SMOKY HILL/SALINE RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Water Body: Fossil Lake
Water Quality Impairment: Eutrophication

Subbasin: Middle Smoky Hill

County: Russell

HUC 8: 10260006 **HUC 11** (HUC 14)**: 040** (020)

Ecoregion: Central Great Plains, Smoky Hills (27a)
Central Great Plains, Rolling Plains and Breaks (27b)

Drainage Area: Approximately 15.5 square miles

Conservation Pool: Area = 44.6 acres
Watershed Area: Lake Surface Area = 222:1
Maximum Depth = 3.0 meters (9.8 feet)
Mean Depth = 1.3 meters (4.3 feet)
Retention Time = 0.21 years (2.5 months)

Designated Uses: Primary and Secondary Contact Recreation; Expected Aquatic Life Support; Domestic Water Supply; Food Procurement; Industrial Water Supply

Authority: City of Russell

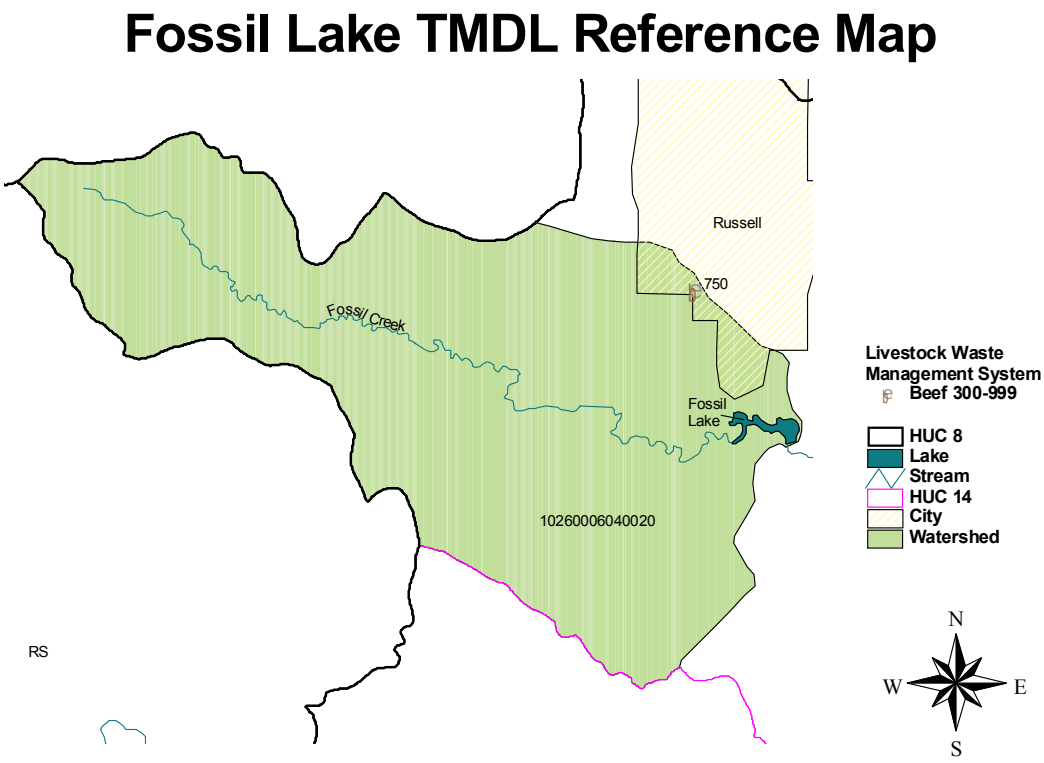
2002 303(d) Listing: Smoky Hill/Saline River Basin Lakes

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)).

Figure 1



2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Eutrophication: Argillotrophic, Trophic State Index = 47.11

Monitoring Sites: Station 052601 in Fossil Lake (Figure 1).

