North Carolina Division of Water Quality
Surface Water Protection Section – Program Development Unit
Watershed Assessment Team
May 27, 2008

Summary of Existing Data for Indian and Howard's Creeks
Catawba, Lincoln, and Gaston Counties

Catawba River Basin
Catalog Unit # 03050102
HU # 050010, 040030, and 040040

This document summarizes existing water quality data for a portion of the South Fork Catawba River watershed including Indian and Howard's Creeks and their tributaries (Figure 1) in the Catawba River Basin. The purposes of this summary are:

1) To compile and summarize existing water quality and related monitoring data for the North Carolina Ecosystem Enhancement Program (EEP) Local Watershed Plan (LWP) study area;
2) To determine whether causes and sources of any water quality and/or aquatic habitat problems can be identified;
3) To identify critical gaps in watershed monitoring data that need to be addressed during Phase II of the LWP effort.

This report will form the basis for development of a water quality monitoring plan for the LWP study area by Division of Water Quality (DWQ) Watershed Assessment Team (WAT) staff.

I. INTRODUCTION

A. Watershed Description

The EEP has selected the Indian Creek (HU 050010), Howard's Creek (HU 040040), and the Middle South Fork Catawba River (HU 040030) watersheds in catalog unit 03050102 for the development of a Local Watershed Plan (LWP). Indian and Howard's Creeks are part of the South Fork of the Catawba River basin of the Southern Outer Piedmont ecoregion and are located primarily in Lincoln County. The Indian and Howard's Creek watersheds are largely rural and are dominated by forest/wetlands and farmland (mostly pasture), although tributaries of Indian Creek drain the northern part of Cherryville (Figure 1, Appendix 1). These watersheds and their tributaries also include portions of NC Highways 27, 150, 182, and 274. The total area of the LWP area is approximately 114 square miles. Eight permitted animal facilities are present in the Indian and Howard's Creeks watersheds. The wastewater treatment plants (WWTP) for the City of Cherryville and West Lincoln High School are located on Indian Creek.

Indian Creek and its major tributary, Little Indian Creek, originate in Catawba County about one-half mile north of the Lincoln County line; Indian Creek flows southward across Lincoln County just into the northern edge of Gaston County north of Cherryville, and then eastward about one mile and back into Lincoln County, where it continues eastward to its confluence with the South Fork Catawba River south of Lincolnton. Four other named creeks, including Little Creek, Mill

Creek, and Leonard Fork in Lincoln County, and Lick Fork in Gaston County and several un-named tributaries (UTs) to these creeks flow into Indian Creek. The entire Indian Creek watershed is 75 square miles.

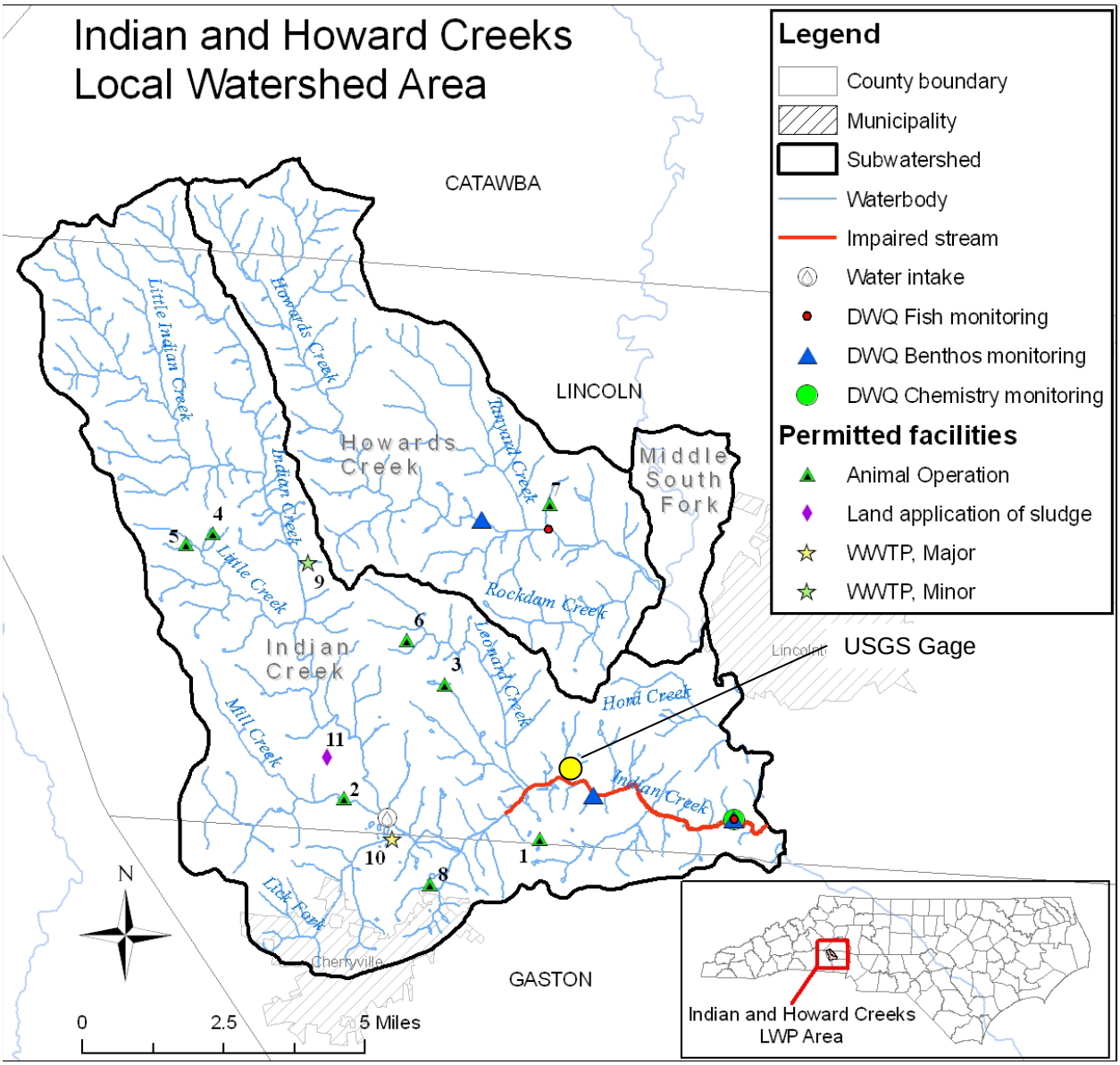

Figure 1. Map of Indian and Howard Creeks LWP area showing streams, watershed boundaries, existing water quality monitoring sites, permitted facilities including wastewater treatment plants and public water supply intakes. (The numbers on the map correspond to the map codes shown in Table 9.)

Howard's Creek and its headwater UTs originate in Catawba County about a mile north of the Lincoln County line and flow southeast to its confluence with the South Fork of the Catawba River about one mile northwest of Lincolnton. Rockdam Creek, Tanyard Creek, and several UTs flow into Howard's Creek. The entire Howard's Creek watershed is 34 square miles.

The Middle South Fork Catawba River also is part of the LWP planning area, but is part of the mainstem South Fork Catawba River and is only five square miles in extent. Water quality in the Middle South Fork Catawba River is influenced primarily from areas upstream of the LWP area, rather than from within the immediate LWP planning area. This large drainage area is beyond the scope of this LWP and will not be addressed further in this data summary.

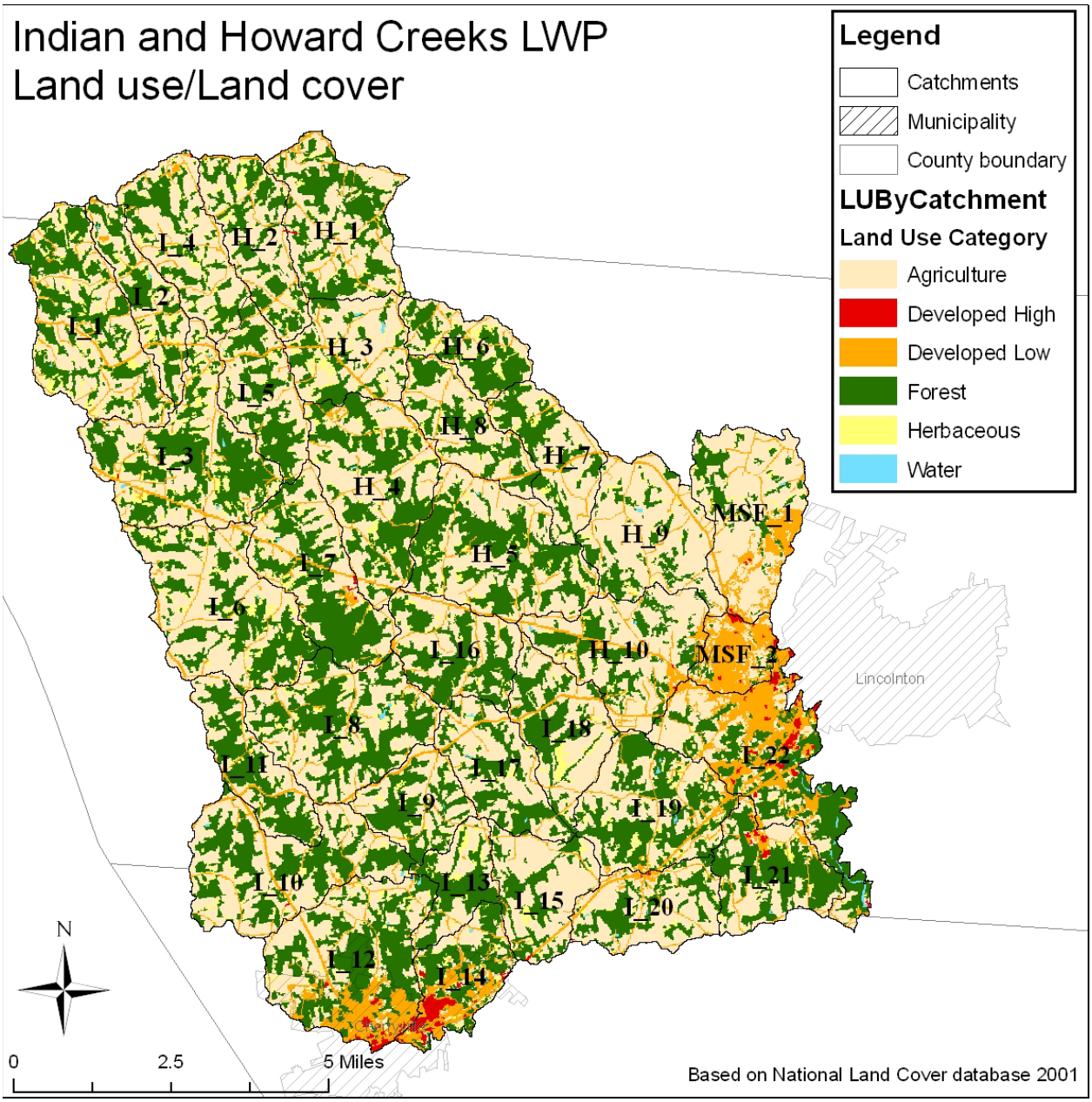

Figure 2. Land use/land cover in the Indian and Howard's Creeks watersheds.

B. Water Quality Standards and Action Levels, Stream Classifications, Use Support Ratings, and Impaired Listings

North Carolina has a set of regulations that specify the minimum standards for the waters of the state (NC Environmental Management Commission 2007; http://h2o.enr.state.nc.us/admin/rules/documents/Redbook2007_000.pdf). These water quality standards may be narrative, but more commonly are numerical criteria (e.g., maximum allowable instream concentrations). For certain constituents (such as copper, iron, silver, and zinc), firm numerical standards are not in place as actual toxicity to aquatic organisms can vary depending on additional factors, such as water hardness. In these cases the numerical criteria are referred to as action levels. A listing of the NC water quality standards and action levels for parameters summarized in this document is shown in Table 1.

The NC water quality standards and action levels (AL) vary in accordance with the specified use of the water body in question. Certain uses, such as primary recreation or water supplies, require more stringent standards than others, such as aquatic life support. The uses of a water body are designated by a stream classification assigned by DWQ. The state has inventoried the waters of the state, assigned a unique identifier ("index number") to each reach, and assigned each reach a stream classification. Data shown and discussed in this summary will be compared with NC water quality standards and action levels (AL) for all parameters for which standards or ALs exist.

The headwaters of Indian Creek, along with the entirety of Little Indian Creek, Little Creek and Mill Creek are classified WS-II HQW. Additionally, 0.5 miles of both Indian Creek and Mill Creek, immediately upstream from the Cherryville water supply intake, are classified WS-II HQW, CA (critical area). Immediately downstream from the water supply intake, to a

Table 1. NC water quality standards and action levels

Parameter	Class C[a]	Classes WS-II and WS-V[a]
Fecal coliform *(GM = geometric mean)*	GM<200[b]; <20% samples >400 cfu/100 ml	GM<200[b]; <20% samples >400 cfu/100 ml
Turbidity (NTU)	50	50
Nutrients (mg/L)		
NO_2+NO_3 as N	--	10.0 (NO_3^-)
Metals (µg/L)		
Arsenic (As)	50	10
Cadmium (Cd)	2.0	2.0
Chromium (Cr)	50	50
Copper (Cu)	7[c]	7[c]
Iron (Fe)	1000[c]	1000[c]
Lead (Pb)	25	25
Manganese (Mn)	--	200
Mercury (Hg)	0.012	0.012
Nickel (Ni)	88	25
Selenium (Se)	5	5
Silver (Ag)	0.06[c]	0.06[c]
Zinc (Zn)	50[c]	50[c]
Field measurements		
Dissolved oxygen (mg/L)	4.0[d], 5.0[e]	4.0[d], 5.0[e]
pH (s.u.)	6.0-9.0	6.0-9.0
Water temperature (^oC)	32	32

[a] "--" indicates there is no NC WQ standard. Units are the same as listed under "Reporting Limit".
[b]Geometric mean is based on five consecutive samples taken during a 30-day period
[c]Action level
[d]This is the standard for instantaneous readings.
[e]Daily mean

point 0.3 mi. upstream of SR 1169, Indian Creek is classified C; Lick Fork is also C. The final downstream reach of Indian Creek to its mouth at South Fork Catawba River is classified WS-IV. Howard's Creek is classified for aquatic life protection/propagation and secondary recreation (C).

