VERDIGRIS RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Water Body: Woodson Wildlife Area
Water Quality Impairment: Eutrophication Bundled with Dissolved Oxygen

Subbasin: Upper Verdigris
County: Woodson
HUC 8: 11070101 HUC 11 (HUC 14): 040 (030)
Ecoregion: Central Oklahoma/Texas Plains - Cross Timbers (29a)
Drainage Area: Approximately 3.5 square miles.
Conservation Pool: Area = 1.0 acres
Maximum Depth = 1.0 meters (3.3 feet)
Mean Depth = 0.1 meters (0.33 feet)
Retention Time = 0.2 day
Designated Uses: Primary and Secondary Contact Recreation; Special Aquatic Life Support; Food Procurement
Authority: State (Kansas Department of Wildlife and Parks)
1998 303d Listing: Table 4 - Water Quality Limited Lakes
Impaired Use: All uses are impaired by inadequate dissolved oxygen induced by accelerated 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)).

Dissolved Oxygen: 5 mg/L (KAR 28-16-28e(c)(2)(A))
2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Eutrophication: Fully Eutrophic, Trophic State Index = 55.59

Monitoring Sites: Station 011841 in Woodson WA (Figure 1).

Period of Record Used: Four surveys during 1997 - 2000.

Figure 1

Woodson Wildlife Area
TMDL Reference Map and Land Use

Current Condition: The average chlorophyll a concentration was 12.81 ppb. The average, total phosphorus concentration was 140 ppb over the period of record (Appendix A). The chlorophyll a to total phosphorus yield appears low. Light is the primary limiting factor, due to clay turbidity. Nitrogen is a secondary limiting factor (Appendix B). The Total Kjeldahl Nitrogen concentrations average 1.68 mg/L; nitrate and nitrite are often below the detection limit. Based on use attainability analysis done in 2001, the wetland is proposed to be designated for primary contact recreation, pending the adoption and approval of the 2002 Water Quality Standards.

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
5. Very Eutrophic TSI: 60 - 63.99
6. Hypereutrophic TSI: ≥ 64

It is possible that the low dissolved oxygen observed within the top meter of Woodson WA is due to either organic or nutrient loads and subsequent eutrophication or to thermal stratification. At the surface, the average dissolved oxygen concentration was 4.2 mg/L, an insufficient amount of dissolved oxygen for aquatic life support. The highest dissolved oxygen concentration (6.5 mg/L) was seen in 1998; the lowest level was seen in the following year. (See below the table and Appendix A).

<table>
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<tr>
<th>Station</th>
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<th>Depth (feet)</th>
<th>Dissolved Oxygen</th>
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</table>

Interim Endpoints of Water Quality (Implied Load Capacity) at Woodson WA over 2007 - 2011:
The desired endpoint will be to maintain summer chlorophyll a concentrations at or below 12 µg/L. Indicative of moderate eutrophic conditions which should also result in dissolved oxygen concentrations remaining above 5 mg/L. The Total Nitrogen concentration in the wetland 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 analysis and assessment of the status of the wetland.

3. SOURCE INVENTORY AND ASSESSMENT

The watershed has a low to moderate potential for nonpoint source pollutants. An annual phosphorus load of 795 pounds per year is necessary to correspond to the concentrations seen in the wetland (Appendix C).

**Land Use:** Nitrogen and phosphorus from animal waste (wildlife and livestock) is a contributing factor. Eighty-six percent of land around the wildlife management area is grassland. Grazing density of livestock is moderate in summer and winter. Some organic pollution is contributed by
wildlife; it is likely that the population of animals such as deer and water fowl is high in the Wildlife Management Area.

Fertilizer and manure applied to cropland is another source of nutrients. Land use coverage analysis indicates that 13.4% of the watershed is cropland.

**On-Site Waste Systems:** The population density in the watershed is low (2.6 people per square mile). The population projections for Yates Center through 2020 show the density declining (-2.6%). Failing on-site waste systems can contribute to nutrient loadings.

