DRAFT
Summary of Existing Water Quality Data

for

Little Alamance Creek
Travis Creek
Tickle Creek

Guilford and Alamance Counties
North Carolina

NC Division of Water Quality
Watershed Assessment Team
September 2006

Introduction and Background

The Ecosystems Enhancement Program (EEP) has selected Little Alamance, Tickle and Travis creek watersheds (LATT) for the development of a Local Watershed Plan (LWP). In support of this plan, the NC Division of Water Quality (DWQ) -- Watershed Assessment Team (WAT) has developed this summary of available water quality data. This summary identifies and summarizes water quality data that have been collected in the LATT LWP planning area. Data collected as part of synoptic surveys during the summer of 2006 are also summarized.

The LATT watersheds lie partially within Guilford County but primarily within Alamance County near the municipalities of Gibsonville, Elon, Burlington and Graham. Although the acronym LATT reflects the names of three streams (Little Alamance, Tickle, and Travis), others (e.g. Dry Creek) are included in the LWP planning area (Figure 1). Information on watersheds is often filed or cataloged using watershed codes. In North Carolina, two formal watershed-cataloging systems are used. The United States Geological Survey (USGS) and other federal agencies use Hydrologic Unit Codes (HUCs) extensively. The NC Division of Water Quality uses subbasin codes. The codes that are used for the LATT watersheds are provided in Table 1.

Table 1. USGS and DWQ watershed codes that include the Little Alamance, Tickle and Travis Creek (LATT) watersheds. (Eight-digit HUC codes are in **bold** font)

Watershed	14-digit Hydrologic Unit Code (HUC)[1]	DWQ Subbasin[2]	Area (mi^2) (14-digitit HUC)
Tickle, Travis	**03030002**030010	03-06-02 or CPF02	35
Little Alamance	**03030002**040110	03-06-03 or CPF03	16

[1] The United States Geological Survey designates watershed using Hydrologic Unit Codes (HUCs). Natural resource professionals often refer to 8-digit HUCs and 14-digit HUCs. The 14-digit HUCs represent smaller watersheds. All of the LATT watersheds lie within the 8-digit "03030002" HUC

[2] The DWQ uses a different numbering scheme. The DWQ scheme is useful when referring to sections or chapters within the DWQ's Basin Assessment Reports (http://h2o.enr.state.nc.us/esb/bar.html) or the Basinwide Management Plans (http://h2o.enr.state.nc.us/basinwide).

Watershed Land Uses, Geology and Point Source Dischargers

The Little Alamance Creek watershed consists mostly of urban and suburban areas, while the Travis and Tickle Creek watersheds have mostly suburban and rural land uses.

Streams within the LWP planning area are along the border between the Carolina Slate Belt, which is mostly east of the watersheds, and the mixed felsic and mafic region to the west. Streams within the Carolina Slate Belt can exhibit low flows, or even cease flowing due to natural conditions.

There are three small point-source discharges in the LWP areas (Table 2), and no agricultural animal operations with NPDES permits in these watersheds. No individual stormwater permits have been issued within these watersheds.

Table 2. NPDES point source dischargers

Permittee	Permit Number	Permitted discharge	Waterbody
Shields Mobile Home Park	NC0055271	0.006 MGD	Travis Cr
Western Alamance Middle School	NC0031607	0.015 MGD	Haw River
Western Alamance High School	NC0045144	0.0115 MGD	Haw River