The draft NC 303(d) list (NCDWQ 2008) classifies Indian Creek as impaired from a point 0.3 mile upstream of Lincoln County SR 1169 to the South Fork Catawba River. The creek is impaired based upon the biological monitoring (both fish and benthos) conducted in 2006. There are no specific stressors identified, however there are two wastewater discharges upstream, including West Lincoln High School and the City of Cherryville WWTP. Both are potential sources of pollutants.

C. Types of Data Summarized

Data included in this summary were taken from the following sources:

- DWQ in-stream water quality data from STORET[1] for the AMS (Ambient Monitoring System) station on Indian Creek at SR 1252;
- DWQ in-stream water quality data from STORET for AMS monitoring stations on Jacob Fork at SR 1924, Dutchman's Cr. at SR 1918, Long Cr. at SR 2042, Long Cr. at SR 1456, and Twelve Mile Cr. at NC 16 for comparison of regional data with Indian Creek;
- Benthic macroinvertebrate community monitoring by the DWQ at three sites;
- Fish data collected by DWQ at two sites;
- Habitat data collected by DWQ at four sites;
- USGS streamflow data from the gage on Indian Creek near Laboratory, NC;
- USGS in-stream water quality data from Indian Creek near Laboratory, NC;
- Fecal coliform data for 2007 from the City of Cherryville water supply intake on Indian Creek;
- Effluent water quality data from the West Lincoln High School and the City of Cherryville WWTPs;
- Effluent toxicity testing data from the City of Cherryville WWTP.

D. Monitoring Sites

Monitoring locations (Figure 1 and Table 2) include: a single AMS site on Indian Creek near its confluence with South Fork Catawba River (STORET #C5170000); two benthos sites on Indian Creek (at SR 1177 and SR 1252) and one on Howard's Creek (at SR 1200); one fish site each on Indian Creek (at SR 1252) and Howard's Creek (at SR 1185); one WWTP effluent site each for West Lincoln High School and the City of Cherryville, both on Indian Creek; the City of Cherryville's drinking water intake on Indian Creek just below its confluence with Mill Creek; and the USGS stream gage (USGS 02143500) and water quality monitoring site on Indian Creek

[1] STORET (short for STOrage and RETrieval) is the repository used by DWQ for water quality data collected through the Ambient Monitoring System (AMS) program. (http://www.epa.gov/storet/)

Table 2. Monitoring stations and types of data for the Indian-Howard's Creeks LWP area and nearby regional streams.
(An "-" denotes the absence of data)

Station	Location	Latitude	Longitude	Type of Data					
				Water Quality	Field Meter Data	Benthos	Habitat	Fish	Stream Flow
Indian and Howard's Creeks LWP Area									
Indian Cr. Ambient Monitoring Station	Indian Creek at SR 1252 near Laboratory	35.4227	81.2592	X	X	X	X	X	-
Indian Cr. Benthos Station	Indian Creek at SR 1177	35.4281	81.3036	-	X	X	X	-	-
Howard's Cr. Benthos Station	Howard's Cr. at SR 1200	35.4983	81.3406	-	X	X	X	-	-
Howard's Cr. Fish Monitoring Station	Howard's Cr. at SR 1185	35.4961	81.3200	-	X	-	X	X	-
City of Cherryville Water Intake	Indian Cr. below confluence with Mill Cr.	35.4212	81.3683	X	-	-	-	-	-
USGS Gage & Water Quality Monitoring Station	Indian Cr. about 1/2 mi. above SR 1252 near Laboratory	35.4210	81.2650	X	X	-	-	-	X
Other Regional Streams									
Jacob Fork Ambient Monitoring Station	Jacob Fork at SR 1924 near Ramsey	35.5906	81.5671	X	-	-	-	-	-
Dutchman's Cr. Ambient Monitoring Station	Dutchman's Cr. at SR 1918 at Mountain Island	35.3365	81.0133	X	-	-	-	-	-
Long Creek Ambient Monitoring Station	Long Cr. at SR 2042 near Paw Creek	35.3285	80.9096	X	-	-	-	-	-
Long Creek Ambient Monitoring Station	Long Cr. at SR 1456 near Bessemer City	35.3052	81.2326	X	-	-	-	-	-
Twelve Mile Cr. Ambient Monitoring Station	Twelve Mile Cr. at NC16 near Waxhaw	34.9523	80.7558	X	-	-	-	-	-

near Laboratory, NC. For comparisons, five additional nearby AMS stations also are included as representative of water quality in the region. Land uses in the watersheds of these regional stations are primarily pasture and forest, and none of these stations are below urban areas or are situated downstream of a WWTP. The only known point pollution sources in the Indian and Howard's Creeks watersheds are the two WWTPs on Indian Creek. The land (sludge) applications site for the City of Cherryville WWTP and animal operations in the Indian and Howard's Creeks watersheds may also be sources of pollution in the Indian and Howard's Creeks watersheds.

II. SUMMARY OF EXISTING DATA

This data summary includes water chemistry, field measurements, biological evaluations, habitat assessments, WWTP effluent toxicity test results, and stream flow.

A. In-Stream Water Quality Data

1. Field Measurements

Water temperature, pH, dissolved oxygen, and specific conductance measurements were taken in the field as part of the AMS monitoring on Indian Creek at SR 1252. Water temperatures and dissolved oxygen concentrations on Indian Creek at the AMS station from 1980 to the present time did not exceed any NC water quality standards. Both pH and specific conductance dropped sharply after 2004 and remained low through 2007 (Figure 3). This drop in pH and specific conductance also corresponded to a substantial decline in pH and specific conductance in the Cherryville WWTP effluent during the same time frame. On several occasions in 2004, the pH fell below the state standard of 6.0 s.u. but subsequently has remained within the acceptable range of 6.0 to 9.0 s.u.

The USGS collected limited field data over the same time frame just upstream of the AMS monitoring site on Indian Creek, but dissolved oxygen concentrations were the only data collected regularly. Dissolved oxygen (Figure 4) fell within the same range as the AMS data collected just downstream on Indian Creek at SR 1252, and no exceedences of the 4 mg/L NC instantaneous standard occurred. Additional USGS data are shown in Appendix 2.

Upstream to downstream comparisons of field data were available only from the USGS and included just two sampling periods and a very limited number of stations (eight during the 8/13-8/15/1991 sampling and two during the 10/16/1997 sampling). Upstream-downstream comparisons are helpful for locating environmental changes. The only point in common for the USGS data was the site near Laboratory, NC. These data (Table 3) do not suggest any substantial upstream to downstream gradients for water temperature, pH, or dissolved oxygen. Specific conductance, however, increased at the more downstream locations, particularly on 10/16/1997. Substantially more data will be needed before any upstream to downstream patterns can be elucidated. A comparison of data for Indian Creek at SR 1252 with AMS data for nearby streams (Figure 5) showed that dissolved oxygen concentrations and pH in Indian Creek fell within the same ranges as those for other nearby streams in the region.

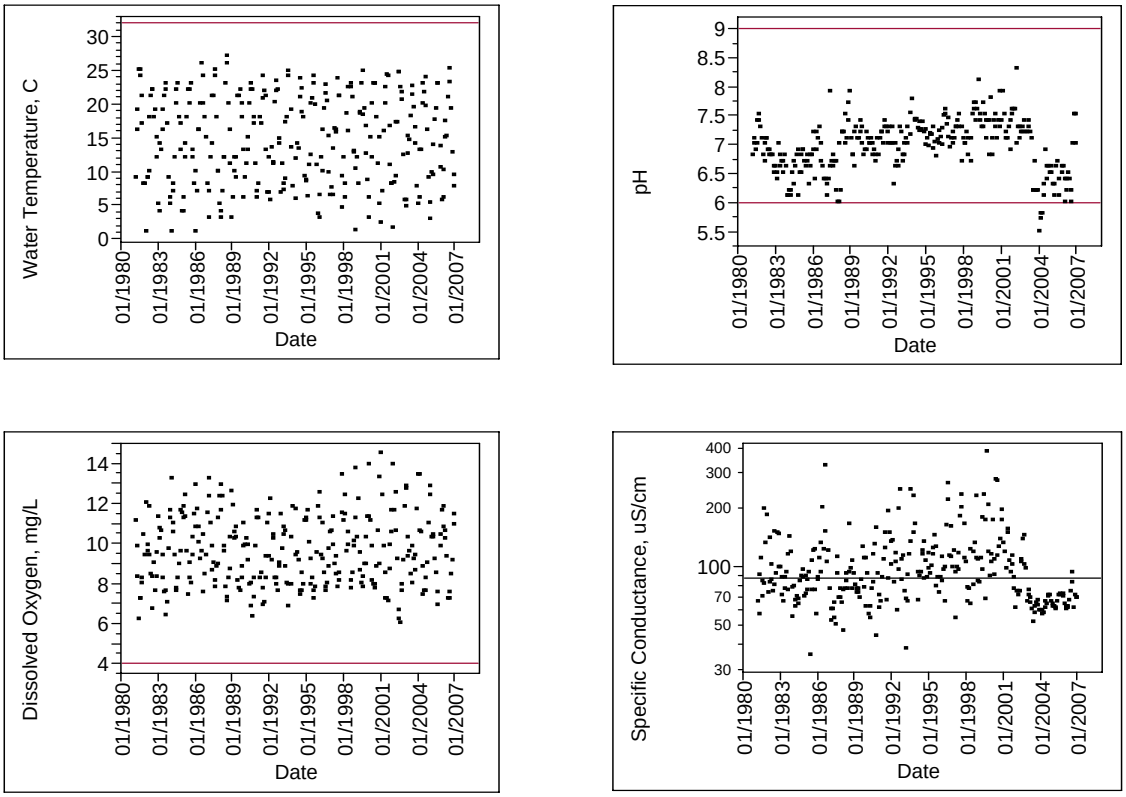

Figure 3. Field measurements at the AMS monitoring site on Indian Creek at SR 1252, 1980-2007. Dashed red lines are NC water quality standards. A solid black line is the grand median over time.

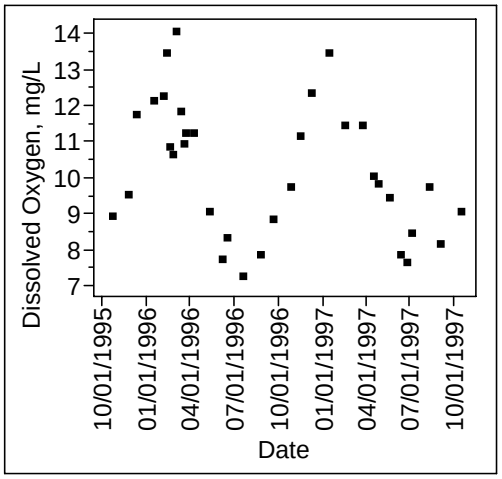

Figure 4. Dissolved oxygen concentrations in Indian Creek near Laboratory (USGS data).

Table 3. Comparison of data for eight sites on Indian Creek and its tributaries on 8/13/1991 through 8/15/1991 and two sites on Indian Creek on 10/16/1997 (USGS Data)*.

Site Location	Sampling Date	Water Temperature, (°C)	Specific Conductance, (µS/cm)	pH (s.u.)	Dissolved Oxygen, (mg/L)
Indian Cr. at SR 1108 near Henry	8/13/1991	20	47	6.7	
Indian Cr. at SR 1129 near Dora	8/13/1991	21	47	6.5	
Indian Cr. at NC27 near Dora	8/14/1991	20	48	6.6	
UT Indian Cr. at SR 1140 near Flay	8/14/1991	20	50	6.6	
Indian Cr. at SR 1168 near Johnstown	8/15/1991	21	53	6.5	
UT Indian Cr. at SR 1636 near Cherryville	8/15/1991	23	100	7.0	
UT Indian Cr. at SR 1178 near Crouse	8/15/1991	22	57	6.5	
Indian Cr. near Laboratory	8/15/1991	22	70	7.0	
Indian Cr. at SR 1130	10/16/1997	13	51	6.4	9.0
Indian Cr. near Laboratory	10/16/1997	15	219	7.0	9.0

*Sites are listed in an upstream to downstream order.

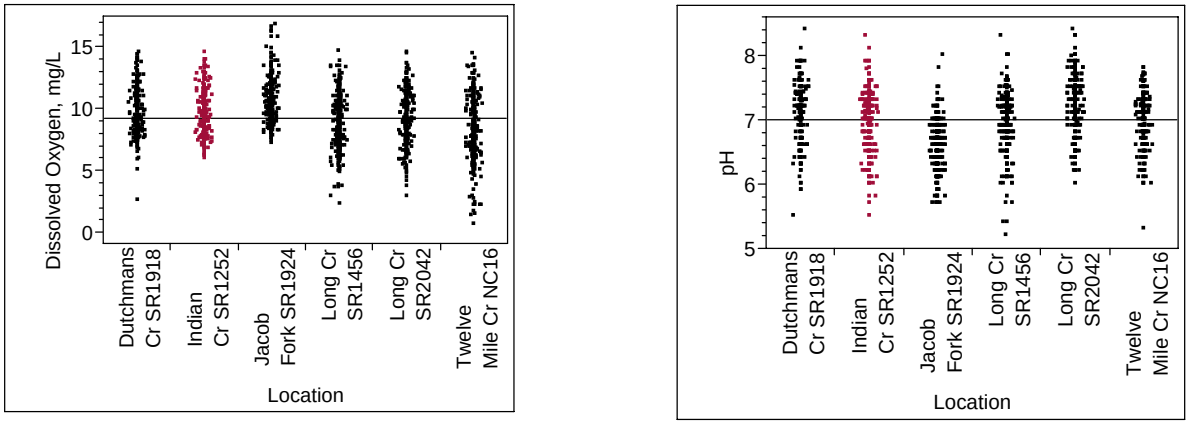

Figure 5. A comparison of dissolved oxygen concentrations and pH in Indian Creek with AMS data from regional streams. Solid black lines are the grand median across all sites.

