MISSOURI RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody: Jerry's Lake
Water Quality Impairment: Eutrophication

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Independence-Sugar **County:** Leavenworth

HUC 8: 10240011 **HUC (10) 12:** (05) 00

Ecoregion: Central Irregular Plains, Osage Cuestas (40b)

Drainage Area: 25 acres

Conservation Pool: Surface Area = 1 acre
Watershed/Lake Ratio: 25:1
Maximum Depth = 2.0 meters
Mean Depth = 0.77 meters
Storage Volume = 2.5 acre-feet
Estimated Retention Time = 0.16 years
Mean Annual Precipitation = 34.1 inches
Mean Annual Evaporation = 44.0 inches
Mean Annual Discharge = 15.3 acre-feet

Designated Uses: Primary Contact Recreation Class B; Expected Aquatic Life Support; Domestic Water Supply; Food Procurement; Industrial Water Supply; Irrigation Use; Livestock Watering Use.

303(d) Listings: Jerry's Lake Eutrophication: 2002, 2004, 2008, 2010, 2012 Missouri River Basin Lakes.

Impaired Use: All uses in Jerry's Lake are impaired to a degree by eutrophication.

Water Quality Criteria: 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)(A)).

The introduction of plant nutrients into surface waters designated for domestic water supply use shall be controlled to prevent interference with the production of drinking water (K.A.R. 28-16-28e(c)(3)(A)).

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 Support for Designated Uses under 2012-303(d): Excessive nutrients are not being controlled and are thus contributing to eutrophication which is impairing aquatic life use by supporting objectionable types and quantities of algae which also leads to impairment of contact recreation within Jerry's Lake. Jerry's Lake has no municipal water rights attached to its storage, it is not being used for domestic water supply, nor is it planned as a reserve for a municipal water supply. The chlorophyll *a* endpoint of 12 μg/L is appropriate to protect the immediate uses of aquatic life support and contract recreation in Jerry's Lake. Should the lake serve as a domestic or municipal water supply in the future, as evidenced by the installation of a point of diversion within the lake, a subsequent use attainability analysis will be conducted to ascertain if the 12 μg/L endpoint adequately supports such use in the lake.

Level of Eutrophication: Hypereutrophic, Trophic State Index = 64.6

The Trophic State Index (TSI) is derived from the chlorophyll *a* concentration. Trophic state assessments of potential algal productivity were made based on chlorophyll *a*, nutrient levels, and values of the Carlson Trophic State Index (TSI). Generally, some degree of eutrophic conditions is seen with chlorophyll *a* over 12 ppb and hypereutrophy occurs at levels over 30 ppb. The Carlson TSI derives from the chlorophyll *a* 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

Lake Monitoring Sites: KDHE Station LM067801 at Jerry's Lake (Figure 1).
Period of Record: Two surveys conducted by KDHE in the summers of 1994 & 2003.

Long-Term Hydrologic Conditions: There is no stream flow directly into Jerry's Lake, however CNET reservoir eutrophication modeling estimates inflow to the lake at 19.0 acre-feet per year, based on the drainage area. According to the USGS Lake Hydro data, the mean runoff in the watershed is 7.75 inches/year; the mean precipitation in the watershed is 34.1 inches/year; the mean loss due to evaporation for the lake is 44.0 inches/year; and the calculated mean annual outflow for the lake is 15.3 acre-feet/year.

Figure 1. Jerry's Lake Watershed.

Current Condition: Chlorophyll *a* concentrations were 29.0 µg/L and 35.1 µg/L in 1994 and 2003, respectively, resulting in an average chlorophyll *a* concentration of 32.0 µg/L for the period of record. Total phosphorus, Total Nitrogen, Secchi depth, turbidity and TSS data are available for sampling year 2003 (Table 1).

Table 1. Water Quality Data for Jerry's Lake.

Sample Year	Chl-a (µg/L)	Total Phosphorus (mg/L)	Total Nitrogen (mg/L)	Secchi Depth (m)	Turbidity (NTU)	TSS (mg/L)
1994	29.0	0.120	*	*	7.0	*
2003	35.1	0.104	1.61	0.5	19.2	22.0
Average	*32.0*	*0.112*	*1.61*	*0.5*	*13.1*	*22.0*

*Data not available

The median trophic conditions within Jerry's Lake compared to benchmarks established for lakes in Kansas are summarized in Table 2. None of the trophic indicators for Jerry's Lake meet any of the Federal Lake, Central Irregular Plains Lake or statewide benchmarks.