Period of Record Used: One survey during 1989
One bottom deposits survey in 1992

Current Condition: In 1989, Fossil Lake had chlorophyll a concentration of 5.4 μg/L (Appendix A). The Secchi Disc Depth was 0.15 meter. The total phosphorus concentrations averaged 243 μg/L. The bottom deposits samples taken in 1992 had concentrations of 916.5 mg/kg dry weight of Total Kjeldahl Nitrogen, 12.8 mg/kg of nitrate, and 52.5 mg/kg of phosphate.

Light is indicated to be the primary limiting factor (Appendix B). Surface water in Fossil 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 low; the algal production is reduced because light cannot penetrate through the turbid water. There is an accompanying TMDL for siltation in Fossil 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. Assessment of the eutrophication impairment is based on modeling rather than direct measurement.

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 μg/l and hypereutrophy occurs at levels over 30 μg/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: $\geq$ 64

Interim Endpoints of Water Quality (Implied Load Capacity) at Fossil Lake over 2008 - 2012:

In order to prevent further degradation, the desired endpoint will be to maintain summer chlorophyll a concentrations at less than or equal to 5.4 μg/L. To ensure the clarity of the water, the desired Secchi disc depth endpoint will be summer average readings greater than 88 cm. Both the chlorophyll a and Secchi disc depth endpoints must be met in order to comply with the Water Quality Standards.

Current Condition and Reductions for Fossil Lake

Parameter	Current Condition	TMDL	Percent Reduction
Total Phosphorus Load (lb/year)	396	184	54 %
Total Phosphorus Concentration (μg/L)*	24	13	46 %
Chlorophyll a (μg/L)	5.4	$\leq$ 5.4	0 %
Secchi Disc Depth (cm)	15	88	486 % Increase

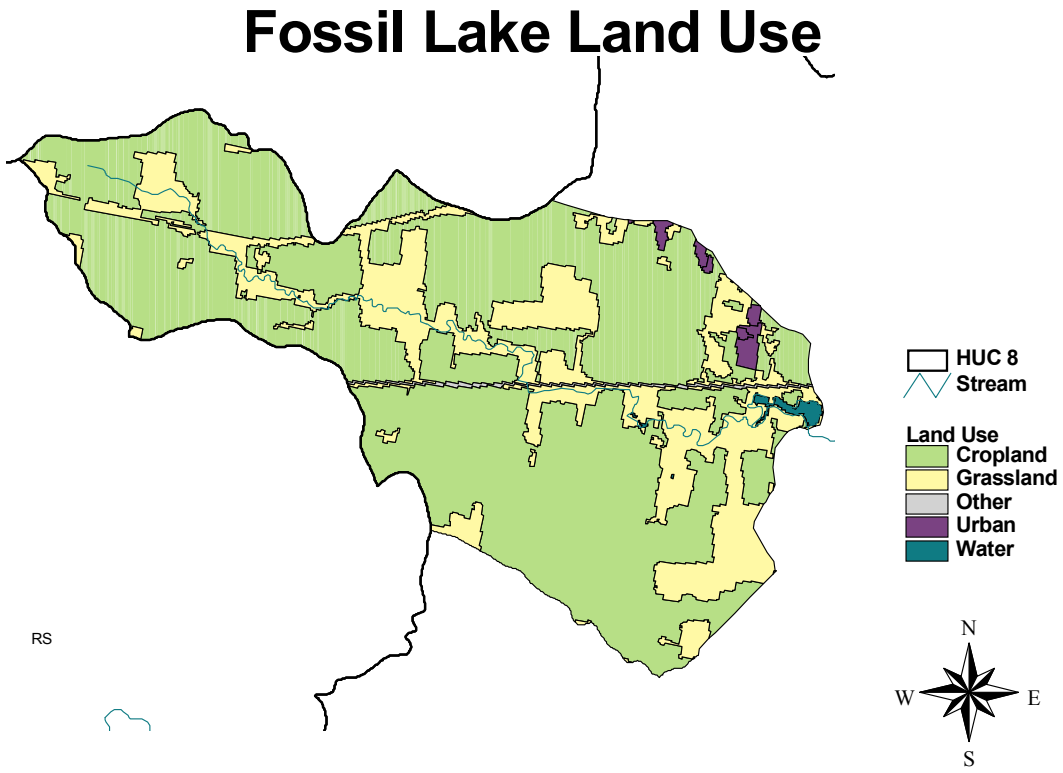
* Concentration of total phosphorus predicted by CNET model. The number does not account for nutrient recycling.