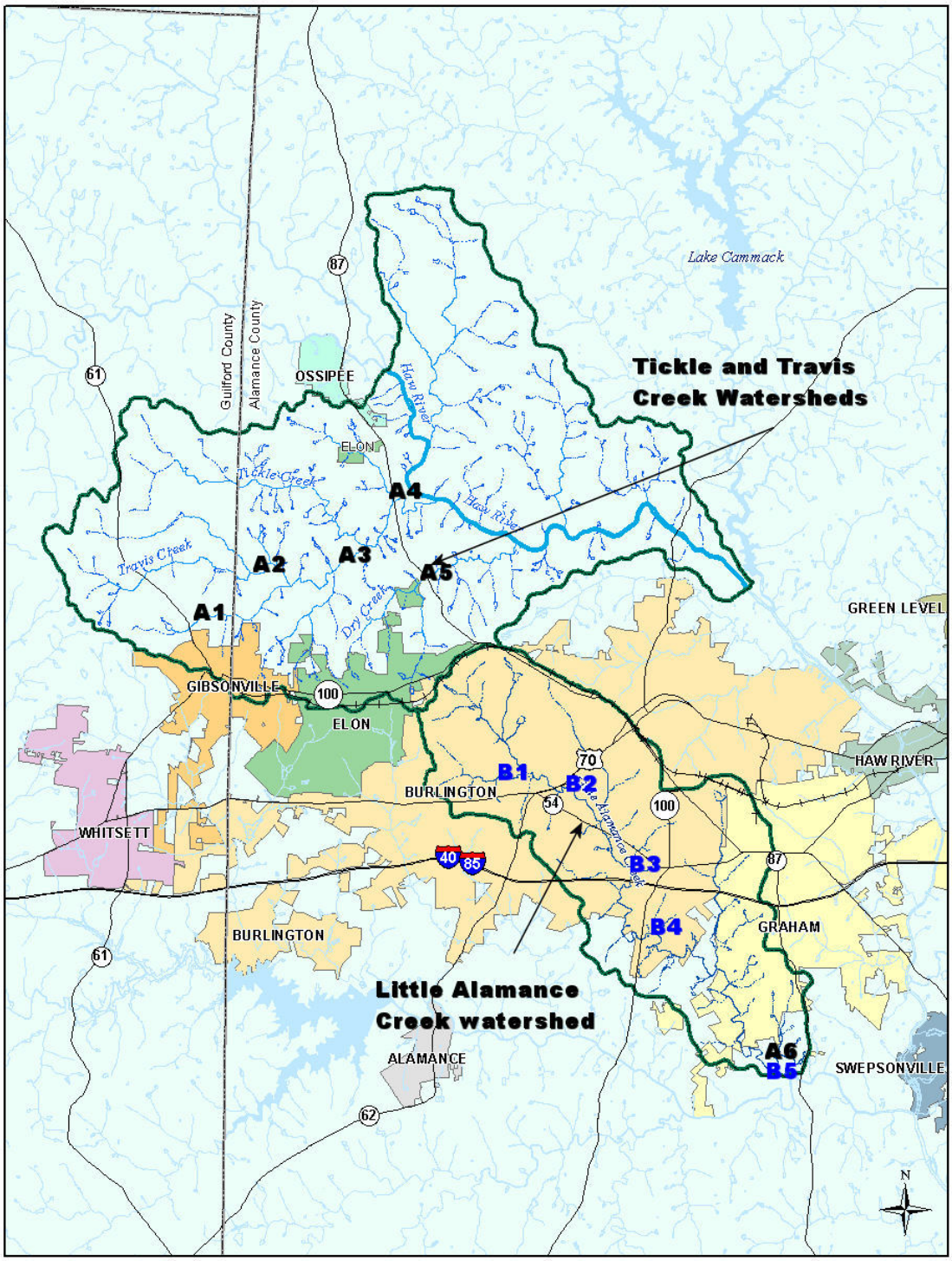

Figure 1. Boundaries of the Little Alamance, Tickle and Travis Creek (LATT) watersheds depicting the approximate locations of ambient water quality monitoring stations (A1-A6) sampled during 1968-1978 and benthic macroinvertebrate sites (B1-B5) sampled during 1984-2003

Water Chemistry

Within the LATT watershed boundaries (Figure 1) there is one currently active monitoring station along the Haw R (Haw R. and SR 1530 --Gerringer Mill Road) that is being monitored by the Upper Cape Fear River Basin Association (UCFRBA; see http://www.cfra-nc.org/ucfrba.htm). However results from this station strongly reflect influences on water quality that exist outside the LWP. An example of these influences includes the discharge of a City of Greensboro's wastewater treatment plant into North Buffalo Creek. Therefore results from this station are not presented here.

Overall, little information exists on the physical and chemical properties in the LATT watersheds. Historically a few sites were monitored between 1968 through 1978 (Table 3 and Figure 1). These were located primarily along Travis creek. However, since 1978 there has been no sustained monitoring program for physical and chemical parameters in any of the LATT watersheds except for the one UCFRBA station located on the Haw River.

Although a variety of parameters were sampled between 1968 and 1978, the greatest numbers of results were for nutrients, fecal coliform bacteria, water temperature, specific conductance and dissolved oxygen. Scatterplots of the results for these parameters are provided (Figures 2 and 3). It is important to note, that administrative procedures addressing quality assurance, and analytical techniques have improved since that time period.

Table 3. Locations of ambient water quality monitoring stations. (Latitude and Longitude are in decimal degrees.)

Map Code	STORET[1] No.	Location	Latitude	Longitude	Period
A1	B0900000	Travis Cr at Gibsonville	36.1150	-79.5420	1968-1975
A2	B0930000	Travis Cr at SR 1500 near Gibsonville	36.1250	-79.5250	1970-1975
A3	B0960000	Travis Cr. near Gibsonville	36.1290	-79.5130	1968-1975
A4	B0990000	Travis Cr. near Glen Raven	36.1400	-79.4990	1969-1978
A5[2]	B1020000	Haw R. at Hopedale[2]	36.1240	-79.4920	1968-1975
A6	B1920000	Little Alamance Cr. near Graham	36.0330	-79.4080	1968-1975

[1] A STORET number represents the station number in a the national database (STORET) for water quality data. More information is available: http://www.epa.gov/storet/

[2] The latitude and longitude for this site may be incorrect. Older geospatial data have a higher frequency of errors for latitude and longitude. The description (Haw R. at Hopedale) is likely correct.

The data obtained between 1968 and 1978 do reveal a few water quality issues. These include violations of the NC water quality standard for instantaneous values (4 mg/L) for dissolved oxygen (Figure 2). These occurred in Travis Cr. In addition, results for fecal coliform bacteria are high at most sites (Figure 2.) At this time (2006) it is difficult to make statements about what may have been responsible for these problems occurring decades ago. It appears that water chemistry in these watersheds was affected more by multiple *nonpoint* sources of pollution than by any single (or few) discharge(s) from municipal or industrial sources.

