NEOSHO RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Water Body: Olpe City Lake
Water Quality Impairment: Eutrophication

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Neosho Headwaters

County: Lyon

HUC 8: 11070201 **HUC 11** (HUC 14)**:** **040** (030)

Ecoregion: Flint Hills (28)

Drainage Area: Approximately 1.6 square miles

Conservation Pool: Area = 85 acres
Maximum Depth = 5.0 meters (16 feet)
Mean Depth = 2.0 meters (6.6 feet)
Retention Time = 1.0 years (12 months)

Designated Uses: Primary and Secondary Contact Recreation; Expected Aquatic Life Support; Food Procurement

Authority: Kansas Department of Wildlife and Parks

2002 303(d) Listing: Neosho Basin Lakes

Impaired Use: All uses are impaired to a degree by eutrophication

Water Quality Standard: Nutrients - Narrative: The introduction of plant nutrients into streams, lakes, or wetlands from artificial sources shall be controlled to prevent the accelerated succession or replacement of aquatic biota or the production of undesirable quantities or kinds of aquatic life. (KAR 28-16-28e(c)(2)(B)).

The introduction of plant nutrients into surface waters designated for primary or secondary contact recreational use shall be controlled to prevent the development of objectionable concentrations of algae or algal by-products or nuisance growths of submersed, floating, or emergent aquatic vegetation. (KAR 28-16-28e(c)(7)(A)).

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Eutrophication: Fully Eutrophic, Trophic State Index = 58.98

Monitoring Sites: Station 041001 in Olpe City Lake (Figures 1 & 2).

Period of Record Used: Four surveys in 1989 - 2002.