3. SOURCE INVENTORY AND ASSESSMENT

Land Use: The watershed around Fossil Lake has a moderate potential for nonpoint source pollutants. An annual phosphorus load of 396 pounds per year is necessary to correspond to the concentrations seen in the lake.

One source of phosphorus within Fossil Lake is probably runoff from agricultural lands where phosphorus has been applied. Land use coverage analysis indicates that 74% of the watershed is cropland (Figure 2).

Figure 2



Phosphorus from animal waste is a contributing factor. Animal waste, from livestock waste management systems, may add to the phosphorus load going into the lake. However, given the controls for the systems, animal waste coming from grazing areas is a more likely contributor. Twenty-four percent of land around the lake is grassland. There is one beef animal feeding operation in the watershed (Figure 1). All permitted livestock facilities have waste management systems designed to minimize runoff entering their operations or detaining runoff emanating from their areas. Such systems are designed for the 25 year, 24 hour rainfall/runoff event, which

would be indicative of flow durations well under 10 percent of the time. In Russell County, such an event would generate 5.2 inches of rain, yielding 4.1 to 4.9 inches of runoff in a day. NPDES permits, also non-discharging, are issued for facilities with more than 1,000 animal units. The facilities in this watershed are not of this size. The potential number of animals for these facilities in the watershed is equal to 750 animal units. The actual number of animal units on site is variable, but typically less than potential numbers.

Part of Russell is located within the watershed. Russell anticipates a 2.2% population decrease by the year 2020. The average population density in the watershed is 83.8 people per square mile. One percent of the watershed is a combination of commercial and residential properties. Fertilizer applications to lawns may be contributing to the nutrient load.

A potential source is septic systems located around the lake. Failing septic systems can be a significant source of nutrients. The Russell County has 730 septic systems, accounting for 18% of the sewage systems present in the county.

Contributing Runoff: The watershed's average soil permeability is 1.5 inches/hour according to NRCS STATSGO database. About 91.4% of the watershed produces runoff even under relatively low (1.5''/hr) potential runoff conditions. Runoff is chiefly generated as infiltration excess with rainfall intensities greater than soil permeabilities. As the watersheds' soil profiles become saturated, excess overland flow is produced. Generally, storms producing less than 0.5"/hr of rain will generate runoff from 4.9% of this watershed, chiefly along the stream channels.

Background Levels: The atmospheric phosphorus and geological formations (i.e., soil and bedrock) may contribute to phosphorus loads. Nutrients from wildlife waste are another contributing factor.

4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

Total Phosphorus is allocated under this TMDL, because a phosphorus reduction will have a large effect on the managing the algal community. The Load Capacity is 184.0 pounds per year of phosphorus and was calculated using the CNET model. 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.

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. As previously noted in the inventory and assessment section, sources such as non-discharging permitted livestock waste management systems located within the

watershed do not discharge with sufficient frequency or duration to add to an impairment in the lake.

Nonpoint Sources: Water quality violations are partially due to nonpoint source pollutants. Background levels may be attributed to atmospheric deposition and geological sources. The assessment suggests that cropland, animal waste, and urban runoff contribute to the elevated total phosphorus concentrations in the lake. Generally a Load Allocation of 165.6 pounds of total phosphorus per year, leading to a 54% reduction, is necessary to reach the endpoint.

Defined Margin of Safety: The margin of safety provides some hedge against the uncertainty of variable annual total phosphorus load and the chlorophyll a endpoint. Therefore, the margin of safety will be 18.4 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.

