MISSOURI BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody: **Indian Creek**
Water Quality Impairment: Nitrate

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Lower Missouri - Crooked **County:** Johnson

HUC 8: 10300101 **HUC 11** (HUC 14s)**: 010** (040 and 050)

Ecoregion: Southeastern Temperate Forested Plains & Hills: Central Irregular Plains, Osage Cuestas (40b) & Wooded Osage Plains (40c)

Drainage Area: 64 square miles

Main Stem Segment: 32; starting at the state line and traveling upstream to headwaters in Olathe (**Figure 1**).

Tributary Segment: Tomahawk Creek (53)

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

303(d) Listings: 2004 & 2006 Kansas Section 303d Lists

Impaired Use: Expected Aquatic Life & potentially attainable Domestic Water Supply

Water Quality Standard: K.A.R. 28-16-28e(c)(2)(A). Nutrients. 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.

Nitrate (as N): 10 mg/l (K.A.R. 28-16-28e(c)(3)(A)): … the criteria listed in table 1a, as adopted in subsection (d) of this regulation, for domestic water supply use shall not be exceeded at any point of domestic water supply diversion.

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 2006 303(d): Not Supporting Existing Aquatic Life

Monitoring Sites: KDHE Station 204 near Leawood; USGS sampling stations at Tomahawk Creek at Antioch Road; Tomahawk Creek near 111th Street; Indian Creek at BlackBob Road; Indian Creek near Middle Basin WWTP; Indian Creek at 111th Street; Indian Creek near 111th Street and Indian Creek at Stateline Road in Leawood.

Period of Record Used: 1986-2006 for Station 204; 2002-2005 at USGS sampling sites.

Flow Record: Indian Creek at Overland Park (USGS Gaging Site 06893300) 1970-2007; Indian Creek at Stateline Road in Leawood (06893390) 2003-2007 [same location as Station 204].

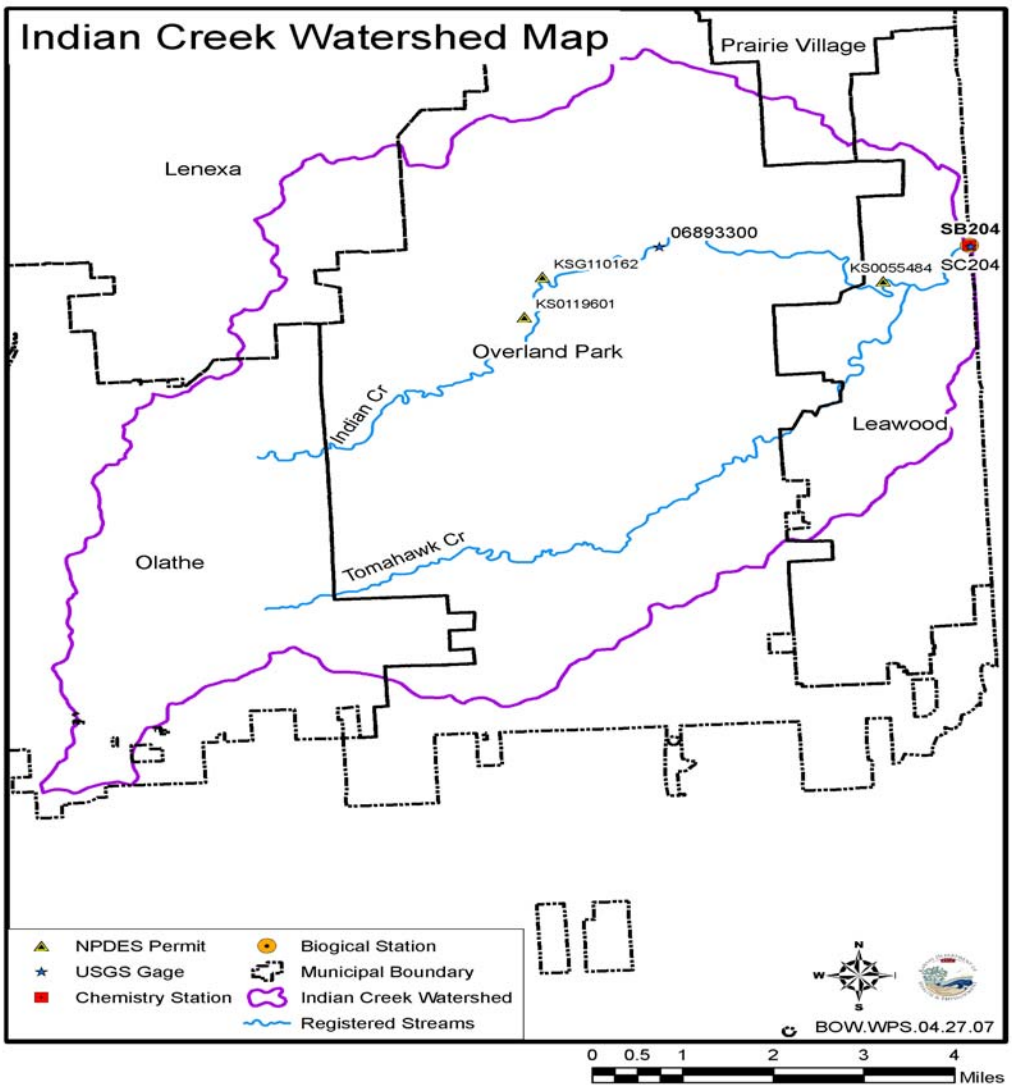
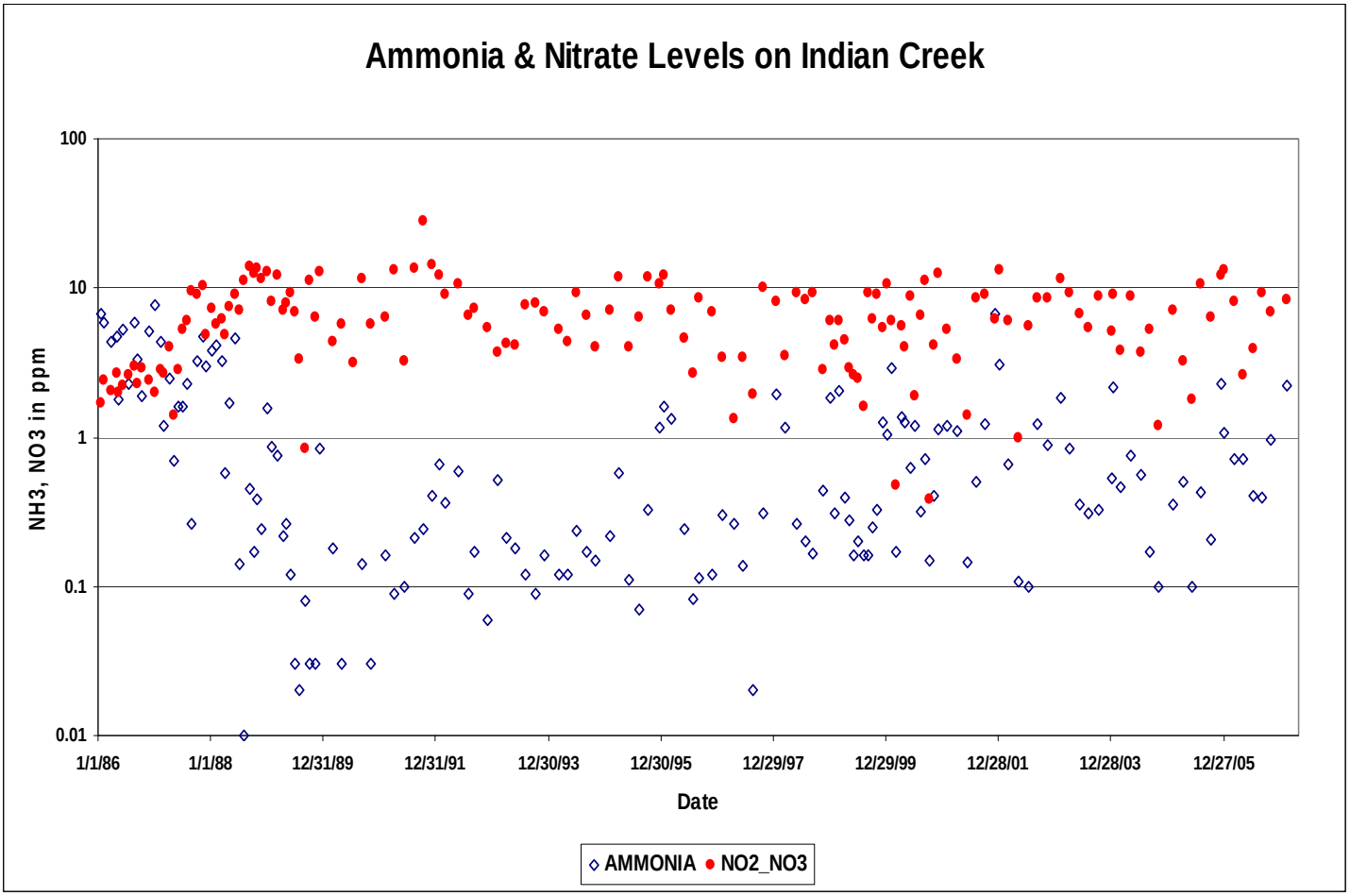


Figure 1. Indian Creek Watershed in Johnson County

Current Conditions: Ammonia and nitrate levels are elevated on Indian Creek at the stateline

(Figure 2). Table 1 displays the average concentrations of certain parameters at Station 204. Although average ammonia levels have declined when comparing recent data to the overall period of record, Figure 2 indicates that the highest ammonia levels were seen in the mid-1980's, followed by a dropoff from 1990-1996, then a gradual increase to present time. Nitrate levels have been consistently elevated throughout the period of record, although the number of samples over 10 mg/l has proportionately declined since 1996 (Table 2). The elevated ammonia, nitrate and ortho-phosphate concentrations are indicative of influences by wastewater effluent.



