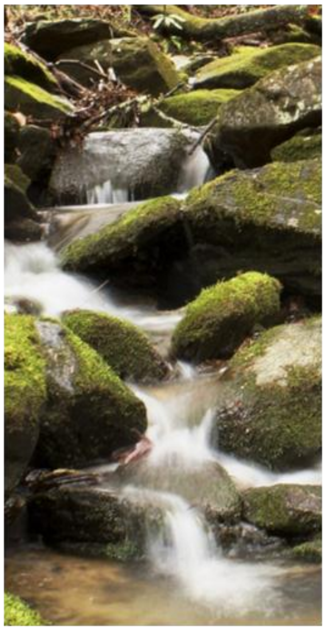

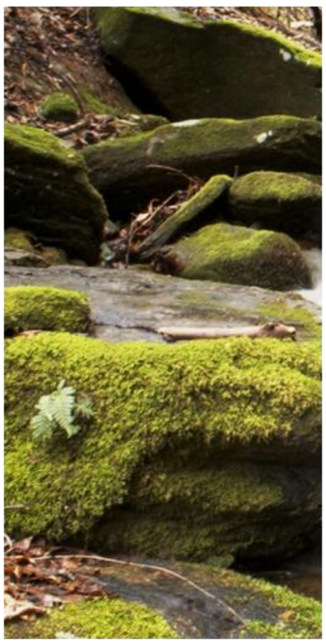

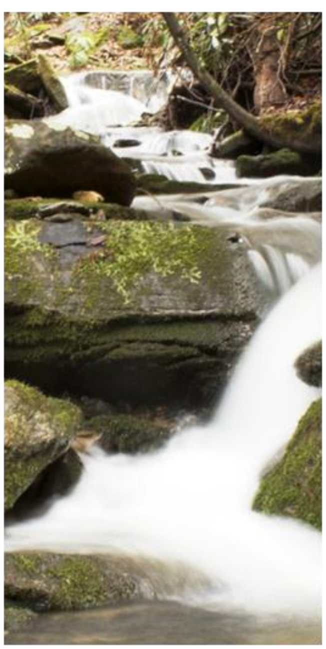

ALTAMONT ENVIRONMENTAL, INC.

ENGINEERING & HYDROGEOLOGY

Green River Watershed Assessment

Isothermal Planning and Development Commission

September 30, 2013

Prepared for
Isothermal Planning and Development Commission
111 West Court Street
Rutherfordton County, North Carolina 28139
Project Number 2354.03

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Green River Watershed Assessment

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September 30, 2013

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Executive Summary

Sediment is the leading pollutant to waterbodies (“Nonpoint Source”), and the aim of the Green River Watershed (GRW) Assessment was to examine stressors and potential sources of excess sediment to the GRW. This was accomplished by reviewing existing data, conducting interviews with government officials as well as local residents, and conducting visual site inspections throughout the watershed. The GRW is bound by Henderson County on the west and northwest, Polk County on the east and north east and South Carolina on the south. The GRW is comprised of hydrologic unit codes (HUCs) 0305010501 & 0305010502. The GRW is approximately 245 square miles, however to preserve time and resources, the assessment area of this investigation, the GRW study area, was truncated from the Polk County boundary to Lake Adger and is approximately 60 square miles. Figure 1 depicts the GRW study area.

The primarily surface water drainage feature in the GRW study area is the Green River, which was dammed in 1925 to form Lake Adger. The main tributaries that drain to the Green River and Lake Adger within the GRW study area are: Brights Creek, Casey Branch, Cove Creek, Gadd Creek, Ostin creek, Panther Creek, Pulliam Creek, Rotten Creek, Rash Creek, and Silver Creek.

Summary of Collected Data

Water quality data within the GRW study area were not abundant, and no ambient water quality stations exist within the study area. However, accessible water quality data indicate that water quality results were generally below the 15A North Carolina Administrative Code (NCAC) 2B surface-water quality standards (2B standard). During the monitoring conducted at three locations in the GRW study area between 1993 to 2009 by the University of North Carolina at Asheville, only one sample exceeded a 2B standard and that exceedance was for turbidity. Data collected from the U.S. Environmental Protection Agency (EPA) STOrage and RETrieval (STORET) Data Warehouse reveal sporadic water surface physical conditions results collected around Lake Adger and near Cove Creek from 1969 to 1989, where surface physical conditions were below 2B standards, except for ten exeedances for fecal coliform. The 2011 *Lake & Reservoir Assessments Broad River Basin* (Lake & Reservoir) published by the North Carolina Department of Environment and Natural Resources (DENR) stated that all water quality samples collected from Lake Adger were below the 2B standards. See Figures 2 and 3 for STORET and Lake & Reservoir sample locations.

The 2008 *NC DWQ [Division of Water QualityBroad River Basin Plan: Green River Watershed HUC’s 0305010501 & 0305010502* stated that all monitored streams within the watershed were listed as ‘Supporting’ for aquatic life. Benthic sample results indicated species number and type have decreased due to increases in sediment and nutrients at sample location AB-24, which is located at the downstream portion of the Green River proximate to the confluence with the Broad River at the Polk County and Rutherfordton County boundary (outside the GRW study area).

Summary of Site Reconnaissance

Altamont analyzed the existing conditions throughout the GRW to determine areas of concern deemed “priority sites” (Sites 1 through 17) that would be visited during the site investigation; additional sites identified in the field (Sites 18 through 31) were also examined. A map with Sites 1 through 31 is included as Figure 4. Sites 3, 4, 6, 7, 8, 9, 12, 13, 14, 16, 17, 18, 21, 22, 23, 24, 26, 27, 28, 29, 30, and 31 exhibited signs of erosion, channel incision, sediment accumulation, and the potential for downstream sedimentation impacts.

Large depositional islands were observed at the Ostin Creek entrance to Lake Adger. Stressors to Ostin Creek include exposed soil hillside erosion and a sediment-laden inline pond (Site 22), lack of riparian buffers along portions of the reach, erosion along gravel and dirt roads within the watershed, and eroding banks (Site 14 and proximate to Site 15) along the stream. Moreover, the abrupt change in channel morphology (i.e., decrease in longitudinal slope) near the entrance to Lake Adger causes Ostin Creek to lose stream power and the ability to transport sediment. Therefore, sediment from the watershed is readily deposited near the entrance to Lake Adger.

Large depositional islands were also observed at the Panther Creek entrance to Lake Adger. Some stressors to Panther Creek include an eroding roadside ditch (near Site 6), livestock access to the creek, and lack of riparian buffer (Site 27). Additionally, the Brights Creek Development appears to have cleared some land and installed service roads near Panther Creek, stockpile areas, and construction entrances. The construction staging areas and past construction activity could be potential sources of sediment to Panther Creek.

The Brights Creek construction staging areas also affect Rash Creek, which is just west of Panther Creek. Stressors to Rash Creek include construction activities and lack of riparian buffer (Site 26).

Some sediment accumulation was observed at the Rotten Creek entrance to Lake Adger. Rotten Creek was observed to be heavily impacted by sediment pollution. Stressors to Rotten Creek include runoff from agricultural areas (Site 12), lack of riparian buffer (Sites 12 and 31), and clear-cut land (Site 12).

