WATER QUALITY RESULTS

PROPERTY NAME: Lake Springdale Estates – NC
SAMPLING DATE: October 22, 2020
REPORT DATE: November 3, 2020
SUBMITTED TO: Van Cotter
SUBMITTED BY: Trent Nelson and Tyler Meighan

At your request, we sampled the water quality in the Lower Lake at Springdale Estates. The results are summarized in the table on the last page. The table also indicates a reference water quality standard for each parameter, if applicable. Below are descriptions of each parameter and how they relate to the ecology of the waterbody.

These water quality parameters are essential to document the condition of a waterbody and design custom treatment prescriptions to achieve desired management objectives.

PHYSICAL PARAMETERS

The physical parameters were tested *in situ* (within the waterbody).

Dissolved Oxygen – Dissolved oxygen (DO) is the amount of oxygen gas dissolved in the water column. Small amounts of oxygen enter the water column by direct diffusion at the air/water interface. However, the primary source of oxygen in a lake or pond is production during photosynthesis by aquatic plants and algae. Lakes and ponds impacted by heavy sediment loads may experience low DO levels since the increased turbidity (cloudiness) caused by suspended clay and soil particles can restrict light penetration and limit photosynthesis. The breakdown of organic matter (i.e., aquatic plants, leaf litter, manure, fish waste) also consumes large amounts of oxygen from the water column. Fish require oxygen for respiration, and become stressed at levels less than 5 mg/L. Colder water is physically able to hold a greater concentration of oxygen then warmer water, and waterbodies may become naturally stressed with low dissolved oxygen levels during the warmer months.

<2 mg/L likely toxicity with enough exposure duration; <5 stressful to many aquatic organisms; ≥5 able to support most fish and invertebrates

Temperature – Water temperature affects the dissolved oxygen concentration of the water, the rate of photosynthesis by aquatic plants, the metabolic rates of aquatic organisms, and the sensitivity of organisms to toxic wastes, parasites, and diseases. All aquatic organisms are dependent on certain temperature ranges for optimal health. If temperatures are outside of this optimal range for a prolonged period, the organisms become stressed and can die. Water temperature generally increases with high suspended sediment readings because the particles absorb heat, which reduces dissolved oxygen levels. Since warmer water is able to hold less oxygen than colder water, lakes and ponds may become naturally stressed with low dissolved oxygen levels during the warmer months.

CHEMICAL PARAMETERS

A water sample was collected and sent to the laboratory for analysis of the chemical parameters.

Nutrients – Nutrients are essential for plant growth, but periodic over enrichment can lead to the excess growth of algae and aquatic plants and can alter the composition and species diversity of the aquatic community. Nitrogen and phosphorus are the elements most likely to control plant growth, although phosphorus is generally the limiting nutrient in freshwater bodies.

Phosphorus – Phosphorus can be found in several forms in freshwater, but the biologically available form for nuisance plant growth is soluble, inorganic orthophosphate. Organic phosphates quickly bind to soil particles and plant roots, and consequently, much of the phosphorus in aquatic systems is bound and moves through the system as sediment particles. This organic form of phosphorus is biologically unavailable. However, under anoxic (zero oxygen) conditions, bound phosphorus can be released from bottom sediments, and the concentration of biologically available orthophosphate can increase dramatically.

The erosion of soil particles from steep slopes, disturbed ground, and streambeds is the primary source of phosphorus in aquatic systems. Surface runoff containing orthophosphates from fertilizers and decaying organic matter will also contribute to biologically available phosphorus enrichment.

> **Total Phosphorus (TP)** is the measure of all phosphorus in a sample as measured by persulfate digestion and includes inorganic, oxidizable organic and polyphosphates. This includes what is readily available, potential to become available and stable forms. *<12 µg/L oligotrophic; 12-24 µg/L mesotrophic; 25-96 µg/L eutrophic; >96 µg/L hypereutrophic*

> **Free Reactive Phosphorus (FRP)** is the measure of inorganic dissolved reactive phosphorus (PO_4^{-3}, HPO_4^{-2}, etc.). This form is readily available in the water column for algae and nuisance aquatic plant growth.

Nitrogen - Nitrogen can exist in organic and inorganic, particulate, and soluble forms. The soluble, inorganic forms (ammonium, nitrite, and nitrate) are the most available for plant growth. Particulate and dissolved organic forms of nitrogen are not immediately available for plant growth, but they can be converted to ammonium by bacteria and fungi and can be oxidized to form nitrites then nitrates. Surface runoff can contain nitrogen in various forms. Inorganic nitrogen from fertilizers and organic nitrogen from animal waste and poorly functioning septic systems are examples.

> **Total Nitrogen –** Total nitrogen is the quantity of all the nitrogen in the water and is calculated by adding the measured forms of organic nitrogen, oxidized nitrogen, and ammonia. Nitrogen is an essential nutrient that can enhance growth of algae.

Nitrites and Nitrates are the sum of total oxidized nitrogen, often readily free for algae uptake. *<1 mg/L typical freshwater; 1-10 potentially harmful; >10 possible toxicity, above many regulated guidelines*

Nitrogen/Phosphorus Ratio - The ratio of total nitrogen to total phosphorus in a waterbody provides insight into nutrient limitation in the waterbody. Since many species of harmful cyanobacteria (blue-green algae) can fix nitrogen, they have a competitive advantage over other algae in phosphorus-rich environments when nitrogen is limited and can become dominant over the more beneficial green algae species. Maintaining an N/P ratio greater than 16:1 will favor green algae and discourage blue-green algae.