State Water Plan Implementation Priority: Because of the lack of recent monitoring data, this TMDL will be a Low Priority for implementation.

Unified Watershed Assessment Priority Ranking: Fossil Lake lies within the Middle Smoky Hill (HUC 8: 10260006) with a priority ranking of 51 (Low Priority for restoration).

Priority HUC 11s: The HUC 11 (040) contains the Fossil Lake, and thus this subwatershed should take priority.

5. IMPLEMENTATION

Desired Implementation Activities

There is good potential that agricultural best management practices will allow full use support to take place in Fossil Lake. 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

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. Update and implement nutrient and sediment abatement strategies.
e. Develop a Watershed Restoration and Protection Strategy for HUC 10260006.

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. Continue to educate residents and landowners about nonpoint source pollution.
b. Educate agricultural producers on sediment, nutrient, and pasture management.
c. Educate livestock producers on livestock waste management and manure applications and nutrient management planning.
d. Provide technical assistance on livestock waste management systems and nutrient management plans.
e. Provide technical assistance on buffer strip design and minimizing cropland runoff.
f. Encourage annual soil testing to determine capacity of field to hold phosphorus.

Time Frame for Implementation: Continued monitoring over the years from 2003 to 2008.

Targeted Participants: Primary participants for implementation will be agricultural producers and residents who are within the drainage of the lake. A detailed assessment of sources will be conducted by KDHE over 2003-2008.

Milestone for 2008: The year 2008 marks the midpoint of the ten-year implementation window for the watershed. At that point in time, sampled data from Fossil Lake will be reexamined to confirm the impaired status of the lake. Should the case of impairment remain, source assessment, allocation, and implementation activities will ensue.

Delivery Agents: The primary delivery agents for program participation will be the City of Russell. 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 Smoky Hill/Saline 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 Low Priority consideration and should not receive funding.

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 and installation of buffer strips within the watersheds cited in this TMDL.

6. MONITORING

Additional data, to further determine source loading and mean summer lake trophic condition, would be of value prior to 2008. Further sampling and evaluation should occur twice before 2008.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Smoky Hill/Saline Basin were held January 7 and March 5, 2003 in Hays. 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 Smoky Hill/Saline Basin.

Public Hearing: A Public Hearing on the TMDLs of the Smoky Hill/Saline Basin was held in Hays on June 2, 2003.

Basin Advisory Committee: The Smoky Hill/Saline Basin Advisory Committee met to discuss the TMDLs in the basin on October 3, 2002, January 7, March 5, and June 2, 2003.

Milestone Evaluation: In 2008, evaluation will be made as to the degree of implementation which has occurred within the watershed and current condition of Fossil Lake. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

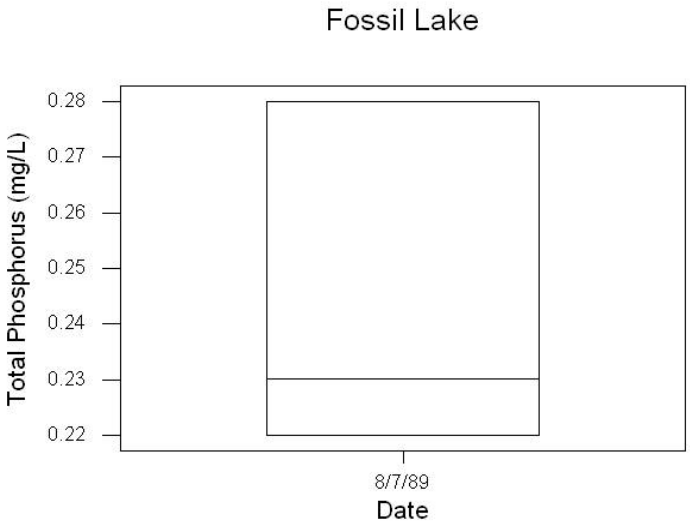
Consideration for 303(d) Delisting: The lake will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2008-2012. Therefore, the decision for delisting will come about in the preparation of the 2012 303(d) list. Should modifications be made to the applicable water quality criteria during the ten-year implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