Lake Adger was observed to be shallow in multiple locations throughout the marina and at multiple tributary entrances to Lake Adger, actively eroding banks were also observed throughout the lake. Depositional islands were also observed throughout the lake. The sedimentation buildup in Lake Adger appears to be primarily attributed to cumulative watershed effects of sediment inputs to the Green River which lead to Lake Adger.

Recommendations

The GRW is a valuable resource, particularly, the Green River Game Land area is utilized by hunters, and the Green River is a truly spectacular resource for fishermen, kayakers, and tubers. As recreational use of the Green River increases, it would be beneficial to adopt best management practices (BMPs), such as installing bioretention basins, stormwater wetlands, installing cattle exclusion fencing along streams, stabilizing exposed and vulnerable soil slopes, restoring eroding streambanks, and restoring riparian buffers throughout the GRW to preserve the water quality of the streams and also preserve the Green River as a recreational resource.

The stressors identified throughout this report should be investigated further along with potential stressors to the Green River from upstream sources in Henderson County. If property owners are responsive and wish to improve water quality, they could potentially partner with local non-profits, Polk County Soil and Water Conservation District, and the DENR Division of Water Resources, to implement BMPs that would reduce erosion and benefit the water quality of the GRW.

Lake Adger has not been thoroughly dredged to remove accumulated sediment since it was constructed in 1925. When the dam was constructed in 1925, the contributing creeks and rivers lost their natural ability to transport sediment from the contributing watershed to areas downstream of the dam. Therefore, sediment has accumulated in the lake for almost 90 years. This accumulated sediment has reduced the water storage capacity of Lake Adger and has become a nuisance to residents and recreational users of the lake. An analysis of dredging requirements could be conducted to determine optimal locations throughout the lake to remove excess sediment. It is not likely all locations could be dredged at once, and critical areas like the public marina, Marina Cove, where Panther Creek enters Lake Adger, and Island Cove, where Ostin Creek enters Lake Adger should be considered primary priorities for dredging. Low impact development strategies could be practiced in future development around Lake Adger, and sustainable shoreline stabilization techniques could be implemented on the Lake Adger shoreline to improve water quality and reduce further sedimentation to Lake Adger.

1.0 Introduction

The Isothermal Planning and Development Commission (IPDC) was awarded a 2012 Clean Water Act Section 205(j) Grant by the North Carolina Department of Environment and Natural Resources (DENR) Division of Water (DWQ) Quality for "Assessment of the Green River Watershed: A Supplement to the NC Division of Water Quality (DWQ) Broad River Basinwide Water Quality Plan". Federal funds from the U.S. Environmental Protection Agency (EPA) pursuant to Sections 604(b) and 205(j) of the Clean Water Act, amended in 1987, are distributed to regional Councils of Government (COGs) in the form of grants for water quality projects. The funds are to be used for the following purposes: (1) identifying most cost effective and locally acceptable facility and non-point source measures to meet and maintain water quality standards, (2) developing an implementation plan to obtain state and local financial regulatory commitments to implement measures developed under (1), and (3) determining the nature, extent, and cause of water quality problems in various areas of the state. In North Carolina, the federal program is overseen and administered by the DENR DWQ. The IPDC is a COG for Region C (includes Cleveland, McDowell, Polk and Rutherford Counties) in western North Carolina.

The Green River Watershed Alliance (GRWA) was founded in 2010 by Sky Conard. The GRWA is a grassroots organization focusing on protecting the resources of the GRW. The GRWA provided pertinent works, data, photographs, personal interviews, and local hands-on knowledge of the GRW.

Altamont Environmental, Inc. (Altamont) executed the 205(j) grant on behalf of IPDC. Altamont reviewed existing reports, water quality data, historical records, and conducted visual inspections throughout the watershed. The results of this investigation are presented throughout the report.

2.0 Background

According to the U.S. Environmental Protection Agency (EPA), sediment is the number one pollutant in rivers, streams, lakes, and reservoirs throughout the U.S. Natural erosion produces sediment. However, erosion can be accelerated from anthropogenic activities such as land use disturbing activities. Accelerated erosion and sediment inputs from hillslope and channel processes can degrade streams and lead to channel instability. Excess erosion and sedimentation are results of channel instability; therefore signs of channel instability were documented during this assessment to discern what watershed stressors persist in the GRW study area. Excess sedimentation can severely impact aquatic life, and negatively affect recreation, navigation, water treatment systems, and water storage.

Stable streams maintain their dimension, pattern, and profile such that they neither aggrade nor degrade, and are able to transport the sediment load supplied to the stream by the watershed. Stream instability and excess sedimentation can be caused by watershed stressors such as: increased impervious area due to development, active construction sites, agriculture, clear-cutting, mining, streambank erosion, loss of stream buffer, and channelization.

Sediment and overall watershed health have been of interest to local residents and as stated in the most recent 2008 *NC DWQ Broad River Basin Plan: Green River Watershed HUC's 0305010501 & 0305010502* in the Green River Watershed (GRW). Consequently, this initial investigation of the GRW was aimed at finding watershed stressors, potential sources of excess sediment to the GRW, and unstable streams within the GRW.

3.0 Watershed Characteristics

The Green River is a tributary to the Broad River in southwestern North Carolina. The 5,419-square-mile Broad River basin is delineated into the following smaller watersheds:

- Green River
- Broad River Headwarters
- Buffalo, Kings and Bullocks Creek
- First Broad River Headwaters
- First Broad River,
- North Pacolet River
- Sandy Run-Broad River
- Second Broad River

The GRW is comprised of hydrologic unit codes (HUCs) 0305010501 and 0305010502 and is approximately 245 square miles. To better conserve resources, the study area of the assessment described in this report (GRW study area) is further delineated to an approximately 60 square mile area within Polk County from the Henderson County line eastward to the Lake Adger Dam. The GRW study area consists of approximately 182 miles of stream. The GRW study area is shown in Figure 1.

The GRW is largely forested land, with some agricultural and developed land. The primarily surface water drainage feature in the GRW is the Green River, which was dammed in 1925 to form Lake Adger. The Green River begins in Henderson County, is dammed at Lake Summit, continues into Polk County, is dammed again at Lake Adger and eventually flows into the Broad River at the Polk County and Rutherford County line. The following ten main tributaries drain into the Green River and Lake Adger within the study area:

- Brights Creek
- Casey Branch
- Cove Creek
- Gadd Creek
- Ostin Creek
- Panther Creek
- Pulliam Creek
- Rotten Creek
- Rash Creek
- Silver Creek

4.0 Summary of DENR Reports

4.1 Green River Watershed Basin Plan

The *NC DWQ Broad River Basin Plan: Green River Watershed HUC's 0305010501 & 0305010502* was published by DWQ in 2008. This section summarizes findings presented in that report.

