%	41%	57%	97%	61%
48%	38%	39%	94%	60%
44%	33%	26%	85%	60%
42%	30%	24%	79%	59%
40%	26%	23%	77%	59%
38%		23%	74%	58%
36%		23%	68%	57%
			66%	
			65%	
tal Depth (m)				
11	9.75	11.6	13.1	11.5

Number of pH values (all depths)

	> 9.00	All data	< 6.00
ƆUA016N	0	54	0
OUA016S	0	27	0
ƆUA016B	1	76	0
ƆUA016L	2	96	0
,OUA016J	1	50	0
Totals	4	303	0

Number of pH values (depth <= 1.0 m)

	> 9.00	All data	< 6.00
ƆUA016N	0	16	0
OUA016S	0	16	0
ƆUA016B	1	16	0
ƆUA016L	2	16	0
,OUA016J	1	16	0
Totals	4	80	0