SMOKY HILL/SALINE RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Water Body/Assessment Unit: Wilson Lake Watershed
including Paradise Creek and Saline River (Russell, Hays)
Water Quality Impairment: Selenium

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Upper Saline

Counties: Ellis, Ellsworth, Gove, Graham, Lincoln, Logan, Osborne, Rooks, Russell, Sheridan, Thomas, Trego

HUC 8: 10260009 **HUC 11** (14)**:** **010** (010, 020, 030, 040, 050, 060, 070) (Figure 1)
020 (010, 020, 030, 040, 050, 060, 070, 080)
030 (010, 020, 030, 040, 050, 060, 070, 080)
040 (010, 020, 030, 040, 050)
050 (010, 020, 030, 040, 050)
060 (010, 020, 030, 040, 050, 060)
070 (010, 020, 030, 040)

Ecoregion: Western High Plains, Flat to Rolling Cropland (25d)
Central Great Plains, Smoky Hills (27a)
Central Great Plains, Rolling Plains and Breaks (27b)

Drainage Area: Approximately 1,900 square miles.

Wilson Lake (Not Impaired)

Conservation Pool: Area = 8,293 acres
Watershed Area: Lake Surface Area = 147:1
Maximum Depth = 18 meters (59 feet)
Mean Depth = 7.4 meters (24 feet)
Retention Time = 1.9 years (23 months)

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

Authority: Federal (U.S. Army Corps of Engineers) and State (Kansas Dept. of Wildlife and Parks)

Wilson Lake Watershed

Main Stem Segment: WQLS: (4), 8, 9, 11, 12, 14, & 16 (Saline River) starting at Wilson Lake and traveling upstream to the headwaters west of Oakley.

Main Stem Segments with Tributaries by HUC 8 and Watershed/Station Number:

HUC8:	**10260009**		
Watershed:	**Wilson Lake (014001)**		
	Saline R (4)	Cedar Cr (30)	
HUC8:	**10260009**		
Watershed:	**Paradise Creek (538)**		
	Paradise Cr (5)	Eagle Cr (6)	
	Paradise Cr (7)		
HUC8:	**10260009**		
Watershed:	**Saline R. (Russell) (011)**		
	Saline R (8)	Salt Cr (20)	
	Saline R (9-part)	Sweetwater Cr (29)	
HUC8:	**10260009**		
Watershed:	**Saline River (Hays) (548)**		
	Saline R (9-part)	Sand Cr (10)	
	Saline R (11)	E. Spring Cr (19)	
	Saline R (12)	Tomcat Cr (28)	
		Wild Horse Cr (27)	
		Unnamed Stream (13)	
	Saline R (14)	Chalk Cr (26)	
		Happy Cr (25)	
		Trego Cr (24)	
		N. Fk. Saline R. (15)	
	Saline R (16)	Coyote Cr (23)	Unnamed Stream (1061)
		Plum Cr (22)	
		Spring Brook Cr (21)	
		N. Fk. Saline R (17)	
		S. Fk. Saline R (18)	

Designated Uses: Secondary Contact Recreation; Expected Aquatic Life Support; Drinking Water; Food Procurement; Groundwater Recharge, Industrial Water Supply, Irrigation; Livestock Watering on Main Stem Segments

Primary Contact Recreation on Main Stem Segments except 14 and 16

2002 303(d) Listing: Wilson Watershed Streams

Impaired Use: Expected Aquatic Life Support

Water Quality Standard: 5 Fg/liter for Chronic Aquatic Life (KAR 28-16-28e(c)(2)(F)(ii)

In stream segments where background concentrations of naturally occurring substances, including chlorides and sulfates, exceed the domestic water supply criteria listed in table 1a in subsection (d), at ambient flow, due to intrusion of mineralized groundwater, the existing water quality shall be maintained, and the newly established numeric criteria for domestic water supply shall be the background concentration, as defined in K.A.R. 28-16-28b(e). Background concentrations shall be established using the methods outlined in the ‘‘Kansas implementation procedures: surface water quality standards,’’ as defined in K.A.R. 28-16-28b(ee), available upon request from the department. (K.A.R. 28-16-28e(c) (3)(B))

Figure 1

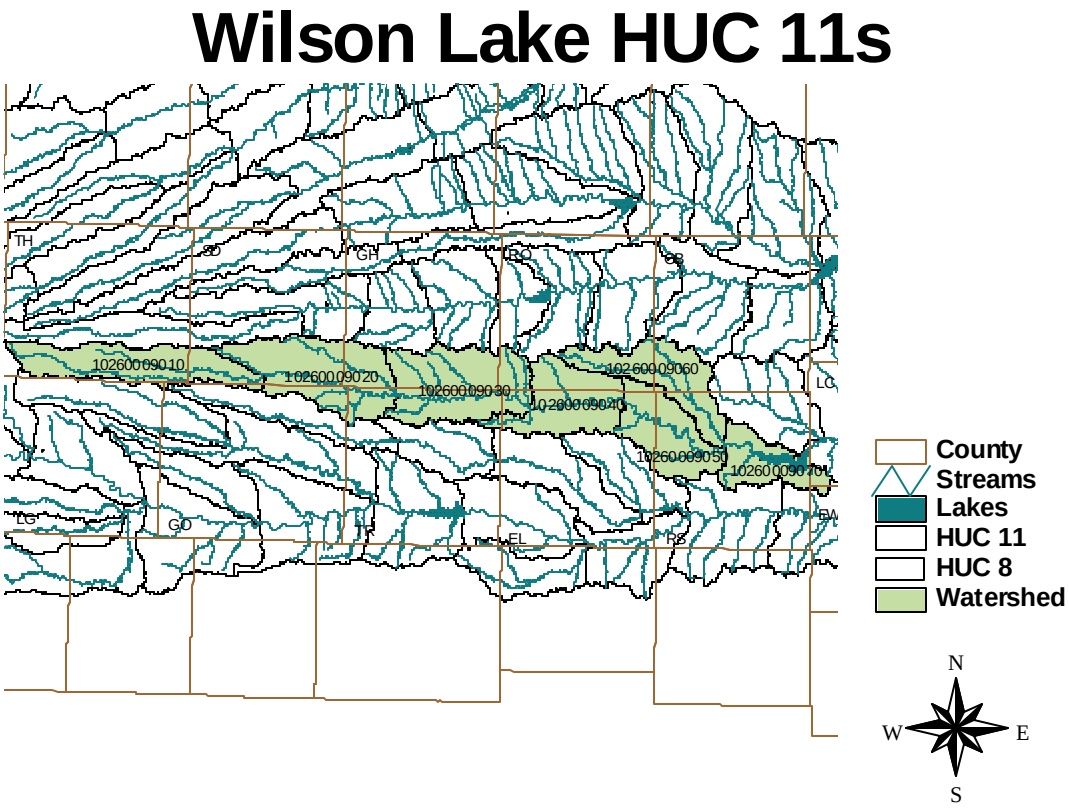
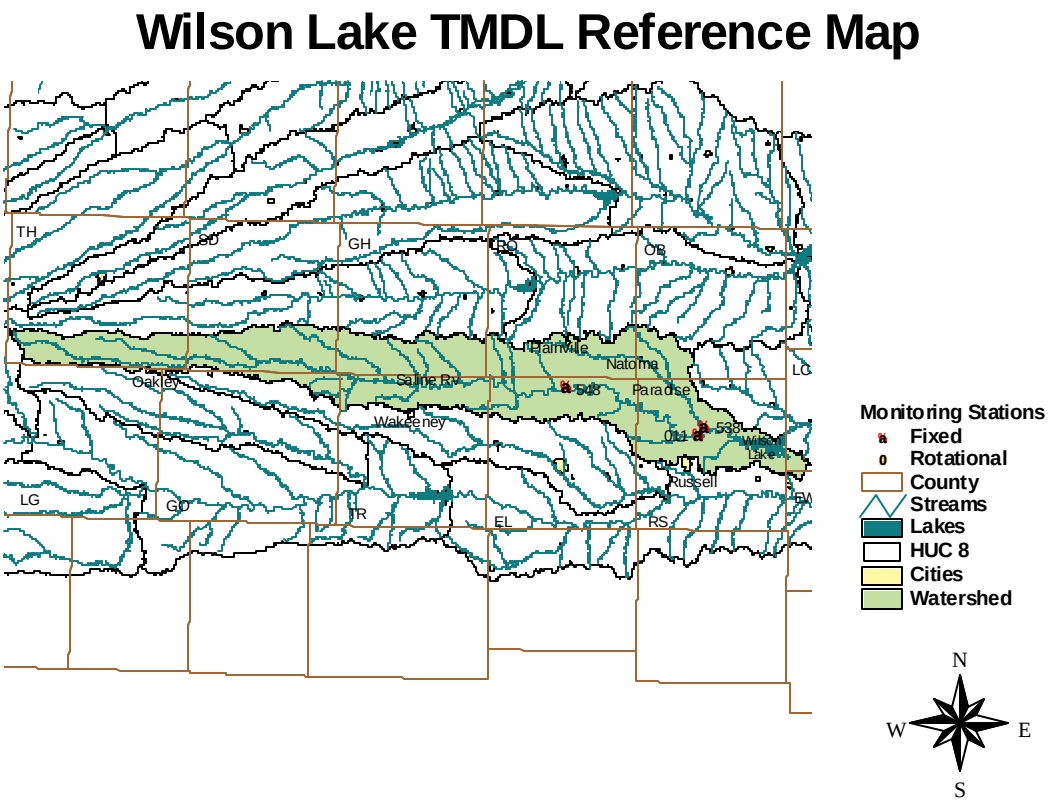