The results for all four nutrients (Figure 3) were not extremely high except for the one sample taken on 8/18/1971. On this day, results for all four measures of nutrients were very high. High values, such as these, often occur during or just after significant precipitation. The USGS National Water Information System (http://waterdata.usgs.gov/nc/nwis) was queried to determine if there were any peaks in stream flow during Aug. 1971 for the monitoring station USGS 02094500 at Reedy Fork near Gibsonville, NC. This is the closest gaging station to the LWP planning area. Results indicated mean stream flow ranged from 36 cfs on 8/17/1971 to 315 cfs on 8/18/1971. The significantly higher flow on Aug 18, 1971 was due to precipitation. The high nutrient levels were likely due to runoff since ammonia is usually quickly converted to nitrate. Flows decreased to 48 cfs on 8/19/1971.

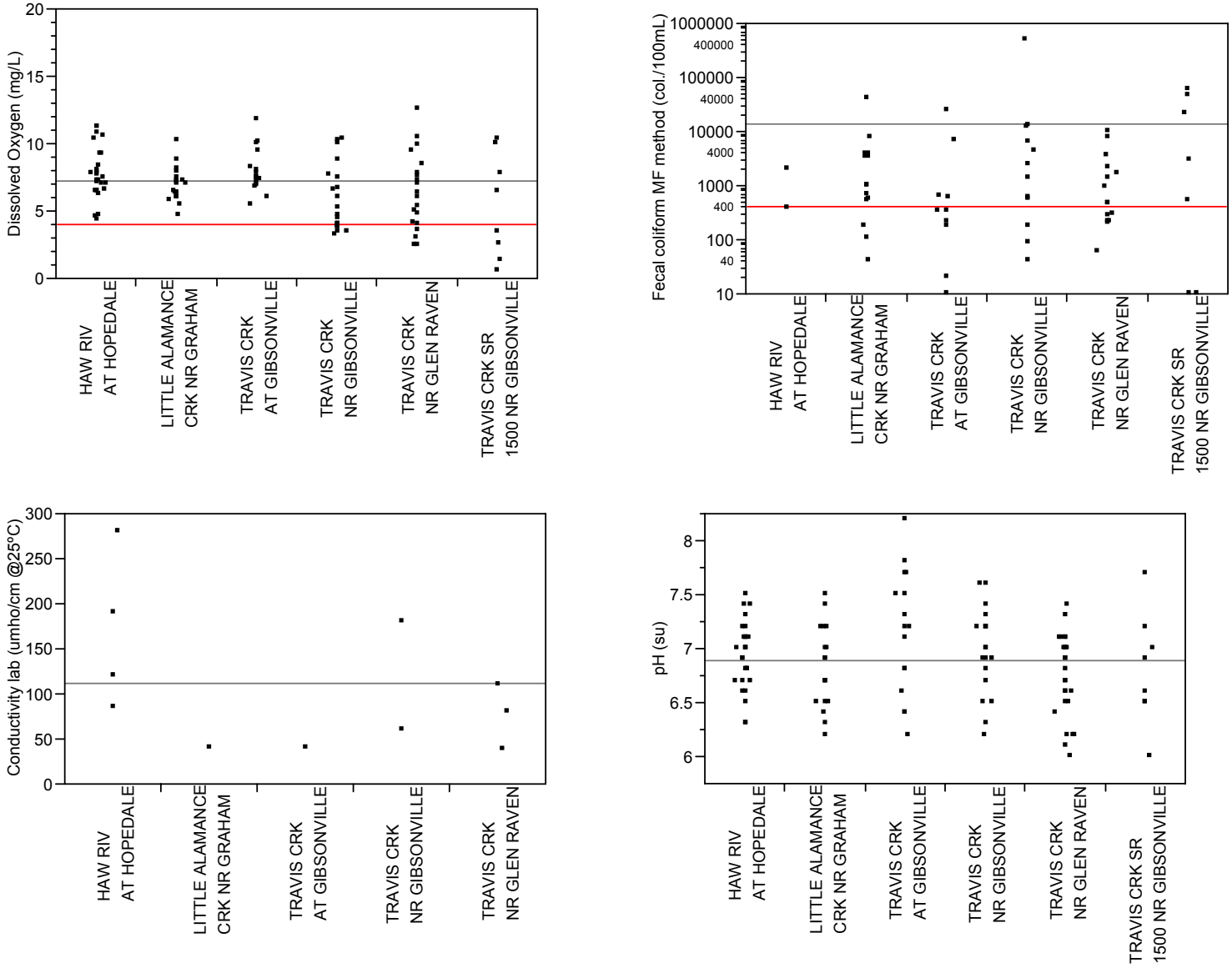

Figure 2. Ambient monitoring results for dissolved oxygen, fecal coliform bacteria, conductivity (laboratory-measured) and pH from sites monitored from 1968-1978. (Horizontal gray line is the mean for all observation. A reference line at 4.0 mg/L was added to the graph representing dissolved oxygen and 400 colonies/100 ml for fecal coliform bacteria.)