According to the report, 82 percent of the watershed is forest, 10 percent is agricultural, 7 percent is other, and 1 percent is developed. The report states that six minor National Pollutant Discharge Elimination System (NPDES) discharge permits exist within the watershed, and a seventh was recently issued. None of the seven NPDES discharges are within the GRW study area. The report indicates the Brights Creek Development has contributed excess sediment to Brights Creek, which drains to the Green River within the GRW study area.

No waters are listed as impaired in the GRW, although sedimentation was observed in many of the streams. The report states that stressors such as sedimentation and erosion, agriculture activities, land-disturbing activities, and increases in impervious surface coverage are likely leading to habitat degradation within the GRW. Additionally, the report states that further investigation is needed to determine if sedimentation is impairing the Green River.

4.1.1 Data Results of the Green River Watershed Basin Plan

Approximately 109 miles of the 268 miles of stream within the GRW were monitored by DWQ. All stream segments were rated as "Supporting" for aquatic life. The GRW study area consists of approximately 182 miles of stream.

Three benthic samples were collected in the Green River in 2010. Site AB22 and AB24 are located outside the Study Area, while Site AB23 is located within the Study Area. Site AB22 is the most upstream sample location proximate to Lake Summit in Henderson County. Site AB22 received a Good-Fair bioclassification. Also, a significant decline in water quality between the earlier 1989 and the 1993 samples was noted in this area. Site AB23 is located between Lake Summit and Lake Adger, and received a Good bioclassification, with a slight improvement since 1995 and 2000. Site AB24 is located near the downstream end of the Green River, and received a Good bioclassification. The report noted that a significant decline in species number and type at Site AB24 is likely due to increases in sediment and nutrients to the GRW.

The benthic sample locations and data results are readily available from NC OneMap. The benthic monitoring data shapefile was downloaded from NC OneMap and incorporated in this analysis. Figure 2 displays the benthic monitoring assessment results within the GRW.

4.2 Lake & Reservoir Assessments Broad River Basin

The May 31, 2011 *Lake & Reservoir Assessments Broad River Basin* (Lake & Reservoir) published by the Intensive Survey Unit Environmental Sciences Section of the DENR DWQ was reviewed during this investigation. According to the 2011 report, the Lake Adger dam was constructed in 1925 and created a 460-acre impoundment with a maximum depth of 66 feet. In 2008, Polk County purchased the reservoir, water and dam from Duke Energy with the intent of using the reservoir for a public water supply source.

4.2.1 Data Results of the Lake & Reservoir Assessments Broad River Basin

Three sample locations, Station BRD007J, BRD007L, and BRD007P were established on Lake Adger by the DENR DWQ. Station BRD007J is located near the entrance of the Green River to Lake Adger on the western side of the lake, station BRD007L is located near the center of Lake Adger, and BRD007J is located on the eastern side of the lake just upstream of the dam. These sample locations are shown on Figure 3 of this report. Between May and September 2010 the stations were sampled six times for surface metals and five times for surface physical conditions (i.e., dissolved oxygen, temperature, etc.), photic zone conditions (i.e., total phosphorus, nitrogen, etc.), water clarity (i.e., suspended solids, turbidity, etc.), and fecal coliform,. These sample locations are essentially the same sample locations sampled by the DWQ from 1969 to 1989 (as described further in Section 7.0).

Station BRD007J was sampled six times from June 13, 2000 to September 1, 2010. All results were within the 15A NCAC 2B surface water quality standards (2B standards). Dissolved oxygen levels stayed relatively consistent around 8.0 milligrams per liter (mg/L). Metals, barium, calcium, chloride, iron, lead, magnesium, and manganese, were detected in samples, and concentrations remained fairly consistent among the samples. Aluminum concentrations decreased slightly with time at Station BRD007J.

Station BRD007L was sampled six times from June 13, 2000 to September 1, 2010; all results were within the 2B standards. Metals, calcium, chloride, iron, magnesium, and manganese, were detected in samples, and concentrations remained fairly consistent among the samples. Aluminum concentrations decreased slightly with time at Station BRD007L.

Station BRD007P was sampled five times from June 13, 2000 to September 1, 2010. All results were within the 2B standards. Dissolved oxygen levels stayed relatively consistent around 8.0 mg/L. Metals, barium, calcium, chloride, lead, magnesium, and manganese, were detected in samples, and concentrations remained fairly consistent among the samples. Aluminum and iron concentrations decreased slightly with time at Station BRD007P.

According to the report, nutrients within the photic zone were commonly below the DWQ laboratory detection level, and surface metals and hardness were within the allowable 2B standards water quality standards. During the 2010 monitoring, turbidity ranged from 2.1 to 19.0 Nephelometric Turbidity Units (NTU), which is below the 2B standard (50 formazine turbidity units [FTUs], which are equivalent to NTUs). Average secchi depths (a measurement of water transparency) ranged from 3.3 to 22.2 feet. Fecal coliform units were low (1 to 5 per 100 milliliters [mL]), and well below the 2B standard (200 per 100 mL). According to the report, Lake Adger has very low biological productivity and is considered oligotrophic. Little variation in water quality was observed near the entrance to Lake Adger (station BRD007J), in the middle of Lake Adger (station BRD007L), and near the downstream end of Lake Adger (BRD007P).

The above-mentioned data was incorporated into a Geographic Information System (GIS) shapefile "2010_DWQ_Lake_Adger.shp", and submitted with this report as a final deliverable to IPDC.

5.0 Summary of University Reports

5.1 Polk County Stream Water Quality: Year Sixteen

A technical report by Marilyn Westphal, Steven Patch, and Ann Marie Traylor from the Environmental Quality Institute at the University of North Carolina at Asheville, titled *Polk County Stream Water Quality: Year Sixteen* (Westphal et al., 2009), was reviewed during this investigation. The technical report summarizes 16 years (1993 through 2009) of water quality data collected throughout Polk County by the Volunteer Water Information Network (VWIN). The approximate monitoring locations are shown in Figure 3.

5.1.1 Data Results of the Polk County Stream Water Quality: Year Sixteen

Three of the 14 VWIN monitoring stations are located within the GRW study area. Monitoring station 18 Camp Creek (Green River Watershed) is located at the upstream end of the study area, and monitoring stations 8 Demannu Creek (Green River Watershed) and 13 Green River are located at the downstream end of the GRW study area. The VWIN monitoring stations are shown in Figure 3.

Only the low, median, and high values were reported for the sample results from years 2006 to 2009, and only the median sample results from all 16 years of data for each constituent were reported. Therefore, all data associated with the 16-year investigation was not available for analysis during this investigation. However, all high sample results within the study area were below 2B standards, except the high turbidity sample from station 8 which was measured at 75 NTU (the maximum allowable turbidity according to the 2B standard is 50 NTU); the high turbidity sample date is not listed.

Conductivity, which is a measurement of dissolved ions, was shown to increase over time at stations 13 and 18. On the downstream monitoring sites (stations 8 and 13) alkalinity was shown to increase over time, which indicates the waters have a higher ability to neutralize acidic inputs into the stream. Turbidity and total suspended solids (TSS) were shown to increase over time at site 13. Increases in turbidity and TSS indicate the stream is receiving more sediment either through runoff or erosion within the watershed. Conductivity and zinc were shown to increase over time at station 13. Zinc is commonly associated with vehicular degradation of rubber tires, and brake pads, and may indicate runoff from nearby roadways is entering the streams at greater or more concentrated quantities than before. The increases in TSS and metals measured at this location indicate the GRW has increased sediment input to streams throughout the watershed.