Figure 2



2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Lake Monitoring Site: Station 014001 in Wilson Lake (Figure 2).
Period of Record Used: Six surveys during 1988 - 2003
Elevation Record: Wilson Lake near Wilson, KS (USGS Gage 06868100)

Stream Chemistry Monitoring Site: Station 011 near Russell (Saline River)
Period of Record Used: 1990 - 2003
Flow Record: Saline River near Russell, KS (USGS Gage 06867000), Median Flow = 29.2 cfs

Stream Chemistry Monitoring Site: Station 538 near Waldo (Paradise Creek)
Period of Record Used: 1990 - 2003
Flow Record: Matched to flow duration for Salt C near Ada (06876700), Median Flow = 4.4 cfs

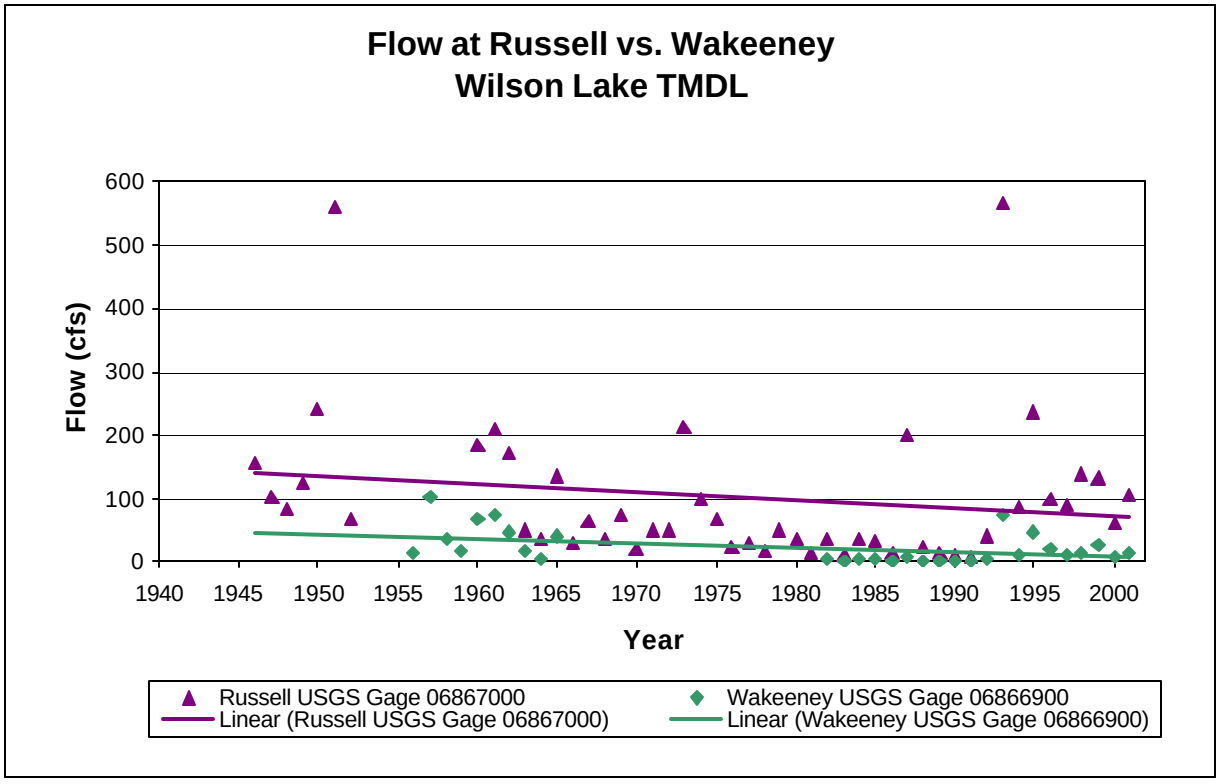
Stream Chemistry Monitoring Site: Station 548 near Hays (Saline River)
Period of Record Used: 1990 - 2003
Flow Record: Saline River near Russell, KS (USGS Gage 06867000), Median Flow = 29.2 cfs

Current Condition: There is a relatively good relationship between flow within the drainage basin of the Saline River and the selenium content of Wilson Lake. Large fluctuations in the amount of rainfall that flows into Wilson Lake cause variations in the selenium concentrations. The rain infiltrates the high selenium soils, and the runoff carries increased levels of selenium into the streams and lake (Figures 8-10). The flood of 1993 significantly increased the flow at the Saline River near Russell to an annual average flow of 566 cfs (Figure 3). The lake was replenished, and the selenium content in the lake increased four fold. A high of 0.0055 mg/L of selenium was seen in 1994. In drought years, the selenium is often not detected in the lake water (Appendix A).

Average Selenium Concentrations in Wilson Lake

Date	Selenium (mg/L)	Average Annual Flow at Saline Rv. Near Russell (cfs)
6/27/1988	< 0.0010	22.2
8/13/1991	0.0015	5.3
6/7/1994	0.0055	85.4
6/24/1997	0.0031	87.0
7/18/2000	< 0.0020	60.3
7/21/2003	0.0029	16.6

Figure 3



The selenium concentrations in Wilson Lake parallel the concentrations at the stream stations during the six months prior to sampling (Figure 4). The levels tend to be higher at the stream stations and lower in the lake. The concentrations seen at stations 011, 538, and 548 are not statistically different from each

other. Concentrations over the period of record for the three stream stations can be seen in Figures 5 through 7. From 1990 to 2003, the mean selenium concentrations were 0.0047 mg/L for the Saline River near Russell (station 011), 0.0044 mg/L for Paradise Creek (station 538), and 0.0052 mg/L for the Saline River near Hays (station 548).