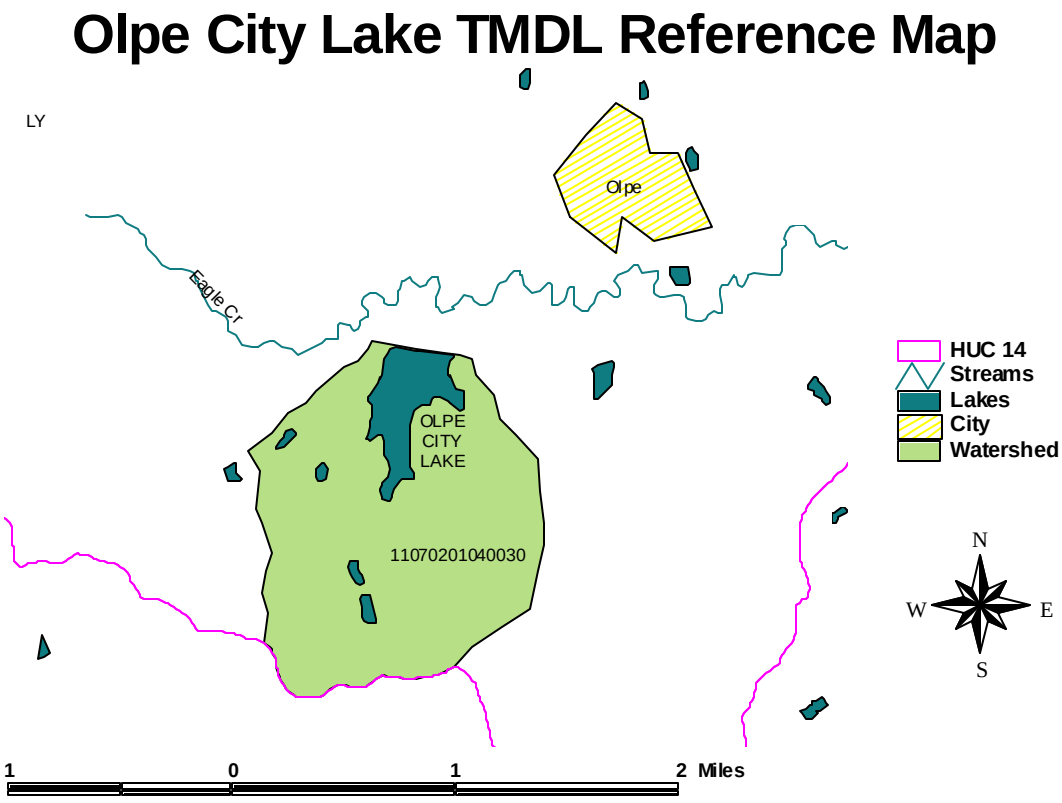


Figure 1

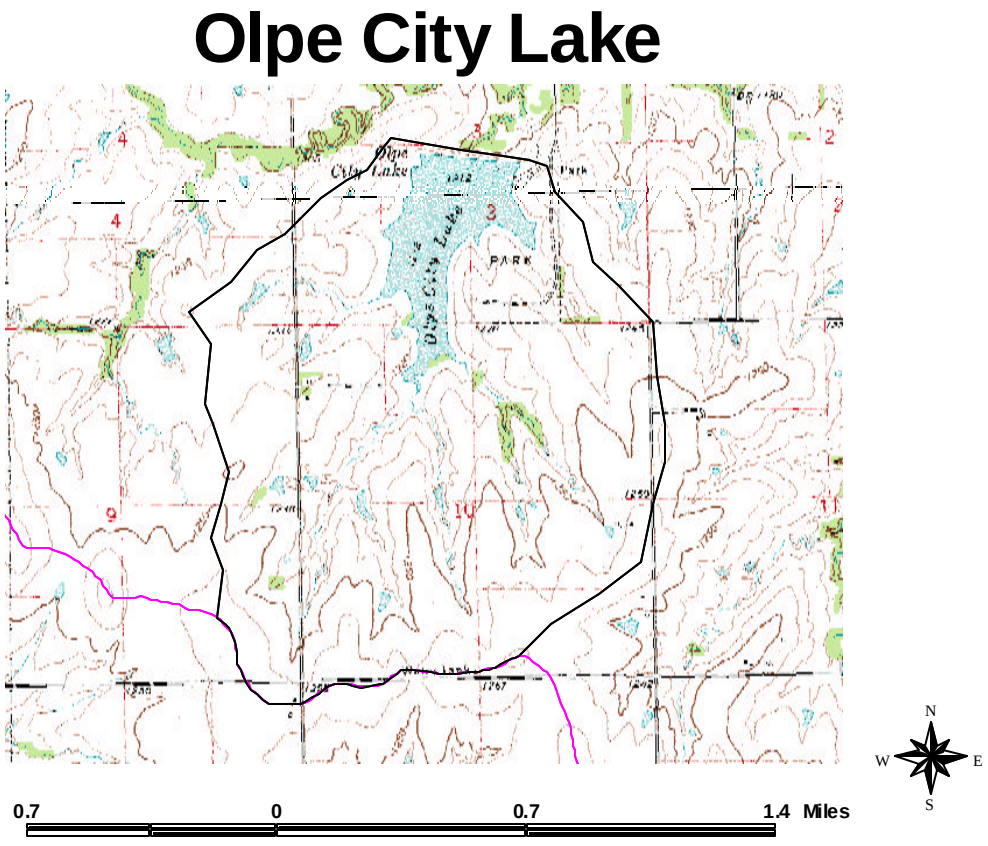
Current Condition: Over the period of record, the average chlorophyll a concentration was 18.1 ppb (Appendix A). The average, total phosphorus concentration was 81 ppb. Total Kjeldahl Nitrogen was above the detection limit in 2002, averaging 0.789 mg/L. The nitrate concentrations were above the detection limit in 1998 and 2002 with concentrations of 0.58 mg/L and 0.37 mg/L respectively. The concentrations over time are as follows:

Average Concentrations in Olpe City Lake

Date	Kjeldahl Nitrogen (mg/L)	Secchi Disc Depth (m)	Chlorophyll a (ug/L)	Nitrate (mg/L)	Nitrite (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)	Turbidity (Formazin Turbidity Units)
6/17/1989		0.65	14.7			0.100		
8/19/1991		0.50	28.6	<0.00		0.050	24.0	19.9
6/8/1998	<0.100	0.20	10.7	0.58	<0.05	0.100	38.0	68.0
7/15/2002	0.789	0.46	18.5	0.37	<0.05	0.082	21.3	43.3

Light is indicated to be the primary limiting factor; nitrogen is the secondary limiting factor (Appendix B). Surface water in Olpe City Lake has high turbidity, dominated by inorganic materials because the lake receives a steady inflow of silt. The chlorophyll a to total phosphorus yield is moderately low; the algal production is reduced because light cannot penetrate through the turbid water. There is an accompanying TMDL for siltation in Olpe City Lake. The chlorophyll a levels will rise when the turbidity decreases and the Secchi disc depth increases, if current phosphorus levels in the lake are not reduced simultaneously. Because the nutrient concentrations in the lake are so elevated, algal blooms may be seen as the clarity improves even though measures are being taken to decrease the nutrient load. If the clarity (Secchi Disc Depth) of the lake does not improve, then a gradual decline in the chlorophyll a concentration will be seen.