Period	NH3	NO3	TKN	TP	PO4	BOD	TOC	TSS
1986-2006	1.13 mg/l	6.60 mg/l	2.38 mg/l*	2.47 mg/l	1.27 mg/l	5.36 mg/l**	9.41 mg/l***	65 mg/l
2002-2006	0.80 mg/l	6.94 mg/l	2.24 mg/l	1.81 mg/l	1.27 mg/l	----------	9.22 mg/l	25 mg/l
			* 2000 – 2006			**1986 – 2001	*** 2001 – 2006	

Table 1. Average Concentrations of Water Quality Parameters at Station 204 on Indian Creek

Period	# of Hits over 10 mg/l	Total # of Samples
1986-1990	11	54
1991-1995	9	29
1996-2001	5	47
2002-2006	5	31
1986-2006	30	161

Table 2. Frequency of Exceedance of Nitrate on Indian Creek by Time Period

The USGS carried out some short-term synoptic sampling in the Indian Creek Watershed in November 2002 and July 2003. Nutrient levels in the upper portion of the watershed were moderately low, but rose substantially below the two wastewater treatment plants operated by Johnson County that discharge to Indian Creek (Table 3). The influence by wastewater can be seen in the increase in flows in Indian Creek and the high levels of nitrate and ortho-phosphate. The Tomahawk Creek wastewater plant appears to discharge higher levels of ammonia and nitrate than the upstream Middle Basin plant, although summer nitrates were higher at Middle Basin and the volume of effluent discharged by Middle Basin equates to larger nitrogen loadings from that plant. At low flows, a substantial proportion of the flow reaching the stateline comprises the discharges from the two wastewater treatment plants.

Date & Location	**Parameter (mg/l)**					
11-6-02	**NH3**	**NO3**	**TKN**	**TP**	**PO4**	**Q**
Indian – BlackBob Road	0.02	0.8	0.5	0.05	0.01	1.2 cfs
Indian abv WWTP	0.04	1.36	0.47	0.05	0.03	2.3 cfs
JoCo Indian Creek Middle Basin WWTP	0.25	12.2	1.9	3.86	3.71	15 cfs
Indian Creek at 111th Street	0.15	9.46	1.4	2.73	2.71	18 cfs
Tomahawk Creek at Antioch Road	0.04	1.81	0.36	0.05	0.04	1.9 cfs
Tomahawk Creek at 111th Street	0.04	1.32	0.53	0.05	0.03	6.2 cfs
JoCo Tomahawk Creek WWTP	2.34	10.5	6.2	4.34	3.75	7.9 cfs
Indian Creek below Tomahawk Creek	0.54	4.89	1.8	1.50	1.42	31 cfs
7-17-03	**NH3**	**NO3**	**TKN**	**TP**	**PO4**	**Q**
Indian – BlackBob Road	0.02	0.05	0.3	0.04	0.01	0.33 cfs
Indian abv WWTP	0.05	0.17	0.99	0.03	0.01	1.3 cfs
JoCo Indian Creek Middle Basin WWTP	0.3	17.9	1.8	4.19	4.02	17 cfs
Indian Creek at 111th Street	0.18	16.8	1.8	3.67	3.46	15 cfs
Tomahawk Creek at Antioch Road	0.03	0.46	0.4	0.08	0.01	0.47 cfs
Tomahawk Creek at 111th Street	0.07	0.34	0.4	0.05	0.02	1.6 cfs
JoCo Tomahawk Creek WWTP	2.8	9.1	6.3	4.49	4.31	5.9 cfs
Indian Creek below Tomahawk Creek	0.6	10.9	2.2	3.09	2.91	21 cfs
Indian Creek at Stateline	0.5	10.7	1.8	2.96	2.76	20 cfs

Table 3. USGS Synoptic Nutrient Levels Along Indian and Tomahawk Creeks

USGS also collected grab samples at the stateline during runoff events. Table 4 shows that

nitrates are not highly concentrated in stormwater, even though the loadings might be significantly higher than at low flows. Grab samples taken at low flows confirm the dominant influence of wastewater with higher concentrations of ammonia, nitrate and ortho-phosphate and lower total suspended solids.

Wet Weather Samples (mg/l)						
Flow (cfs)	**TSS**	**NH3**	**NO3**	**TKN**	**TP**	**PO4**
1380	3420	0.34	0.66	8.0	2.72	0.06
1750	696	0.40	2.19	2.6	1.27	0.38
5170	750	0.20	1.53	1.5	0.64	0.17
5290	3530	0.17	0.69	5.9	2.18	0.10
519	221	0.20	2.16	2.5	1.02	0.50
264	54	0.30	4.33	1.8	0.98	0.75
872	158	0.30	1.38	1.8	0.62	0.24
1640	1140	0.06	0.54	0.45	0.12	0.10
6870	960	0.30	0.43	2.5	0.86	0.15
146	67	0.20	2.12	1.7	0.64	0.42
2370	1170	0.20	0.94	2.6	1.01	0.16
1110	854	0.20	0.78	2.7	0.93	0.10
1120	573	0.20	0.80	1.9	0.72	0.12
9830	1140	0.15	0.63	2.5	1.04	0.10
1130	286	0.06	1.12	1.6	0.50	0.18
1710	312	0.20	1.10	1.2	0.57	0.19
Averages						
2575	958	0.22	1.34	2.6	0.99	0.23
Dry Weather Samples (mg/l)						
Flow (cfs)	**TSS**	**NH3**	**NO3**	**TKN**	**TP**	**PO4**
20	7	0.5	10.7	1.8	2.96	2.76
38	11	0.8	4.48	1.8	1.33	1.22
27	6	0.2	5.18	1.7	1.02	0.91
30	4	1.27	8.44	2.4	2.24	1.80
37		0.38	5.49	1.4	1.36	1.18
74		0.85	4.44	1.7	0.61	0.56
84	21	1.00	3.49	2.9	0.92	0.77
14	2	0.04	7.46	0.89	1.41	1.40
Averages						
41	8.5	0.63	6.21	1.8	1.48	1.33

Table 4. Wet and Dry Grab Samples from Indian Creek at Stateline (2003-2005)

These data insinuate that the excessive nitrate concentrations are prevalent as a low flow problem and directly result from wastewater discharges. The flow duration curves during the period since 2003 when both USGS stream gages were operating on Indian Creek indicate a consistent increase in flow at the downstream stateline gage (Figure 3). By regressing recent

flows at the upstream gage to those at the stateline, a strong relationship develops between the two gages (log stateline = 1.06*log upstream + 0.208; $R^2 = 0.994$). Under most conditions, the increase in flows is a result of wastewater discharges from the Indian Creek Middle Basin and Tomahawk Creek Wastewater Treatment Plants. The Middle Creek plant is located upstream of the USGS Overland Park gage and the Tomahawk Creek Plant discharges to Indian Creek above the confluence with Tomahawk Creek. Flow records from the 1970's indicate Tomahawk Creek itself contributes little flow to Indian Creek (Figure 4).

In order to project future flows on Indian Creek, the regression was applied to the long-term record from the Overland Park gage. An estimate of stream gains between the Overland Park and Stateline gages was then made and the amount of those gains coming from wastewater discharges from the two treatment plants was estimated. Then the wastewater discharges were inflated to the design flows of the two plants (14.5 MGD [22.4 cfs] from Middle Basin; 10 MGD [15.6 cfs] from Tomahawk Creek). Finally, an estimated future flow was determined at the Overland Park gage (upstream Indian Creek flows plus Middle Creek plant discharge) and at the Stateline (resulting Overland Park flow plus Tomahawk Creek plant discharge plus downstream gains). The resulting hydrographs indicate a stream dominated by wastewater discharges until runoff conditions become prevalent (Figure 5). Flows exceeded over 40 percent of the time are composed chiefly of wastewater in the future.

Table 5 indicates the relative contributions of estimated flow on the three segments comprising the Indian Creek Watershed. Similar as what was seen in Figure 4, Tomahawk Creek does not contribute much water during low flows, although it can produce up to 40% of flow during a two-year flood event. The Indian Creek watershed does not generate much flow during dry periods, either, but is buttressed by the discharges of the two wastewater treatment plants.