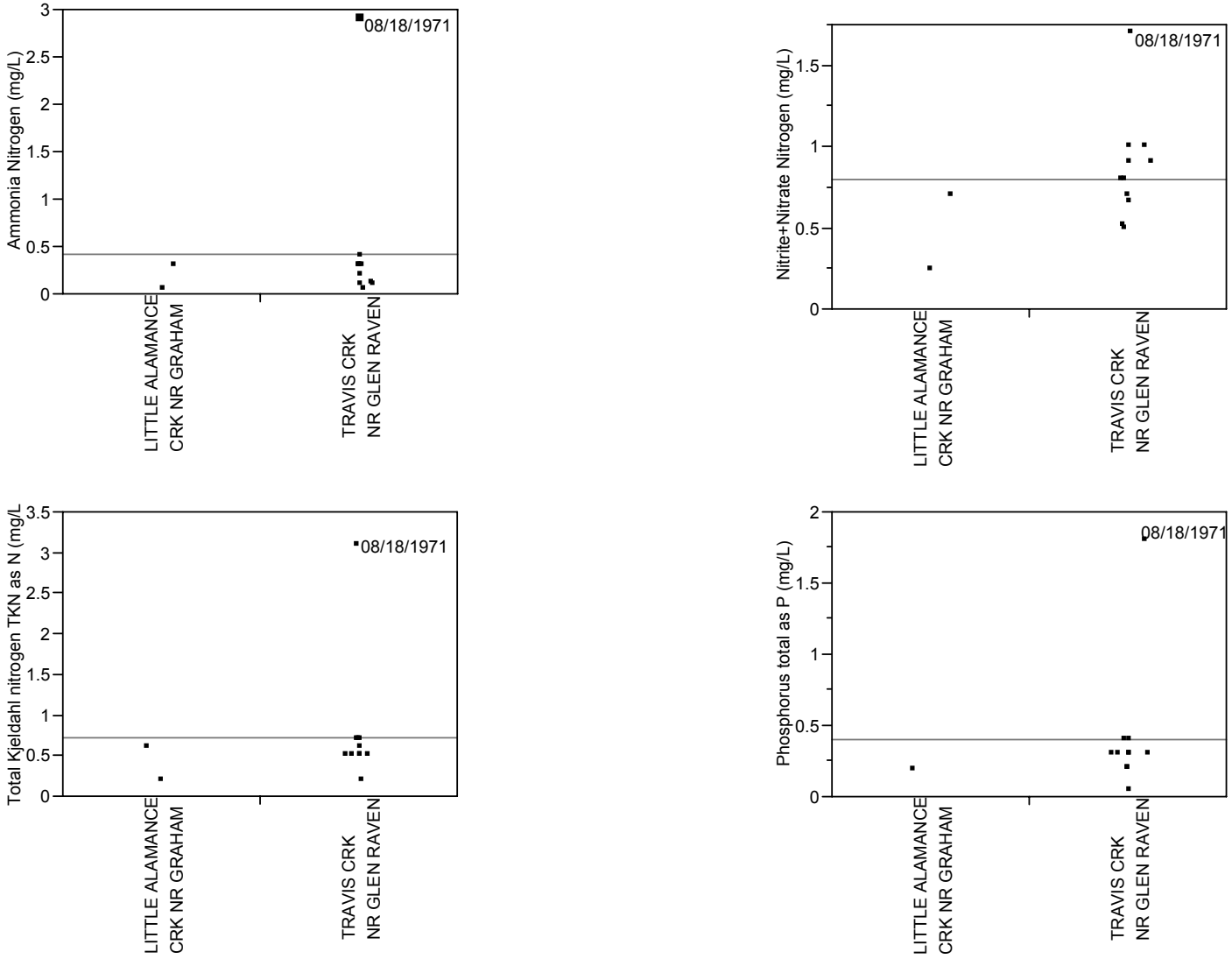

Figure 3. Ambient monitoring results for nutrients from sites monitored from 1968-1978. (Horizontal gray line is the mean for all observation.

Biological Data

Assessments of aquatic biological communities, and how well the communities reflect the ability of a stream to support aquatic life, are the focus of biological monitoring. Benthic macroinvertebrates are most often collected due to the ease in obtaining samples. Fish community assessment may be done as well. In the LATT LWP planning area, biological collections representing benthic macroinvertebrates and/or fish have been completed only in Little Alamance Creek between 1985 and 2003. (The majority of sites were sampled during 2003). By examining what species are present at a sample site, and the relative abundances of the species, biologists can provide "bioclassifications[1]," which determine how well aquatic life is being supported.

Bioclassifications for Little Alamance Creek range from Poor to Good (Table 4). The fish community was rated Good in 1993, Fair in 1998 and Good in 2003. All benthic sampling sites that have been rated have received at least one "Poor" rating. The most downstream site (B5; Figure 1) received a "Fair" rating in 2003, which is an improvement from its 1998 rating of "Poor." Additional benthic macroinvertebrate sampling in Little Alamance Creek, as well as sampling in Travis and Tickle Creeks will be conducted in September 2006 for EEP's Local Watershed Plan.

Table 4. Location of fish and benthic macroinvertebrate sample sites and bioclassification.