Figure 2



The Trophic State Index is derived from the chlorophyll a concentration. Trophic state assessments of potential algal productivity were made based on chlorophyll a concentrations, nutrient levels and values of the Carlson Trophic State Index (TSI). Generally, some degree of eutrophic conditions is seen with chlorophyll a concentrations over 7 Fg/L and hypereutrophy occurs at levels over 30 Fg/L. The Carlson TSI, derives from the chlorophyll concentrations and scales the trophic state as follows:

1. Oligotrophic TSI < 40
2. Mesotrophic TSI: 40 - 49.99
3. Slightly Eutrophic TSI: 50 - 54.99
4. Fully Eutrophic TSI: 55 - 59.99
5. Very Eutrophic TSI: 60 - 63.99
6. Hypereutrophic TSI: $ 64

Interim Endpoints of Water Quality (Implied Load Capacity) at Olpe City Lake over 2007 - 2011:

Current Condition and Reductions for Olpe City Lake

Parameter	Current Condition	TMDL	Percent Reduction
Total Phosphorus Load (lb/year)	**593**	**310**	**48 %**
Total Phosphorus Concentration (Fg/L)	**81**	**34**	**58 %**
Chlorophyll a (Fg/L)	**18.1**	**< 12.0**	**34 %**
Total Nitrogen (mg/L)	**0.97**	**0.62**	**36 %**
Secchi Disc Depth (m)	**0.45**	**> 0.50**	**11 % Increase**

In order to improve the trophic condition of the lake from its current fully eutrophic status, the desired endpoint will be to maintain summer chlorophyll a concentrations at or below 12 Fg/L. To ensure the clarity of the water, the desired Secchi disc depth endpoint will be summer average readings greater than 0.5 m. Both the chlorophyll a and Secchi disc depth endpoints must be met in order to comply with the Water Quality Standards.

The Total Nitrogen concentration in the lake should be maintained below 0.62 mg/L. A regression of 2000 - 2001 lake data and 1997 - 2000 wetland data was used to determine the current, in-lake nitrogen concentration and to calculate how much of a nutrient reduction was need to meet water quality standards. Refined endpoints will be developed in 2007 to reflect additional sampling and artificial source assessment and confirmation of impaired status of lake.

3. SOURCE INVENTORY AND ASSESSMENT

Land Use: The watershed around Olpe City Lake has a moderate potential for nonpoint source pollutants. An annual phosphorus load of 593 pounds per year is necessary to correspond to the concentrations seen in the lake (Appendix C).

One source of nutrients within Olpe City Lake is probably runoff from agricultural lands where phosphorus and nitrogen have been applied. Land use coverage analysis indicates that 17% of the watershed is cropland (Figure 3). Animal waste coming from grazing areas is a contributor. Seventy-four percent of land around the lake is grassland. The winter grazing density is high and the summer grazing density is low.