2. Water Chemistry and Microbiological Analyses

The DWQ Laboratory Section analyzes water samples and provides the concentrations of nutrients, metals, and various organic pollutant stressors in the water column. Repeated measurements of water chemistry over time help characterize the chemical nature of the water and may identify pollutants that contribute to the degradation of water quality in a particular stream or water body. Microbiological techniques use the levels of fecal coliform bacteria in the water column as an indicator of fecal contamination from human and animal wastes, which often contain viruses and other pathogens. High fecal coliform counts often are indicators of sewage contamination from spills, leaking sewers, and failing septic systems. Water chemistry and fecal coliform data summarized below are from the AMS site on Indian Creek at SR 1252, from AMS sites on regional creeks, and from the USGS.

a. **Nutrients**. Nutrient data from the AMS site on Indian Creek (Figure 6) were available from 1981 through 2002. There was a data gap between 1987 and 1992 in which nutrient data were not collected, and nutrient sampling was discontinued after 2002. Ammonia nitrogen concentrations clustered around 0.1 mg/L most of the time, with a few higher values. Nitrite + nitrate nitrogen concentrations averaged less than 1.0 mg/L, with an occasional value exceeding 2.0 mg/L. Total Kjeldahl nitrogen (organic N + ammonia N) averaged about 0.3 mg/L and had occasional values exceeding 0.8 mg/L. Phosphorus concentrations averaged under 0.2 mg/L but had occasional values exceeding 1.0 mg/L. There was no obvious pattern for either ammonia nitrogen or total Kjeldahl nitrogen over time. Nitrite + nitrate nitrogen appeared to increase slightly, whereas phosphorus concentrations decreased slightly over time.

   An examination of additional AMS nutrient data from nearby streams showed that total phosphorus and nitrite + nitrate nitrogen concentrations averaged considerably higher in Indian Creek at SR 1252 than in the other five creeks (Figure 7), but total Kjeldahl nitrogen and ammonia nitrogen (Appendix 3) were not elevated. It is uncertain whether elevated concentrations of these nutrients in Indian Creek are the results of upstream runoff from cattle facilities or are caused by the two wastewater effluents on Indian Creek, since none of the five regional creeks had a wastewater effluent upstream of the AMS sampling site. The source of elevated phosphorus and nitrite + nitrate nitrogen in Indian Creek needs to be examined further.

   USGS data for two locations on Indian Creek on 10/16/1997 suggest an upstream to downstream gradient in nitrogen concentrations in Indian Creek (Table 4). The upstream station is located in the headwaters of Indian Creek. This possible relationship also needs to be examined further.

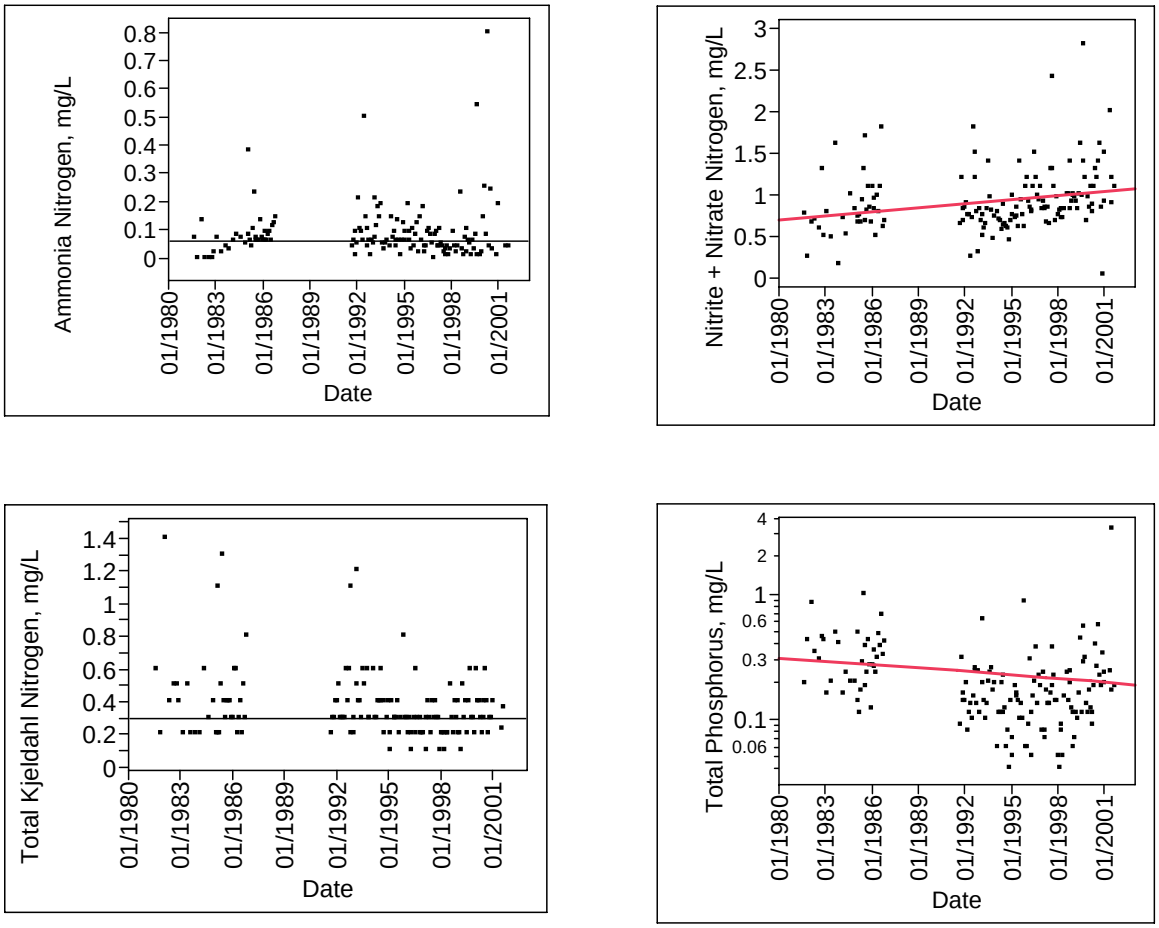

Figure 6. Nutrient concentrations in Indian Creek at SR 1252, 1980-2001. Red solid lines are fitted linear regression lines to show trends for data over time. Solid black lines are the grand medians over time.

Table 4. Upstream-downstream comparison of nutrients and fecal coliform bacteria for two sites on Indian Creek on 10/16/1997 (USGS Data).

Site	Total Nitrogen, (mg/L)	Organic Nitrogen, (mg/L)	Total Kjeldahl Nitrogen, (mg/L)	Fecal Coliform Bacteria, (cfu/100 ml)
Indian Cr. at SR 1130 (upstream)	0.69	0.19	0.21	74
Indian Cr. nr Laboratory (downstream)	1.00	0.36	0.38	190

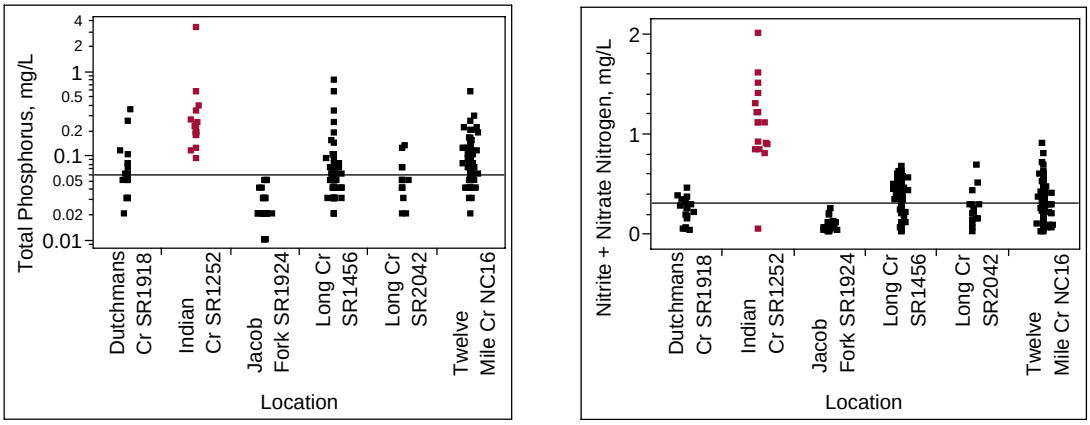

Figure 7. A comparison of total phosphorus and nitrite + nitrate concentrations in Indian Creek with AMS data from regional streams. Solid black lines are the grand medians across all sites.

b. **<u>Fecal coliform counts</u>.** Data from the AMS site on Indian Creek (Figure 8) show that fecal coliform counts were slightly higher during the 1980s than since 1992. Data from five nearby creeks indicate that coliform counts are similar at Indian Creek to other creeks within the region (Figure 9). Fecal coliform counts from a single date at two USGS sampling sites on Indian Creek suggest a possible upstream to downstream relationship (Table 4). Coliform counts at the USGS site on Indian Creek near Laboratory decreased between 1995 and 1997 (Appendix 2). Fecal coliform counts in raw water from the City of Cherryville water supply intake during 2007 (data collected daily) also suggest that occasional problems still exist upstream in Indian Creek. In March, 2007, fecal coliform counts averaged 1053 cfu/100 ml, and the maximum reading was 22,100 cfu/100 ml (Table 5). Data from previous years were not examined at this time, as all data was hand-entered on hard-copy data sheets.

Effluent data from the Cherryville and West Lincoln High School WWTPs in 2006 and 2007 (Figure 10) and longer-term effluent data (Appendix 4) show fecal coliform counts too low to account for most of the elevated counts observed for in-stream monitoring data at the AMS site on Indian Creek at SR 1252. Effluent fecal coliform counts in the effluents were more in the range seen at the USGS station for 1997 (Appendix 2). The available data suggest that the frequent occurrences of excessive fecal coliform counts observed at the AMS station at SR 1252 during the past decade more likely are the results of animal operations in the headwaters and/or re-suspension from the sediments during stream flow than to current WWTP operations on Indian Creek.

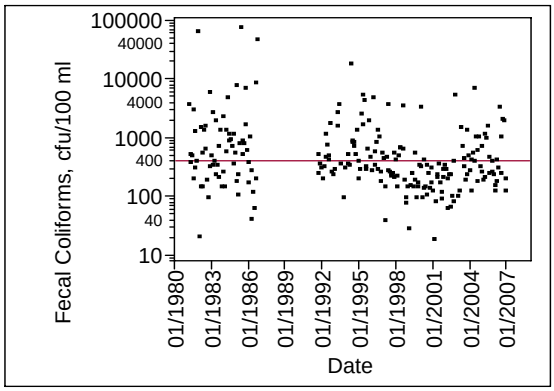

Figure 8. Fecal coliform counts for Indian Creek at SR 1252, 1980-2007. The dashed red line is a reference level used as a surrogate for the NC water quality standard. The NC standard states that "fecal coliforms shall not exceed a geometric mean of 200/100ml based upon at least five consecutive samples examined during any 30 day period, nor exceed 400 cfu/100ml in more than 20 percent of the samples examined during such period" (NCDWQ 2007).

Table 5. Monthly arithmetic means and ranges for fecal coliform bacteria (cfu) in the City of Cherryville water supply raw intake water during 2007.

Month	Min	Mean	Max
Jan	10	232	1,240
Feb	0	52	100
Mar	0	1,053	22,100
Apr	0	17	100
May	0	10	100
Jun	0	21	100
Jul	0	56	800
Aug	0	29	200
Sep	0	22	100
Oct	0	17	200
Nov	0	77	400
Dec	120	462	1,400

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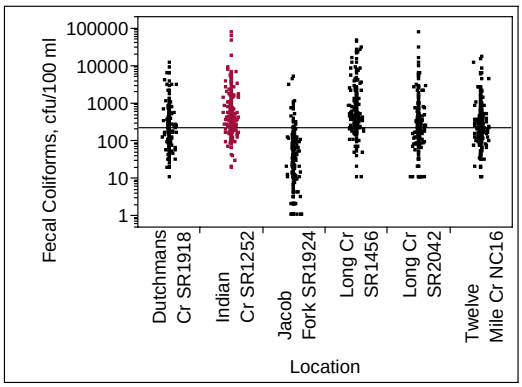

Figure 9. A comparison of fecal coliform counts in Indian Creek with AMS data from regional streams. The solid black line is the grand medians across all sites.