Stream Segment	Drainage Area	Mean Flow	90th	75th	50th	25th	10th	2-yr flood
Indian Creek above Tomahawk Creek	27.5 sq. miles	34.6 cfs	1.3 cfs	4.7 cfs	13 cfs	22 cfs	56 cfs	4060 cfs
Tomahawk Creek	25.2 sq. miles	25.2 cfs	0.0 cfs	0.24 cfs	3.0 cfs	10.6 cfs	30 cfs	2630 cfs
Indian Creek below Tomahawk Creek	54.6 sq. miles	55.7 cfs	1.3 cfs	5.4 cfs	15.8 cfs	32.1 cfs	87 cfs	6680 cfs

Table 5. Estimated Flow Characteristics for Segments in the Indian Creek Watershed

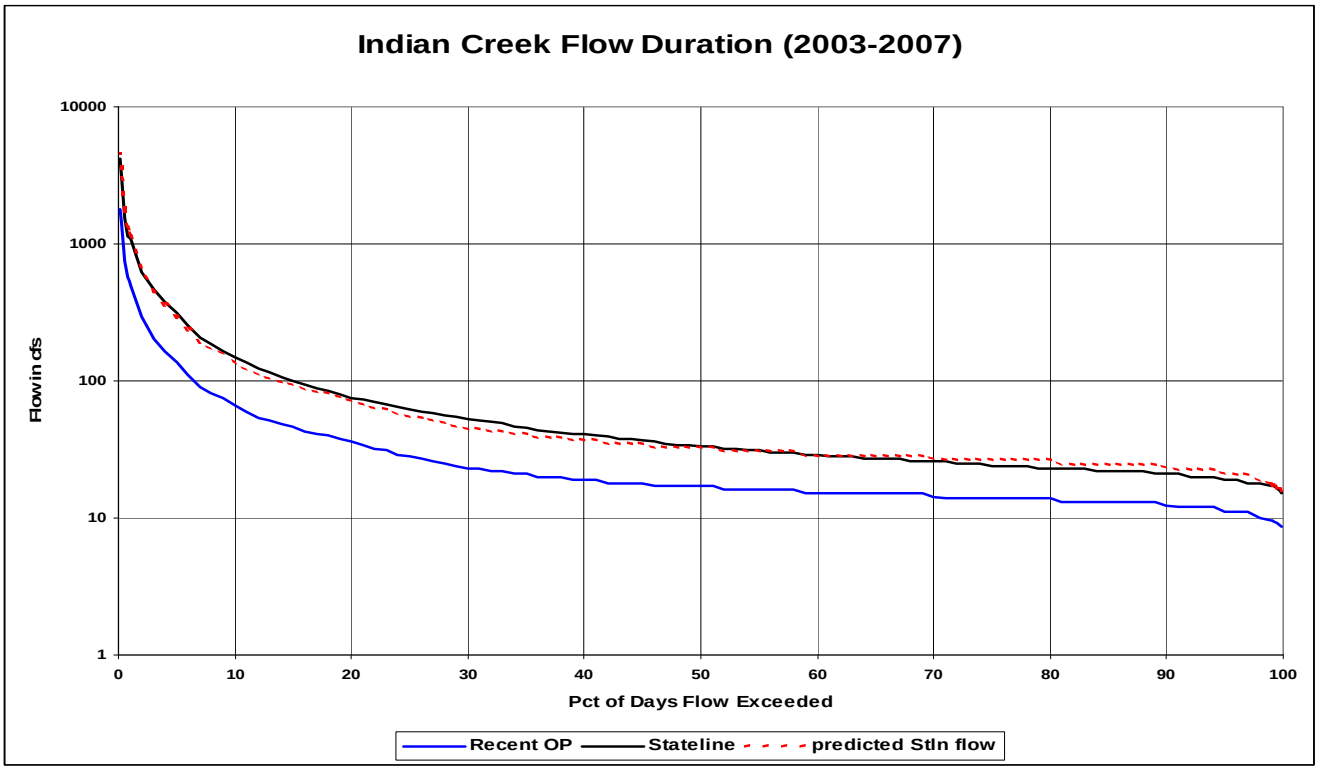


Figure 3. Recent Flow Conditions on Indian Creek in Overland Park and the Stateline

