



Watauga River Basin Ambient Monitoring System Report

January 1, 2005 through December 31, 2009

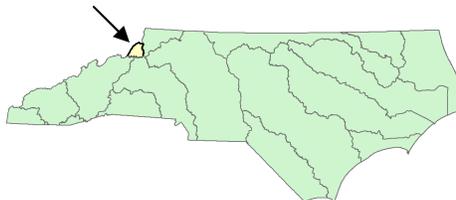


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Evaluation Levels

In order to assist the reader in developing a rapid understanding of the summary statistics provided throughout this data review, concentrations of water quality variables may be compared to an Evaluation Level (EL). Evaluation levels may be a water quality standard, an action level, an ecological threshold, or simply an arbitrary threshold that facilitates a rapid data review. Evaluation levels are further examined for frequency to determine if they have been exceeded in more than 10 percent of the observed samples. This summary approach facilitates a rapid and straightforward presentation of the data but may not be appropriate for making specific use support decisions necessary for identification of impaired waters under the Clean Water Act's requirements for 303(d) listings. The reader is advised to review the states 303(d) listing methodology for this purpose. (see <http://portal.ncdenr.org/web/wq/ps/mtu/assessment>).

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EXECUTIVE SUMMARY

A general understanding of human activities and natural forces that affect pollution loads and their potential impacts on water quality can be obtained through routine sampling from fixed water quality monitoring stations. During this assessment period (January 1, 2005 through December 31, 2009) chemical and physical measurements were obtained by the Division of Water Quality (DWQ) from two stations in the Watauga River Basin, located on the Watauga River near Shulls Mill and Sugar Grove.

DWQ uses a 10% criteria to determine whether a water body is meeting the applicable water quality standards. If more than 10% of the monitoring results violate the standard in question then the water body is not meeting the standard. When more than 10 percent of the results exceeded the evaluation level (10% criteria), a binomial statistical test is employed to determine how much statistical confidence there is that the results statistically exceed the 10% criteria. If at least 95% confidence was found that a 10% exceedance occurred, then that is termed a statistically significant exceedance (SSE).

In a typical basin there will be several or many such 10% exceedances, several SSEs and many monitoring sites. However in the Watauga River Basin there are only two monitoring sites, and neither had a SSE or 10% exceedances. Similarly in the 2005 Watauga River Basin Ambient Monitoring Report there were also none reported, except for one 10% exceedance for temperature, which was later judged to be a misapplication of the standard. Surface water regulations reference a temperature limit of 20 degrees Celsius for trout waters that are receiving waters of a thermal discharge. This standard was misapplied because there is no thermal discharge at the monitoring site. Based on the data from the two AMS stations, this river basin has remained in good health throughout the past ten years, and there are no worrisome trends.

INTRODUCTION

The DWQ's Ambient Monitoring System (AMS) is a network of stream, lake, and estuarine stations strategically located for the collection of physical and chemical water quality data. The stations are located at convenient access points (e.g. bridge crossings) that are sampled on a monthly basis. These locations were chosen to characterize the effects of point source dischargers and nonpoint sources such as agriculture, animal operations, and urbanization within watersheds.

The data are used to identify long term trends within watersheds, to develop Total Maximum Daily Loads (TMDLs) and to compare measured values with water quality standards to identify possible areas of impairment. Parametric coverage is determined by freshwater or saltwater waterbody classification and corresponding water quality standards. Under this arrangement, core parameters are based on Class C waters with additional parameters added when justified (**Table 1**).

Within this document, an analysis of how monitoring results compare with water quality standards and evaluation levels is presented. An educational and conceptual overview of water quality standards is provided at: <http://www.epa.gov/waterscience/standards>. Specific information on North Carolina water quality standards is provided at: <http://portal.ncdenr.org/web/wq/ps/mtu/assessment>. A summary of selected water quality standards are listed in **Table 2**.

Water quality data in this report are evaluated in five year periods. Data summaries for both stations are included in this report. DWQ monitored water quality and collected samples at two stations in the basin throughout the assessment period. The locations of the sampling sites are illustrated in **Figure 1**, and listed in **Table 3**.

In January 2007 the DWQ began collection of samples from a series of randomly determined sites. A description of the Random Ambient Monitoring System (RAMS) can be found here: <http://portal.ncdenr.org/web/wq/ess/eco/rams>. Two past RAMS stations were located in this basin. Because the basinwide reports assess in five-year windows and RAMS stations have only two years of data, they are not included in the ambient reports. Once a sufficient number of samples have been collected statewide, RAMS data will be discussed in a separate report.

Table 1. Parametric coverage for the Ambient Monitoring System.

Parameter
Dissolved oxygen (s)
pH (s)
Specific conductance
Temperature (s)
Total phosphorus
Ammonia as N
Total Kjeldahl as N
Nitrate+nitrite as N (s)
Total suspended solids
Turbidity (s)
Fecal coliform bacteria (s)
Chlorophyll <i>a</i> (s)

Notes:

An 's' indicates the parameter has a numeric standard.

Chlorophyll *a* and nutrient sampling is only done in areas of concern, such as NSW, estuaries, lakes, and areas with known enrichment issues.

Table 2. Selected Water Quality Standards

Parameter	Standards for All Freshwater			Standards to Support Additional Uses		
	Aquatic Life	Human Health	Water Supply Classifications	Trout Water	HQW	Swamp Waters
Chloride (mg/l)	230		250			
Chlorophyll <i>a</i> (ug/L)	40 ²			15 ²		
Coliform, total (MFTCC/100 ml) ³			50 ² (WS-I only)			
Coliform, fecal (MFFCC/100 ml) ⁴		200 ²				
Dissolved oxygen (mg/L)	4.0 ^{5,6}			6.0		2, 6
Hardness, total (mg/L)			100			
Nitrate nitrogen (mg/L)			10			
pH (units)	6.0 - 9.0 ^{2,6}					2, 6
Solids, total suspended (mg/L)					10 Trout, 20 other ⁷	
Turbidity (NTU)	50, 25 ²			10 ²		

Notes:

Standards apply to all classifications. For the protection of water supply and supplemental classifications, standards listed under Standards to Support Additional Uses should be used unless standards for aquatic life or human health are listed and are more stringent. Standards are the same for all water supply classifications (Administrative Code 15A NCAC 2B 0200, eff. August 1, 2005).

²Refer to 2B.0211 for narrative description of limits.

³Membrane filter total coliform count per 100 ml of sample.

⁴Membrane filter fecal coliform count per 100 ml of sample.

⁵An instantaneous reading may be as low as 4.0 mg/L, but the daily average must be 5.0 mg/L or more.

⁶Designated swamp waters may have a dissolved oxygen less than 5.0 mg/L and a pH as low as 4.3, if due to natural conditions.

⁷For effluent limits only, refer to 2B.0224(1)(b)(ii).

Figure 1. DWQ's Ambient Monitoring System in the Watauga River Basin.