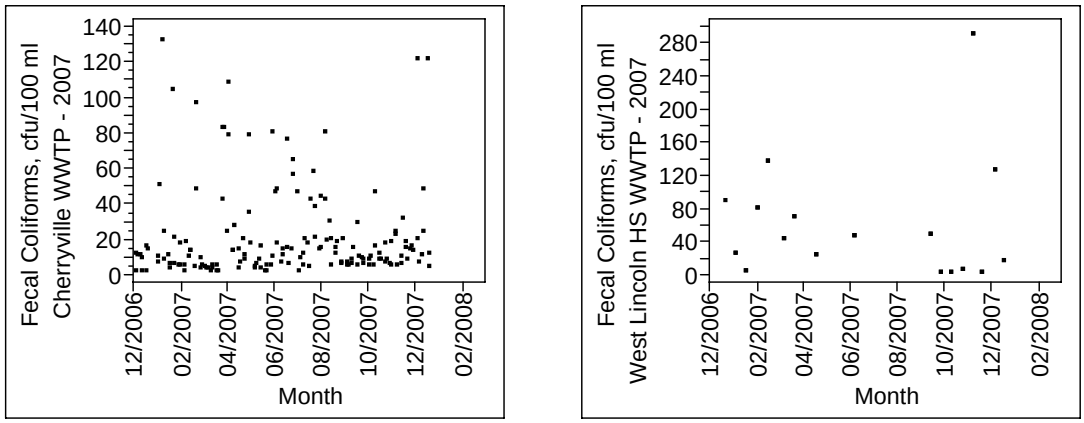

Figure 10. Fecal coliform counts in the Cherryville (left) and West Lincoln High School WWTP effluents from 2006 through the present.

c. **<u>Turbidity, total suspended solids, and total solids</u>.** Turbidities at the AMS site on Indian Creek (Figure 11) averaged well below the NC standard of 50 NTU across the entire time span of AMS sampling, and only 14 of 226 measurements (6%) exceeded the standard. Turbidity in Indian Creek fell well within the same ranges as observed at nearby AMS creek monitoring stations (Appendix 3).

Total suspended solids (TSS) averaged about 5.5 mg/L and showed no pattern over time (Figure 11). Total solids (includes TSS and dissolved solids) averaged about 70 mg/L and seemed to increase somewhat in the late 1990s through 2001. The reason for this increase is unknown.

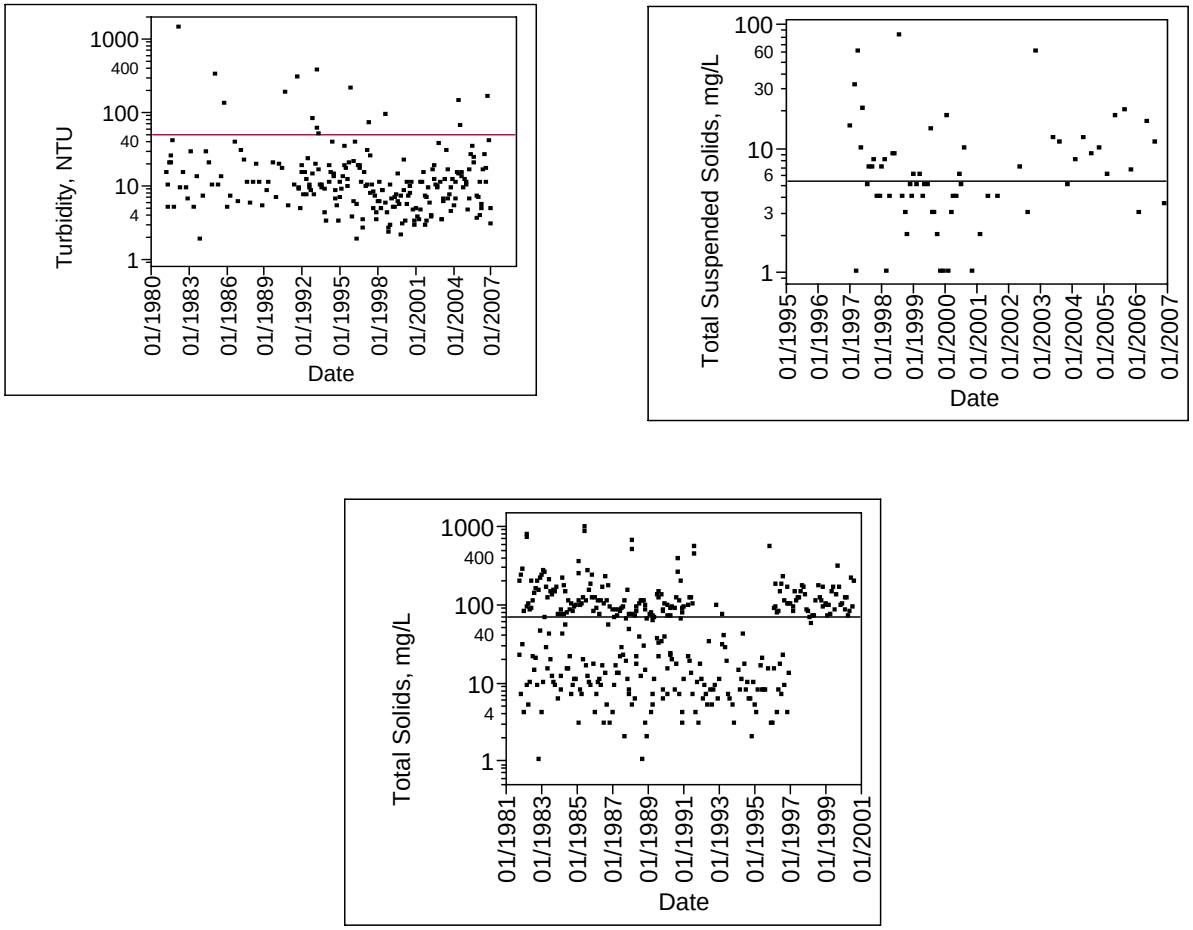

Figure 11. Turbidity, total suspended solids, and total solids concentrations, for Indian Creek at SR 1252, 1980-2007. Dashed red lines are NC water quality standards. A solid black line is the grand median over time.

d. **Metals**. Data from the AMS site show that metals generally are not a significant issue in Indian Creek (Figure 12). Relatively high concentrations of aluminum and iron generally reflect the abundance of these metals in the soils within the watershed. Although nearly a third of the iron concentrations exceeded the action level (AL) of 1000 mg/L, most of these exceedences occurred prior to 2002. Chromium concentrations exceeded the 50 µg/L NC standard on three occasions, and lead exceeded the 25 µg/L standard twice during the 1980s and 1990s. Manganese exceeded the 200 µg/L standard for water supplies twice in the early 1990s. Copper concentrations exceeded the 7 µg/L AL on approximately 25% of the sampling dates; however, all of these exceedences occurred prior to 2001. Copper no longer appears to be an issue in Indian Creek. Copper and lead concentrations are within the ranges of those observed at other AMS stations on nearby creeks (Appendix 3).

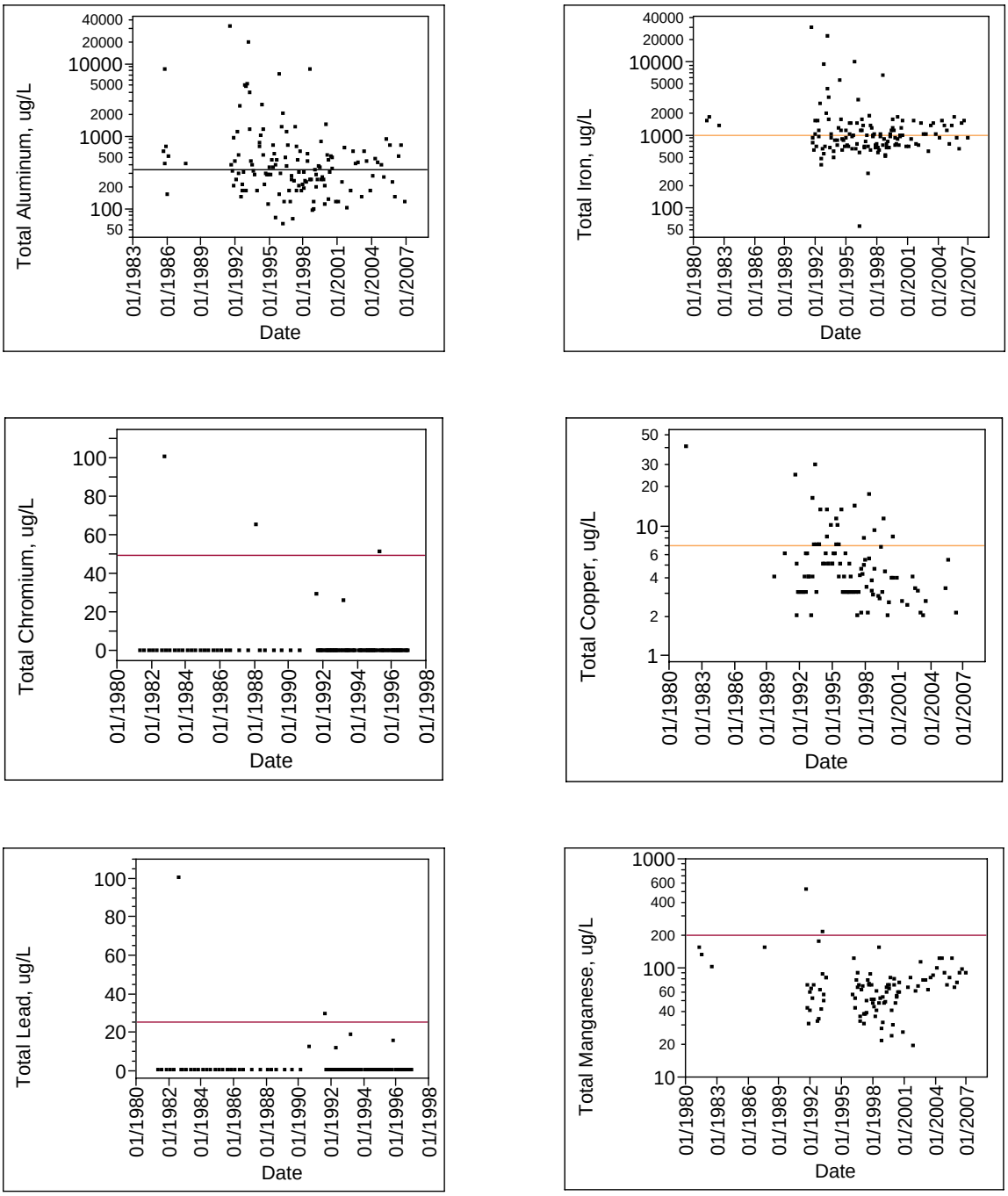

Figure 12. Metals concentrations in Indian Creek at SR 1252, 1980-2007. Dashed red lines are NC water quality standards. Orange dashed lines are NC action levels. A solid black line is the grand median over time.

B. Benthic Macroinvertebrate Assessments

Benthic macroinvertebrate sampling was conducted by the DWQ Biological Assessment Unit (BAU) on Indian and Howard's Creeks. The DWQ uses benthic macroinvertebrate monitoring in free-flowing freshwater streams to assign one of five bioclassifications to each water body. These bioclassifications are: Poor, Fair, Good-Fair, Good, and Excellent. Macroinvertebrate sampling was conducted in accordance with standard operating procedures (NCDWQ 2006a).

Two primary indicators of stream health are derived from benthic macroinvertebrate community data: 1) the diversity of a more sensitive subset of the invertebrates (EPT) is evaluated using taxa richness; and 2) the pollution tolerance of those organisms present is evaluated using a biotic index (BI). "EPT" is an abbreviation for Ephemeroptera + Plecoptera + Trichoptera (mayflies, stoneflies and caddisflies), insect groups that are generally intolerant of many kinds of pollution. Generally, a high number of different EPT species (species richness) indicates a healthy benthic community. A low BI indicates that the community is dominated by taxa that are relatively sensitive to pollution and other disturbances (i.e., intolerant species). Thus, a lower biotic index represents a benthic community composed of species intolerant of pollution.

Biotic index values are combined with EPT taxa richness ratings to assign a bioclassification. Streams with bioclassifications of Excellent, Good, and Good-Fair are all considered unimpaired. Those with Fair and Poor ratings are considered impaired.

Howard's Creek was sampled at SR 1200 on four occasions from 1992 to 2006, and Indian Creek was sampled at SR 1252 on eight occasions from 1983 through 2006 and upstream at SR 1177 on four occasions from 2002 to 2006 (Table 6). The three earlier samples from Howard's Creek and Indian Creek at SR 1177 were EPT samples (only EPT collected and evaluated), whereas all other samples collected were full benthic macroinvertebrate assessments (i.e., all groups collected and evaluated). Howard's Creek has maintained a bioclassification of Good or Good-Fair in all of its assessments. Indian Creek at SR 1252 has continually received either Good or Good-Fair bioclassifications except in 1983, when it was classified as Fair. The upstream site on Indian Creek at SR 1177 received bioclassifications of Fair in 2002 and 2006, although an earlier bioclassification (2003) was Good-Fair. Because of this rating in 2006 of Fair for benthos (and a similar rating of fair in 2006 for fish - see section below), Indian Creek from a point 0.3 mile upstream of Lincoln County SR 1169 to the South Fork Catawba River (Figure 1) was placed on the NC 303 (d) list.

C. Fish Community Assessments

The condition of the fish community is one of the most meaningful indicators of ecological integrity to the public. Fish occupy the upper levels of the aquatic food web and are both directly and indirectly affected by physical, chemical, and biological changes in the environment. Since fish spend their entire lives in the aquatic environment, they incorporate chemicals from this environment into their body tissues. This directly affects the presence, abundance, and condition of the fish populations in the stream.

Table 6. Benthic data and bioclassifications for Howard's and Indian Creeks.