The above-mentioned data was incorporated into two GIS shapefiles: “VWIN_1993_2009_MedianData.shp” is the median analysis values from samples collected from 1993 through 2009; “VWIN_2007_2009_MedianData” is the median analysis values from samples collected from 2007 through 2009. The shapefiles were submitted with this report as a final deliverable to IPDC.

6.0 Summary EPA STORET Data

Water quality data were retrieved from the U.S EPA STOrage and RETrieval (STORET) Data Warehouse. The samples were collected by DENR DWQ sporadically from 1969 to 1989. Only surface water results collected with a sample depth less than 1.64 feet (0.5 meters) are discussed herein. The monitoring results for the samples are shown in Table 1. The sample locations are shown on Figure 3.

As shown on Figure 3, all sample station locations are on or adjacent to Lake Adger, except for sample station A2120000 which is located on Cove Creek near Saluda, North Carolina. Sample stations A2146000 and A2146010 are located near the mouth of the Green River entrance to Lake Adger near the western end of the lake. Station A2148000 and A2148010 are located in the center of Lake Adger, and station IDs A2188000 and A2188010 are located in the eastern end of Lake Adger just upstream of the Lake Adger Dam. Station A2190000 is located just downstream of the Lake Adger Dam on the Green River.

Ten monitoring locations were located within the GRW. Of the 10 monitoring stations, three are stations sampled and reported in the May 31, 2011 *Lake & Reservoir Assessments Broad River Basin Report* published by DENR DWQ. Refer to section 5.2 for a summary of those results. The following EPA STORET Stations correspond to the *Lake & Reservoir* stations:

- EPA STORET stations A2146000 and A2146010 are at essentially the same location as DWQ site BRD007J.
- EPA STORET stations A2148000 and A2148010 are at essentially the same location as DWQ site BRD007L.
- EPA STORET stations A2188000 and A2188010 are at essentially the same location as DWQ site BRD007P.

Additionally, VWIN Site 13 is located in essentially the same location as EPA STORET Station A2190000 (see Section 8.0 for a comparison).

6.1.1 Data Results of EPA STORET

Surface water surface physical conditions were sampled 12 times from June 18, 1969 to December 1, 1973 at station A2120000. All water surface physical conditions were within 2B standards except fecal coliform measured on June 18, 1969, June 15, 1970, October 21, 1970, March 30, 1971, June17, 1971, August 25, 1971, June 26, 1972, and June 14, 1973.

Stations A2146000 and A2146010 were sampled once on August 1, 1989; all surface water characteristics (i.e., dissolved oxygen, pH, and water temperature) were within the 2B standards.

Station IDs A2148000 and A2148010 were sampled once on August 1, 1989; all surface water characteristics were within the 2B standards.

Stations A2188000 and A2188010 were sampled once on August 1, 1989; all surface water characteristics were within the 2B standards.

Station A2190000 was sampled 20 times from December 20, 1973 to May 20, 1975. Metals, arsenic, calcium, lead, magnesium, and manganese were detected in samples, and concentrations remained fairly consistent among the samples and within the allowable 2B standards. Ph levels decreased slightly from 7.3 to 6.4, but were still within the acceptable 2B range. Iron sampled on May 20, 1975 was above the 2B standard, and was measured at a concentration of 1,400 mg/L. Fecal coliform levels increased over time, and two separate exceedances above the 2B standard were detected on March 3, 1975 and May 20, 1975.

The above-mentioned data was incorporated into a GIS shapefile “EPA_STORET_Green_Watershed.shp”, and submitted with this report as a final deliverable to IPDC.

7.0 Data Comparisons

EPA STORET data corresponds to similar sample locations from the *Lake & Reservoir* stations (Section 5.2) and the VWIN stations from Westphal et al., 2009 (Section 6.0). The following summarizes the station locations and data sample dates:

- EPA STORET stations A2146000 and A2146010 (sampled in 1989) are at essentially the same location as *Lake & Reservoir* station BRD007J (sampled in 2010), which are located in the western end of Lake Adger.
- EPA STORET stations A2148000 and A2148010 (sampled in 1989) are at essentially the same location as *Lake & Reservoir* station BRD007L (sampled in 2010), which are located in the center of Lake Adger.
- EPA STORET stations A2188000 and A2188010 (sampled in 1989) are at essentially the same location as *Lake & Reservoir* station BRD007P (sampled in 2010), which are located in the eastern end of Lake Adger.
- EPA STORET station A2190000 (sampled from 1973 to 1975) is at essentially the same location as VWIN station 13 (median data from 2007 to 2009), which are located just downstream of the Lake Adger dam.

Of the constituents sampled in the EPA STORET dataset and the *Lake & Reservoir* dataset, only pH, dissolved oxygen and conductivity were sampled in both datasets. It appears pH has remained fairly constant or slightly increased over time, while conductivity has slightly decreased and dissolved oxygen remained fairly constant. There does not appear to be sufficient sampling data to indicate water quality trends or changes over time for the study area.

Of the constituents sampled in the EPA STORET dataset and the Westphal et al. 2009 dataset, only pH, turbidity, nitrate, conductivity, copper, lead, and zinc were sampled in both datasets. The following summarizes the comparison of EPA STORET station A2190000 and VWIN station 13:

- Ph has remained fairly constant or increased slightly.
- Turbidity remained fairly constant.
- Nitrate has remained fairly constant or increased slightly.
- Conductivity has remained fairly constant.
- Copper was not detected in the EPA STORET dataset, and had a median value from 2007 to 2009 of 0.5 micrograms per liter (µg/L) in the Westphal et al. 2009 dataset, which is below the 2B standard of 7 µg/L.
- Lead was not detected in the EPA STORET dataset, and had a median value from 2007 to 2009 of 0.3 µg/L in the Westphal et al. 2009 dataset, which is below the 2B standard of 25 µg/L.
- Zinc was not detected in the EPA STORET dataset, and had a median value from 2007 to 2009 of 1.6 µg/L in the Westphal et al. 2009 dataset, which is below the 2B standard of 50 µg/L.

It appears metal concentrations have increased over time, although detection limits for the EPA STORET dataset are unknown. Therefore, it is difficult to compare metal results from the EPA STORET dataset to the Westphal et al. 2009 dataset.

8.0 Summary of Interviews

8.1 Summary of Interviews with North Carolina Wildlife Resources Commission

Mr. Doug Besler with North Carolina Wildlife Resources Commission (WRC) was contacted on April 26, 2013. Mr. Besler related the following details to Altamont:

- Mr. Besler indicated that the WRC had limited involvement with Lake Adger and the surrounding area.
- Mr. Besler stated that the WRC maintains a public angler access on Lake Adger, and is responsible for keeping the access open.
- Mr. Besler stated that he was not aware of any water quality data for Lake Adger.
- Mr. Besler was aware of sediment dredging on Lake Adger. However, Mr. Besler indicated he did not know when the last dredging occurred or the quantity of sediment removed from Lake Adger.