Map Code	Water Body.	Date	Bioclassification	
			Fish	Benthos
B1	Coble Br. at Engleman Ave.	06/24/2003	.	Not Rated[1]
B2	L. Alamance at Overbrook Rd.	06/24/2003	.	Poor
B3	L. Alamance at I-85 Frontage Rd.	06/23/2003	.	Poor
B4	L. Alamance at NC 49	06/23/2003	.	Poor
B5	L. Alamance at SR 2309	07/29/1985	.	Fair
B5	L. Alamance at SR 2309	1993	Good	.
B5	L. Alamance at SR 2309	1998	Fair	.
B5	L. Alamance at SR 2309	07/10/1998	.	Poor
B5	L. Alamance at SR 2309	2003	Good	.
B5	L. Alamance at SR 2309	06/23/2003	.	Fair

[1]Watershed too small for rating.

Summer 2006 – Watershed Assessment Team Synoptic Surveys

During the summer of 2006, DWQ personnel collected a limited amount of field data to ascertain if any water quality problems could be readily identified, and to aid in the development of a plan for additional monitoring. This monitoring included the measurements of specific conductance at many of the bridge crossings over streams in the planning area, and the deployment of equipment called datasondes that recorded temperature, pH, specific conductance, dissolved oxygen and the percent saturation of dissolved oxygen at hourly intervals between July 25 and 31, 2006.

[1] NC uses five bioclassifications: Excellent, Good, Good-Fair, Fair and Poor for benthos and fish.

Synoptic Survey – Specific Conductance at Bridge Crossings (July 19, 20, 2006)

Specific conductance is a measure of the ability of water to conduct electricity. High values can indicate geological influences or sources of pollution. Generally large differences between values within a stream or between streams within a localized area reflect point source discharges.

Results for specific conductance for streams obtained from bridge crossings within the planning area (Table 5) ranged from 119 to 226 µS/cm. The median is 157 (µS/cm). These results are typical of streams in the piedmont physiographic province of North Carolina. Within and among stream variations were not great enough to readily discern point source influences using measurements of specific conductance. Table 5 does contain a value of 403 (µS/cm) for a site influenced by point source discharges, but this stream, Reedy Fork, is not in the LWP planning area.

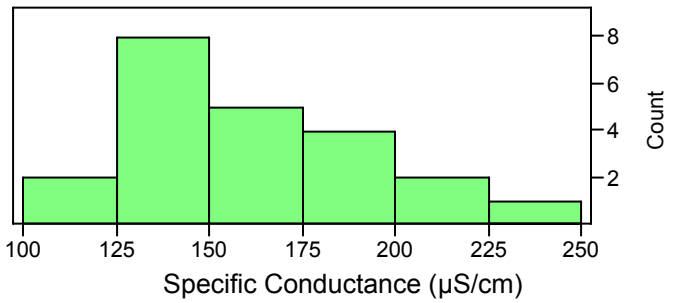

Figure 4. Distribution of specific conductance results listed in Table 5.

Table 5. Results of a survey of specific conductance conducted on July 19 and 20, 2006.

Stream[1]	**Road crossing**	**Latitude**	**Longitude**	**Specific Conductance** (µS/cm)**)**
Stinking Quarter Cr	Bellemont-Mt Hermon Rd	36.0139	79.4318	140
Big Alamance Cr	Rogers Rd	36.0169	79.4137	143
Little Alamance Cr	Rogers Rd	36.0360	79.4091	133
Little Alamance Cr	NC 49	36.0528	79.4348	176
Little Alamance Cr	Plantation Dr (I-85 Frontage)	36.0655	79.4405	207
Little Alamance Cr	NC 54 (Tucker St)	36.0744	79.4444	203
Meadowbrook Cr	Mebane St	36.0836	79.4432	226
Little Alamance Cr	Edgewood St	36.0906	79.4679	191
Coble Brook	Engleman St	36.0863	79.4695	197
Little Alamance Cr	Woodland Ave	36.0964	79.4732	195
Reedy Fork Cr	NC 87	36.1732	79.5103	403 (not in planning area)
Haw River	NC 87	36.1826	79.5099	148
Travis Cr	Durham St Ext;-SR 1529	36.1418	79.4896	135
Travis Cr	SR 1504	36.1281	79.5123	148
Travis Cr	SR 1500	36.1291	79.5278	173
Travis Cr	County Farm; Rd; SR 2741	36.1296	79.5526	153
UT 1 Travis Cr	Barber Rd; SR 1552	36.1427	79.4981	119

Table 5. Results of a survey of specific conductance conducted on July 19 and 20, 2006.

Stream[1]	Road crossing	Latitude	Longitude	Specific Conductance (µS/cm))
Table 5. continued				
UT 2 Travis Cr	SR 1500	36.1243	79.5273	172
Tickle Cr	SR 1504	36.1382	79.5125	134
Tickle Cr	SR 1500	36.1448	79.5284	140
Dry Cr	Durham St Ext; SR 1529	36.1306	79.4763	173
Basin Cr	Basin Cr Rd; SR 1594	36.1751	79.4827	160
UT to Basin Cr	Hub Mill Rd; SR 1002	36.1808	79.4949	123

[1] UT is the abbreviation for "unnamed tributary."

Synoptic Survey – Datasonde Deployment (July 25 to 31, 2006)

Automated sampling devices (datasondes) were deployed at the most downstream bridge crossings (Table 6) to characterize five parameters among four different watersheds – Little Alamance, Tickle, Travis and Dry Creeks. Water temperature, dissolved oxygen, dissolved oxygen – percent saturation, pH and specific conductance were measured at hourly intervals between July 25 and July 31. Data obtained in both a temporal and spatial manner reveal how results vary among watersheds and over time. During this sample period, datasondes were paired at all creeks except for Dry Creek. Only one datasonde was deployed here. Datasondes were paired to provide a measure of quality assurance.