Waterbody	Location	Date	Sample Type	Total Species	EPT Species	Biotic Index	EPT Biotic Index	Bioclassification
Howard's Cr.	SR 1200	5/3/2006	Full	118	34	5.79	4.30	Good
		8/21/2002	EPT	---	17	---	4.50	Good-Fair
		8/19/1997	EPT	---	25	---	4.15	Good
		8/17/1992	EPT	---	25	---	4.33	Good
Indian Cr.	SR 1177	5/3/2006	Full	79	17	6.71	6.50	Fair
		9/16/2003	EPT	---	17	---	5.00	Good-Fair
		2/3/2003	EPT	---	12	---	4.90	Not Rated
		8/21/2002	EPT	---	13	---	4.80	Fair
Indian Cr.	SR 1252	5/3/2006	Full	81	22	5.74	4.86	Good
		8/19/1997	Full	73	24	5.23	4.63	Good
		8/17/1992	Full	79	29	6.06	5.38	Good
		7/25/1990	Full	72	25	6.00	5.20	Good
		7/22/1987	Full	67	18	6.33	5.52	Good-Fair
		7/23/1986	Full	77	18	6.58	5.40	Good-Fair
		11/16/1983	Full	50	6	6.90	5.36	Fair
		8/12/1983	Full	51	12	6.39	6.00	Good-Fair

The BAU assessed the fish community (Table 7) on Indian Creek on three dates (1997, 2002, and 2006) at SR 1252 and once (2006) on Howard Creek at SR 1185. All assessments were conducted according to DWQ standard operating procedures (NCDWQ 2006b). Fish populations were evaluated using the North Carolina Index of Biotic Integrity (NCIBI), which incorporates information about species richness and composition, trophic composition, fish abundance, and fish condition in wadeable streams. The fish community then was assigned a rating based on the calculated NCIBI and the basin in which the stream is located.

Howard's Creek received a bioclassification of Good, based on the single fish community evaluation in 2006. The most abundant species found was the bluehead chub. Two exotic species, green sunfish and redear sunfish were present. Indian Creek, however, has received ratings of Fair on all three dates on which it was evaluated. These fish community ratings of Fair and the similar rating of the benthic community in 2006 led to placement of Indian Creek on the Impaired list (see section above). The most abundant fish species were bluehead chub and green sunfish; the green sunfish was the only exotic species present.

Table 7. Fish community data and bioclassifications for Howard's and Indian Creeks.

Waterbody	Location	Date	Total Species	NCIBI	Bioclassification
Indian Cr.	SR 1252	6/01/2006	14	38	Fair
Indian Cr.	SR 1252	5/21/2002	11	38	Fair
Indian Cr.	SR 1252	7/01/1997	11	38	Fair
Howard's Cr.	SR 1185	4/24/2007	20	48	Good

D. Habitat Assessment Data

All habitat assessments for Indian and Howard's Creeks were conducted by the BAU using the DWQ approved methodology (NCDWQ 2006a). Habitat assessments are conducted whenever benthic macroinvertebrates or fish assessments are done. These habitat assessments evaluate the suitability of a given stream segment to support aquatic life, particularly benthic invertebrates and fish, and are conducted routinely at field sites. The stream habitat assessment usually evaluates a reach approximately 100 yards in length that includes the field site in which other evaluations (e.g., benthic invertebrates, water chemistry, etc.) are being made. Habitat assessments can provide indications of problems existing within the watershed and further upstream that are contributing to habitat degradation and/or biological impairment within the specific reach being evaluated. Evaluations are made visually and are qualitative.

A habitat assessment contains several individual metrics that are added to form a total score (range 0 to 100, where 100 is the highest possible score). The total score represents the overall quality of that specific reach relative to entirely unimpacted (pristine) conditions. These metrics include:

- Channel modifications (e.g., natural channel vs. channelization);
- In-stream habitat (percentage of reach favorable for colonization by invertebrates or providing fish cover);
- Bottom substrate and embeddedness (percent silt, sand, gravel, cobble, boulders, etc.)
- Pool variety (frequency and size within the reach);
- Riffle habitats (narrow channel areas where water moves quickly and is more aerated);
- Bank stability (evaluates contribution of vegetation types to preventing bank erosion);
- Light penetration (vegetative cover over stream affects water temperature and photosynthesis);
- Riparian buffer width (intactness of the riparian zone on each side of the stream).

A total of three habitat assessments have been made on Howard's Creek and seven on Indian Creek (Table 8). Total scores for Howard's Creek were consistently in the lower 50s (out of a possible 100). There were some slight differences in scores for individual metrics at this site, particularly in the categories Riffles, Bank Stability, and Riparian Buffer. Total scores at Indian Creek were substantially higher when rated during fish population assessments than during benthic collections. These differences probably are largely a function of differences in the location of the evaluated reaches along the creek (all but one of the habitat assessments conducted from 2002 through 2006 during benthos collections occurred at SR 1177, whereas both assessments conducted during fish collections occurred downstream at SR 1252). The observed differences at SR 1252 may either reflect individual differences as seen by the personnel evaluating the reach or, possibly, slight differences in the positioning of the reach evaluated at SR 1252. Habitat total scores for Indian Creek at SR 1177 (all conducted during benthos collections) declined slightly between 2002 and 2006, however. Although scores for Bank Stability increased, those for Pools actually decreased, which suggests that pools may be filling in due to activities in the vicinity of the reach and/or upstream. Decline in habitat quality may be one of the factors that affected populations of fish and benthic invertebrates, resulting in the placement of Indian Creek on the 303 (d) list.

Table 8. Habitat data for Indian and Howard's Creeks[1].

Waterbody	Location	Date	Channel Modification (5)	Instream Habitat (20)	Bottom Substrate (15)	Pool Variety (10)	Riffles (16)	Bank Stability (14)	Light (10)	Riparian Buffer (10)	Total Score (100)
Benthic Studies											
Howard's Cr	SR 1200	8/21/2002	4	11	3	4	3	11	7	8	51
Howard's Cr	SR 1200	5/3/2006	5	7	4	6	3	12	7	7	51
Indian Cr	SR 1177	8/21/2002	5	15	3	8	3	6	10	10	60
Indian Cr	SR 1177	2/3/2003	5	19	3	10	3	4	10	6	60
Indian Cr	SR 1177	9/16/2003	5	16	3	6	0	12	10	10	57
Indian Cr	SR 1177	5/3/2006	5	11	4	0	3	12	10	6	51
Indian Cr	SR 1252	5/3/2006	5	12	4	0	5	12	7	8	53
Fish Studies											
Howard's Cr	SR 1185	4/24/2007	4	14	4	6	7	8	8	1	52
Indian Cr	SR 1252	5/21/2002	4	16	8	10	12	6	8	6	70
Indian Cr	SR 1252	6/1/2006	5	16	3	9	10	10	9	10	72

[1]The value in parentheses beneath each habitat metric is the maximum possible score for that specific metric.

F. USGS Stream Gage, Rainfall, and Other Flow Data

Flow data (daily discharge) were available from the USGS stream gage (USGS 02143500) on Indian Creek near Laboratory (Figure 13). The USGS data show a fairly consistent variation in flow pattern from 1982 through approximately 2000, with a precipitous drop in flow during the drought in late 2002 and again during the exceptional drought of late 2007 and early 2008.

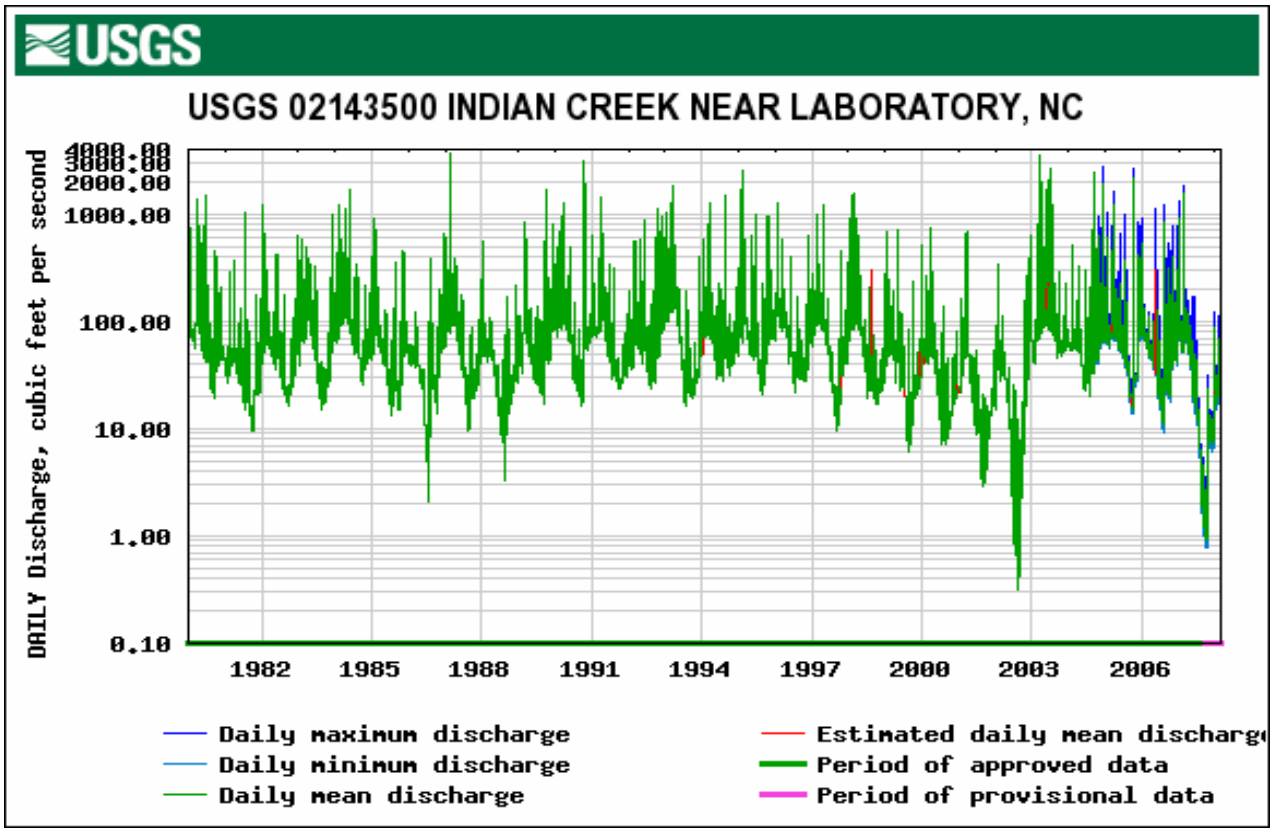

Figure 13. Daily stream flow data from the USGS gage on Indian Creek – January 1980 through February 2008.

E. Toxicological Data

In-Stream Water or Sediment Toxicity Data. No water column or sediment toxicity tests have been conducted in the LWP area.

Effluent Toxicity Data. Data were available from the Cherryville WWTP. Effluent toxicity was evaluated from March 1994 through December 2007 using a 7-day *Ceriodaphnia* chronic toxicity test procedure. All tests were evaluated as either pass or fail. Test results were failing on only two occasions (3/21/94 and 4/25/95).

III. POLLUTION SOURCES

A. NPDES Dischargers and Other Permits

Two wastewater treatment facilities discharge into Indian Creek (Figure 2 and Table 9). The City of Cherryville WWTP, located on Indian Creek below the confluence with Lick Fork, is permitted to discharge 2 million gallons per day., and the West Lincoln High School WWTP, located on Indian Creek approximately 6 miles upstream from the Cherryville WWTP is permitted to discharge 14,000 gallons per day.

A violation of permit limits for fecal coliforms occurred at the City of Cherryville WWTP on 01/07/2006, but no violations have occurred at the upstream West Lincoln High School effluent.

B. Permitted Animal Facilities

Four Animal Deemed State facilities and four Cattle State facilities are present in the Indian Creek and Howard's Creek watersheds (Figure 1 and Table 9).

Table 9. Permitted facilities in the Indian and Howard's Creeks watersheds.

Map Code	Latitude	Longitude	Permit No.	Facility Name	Permit Type	Gal/ day Permitted
1	35.4167	81.3200	AWC550002	Gar-Mac Dairy	Cattle State	-
2	35.4258	81.3817	AWC550007	Beam Dairy	Cattle State	-
3	35.4556	81.3511	AWC550018	Treasure Chest Jerseys	Cattle State	-
4	35.4931	81.4250	AWD550003	Dennis Shidal	Animal Deemed State	-
5	35.4900	81.4333	AWD550013	Houser Dairy	Animal Deemed State	-
6	35.4667	81.3633	AWD550014	Reep Dairy	Animal Deemed State	-
7	35.5028	81.3194	AWD550015	Lutz Dairy	Animal Deemed State	-
8	35.4042	81.3542	AWC360004	Eaker Dairy	Cattle State	-
9	35.4861	81.3950	NC0041246	West Lincoln High School	Discharging 100% Domestic < 1MGD	14,000
10	35.4158	81.3664	NC0044440	Cherryville WWTP	Municipal Wastewater Discharge, Large	2,000,000
11	35.4361	81.3875	WQ0000430	Cherryville Residuals Land Application	Land Application of Residual Solids	

C. Other Potential Pollution Sources

The City of Cherryville's land application of residual solids site is located approximately two miles northwest of the WWTP, between Indian Creek and its tributary, Mill Creek (Figure 2). Other potential sources of pollution may include pastures throughout the LWP area.

IV. SUMMARY

Indian and Howard's Creeks watersheds are largely rural and are dominated by forest/wetlands and farmland, although tributaries of Indian Creek drain the northern part of Cherryville. Very little data were available for the LWP area. Water chemistry data were limited exclusively (except for field parameters) to the AMS station at SR 1252 on Indian Creek, the USGS monitoring station on Indian Creek just above the AMS station, USGS data for a single date at eight additional sites on Indian Creek and its tributaries, and the raw intake water at the Cherryville water treatment plant on Indian Creek. Effluent toxicity data were available for the Cherryville WWTP, and streamflow data were available from a single USGS gage near Laboratory, NC. Limited biological, field parameter, and habitat data were available for two locations on Indian Creek and one location on Howard's Creek.