Mr. David Yow with WRC was contacted on April 29, 2013, and related the following details to Altamont:

- Fisheries have conducted shoreline electrofishing in Lake Adger for muskellunge in several years since 2000. One year's worth of late summer temperature and dissolved oxygen measurements were also collected in Lake Adger.
- Mr. Yow provided Altamont the muskellunge and temperature and dissolved oxygen data described above. The temperature and dissolved oxygen data are included in Table 2.

Mr. David McHenry with WRC was contacted on May 1, 2013, and related the following details to Altamont:

- Mr. McHenry indicated he had limited knowledge of activities within Lake Adger.
- Mr. McHenry stated that according to his records, in 2000, there was some dredging and shoreline stabilization done by Lake Adger Developers, Inc. on a public recreational access.
- Mr. McHenry indicated additional small-scale dredging projects done in other areas of Lake Adger occurred after 2000.
- Mr. McHenry stated that he did not have records regarding the quantity of sediment removed from Lake Adger.

8.2 Summary of Interviews with DENR Officials

Mr. Ed Williams, River Basin Planner with the Asheville Regional Office DENR DWQ, was contacted on February 19, 2013 and related the following details to Altamont:

- No Watershed Assessment Team (WAT) projects have occurred in the GRW.
- No Watershed Assessment and Restoration Programs (WARP) have occurred in the GRW.
- No local watershed plans (LWP) exist in the GRW.
- No DWQ ambient water quality sites exist in the GRW.
- Several macroinvertebrate and fish community monitoring sites exist in the GRW. These data can be found on the DENR website.

Altamont subsequently located the above-mentioned data as part of this investigation and incorporated the results herein.

Ms. Melanie Williams, River Basin Planner with the DENR DWQ Basinwide Planning Unit was contacted on May 29, 2013 and related the following details to Altamont:

- The 2008 *NC DWQ Broad River Basin Plan: Green River Watershed HUC's 0305010501 & 0305010502* is the most recent and up-to-date basin plan for the GRW.
- The River Basin Plans were previously scheduled to be updated on a 5-year cycle, and a draft report of the Broad Basinwide Plan was anticipated in 2013. However, the cycle to update the River Basin Plans has been augmented to a 10-year cycle. Therefore, the next Broad Basinwide Plan is projected to be completed in 2018.
- Ms. Williams was not aware of additional water quality data or plans to conduct future investigations within the GRW at this time.

8.3 Interviews with Green River Watershed Residents

Long-term residents of the watershed offer valuable insight into the overall watershed health. Residents of the GWR were contacted and interviewed as described below.

Ms. Sue Rothemick was interviewed on May 8, 2013 and related the following details to Altamont:

- Ms. Rothemick has been a resident of Lake Adger for over 25 years.
- Ms. Rothemick stated her land was originally part of a land grant, and her parcel includes 7 acres into Lake Adger.
- Ms. Rothemick stated her house was built in the 1960s.
- Ms. Rothemick stated she had seen erosion of the shores that has increased dramatically since the recent housing development within the last 15 years.
- Ms. Rothemick stated that she had a retaining wall replaced 2 years ago since the original wall had eroded away.
- Ms. Rothemick stated that increased sediment build up in Lake Adger is evident from her parcel.

Mr. Glenn Duelkan and Ms. Lynn Duelkan (the Duelkans) were interviewed on July 20, 2013 and related the following details to Altamont:

- The Duelkans purchased their property on Lake Adger in 1998.
- The Duelkans' property is situated on Island Cove and overlooks the entrance of Ostin Creek to Lake Adger.
- The Duelkans indicated that their property, which includes a peninsula on Lake Adger, has receded approximately 5 to 6 feet in some areas since their purchase of the property.
- The Duelkans indicated that when they purchased the property, they had used a boat and depth meter to measure the lake depth at approximately 25 feet. They indicated the depth at this same location is approximately 5 feet today.
- The Duelkans indicated that the Ostin Creek bed had consisted of pebbles and river rock, and that they could use kayaks to paddle from Lake Adger upstream into Ostin Creek. They indicated that Ostin Creek is inundated with sediment, and not deep enough to kayak through today.

8.4 Interview with Sky Conard of the Green River Watershed Alliance

Sky Conard, founder of the GRWA, was interviewed on August 22, 2013. Mrs. Conard is also a resident of Lake Adger and has owned a home on the lake since 2006.

Ms. Conard related the following to Altamont:

- Sediment accumulation within the Green River has become visually apparent in recent years.
- The water in Lake Adger has become less clear since 2006, and the suspended sediment is noticeable when swimming in Lake Adger.
- During storm events, the water turns from green to muddy brown.
- There is an increase in trash, debris, and grease/oil in Lake Adger.
- Ms. Conard operates a pontoon boat on Lake Adger, and notes that it is very difficult to navigate the boat due to the shallow water depth. She stated it is impossible to navigate from the public marina across and into the Green River due to sediment accumulation.
- The coves throughout Lake Adger were once deeper, and boat navigation through the coves is now restricted due to sediment accumulation.
- Panther Creek enters into Lake Adger and is often muddy and brown during storm events.
- Silver Creek enters into Lake Adger and river rocks that were once visible are now buried with sediment. Silver Creek is also muddy and brown during storm events.
- The Lake Adger Community recently started a Lake Management Planning Committee, comprised of Ms. Conard and nine other Lake Adger residents. They are working on setting management goals and strategies to stabilize and restore Lake Adger shores, as well as watershed management goals for Lake Adger.
- The GRWA is interested in partnering with regional and local agencies and stakeholders to develop a realistic management plan and is also interested in public outreach to broaden the public's knowledge of watershed management.
- The GRWA has built relationships with the Polk County government, Polk County Soil and Water Conservation District, Henderson County Soil and Water Conservation District, Lake Adger Board of Directors, Walnut Creek Preserve, Brights Creek Community, Save our Slopes, Trout Unlimited, Pacolet Area Conservancy, Saluda Community Land Trust, Carolina Mountain Land Conservancy, Western North Carolina Alliance, Green River Adventures, Gorge Zipline, Northbrook Hydroelectric, Slow Foods Organization, John Grace (promoter of Green River Games/Narrows Kayak Race, and DENR, DWQ, WRC, and the NC State Regional Water Quality Summit Organization.
- The GRWA hopes to continue promoting and facilitating work in the GRW to protect water resources. Ms. Conard hopes this assessment will serve as a meaningful tool to continue work in the GRW.

9.0 Watershed Site Reconnaissance

Altamont conducted visual inspections of the GRW on July 2, 8, 20, and 24, 2013. Representative photographs from the visual inspections are included in Appendix A.

Prior to the visual site inspections, Altamont analyzed the existing conditions throughout the GRW to determine areas of concern deemed "priority sites" that would be visited during the site investigation. Priority sites were determined based on aerial imagery, available water quality data, and information gathered from local sources. Areas with adequate road access, urban development, agriculture, or streams that appeared to be lacking adequate buffer were identified as priority sites to visit. Sites 1 through 17 were identified prior to watershed inspection, and Sites 18 through 31 were additional sites identified throughout site reconnaissance. A map with Sites 1 through 31 is included as Figure 4. Due to the limited nature of this study, and access limitations to private property, Altamont was not able to inspect all stream segments within the study area.

