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# Moosic Lakes Community Association

Marcellus Shale Baseline Monitoring Report

On October 20, 2011, Ecological Solutions, Inc. (ECS) visited Moosic Lakes to perform a series of monitoring activities. During that site visit the following tasks were performed:

1. Water Quality Monitoring

| Month | Parameter | Mossic #1 | Mossic #2 | L. Moosic |
|---|---|---|---|---|
| October | **Surface Temp (℉)** | 17.6 | 18.5 | 19.3 |
| | **Surface D.O. (mg/l)** | 10.0 | 10.2 | 9.3 |
| | **pH** | 7.61 | 7.33 | 6.79 |
| | **Conductivity *(µm/hos*)** | 55.9 | 53.6 | 32.2 |
| | **Total Dissolved Solids *(*mg/l)** | 38.5 | 38.5 | 21.7 |
| | **Turbidity (FTU)** | 0 | 0 | 8 |
| | **Nitrate Nitrogen (ppm)** | 0.00 | 0.08 | 0.00 |
| | **Total Phosphorous (ppm)** | 0.00 | >3.00 | 2.03 |
| | **Alkalinity (ppm)** | N/A | N/A | N/A |
| | **Hardness (ppm)** | N/A | N/A | N/A |
| | **Secchi (m)** | 2.0 | 2.0 | 1.5 |

Table 1. Table displaying the water quality results collected at Birchwood Lakes on October 20, 2011 by ECS.

In general, the results of the water chemistry showed average surface temperatures in the lakes for this time of year. Based on the consistent surface and bottom temperatures in the temperature profile, it was determined that Moosic Lake is not stratified. This is common for this time of year when lakes go through a turnover process. Turnover occurs when the air temperature and upper layers of a body of water drop. As these upper layers cool they become denser and heavier. Eventually they become cold and heavy enough that they begin to sink. As this heavy dense layer sinks it displaces the water at the lake bottom, forcing the lower, nutrient rich layers to the surface. In turn, the lake becomes the same temperature from the surface to the bottom. The dissolved oxygen values were considered to be within normal limits (>5.0 mg/l) and there was no concern about the amount of available oxygen for fish populations.

According to the Sørenson scale, all of the pH values fell within the neutral range (7.00 standard units) and the water clarity was considered to be average in the lakes, as indicated by the turbidity and secchi disk measurements levels. The turbidity and secchi disk values were 0-8 FTU's and 1.5-2.0 meters respectively.

| Test Name | Test Result (mg/l) | Standard (mg/l) |
|---|---|---|
| pH | 6.8 su | 6.5-8.2 |
| Specific Conductance | 65 micro mhos | <1500 |
| Total Dissolved Solids | 46 | <1500 |
| Alkalinity, Total as CaCO3 | 6.1 | 20-200 |
| Hardness, Total | 11.3 CaCO3 | 100-200 |
| Flouride | <0.20 | 4.0 |
| Chloride | 12.2 | 250 |
| Nitrite as N | <0.10 | 1.0 |
| Nitrate as N | <0.5 | 10.0 |
| Sulfate, SO4 | <5.0 | 250 |
| Ammonia-Nitrogen | <0.5 | <1.0 |
| Phosphorous, Total, All Forms | <0.20 | 0.01 |
| Nitrogen, Total Kjeldahl | 0.5 | **N/A** |
| Nitrate as N | <0.5 | 10.0 |
| Nitrite as N | <0.10 | 1.0 |
| Organic Nitrogen | 0.5 | **calculated* |
| Arsenic, Total ICP-MS | <0.001 | 0.34 |
| Barium, Total ICP-MS | 0.0112 | 2.0 |
| Cadmium, Total ICP-MS | <0.001 | 0.005 |
| Chromium, Total ICP-MS | <0.001 | 0.10 |
| Lead, Total ICP-MS | <0.001 | 0.65 |
| Selenium, Total ICP-MS | <0.005 | 0.05 |
| Silver, Total ICP-MS | <0.001 | 0.10 |
| Mercury, Total | <0.0002 J | 0.002 |

Table 2. Table displaying the test results from Hawk Mountain Laboratory and the National Drinking Water Standards for Moosic Lake Sample #1.