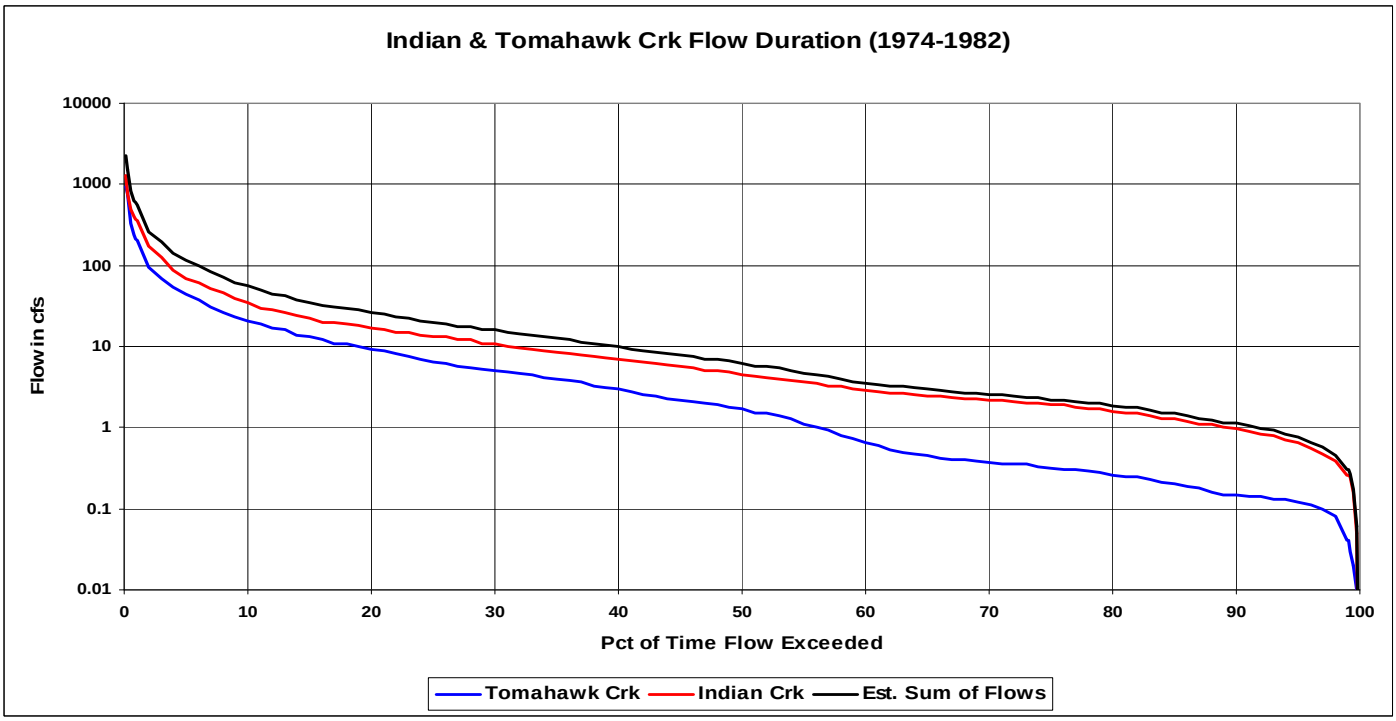


Figure 4. Relationship of Flow Conditions on Indian Creek and Tomahawk Creek

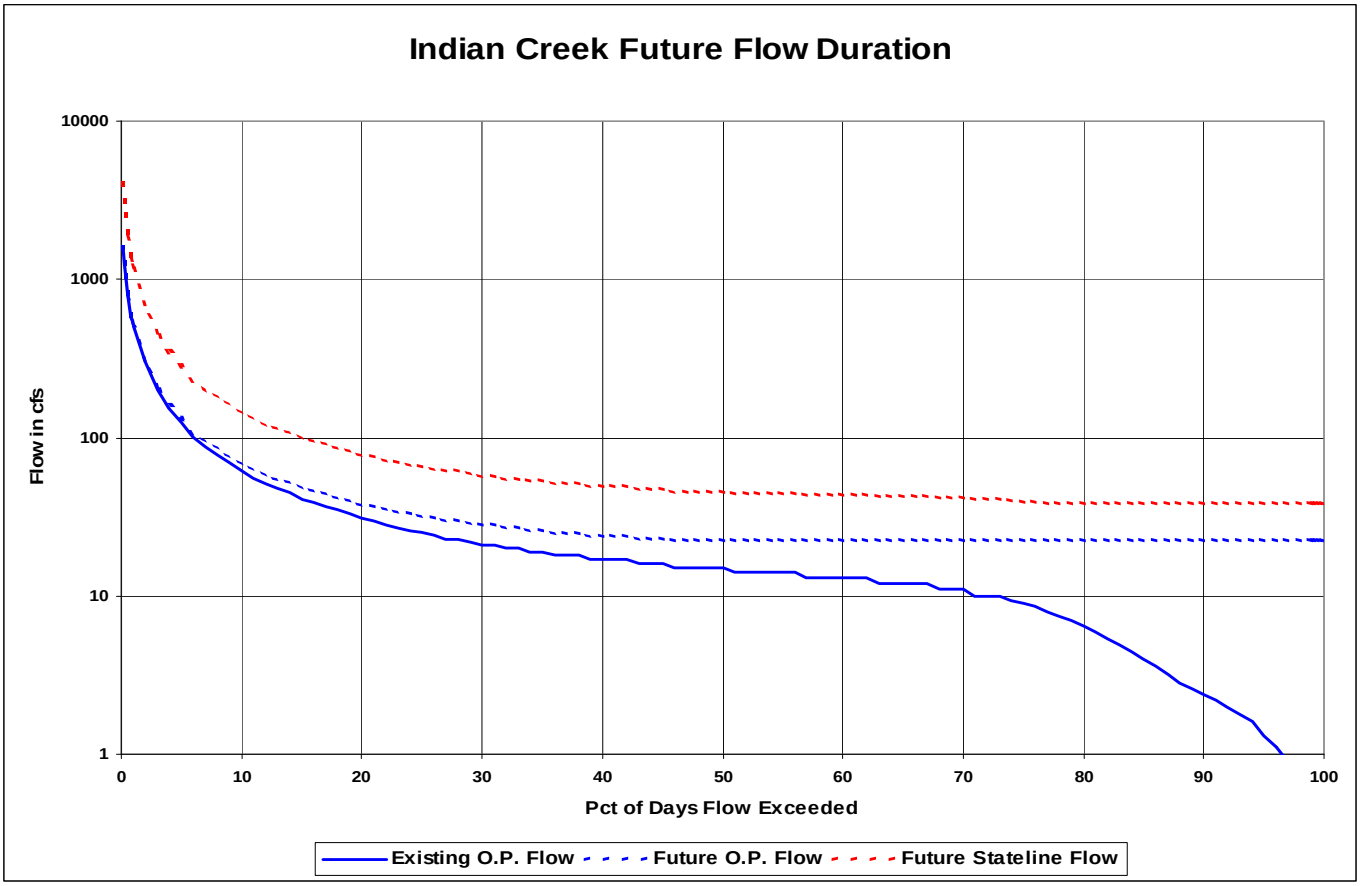


Figure 5. Projected Future Flows on Indian Creek at Overland Park and the Stateline

Nitrate concentrations respond to flow condition as well. Figure 6 shows the relationship between nitrate and streamflows on Indian Creek at Stateline. There is a marked decrease in nitrate concentrations once flows rise above 30 cfs. There are no exceedances above 10 mg/l above 45 cfs. Figure 7 displays the same concentrations as a function of flow exceedance. The lower flows, indicated by flow percentiles of 50% or greater, have a majority of the nitrate exceedances. Only four exceedances occur at flows exceeded less than 50% of the time. On this stream system, a majority of the flows seen in the creek comprise wastewater discharges. Only when runoff events occur in response to rainfall do nitrate concentrations become depressed.

Nitrate does not appear to have any significant response to temperature, although more exceedances occur at colder water temperatures (Figure 8). Because wastewater is the primary source of nitrate in the stream and point source discharges are constant, regardless of season, elevated nitrate concentrations might be seen at any temperature. The preponderance of elevated nitrate at lower temperatures is likely indicative of retarded biological processes unable to fully assimilate nitrate. Relations between nitrate and total suspended solids are similar as nitrate-flow relations (Figure 9). Since TSS levels rise with runoff and the propensity to transport sediment, an inverse relationship exists between TSS and nitrate, mirroring the relationship between runoff and nitrate.

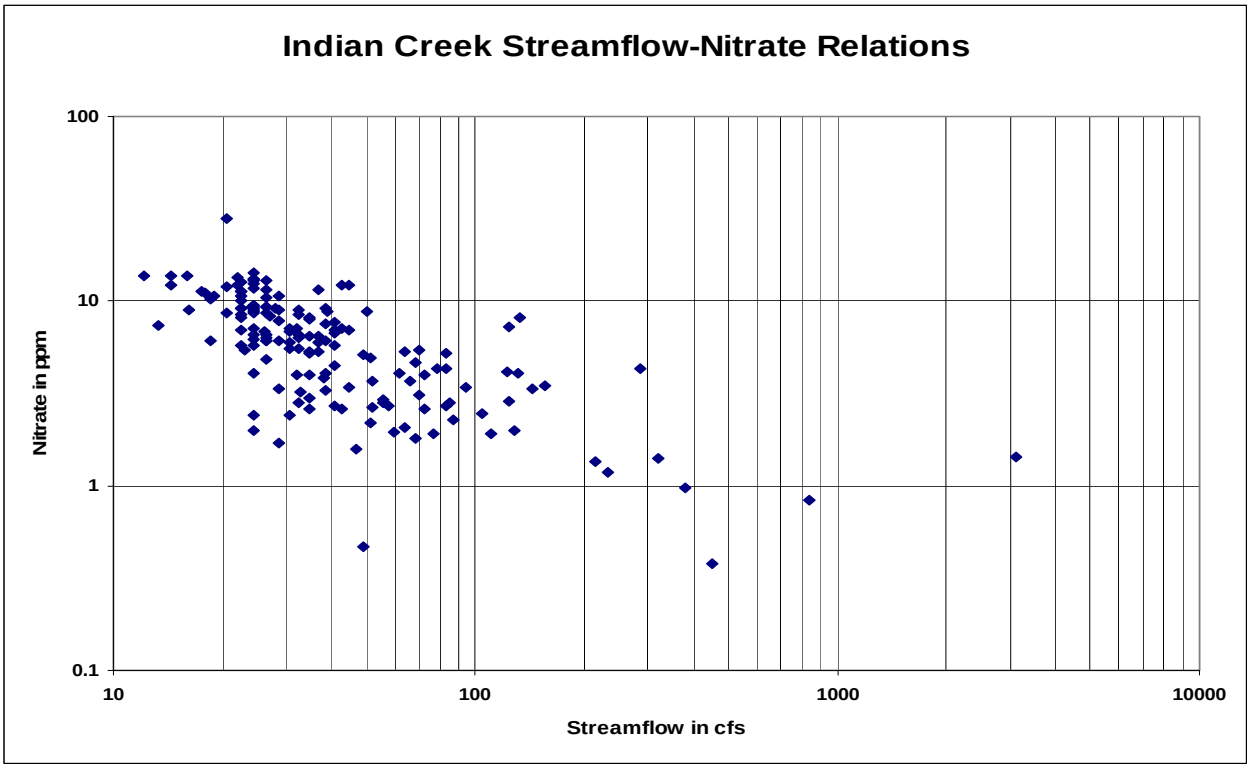


Figure 6. Nitrate and Flow Conditions on Indian Creek at the Stateline.

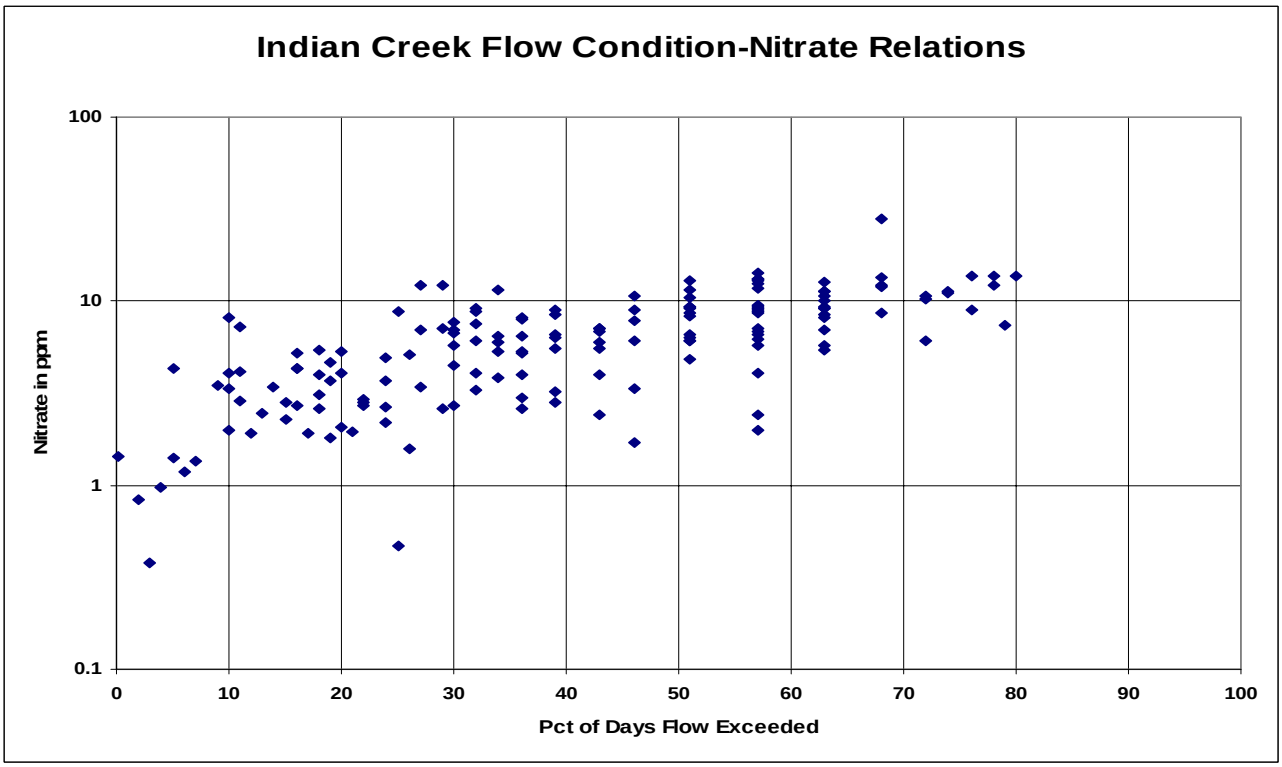


Figure 7. Nitrate Concentrations on Indian Creek at the Stateline at Given Flow Percentiles