The site reconnaissance focused on identifying potential watershed stressors and sources of sediment. General site characteristics, channel stability, riparian vegetation, buffer width, bed material, and livestock presence near the stream, were recorded for each Site. Site characteristics were rated on a qualitative scale, and quantitative data was not collected herein. According to the NC Ecosystem Enhancement Program (EEP), stream buffers should be a mix of shrubs and trees and be at least 30 feet in width directly adjacent to the stream. The following site characteristics were rated as follows:

- Buffer width
  - Adequate = at least 30 feet in width
  - Limited = less than 30 feet in width
- Riparian vegetation
  - Excellent = mix of woody and shrubby vegetation
  - Good = mix of woody and shrubby vegetation lacking mature trees
  - Fair = mostly shrubby vegetation
  - Poor = lacking woody and shrubby vegetation
- Channel
  - Stable = no observed erosion and/or stressors
  - Mostly Stable = stable with areas of erosion
  - Eroded = eroded streambank
  - Incised = incised channel with tall banks and no or limited access to a floodplain
- Channel bed material (large boulders, cobble, gravel, and sand)
  - Was listed in descending order of observed abundance
- Livestock
  - Yes = livestock presence adjacent to the channel was observed
  - No = livestock were not observed adjacent to the channel

Table 3 describes the site characteristics of Sites 1 through 31. The major tributaries feeding into Lake Adger and including Lake Adger are discussed below. However, Pulliam Creek was not observed during this investigation as the general land use surrounding Pulliam Creek appeared to be primarily forested and potential stressors were not identified.

9.1 Brights Creek

Sites 5, 21, and 29 were observed on Brights Creek.

Site 5 is located on Brights Creek within the Brights Creek residential and golf development just downstream of a detention pond located on the golf course. The channel was observed to be in stable condition with a good riparian buffer. The substrate of the channel appeared to be cobble and sand. This site was observed during a rain event and the water was slightly turbid.

Site 29 is located approximately 0.8 miles downstream of Site 5 on Brights Creek on Palmer Road just outside of the Brights Creek development. The channel was observed to be moderately incised with healthy vegetation and an adequate stream buffer. Riffles and pools were observed in the predominately cobble and gravel substrate of the channel. Just downstream of Site 29, on Palmer Road Brights Creek was observed to be actively eroding. This reach flows through a corn field on private property and it was not possible to directly observe the entire channel. However, tall and eroding banks with exposed soil were observed, and are likely inputs of sediment to the GRW.

Site 21 is located downstream at the Palmer Road bridge over Brights Creek, just upstream of the confluence with the Green River. Large amounts of sediment were observed in the channel. The sediment is likely from upstream sources and from a backwater effect of the larger Green River. The riparian vegetation was a mix of woody and shrubby species; however, some trees were falling into the channel. The buffer width was adequate.

Additional unnamed tributaries to Brights Creek located on the Brights Creek development were observed during a rain event. The tributaries were turbid during the rain event and likely contribute sediment to the GRW. Additionally, it is likely that the Brights Creek development contributed sediment to the GRW during the construction phase of the project.

Photographs 1 through 11 of Brights Creek are included in Appendix A.

9.2 Cove Creek

Site 9 was observed on Cove Creek, and Site 7 and 8 were observed on a tributary to Cove Creek.

Site 7 is located on an unnamed tributary to Cove Creek off of Howard Gap Road. Site 7 was observed to be stable with adequate stream buffer in most locations, with the exception of a few areas adjacent to agricultural property. Livestock was observed adjacent to Site 7, and a fence was observed in most locations except in one area where livestock had access to the stream and bank erosion was observed. The substrate was predominately gravel and sand.

Site 8 is located approximately 0.1 miles downstream of Site 7 on an unnamed tributary at the intersection of Howard Gap Road and Ozone Drive. A gas station is located directly adjacent to the stream at Site 8. The parking lot is paved, and a section of the parking lot was observed to be cracked and crumbling; the debris likely erodes to the tributary. The channel appeared to be incised. Access to the channel was not possible, and the channel substrate could not be observed. The stream buffer vegetation was fair; however the buffer width was constricted by the road and gas station.

Site 9 on Cove Creek is situated on private property on Thomson Road. The channel was observed to be eroded. The substrate of the channel appeared to be cobble, gravel, and sand. Cove Creek did not have an adequate riparian buffer at this location. Furthermore, the stream buffer was lacking vegetation diversity and woody vegetation. It appeared that the buffer, which was predominantly grass, had been mowed to the water's edge.

Cove Creek was observed again, slightly downstream on Canary Road. The streambanks appeared to be eroded and the channel was incised. Lack of riparian corridor, like that of Site 9, was also observed.

Photographs 12 through 19 of Cove Creek are included in Appendix A.

9.3 Green River

Sites 1, 10, 11, and 28 were observed on the Green River and Sites 17 and 24 and were observed on unnamed tributaries to the Green River. Site 3 was observed in an upland area that drains to the Green River. The Green River was observed from Site 1 to the confluence with Lake Adger.

Site 1 is located at the Fish Top Access Area off Green Cove Road. The Green River appeared stable with excellent riparian buffer vegetation. The buffer width also appeared wide and adequate for the river. The channel substrate was mainly cobble with large boulders. Riffle and pools were observed in channel. Some turbidity was observed from likely upstream sources.

Site 10 is located approximately 0.6 miles downstream from Site 1 at the Wilderness Cove Tubing Company off Green River Cove Road. The Green River appeared similar to Site 1. However, the tubing access has eroded the bank and decreased the riparian buffer in this location.

The Green River Cove Tubing property is located along the Green River by the confluence with Gadd Creek (Site 2). The parking lot of the tubing company is soil. The area was observed during a rain event and the soil parking lot was contributing sediment to the Green River. The banks of the Green River were also observed to be actively eroding into the channel near the tubing company parking lot.

Site 28 is located approximately 3 miles downstream of Site 10 off Green River Cove Road. The Green River appeared similar to Sites 1 and 10. However, a large area of exposed soil along Green River Cove Road was observed adjacent to the Green River. This exposed soil likely contributes sediment to the Green River.

Site 11 is located approximately 0.4 miles downstream of Site 28 at the bridge over the Green River on Green River Cove Road near DENR benthic macroinvertibrate sampling location AB-23. The channel appeared to be stable, with an excellent riparian buffer. The channel substrate was mainly cobble, gravel, and sand. According to the 2008 *NC DWQ Broad River Basin Plan: Green River Watershed HUC's 0305010501 & 0305010502,* benthic site AB-23 received a "Good" bioclassification and improved slightly from "Good-Fair" in both 1995 and 2000.