Table 2. Median trophic indicator values of Jerry's Lake in comparison with federal lakes and draft nutrient benchmarks in Kansas. The nutrient benchmarks were derived from 47-58 lakes and reservoirs, based on the data collected between 1985-2002 (Dodds et al., 2006).

Trophic Indicator	Jerry's Lake	Federal Lake	Central Irregular Plains	Statewide Benchmark
Secchi Depth (cm)	50	95	130	129
TN (μg/L)	1,605	903	362	625
TP (μg/L)	112	76	20	23
Chlorophyll *a* (μg/L)	32	12	8	8

Desired Endpoints of Water Quality (Implied Load Capacity) in Jerry's Lake:

In order to improve the trophic condition of Jerry's Lake from its current, Hypereutrophic status, the desired endpoint will be to maintain summer chlorophyll *a* average concentrations below 12 μg/L, corresponding to a Carlson Trophic State Index of 55, with reductions focused on phosphorus loading in the lake. Reductions in phosphorus loading will address the accelerated succession of aquatic biota and the development of objectionable concentrations of algae and algae by-products as determined by the chlorophyll *a* concentrations in the lake. A chlorophyll *a* endpoint of 12 μg/L will also ensure long-term protection to fully support Primary Contact Recreation within the lake. If and when Jerry's Lake becomes an active or reserve municipal water supply, as determined by the addition of a point of diversion for municipal use, a use attainability analysis will be conducted to ascertain if the 12 μg/L endpoint adequately supports such use in the lake.

Based on the CNET reservoir eutrophication model (Appendix A), the total phosphorus entering the lake must be reduced by 77% in order to meet the chlorophyll *a* endpoint of 12 μg/L. Water quality data for the inflow in Jerry's Lake was estimated by calibrating the stream total phosphorus concentration input in CNET to the current lake mean phosphorus concentration of 112 μg/L resulting in an estimated total phosphorus concentration at the inflow of 260 μg/L before reductions. Reduction of the total phosphorus concentration in the inflow to 60 μg/L will result in a 62% reduction in total phosphorus concentration to 43.0 μg/L and a 63% reduction in chlorophyll *a* concentration to the endpoint of 12 μg/L in the lake (Table 3). Achievement of the endpoint indicates loads are within the loading capacity of the lake, the water quality standards are attained, and full support of the designated uses of the lake has been achieved. Seasonal variation has been incorporated in this TMDL since the peaks of algal growth occur in the summer months. The current average condition for Jerry's

Lake utilized in the model input was based on data from KDHE station LM067801 for sampling years 1994 and 2003.

Table 3. Jerry's Lake current average condition and TMDL based on CNET.

	Current Avg. Condition	**TMDL**	**Reduction**
Total Phosphorus – Annual Load (lbs/year)	11.47	2.716	76%
Total Phosphorus – Daily Load* (lbs/day)	0.0843	0.0199	76%
Total Phosphorus – Lake Concentration (µg/L)	112	43.0	62%
Chlorophyll *a* Concentration (µg/L)	32.0	12.0	63%

*See Appendix B for Daily Load Calculations

3. SOURCE INVENTORY AND ASSESSMENT

Point Sources: The only discharge permit that applies to this TMDL is the City of Leavenworth's stormwater discharge (MS4) permit (Table 4). This stormwater discharge permit requires the implementation of best management practices in order to attenuate the discharge of pollutants into the Leavenworth stormwater discharge system's receiving lakes and streams.

Table 4. Discharge permits in the Jerry's Lake watershed.