Table 3. Monitoring stations in the Watauga River Basin

Station	Location	Stream Class	First Sample	Latitude	Longitude
HUC 06010103: Watauga River					
L1700000	Watauga River at SR 1557 near Shulls Mill	B Tr HQW	6/1/2000	36.17352	-81.74597
L4700000	Watauga River at SR 1121 near Sugar Grove	B Tr HQW	9/10/1973	36.23874	-81.82290

Primary Water Use Classifications

- C: Aquatic Life
- B: Primary Recreation
- WS-I, WS-II, WS-III, WS-IV, WS-V: Water Supply
- SA: Saltwater Shellfish Harvesting
- SB: Saltwater Primary Recreation
- SC: Saltwater Aquatic Life

Secondary Water Use Classifications

- Sw: Swamp Water
- HQW: High Quality Water
- ORW: Outstanding Resource Water
- Tr: Trout Waters
- CA, +: Critical Area
- NSW: Nutrient Sensitive Waters

PARAMETERS

Dissolved Oxygen

Dissolved oxygen is one of the most important of all the chemical measurements. Dissolved oxygen provides valuable information about the ability of the water to support aquatic life and the capacity of water to assimilate point and nonpoint discharges. Water quality standards for dissolved oxygen vary depending on the classification of the body of water. For freshwaters, 15A NCAC 02B .0211 (3)(b) specifies:

Dissolved oxygen: not less than 6.0 mg/l for trout waters; for non-trout waters, not less than a daily average of 5.0 mg/l with a minimum instantaneous value of not less than 4.0 mg/l; swamp waters, lake coves or backwaters, and lake bottom waters may have lower values if caused by natural conditions.

pH

The pH of natural waters can vary throughout the state. Low values, such as less than 7.0 Standard Units (SU), can be found in waters rich in dissolved organic matter, such as swamp lands. High values, such as greater than 7.0 SU may be found during algal blooms. Point source dischargers can also influence the pH of a stream. The measurement of pH is relatively easy; however the accuracy of field measurements is limited by the abilities of the field equipment, which is generally accurate to within 0.2 SU. This is due, in part, because the scale for measuring pH is logarithmic (i.e. a pH of 8 is ten times less concentrated in hydrogen ions than a pH of 7). The water quality standards for pH in freshwaters consider values less than 6.0 SU or greater than 9.0 SU to warrant attention. In swamp waters, a pH below 4.3 SU is of concern.

Specific Conductance

In this report, conductivity is synonymous with specific conductance. It is reported in micro-mhos per centimeter ($\mu\text{mhos/cm}$) at 25°C. Conductivity is a measure of the ability of water to conduct an electric current. The presence of ions and temperature are major factors in the ability of water to conduct a current. Clean freshwater has a low conductivity, whereas high conductivities may indicate polluted water or saline conditions. Measurements reported are corrected for temperature, thus the range of values reported over a period of time indicate the relative presence of ions in water. North Carolina freshwater streams have a natural conductance range of 17-65 $\mu\text{mhos/cm}$ (USGS 1992).

Conductivity can be used to evaluate variations in dissolved mineral concentrations (ions) among sites with varying degrees of impact resulting from point source discharges. Generally, impacted sites show elevated and widely ranging values for conductivity.

Turbidity

Turbidity data may denote episodic high values on particular dates or within narrow time periods. These can often be the result of intense or sustained rainfall events; however elevated values can occur at other times.

Nutrients

Compounds of nitrogen and phosphorus are major components of living organisms and thus are essential to maintain life. These compounds are collectively referred to as “nutrients.” Nitrogen compounds include ammonia-nitrogen (NH₃-N), total Kjeldahl nitrogen (TKN) and nitrite+nitrate nitrogen (NO₂+NO₃-N). Phosphorus is measured as total phosphorus. When nutrients are introduced to an aquatic ecosystem from municipal and industrial treatment processes, or runoff from urban or agricultural land, the excessive growth of algae and other plants may occur (i.e. algal blooms and infestations).

At neutral pH in water, ammonia normally forms an ionized solution of ammonium hydroxide, with only a small amount of ammonia. However, as pH increases, more ammonia is left unionized. Unionized ammonia is toxic to fish and other aquatic organisms.

Fecal Coliform Bacteria

Concentrations of fecal coliform bacteria can vary greatly. The descriptive statistics used to evaluate fecal coliform bacteria data include the geometric mean and the median depending on the classification of the waterbody. For all freshwater sites in the Watauga River Basin, the standard specified in Administrative Code 15A NCAC 02B.0211 (3)(e) (May 1, 2007) is applicable:

“Organisms of the coliform group: fecal coliforms shall not exceed a geometric mean of 200/100ml (MF count) based upon at least five consecutive samples examined during any 30 day period, nor exceed 400/100ml in more than 20 percent of the samples examined during such period; violations of the fecal coliform standard are expected during rainfall events and, in some cases, this violation is expected to be caused by uncontrollable nonpoint source pollution; all coliform concentrations are to be analyzed using the membrane filter technique unless high turbidity or other adverse conditions necessitate the tube dilution method; in case of controversy over results, the MPN 5-tube dilution technique shall be used as the reference method.”

Fecal coliform problems are screened using annual summaries of Ambient sampling results. If the screening indicates that the station may be in violation of the standard, the standard is assessed using the method required by law. All such class B waters are assessed, and other waters as resources permit. The required assessment method is known as “5 in 30”, collecting a minimum five samples within a span of 30 days. If a water body exceeds the standard more than 20% of the time during the 30-day period or the geomean for the 30-day period is greater than 200, then that water body is considered impaired and is added to the impaired water list, the 303(d) list.

Total Metals

The North Carolina Division of Water Quality is currently reviewing water quality standards for metals. Review of historical total metals data and biological data has shown that no correlation exists between exceedance of total metals ambient standards and biological impairment. Therefore, as of May 2007 DWQ has suspended collection of total metals at AMS stations. Both stations in the Watauga River Basin have total metals results from before the suspension. However, none of the metals results meet the requirement of a minimum of 10 samples for assessment. However, it is worth noting that of the 158 metal parameters tested for during the monitoring period, only one was above standard (for iron). The results are summarized in Appendix A on the Station Summary Sheets.

WATER QUALITY MONITORING RESULTS SUMMARY

Water Quality within the basin during the evaluation period is summarized in the following tables. **Table 4** shows how often water quality evaluation levels were exceeded. **Table 5** shows average values, for comparison against HUC and basinwide averages.

Table 4. Frequency of Evaluation Level Exceedances

Station ID	Stream Class	Water Temperature (>29 °C)	Turbidity (>10 NTU)	Fecal Coliform (>400 colonies/100 mL)
		Mountain Region	Troutwater	Freshwater
HUC 06010103: Watauga River				
L1700000	B Tr HQW	0.0%	3.5%	5.7%
L4700000	B Tr HQW	1.7%	6.9%	5.0%

If there are no exceedances for a given combination of evaluation level, stream class, and parameter during the assessment period, then that column is not included in the table.