Figure 4

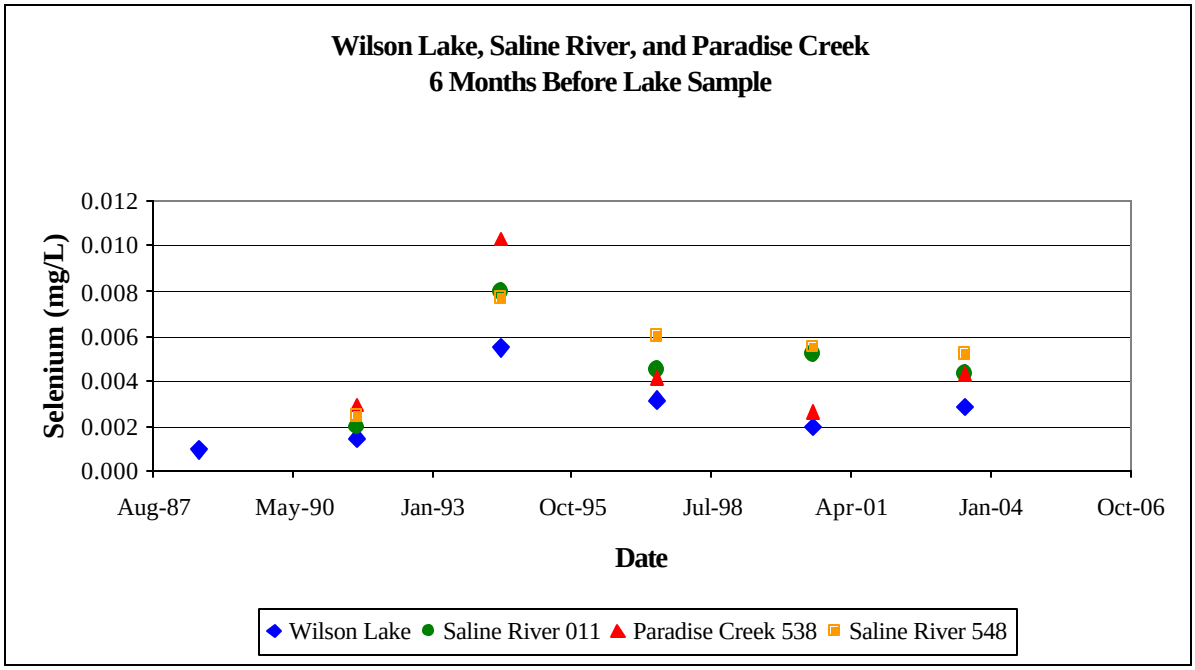


Figure 5

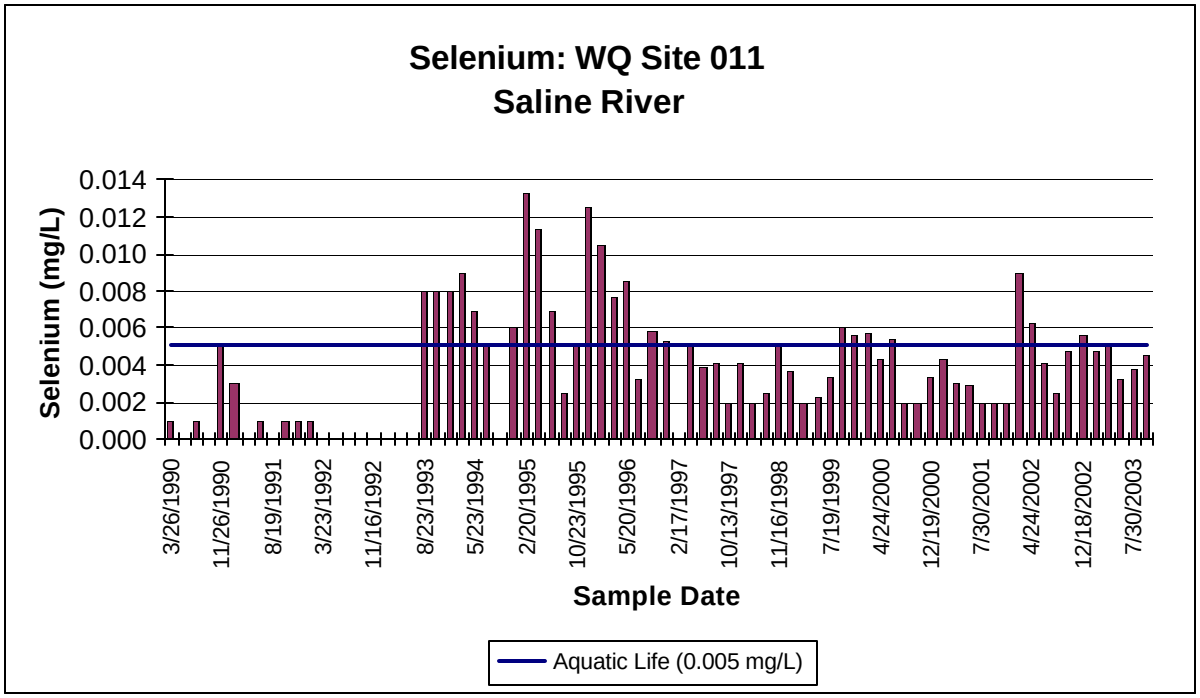


Figure 6

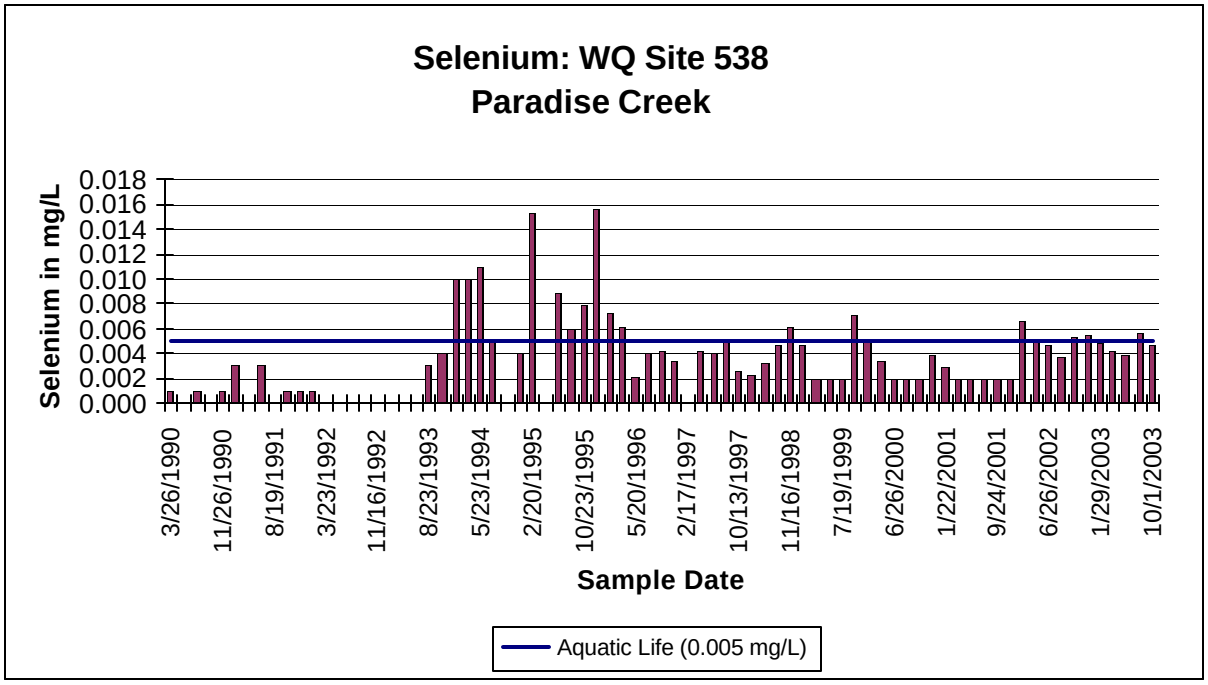
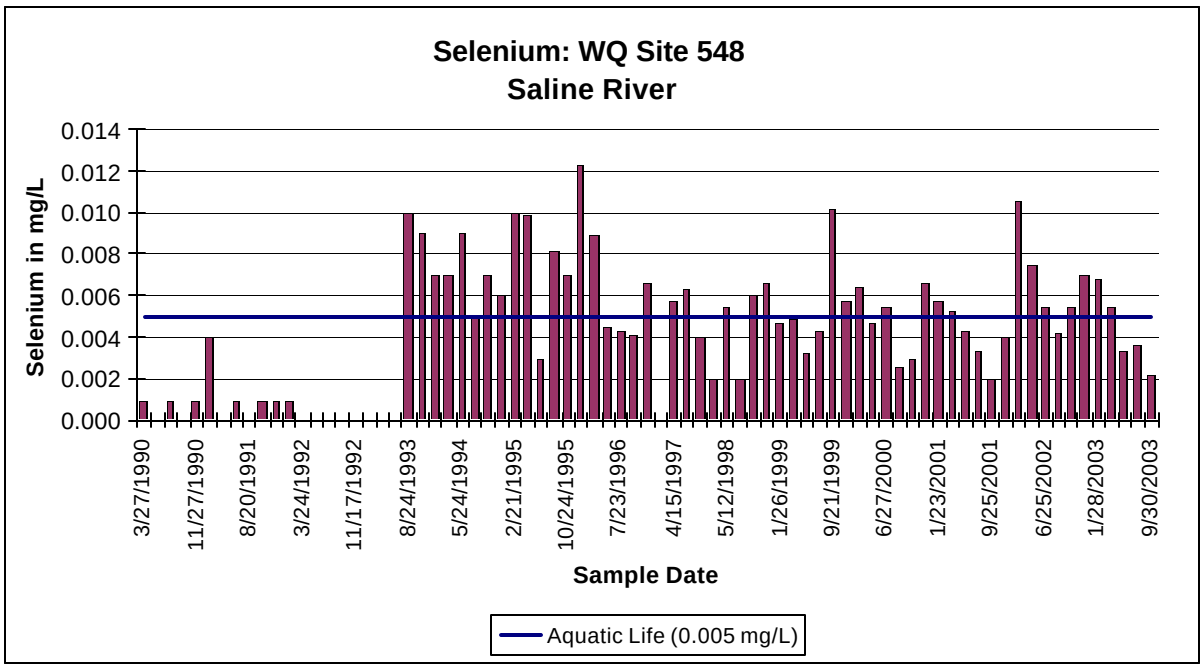