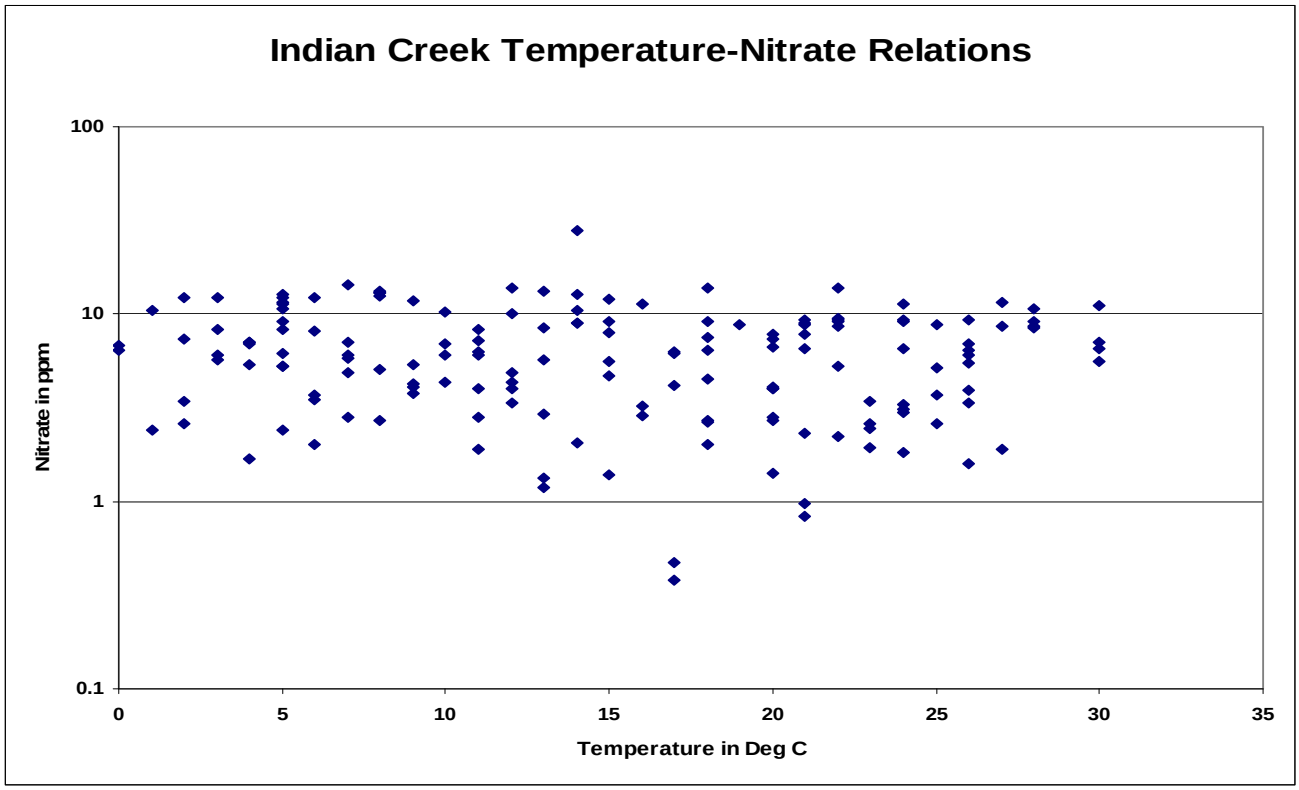


Figure 8. Water Temperature and Nitrate Concentrations on Indian Creek at the Stateline

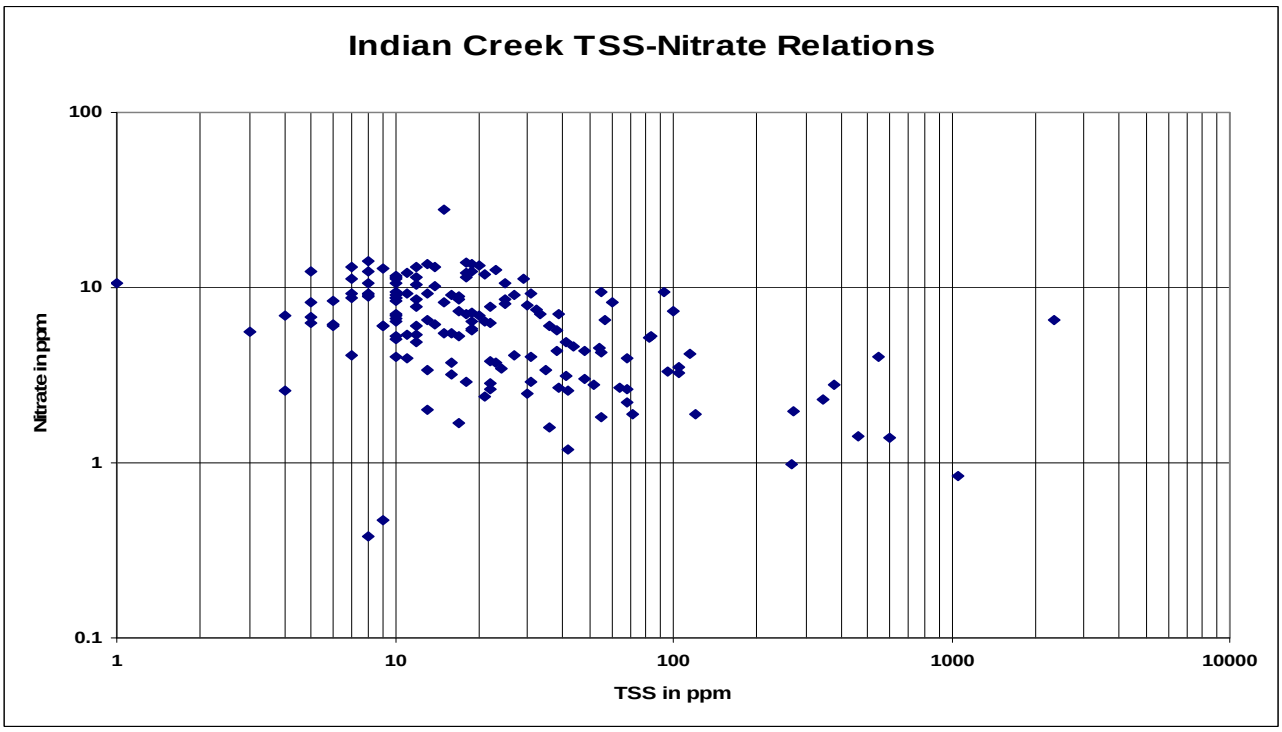


Figure 9. Total Suspended Solids and Nitrates on Indian Creek at the Stateline

Monthly averages of nitrate concentration show a marked seasonality, with elevated nitrate appearing during the colder winter months when biological activities are minimal (Figure 10). Averages in each month have not varied significantly since 1985, indicating that there has been little change in the wastewater content influencing Indian Creek nitrate levels.

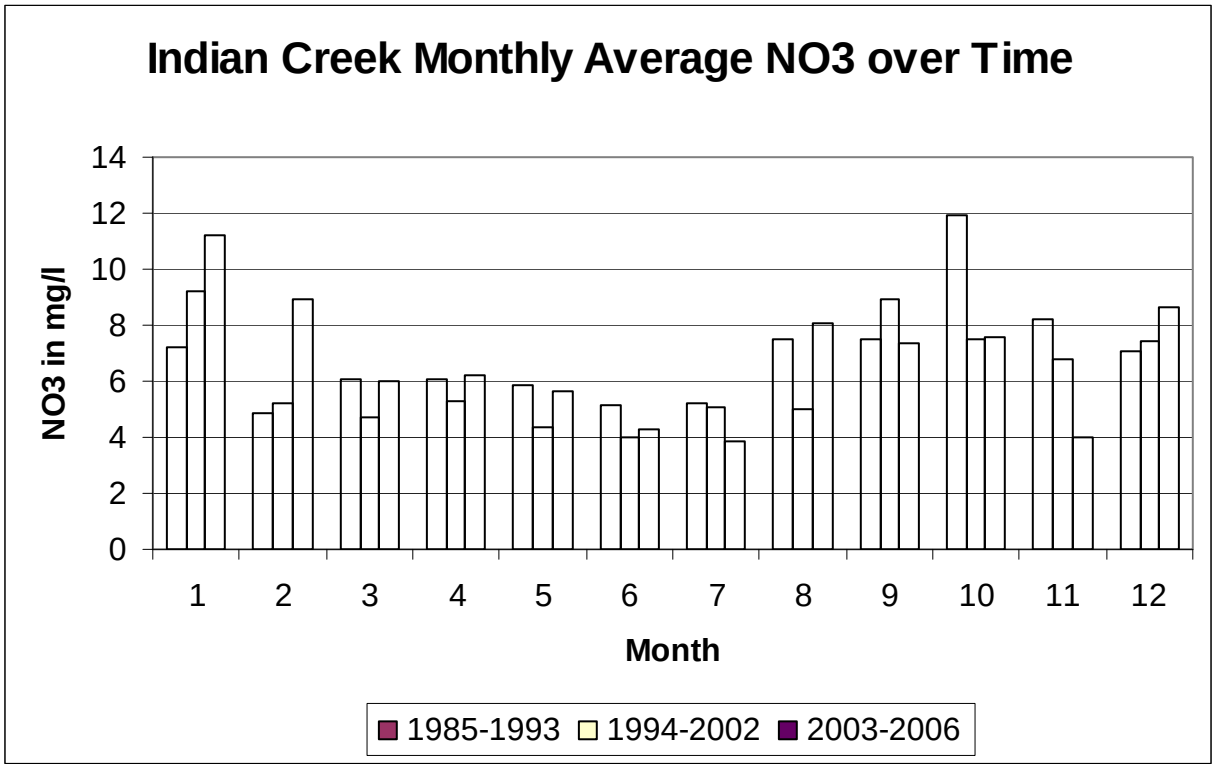


Figure 10. Monthly Average Nitrate Levels on Indian Creek in Three Distinct Time Periods