1. There were no exceedances for **dissolved oxygen** during the assessment period.
2. There were no exceedances for **pH** during the assessment period.
3. No samples were collected for **chlorophyll a** during the assessment period.

Table 5a. Summary of Water Quality Parameter Averages

Station	Stream Class	Water Temperature (°C)		D.O. (mg/L)		pH (SU)		Spec. conductance (µmhos/cm at 25°C)		Turbidity (NTU)		Fecal coliform (# colonies per 100mL)	
		n	mean	n	mean	n	mean	n	mean	n	mean	n	mean
Entire Basin		115	13.3	115	10.4	113	7.6	113	69	115	7.3	109	30
HUC 06010103		115	13.3	115	10.4	113	7.6	113	69	115	7.3	109	30
L1700000	B Tr HQW	57	12.9	57	10.3	56	7.6	55	51	57	2.5	53	19
L4700000	B Tr HQW	58	13.8	58	10.6	57	7.7	58	86	58	12.0	56	46

Note: all means are arithmetic means, except for fecal coliform, which is a geometric mean.

Table 5b. Summary of Water Quality Parameter Averages for Nutrients

Station	Stream Class	Total Inorganic Nitrogen (mg/L)		Total Organic Nitrogen (mg/L)		NH3 as N (mg/L)		NO2 + NO3 as N (mg/L)		TKN as N (mg/L)		Total Phosphorus (mg/L)	
		n	mean	n	mean	n	mean	n	mean	n	mean	n	mean
Entire Basin		114	0.47	114	0.23	115	0.02	113	0.45	114	0.25	115	0.04
HUC 06010103		114	0.47	114	0.23	115	0.02	113	0.45	114	0.25	115	0.04
L1700000	B Tr HQW	56	0.33	57	0.19	57	0.02	55	0.30	57	0.21	57	0.03
L4700000	B Tr HQW	58	0.61	57	0.26	58	0.02	58	0.59	57	0.29	58	0.05

ASSESSMENT AND INTERPRETATION METHODS

Monitoring and sampling results considered in this report represent samples collected or measurements taken at less than one-meter depth.

Percentile statistics were calculated for most of the data using JMP statistical software (version 8.02; SAS Institute, Cary, NC). Values less than the minimum reporting level (non-detects) were evaluated as equal to the reporting level. Box and whisker plots (constructed using SigmaPlot version 9) and maps are presented for most water quality parameters collected at each monitoring station. Significant trends in water quality parameters (constructed using Microsoft Excel) are illustrated as scatterplots. Significant trends are found by assessing the probability that the linear model explains the data no better than chance. If that chance is 5% or less (an observed significance probability of 0.05 or less) then that is considered evidence of a regression effect in this document. The strength of the regression effect is given as an r^2 value, the portion of the data that is explained by the linear model. There are many other types of modeling (non-linear) that can be used to explore trends, but they were not used in this document.

Assessment Considerations

Total Metals

The North Carolina Division of Water Quality is currently reviewing water quality standards for metals. Review of historical total metals data and biological data has shown that no correlation exists between exceedance of total metals ambient standards and biological impairment. Therefore, as of May 2007 DWQ has suspended collection of total metals at AMS stations. Both stations in the Watauga River Basin have total metals results from before the suspension. However, none of the metals results meet the requirement of a minimum of 10 samples for assessment. Because of this, these results are not considered in this report.

Providing Confidence in the Exceedance of Water Quality Standards

Historically, NC DWQ has used guidance provided by the US EPA for determining when the number of results that exceed a water quality standard indicate potential water quality issues. The US EPA has suggested that management actions be implemented when 10 percent of the results exceeded a water quality standard. This interpretation is the same whether 1 out of 10, or 5 out of 50, or 25 out of 250 results exceed a standard. Evaluating exceedances in this manner is termed the “raw-score” approach. Although this “10 percent exceedance criterion” defines a point where potential water quality issues may be present, it does not consider uncertainty. Some results are subject to chance or other factors such as calibration errors or sample mishandling. Uncertainty levels change with sample size. The smaller the sample size, the greater the uncertainty.

This document uses a nonparametric procedure (Lin *et al.* 2000) to identify when a sufficient number of exceedances have occurred that indicate a true exceedance probability of 10 percent. Calculating the minimum number of exceedances needed for a particular sample size was done using the BINOMDIST function in Microsoft Excel®. This statistical function suggests that at least three exceedances need to be observed in a sample of 10 in order to be [about] 95 percent confident that the results statistically exceed the water quality standard more than 10% of the time. For example, there is less statistical confidence associated with a 1 exceedance out of 10 (74 percent) than when there are 3 exceedances out of 10 (99 percent confidence) (**Table 6**).

Table 6. Exceedance Confidence

Number of Samples	Number of Exceedances																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
10	74%	93%	99%	100%													
12	66%	89%	97%	100%													
14	58%	84%	96%	99%	100%												
16	51%	79%	93%	98%	100%												
18	45%	73%	90%	97%	99%	100%											
20	39%	68%	87%	96%	99%	100%											
22	34%	62%	83%	94%	98%	100%											
24	29%	56%	79%	91%	97%	99%	100%										
26	25%	51%	74%	89%	96%	99%	100%										
28	22%	46%	69%	86%	94%	98%	100%										
30	18%	41%	65%	82%	93%	97%	99%	100%									
32	16%	37%	60%	79%	91%	96%	99%	100%									
34	13%	33%	55%	75%	88%	95%	98%	99%	100%								
36	11%	29%	51%	71%	85%	94%	98%	99%	100%								
38	10%	25%	46%	67%	83%	92%	97%	99%	100%								
40	8%	22%	42%	63%	79%	90%	96%	98%	99%	100%							
42	7%	20%	38%	59%	76%	88%	95%	98%	99%	100%							
44	6%	17%	35%	55%	73%	85%	93%	97%	99%	100%							
46	5%	15%	31%	51%	69%	83%	92%	96%	99%	100%							
48	4%	13%	28%	47%	65%	80%	90%	95%	98%	99%	100%						
50	3%	11%	25%	43%	62%	77%	88%	94%	98%	99%	100%						
52	3%	10%	22%	40%	58%	74%	86%	93%	97%	99%	100%						
54	2%	8%	20%	36%	54%	71%	83%	91%	96%	98%	99%	100%	100%	100%	100%	100%	100%
56	2%	7%	18%	33%	51%	67%	81%	90%	95%	98%	99%	100%	100%	100%	100%	100%	100%
58	2%	6%	16%	30%	47%	64%	78%	88%	94%	97%	99%	100%	100%	100%	100%	100%	100%
60	1%	5%	14%	27%	44%	61%	75%	86%	93%	97%	99%	99%	100%	100%	100%	100%	100%
62	1%	5%	12%	24%	40%	57%	72%	84%	91%	96%	98%	99%	100%	100%	100%	100%	100%
64	1%	4%	11%	22%	37%	54%	69%	81%	90%	95%	98%	99%	100%	100%	100%	100%	100%
66	1%	3%	9%	20%	34%	51%	66%	79%	88%	94%	97%	99%	99%	100%	100%	100%	100%
68	1%	3%	8%	18%	31%	47%	63%	76%	86%	93%	96%	98%	99%	100%	100%	100%	100%
70	1%	2%	7%	16%	29%	44%	60%	74%	84%	91%	96%	98%	99%	100%	100%	100%	100%
72	0%	2%	6%	14%	26%	41%	57%	71%	82%	90%	95%	97%	99%	100%	100%	100%	100%
74	0%	2%	5%	13%	24%	38%	54%	68%	80%	88%	94%	97%	99%	99%	100%	100%	100%
76	0%	1%	5%	11%	22%	35%	51%	65%	77%	86%	93%	96%	98%	99%	100%	100%	100%
78	0%	1%	4%	10%	20%	33%	48%	62%	75%	85%	91%	95%	98%	99%	100%	100%	100%
80	0%	1%	4%	9%	18%	30%	45%	59%	72%	83%	90%	95%	97%	99%	99%	100%	100%