According to the water quality results, it was concluded that the lake contains soft water but the alkalinity is low. Low alkalinity values make the lake susceptible to acid rain, which could cause significant fluctuations in pH following a rain event. The secchi depth measurements of 1.5 – 2.0 meters (5.0 – 6.7 feet) indicate average water clarity for this time of year. ECS uses 1.5 meters (3 feet) as a management threshold to make decisions on how to manage the lake. The depth of 1.5 meters is used because it is usually when the water clarity becomes degraded enough to make the lake unappealing for use by residents.

The nitrate nitrogen concentrations in the lakes were considered to be low, while the total phosphate levels at Moosic Lake Sample #2 and Little Moosic Lake contained high levels of total phosphorous. High levels of total phosphorous indicate the potential for an algae bloom to occur. However, the total phosphorous was considered to be low at Moosic Lake Sample #1 and at the McGraw residence. In addition, the water clarity at the McGraw residence was excellent. Moreover, the nitrate nitrogen levels were considered to be low at the McGraw residence. Typically, phosphate concentrations are less than 0.01 mg/l in natural waters.

| Test Name | Test Result (mg/l) | Standard (mg/l) |
|---|---|---|
| pH | 6.3 su | 6.5-8.2 |
| Specific Conductance | 67 micro mhos | <1500 |
| Total Dissolved Solids | 36 | <1500 |
| Alkalinity, Total as CaCO3 | 4.1 | 20-200 |
| Hardness, Total | 10.9 $CaCO_3$ | 100-200 |
| Flouride | <0.20 | 4.0 |
| Chloride | 10.7 | 250 |
| Nitrite as N | <0.10 | 1.0 |
| Nitrate as N | <0.5 | 10.0 |
| Sulfate, SO4 | 5.02 | 250 |
| Ammonia-Nitrogen | <0.5 | <1.0 |
| Phosphorous, Total, All Forms | <0.20 | 0.01 |
| Nitrogen, Total Kjeldahl | <0.5 | **N/A** |
| Nitrate as N | <0.5 | 10.0 |
| Nitrite as N | <0.10 | 1.0 |
| Organic Nitrogen | <0.5 | **calculated* |
| Arsenic, Total ICP-MS | <0.001 | 0.34 |
| Barium, Total ICP-MS | 0.0115 | 2.0 |
| Cadmium, Total ICP-MS | <0.001 | 0.005 |
| Chromium, Total ICP-MS | <0.001 | 0.10 |
| Lead, Total ICP-MS | <0.001 | 0.65 |
| Selenium, Total ICP-MS | <0.005 | 0.05 |
| Silver, Total ICP-MS | <0.001 | 0.10 |
| Mercury, Total | <0.0002 J | 0.002 |

Table 3. Table displaying the test results from Hawk Mountain Laboratory and the National Drinking Water Standards for Moosic Lake Sample #2.

2. Aquatic Plant Growth

During the monitoring visit no submerged weed species were observed in the Lakes but a slight planktonic bloom was detected on Moosic Lake. In addition, a moderate algae bloom was observed on Little Moosic Lake. No weeds or algae were observed by the McGraw residence and the bottom could clearly be seen from this location. ECS recommends treating a lake for algae when water clarity is less than 1.5 meters (5 feet). At this level, algae can be a nuisance to residents and pose health risks. The lakes had a secchi depth between 1.5-2.0 meters indicating that a treatment would not be necessary.

If you have any questions regarding any aspect of this report, please do not hesitate to contact us.

Sincerely,

*Jessica Mullin*

Jessica Mullin
Consulting Ecologist

# Water Quality Parameters

A FACT SHEET OF THE PENNSYLVANIA LAKE MANAGEMENT SOCIETY

Managing a lake requires a basic understanding of an extensive set of constituents that affect water quality. The purpose of this fact sheet is to provide an explanation of the most important parameters, to present typical or acceptable values, and to provide established criteria where appropriate. An explanation of units and sources for additional information and assistance are included at the bottom of page 2.