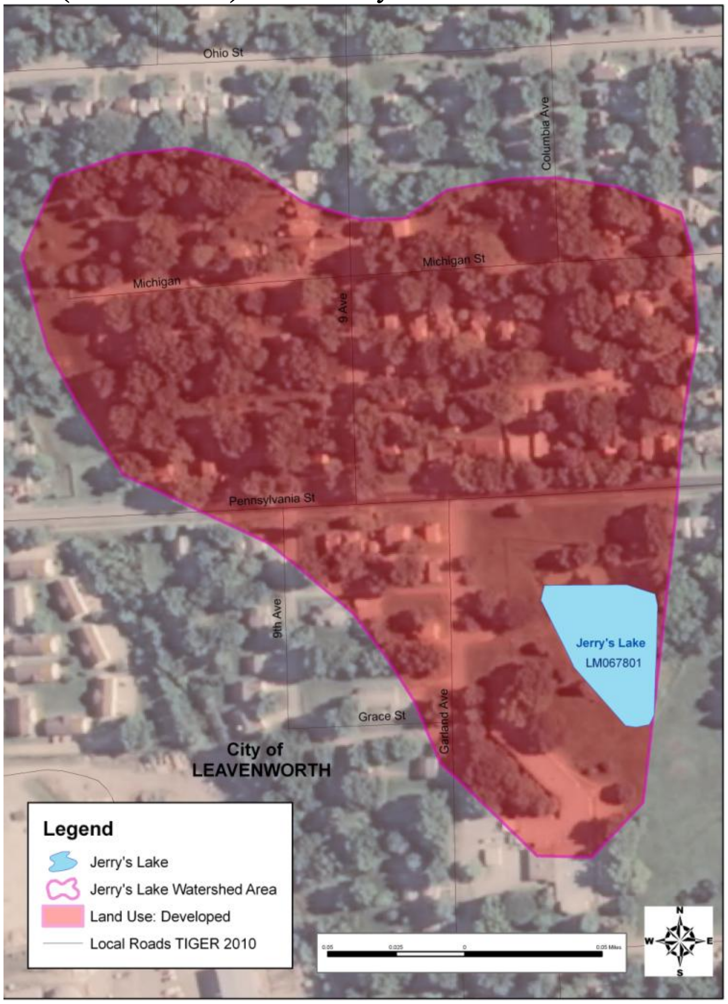
Permittee	**NPDES Permit #**	**State Permit #**	**Type**	**Expiration Date**
City of Leavenworth	KSR044011	M-MO12-SN01	Stormwater	September 30, 2009*

*Permit Pending

Livestock Waste Management Systems: There are no active permitted or certified confined animal feeding operations (CAFOs) in the Jerry's Lake watershed.

Land Use: The Jerry's Lake watershed is located entirely within the boundaries of the City of Leavenworth and, although there are green spaces primarily in the form of urban lawns, it is 100% developed according to the 2001 National Land Cover Database (Figure 2). The location of the lake in a watershed that is 100% developed makes the lake vulnerable to the runoff from domestic lawns where there may substantial nutrient loading from lawn fertilizers, domestic pet waste and other toxics found in the urban environment. The high percentage of impervious surfaces in the watershed makes a properly functioning stormwater collection and discharge system vital because the watershed's ability to absorb surface water runoff is severely compromised.

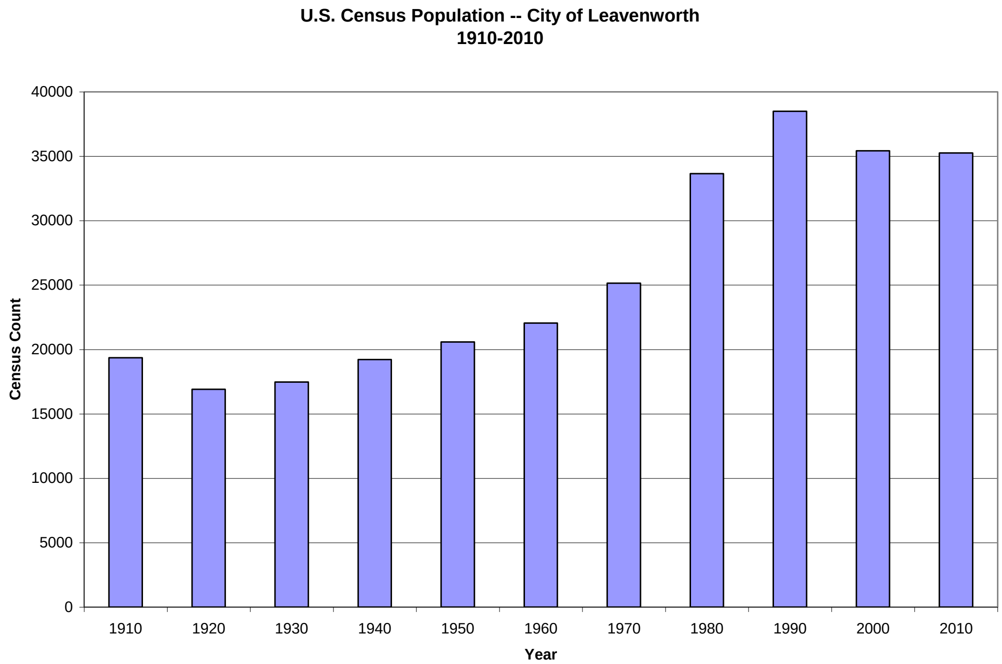
Figure 2. Land Use (2001 NLCD) in the Jerry's Lake watershed.