Figure 7



Since loading capacity varies as a function of the flow present in the stream, this TMDL represents a continuum of desired loads over all flow conditions, rather than fixed at a single value. Sample data for the sampling sites were categorized for each of the three defined seasons: Spring (Apr-Jul), Summer-

Fall (Aug-Oct) and Winter (Nov-Mar). High flows and runoff equate to lower flow durations; baseflow and point source influences generally occur in the 75-99% range. A Load curve was established for the Aquatic Life Support criterion by multiplying the flow values along the curve by the applicable water quality criterion and converting the units to derive a load duration curve of tons of selenium per day. This load curves represent the TMDL since any point along the curve represents water quality for the standard at that flow. Historic excursions from the water quality standard are seen as plotted points above the load curve. Water quality standards are met for those points plotting below the load duration curve (Figures 8-10).

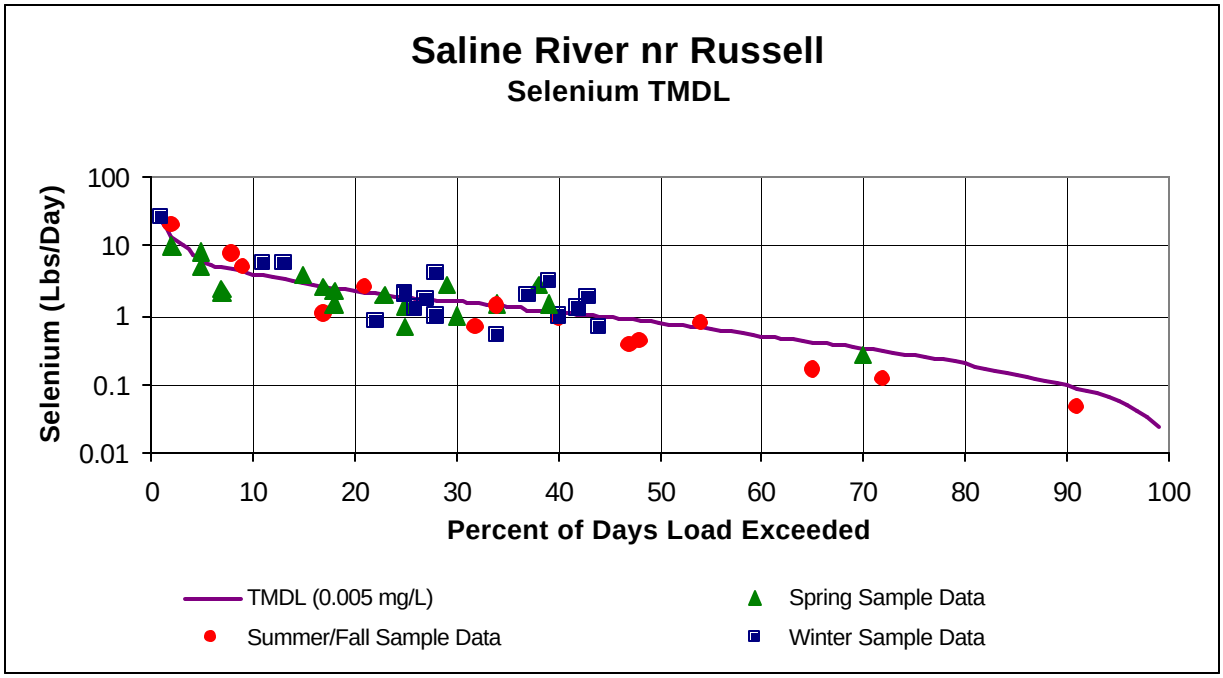


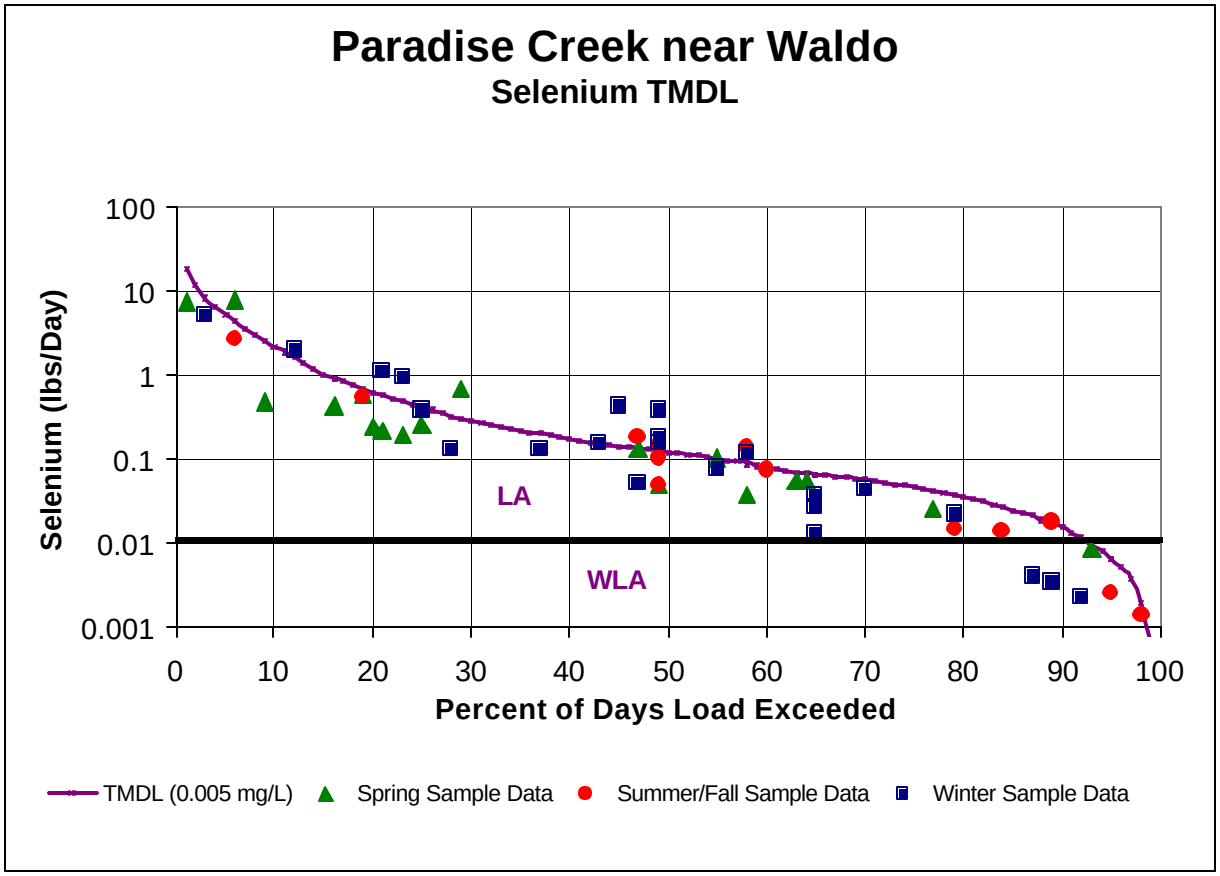
Figure 8

Station 011: Excursions were seen in each of the three defined seasons and are outlined below. Thirty-three percent of Spring samples and 36% of Summer-Fall samples were over the domestic supply criterion. Fifty-nine percent of Winter samples were over the criterion. Overall, 43% of the samples were over the criteria. This represents a baseline condition of non-support of the impaired designated use.