| PARAMETER | LAKES | STREAMS | EXPLANATION |
|---|---|---|---|
| **Alkalinity** | | 20 to 200 mg/L<br>PA standards require 20 | Usually expressed in terms of calcium carbonate<br>Carbonate compounds are abundant in nature & provide natural buffering<br>Optimal is 100-200 ppm<br>Low alkalinity cannot mediate low pH events |
| **Calcium (Ca)** | < 11 mg/L = oligotrophic<br>> 24 mg/L usually are eutrophic | In limestone areas, typically 30 - 100 mg/L | Leached from nearly all rocks but most prevalent in regions with limestone, dolomite & gypsum deposits<br>Low calcium in areas with granite or siliceous deposits<br>Important for biological activity - plant cell walls, bony tissue & shells |
| **Chlorine, total residual** | | 4 day average not to exceed 0.011 mg/l and 1 hr maximum not to exceed 0.019 mg/l | Used for disinfection<br>Does not occur naturally |
| **Chlorophyll a (mean growing season limit)** | <2.0 µg/L = oligotrophic<br>2.0 - 6.0 µg/L = mesotrophic<br>6.0 - 40.0 µg/L = eutrophic<br>> 40.0 = hypereutrophic | Recreation / aesthetics:<br>< 0.025 mg/L | 0-10 µg/L - no problems evident; no water discoloration<br>10-20 µg/L - algal scums evident; some discoloration<br>20-30 µg/L - nuisance conditions encountered<br>>30 µg/L - severe conditions encountered; very deep discoloration |
| **Dissolved Oxygen** | Same as streams<br>4 - 5 mg/L minimum | < 3 - 4 mg/L is stressful to aquatic life<br>6 mg/L is best for coldwater fishes | $O_2$ levels controlled by photosynthetic & respiratory activity & diffusion<br>Higher late in the day; lowest early AM |
| **Fecal coliform bacteria** | < 200/100 ml<br>(summer months) | | Not necessarily bad in itself, but may indicate presence of pathogens |
| **Hardness** | | 0 - 60 mg/l = soft<br>61 - 120 = mod. hard<br>121 - 180 = hard<br>>180 = very hard<br>100-200 mg/L optimal | Due to dissolved salts of calcium, magnesium & sometimes aluminum, manganese and iron<br>Usually expressed in mg/L as $CaCO_3$<br>>250 mg/L $CaCO_3$ can precipitate out to stream bottom<br>May affect fish tolerance to toxic metals, toxicity of mercury, copper, lead, ammonia, phenols increases with lower alkalinity |
| **Iron (Fe)** | Will be higher near lake bottom | Not to exceed 1500 µg/L<br>Acceptable level: 0.3 mg/l | At pH > 3, iron precipitates out in water as "yellow boy" (ferric hydroxide)<br>Can clog gills & smother habitats |
| **Manganese (Mn)** | Similar to iron | | Mostly a color problem |
| **Magnesium (Mg)** | | In areas with source, 5 - 50 mg/L | Mainly from leaching of igneous & carbonate rocks; essential micronutrient in plants for chlorophyll production |
| **Nitrogen (N)** | | | Present in several forms - organic nitrogen, ammonia (the product of decomposition), nitrate and nitrite.<br>Occasionally it is the nutrient that limits algae growth. |
| **Ammonia nitrogen (NH3-N)** | May reach 5 to 10 mg/L in anoxic bottom waters in a eutrophic lake | Non polluted: <1 mg/L | EPA's recommended criteria is 0.02 mg/L for freshwater aquatic life with caution against using with temp. < 5 °C & pH > 8.5 (Toxicity affected by temp. & pH)<br>Acute lethal levels for fish ranges 0.2 to 2.0 mg/L<br>Sources - wastewater, agricultural runoff, decay of organisms |
| **Nitrate nitrogen (NO3-N)** | Relatively "Healthy" lake = <0.05mg/L in summer, top layers of eutrophic lake has low levels due to plant uptake; bottom higher due to decay | Rarely exceeds 10 mg/L<br>Frequently < 1 mg/L during high primary production | The most abundant inorganic form of nitrogen<br>Drinking water standard is 10 mg/L.<br>Algae can use nitrate as nitrogen source for growth |
| **Nitrite N (NO2-N)** | | Typically present in extremely low concentrations | Rarely measurable in unpolluted natural waters; generally <1 mg/L<br>High concentrations may be indicative of septic or sewage |

