Water Quality Parameters

A FACT SHEET OF THE PENNSYLVANIA LAKE MANAGEMENT SOCIETY

Managing lakes and reservoirs 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 is included at the bottom of Page 2.

PARAMETER	LAKES	STREAMS	EXPLANATION
Alkalinity		20 to 200 mg/L PA standards require 20	Usually expressed in terms of calcium carbonate Carbonate compounds are abundant in nature & provide natural buffering Optimal is 100-200 ppm Low alkalinity cannot mediate low pH events
Calcium (Ca)	< 11 mg/L = oligotrophic > 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 Low calcium in areas with granite or siliceous deposits 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 Does not occur naturally
Chlorophyll a (mean growing season limit)	< 2.0 µg/L = oligotrophic 2.0 - 6.0 µg/L = mesotrophic 6.0 - 40.0 µg/L = eutrophic > 40.0 = hypereutrophic	Recreation / aesthetics: < 0.025 mg/L	0-10 µg/L - no problems evident; no water discoloration 10-20 µg/L - algal scums evident; some discoloration 20-30 µg/L - nuisance conditions encountered > 30 µg/L - severe conditions encountered; very deep discoloration
Dissolved Oxygen	Same as streams 4 - 5 mg/L minimum	< 3 - 4 mg/L is stressful to aquatic life; 6 mg/L is best for coldwater fishes	O_2 levels controlled by photosynthetic & respiratory activity & diffusion Higher late in the day; lowest early AM
Fecal coliform bacteria	< 200/100 ml (summer months)		Not necessarily bad in itself, but may indicate presence of pathogens
Hardness		0 - 60 mg/l = soft 61 - 120 = mod. hard 121 - 180 = hard > 180 = very hard 100-200 mg/L optimal	Due to dissolved salts of calcium, magnesium & sometimes aluminum, manganese and iron Usually expressed in mg/L as $CaCO_3$ > 250 mg/L $CaCO_3$ can precipitate out to stream bottom 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 Acceptable level: 0.3 mg/l	At pH > 3, iron precipitates out in water as "yellow boy" (ferric hydroxide) Can clog gills & smother habitats
Manganese (Mn)	Similar to iron		Mostly a color problem
Magnesium (Mg)		In areas with source, 5 - 50mg/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. 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) Acute lethal levels for fish ranges 0.2 to 2.0 mg/L Sources - wastewater, agricultural runoff, decay of organisms
Nitrate nitrogen (NO3-N)	Relatively "healthy" lake = <0.05 mg/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 Frequently < 1 mg/L during high primary production	The most abundant inorganic form of nitrogen Drinking water standard is 10 mg/L. Algae can use nitrate as nitrogen source for growth
Nitrite nitrogen (NO2-N)		Typically present in extremely low concentrations	Rarely measurable in unpolluted natural waters; generally <1 mg/L High concentrations may be indicative of septic or sewage

PARAMETER	LAKES	FLOWING	EXPLANATION
pH (standard units)	6.0 to 9.0 ideal range for aquatic organisms	6.5 - 8.2 optimal	7.0 is neutral 8.5 and above may result from biological productivity (CO_2) 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 < 0.02 mg/L avoids nuisance algal growth > 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 Very biologically active and cyclic Sources - leaching from phosphate bearing rocks; fertilizers; sewage; detergents; septic tanks; soil erosion; agriculture; development The element most likely to cause stimulation of plant production (Algae and aquatic plants use only the orthophosphate (PO_4) form of phosphorus)
Ortho – Phosphorus (DRP)	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 Rarely > 60 mg/L	Common in nature from igneous rocks, quartz & sand Principle component of diatoms (silica-shelled algae); use by diatoms influences silica cycle
Sulfate (SO4)	Much higher in saline lakes Conc. cyclic in lakes	5 - 50 mg/L in natural waters 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		Usually between 50-1500µmhos	In natural waters, unit is micromho (µmho) Affected by temperature Indicator of the amount of total dissolved solids
Temperature	Above 30 °C (88 °F) can be stressful to fish	Up to 66 °F for coldwater fish Up to 87 °F for warmwater fish	Maximum allowable temperature varies by season and water body
Total Dissolved Solids (TDS)	Unpolluted = 17 - 30mg/L Polluted = 400 mg/L	Maximum = 1,500 mg/L	The total amount of solids that are in solution in water; TDS 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 Intermediate = 25-100 mg/L Muddy = >100 mg/L TSS of 25mg/L produces a "turbid" appearance generally perceived as a water quality problem	High level of protection = < 25mg/L Moderate protect. = 80 mg/L Low level protect. = 400 mg/L Very Low protect. = > 400 mg/L Harmful to fish eggs = 75 - 100mg/L	Not all kinds of TSS are equally harmful Walleye are sensitive to TSS with death rates at > 200 mg/L (reduced sight affects feeding ability) Good to moderate fisheries - 25 to 80 mg/L 80 to 400 mg/L unlikely to support good fishery 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 50 NTU is considered turbid	Turbidity is caused by the presence of suspended matter in water such as clays, mud, algae, silica, and bacteria.
Clarity – Secchi Disk (SD)	Excellent = 15 - 20+ feet Poor = < 2 feet Oligotrophic = > 8 meters Mesotrophic = 4 - 8 meters Eutrophic = 2 - 4 meters		20 cm (8@) diameter standard Secchi disk, black and white; Used to measure the clarity of lake water; 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*
- *US Environmental Protection Agency (EPA): www.epa.gov*
- *PA Department of Environmental Protection (DEP): www.dep.pa.gov*

FOR MORE INFORMATION, CONTACT:

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This Fact Sheet made possible through a grant from the US EPA & PA DEP Section 319 Non-Point Source Program