Note: Bold entries indicate that there is at least 95% confidence that at least 10% of the possible samples exceed the evaluation level.

Methods Used to Summarize Results

Methods used to summarize the results in this report encompass both tabular and graphical formats. Box and whisker plots, scatterplots, and maps were used to depict data for a variety of water quality parameters throughout the basin. For the box plots, stations with fewer than 10 data points for a given parameter were not included. This occasionally occurred when a new station was added, an old station was removed, or a station was moved to a new location in the basin.

Individual station summary sheets provide details on station location, stream classification, along with specifics on what parameters were measured, the number of samples taken (i.e. sample size), the number of results below reporting levels, the number of results exceeding a water quality standard or evaluation level, statistical confidence that 10% of results exceeded the evaluation level, and a general overview of the distribution of the results using percentiles. These station summary sheets provide the greatest details on a station-by-station basis. They are included as **Appendix A** to this report.

The results were depicted in the following ways:

- Comparing stations – box plots
- Assessing stations – tables
- Illustrating regional variation – maps

Box and Whisker Plots

One method of analyzing data in this report is through the use of box and whisker plots. **Figure 2** is an annotated example of a box and whisker plot that illustrates the distribution of the results for a particular parameter at a single site. This box plot contains both the median and mean values. Differences between the median and mean can illustrate the distribution of the results. For example, if the mean is considerably larger than the median, then there are likely a few very high concentrations raising the mean. Another useful measure is to compare the 90th percentile against the evaluation level. For most parameters, 10% exceedance of the evaluation levels is considered a violation. Therefore the 90th (or 10th in the case of minimum evaluation levels) percentile exceeding the evaluation level is an equivalent statement. Box plots for each station are included in **Appendix B**.

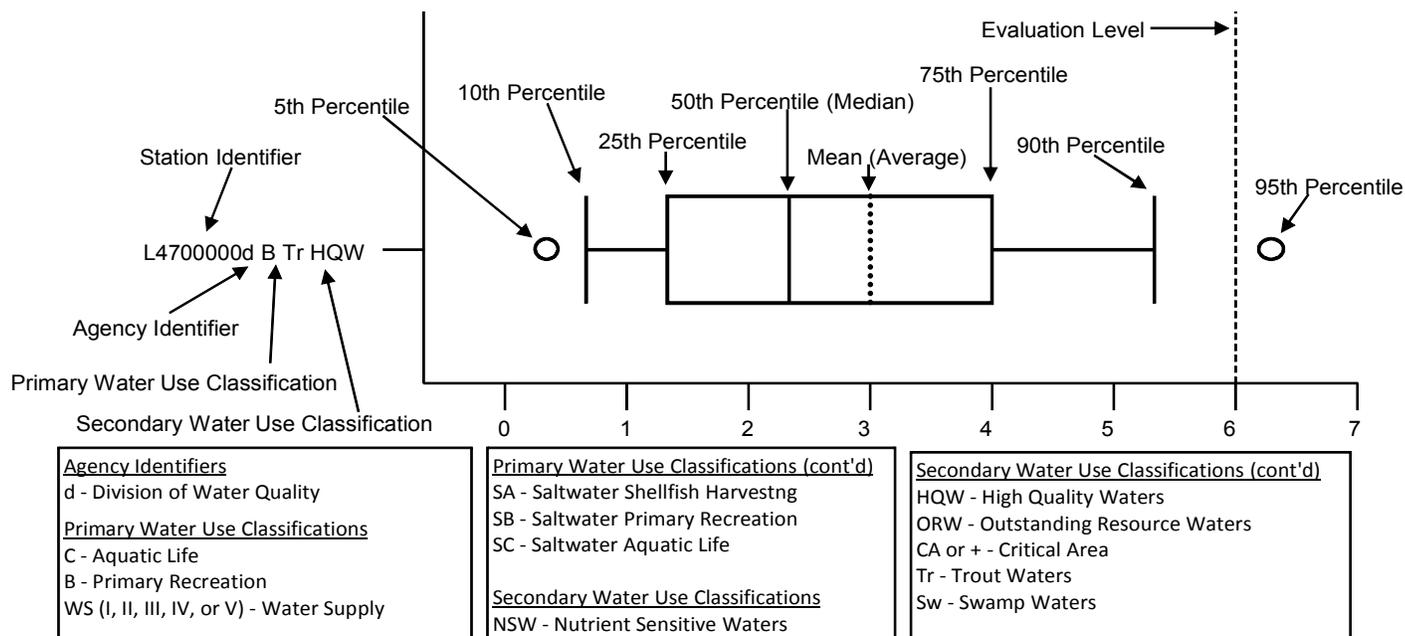
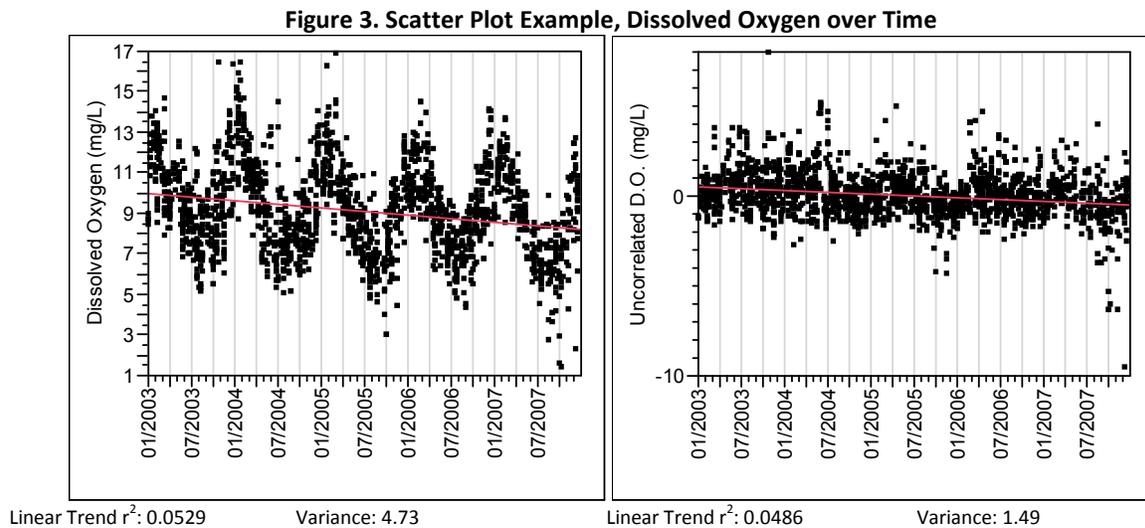