Points of Diversion: There are no unique points of diversion in the Jerry's Lake watershed.

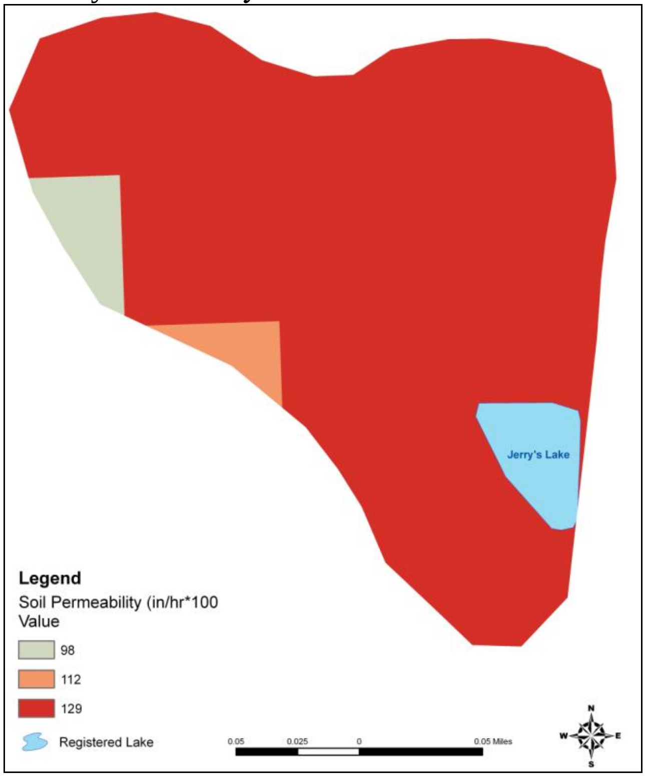
Population & On-Site Waste Systems: According to the 2010 census data from the U.S. Census Bureau, the total population within Jerry's Lake watershed is 154 people (3,850 people/mi^2). Population in Leavenworth has been on the decline since 1990 with the 2000 and 2010 censuses showing an 8% and 0.5% decrease from 1990, respectively (Figure 3). Nutrient contribution from on-site septic systems is unlikely as dwellings lying within the Jerry's Lake watershed are connected to the City of Leavenworth's municipal sewer.

Figure 3. U.S. Census results for population in the City of Leavenworth.



Contributing Runoff: The watershed of Jerry's Lake has a mean soil permeability value of 1.28 inches/hour, with over 97% of the watershed having a permeability value of 1.29 inches/hour according to NRCS STATSGO database (Figure 4). According to a USGS open-file report (Juracek, 2000), the threshold soil-permeability values are set at 3.43 inches/hour for very high, 2.86 inches/hour for high, 2.29 inches/hour for moderate, 1.71 inches/hour for low, 1.14 inches/hour for very low, and 0.57 inches/hour for extremely low soil-permeability. Runoff is primarily generated as infiltration excess when rainfall intensities are greater than soil permeability. As the watershed's soil profile becomes saturated, excess overland flow is produced.

Figure 4. Soil permeability in the Jerry's Lake watershed.



Background and Natural Sources: Atmospheric deposition from geological formations may also contribute to nutrient loads. The suspension of sediment and nutrients may be influenced by the wind and bottom feeding fish may also re-suspend sediment and contribute to available nutrients in the lake. Because Jerry's Lake is a small lake, nutrient cycling of the sediment is likely contributing available nutrients to the lake for algal uptake. Some nutrient loading also occurs as a result of leaf litter in the watershed.

4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

Although the limited data for the period of record suggests Jerry's Lake is nitrogen/phosphorus co-limited, this TMDL will focus on reducing the amount of total phosphorus entering the lake in order to achieve the endpoint. It is expected that practices implemented to reduce total phosphorus loading in the lake will also achieve reductions in nitrogen loading to the watershed as well. The general inventory of sources within the drainage area of the lake indicates load reductions should be focused on stormwater runoff contributions attributed to lawn fertilizer applications and domestic animal waste in the watershed. Because of the atmospheric deposition, the allocation of phosphorus will include a proportional decrease in phosphorus between the current condition and the desired endpoint.

Nonpoint Sources: Due to the urban nature of the watershed, the bulk of the phosphorus load in this TMDL is assigned to the City of Leavenworth's MS4 resulting in a total phosphorus load allocation comprised only of the atmospheric load allocation (Table 4).