The lower section of Indian Creek was placed on the NC 303 (d) list as "Impaired" based on macrobenthos and fish community assessments in 2006, but the source(s) and specific cause(s) are not known.

The AMS water quality data for Indian Creek were compared over the same time span with AMS data for five nearby creeks having similar land cover/land uses in their respective watersheds. Data for Indian Creek generally fell within the same ranges as the data for these other creeks. The exceptions were that total phosphorus and nitrite + nitrate nitrogen averaged higher in Indian Creek than in these other creeks.

V. CONCLUSIONS

- Based upon biological data, Howard's Creek appears to have better water quality (i.e. better bioclassifications) than Indian Creek at SR 1177, but water quality Indian Creek at SR 1252 appears comparable to that of Howard Creek.
- Very little is known about water quality in Indian Creek above the WWTP facilities or in the named and unnamed tributaries to both of these creeks, with the exception of single measurements (field parameters) taken between 8/13/1991 and 8/15/1991 at eight locations on Indian Creek and its tributaries.
- Currently there are no known water quality issues in Indian Creek. However, potential sources of pollution are the wastewater effluents from the WWTPs of the City of Cherryville WWTP (primarily) and West Lincoln High School.
- Other potential sources of pollution may include the land application site for sewage sludge from the City of Cherryville, eight permitted livestock facilities, the Lincoln

County landfill, and agriculture. However, there are no data to document pollution from any of these possible sources.

- Nutrients (total phosphorus and nitrite + nitrate nitrogen) and, possibly, fecal coliform bacteria have been elevated occasionally, possibly because of the influence of animal operations in the watershed and/or the impacts of the WWTP effluents.
- The source(s) and specific cause(s) of biological impairment in Indian Creek are unknown and need to be determined.

VI. DATA GAPS AND POTENTIAL MONITORING NEEDS

- Preliminary reconnaissance (field parameters and some limited laboratory water analyses including iron, copper, lead, zinc, nutrients, turbidity, residues, and fecal coliform counts at selected sites) of the Indian-Howard's Creek LWP area has been initiated and is nearing completion. Additional reconnaissance may be needed in some locations after the results of all water analyses are known. This may include field parameters as well as the use of field water quality kit tests to pinpoint the nature and sources of potential problem areas.
- Additional biological monitoring (benthic macroinvertebrates and fish) and habitat assessments are needed to help ascertain the cause(s) and pinpoint possible source(s) of biological impairment in the lower part of Indian Creek. Water chemistry may be needed in association with some or all of these assessments.
- Water chemistry data, biological monitoring, and habitat assessments are needed to evaluate water quality for Howard's Creek, Indian Creek above and below the WWTPs, and for the major tributaries to both of these creeks.
- Further sampling needs to be conducted by the DWQ Watershed Assessment Team (WAT) at the original AMS monitoring location to determine whether nutrients may be a concern in Indian Creek.
- An initial scan for metals should be done at least once or twice at all selected monitoring sites to determine if any metals exceed water quality standards or action levels.
- Fecal coliform bacteria and nutrients need to be measured at least once or twice both upstream and downstream from the drainage of the permitted animal operations to see if any problems exist.
- Streamwalks should be conducted to determine animal access in watersheds showing elevated fecal coliform bacteria and/or nutrients.
- Wetland functional assessments using the NC WAM procedure (NC Wetland Functional Assessment Team 2008) are needed to assess wetland quality in the Indian/Howard's Creek watersheds to determine their potential for use in wetland mitigation.

VII. REFERENCES

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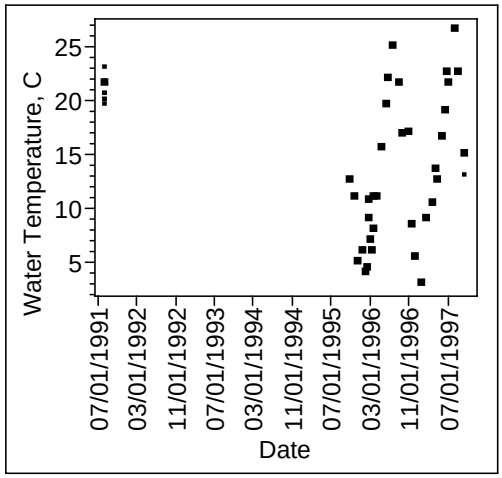
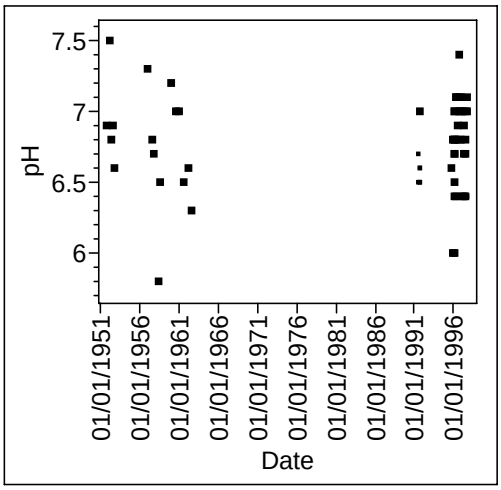
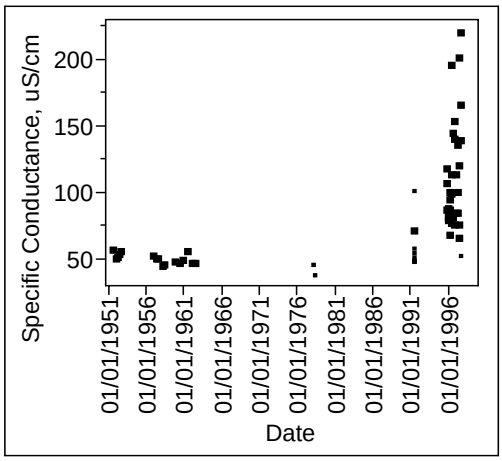
Appendix 1 -- Land Use/Land Cover in the Indian and Howard's Creeks Watersheds

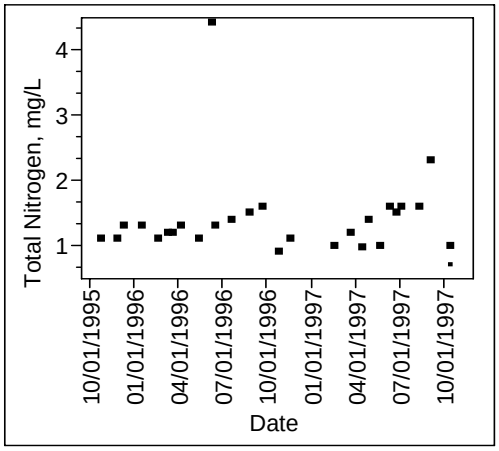
			Proportion (%)					
				Developed				
Subwatershed Name	EEP Sub-watershed ID	Total Area (sq mi)	Agriculture	High	Low	Forest	Herbaceous	Water
UT to Upper Howard Cr.	H_1	4.0	50.0	0.1	6.6	38.4	4.9	-
Rockdam Cr.	H_10	4.0	58.6	0.1	12.9	26.0	2.2	0.2
Howards Cr.-Upper	H_2	2.9	51.8	0.0	5.8	36.3	6.0	<0.1
Howards Cr.-Middle	H_3	2.8	60.9	0.0	6.3	24.9	7.3	0.5
Howards Cr.-Middle	H_4	4.7	45.2	0.1	6.5	42.1	6.2	0.1
Howards Cr.	H_5	5.0	47.1	0.0	5.1	42.8	4.9	<0.1
Tanyard Cr.	H_6	1.9	40.8	0.0	5.6	44.6	9.0	-
Tanyard Cr.	H_7	2.4	55.4	0.0	5.0	33.7	6.0	-
UT to Tanyard Cr.	H_8	2.4	51.6	0.0	6.8	36.7	4.8	-
Howards Cr.	H_9	3.8	71.8	0.0	7.1	17.8	3.0	0.1
Little Indian Cr.	I_1	5.0	44.0	0.0	7.9	39.3	8.8	0.1
Mill Cr.	I_10	4.8	50.5	0.1	6.5	39.1	3.6	0.2
Mill Cr.	I_11	2.3	39.7	0.0	6.5	50.1	3.6	0.1
Lick Fork	I_12	5.3	34.9	2.0	19.7	39.7	3.6	0.1
Indian Cr.-Middle	I_13	1.6	41.9	0.0	3.7	46.9	7.6	<0.1
Indian Cr.-Middle	I_14	2.3	20.3	9.4	26.7	37.6	5.6	0.3
Indian Cr.-Lower	I_15	2.6	65.6	0.2	4.7	25.9	3.7	-
Leonard Cr.	I_16	2.8	44.5	0.0	6.0	45.8	3.7	-
UT1 to Indian Cr.-Lower	I_17	2.7	55.8	0.0	4.9	35.5	3.4	0.4
Leonard Cr.	I_18	2.8	55.0	0.0	5.5	33.5	6.0	-
Indian Cr.-Lower	I_19	4.0	41.6	0.0	8.8	44.2	5.1	0.3
Little Indian Cr.	I_2	2.0	45.5	0.1	7.1	38.1	8.9	0.3
Indian Cr.-Lower	I_20	2.7	58.5	0.2	9.2	28.4	3.4	0.3
Indian Cr.-Lower	I_21	2.8	36.4	1.4	8.4	50.3	3.3	0.1
South Fork-Lower	I_22	5.2	26.0	3.8	31.8	35.5	2.1	1.0
Little Indian Cr.	I_3	5.1	40.6	0.1	7.6	42.3	9.2	0.3
Indian Cr.-Upper	I_4	3.2	57.2	0.1	6.3	30.1	6.2	-
Indian Cr.-Upper	I_5	2.5	46.3	0.1	5.0	42.8	5.7	0.1
Little Cr.	I_6	5.2	53.4	0.0	5.6	33.9	7.0	0.1
Indian Cr.-Upper	I_7	3.8	39.8	0.2	7.4	46.8	5.6	0.1
Indian Cr.-Middle	I_8	4.8	45.4	0.0	4.4	45.0	4.8	0.3
Indian Cr.-Middle	I_9	2.1	46.8	0.0	6.0	42.4	4.8	0.1
Middle South Fork-Upper	MSF_1	4.1	66.2	0.3	18.0	13.4	2.0	0.1
Middle South Fork-Lower	MSF_2	1.3	23.1	3.3	67.3	6.10	0.2	-
TOTAL	---	115.1	47.6	0.6	9.9	36.7	5.0	0.2

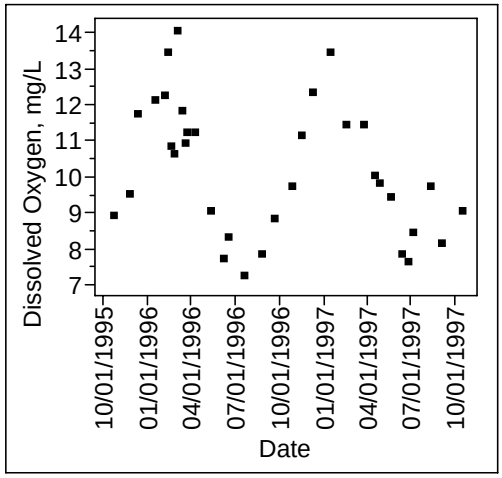
Appendix 2
USGS Data for Indian Creek Near Laboratory