| PARAMETER | LAKES | FLOWING | EXPLANATION |
|---|---|---|---|
| **pH** | 6.0 to 9.0 ideal range for aquatic organisms | 6.5 - 8.2 optimal | 7.0 is neutral<br>8.5 and above may result from biological productivity ($CO_2$)<br>5.5 and below is stressful to organisms, may indicate acid rain/acid mine drainage; low pH can release metals into water |
| **Phosphorus (P)** | TP (total P) - below 0.01 mg/L (<10µg/L) provides a high level of protection; oligotrophic<br><0.02 mg/L avoids nuisance algal growth<br>>0.03 mg/L = likely to experience problem weed and algae growth; eutrophic | Non polluted waters - total phosphorus usually < 0.1 mg/L | Present in several forms - organic bound, inorganic polyphosphates and inorganic orthophosphates<br>Very biologically active and cyclic<br>Sources - leaching from phosphate bearing rocks; fertilizers; sewage; detergents; septic tanks; soil erosion; agriculture; development<br>The element most likely to cause stimulation of plant production (Aglae and aquatic plants use only the orthophosphate ($PO_4$) form of phosphorus) |
| **Ortho - Phosphorus** | In unproductive lakes, ortho-P <0.005 - 0.007 mg/L | Ortho-phosphorus < 0.01mg/L | Soluble Ortho-Phosphorus is the form most available to plants |
| **Silica (Si)** | Lakes can have a silica cycle | Natural waters - 1 to 10 mg/L<br>Rarely >60 mg/L | Common in nature from igneous rocks, quartz & sand<br>Principle component of diatoms (silica-shelled algae); use by diatoms influences silica cycle |
| **Sulfate (SO4)** | Much higher in saline lakes<br>Conc. cyclic in lakes | 5 - 50 mg/L in natural waters<br>Not to exceed 250 mg/L | Usually the 2nd most common anion; from sedimentary rocks; in lakes is cyclic - organically reduced forms & free Sulfate is taken up by higher plants and algae |
| **Specific conductance (conductivity)** | | Usually between 50-1500 µmhos | In natural waters, unit is micromho (µmho)<br>Affected by temperature<br>Indicator of the amount ot total dissolved solids |
| **Temperature** | Above 30 °C (88 °F) can be stressful to fish | Up to 66 F for coldwater fish<br>Up to 87 F for warmwater fish | Maximum allowable temperature varies by season and water body |
| **Total Dissolved Solids** | Unpolluted = 17 - 30mg/L<br>Polluted = 400 mg/L | Maximum = 1500 mg/L | The total amount of solids that are in solution in water; total dissolved solids consist of the anions and cations that are dissolved in water and include sodium, calcium, sulfates, orthophosphate, and other dissolved chemicals. |
| **Total Suspended Solids (TSS)** | Clear water = <25mg/L<br>Intermediate = 25-100 mg/L<br>Muddy = >100 mg/L<br>TSS of 25mg/L produces a "turbid" appearance generally perceived as a water quality problem | High level of protection = < 25 mg/L<br>Moderate protect. = 80 mg/L<br>Low level protect. = 400 mg/L<br>Very Low protect. = > 400 mg/L<br>Harmful to fish eggs = 75 - 100mg/L | Not all kinds of TSS are equally harmful<br>Walleye are sensitive to TSS with death rates at > 200 mg/L (reduced sight affects feeding ability)<br>Good to moderate fisheries - 25 to 80 mg/L<br>80 to 400 mg/L unlikely to support good fishery but could get by at lower end<br>AFS suggests limit of 100 mg/L to prevent aquatic life mortality, but concentrations can be greater without adverse effects |
| **Turbidity** | | >100 NTU is excessive<br>50 NTU is considered turbid | Turbidity is caused by the presence of suspended matter in water such as clays, mud, algae, silica, and bacteria. |
| **Visibility - Secchi Disk** | Excellent = 15 - 20+ feet<br>Poor = < 2 feet<br>Oligotrophic = > 8 meters<br>Mesotrophic = 4 - 8 meters<br>Eutrophic = 2 - 4 meters | | 20 cm (8") diameter standard Secchi disk, black and white;<br>Used to measure the clarity of lake water;<br>Excellent, inexpensive measurement of lake water quality condition. |