Site 3 is located within the River Park development off of River Park Lane in an upland area proximate to the Green River. A large exposed soil area was observed at Site 3. It is likely that the development began clearing the land to construct homes, and then failed to erect homes and left the earth exposed. This area is on a hillslope and likely contributes sediment to the Green River via stormwater runoff.

Altamont observed the Green River in a kayak from the Big Rock access area down to Lake Adger. The streambanks were stable with the exception of one small area of erosion on the right bank. As the river approaches Lake Adger, the channel slope and velocity decreased and the channel substrate changed from boulders and cobble to a sand bed. Large sediment deposits were observed where the Green River enters Lake Adger.

Site 17 is located on an unnamed tributary to the Green River downstream of the Lake Adger Dam off Garret Road. The channel was moderately incised with a predominately sandy, substrate with some cobble, and gravel. The stream buffer vegetation was fair, and was lacking mature woody vegetation. The stream buffer width was also fair, and slightly constrained by Garrett Road.

Site 24 is located approximately 0.3 miles downstream from Site 17 on the same unnamed tributary of Site 17 off Garrett Road. The channel was eroded and incised. The stream buffer was predominately grass with a few hardwood trees dispersed throughout the corridor. The stream buffer width was limited, as it appeared the grass had been mowed to the water's edge. The channel substrate was sand and gravel. This Site is a likely source of sediment to the Green River.

Photographs 20 through 39 of the Green River are included in Appendix A.

9.4 Ostin Creek

Sites 13, 14, 15, 18, 19, 20, and 30 were observed on Ostin Creek, and Site 22 was observed on an unnamed tributary to Ostin Creek.

Site 20 is located at the Ostin Creek headwaters located off Holbert Cove Road. The channel was stable with excellent riparian vegetation. The stream buffer width was wide and unrestricted. The channel substrate was mainly cobble with some sand.

Site 19 is located approximately 1.9 miles downstream from Site 20 off Holbert Cove Road. The channel appeared stable. No livestock were observed adjacent to the channel. However a wet ford crossing was observed through Ostin Creek and it is possible that it is used for vehicular traffic and cattle crossing. Small stormwater runoff gullies were noted in the crossing that could contribute sediment to the creek. The channel appeared stable with a well-vegetated stream buffer. The channel substrate was mainly gravel with some cobble and sand.

Site 18 is located approximately 400 feet downstream from Site 19 off Holbert Cove Road. The channel appeared incised and eroded. The stream buffer was wide enough for the channel, although Holbert Cove Road appeared close to the channel in some locations. The vegetation within the stream buffer was a good mix of woody and shrubby species. However, the rooting depth of the vegetation appeared to be lacking, and the channel banks were eroded. The channel substrate was mainly cobble and sand.

Site 15 is located approximately 0.6 miles downstream from Site 18 off Holbert Cove Road. Site 15 is located in a largely agricultural area, and livestock were observed adjacent to the stream. A fence along the stream was observed with one locked wet ford crossing. Cattle access to the stream is limited by the cattle exclusion gate on the wet ford. A section of Ostin Creek was restored in 2008 on Site 15 and appeared to be stable. The plentiful riparian vegetation was a mix of woody species, shrubs, and grasses. The channel substrate was predominately cobble with some sand and gravel. Instream stabilization structures (e.g., rock cross vanes and log vanes) were stable and directing flow and shear stress away from the streambanks. The restoration project appears to have reduced downstream sedimentation by stabilizing the streambanks along this reach. This site could be a good demonstration site for other agricultural properties in the GRW that have issues with eroding streambanks.

A small tributary coming into Ostin Creek upstream of site 15 was observed to be incised and eroded. Additionally, a dirt road was observed adjacent to the tributary and identified as a potential source of sediment.

Site 14 is located approximately 0.5 miles downstream of Site 15 on Silver Creek Road. Site 14 is located near Silver Creek Road and a power line easement runs through the riparian corridor. Site 14 appeared stable, although depositional sandbars were observed in the channel and some bank erosion was noted in an area with tight meander bends. This deposition is likely due to upstream sources from land clearing activities and agricultural land uses. The stream buffer was also observed to be limited.

Site 30 is located approximately 1 mile downstream of Site 14 on the Lake Adger Development. Site 30 is accessed via a gravel road or "trail" as listed on the Lake Adger Development. Ostin Creek at Site 30 appeared to be in a stable condition. Erosion was noted along the gravel trail that drains to Ostin Creek at Site 30.

Site 13 is approximately 1.9 miles downstream of Site 14 and is located just upstream of the Ostin Creek entrance to Lake Adger. The channel was eroded and appeared much wider and shallower than upstream locations on Ostin Creek. Sediment deposition was also apparent in the channel. The stream buffer was adequately wide and vegetation was a good mix of woody and shrubby vegetation.

Site 22 is located off Hitching Post Road slightly upstream of an unnamed tributary to Ostin Creek. A large muddy pond was observed at Site 22 to be holding turbid water that discharges to the tributary. The discharge appeared to have eroded the tributary and rip-rap was observed at the discharge location. However the rip-rap was scattered and migrating downstream. The pond discharge to the tributary was very turbid and likely a source of sediment to Ostin Creek. An upland exposed soil hillslope was observed upstream of Site 22 and likely contributes sediment to the pond and tributary.

The Ostin Creek entrance to Lake Adger was also observed during this investigation (see Section 10.10), and was observed to be heavily impacted by sediment deposition.

Photographs 40 to 61 of Ostin Creek are included in Appendix A.

9.5 Panther Creek

Sites 6 and 27 were observed on Panther Creek.

Site 6 is located near Regan Jackson Road in a predominately wooded area. The surrounding area is used as a service entrance to the Brights Creek Development, and access roads and stockpile areas were observed. There was no evidence of active construction during the site visit. However, there were likely sediment impacts during the active construction phase of the development. The channel at Site 6 was moderately incised. The riparian vegetation was a mix of woody and shrubby vegetation, although large mature trees were not present. An eroding roadway ditch was observed upstream of Site 6, and sediment likely washes to Panther Creek. The buffer width was adequately wide. The channel substrate was mainly gravel with some cobble and sand.

Site 27 is located approximately 0.3 miles downstream of site 6 at the intersection of Rose Hollow Road and Regan Jackson Road. The channel appeared stable, and a limited buffer was observed adjacent to the stream. The channel substrate was mainly gravel with some sand and cobble. The creek flows through a pasture just downstream of Site 27. Livestock with unrestricted access to the creek were observed in the pasture adjacent to the creek.

Photographs 62 to 65 of Panther Creek are included in Appendix A.

9.6 Rash Creek

Site 26 was observed on Rash Creek, a tributary to Brights Creek.

Site 26 is located near the headwaters of Rash Creek on Regan Jackson Road. This area is the same service entrance to the Brights Creek Development and stockpile areas were observed near Site 26. Three concrete culverts are used to cross the gravel road over Rash Creek at Site 26. A gravel stockpile was located adjacent to Site 26 and appears to be contributing gravel to the stream. The channel appeared to be moderately incised, although a large grassy floodplain is located adjacent to the stream. The stream has a limited buffer width and the riparian vegetation is largely grasses and lacking woody species. The channel substrate was sand and gravel.