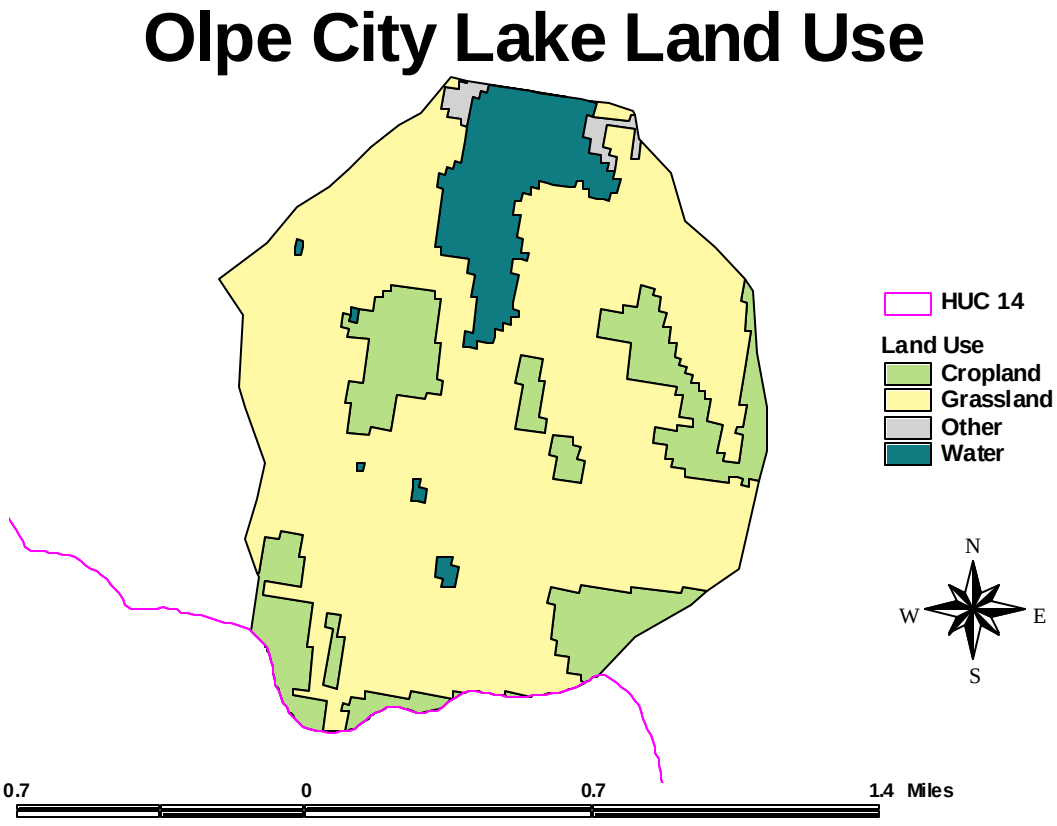


Figure 3

The City of Olpe is adjacent to the watershed. Olpe anticipates a 0.7% population decrease by the year 2020. The average population density in the watershed is 9.8 people per square mile.

A potential source is septic systems located around the lake. Failing septic systems can be a significant source of nutrients. The Lyon County has 2,063 septic systems, accounting for 14% of the sewage systems present in the county.

Background Levels: The atmospheric deposition and geological formations (i.e., soil and bedrock) may contribute to phosphorus and nitrogen loads. Wind mixing and carp may cause some resuspension of sediment.

4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

While light is the limiting factor in Olpe City Lake, phosphorus is allocated under this TMDL. The Load Capacity is 310 pounds per year of phosphorus. More detailed assessment of sources and confirmation of the trophic state of the lake must be completed before detailed allocations can be made. The general inventory of sources within the drainage does provide some guidance as to areas of load reduction. Because of atmospheric deposition, initial allocations of nitrogen will be based on a proportional decrease in nitrogen between the current condition and the desired endpoint.

Point Sources: A current Wasteload Allocation of zero is established by this TMDL because of the lack of point sources in the watershed. Should future point sources be proposed in the watershed and discharge into the impaired segments, the current wasteload allocation will be revised by adjusting current load allocations to account for the presence and impact of these new point source dischargers.

Nonpoint Sources: Water quality violations are predominantly due to nonpoint source pollutants. Background levels may be attributed to atmospheric and geological sources. The assessment suggests that fertilizer applications to cropland and animal waste contribute to the elevated total phosphorus and nitrogen concentrations in the lake. Generally a Load Allocation of 279 pounds of total phosphorus per year, leading to a 48% reduction, is necessary to reach the endpoint. A proportional decrease of 32% in nitrogen loading will allow the total nitrogen endpoint to be achieved.

Defined Margin of Safety: The margin of safety provides some hedge against the uncertainty of variable annual total phosphorus and the chlorophyll a endpoint. Therefore, the margin of safety will be 31 pounds per year of total phosphorus taken from the load capacity subtracted to compensate for the lack of knowledge about the relationship between the allocated loadings and the resulting water quality. For nitrogen, the margin of safety will be an additional 4% reduction in nitrogen to ensure that the endpoint is reached.

State Water Plan Implementation Priority: Because the Kansas Department of Wildlife and Parks is renovating the lake, the Olpe City Lake TMDL will be a High Priority for implementation.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Neosho Headwaters (HUC 8: 11070201) with a priority ranking of 38 (Medium Priority for restoration).

Priority HUC 11s: The watershed is within HUC 11 (040).