Figure 2. An Example Box Plot for a Station

Scatter Plots – Change Over Time and Trends

Constructing trends helps us to answer the question, “Are things getting better or worse?” In this document change over time trends are illustrated in scatterplots. If there is at least 95% confidence that a particular linear trend explains the data better than random chance (Prob > F of 0.05 or less) then that linear trend was included on the graph. Unfortunately clear trends are rare. Confounding effects, such as flow and seasonal change can mimic or obscure a trend. The figure below on the left shows dissolved oxygen data exhibiting a strong seasonal pattern. In order to search for an underlying trend we first need to remove the seasonal component.

Linear regression can remove the seasonal effect by comparing the target parameter to another seasonally variable parameter, (in this case water temperature) and removing the variation that is common to both. Variation due to flow can be removed in the same fashion. The graph on the right shows the same dissolved oxygen data, but with the seasonal component removed. The data is considerably less variable now (as shown in the variance). The new graph still displays a trend, weaker than it was when influenced by water temperature.



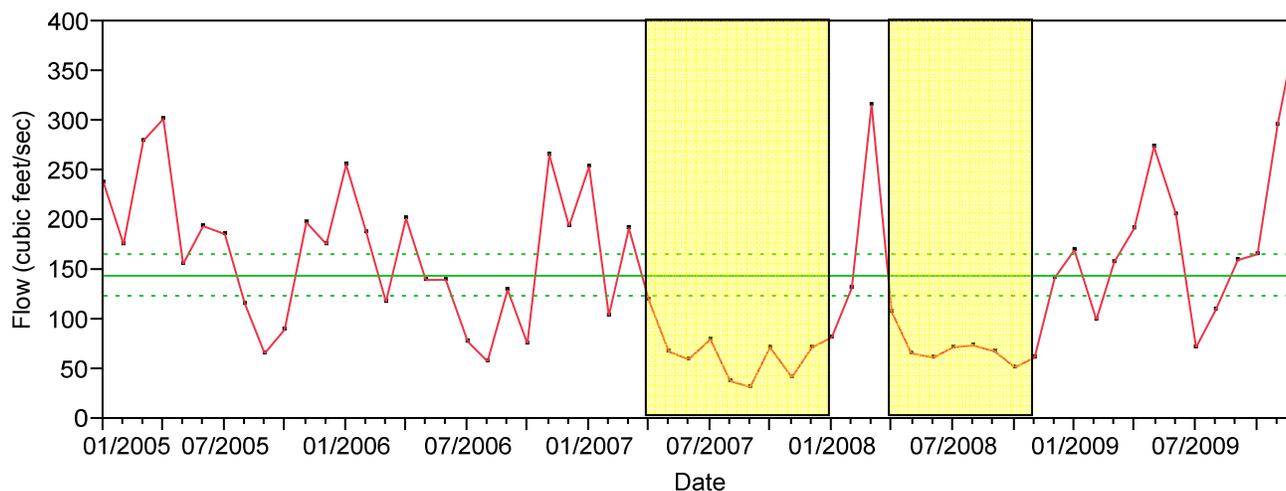
WATER QUALITY ANALYSIS

Stream Flow and Drought

The rate at which a volume of water moves through a stream (the flow rate) can have an impact on the measurement of other parameters. In particular, droughts can have major effects on parameters such as dissolved oxygen, turbidity, pH, and others by reducing stream flow. Therefore it is useful to track changes in stream flow over the course of the assessment period, to see when drought or high flow events might be present. In the following graph the average monthly flow (red variable line) is displayed and compared to the average flow for the entire period (green line). The 95% confidence interval for the average (green dotted lines) is also given. For this graph, any period with four or more consecutive months below the 95% confidence interval is considered a drought.

One site was assessed for flow: the Watauga River near Sugar Grove. A drought affected this site in 2007, and 2008. During those two years 18 out of 24 months (75%) were drought months. Figure 5 displays the water flow at this station.

Figure 4. Average Monthly Flow in the Watauga River Basin
Watauga River near Sugar Grove



Long Term Trends

In order to develop useful long term trends, it is important to remove as many confounding effects as possible. The most common confounding effect is flow rate. Many environmental parameters can be affected by flow rate. If flow is not accounted for, a drought may accidentally be interpreted as a significant historical shift. In addition, some parameters have strong seasonal components that can be removed in order to see an underlying trend.

Water Quality Data collected by DWQ from inception through 2009 were downloaded from the EPA STORET database for one station: L4700000 – Watauga River near Sugar Grove. Flow data from the USGS website were also downloaded. If flow or other confounding trends were found in the data, it was removed using linear regression. Linear regression and best professional judgment was then used to evaluate change over time.

The data were evaluated for the presence of trends for parameters including water temperature, specific conductance, pH, dissolved oxygen, turbidity, fecal coliform, ammonia, nitrates/nitrites, kjeldahl nitrogen, and phosphorus.

L4700000 – Watauga River at SR 1121 near Sugar Grove

Trends were explored for this station from station inception (1975) through 2009. There were no strong trends found for this station. There were several weak ones. Nitrates/Nitrites were found to be decreasing over time (-0.005 mg/L per year) and Dissolved Oxygen was found to be increasing over time (+0.02 mg/L per year). Specific Conductance was found to be increasing over time (+0.6 umhos/cm per year) and fecal coliform was found to be decreasing (-17 colonies/100 mL per year).

Based on best professional judgment, water quality at this station remains high and there are no worrisome trends.

Other Issues

No significant issues were identified in the Watauga River basin. Information on specific parameters and specific stations can be found in **Appendix A** (station summary sheets) and **Appendix B** (box plots). Box plots were constructed for each of the following parameters: water temperature, dissolved oxygen, pH, specific conductance, turbidity, fecal coliform, ammonia, total kjeldahl nitrogen, total nitrates and nitrites, and total phosphorus.