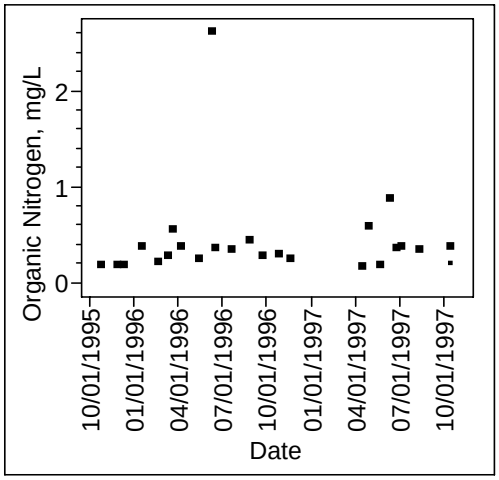




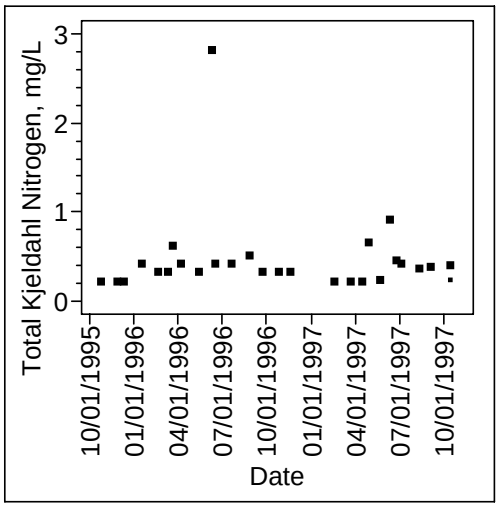


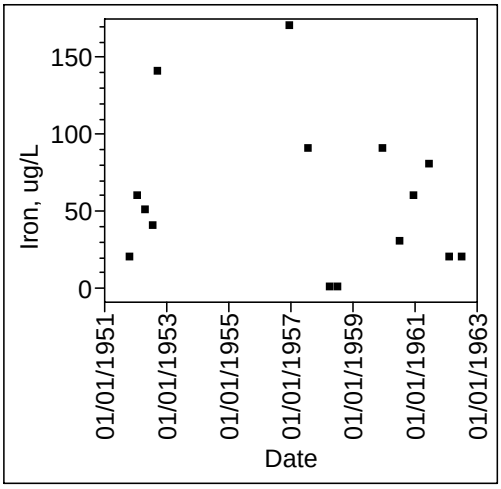


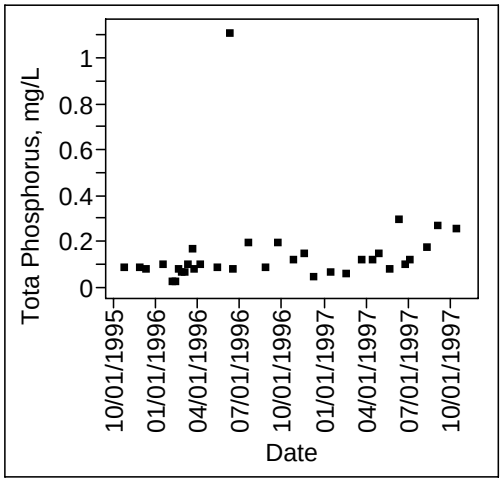


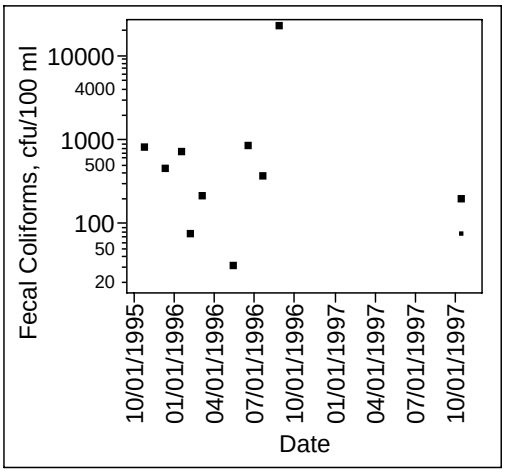


Appendix 2, Continued
USGS Data for Indian Creek Near Laboratory

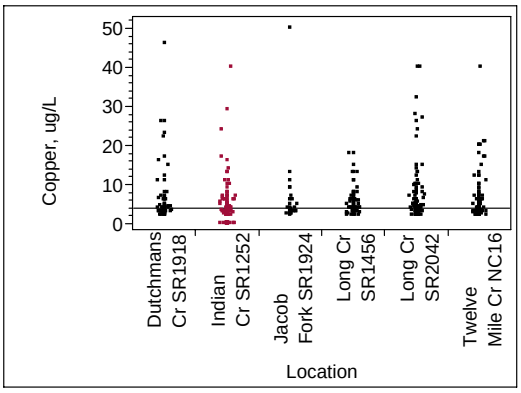


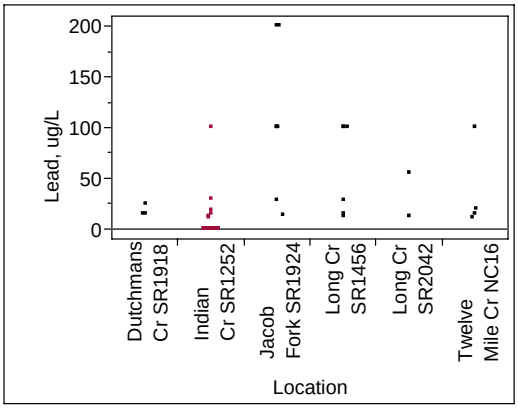


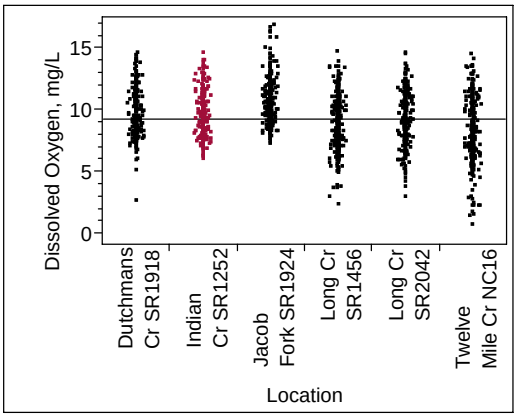


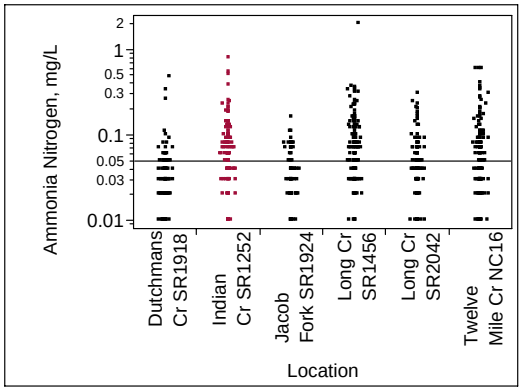


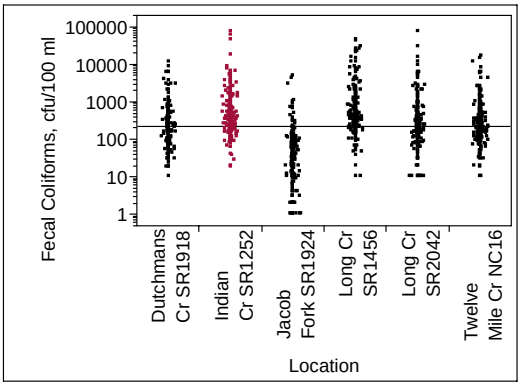
Appendix 3
Regional AMS Data Including Indian Creek
(Solid black lines are grand medians across all locations.)

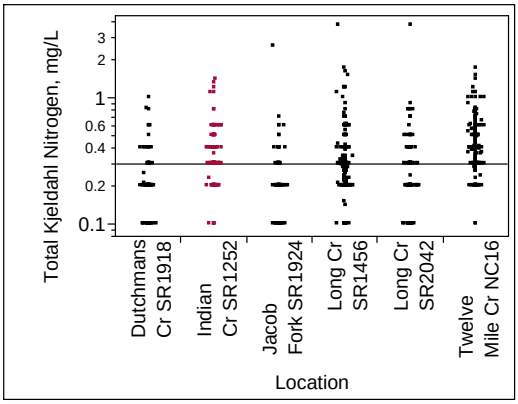




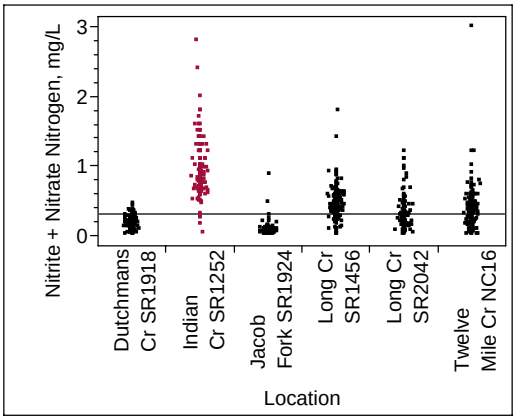


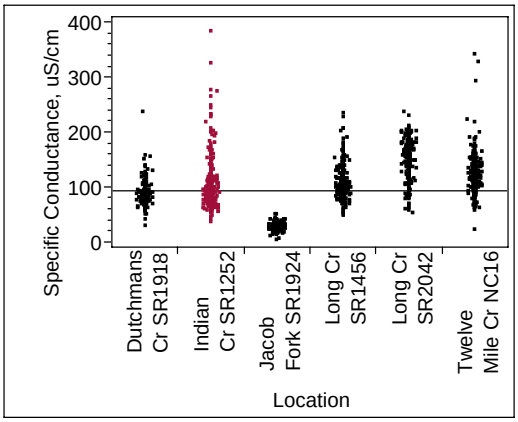


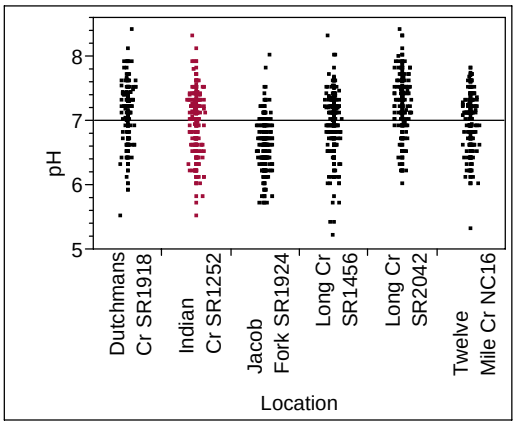


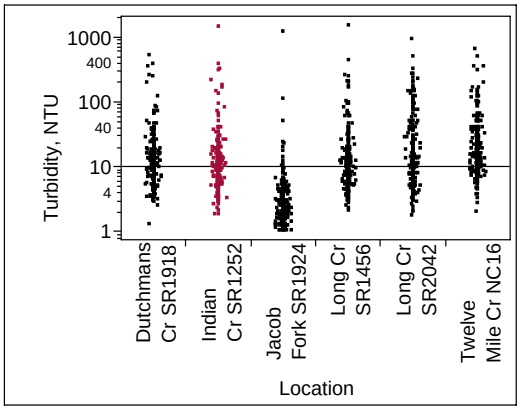


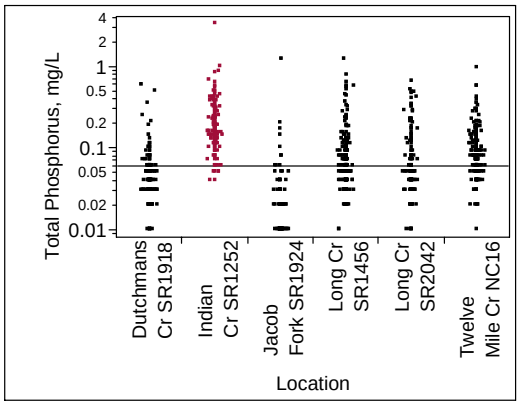
Appendix 3, Continued
Regional AMS Data Including Indian Creek – Continued.
(Solid black lines are grand medians across all locations.)

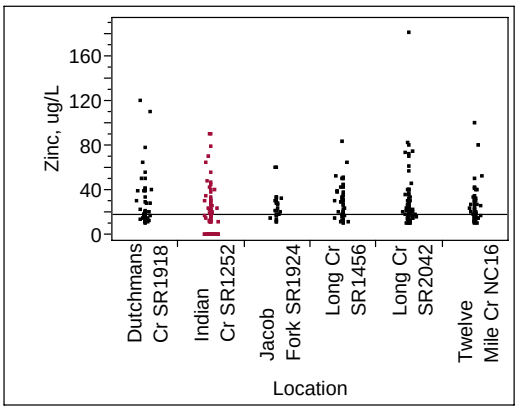




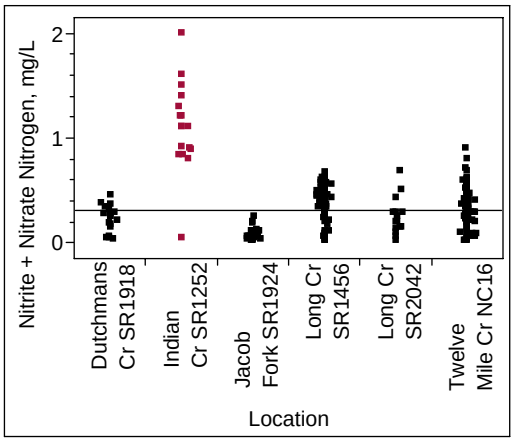


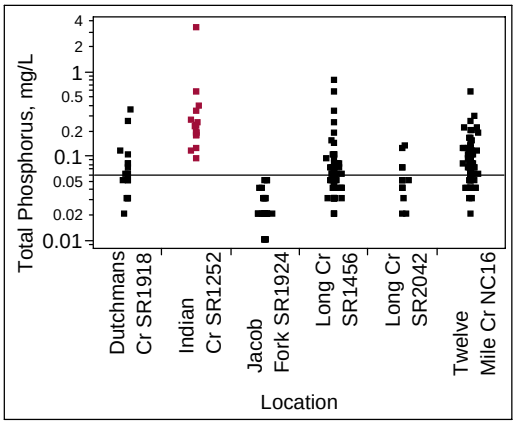




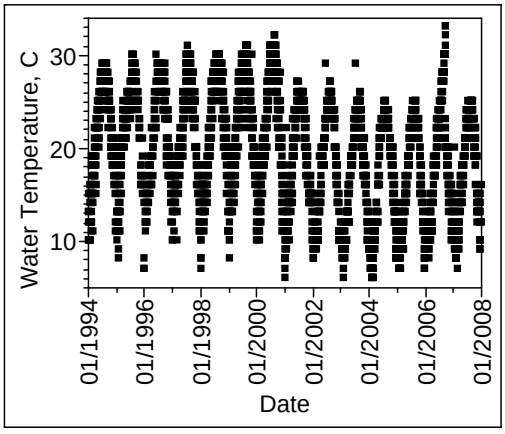


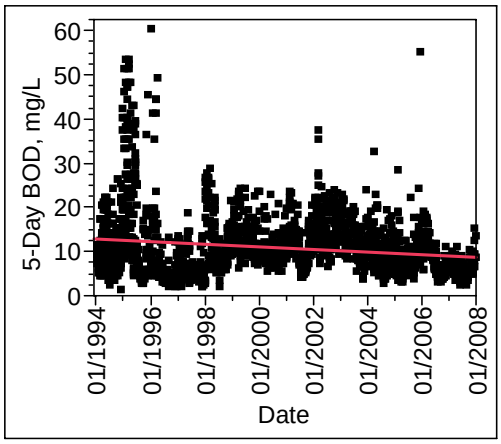
Appendix 3, Continued
Regional AMS Data Since 2000 Including Indian Creek
(Solid black lines are grand medians across all locations.)