5. IMPLEMENTATION

Desired Implementation Activities

There is some potential for reducing pollutant loads to this lake through the use of agricultural best management practices. Some of the recommended agricultural practices are as follows:

1. Implement soil sampling to recommend appropriate fertilizer applications on cropland.
2. Maintain conservation tillage and contour farming to minimize cropland erosion.
3. Install grass buffer strips along streams.
4. Reduce activities within riparian areas.
5. Implement nutrient management plans to manage manure application to land.

Implementation Programs Guidance

Fisheries Management - KDWP

a. Assist evaluation in-lake or near-lake potential sources of nutrients to lake.

b. Use applicable lake management techniques which may reduce nutrient loading and cycling in lake.

Nonpoint Source Pollution Technical Assistance - KDHE

a. Support Section 319 demonstration projects for reduction of sediment runoff from agricultural activities as well as nutrient management.

b. Provide technical assistance on practices geared to establishment of vegetative buffer strips.

c. Provide technical assistance on nutrient management in vicinity of streams.

d. Develop a Watershed Restoration and Protection Strategy for HUC 11070201.

Water Resource Cost Share Nonpoint Source Pollution Control Program - SCC

a. Apply conservation farming practices, including terraces and waterways, sediment control basins, and constructed wetlands.

b. Provide sediment control practices to minimize erosion and sediment and nutrient transport.

Riparian Protection Program - SCC

a. Establish or reestablish natural riparian systems, including vegetative filter strips and streambank vegetation.

b. Develop riparian restoration projects.

c. Promote wetland construction to assimilate nutrient loadings.

Buffer Initiative Program - SCC

a. Install grass buffer strips near streams.

b. Leverage Conservation Reserve Enhancement Program to hold riparian land out of production.

Extension Outreach and Technical Assistance - Kansas State University

a. Educate agricultural producers on sediment, nutrient, and pasture management.

b. Educate livestock producers on livestock waste management and manure applications and nutrient management planning.

c. Provide technical assistance on livestock waste management systems and nutrient management plans.

d. Provide technical assistance on buffer strip design and minimizing cropland runoff.

e. Encourage annual soil testing to determine capacity of field to hold nutrients.

Time Frame for Implementation: Pollutant reduction practices should be installed within the priority subwatersheds before 2007, with minor followup implementation, including other subwatersheds over 2007-2011.

Targeted Participants: Primary participants for implementation will be agricultural producers within the drainage of the lake. Initial work in before 2007 should include local assessments by conservation district personnel and county extension agents to locate within the lake drainage:

1. Total row crop acreage
2. Cultivation alongside lake
3. Drainage alongside or through animal feeding lots
4. Livestock use of riparian areas
5. Fields with manure applications

Milestone for 2007: The year 2007 marks the midpoint of the ten-year implementation window for the watershed. At that point in time, sampled data from Olpe City Lake should indicate evidence of reduced phosphorus and nitrogen levels in the conservation pool elevations relative to the conditions seen over 1989-2002.

Delivery Agents: The primary delivery agents for program participation will be the Kansas Department of Wildlife and Parks and conservation districts for programs of the State Conservation Commission and the Natural Resources Conservation Service. Producer outreach and awareness will be delivered by Kansas State Extension.

Reasonable Assurances:
Authorities: The following authorities may be used to direct activities in the watershed to reduce pollutants.

1. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.

2. K.S.A. 2-1915 empowers the State Conservation Commission to develop programs to assist the protection, conservation and management of soil and water resources in the state, including riparian areas.

3. K.S.A. 75-5657 empowers the State Conservation Commission to provide financial assistance for local project work plans developed to control nonpoint source pollution.

4. K.S.A. 82a-901, et seq. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.

5. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the *Kansas Water Plan.*

6. The *Kansas Water Plan* and the Neosho Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

Funding: The State Water Plan Fund annually generates $16-18 million and is the primary funding mechanism for implementing water quality protection and pollutant reduction activities in the state through the *Kansas Water Plan*. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watersheds and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This watershed and its TMDL are a High Priority consideration and should not receive funding until after 2007.

Effectiveness: Nutrient control has been proven effective through conservation tillage, contour farming and use of grass waterways and buffer strips. The key to success will be widespread utilization of conservation farming within the watersheds cited in this TMDL.

6. MONITORING

Additional data, to establish nutrient ratios, source loading and further determine mean summer lake trophic condition, would be of value prior to 2007. Further sampling and evaluation should occur once before 2007, and twice after 2007.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Neosho Basin were held January 9, 2002 in Burlington and March 4, 2002 in Council Grove. An active Internet Web site was established at http://www.kdhe.state.ks.us/tmdl/ to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Neosho Basin.