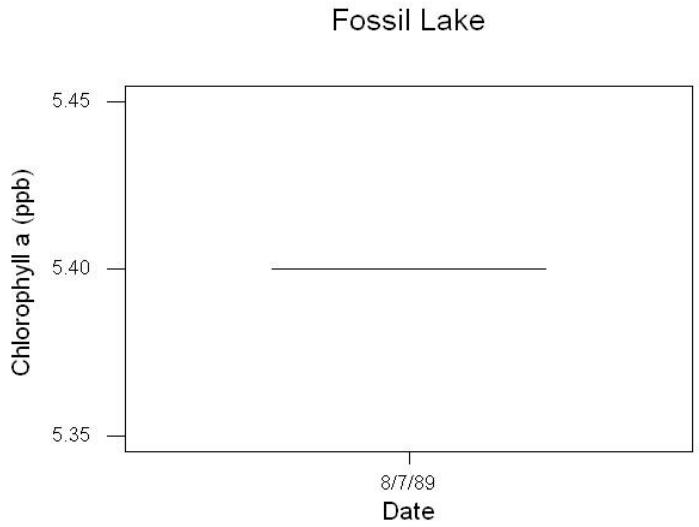
Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision will come in 2004 which will emphasize revision of the Water Quality Management Plan. At that 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 2004-2008.

Bibliography

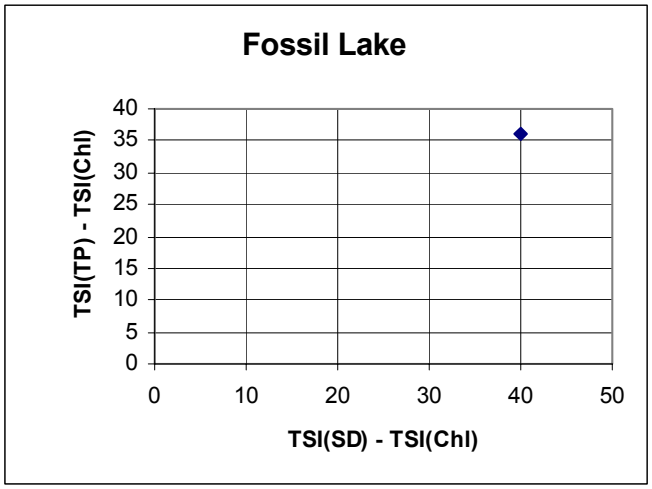
Liscek, Bonnie C. Methodology Used in Kansas Lake TMDLs [web page] Jul. 2001; http://www.kdhe.state.ks.us/tmdl/eutro.htm [Accessed 30 September 2002].

Appendix A - Boxplot





Appendix B - Trophic State Index Plots



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). The deviation of chlorophyll from the sediment load indicates the degree of light penetration, while the difference between chlorophyll and phosphorus indicates the level of phosphorus 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.

Appendix C - Input for CNET Model

Parameter	Value Input into CNET Model
Drainage Area (km^2)	40
Precipitation (m/yr)	0.58
Evaporation (m/yr)	1.6
Unit Runoff (m/yr)	0.04
Surface Area (km^2)	0.18
Mean Depth (m)	1.3
Depth of Mixed Layer (m)	1.2
Depth of Hypolimnion (m)	0.3
Observed Phosphorus (ppb)	243.3
Observed Chlorophyl-a (ppb)	5.4
Observed Secchi Disc Depth (m)	0.15

Output from CNET Model

Parameter	Output from CNET Model
Load Capacity (LC)*	**184.0 lb/yr**
Waste Load Allocation (WLA)	**0 lb/yr**
Load Allocation (LA)	**165.6 lb/yr**
Margin of Safety (MOS)	**18.4 lb/yr**

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

Approved Sep. 30, 2003