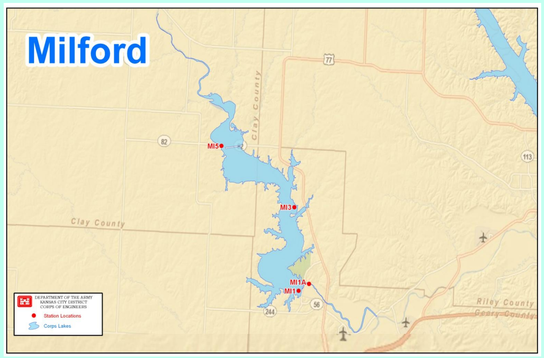
Milford Lake Water Quality Summary

2005-2014

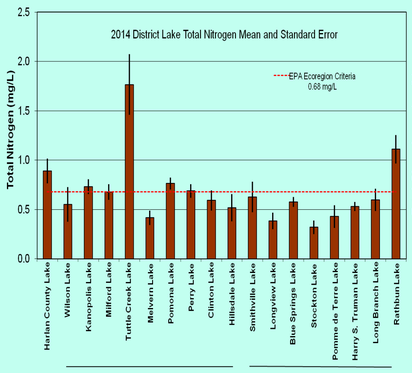


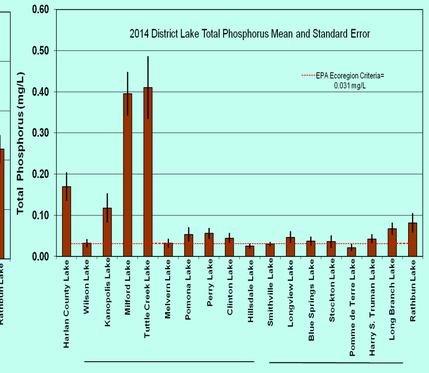
Milford Lake

- Built on Republican River reaching full pool in 1967.
- **Watershed** = 17,388 square miles / 11,130,000 Surface Acres (SA)
- **Capacity**:
  - Flood Control: 756,669 Acre-feet (AF) / 32,979 SA
  - Multipurpose: 388,816 AF / 15,709 SA / 163 miles of shoreline
  - 10-year avg. annual inflow = 455,823 AF; 2014 avg. inflow = 218,582 AF
- **Operating project purposes**: Flood control, water supply, water quality, navigation, recreation, and fish and wildlife conservation.
- **Water Quality** at Milford Lake in 2014 was impacted by harmful algal blooms which required beach closures and 3 months of public health notices.

Nutrient Enrichment

Nutrients (i.e. phosphorus and nitrogen) are essential for aquatic life and are the primary factor driving fish and aquatic plant growth rates and lake productivity. Excess nutrients from urban, agricultural or natural sources increases the natural aging or eutrophication process and cause algal blooms, create low dissolved oxygen affecting fish survival, and lead to taste and odor issues in drinking water. Milford Lake experienced sizeable algal bloom events in 2011 causing closure of the entire lake. High nutrient concentrations and resulting harmful algae blooms have elevated Milford Lake to the 2014 Kansas 303(d) list of impaired waters for eutrophication and low dissolved oxygen. Nine inflow stream(s) sections upstream from Milford Lake are also listed for nutrient related water quality impairments. KDHE and EPA are working with water quality partners, landowners and Milford Lake Watershed Restoration and Protection Strategy (WRAPS) group to improve water quality at Milford Lake. WRAPS provide recommended best management practices for target areas in the watershed to improve inflow water quality to meet long term goals for Milford Lake. In 2014, Milford had the second highest total phosphorus concentrations of all District lakes at the upper lake sites and the dam. Standard error bars in the graph below depicts the variation in sample results from each site in 2014.



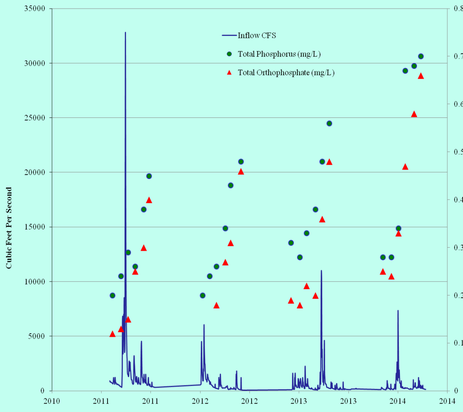


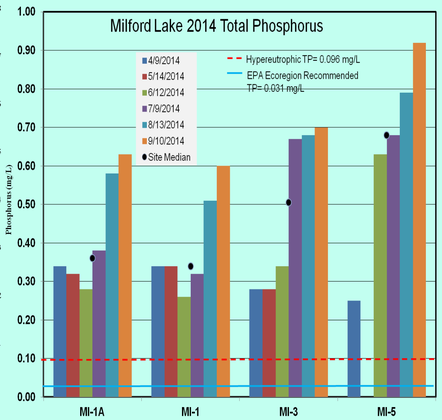
The US Army Corps of Engineers (USACE) Water Quality Program collects monthly water samples at Milford Lake* and inflows from April through September. These figures present data collected between 2005-2014 from three lake sites (#1, 3, 5) and the outflow (#1A). Thirty-four chemical, physical and biological parameters are measured to evaluate water quality. USACE use this data to describe conditions and changes from the inflows through the lake and outflow focusing on eutrophication, nutrients, sediment, herbicides, metals, and contaminants.

*Note: The term "lake" is substituted for technically correct "reservoir" throughout this document for consistency.