NUMBER OF SAMPLES OVER Selenium STANDARD OF 0.005 mg/L BY FLOW AND SEASON

Station	Season	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum Freq.
Station 011 near Russell (Saline River)	Spring	1	1	4	0	0	0	6/18=33%
	Summer	3	1	0	1	0	0	5/14=36%
	Winter	1	4	5	0	0	0	10/17=59%

Figure 9

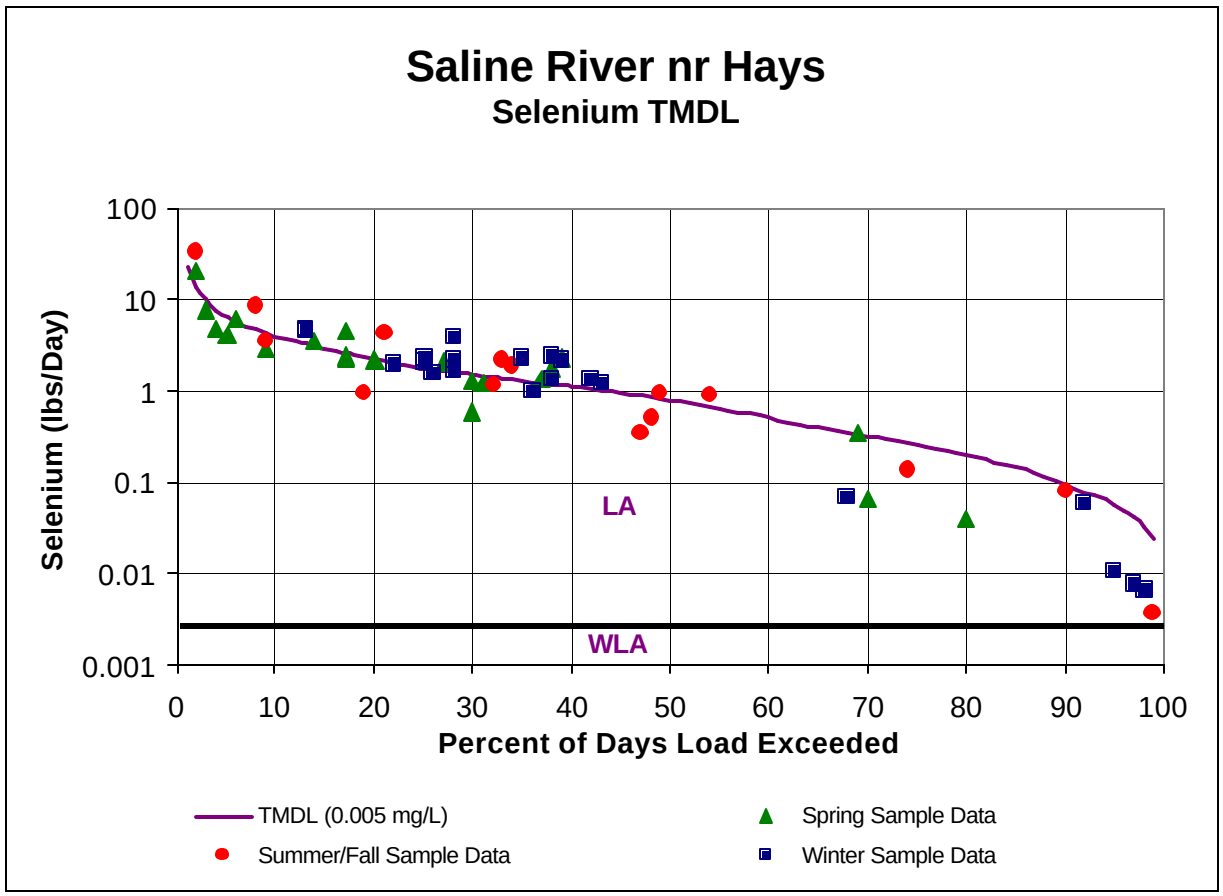


Station 538: Excursions were seen in each of the three defined seasons and are outlined below. Twelve percent of Spring samples and 17% of Summer-Fall samples were over the domestic supply criterion. Thirty-five percent of Winter samples were over the criterion. Overall, 23% of the samples were over the criteria. This represents a baseline condition of non-support of the impaired designated use.

NUMBER OF SAMPLES OVER Selenium STANDARD OF 0.005 mg/L BY FLOW AND SEASON

Station	Season	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum Freq.
Station 538 near Waldo (Paradise Creek)	Spring	1	0	1	0	0	0	2/17=12%
	Summer	0	0	1	1	0	0	2/12=17%
	Winter	0	3	4	1	0	0	8/23=35%

Figure 10



Station 548: Excursions were seen in each of the three defined seasons and are outlined below. Thirty-five percent of Spring samples and 47% of Summer-Fall samples were over the domestic supply criterion. Sixty percent of Winter samples were over the criterion. Overall, 47% of the samples were over the criteria. This represents a baseline condition of non-support of the impaired designated use.

NUMBER OF SAMPLES OVER Selenium STANDARD OF 0.005 mg/L BY FLOW AND SEASON

Station	Season	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum Freq.
Station 548 near Hays (Saline River)	Spring	2	2	3	0	0	0	7/20=35%
	Summer	2	1	3	1	0	0	7/15=47%
	Winter	0	3	9	0	0	0	12/20=60%

Interim Endpoints of Water Quality (Implied Load Capacity) at Stations 011, 538, and 548 over 2008 - 2012:

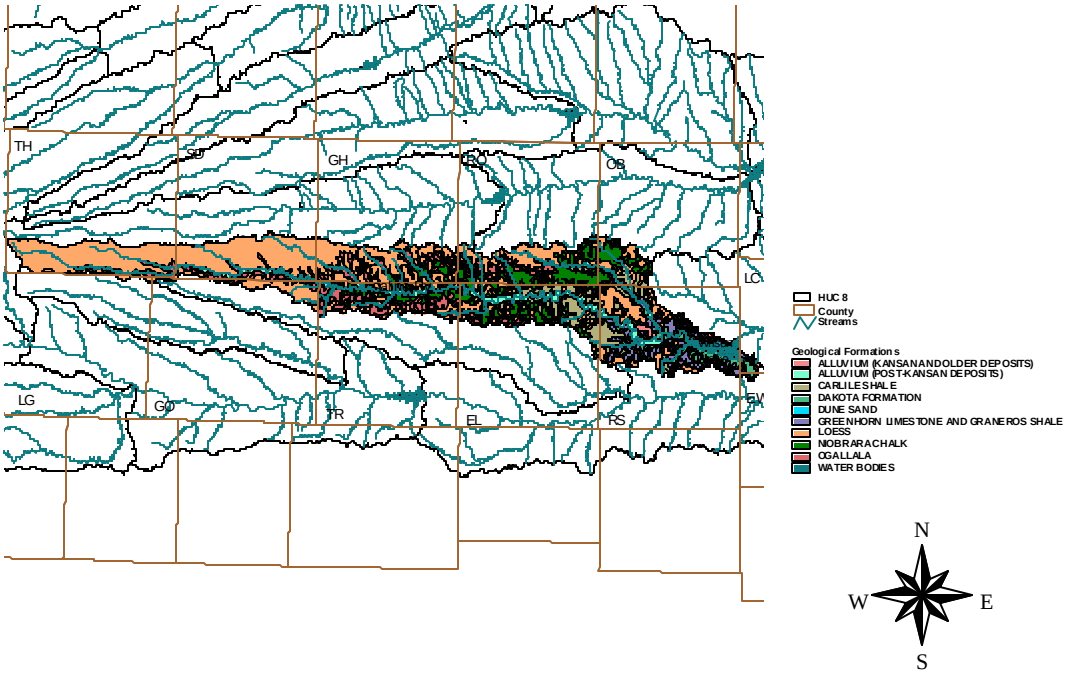
The ultimate endpoint for this TMDL will be to achieve the Kansas Water Quality Standards fully supporting chronic aquatic life support. The current standard of 0.005 mg/L of selenium was used to establish the TMDL. The Wilson Lake Watershed is subject to loading of selenium from the underlying upper Cretaceous bedrock and its high selenium content. As such, the watershed's main stem often has elevated selenium levels from this natural source. Because some of this elevated selenium is tied to historic water consumption via surface water irrigation, the 0.005 mg/l endpoint will apply to all flows at Station 011, 538, and 548.