## EXPLANATION OF UNITS

Typical units of concentration used in water chemistry are milligrams per liter (mg/L) which is equivalent to parts per million (ppm), and micrograms per liter (µg/L) which is equivalent to parts per billion (ppb). The units are related in the following ways:

1 mg/L = 1 ppm; 1 ppm = 1,000 ppb  1 µg/L = 1 ppb; 1 ppb = 0.001 mg/L

***Lake Management References***


- *Nutrient Criteria Technical Guidance Manual-Lakes and Reservoirs, EPA-822-B00-001, April 2000; Nutrient Criteria Technical Guidance Manual-Rivers and Streams, - EPA Water Resource Center, 202-260-7786, center.water-resource@epa.gov*
- *US Environmental Protection Agency (EPA): www.epa.gov*
- *PA Department of Environmental Protection (DEP): www.state.pa.us*
- *National Resource Conservation Service (NRCS): www.nrcs.gov*



FOR MORE INFORMATION, CONTACT

The Pennsylvania Lake Management Society (PALMS)

P.O. Box 425

Lansdale, PA 19446



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Table 4. Table displaying common water quality parameters, which has been provided by the Pennsylvania Lake Management Society.

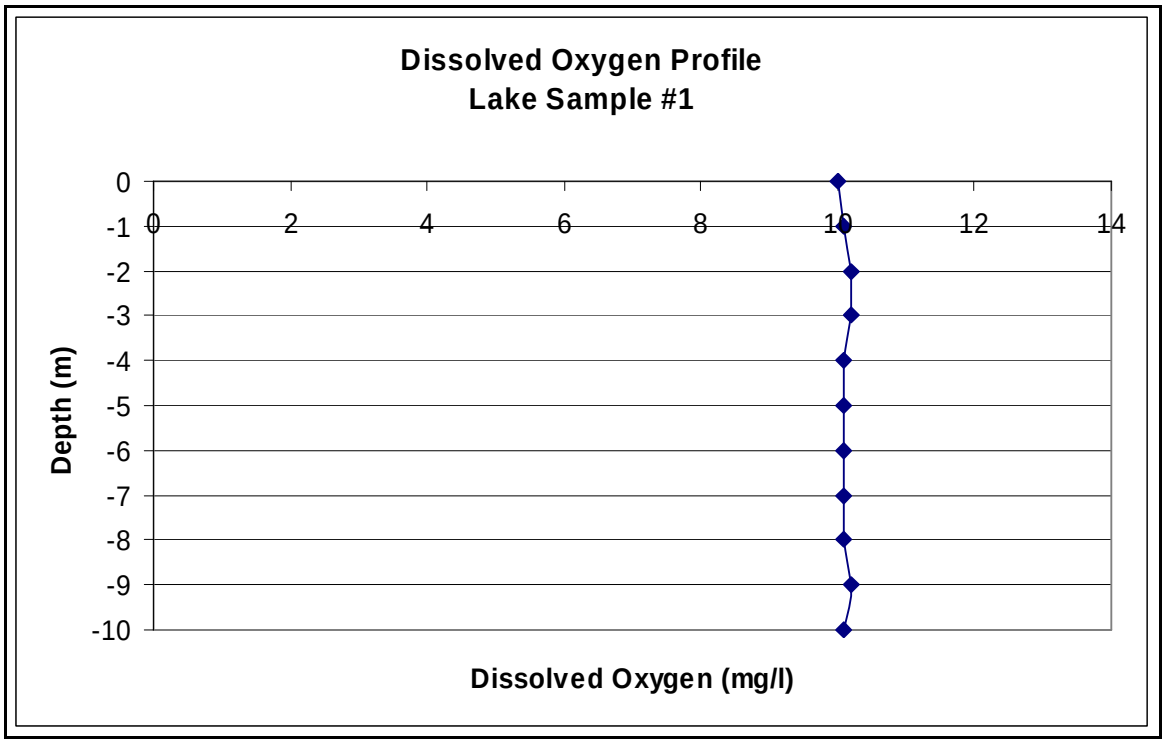


Figure 1. Graph displaying the dissolved oxygen from the surface to the bottom of Moosic Lake #1 on October 20, 2011.