Table 6. Locations of Datasondes (Latitude and longitude are in decimal degrees)

Waters	Description	Latitude	Longitude	Datasonde Serial Numbers
Little Alamance	SR 2309 Rogers Rd	36.0360	79.4091	37710, 38966
Dry Creek	SR 1529	36.1306	79.4763	38965
Tickle Creek	SR 1504	36.1382	79.5125	37711, 38933
Travis Creek	SR 1504	36.1281	79.5123	37712, 37713

Results from the datasondes are depicted in Figures 6 and 7 and a tabular summary is provided in Table 7. Results and figures were obtained using JMP statistical software (www.jmp.com; SAS Institute). These figures depict all individual measurements and provide "overlays" that depict measures of central tendency (i.e. mean or median) and variation. Illustrations and explanations of these overlays are provided in Figure 5.

Specific conductance and pH was considerably greater at Dry Creek than the other watersheds (Figure 6.) Reasons for this are not clear and will be investigated when a more comprehensive monitoring plan is implemented. The greatest range (difference between the high and low results) occurred in the Little Alamance Creek watershed. Little Alamance creek drains an urban watershed, so it is likely the range in specific conductance reflects this.

Overall, results for dissolved oxygen were good (Figure 6). Tickle Creek had the greatest range in results and three of these (out of 270) were just below the 4.0 mg/L water quality standard. These three results occurred just before sunrise, which is often the time when low dissolved oxygen results often occur. The largest diurnal fluctuations in dissolved oxygen were observed at Tickle Creek (Figure 7). Often large daily changes in dissolved oxygen concentrations are due to releases of oxygen via photosynthesis of stream algae. It is not known why the largest daily fluctuation in oxygen is occurring in Tickle Creek and whether this pattern is due to stream algae.

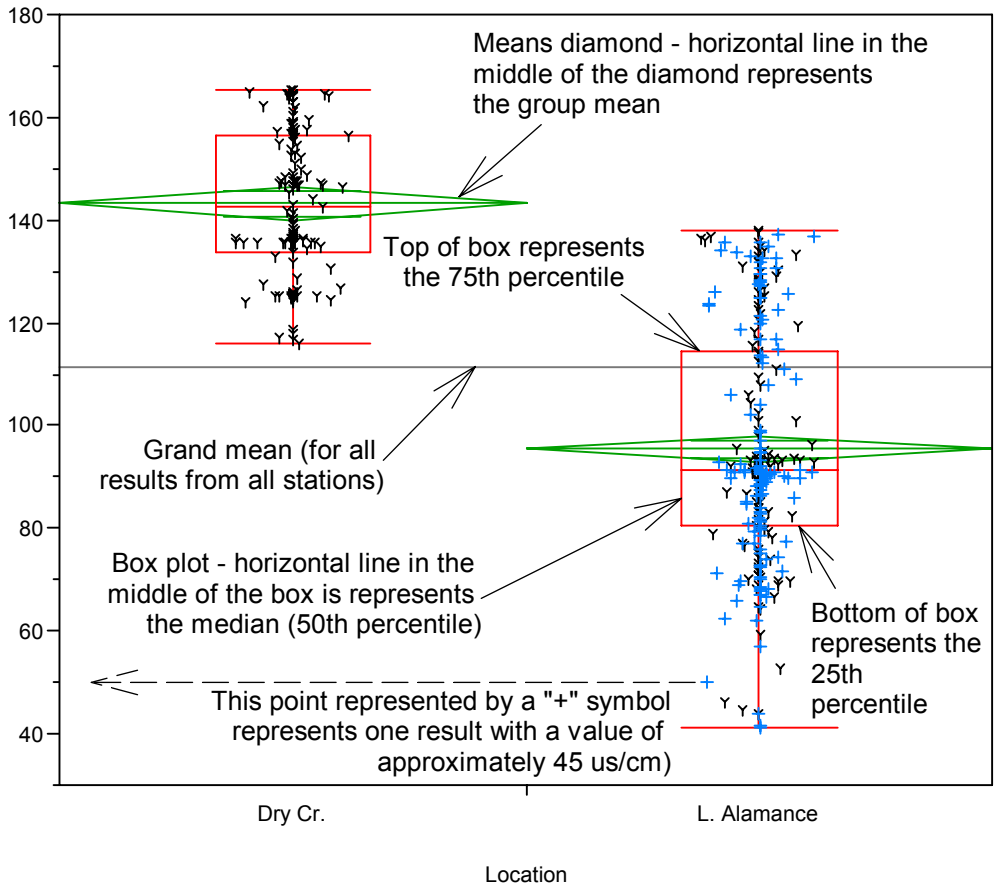

Figure 5. Interpreting box and whisker and means-diamonds plots from JMP statistical software. Data represent specific conductance results (µS/cm) for Dry and Little Alamance Creeks.