Chlorophyll *a* - Chlorophyll is the green pigment in plants that allows them to photosynthesize. The measurement of chlorophyll provides an indirect indication of the quantity of photosynthesizing plants found in the water column, such as algae and phytoplankton. More specifically, chlorophyll *a* is a measurement of the portion of the pigment that was still actively respiring and photosynthesizing at the time of sampling and does not include dead biomass.

0-2.6 µg/L oligotrophic; 2.7-20 µg/L mesotrophic; 21-56 µg/L eutrophic; >56 µg/L hypereutrophic

Conductivity – Conductivity is the ability of water to conduct an electrical current. Conductivity increases when more dissolved inorganic solids (positive and negative ions) are present. High sediment loads do not generally increase conductivity readings since sediment particles are generally considered to be suspended rather than dissolved because of their larger size (greater than 2 microns). The geology of the area around the waterbody is the primary factor affecting conductivity, and the readings for a waterbody will generally be within a relatively constant range. Once baseline data for a waterbody has been determined, periodic conductivity readings can be useful to identify potential problems that may need future investigation.

<50 uS/cm relatively low concentration may not provide enough dissolved ions for ecosystem health; 50-1500 typical freshwaters; >1500 may be stressful to some freshwater organisms, though not uncommon in many areas

pH – The concentration of acids and bases in the water determines its pH. A low pH (less than 7) is considered acidic, while a high pH (greater than 7) is basic. A pH of 7 is considered neutral. Most aquatic organisms survive best in waters with a pH between 6.8 and 8.2.

<6 notably acidic — 6 – 9 standard for typical freshwaters — >9 notably basic

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Alkalinity – The alkalinity of a waterbody is a measure of the acid-neutralizing or "buffering" capacity of the water. Waterbodies with higher alkalinity are resistant to broad swings in pH, which can be stressful for aquatic organisms. Waters with lower levels are more susceptible to pH shifts. Alkalinity is influenced by bicarbonates and is reported as the concentration of calcium carbonate ($CaCO_3$) in the water.

≤50 mg/L as $CaCO_3$ low buffered; 51-100 moderately buffered; 101-200 buffered; >200 high buffered

Hardness – Hardness is a measurement of calcium and magnesium ions in the waterbody and can be important for aquatic organisms that obtain their calcium directly from the water.

0-60 mg/L as $CaCO_3$ soft; 61-120 moderately hard; 121-180 hard; >181 very hard

Turbidity – Turbidity is a measurement of water clarity. Suspended particulates in the water such as algae and plankton, detritus, and soil particles are the primary constituents influencing turbidity. High turbidity can have both detrimental and positive effects on aquatic ecosystems depending on the suspended particles. Algae and plankton in moderation serve as a great source of food for aquatic life while suspended soil particles and detritus materials can clog fish gills and impair respiration, smother spawning areas, negatively affect egg and larval development, and reduce growth rates in fish. Since high turbidity does attenuate light, photosynthesis and the related production of dissolved oxygen may be dangerously reduced. Suspended particles also play a role in transporting phosphates and other compounds, including toxic substances.

Suspended solids usually settle out of standing water over time. However, clay particles can remain in suspension because of the negative electrical charges associated with them. Therefore, persistent turbidity is generally due to the presence of clay particles in the water column.

<4 NTU is clear to the naked eye; <10 NTU drinking water standard and typical trout waters; 10-50 NTU moderate; >50 NTU potential impact to aquatic life

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Table 1: Temperature and oxygen profile.

Location: Deepest area in the waterbody		
Water Depth (Feet)	**Temperature (F)**	**Dissolved Oxygen (mg/l)**
Surface	73	12.3
3	70	12.1
6	70	10.6
9	68	12.4
12	65	**1.6**
15	65	**0.1**
18	62	**0.1**
21	59	**0.1**
Optimal Range	**N/A**	**≥5**

Table 2: Surface Water Quality

Goal: Stormwater Pond Aesthetics and Pond Health		
Parameter	**Surface**	**Optimal Range**
Turbidity (NTU)	**10.5**	<10
Conductivity (us/cm)	73.7	>50
Free Reactive Phosphorus (µg/L)	<5	<25
Dissolved Oxygen (mg/L)	7.2	>5.0
Chlorophyll *a* (µg/L)	**50.7**	<20
Total Phosphorus (µg/L)	**33.5**	<25
Alkalinity (mg/L)	26.9	>20
Hardness (mg/L as $CaCO_3$)	**25.9**	>30
Total Nitrate & Nitrite (mg/L)	<0.02	<5
Nitrites (mg/L)	<0.02	<0.25
Nitrates (mg/L)	<0.02	<5.0
Total Kjeldahl Nitrogen (mg/L)	1.4	<5
Total Nitrogen (mg/L)	**1.4**	<1.0
pH	7.8	6.8-8.2

Table 3: Algae Identification

Algae ID Results

Springdale Estates- Lower

Identification	Classification	Description	Density/Biomass (cells/mL)
***Aphanizomenon* sp.**	Cyanophyta- Blue-green algae	Filamentous, scum-former, planktonic, potential toxin and taste/odor producer	403,000 ★★★★

Other algae in the sample at densities lower than 100 cells/mL include: *Chromulina* (Chrysophyceae); *Anabaenopsis, Aphanocapsa, Dolichospermum, Microcystis, Woronichinia* (Cyanophyta); *Trachelomonas* (Euglenophyta); *Staurastrum* (Streptophyta)

SeSCRIPT* ALERT INDEX	EXPOSURE RISK	CYANOBACTERIA LEVELS (cells/mL)
★	Low	<20,000
★★	Moderate	20,000 to 100,000
★★★	High	>100,000
★★★★	Extreme	>100,000 with scums/mats
See the following Cyanobacteria Alert Guide for additional information		