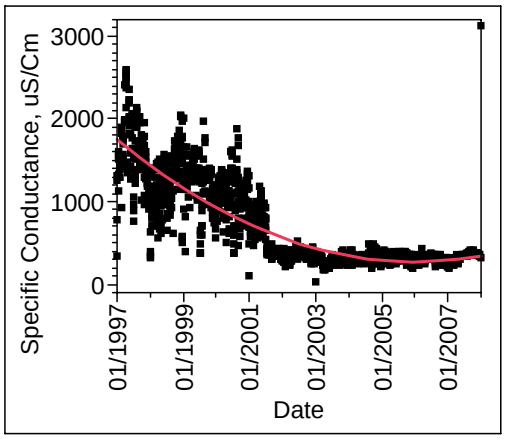


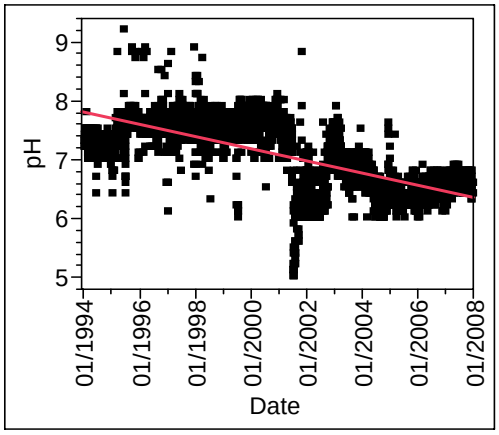


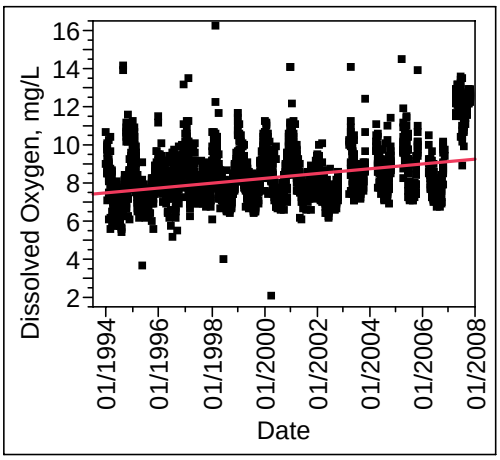
Appendix 4-A
Water Quality Data from the City of Cherryville WWTP
(Solid red lines on graphs are regression lines that show trends in the data over time)

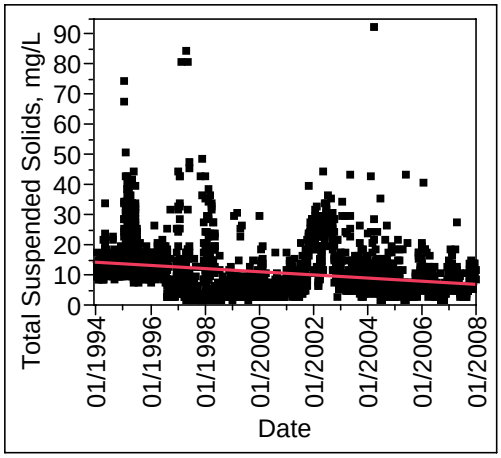




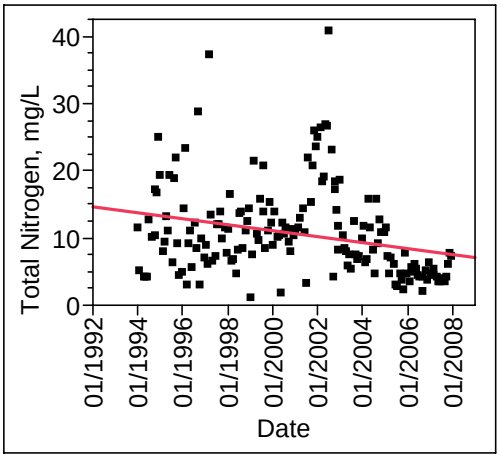


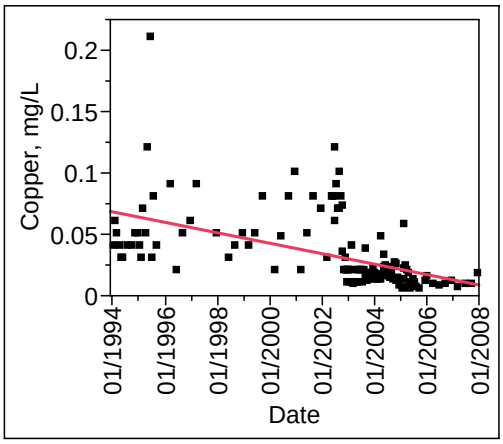


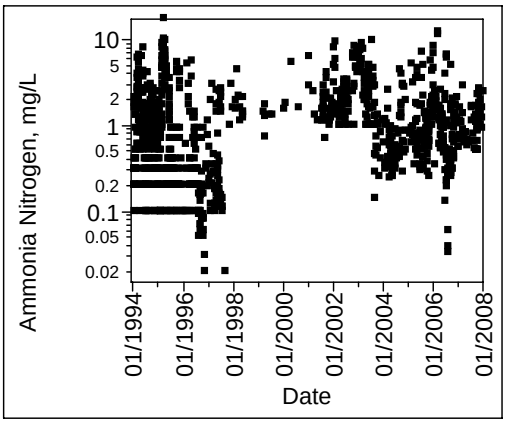


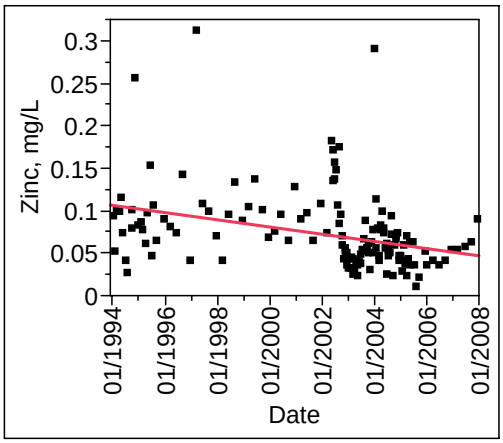


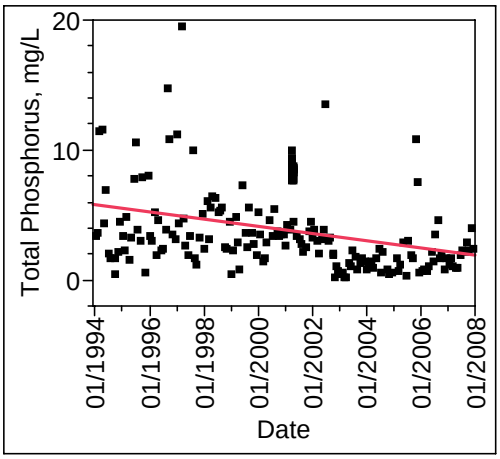
Appendix 4-A, Continued
Water Quality Data from the City of Cherryville WWTP
(Solid red lines on graphs are regression lines that show trends in the data over time)

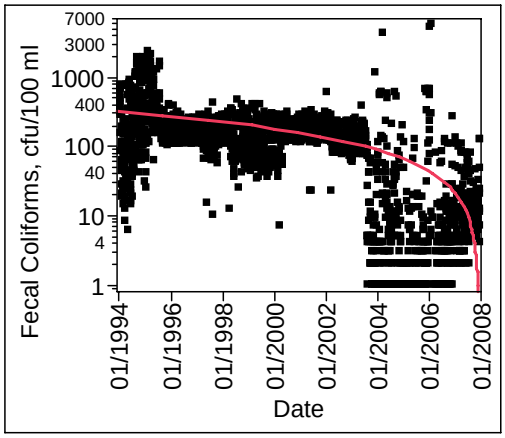




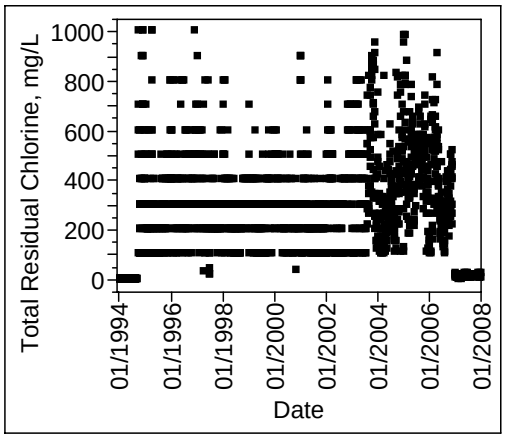


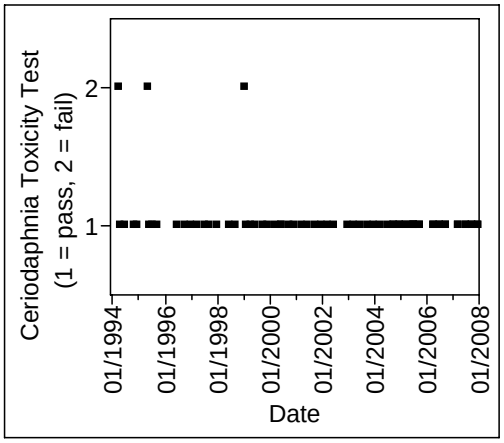




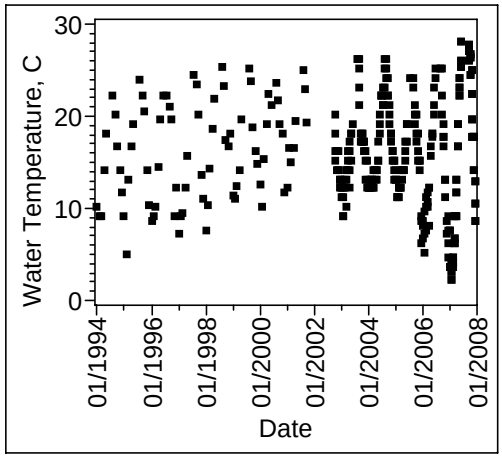


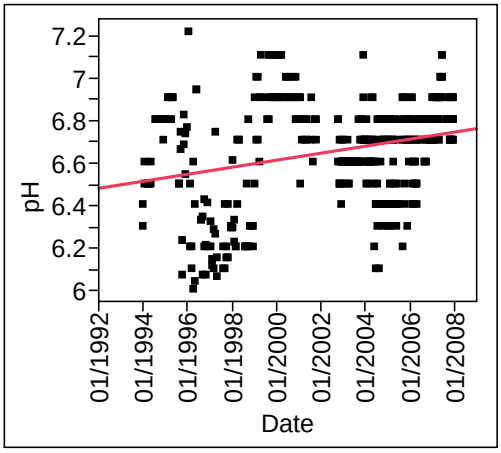
Appendix 4-A, Continued
Water Quality Data from the City of Cherryville WWTP

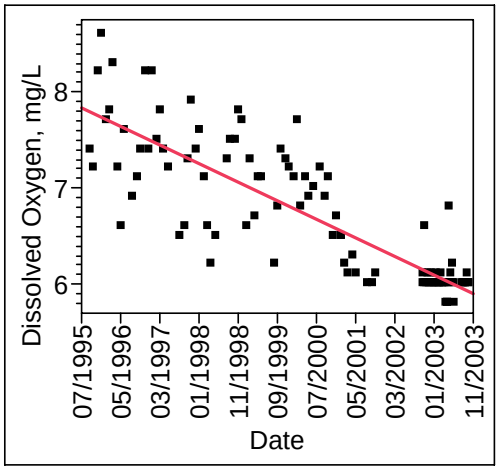


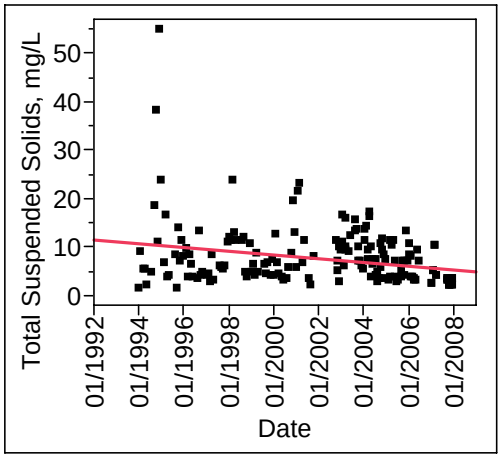


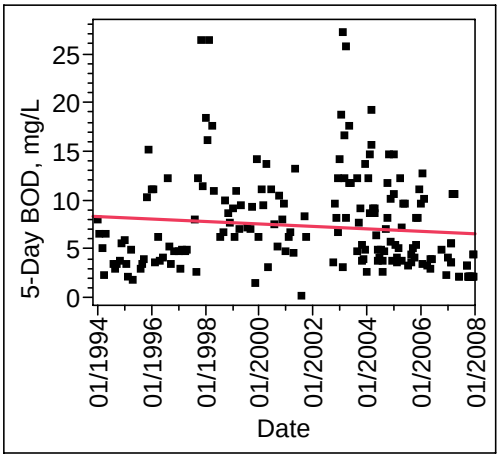
Appendix 4-B
Water Quality Data from the West Lincoln High School WWTP
(Solid red lines on graphs are regression lines that show trends in the data over time)

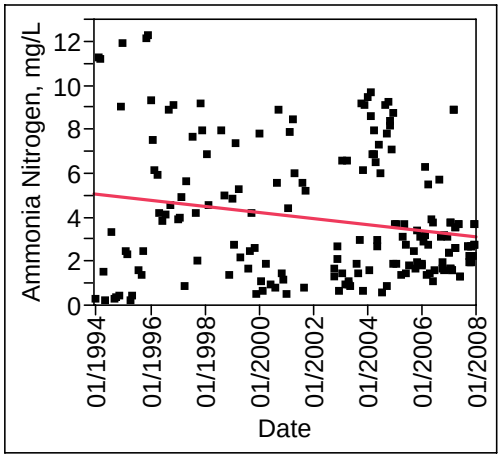












Appendix 4-B, Continued
Water Quality Data from the West Lincoln High School WWTP