Seasonal variation has been incorporated in this TMDL through the documentation of the seasonal consistency of elevated selenium levels. Achievement of the endpoints indicates loads are within the loading capacity of the stream, water quality standards are attained and full support of the designated uses of the stream has been restored.

3. SOURCE INVENTORY AND ASSESSMENT

Figure 11

Wilson Lake Geology



Selenium background: The main natural source of selenium in the Wilson Lake basin is from the weathering of upper Cretaceous bedrock that underlies the drainage basin. The upper Cretaceous bedrock, primarily the Niobrara Chalk, contains relatively high concentrations of selenium in comparison with other bedrock in Kansas. The bentonite beds and shales in the Chalk can be especially high in selenium. Soils weathered from the bedrock can have relatively high selenium content. Some plants growing in grasslands on soils containing high selenium concentration can accumulate enough selenium that they are toxic to livestock. Rainfall infiltrating through the high selenium soils and weathered bedrock leaches selenium. Water discharging from the soil and weathered bedrock transports dissolved selenium into streams. Evapotranspiration consumption of surface and groundwater in the drainage basin then further increases the selenium concentration of the stream water.

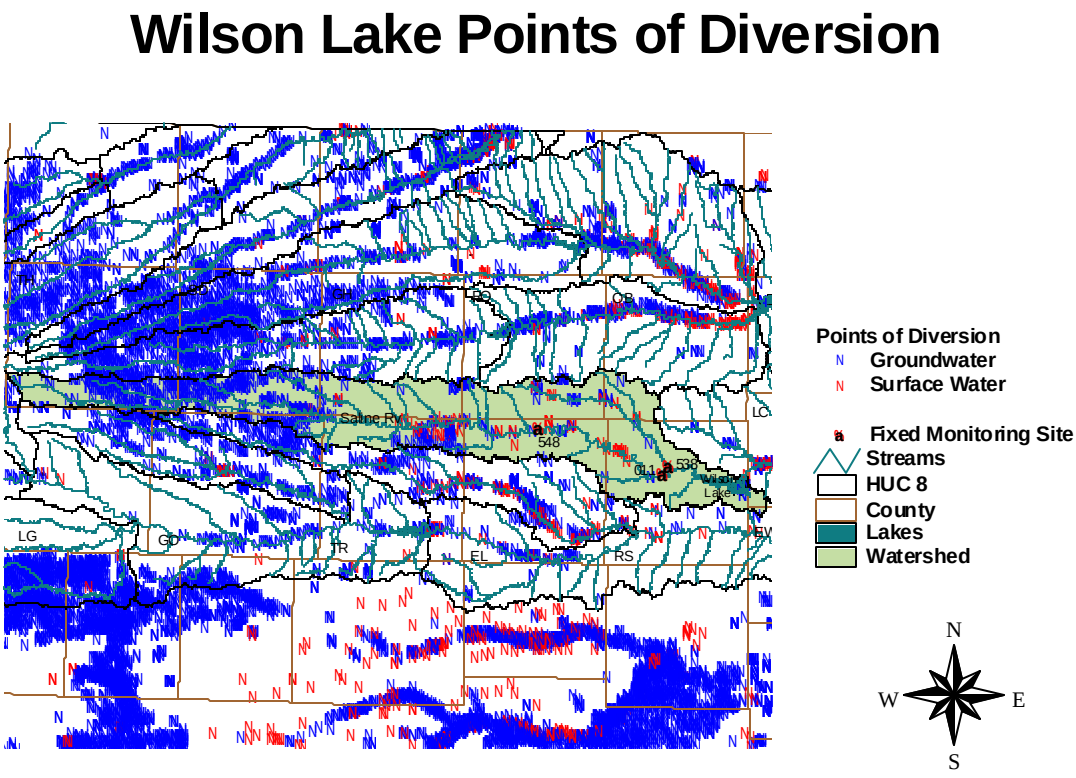


Figure 12

Irrigation Return Flows: Long-term increases in the total dissolved solids and sulfate concentrations with time as a result of increased water consumption in the Saline River basin have probably also

increased the selenium content of the streams and rivers in the basin. The main factor for the dissolved solids increase is the consumption of water by irrigation that leaves the residual dissolved salts, including selenium, in a smaller volume of water. Increases in selenium concentration of surface waters associated with irrigation and soils of high selenium content have been documented elsewhere in the United States (Jacobs, 1989). Nolan and Clark (1997) found that the presence or absence of Upper Cretaceous sediment and irrigation were the two most significant factors related to the selenium contents of surface and groundwaters sampled as part of the National Irrigation Water Quality Program of the U.S. Department of the Interior. See the point of diversion map in Figures 12. Irrigation reports from 2003 show the following:

Water Use Statistics for Each Monitoring Site

Monitoring Sites	Surface Water		Groundwater	
	Area (acres)	Volume (acre-feet)	Area (acres)	Volume (acre-feet)
Station 011 near Russell (Saline River)	0	0	79	64
Station 538 near Waldo (Paradise Creek)	0	0	130	23
Station 548 near Hays (Saline River)	20	15	28,699	27,730

Long-term chemical data of the Saline River and Paradise Creek show no significant trends in selenium content with time (Figure 13). High flow events cause selenium to leach out of selenium rich soils. Thus, concentrations over the water quality standard are seen in high flow conditions (Figures 8, 9, 10, & 14).