Point Sources: The source assessment suggests the source of the nutrients in Jerry's Lake can be attributed to lawn fertilizer and domestic pet waste that is washed into the Lake during storm runoff events in the watershed. Therefore, the all but the atmospheric portion of the pollutant allocation for this TMDL is assigned to the City of Leavenworth's MS4 permit as a wasteload allocation (Table 5). Wasteload reductions should be focused on stormwater runoff contributions attributed to the urban lawn fertilizer applications and domestic pet waste. Using the CNET reservoir eutrophication modeling worksheet (Appendix A) a 77% reduction in the amount of total phosphorus entering the lake is necessary to reach the 12 μg/L endpoint in Jerry's Lake.

Table 5. Jerry's Lake TMDL

Description	Allocations (lbs/year)	Allocations (lbs/day)*
Total Phosphorus Atmospheric Load	0.0891	0.0007
Total Phosphorus Other Nonpoint Source Load Allocation	0	0
Total Phosphorus Wasteload Allocation	2.355	0.0173
Total Phosphorus Margin of Safety	0.2716	0.0020
Total Phosphorus TMDL	2.716	0.0200

*See Appendix B for Daily Load Calculations

Defined Margin of Safety: The margin of safety provides some hedge against the uncertainty of variable annual total phosphorus loads and the chlorophyll *a* endpoint. Therefore, the margin of safety is explicitly set at 10% of the original calculated total phosphorus load allocation, which compensates for the lack of knowledge about the relationship between the allocated loadings and the resulting water quality. The margin of safety is expressed in Table 4.

State Water Plan Implementation Priority: This TMDL will be a Low Priority for implementation.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Independence-Sugar Subbasin (HUC 8: 10240011) with a priority ranking of 25 (Medium Priority for restoration work).

Priority HUC 12: The entire watershed is within HUC 12: 10240110500

5. IMPLEMENTATION

Desired Implementation Activities: There is good potential that urban best management practices will improve the condition of Jerry's Lake.

Some of the recommended urban practices are as follows:

1. Educate watershed residents on proper lawn fertilizer application.
2. Install grass buffer strips along drainage channels in the watershed.
3. Promote proper management of construction sites to minimize sediment and nutrient runoff.

4. Investigate feasibility of installing a stormwater wetland in the watershed to aid in the removal of nutrients.
5. Promote installation of porous and concrete grid pavement in the watershed.

Implementation Program Guidance:

NPDES – MS4

a. It is a condition of the City of Leavenworth stormwater permit to install best management practices (BMPs) that will attenuate the discharge of TMDL regulated parameters; hence, the city should implement BMPs that will reduce the nutrient load to Jerry's Lake.
b. Sample storm events to Jerry's Lake for nutrients in order assess baseline nutrient inputs and any post-BMP improvement.
c. Encourage the City of Leavenworth to retrofit media filters and wetland channels along flow paths of stormwater coming from developed areas around the lake.
d. Support construction of retention ponds and wetland basins to reduce particulate phosphorus, organic nitrogen and nitrates from stormwater.
e. Promote good housekeeping in developed areas near the lake, including street sweeping and prudent fertilizer use on lawns in residential areas.

Time Frame for Implementation: Initial implementation will proceed over the years from 2013-2022. Additional implementation may be required over 2023-2033 to achieve the endpoints of this TMDL.

Targeted Participants: Primary participants for implementation will be the residents and stakeholders within the Jerry's Lake watershed and the City of Leavenworth, Department of Public Works. A detailed assessment of sources conducted over 2013-2014 should include local assessments by conservation district personnel and county extension agents to survey, locate, and assess the sources of urban stormwater runoff within the lake drainage area.

Milestone for 2017: In accordance with the TMDL development schedule for the State of Kansas, the year 2017 marks the next cycle of 303(d) activities in the Missouri River Basin. At that point in time, sample data from Jerry's Lake will be reexamined to assess conditions in the lake. Should the impairment remain adjustments to source assessment, allocation, and implementation activities may begin.

Delivery Agents: The primary delivery agents for program participation will be the Kansas Department of Health and Environment and the City of Leavenworth.

Reasonable Assurances:
Authorities: The following authorities may be used to direct activities in the watershed to reduce pollutants and to assure allocations of pollutant to point and nonpoint sources can be attained.

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.A.R. 28-16-69 to 71 implements water quality protection by KDHE through the establishment and administration of critical water quality management areas on a watershed basis.