Explanations:

Two types of overlays ("means diamonds" and "box plots") can be added to displays of results to assist the reader seeing how results vary at and between each sample locations. A means diamond (green in Figure 5) illustrates a sample mean and 95% confidence interval. The line across each diamond represents the group mean. The vertical span of each diamond represents the 95% confidence interval for each group

The box plots (red in Figure 5) summarize the distribution of points at each factor level. (Factors represent groups – in this case, there are two groups: Dry Creek and Little Alamance Creek.) The ends of the box are the 25th and 75th quantiles. The difference between the quartiles is the interquartile range. The line across the middle of the box identifies the median sample value. Each box has lines, sometimes called whiskers that extend from each end. The whiskers extend from the ends of the box to the outermost data point that falls within the distances computed as upper quartile + 1.5(interquartile range) and lower quartile - 1.5*(interquartile range).*

Explanations from: JMP Statistics and Graphics Guide, Release 6. 2005. SAS Institute, Cary, NC.

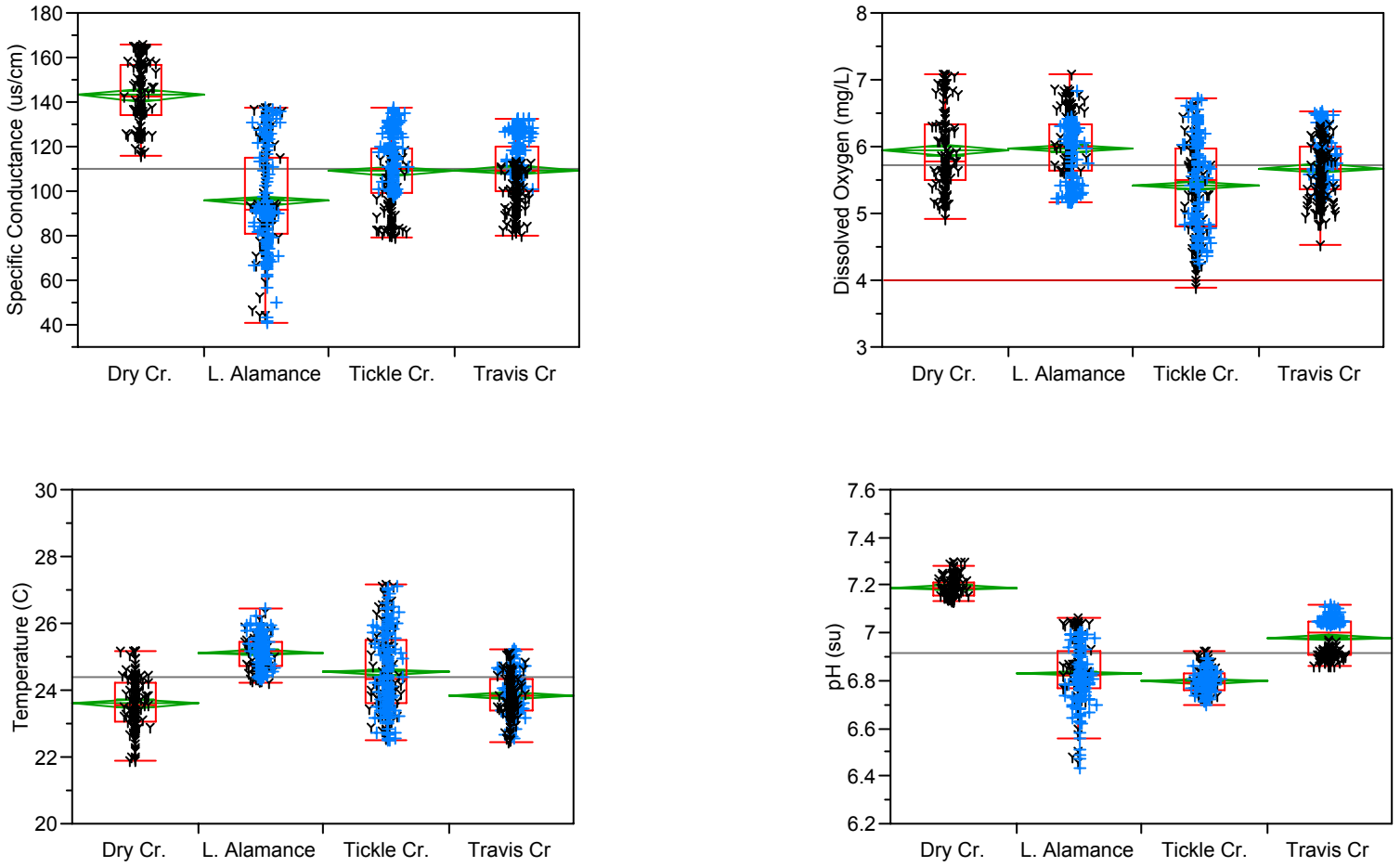

Figure 6. Results of the datasonde deployment between July 25 and 31 2006. These automated measuring devices recorded results hourly. Dry Creek had one datasonde. Datasondes at the remaining watersheds were paired (results are distinguished between datasondes at a site by a black "Y" and a blue "+". See Figure 5 for a description of the green diamonds (means diamonds) and the red boxes (box plots). The graph for dissolved oxygen has a horizontal line at 4.0 mg/L representing the NC water quality standard for instantaneous values.