Figure 13

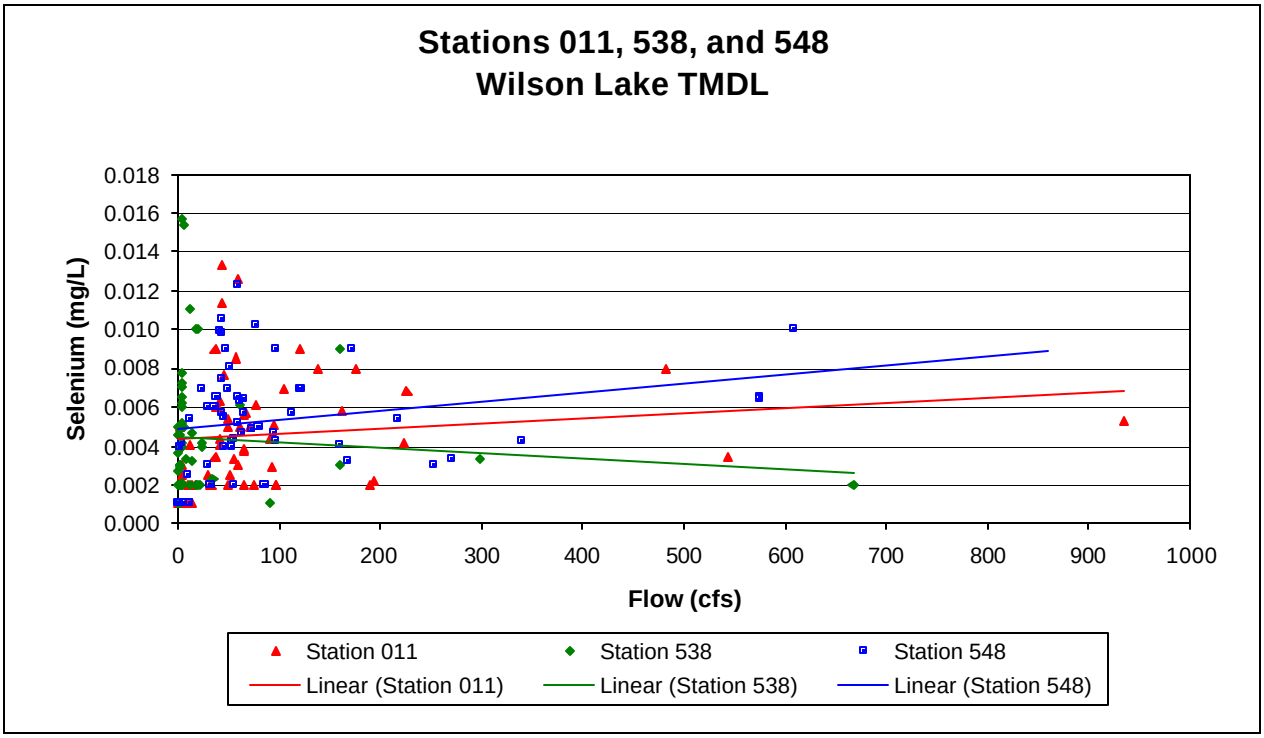
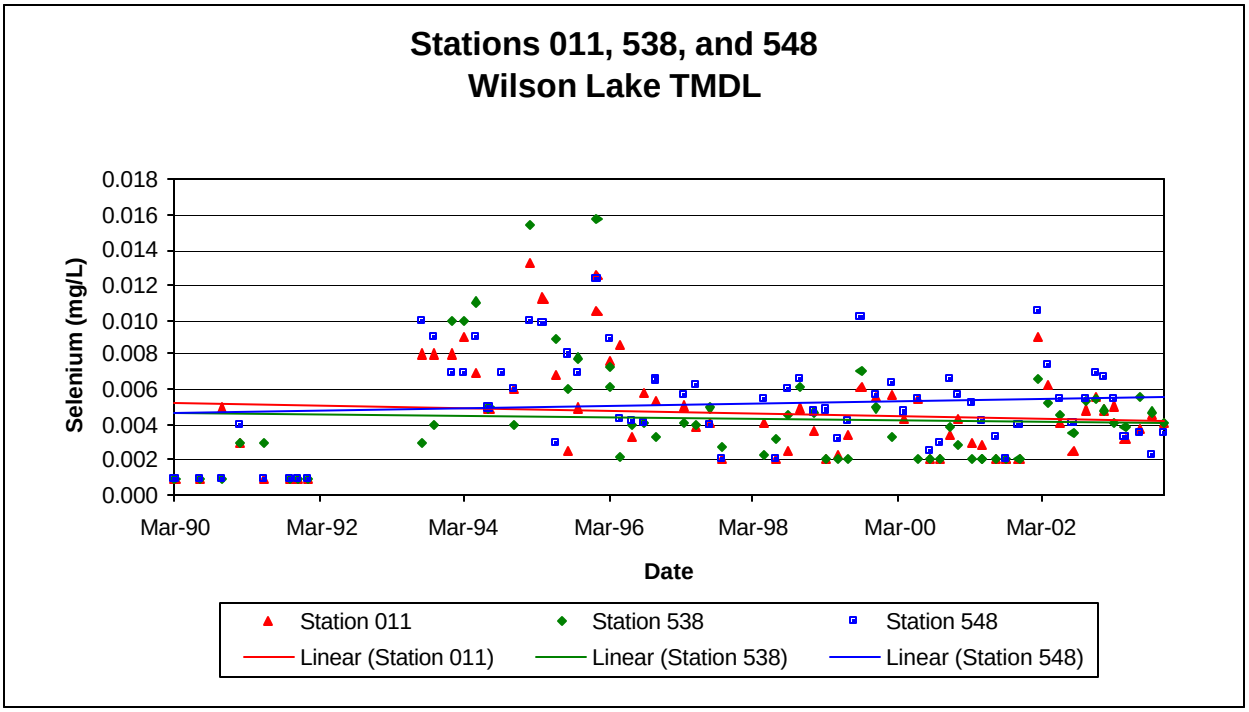


Figure 14



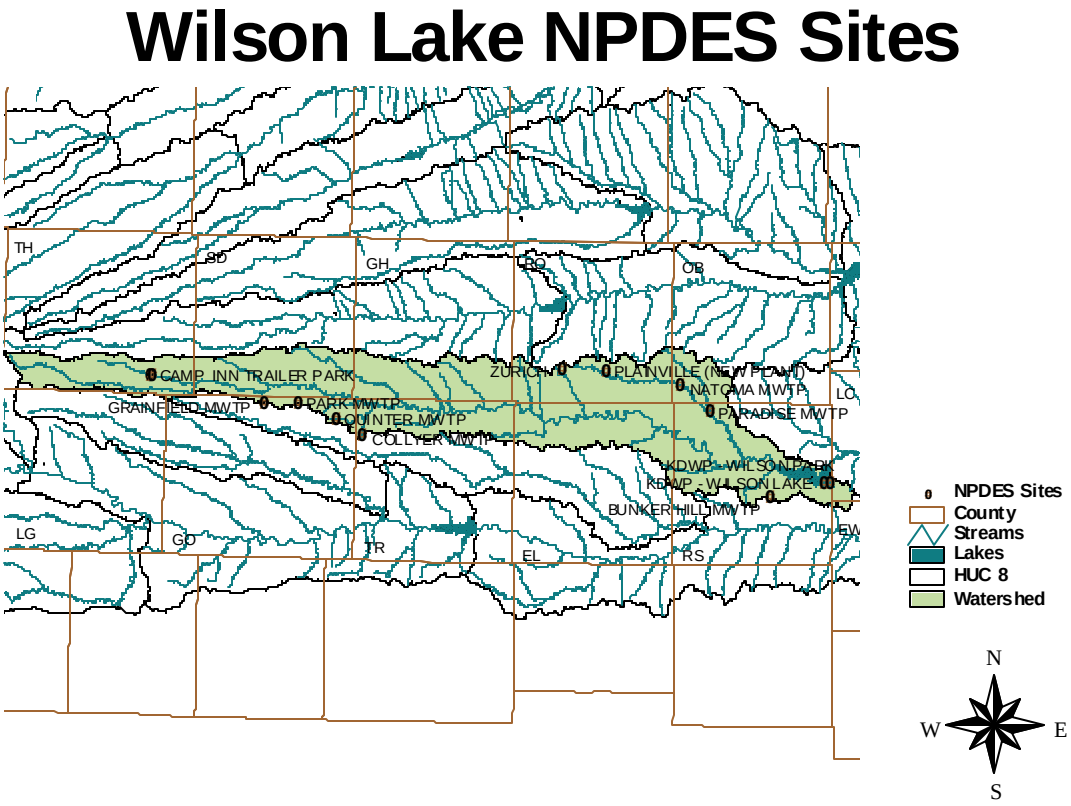
NPDES: Thirteen permitted waste treatment facilities are located within the watershed (Figure 15). Ten are non-overflowing lagoons that are prohibited from discharging. Any anthropogenic selenium sources or hydrologic modifications increasing the selenium concentration would be minor in comparison with the natural selenium source in the watershed.