Public Hearing: Public Hearings on the TMDLs of the Neosho Basin were held in Burlington and Parsons on June 3, 2002.

Basin Advisory Committee: The Neosho Basin Advisory Committee met to discuss the TMDLs in the basin on October 2, 2001, January 9, March 4, June 3, 2002, and July 30, 2004.

Discussion with Interest Groups: Meetings to discuss TMDLs with interest groups include:
Kansas Farm Bureau: February 26 in Parsons and February 27 in Council Grove

Milestone Evaluation: In 2007, evaluation will be made as to the degree of impairment which has occurred within the watershed and current condition of Olpe City Lake. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

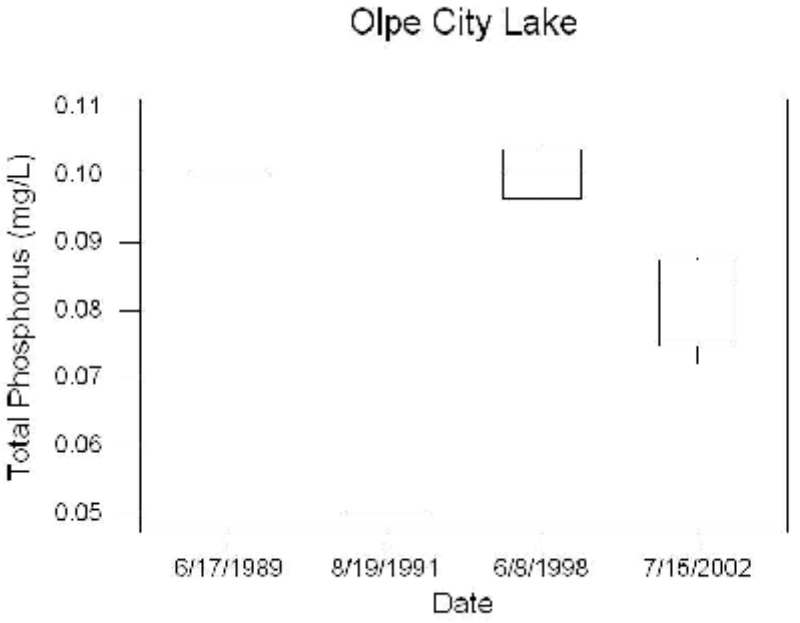
Consideration for 303(d) Delisting: The lake will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2007-2011. Therefore, the decision for delisting will come about in the preparation of the 2012 303(d) list. Should modifications be made to the applicable water quality criteria during the ten-year implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

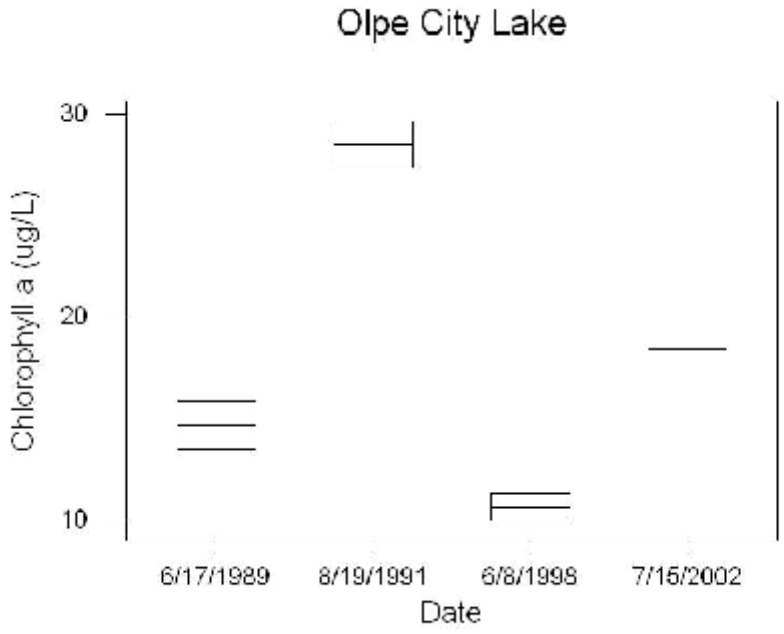
Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision will come in 2003 which will emphasize revision of the Water Quality Management Plan. At that time, incorporation of this TMDL will be made into both documents. Recommendations of this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process for Fiscal Years 2003-2007.