Appendix A: Station Summary Sheets

Ambient Monitoring System Station
 NCDENR, Division of Water Quality
 Basinwide Assessment

Location: WATAUGA RIV AT SR 1557 NR SHULLS MILL
Station #: L1700000 **Hydrologic Unit Code:** 06010103
Latitude: 36.17352 **Longitude:** -81.74597 **Stream class:** B Tr HQW
Agency: NCAMBNT **NC stream index:** 8-(1)

Time period: 01/27/2005 to 12/16/2009

	# results	# ND	EL	Results not meeting EL			Percentiles						
				#	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	57	0	<6	0	0		7.4	8.2	8.6	10.1	12	13.3	14.2
pH (SU)	56	0	<6	0	0		7	7.2	7.4	7.5	7.7	7.9	8.6
	56	0	>9	0	0		7	7.2	7.4	7.5	7.7	7.9	8.6
Spec. conductance (umhos/cm at 25°C)	55	0	N/A				41	43	47	51	55	58	72
Water Temperature (°C)	57	0	>29	0	0		0.8	3.1	6.5	13.7	19.3	21.2	22.7
Other													
TSS (mg/L)	20	14	N/A				2.5	2.5	4.9	6.2	6.4	12.9	20
Turbidity (NTU)	57	16	>10	2	3.5		1	1	1	1.5	2.4	5.8	13
Nutrients (mg/L)													
NH3 as N	57	42	N/A				0.02	0.02	0.02	0.02	0.02	0.04	0.05
NO2 + NO3 as N	55	0	N/A				0.11	0.19	0.23	0.28	0.37	0.45	0.61
TKN as N	57	42	N/A				0.2	0.2	0.2	0.2	0.2	0.23	0.33
Total Phosphorus	57	17	N/A				0.02	0.02	0.02	0.02	0.03	0.04	0.14
Metals (ug/L)													
Aluminum, total (Al)	9	3	N/A				50	50	50	110	215	290	290
Arsenic, total (As)	9	9	>10	0	0		5	5	5	5	5	5	5
Cadmium, total (Cd)	9	9	>0.4	0	0		1	1	2	2	2	2	2
Chromium, total (Cr)	9	9	>50	0	0		10	10	25	25	25	25	25
Copper, total (Cu)	9	8	>7	0	0		2	2	2	2	2	4	4
Iron, total (Fe)	9	0	>1000	0	0		120	120	135	280	500	600	600
Lead, total (Pb)	9	9	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	8	8	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	9	9	>88	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	9	5	>50	0	0		10	10	10	10	12	24	24

Fecal Coliform Screening(#/100mL)

# results:	Geomean	# > 400:	% > 400: %Conf:
53	19.3	3	5.7

Key:

result: number of observations
 # ND: number of observations reported to be below detection level (non-detect)
 EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
 Results not meeting EL: number and percentages of observations not meeting evaluation level
 %Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
 Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station
 NCDENR, Division of Water Quality
 Basinwide Assessment

Location: WATAUGA RIV AT SR 1121 NR SUGAR GROVE
Station #: L4700000 **Hydrologic Unit Code:** 06010103
Latitude: 36.23874 **Longitude:** -81.82290 **Stream class:** B Tr HQW
Agency: NCAMBNT **NC stream index:** 8-(1)

Time period: 01/27/2005 to 12/16/2009

	# results	# ND	EL	Results not meeting EL			Percentiles						
				#	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	58	0	<6	0	0		7.4	8.1	8.8	10.5	12.5	13.5	14.4
pH (SU)	57	0	<6	0	0		6.7	7.3	7.5	7.7	7.9	8.1	8.5
	57	0	>9	0	0		6.7	7.3	7.5	7.7	7.9	8.1	8.5
Spec. conductance (umhos/cm at 25°C)	58	0	N/A				48	57	72	86	96	118	145
Water Temperature (°C)	58	0	>29	1	1.7		1	3.6	6.5	15.1	21	23.3	29.3
Other													
TSS (mg/L)	18	12	N/A				2.5	2.8	4.8	6.2	12	13.1	23
Turbidity (NTU)	58	8	>10	4	6.9		1	1	1.3	2.2	3.9	8.7	500
Nutrients (mg/L)													
NH3 as N	58	51	N/A				0.02	0.02	0.02	0.02	0.02	0.02	0.24
NO2 + NO3 as N	58	0	N/A				0.11	0.3	0.37	0.51	0.76	1.1	1.4
TKN as N	57	33	N/A				0.2	0.2	0.2	0.2	0.25	0.3	3.6
Total Phosphorus	58	13	N/A				0.02	0.02	0.02	0.02	0.03	0.05	1.2
Metals (ug/L)													
Aluminum, total (Al)	9	1	N/A				50	50	94	130	330	750	750
Arsenic, total (As)	9	9	>10	0	0		5	5	5	5	5	5	5
Cadmium, total (Cd)	9	9	>0.4	0	0		1	1	1.5	2	2	2	2
Chromium, total (Cr)	9	9	>50	0	0		10	10	18	25	25	25	25
Copper, total (Cu)	9	8	>7	0	0		2	2	2	2	2	2	2
Iron, total (Fe)	9	0	>1000	1	11.1		160	160	180	270	580	1100	1100
Lead, total (Pb)	9	9	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	7	7	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	9	9	>88	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	9	6	>50	0	0		10	10	10	10	10	24	24

Fecal Coliform Screening(#/100mL)

# results:	Geomean	# > 400:	% > 400: %Conf:
56	46.2	5	8.9

Key:

result: number of observations
 # ND: number of observations reported to be below detection level (non-detect)
 EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
 Results not meeting EL: number and percentages of observations not meeting evaluation level
 %Conf : States the percent statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
 Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Appendix B: Station Box & Whisker Plots

Figure 5. Box Plots of Water Temperature, Specific Conductance, and Dissolved Oxygen