3. 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.

4. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the Kansas Water Plan, including selected Watershed Restoration and Protection Strategies.

5. The Kansas Water Plan and the Missouri River 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.

6. K.S.A. 32-807 authorizes the Kansas Department of Wildlife and Parks to manage lake resources.

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. Additionally, $2 million has been allocated between the State Water Plan Fund and EPA 319 funds to support implementation of Watershed Restoration and Protection Strategies. This watershed and its TMDL are a Low Priority consideration for funding.

Effectiveness: Nutrient control has been proven effective through the implementation of urban best management practices (BMPs) including biofilters, detention basins, permeable pavement, retention ponds and wetlands. In addition, the use of proper fertilizer rates on urban lawns combined with appropriate disposal of pet waste has proven effective at reducing nutrient loading associated with stormwater runoff. The key to success will be widespread utilization of urban BMPs combined with proper fertilizer application and pet waste disposal in the Jerry’s Lake watershed.

6. MONITORING

Jerry's Lake will be scheduled for sampling between 2012 and 2018 and again from 2019 to 2022. Based on these results, adjustments to implementation may occur with subsequent sampling occurring after 2022.

7. FEEDBACK

Public Notice: An active Internet Web site was established at www.kdheks.gov/tmdl/ to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Missouri River Basin.

Public Hearing: This TMDL was presented for comments at the Missouri WRAPS meeting on April 25, 2013 in Troy. A public hearing on this TMDL was held on May 23, 2013 in Ottawa. Public comments for this TMDL were held open from May 4 through June 7, 2013. There were no public comments received for this TMDL.

Basin Advisory Committee: The Missouri River Basin Advisory Committee met on April 9, 2013 in Atchison where this TMDL was discussed. No comments were received.

Milestone Evaluation: In 2017, evaluation will be made as to any implementation of management practices to minimize stormwater runoff contributing to this impairment. Subsequent decisions will be made regarding the implementation approach, priority of allotting resources for implementation and the need for additional or follow implementation in this watersh3ed at the next TMDL cycle for this basin in 2017 with consultation from local stakeholders and the City of Leavenworth.

Consideration for 303d Delisting: Jerry's Lake will be evaluated for delisting under Section 303d, based on the monitoring data over 2012-2021. Therefore, the decision for delisting will come about in the preparation of the 2022-303d list. Should modifications be made to the applicable water quality criteria during the 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 would come in 2014, which will emphasize implementation of WRAPS activities. At that time, incorporation of this TMDL will be made into the WRAPS. Recommendations of this TMDL will be considered in the Kansas Water Plan implementation decisions under the State Water Planning Process for Fiscal Years 2012-202Recommendations of this TMDL will be considered in the Kansas Water Plan implementation decisions under the State Water Planning Process for Fiscal Years 2012-2020.

Rev 09/10/13

References

Dodds W.K., E. Carney, and R.T. Angelo, 2006. Determining ecoregional reference conditions for nutrient, Secchi depth and chlorophyll *a* in Kansas lakes and reservoirs. Lake and Reservoir Management 22(2): 151-159.

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Juracek, K.E., 2000. Soils – Potential Runoff. U.S. Geological Survey Open-File Report 00-253.

Kansas Department of Wildlife and Parks. April 20, 2011. Jerry's State Fishing Lake Information. http://www.kdwp.state.ks.us/news/Fishing/Where-to-Fish-in-Kansas/Fishing-Locations-Public-Waters/Region-3/Jerry's-State-Fishing-Lake

National Agricultural Statistics Service. April 13, 2011. State and County Data. http://www.nass.usda.gov/Data_and_Statistics/Quick_Stats_1.0/index.asp

Appendix A – CNET Eutrophication Model for Jerry's Lake.

Inputs:

Parameter	Input Value (Current)
Drainage Area (km^2)	0.101
Precipitation (m/yr)	0.866
Evaporation (m/yr)	1.12
Unit Runoff (m/yr)	0.197
Stream Total P (ppb)	260
Surface Area (km^2)	0.00405
Max Depth (m)	2.00
Mean Depth (m)	0.770
Current Lake Phosphorus (ppb)	112
Current Lake Chlorophyll *a* (ppb)	32.0
Current Lake Secchi Depth (m)	0.50
Total P Model Number	2
Chl *a* Model Number	4

Outputs:

Parameter	Calculated Values
Stream Total P (ppb)	60
Total Inflow (hm^3/yr)	0.0234
Total Outflow (hm^3/yr)	0.0189
Predicted Lake Phosphorus (ppb)	43
Predicted Lake Chlorophyll *a* (ppb)	12
Predicted Lake Secchi Depth (m)	0.65
Current Phosphorus Atmospheric Load (lbs/yr)	0.0891
Predicted Phosphorus Atmospheric Load (lbs/yr)	0.0891
Current Total Phosphorus Load (lbs/yr)	11.47
TMDL (lbs/yr)	2.716

CNET Model:

RESERVOIR EUTROPHICATION MODELING WORKSHEET — TITLE -> Jerry's Lake -- MO — Based on CNET.WK1 VERSION 1.0

VARIABLE	UNITS	Current	LC
WATERSHED CHARACTERISTICS...	drop down select unit - conversion is automatic	Latitude	39.3
Drainage Area	km2	0.101	0.101
Precipitation	m/yr	0.866	0.866
Evaporation	m/yr	1.12	1.12
Unit Runoff	m/yr	0.197	0.197
Stream Total P Conc.	ppb	260	60
Stream Ortho P Conc.	ppb	52	12
Atmospheric Total P Load	kg/km2-yr	10	10
Atmospheric Ortho P Load	kg/km2-yr	0	0
POINT SOURCE CHARACTERISTICS...			
Flow	hm3/yr	0.000	0.000
Total P Conc	ppb	0.000	0.000
Ortho P Conc	ppb	0	0
RESERVOIR CHARACTERISTICS...			
Surface Area	km2	0.00405	0.00405
Max Depth	m	2.0	2.0
Mean Depth	m	0.77	0.77
Non-Algal Turbidity (1/m)	Dzialowski	1.10	0.52
Mean Depth of Mixed Layer	m	0.6	0.6
Mean Depth of Hypolimnion	m	0.40	0.40
Observed Phosphorus	ppb	112	43
Observed Chl-a	ppb	32	12
Observed Secchi	m	0.50	1.0
MODEL PARAMETERS...			
BATHTUB Total P Model Number	(1-8)	2	2
BATHTUB Total P Model Name		DECAY FUNC	
BATHTUB Chl-a Model Number	(2,4,5)	4	4
BATHTUB Chl-a Model Name		P-LIN	
Beta = 1/S vs. C Slope (m2/mg)	Default	0.0625	0.0859
P Decay Calibration (normally =1)		1	1
Chlorophyll-a Calib (normally = 1)		1	1
Chla Temporal Coef. of Var.		0.35	0.35
Chla Nuisance Criterion	ppb	12	12
WATER BALANCE...			
Precipitation Flow	hm3/yr	0.0035	0.0035
NonPoint Flow	hm3/yr	0.0199	0.0199
Point Flow	hm3/yr	0.0000	0.0000
Total Inflow	hm3/yr	0.0234	0.0234
Evaporation	hm3/yr	0.0045	0.0045
Outflow	hm3/yr	0.0189	0.0189

VARIABLE	UNITS	Current	LC
AVAILABLE P BALANCE...			
Precipitation Load	kg/yr	0.04	0.04
NonPoint Load	kg/yr	5.17	1.19
Point Load	kg/yr	0.00	0.00
Total Load	b	5.21	1.23
Sedimentation	kg/yr	3.04	0.43
Outflow	kg/yr	2.18	0.81
PREDICTION SUMMARY...			
P Retention Coefficient	-	0.583	0.347
Mean Phosphorus	ppb	115	43
Mean Chlorophyll-a	ppb	32	12
Algal Nuisance Frequency	%	99.6	42.7
Mean Secchi Depth	meters	0.32	0.65
Hypol. Oxygen Depletion A	mg/m2-d	1363.9	830.3
Hypol. Oxygen Depletion V	mg/m3-d	3409.8	2075.7
Organic Nitrogen	ppb	976.2	469.0
Non Ortho Phosphorus	ppb	79.5	29.5
Chl-a x Secchi	mg/m2	10.4	7.7
Principal Component 1	-	3.35	2.60
Principal Component 2	-	0.76	0.71
	Observed	Pred	Target
Carlson TSI P	72.2	72.7	58.3
Carlson TSI Chl-a	64.6	64.7	55.0
Carlson TSI Secchi	70.0	76.4	66.3
OBSERVED / PREDICTED RATIOS...			
Phosphorus		0.97	1.01
Chlorophyll-a		0.99	1.00
Secchi		1.56	1.50
OBSERVED / PREDICTED T-STATISTICS...			
Phosphorus		-0.11	0.02
Chlorophyll-a		-0.03	0.01
Secchi		1.63	1.50
ORTHO P LOADS...			
Precipitation	kg/yr	0.00	0.00
Stormwater Runoff	kg/yr	1.03	0.24
Point	kg/yr	0.00	0.00
Total	kg/yr	1.03	0.24
Total	lbs/yr	2.28	0.53