Table 7. Summary statistics of measurements obtained from the use of datasondes for the period July 25 through July 31, 2006

Parameter/ Site	N[1]	Mean	95 % Confidence Interval		Percentile						
			Lower	Upper	Min.	10%	25%	50[a]	75%	90%	Max.
Specific Conductance (µS/cm)											
Dry Cr.	135	143.2	140.3	146.1	116	125	134	143	157	164	166
L. Alamance	270	95.4	93.4	97.5	41	69	81	91	115	131	138
Tickle Cr.	270	108.9	106.9	111.0	79	83	99	110	120	130	137
Travis Cr	270	109.5	107.4	111.5	80	90	100	109	120	129	133
Dissolved Oxygen (mg/L)											
Dry Cr.	135	5.9	5.8	6.0	4.9	5.2	5.5	5.8	6.3	6.9	7.1
L. Alamance	270	6.0	5.9	6.0	5.2	5.3	5.6	6.0	6.3	6.6	7.1
Tickle Cr.	270	5.4	5.4	5.5	3.9	4.5	4.8	5.5	6.0	6.3	6.7
Travis Cr	270	5.7	5.6	5.7	4.5	5.1	5.4	5.7	6.0	6.3	6.5
Dissolved Oxygen (%)											
Dry Cr.	135	70.5	69.4	71.6	59	62	65	70	75	81	83
L. Alamance	270	73.0	72.2	73.8	62	64	69	73	77	81	86
Tickle Cr.	270	65.5	64.7	66.3	46	53	58	66	72	78	83
Travis Cr	270	67.6	66.8	68.4	55	61	64	67	71	74	78
Temperature (C)											
Dry Cr.	135	23.6	23.5	23.7	21.9	22.7	23.1	23.6	24.2	24.5	25.2
L. Alamance	270	25.1	25.0	25.2	24.2	24.4	24.7	25.2	25.5	25.8	26.5
Tickle Cr.	270	24.5	24.4	24.6	22.5	23.2	23.6	24.3	25.5	26.3	27.2
Travis Cr	270	23.8	23.7	23.9	22.5	23.1	23.4	23.8	24.3	24.7	25.2
pH (s.u.)											
Dry Cr.	135	7.2	7.2	7.2	7.1	7.1	7.2	7.2	7.2	7.3	7.3
L. Alamance	270	6.8	6.8	6.8	6.4	6.7	6.8	6.8	6.9	7.0	7.1
Tickle Cr.	270	6.8	6.8	6.8	6.7	6.7	6.8	6.8	6.8	6.9	6.9
Travis Cr	270	7.0	7.0	7.0	6.9	6.9	6.9	7.0	7.1	7.1	7.1

[1] Only one datasonde was deployed in Dry Creek. The remaining watersheds had two datasondes. Thus sample size (N) differs by a factor of 2 between these sets.

[a] The median is also the 50th percentile.

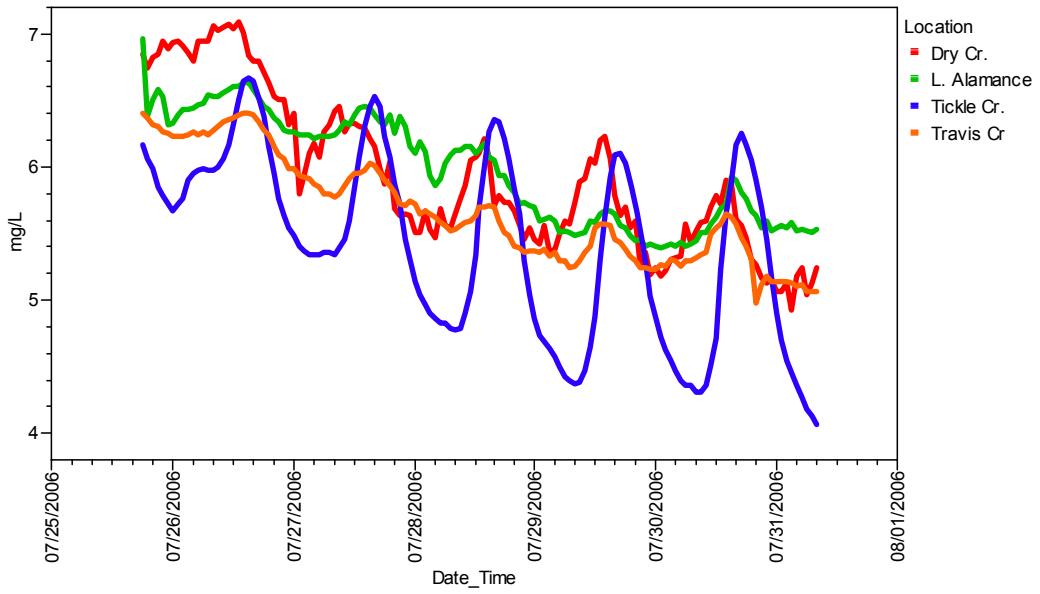

Figure 7. Daily changes in dissolved oxygen among Dry Creek, Little Alamance Creek, Tickle Creek, and Travis Creek. The graph is best observed in color. Note the larger daily fluctuations in dissolved oxygen concentrations for the station in Tickle Creek. These exceed the daily fluctuations observed at the other locations. Additional monitoring, which is being planned, may explain the reason for this large fluctuation.