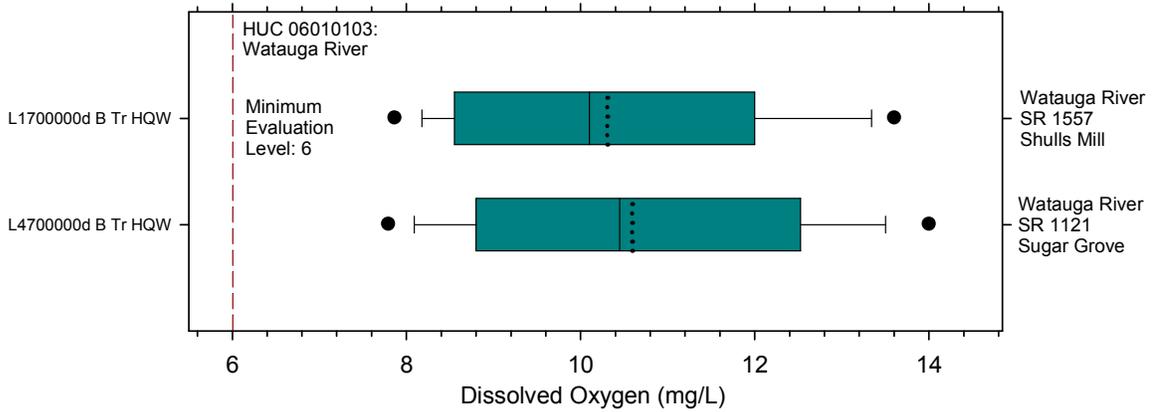
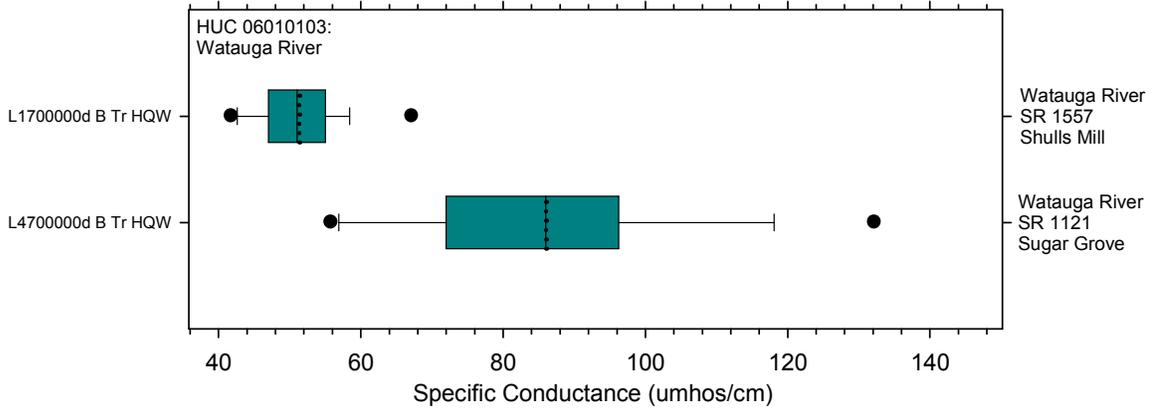
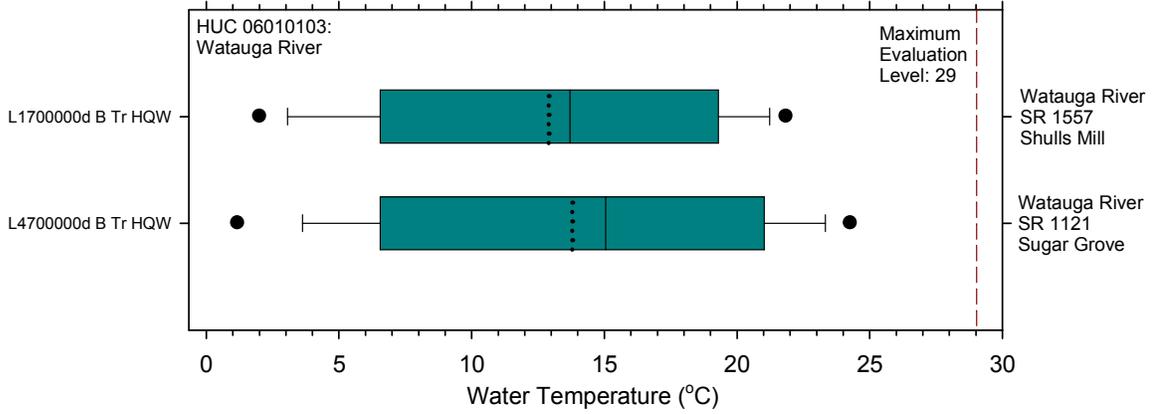


Figure 6. Box Plots of pH, Fecal Coliform, and Turbidity

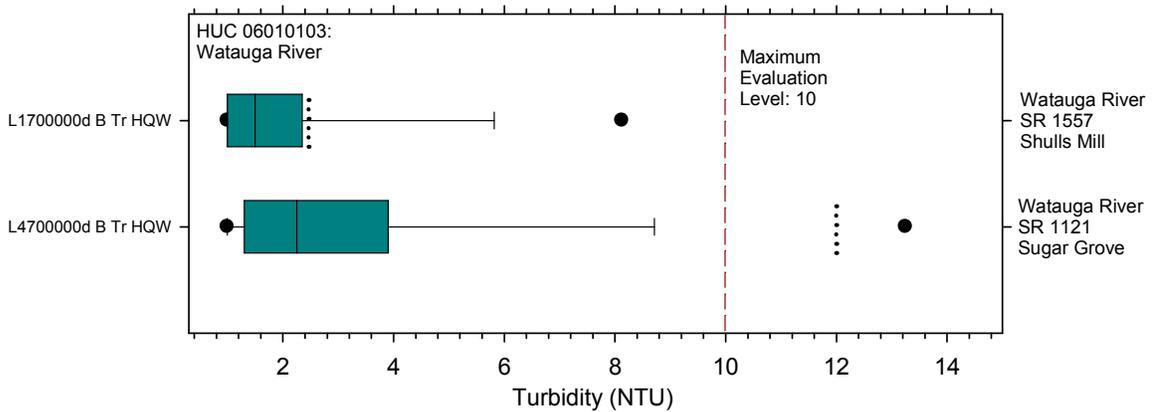
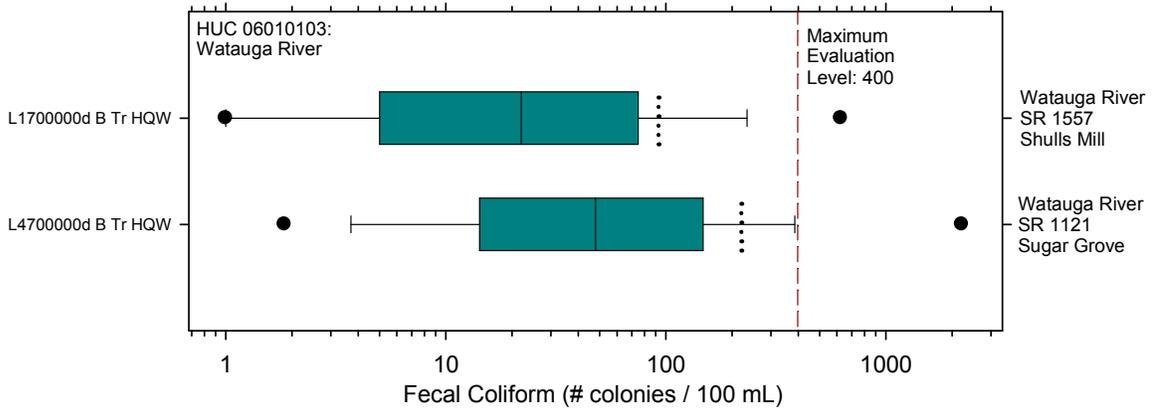
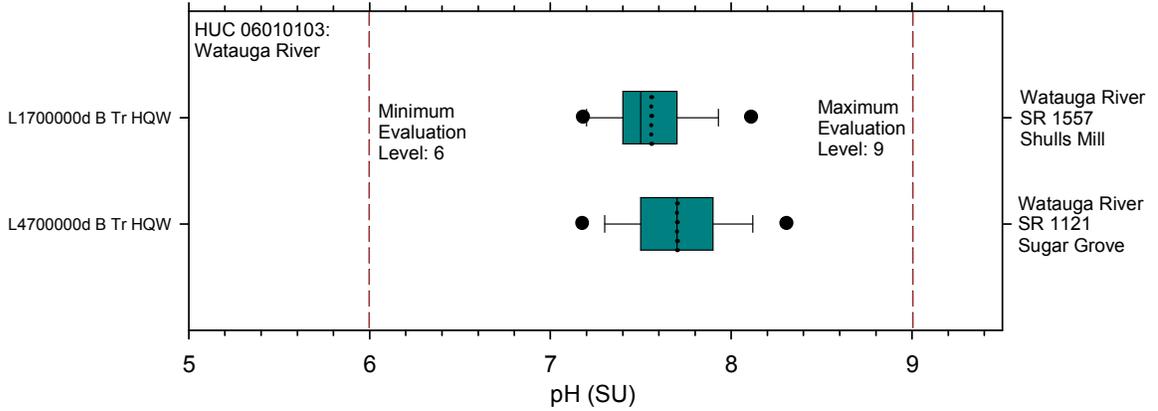