Biological samples taken by KDHE in the 1980's indicate poor biotic communities, probably reflecting the toxic nature of wastewater comprising the majority of flow in Indian Creek at the time (Table 6). MBI scores over 5.4 are indicative of conditions that do not support aquatic life. Similarly, the KBI values (>3) are reported in terms of nutrient oxygen demand and are indicative of tolerant species. A small number of the species sampled came from the Ephermeroptera, Plecoptera and Trichoptera orders that demarcate high quality water. The proportion of species found that was EPT was generally under 20%.

More recent sampling by USGS confirmed a general state of non-support for biology as indicated by the macroinvertebrate community and diversity (Table 7). These sampling occurred on Indian Creek at three locations in 2003, all influenced by wastewater or urban stormwater.

Date	MBI	KBI-NO	EPT Index	EPT % Spp.
1980	6.28	3.32	5	20
1981	8.31	4.17	0	0
1982	6.37	3.27	4	23
1983	9.05	4.48	1	0
1984	6.07	3.50	2	14
1985	6.74	3.51	2	4
1986	8.89	4.32	3	5
1987	7.93	3.93	1	1
1988	5.89	3.24	3	17
1989	5.74	3.07	3	7
1990	5.34	2.95	3	31

Table 6. Biologic Indices for Macroinvertebrates Sampled by KDHE on Indian Creek.

Location	MBI	KBI	EPT Index
Indian Creek at Highway 69	6.18	2.70	5
Indian Creek at College Blvd	7.17	2.79	2
Indian Creek at State Line	7.68	3.76	1

Table 7. Biologic Indices for Macroinvertebrates Sampled by USGS in 2003 on Indian Creek.

Desired Endpoint of Water Quality at Indian Creek:

The short-term endpoint for this TMDL will be to reduce nitrate levels below 10 mg/l and fully support any attainable Domestic Water Supply use on Indian Creek in the future. The long-term endpoint will be to reduce the total nitrogen loads, in accordance with the Kansas Surface Water Nutrient Reduction Plan through installation of Biological Nutrient Removal technology. The long-tem endpoint will result in a downstream nitrate concentration below the criterion and contribute to restoring the biological integrity of Indian Creek. Seasonal variation is accounted for by this TMDL, since the TMDL endpoint is sensitive to stream flow with the higher flow usually occurring in the spring and lower flows in the summer/fall and winter seasons. To reach this endpoint, this TMDL will concern itself with reducing nitrogen loads from wastewater sources in the watershed for the critical flow of concern.

3. SOURCE INVENTORY AND ASSESSMENT

NPDES: There are three NPDES permitted wastewater dischargers along Indian Creek (**Figure 11**). These systems are described in Table 8.

FACILITY	NPDES #	KS PERMIT #	DESIGN FLOW	TYPE
Indian Cr Middle Basin MWTP	KS0119601	M-MO28-OO01	12 MGD	Activated Sludge w/ Aerated Lagoon
Tomahawk Cr MSD No. 1 MWTP	KS0055484	M-MO27-OO01	10 MGD	Trickling Filter w/ Peak Flow Lagoon
Clarkson Construction	KSG110162	I-MO28-PR01	N/A	Stormwater / washout Basin

Table 8. NPDES Permits in the Indian Creek Watershed

The Middle Basin facility discharges near its design flow, typically. The aerated lagoon is to be used only when flows through the mechanical plant exceed 15 MGD during wet weather. At times, raw sewage may be diverted to the Blue River Wastewater Treatment Facility in Missouri via Kansas City, Missouri's Interceptor Line. Middle Basin effluent is monitored for nutrients and ammonia limits are imposed. Ammonia is also monitored above and below the plant outfall. Facility upgrades are under construction currently, which will add nutrient removal (biological for TN; chemical for TP). Nutrient goals of 8 mg/l TN and 1.5 mg/l TP as annual averages are incorporated within the existing and future permit. The upgraded facility will expand its capacity to 14.5 MGD and will direct wet weather flows through activated sludge treatment train, rather than direct these flows to the aerated lagoon. Raw sewage will be diverted to the aerated lagoon only when flows through the upgraded and expanded mechanical plant exceed 23 MGD during wet weather, thereby reducing the pollutant load to Indian Creek. The current NPDES permit expires December 31, 2009, coinciding with the completion of upgrade construction.

The Tomahawk Creek facility actually discharges to Indian Creek. It also requires monitoring of its effluent for nutrient content, has ammonia limits and monitors conditions above and below the outfall. An aerated lagoon captures excessive flows once the capacity of the plant and interceptor connection to Missouri's Blue River WTF is reached. Under the permit's Schedule of Compliance, Johnson County is to conduct a study to assess the feasibility of upgrading the facility to meet the 8/1.5 average annual goals for nitrogen and phosphorus by October 2008. The permit expires December 31, 2009.

Nutrient content of the wastewater from both plants are presented in Table 9. High nitrate levels are consistently seen from Middle Basin, while nitrate averages were somewhat less at Tomahawk Creek, but still occasionally above 10 mg/l. Tomahawk Creek plant does not treat ammonia as readily as the Middle Basin plant, so it is likely less nitrate is produced in the nitrification process.

Clarkson Construction is a portable central ready-mix plant. Wastewater is generated from the washing of the mixer drums and trucks. Wash water is collected in a clay-lined basin along with stormwater runoff. No discharge is expected from the basin, except during heavy rains, which are not conducive to nitrate exceedances. The general permit expires September 30, 2007.

NPDES MS4 Stormwater permits are in place for Olathe (KSR041025, M-KS52-SU01, expires September 30, 2009); Overland Park (KSR041026, M-MO28-SU01, expires September 30, 2009); Leawood (KSR041015, M-MO27-SU01, expires September 30, 2009); Lenexa (KSR041016, M-KS34-SU01, expires September 30, 2009); Prairie Village (KSR041028, M-MO38-SU01, expires September 30, 2009); and Johnson County (KSR041007, M-KS52-SU02, expires September 30, 2009). These permits would be required to put in place appropriate Best Management Practices to address High Priority TMDLs such as this one. However, the nitrate exceedances are associated with low flows and traditional wastewater. Hence, stormwater and the permits intended to control it are not directed to implement this TMDL.

Statistic	**Ammonia**	**Nitrate**	**Nitrite**	**TKN**	**Total Phosphorus**
Middle Basin					
Mean	0.54 mg/l	13.12 mg/l	0.37 mg/l	2.24 mg/l	3.31 mg/l
Median	0.20 mg/l	13.22 mg/l	0.18 mg/l	1.90 mg/l	3.46 mg/l
Maximum	15.0 mg/l	19.69 mg/l	3.08 mg/l	13.0 mg/l	6.33 mg/l
Tomahawk Creek					
Mean	3.17 mg/l	8.32 mg/l	0.25 mg/l	7.13 mg/l	4.08 mg/l
Median	2.90 mg/l	8.10 mg/l	0.19 mg/l	7.00 mg/l	4.15 mg/l
Maximum	8.50 mg/l	14.66 mg/l	2.26 mg/l	16.2 mg/l	5.94 mg/l

Table 9. Nutrient Content of Wastewater Discharged by Johnson County Treatment Plants

Livestock Waste Management Systems: There are no livestock waste management operations registered, certified or permitted within the watershed.

Land Use: Most of the watershed is located within the city limits of Leawood, Lenexa, Olathe, Overland Park and Prairie Village. Based on land use data compiled by USGS (2005), most of the watershed is residential, commercial and industrial (76-78%); 5-9% is undeveloped land, typically agricultural and 4-5% of the land is green space (parks and right-of-ways). Impervious cover lies over 27% of the Indian Creek drainage and 19% of the Tomahawk Creek drainage. A majority of the agriculture land is located in the headwaters of Tomahawk Creek (Figure 11).

On-Site Waste Systems: USGS information obtained from Johnson County indicates an on-site waste system density of 1.1 systems per square mile of drainage for Indian Creek. Given the high percentage of development, most of that drainage would be tied into sanitary sewers. A higher density is seen along Tomahawk Creek (13.8 systems per sq. mi.), probably reflective of the undeveloped land along the southern boundary of the drainage and in the headwater region.