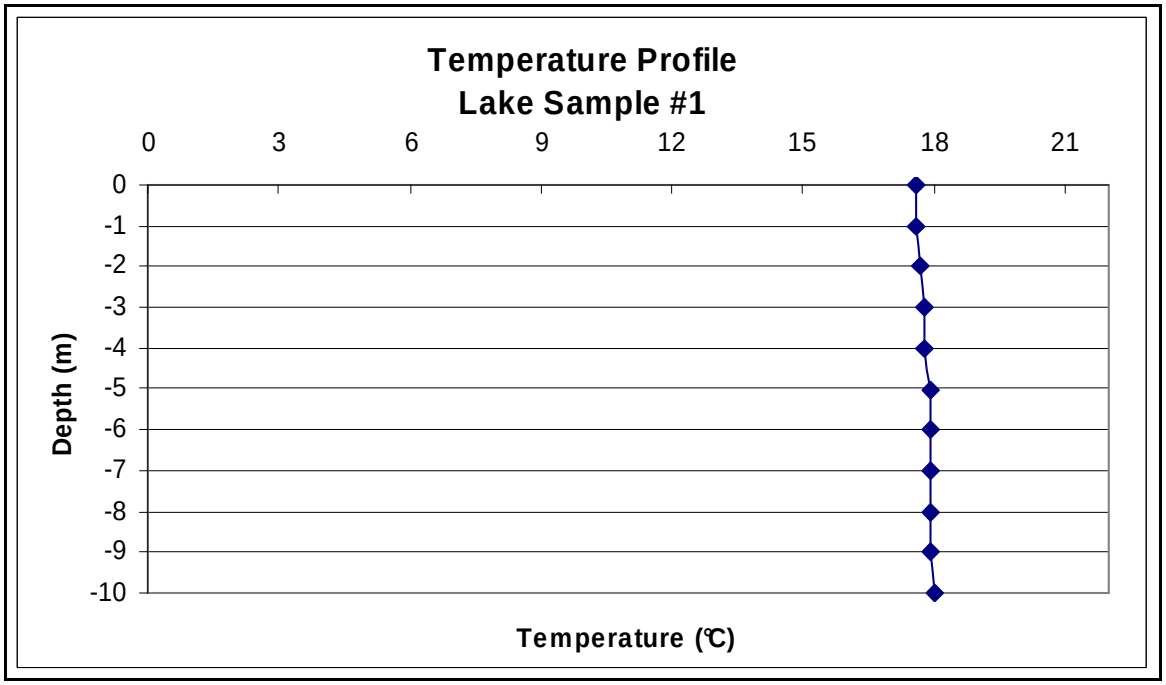


Figure 2. Graph displaying the temperature from the surface to the bottom of Moosic Lake #1 on October 20, 2011.