Bibliography

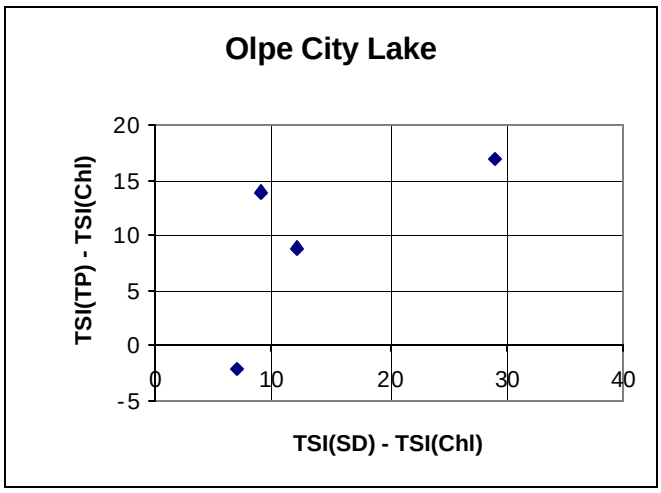
Liscek, Bonnie C. Methodology Used in Kansas Lake TMDLs [web page] Jul. 2001;
http://www.kdhe.state.ks.us/tmdl/eutro.htm [Accessed 17 May 2002].

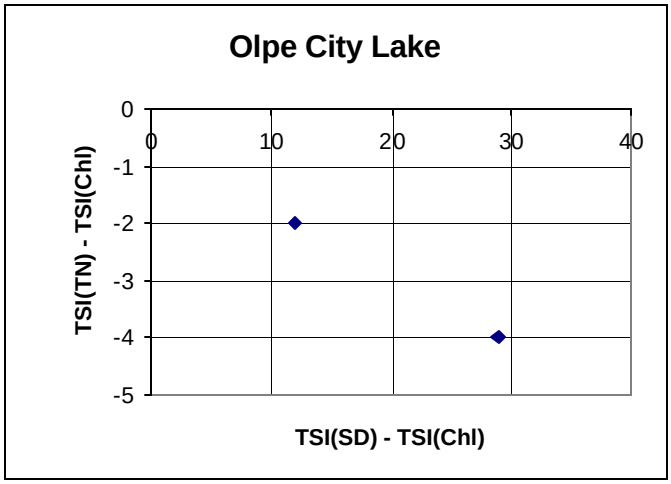
Appendix A–Boxplots





Appendix B - Trophic State Index Plot





The Trophic State Index plots indicate that light is the primary limiting factor, due to clay turbidity. This is inferred by examining the relationship between the TSI(SD) - TSI(Chl) and TSI(TP)-TSI(Chl) or TSI(TN)-TSI(Chl). The deviation of chlorophyll from the sediment load indicates the degree of light penetration, while the difference between chlorophyll and phosphorus, or chlorophyll and nitrogen indicates the level of phosphorus or nitrogen limitation. Therefore, if the final plot is in the first quadrant, it shows that the transparency of the water is impaired due to the presence of small particles, and that phosphorus does not limit algae growth. The positive slope of the graph also indicates a correlation between phosphorus and transparency which is found when phosphorus is bound to non algal particles. The points in the fourth quadrant of the TSI(TN)-TSI(Chl) graph indicate that nitrogen may be a secondary contributing factor.

Appendix C - Input for CNET Model

Parameter	Value Input into CNET Model
Drainage Area (km^2)	4.039
Precipitation (m/yr)	0.86
Evaporation (m/yr)	1.33
Unit Runoff (m/yr)	0.19
Surface Area (km^2)	0.343
Mean Depth (m)	2.0
Depth of Mixed Layer (m)	2.03
Depth of Hypolimnion (m)	0.56
Observed Phosphorus (ppb)	80.71
Observed Chlorophyl-a (ppb)	18.09
Observed Secchi Disc Depth (m)	0.45

Output from CNET Model

Parameter	Output from CNET Model
Load Capacity (LC)*	310 lb/yr
Waste Load Allocation (WLA)	0.0 lb/yr
Load Allocation (LA)	279 lb/yr
Margin of Safety (MOS)	31 lb/yr

***LC = WLA + LA + MOS**