Waste Treatment Plants in the Wilson Lake Watershed

Kansas Permit Number	Name	Design Capacity (MGD)	Type	Average Selenium (mg/L)	Selenium WLA (tons/day)
C-SH29-NO02	CAMP INN TRAILER PARK	non-overflowing	4-cell Lagoon	0	0
C-SH29-NO04	JOHN JONES OIL CO. TRUCK STOP	non-overflowing	2-cell Lagoon	0	0
M-SA03-NO01	BUNKER HILL MWTP	non-overflowing	2-cell Lagoon	0	0
M-SA04-NO01	COLLYER MWTP	non-overflowing	3-cell Lagoon	0	0
M-SA10-OO01	NATOMA MWTP	0.054	3-cell Lagoon	0.0045	0.0020
M-SA12-NO01	PARADISE MWTP	non-overflowing	2-cell Lagoon	0	0
M-SA13-NO01	PARK MWTP	non-overflowing	4-cell Lagoon	0	0
M-SA14-OO02	PLAINVILLE MWTP (NEW)	0.225	4-cell Lagoon	0.0055	0.0103
M-SA15-OO01	QUINTER MWTP	0.107	3-cell Lagoon	0.0046	0.0041
M-SA19-NO01	ZURICH MWTP	non-overflowing	3-cell Lagoon	0	0
M-SH12-NO01	GRAINFIELD MWTP	non-overflowing	3-cell Lagoon	0	0
M-SH05-NO03	KDWP - WILSON PARK	non-overflowing	2-cell Lagoon	0	0
M-SH05-NO02	KDWP - WILSON LAKE	non-overflowing	2-cell Lagoon	0	0

Since none of the municipal NPDES sites in the watershed are currently required to monitor for selenium in their effluent, average selenium concentrations for municipal sources were estimated based on the selenium in their influent. A one to one ratio was used to estimate the selenium in effluent from the cities in the watershed's finished water.

Figure 15



Phreatophytes: Phreatophytes in the riparian corridor of the rivers and tributaries in the Saline River basin have also increased the dissolved solids of shallow ground waters; concomitant increases in selenium contents in the shallow ground water discharged to streams would also be expected.

Contributing Runoff: The watershed's average soil permeability is 1.4 inches/hour according to NRCS STATSGO database. About 82.1% 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 5.4% of this watershed, chiefly along the stream channels.

4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

The source assessment has ascertained that natural selenium loading within the watershed is the primary factor for the excursions seen at the monitoring stations within the Wilson Lake basin. The secondary factor for elevated selenium concentrations along the Saline River is historic consumption of water by irrigation.

Point and Nonpoint Sources: In the table below, the Wasteload and Load Allocations are given for all the stations included in this TMDL. The total Wasteload Allocation entering Wilson Lake is 0.0165 tons per day. The Wasteload Allocations were established based on the concentration of selenium assumed to be in each discharger's effluent, reflecting their source water content. No allowance was made for evaporation.

Allocations for Wilson Lake Watershed

TMDL (0.005 mg/L)			
	SC011	SC538	SC548
Load Capacity (lb/day)	0.7884	0.1199	0.7884
Wasteload Allocation (lb/day)	0.0000 *	0.0124	0.0041
Load Allocation (lb./day)	0.7884	0.1075	0.7843

* Should future point sources be proposed in the subwatershed 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.

Defined Margin of Safety: There are varying degrees of impact on selenium levels from historic irrigation within the drainage of Wilson Lake. In the long term, the Load Allocations established by this TMDL reflect either the existing water quality standard or the background concentrations. The Margin of Safety implicitly assures these Load Allocations will achieve the endpoints of the TMDL through policies and objectives established under the Kansas Water Plan. Two objectives under the State Water Plan call for, by 2010; 1) reduction of water level decline rates within the Ogallala aquifer and implementation of enhanced water management in targeted areas; and, 2) reduction in the number of irrigation points of diversion for which the amount of water applied in acre-feet per acre exceeds an amount considered reasonable for the area and those [irrigation points of diversion] that over pump the amount authorized by their water rights. Pursuit of these two water conservation objectives will have water quality benefits, including assuring excessive irrigation will not directly or indirectly load surface waters with residual salts, thereby causing endpoints to be non-attained.

State Water Plan Implementation Priority: Because the impairment is due to natural geologic sources, this TMDL will be a Low Priority for implementation.

Unified Watershed Assessment Priority Ranking: Wilson Lake lies within the Upper Saline (HUC 8: 10260009) with a priority ranking of 39 (Medium Priority for restoration).

Priority HUC 11s: Because of the natural geologic contribution of this impairment, stream reaches overlying the Niobrara Chalk will be the focus of this TMDL.

5. IMPLEMENTATION

Desired Implementation Activities

1. Monitor any anthropogenic contributions of selenium loading to the lake and streams.
2. Establish an alternative background criterion.

3. Evaluate impacts of irrigation best management practices to abate salt loading.

Implementation Programs Guidance

NPDES and State Permits - KDHE

a. Municipal permits for facilities in the watershed will be renewed after 2004 with selenium monitoring and any appropriate permit limits, which protect the aquatic life criteria.

Non-Point Source Pollution Technical Assistance - KDHE

a. Evaluate any potential anthropogenic activities which might contribute selenium to the lake as part of an overall Watershed Restoration and Protection Strategy.

b. Evaluate impact of irrigation return flows on selenium loading to streams.

Water Quality Standards and Assessment - KDHE

a. Establish background levels of selenium for the river and tributaries.

Subbasin Management - DWR

a. Evaluate Best Management Practices for irrigation which decrease salt loading to streams.

Time Frame for Implementation: Development of a background level-based water quality standard should be accomplished with the next water quality standards revision.

Targeted Participants: Primary participants for implementation will be KDHE and DWR.

Milestone for 2008: The year 2008 marks the midpoint of the ten-year implementation window for the watershed. At that point in time, additional monitoring data from Wilson Lake will be reexamined to confirm the impaired status of the lake and the suggested background concentration. 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 Kansas Department of Health and Environment and the Kansas Department of Agriculture, Division of Water Resources.

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: Minimal control can be exerted on natural contributions to loading.

6. MONITORING

KDHE will continue to collect samples from Wilson Lake and at Stations 011, 538, and 548. Based on that sampling, the priority status will be evaluated in 2008 including application of a numeric criterion based on background concentrations. Should impaired status remain, the desired endpoints under this TMDL will be refined and direct more intensive sampling will need to be conducted under specified seasonal flow conditions over the period 2008-2012.

Monitoring of selenium levels in effluent will be a condition of NPDES and state permits for facilities. This monitoring will continually assess the functionality of the systems in reducing selenium levels in the effluent released to the streams upstream of Wilson Lake.

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 Wilson 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.

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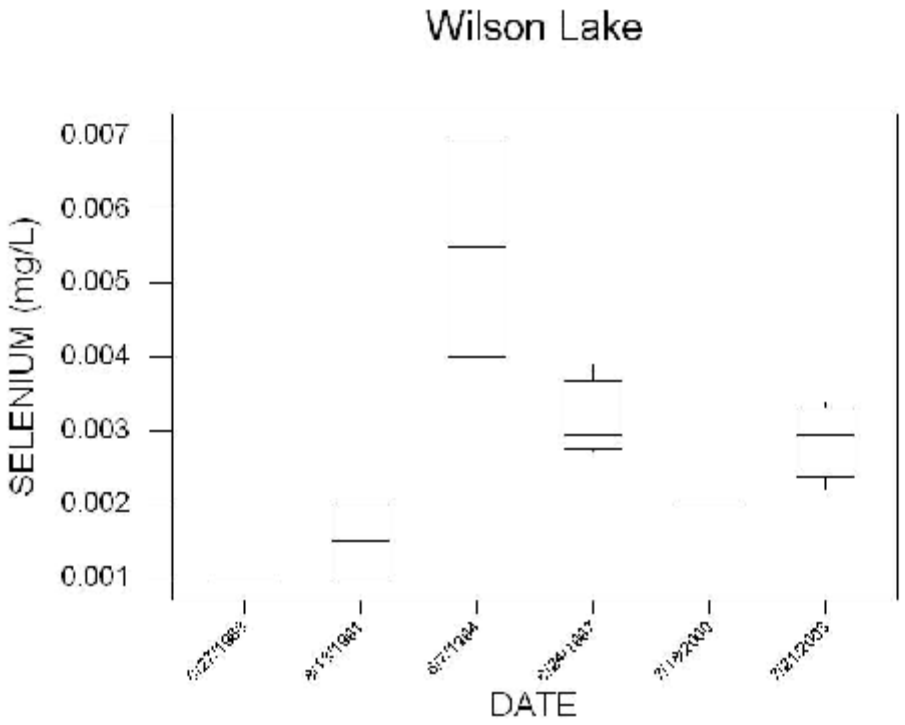
Appendix A - Boxplots



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