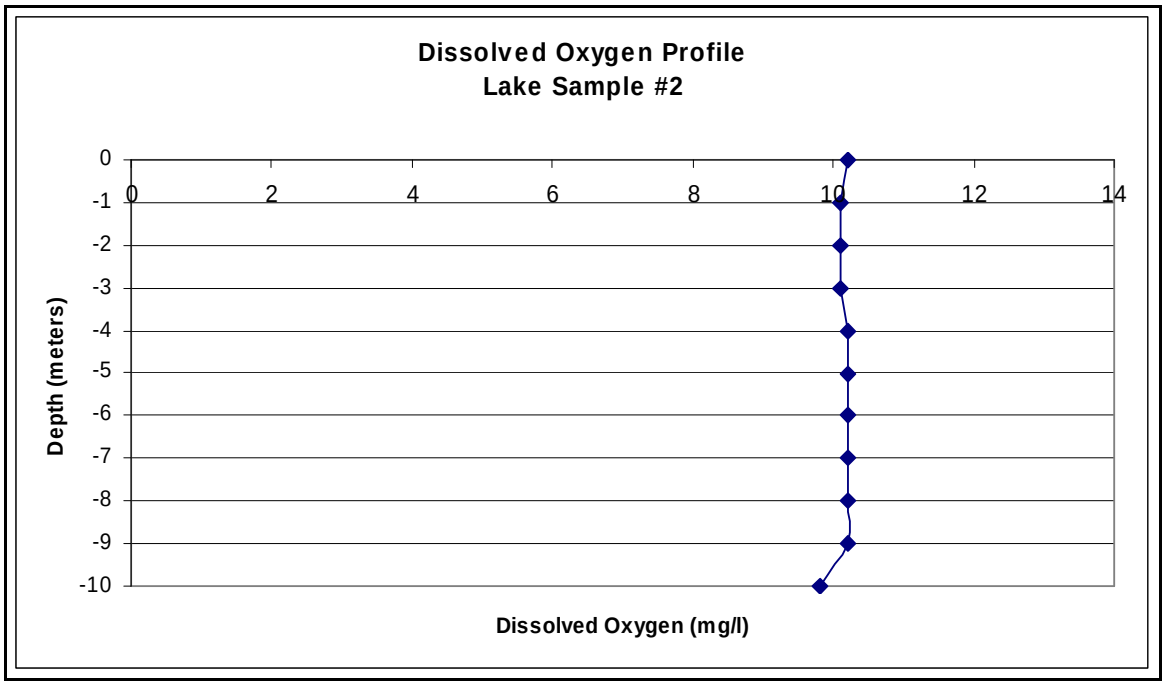


Figure 3. Graph displaying the dissolved oxygen from the surface to the bottom of Moosic Lake #2 on October 20, 2011.

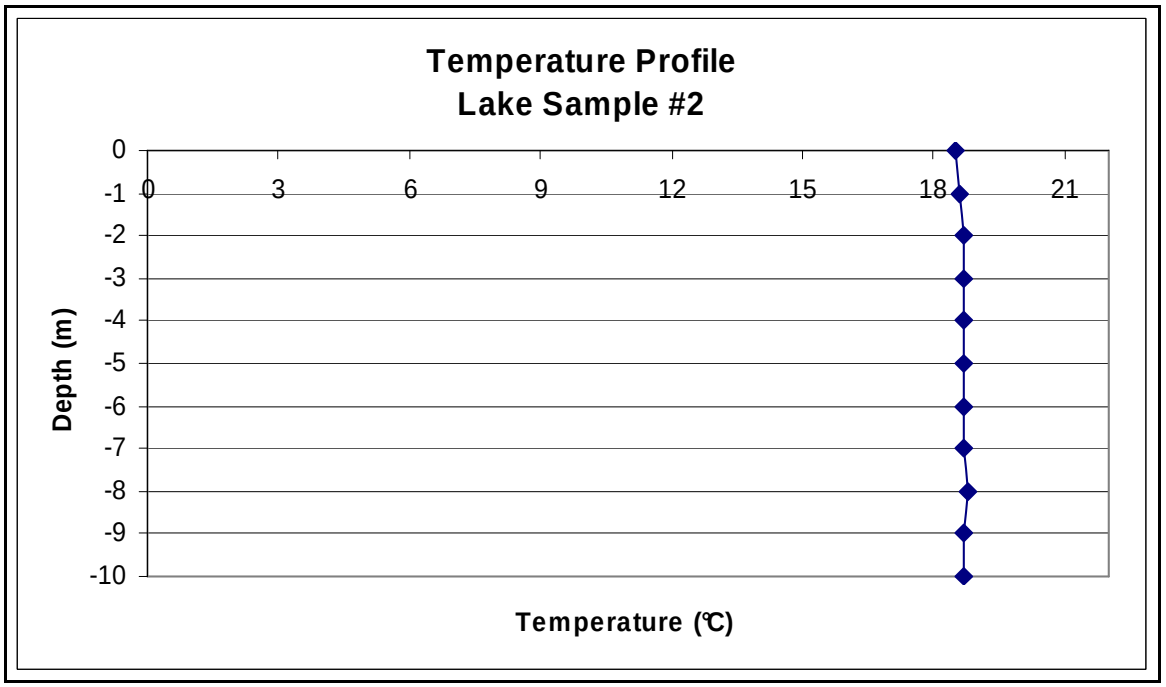


Figure 4. Graph displaying the temperature from the surface to the bottom of Moosic Lake #2 on October 20, 2011.