Figure 7. Box Plots of Ammonia Nitrogen, Total Kjeldahl Nitrogen, and Total Nitrates/Nitrites

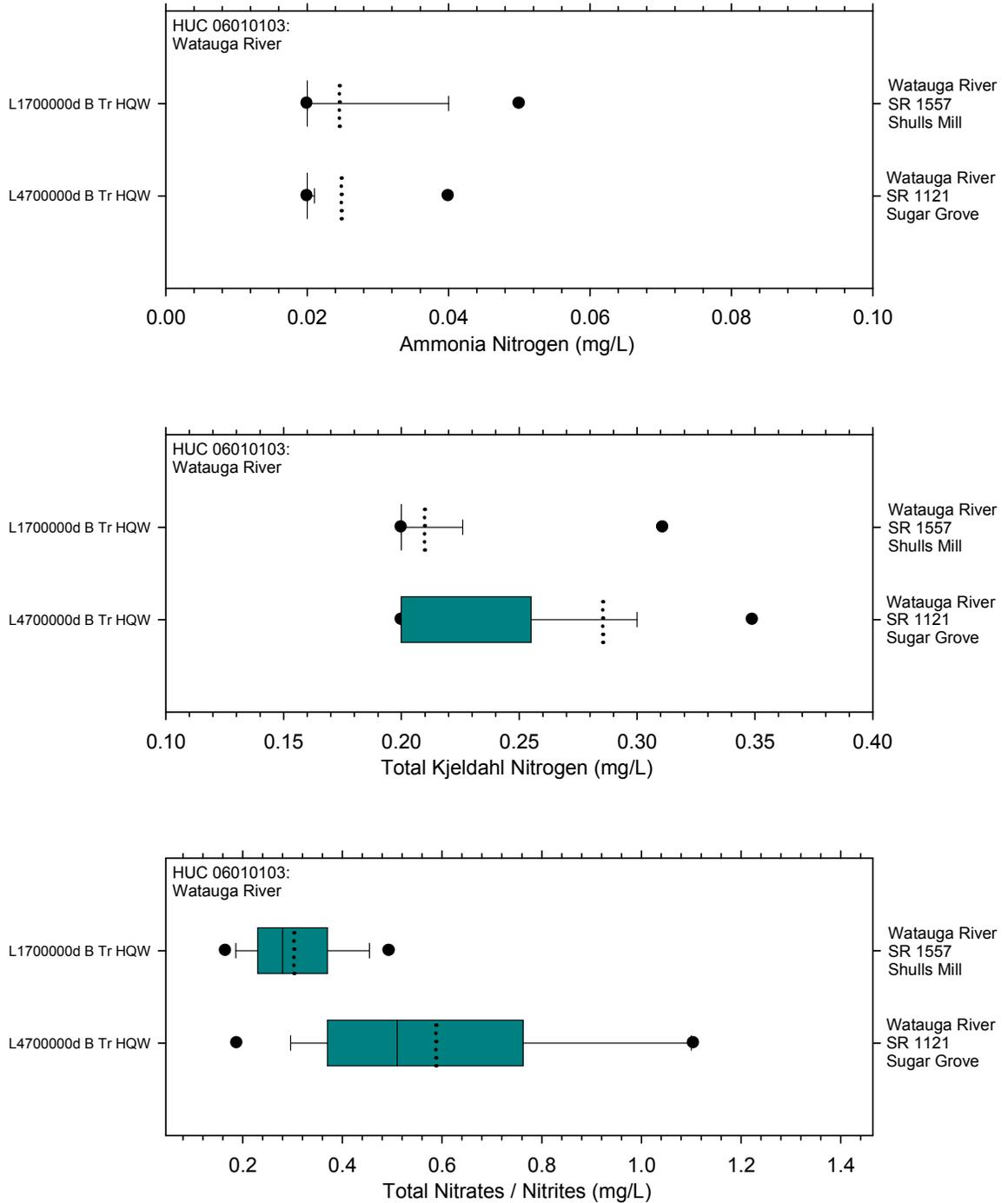
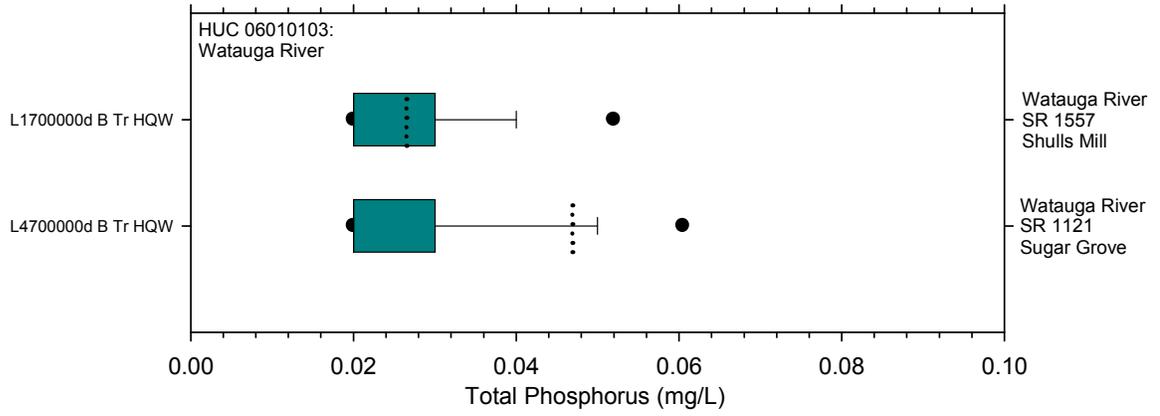


Figure 8. Box Plots of Total Phosphorus in the Watauga River Basin



Appendix C: References

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