VARIABLE	UNITS	Current	LC
RESPONSE CALCULATIONS...			
Reservoir Volume	hm3	0.0031185	0.0031185
Residence Time	yrs	0.1653	0.1653
Overflow Rate	m/yr	4.7	4.7
Total P Availability Factor		1.00	1
Ortho P Availability Factor		0	0
Inflow Ortho P/Total P		0.198	0.193
Inflow P Conc	ppb	276.3	65.4
P Reaction Rate - Mods 1 & 8		2.0	0.5
P Reaction Rate - Model 2		3.3	0.8
P Reaction Rate - Model 3		4.6	1.1
1-Rp Model 1 - Avail P		0.499	0.739
1-Rp Model 2 - Decay Rate		0.417	0.653
1-Rp Model 3 - 2nd Order Fixed		0.371	0.605
1-Rp Model 4 - Canfield & Bach		0.408	0.617
1-Rp Model 5 - Vollenweider 19		0.711	0.711
1-Rp Model 6 - First Order Dec		0.858	0.858
1-Rp Model 7 - First Order Set		0.823	0.823
1-Rp Model 8 - 2nd Order Tp Or		0.499	0.739
1-Rp - Used		0.417	0.653
Reservoir P Conc	ppb	115.3	42.7
Gp		0.129	0.129
Bp	ppb	136.9	35.1
Chla vs. P, Turb, Flush	2	56.9	23.7
Chla vs. P Linear	4	32.3	12.0
Chla vs. P 1.46	5	83.0	19.5
Chla Used	ppb	32.3	12.0
ml - Nuisance Freq Calc.		3.4	2.4
z		-2.654	0.183
v		0.012	0.392
w		0.531	0.943
x		0.004	0.427

TOTAL P LOADS...

BAF Override (KS) (see below)	OrP %	Current	LC
0	0%	0.0405	0.0405
0	20%	5.17	1.194
0	0%	0.00	0.000
		5.21	1.234
		11.47	2.716

Appendix B. **Conversion to Daily Loads as Regulated by EPA Region VII**

The TMDL has estimated annual average loads for TP that if achieved should meet the water quality targets. A recent court decision often referred to as the "Anacostia decision" has dictated that TMDLs include a "daily" load (Friend of the Earth, Inc v. EPA, et al.).

Expressing this TMDL in daily time steps could be misleading to imply a daily response to a daily load. It is important to recognize that the growing season mean chlorophyll *a* is affected by many factors such as: internal lake nutrient loading, water residence time, wind action and the interaction between light penetration, nutrients, sediment load and algal response.

To translate long-term averages to maximum daily load values, EPA Region 7 has suggested the approach describe in the Technical Support Document for Water Quality Based Toxics Control (EPA/505/2-90-001)(TSD).

Maximum Daily Load (MDL) = (Long-Term Average Load) * $e^{[Z\sigma - 0.5\sigma^2]}$

where $\sigma^2 = \ln(CV^2 + 1)$
CV = Coefficient of variation = Standard Deviation / Mean
Z = 2.326 for 99th percentile probability basis

LTA= Long Term Average
LA= Load Allocation
MOS= Margin of Safety

Parameter	LTA lbs/year	CV	$e^{[Z\sigma - 0.5\sigma^2]}$	MDL lbs/day	Atm LA lbs/day	WLA lbs/day	MOS (10%) lbs/day
TP	2.716	0.5	2.68	0.0200	0.0007	0.0173	0.0020

Maximum Daily Load Calculation
Annual TP Load = 2.716 lbs/yr

Maximum Daily TP Load = [(2.716 lbs/yr)/(365 days/yr)]*$e^{[2.326*(0.472) - 0.5*(0.472)^2]}$
= 0.0020 lbs/day

Margin of Safety (MOS) for Daily Load
Annual TP MOS = 0.2716 lbs/yr

Daily TP MOS = [(0.2716 lbs/yr)/(365 days/yr)]*$e^{[2.326*(0.472) - 0.5*(0.472)^2]}$
= 0.0020 lbs/day

Source- *Technical Support Document for Water Quality-based Toxics Control (EPA/505/2-90-001)*