**Contributing Runoff:** The watershed’s average soil permeability is 0.5 inches/hour according to NRCS STATSGO database. About 99.6% 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 only 44.4% of this watershed, chiefly along the stream channels.

**Background Levels:** Less than one percent of land in the watershed is woodland; leaf litter may be contributing to the nutrient loading. The atmospheric phosphorus and geological formations (i.e., soil and bedrock) may contribute to phosphorus loads. Nitrogen loads may be contributed from the atmosphere. Carp may cause some resuspension of sediment.

### 4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

Light is the limiting factor in Woodson WA, and nitrogen is a secondary factor. Total Phosphorus is also allocated under this TMDL, because a phosphorus reduction will have a larger effect on the managing the algal community. The Load Capacity is 752 pounds per year of phosphorus. More detailed assessment of sources and confirmation of the trophic state of the wetland 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 cropland and animal waste contribute to the elevated total phosphorus and nitrogen concentrations in the wetland. Generally a Load Allocation of 677 pounds of total phosphorus per year, leading to an 5.5% reduction, is necessary to reach the chlorophyll a
endpoint. A proportional decrease of 63% 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 load. Therefore, the margin of safety will be 75 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 7% reduction in nitrogen to ensure that the endpoint is reached.

**State Water Plan Implementation Priority:** Because Woodson WA is a wetland under state jurisdiction, this TMDL will be a Medium Priority for implementation.

**Unified Watershed Assessment Priority Ranking:** This watershed lies within the Upper Verdigris (HUC 8: 11070101) with a priority ranking of 58 (Low Priority for restoration).

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

5. **IMPLEMENTATION**

**Desired Implementation Activities**
There is good potential that agricultural best management practices will improve water quality in Woodson WA. 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**

**Public Lands Management - KDWP**
- a. Assist evaluation potential sources of nutrients to wetland.
- b. Evaluate applicable wetland management techniques which may reduce nutrient loading and cycling in the wetland.

**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.
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: Water quality improvement activities are encouraged at the local level prior to 2007. Funding for installing pollution reduction practices should be allocated within the lake drainage after the year 2007. Evaluation of nutrient sources to lake and identification of potential management techniques should occur prior to 2007.

Targeted Participants: Primary participants for implementation will be agricultural producers within the drainage of the wetland. Initial work in 2007 should include local assessments by conservation district personnel and county extension agents to locate within the wetland drainage:
1. Total row crop acreage
2. Cultivation alongside wetland
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 Woodson WA should indicate probable nutrient sources, and plans in place to initiate implementation.
Delivery Agents: The primary delivery agents for program participation will be the Kansas Department of Wildlife and Parks, 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 Verdigris 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 Medium Priority consideration.

Effectiveness: Nutrient control has been proven effective through livestock management systems, conservation programs, and buffer strips. The key to success will be widespread utilization of range management within the watersheds cited in this TMDL.
6. MONITORING
Additional data, to establish nutrient ratios, source loading and further determine mean summer wetland trophic condition, would be of value prior to 2007. Further sampling and evaluation should occur once before 2007 and once between 2007 and 2011.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Verdigris Basin were held January 23 in Fredonia and March 6, 2002 in Neodesha. 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 Verdigris Basin.

Public Hearing: A Public Hearing on the TMDLs of the Verdigris Basin was held in Neodesha on June 4, 2002.

Basin Advisory Committee: The Verdigris Basin Advisory Committee met to discuss the TMDLs in the basin on October 3, 2001, January 23, March 6, and June 4, 2002.

Discussion with Interest Groups: Meetings to discuss TMDLs with interest groups include:
   Kansas Farm Bureau: February 26 in Fredonia

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

Consideration for 303(d) Delisting: The wetland 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
Appendix A - Boxplots

Woodson WA

Boxplot for Total Phosphorus (mg/L)

Woodson WA

Boxplot for Chlorophyll a (ppb)
Appendix B - Trophic State Index Plots

The Trophic State Index plots indicate that light is the primary limiting factor, due to clay turbidity. Nitrogen is a secondary limiting factor.
## Appendix C - Input for CNET Model

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<th>Parameter</th>
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Approved September 30, 2002