Contributing Runoff: The Indian Creek watershed's average soil permeability is 0.8 inches/hour according to NRCS STATSGO database. One hundred percent of the watershed produces runoff even under relatively low (1.71"/hr) potential runoff conditions. Under very low (1.14"/hr) potential conditions, this potential contributing area is reduced by about a third (65%). Runoff is chiefly generated as infiltration excess with rainfall intensities greater than soil permeability. As the watersheds' soil profiles become saturated, excess overland flow is

produced. Generally, storms producing less than 0.57"/hr of rain will generate runoff from 50% of this watershed

Background Levels: Since most of the watershed is developed, natural levels of nitrate might be difficult to ascertain. However, the USGS synoptic data in Table 3 indicate low nitrate levels in the upper reaches of Indian and Tomahawk Creeks. Winter concentrations on Indian Creek ranged from 0.8 to 1.36 mg/l, while summer concentrations of 0.05 – 0.17 mg/l were seen. Winter concentrations in upper Tomahawk Creek ranged from 1.32 – 1.81 mg/l and summer levels were 0.34 – 0.46 mg/l. Wintertime biological processes are depressed relative to summer conditions and that may explain the larger nitrate concentrations. High concentrations in Tomahawk Creek might be influenced by agricultural activities in the upper watershed. Nonetheless, levels below 0.5 mg/l in summer and 2 mg/l in winter might be expected, absent the influence of wastewater treatment plants.

4. ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

The nature of the nitrate exceedances which tend to be predominantly low flow events, where municipal wastewater has a predominant influence (Figure 6), places the emphasis of this TMDL and its allocations on controls on point sources through wasteload allocations. Given the expansion of wastewater volumes in the future, which will dictate flow conditions, except during runoff events, improvements in wastewater treatment and nutrient removal will result in lower nitrate levels seen on Indian Creek at the Stateline. The TMDL Load Capacity will be delineated as the product of flow and the nitrate water quality criterion (10 mg/l) as displayed in Figure 12.

Point Sources: The Wasteload Allocations for the two wastewater facilities are established as the product of their anticipated design flow and a nitrate concentration of 8 mg/l. This allocation anticipates that upgrades to treatment processes involving de-nitrification will achieve the Kansas goals of annual averages of Total Nitrogen of 8 mg/l. The conservative assumption is that nitrate comprises all the nitrogen discharged by the Middle Basin and Tomahawk Creek plants. While nitrate may be the dominant form of nitrogen in the wastewater discharged by upgraded facilities, it is not the only species present. Up to 2 mg/l will be Total Kjeldahl Nitrogen (Organic N & ammonia), therefore, actual nitrate loads should be below the anticipated wasteload allocations.

As seen in Figure 12, Wasteload Allocations comprise the majority of the loading capacity on Indian Creek. Since a majority of stateline flow is wastewater except during runoff events, this result is expected. Table 10 gives the Wasteload Allocations for the Middle Basin and Tomahawk Creek facilities.

While the nitrate impairment is not stormwater related, a Wasteload Allocation for the MS4 permits was computed as the proportional difference between the wastewater WLA and the Loading Capacity (less the Margin of Safety). 88.5% of the watershed is assumed to be developed land subject to the MS4 NPDES permits held by Johnson County and the municipalities lying in the Indian Creek drainage. As seen in Figure 12 and Table 10, the MS4 WLA is zero or low at low flows exceeded 75% of the time or more. Stormwater wasteloads do

not make up much of the TMDL until flow conditions exceed median flow. At median flow, 14% of the TMDL is MS4 WLA. That proportion rises to 37% at the upper quartile (25%) flow and makes up the majority of the TMDL (65%) at the upper decile (10%) flow.

Non-Point Sources: Based on the assessment of sources, the distribution of excursions from water quality standards and the relationship of those excursions to runoff conditions, non-point sources are not seen as a significant cause of water quality violations. Background levels are well below the nitrate criterion. With the degree of development in the watershed, typical non-point sources are displaced by urban-oriented runoff activities. Therefore, the Load Allocation is small, and is computed as the proportion of undeveloped and agricultural land in the watershed (11.5%), potentially generating runoff. The Load Allocation values are listed in Table 10 and the Load Allocation is represented in Figure 12 as the area lying between the MS4 WLA line and the Margin of Safety line.

Defined Margin of Safety: The Margin of Safety is explicitly computed as the load resulting from the flow present in Indian Creek and 2 mg/l nitrate. That concentration of nitrate represents the difference between the existing water quality criterion for nitrate and the expected maximum level of nitrate (8 mg/l) to be discharged by the wastewater facilities after upgrades to incorporate de-nitrification in the treatment process.. The resulting allocation (410 #/d) is seen in Figure 12 as the area immediately below the total Load Capacity Curve of the TMDL. Additionally, the Margin of Safety is implicit since no surface water diversions for domestic water supply exist along Indian Creek.

State Water Plan Implementation Priority: In concert with the state's efforts to reduce nutrient loadings to surface waters, this TMDL will be a High Priority for implementation.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Lower Missouri-Crooked Subbasin (10300101) with a priority of 32 (Medium Priority for restoration work).

Priority HUC 11s and Stream Segments: Priority should be directed toward installing de-nitrification treatment on the two wastewater treatment plants along Segment 32 of Indian Creek.