Phosphorus

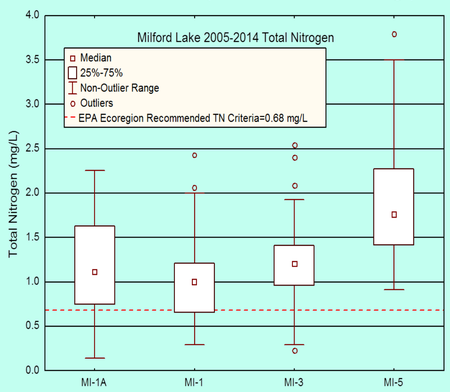
Physical conditions and excessive nutrients in Milford Lake have caused toxic blue-green algae blooms in 2011 and 2014. Median phosphorus concentrations in 2014 were slightly higher than long-term trends. Total phosphorus medians from all sites in 2014 exceeded hypereutrophic thresholds and were 10 to 20 times higher than EPA Ecoregion recommended criteria of 0.031 mg/L. Low inflows and increasing water clarity combine with increases in phosphorus during the hottest part of the summer to create optimum conditions for blue green algae. Internal sources of phosphorus including orthophosphate released by bottom sediments are apparent as TP and TOP concentrations increase exponentially from July-Sept unrelated to inflow volume or timing in 2011-2014. Wind action, invertebrates, bottom feeding fish and bacteria cause the re-suspension of sediment bound phosphorus.

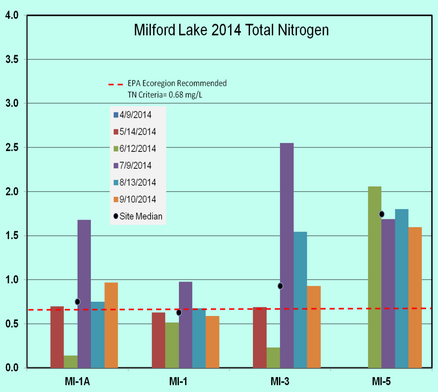




Total Nitrogen

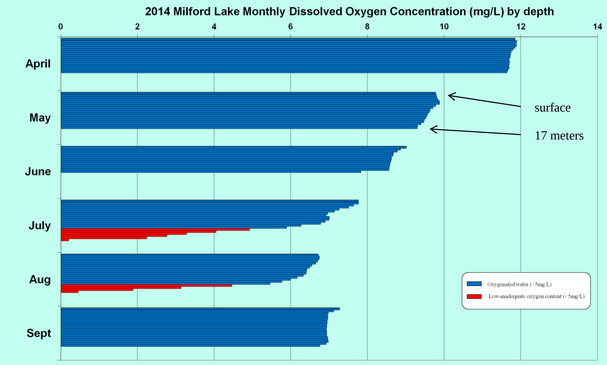
In 2014, total nitrogen concentrations were more variable and slightly reduced compared to the 10-year data range. Only the upper lake site (MI-5) was significantly higher than EPA Ecoregion recommended criteria of 0.68 mg/L. Total nitrogen concentrations are typically variable between sites and years and most related to inflow levels, algae populations, and watershed factors (i.e. soils and farming practices).





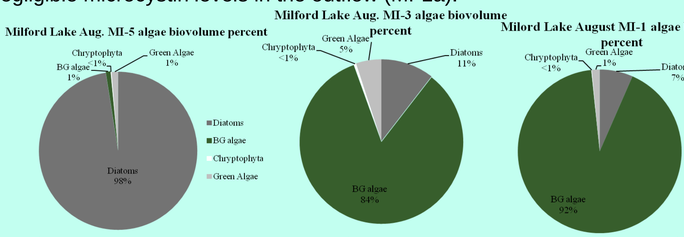
Dissolved Oxygen

Dissolved oxygen is a factor in aquatic species location, growth, and ultimately survival in lakes. The figure below shows dissolved oxygen measured in the water column in one-meter intervals (e.g. each row in each month represents one meter of depth) from April through September. Milford Lake infrequently experiences weak stratification near the dam in summer, however adequate (>5 mg/L) dissolved oxygen exists in all but the bottom 3-4 meters of the water column as illustrated by the red bars (<5 mg/L) in the graph below. In 2014, Milford Lake was oxygenated in the top 15 meters. Increased oxygen consumption from algae decomposition or biological oxygen demand contributes to lower dissolved oxygen after algae blooms, but oxygen related fish kills have not been documented.



Algae

Algae and green plants are the base of the food chain in a lake and function to convert nutrients and CO_2 via photosynthesis into biomass for all aquatic life. In Milford Lake, the algae community is dominated by cyanobacteria which out compete beneficial algae groups like green algae and diatoms. This shift to cyanobacteria as water moves from upper to lower lake is shown in charts below as percentage cyanobacteria exceeds 90% at the dam. The most common algae toxin (microcystin) was documented in KDHE samples June-Sept. USACE samples collected in July-Sept did not detect other toxin varieties and reported negligible microcystin levels in the outflow (MI-1a).



Site	Date	Microcystin (µg/L)	Cylindrospermopsin (µg/L)	Anatoxin-a (µg/L)
MI-1a	8/13/2014	**0.354**	ND	ND
MI-1	8/13/2014	**2.684**	ND	ND
MI-3	8/13/2014	**5.787**	ND	ND
MI-5	8/13/2014	**2.468**	ND	ND

Water Quality Concerns:

- Eutrophication
- Nutrients
- Harmful algae blooms
- Sediment inputs

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