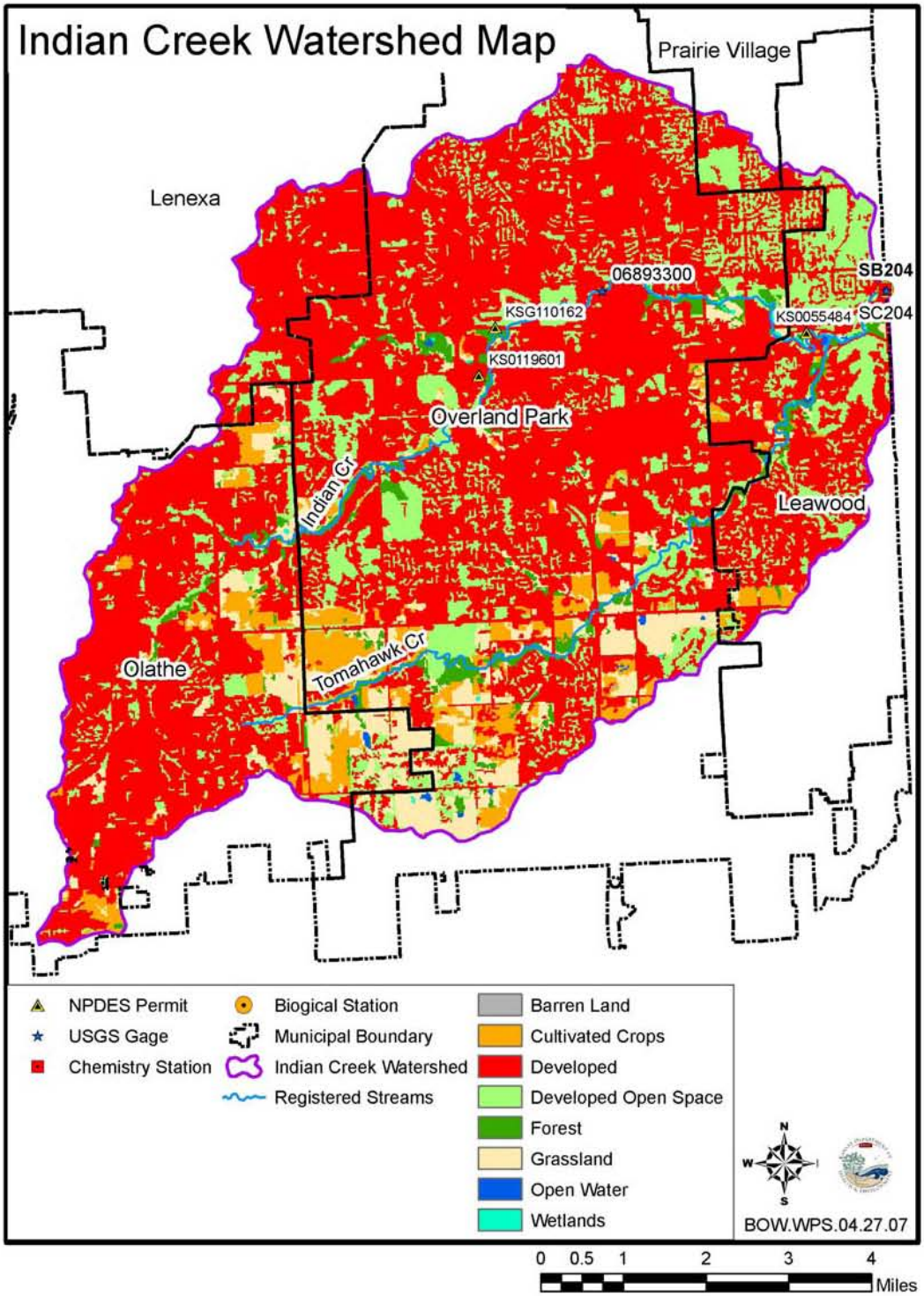


Figure 11. Land Use in the Indian and Tomahawk Creek Watershed

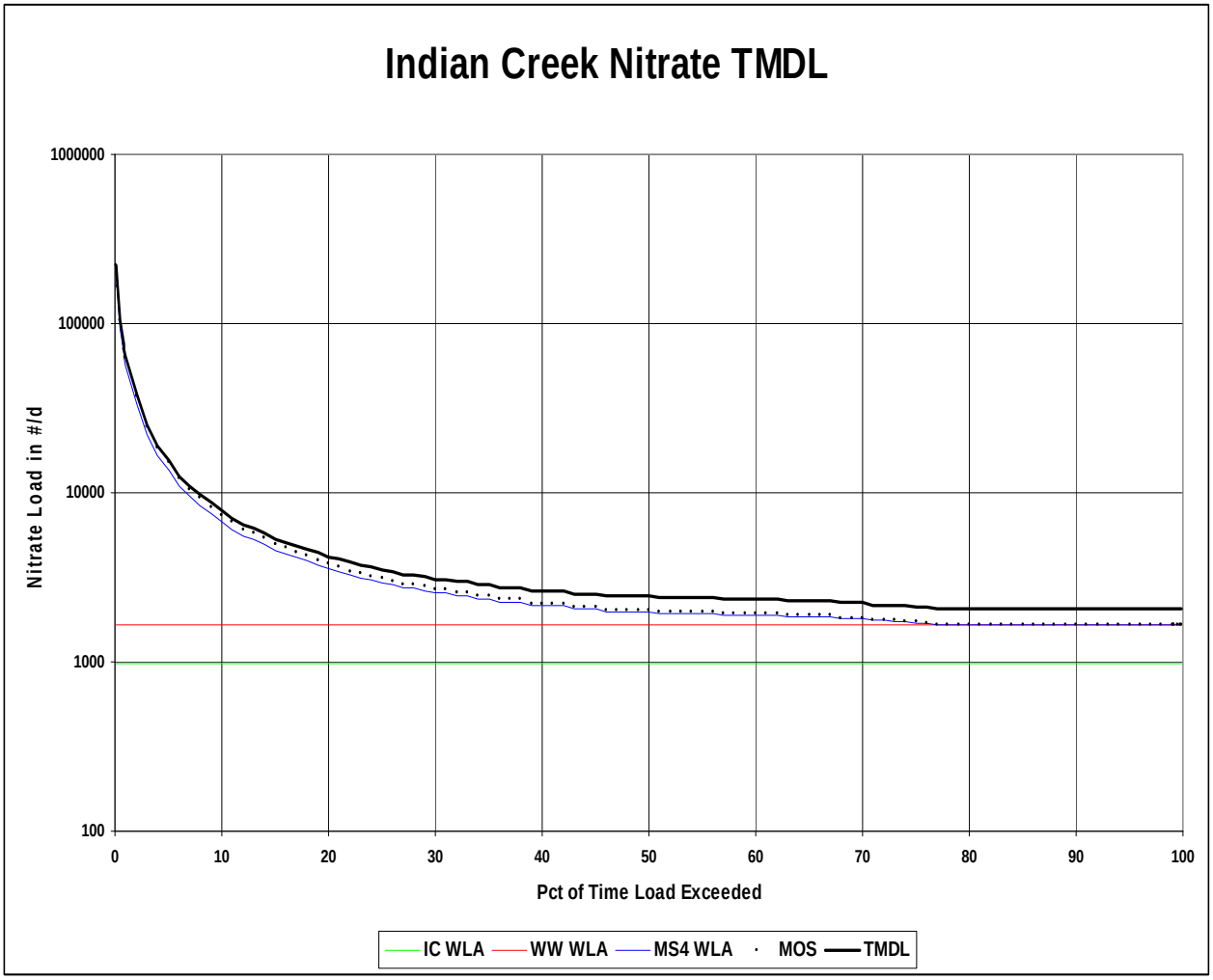


Figure 12. Nitrate TMDL for Indian Creek

Flow Condition	Middle Basin WLA	Tomahawk Crk WLA	MS4 WLA	LA	MOS	TMDL
Low – 90%	968 #/d	674 #/d	0 #/d	0 #/d	410 #/d	2052 #/d
Dry – 75%	968 #/d	674 #/d	66 #/d	8 #/d	410 #/d	2126 #/d
Normal – 50%	968 #/d	674 #/d	348 #/d	45 #/d	410 #/d	2445 #/d
Wet – 25%	968 #/d	674 #/d	1298 #/d	169 #/d	410 #/d	3519 #/d
High – 10%	968 #/d	674 #/d	5085 #/d	661 #/d	410 #/d	7798 #/d

Table 10. Nitrate TMDL and Allocations for Indian Creek

5. IMPLEMENTATION

Desired Implementation Activities

1. Maintain necessary state and federal permits and inspect permitted facilities for permit compliance.
2. Install necessary nutrient reduction treatment technology at wastewater plants
3. Maintain riparian areas along the stream.
4. Insure proper on-site waste system operations in proximity to Indian Creek

Implementation Programs Guidance

NPDES and State Permits - KDHE

a. Municipal permits for facilities along Indian Creek will be renewed after 2009 with on-going schedules of compliance to upgrade treatment process to remove nutrients, effluent nutrient goals will not be expected until such time as treatment upgrades are operating.

b. Municipal permits for facilities will continue to monitor upstream conditions and include nutrients as part of the monitoring suite of parameters.

Stormwater Management - KDHE

a. Review and support urban stormwater management permits and plans, including data collection efforts and measures to maintain riparian areas of streams.

Non-Point Source Pollution Technical Assistance - KDHE

a. Provide technical assistance on riparian management in urban areas and development of vegetated buffer strips.

b. Assist evaluation management of stormwater quality from urbanizing areas of watershed.

Riparian Protection Program - SCC

a. Develop urban riparian restoration projects

b. Coordinate with Public Works Departments to evaluate riparian conditions.

Buffer Initiative Program - SCC

a. Install grass buffer strips near streams

Local Environmental Protection Program - KDHE

a. Inspect any on-site waste systems within one mile of Indian and Tomahawk Creeks.

Timeframe for Implementation: Upgraded treatment technology should be complete on the Middle Basin facility by November 2009. A small remedial compliance project is underway at

the Tomahawk Creek facility that should be completed by October 2008. By October 2008 a feasibility study for upgrading the Tomahawk Creek facility will be completed and KDHE will receive the results by December 2008. Upgrades to Tomahawk Creek will likely be completed near 2015.

Targeted Participants: Primary participants for implementation will be the Johnson County Unified Wastewater Districts. Some riparian management may occur through the stormwater programs of the municipal and Johnson County Public Works Departments.

Milestone for 2012: The year 2012 marks the mid-point of the ten-year implementation window for the watershed. At that point in time, nutrient levels in the effluent from the Middle Basin facility will be substantially reduced. Progress in upgrading the Tomahawk Creek Plant should be underway at this point in time. Additionally, sampled data from the monitoring station should indicate evidence of reduced nitrate levels during dry weather flow conditions over 2010-2012.

Delivery Agents: The primary delivery agents for program participation will be the Johnson County Wastewater and Stormwater Programs. Local Environmental Protection Program personnel for Johnson County will perform on-site waste system inspections.

Reasonable Assurances

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

1. K.S.A. 65-164 and 165 empowers the Secretary of KDHE to regulate the discharge of sewage into the waters of the state.

2. 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.

3. 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.

4. 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.

5. 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.

6. 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.

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

8. The *Kansas Water Plan* and the Missouri 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 Revolving Loan Fund is operated through the Municipal Program at KDHE and provides low interest loans for wastewater treatment improvement. Since its inception, $128 million in loans have been made to municipal dischargers in the state. The Non-Point Source Pollution Control Fund of the state Conservation Commission distributes $2.8 million annually to the 105 Conservation Districts to implement non-point source abatement practices, including repair and replacement of faculty septic systems and riparian area improvement.

Effectiveness: Denitrification techniques with mechanical treatment plants have been very effective in reducing nitrate concentrations in wastewater effluent. Likewise, biological nutrient removal has also been proved to be effective in reducing nitrogen and phosphorus concentrations in effluent at a number of treatment plants.

MONITORING

KDHE will continue to collect bimonthly samples over 2008-2013 at monitoring Station 204 in order to assess the nitrate levels under this TMDL. Based on these samplings, the status of impairment will be evaluated in 2012 and 2014. Should impaired status continue, sampling in 2014-2016 will be used to assess the status of Indian Creek after any upgrades at the Tomahawk Creek facility are complete.

7. FEEDBACK

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

Public Hearing: A Public Hearing on the TMDL for Indian Creek was held in Overland Park in City Hall on July 11, 2007.

Basin Advisory Committee: The Kansas-Lower Republican Basin Advisory Committee met to discuss this TMDL on March 6, May 16, and July 17, 2007.

Discussion with Interest Groups: Correspondence was exchanged with Johnson County Wastewater regarding the applicability of the nitrate criterion on Indian Creek where no surface water points of diversion exist.

Milestone Evaluation: In 2012, evaluation will be made as to the progress in upgrading the Indian Creek wastewater treatment plants with biological and chemical nutrient removal. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

Consideration for 303(d) Delisting: The stream will be initially evaluated for delisting under Section 303(d), based on the monitoring data in 2009 - 2013. Therefore, the decision for delisting will come about in the preparation of the 2014 303(d) list. Should modifications be made to the applicable water quality criteria during the intervening 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 (CPP), the next anticipated revision will come in 2007 that will emphasize revision of the Water Quality Management Plan. At that time, incorporation of this TMDL will be made into the CPP. Recommendations of this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process after Fiscal Years 2008 – 2012.

Revised October 18, 2007

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