Photographs 66 and 67 of Rash Creek are included in Appendix A.

9.7 Rotten Creek

Site 12 was observed on Rotten Creek and Site 31 was observed on a tributary to Rotten Creek.

Site 12 is located off Lake Adger Road near the study area boundary. The surrounding area is largely agricultural and cattle were observed adjacent to the stream. There appeared to be gaps in the cattle exclusion fencing near the stream that allowed the cattle access to the stream. The channel was eroded and incised, with a limited buffer width adjacent to the stream. The stream was observed to be very turbid even though a rain event had not occurred during or prior the site inspection.

A large area proximate to Site 12 appeared to be clear-cut and areas of exposed soil were observed. This open area likely contributes sediment to the stream.

Site 31 is located on an unnamed tributary to Rotten Creek approximately 0.6 miles southwest of Site 12. Site 31 was observed to be in similar condition to Site 12. The channel was eroded and the buffer width was limited. The riparian vegetation was predominately shrubs and was lacking woody species. Livestock were not observed adjacent to the stream, but it is possible that the adjacent land is used as cattle pasture. The channel substrate was sand and gravel, and the stream appeared turbid even though a rain event had not occurred during or prior to the site inspection.

Photographs 68 to 71 of Rotten Creek are included in Appendix A.

9.8 Silver Creek

Sites 16, 23, and 25 were observed on Silver Creek.

Site 16 is located off Lone Pine Drive on private property. It was not possible to observe the site directly, although limited observation indicated the riparian buffer was mowed to the water's edge. The buffer was grass only and lacked diverse woody and shrubby vegetation. The channel appeared eroded.

Site 23 is located approximately 0.5 miles downstream from Site 16 located off Silver Creek Road. The channel appeared eroded. The riparian buffer was at least 30 feet wide, and was a mix of woody and shrubby vegetation. Livestock were observed adjacent to the stream, although a cattle exclusion fence likely limits their access to the stream.

Site 25 is located approximately 1.2 miles downstream from site 23 on Sloping Meadow Road. The channel appeared stable and the riparian buffer was in excellent condition. The buffer was also at least 30 feet wide and adequately wide for the stream. The channel substrate was predominately sand with some cobble, and sand was observed to be embedded into the channel from likely upstream sources.

Photographs 72 to 76 of Silver Creek are included in Appendix A.

9.9 Gadd Creek

Site 2 was observed on Gadd Creek.

Site 2 is located at Gadd Creek, which is a tributary to the Green River off Green River Cove Road. Gadd Creek appeared to be in stable condition. The riparian buffer appeared wide enough for the stream and vegetation was observed to be healthy and diverse. The stream was running clear during a rain event indicating that the contributing watershed is stable.

Photographs 77 and 78 of Gadd Creek are included in Appendix A.

9.10 Lake Adger

Lake Adger was observed via boat, kayak, and by a walking inspection. Lake Adger development began constructing homes around the lake around 2000. A few active construction sites were also observed around Lake Adger during this investigation, although housing construction has largely decreased since 2000. Upland areas throughout the Lake Adger development were also observed, and streets within the

Lake Adger development were stained with sediment that likely eroded from exposed soil patches located throughout the development.

Much of the shoreline along the lake was eroded and tall near vertical banks were observed throughout the lake. However, many stretches of shoreline (where development was scarce) appeared to be stable and well vegetated. It is likely that the eroding banks are contributing sediment to the lake.

Large amounts of sediment were observed throughout the lake, and particularly at the public marina entrance where the Green River enters Lake Adger, and at the entrance of Panther Creek and Ostin Creek. Historical photographs comparing Lake Adger are included in Appendix B. A photo comparison of the Lake Adger marina taken in 1953 and again in 2013 illustrates the advent of sediment accumulation and depositional islands on Lake Adger. The sediment accumulation in Lake Adger is also highlighted in a photo comparison from 2004 and 2013 (Appendix B). The depositional islands in this cove of Lake Adger are not visible in the 2004 photograph, but are apparent in the 2013 photograph. The marina appeared shallow in most locations, and the lake depth was as shallow as 3 feet in some locations. Consequently, sediment deposition and accumulation is a notable concern in this lake.

According to Lake Adger residents, Ostin Creek was once navigable by kayak from Lake Adger and had a cobble and stone substrate that is now filled in with fines. Island Cove, where Ostin Creek enters Lake Adger, was observed to be heavily filled with sediment and sediment islands were also observed. The lake depth was observed to be shallow in most locations around Island Cove.

Marina Cove, where Panther Creek enters Lake Adger, was also observed to be heavily filled with sediment. Jackson Cove, where Rotten Creek enters Lake Adger, was observed to have some sediment accumulation, although less than the Panther Creek and Ostin Creek entrances. Marina Cove was observed to be fairly shallow in many locations, and the lake depth was as shallow as 4 feet in some locations.

South Cove, where Silver Creek enters Lake Adger, was observed to be in fairly good condition. Some bank erosion was visible, but sediment depositional bars were not observed.

Photographs 79 to 95 of Lake Adger are included in Appendix A.

10.0 Conclusions

Overall, the streams within the GRW study appeared to be in relatively stable condition. The GRW study area was observed to be largely forested land, with some agricultural and developed land. Some stream sections were observed to be eroded and unstable, and likely contribute sediment to the Green River and eventually Lake Adger, which is the downstream extent of the study area. Additionally, current and historic development and land clearing activities in upland areas within the GRW have likely contributed excess sediment to the watershed. Locations around Lake Adger also showed signs of distress as banks were noted to be eroded and unstable.

The sediment accumulation observed in Lake Adger is likely attributed to the stressors observed in the GRW specifically, erosion along the lake shoreline and the construction the Lake Adger Dam. When the lake was created approximately 90 years ago, the sediment-carrying capacity of the streams draining to the lake was significantly decreased. Therefore, the streams are no longer capable of transporting the sediment load from the watershed and sediment is deposited into Lake Adger. Sediment is continually being supplied to the streams within the GRW, and the only way to reduce sediment inputs is to implement best management practices (BMPs) and stabilize exposed soil throughout the GRW. Additionally, Polk County and residents of the lake should explore options for periodic dredging of accumulated sediment deposited in the lake.

10.1 Watershed Data

Water quality data within the GRW study area was not abundant. No ambient water quality monitoring stations are located within the study area. The available water quality data is summarized below.

The 2008 *NC DWQ Broad River Basin Plan: Green River Watershed HUC's 0305010501 & 0305010502* stated that all 109 miles of the total 268 miles of streams within the watershed were listed as "Supporting" for aquatic life. Benthic sample results indicated species number and type has decreased due to increases in sediment and nutrients at sample location AB-24, which is located near the end of the Green River at the entrance to the Broad River at the Polk County and Rutherfordton County boundary (outside the GRW study area). AB-23, located on the Green River near Site 11, was rated "Good" and slightly improved from previous samples collected in 1995 and 2000.

The May 31, 2011 *Lake & Reservoir Assessments Broad River Basin* indicated that all sample results collected from Lake Adger in 2010 were within 2B standards.

The University of North Carolina at Asheville report titled *Polk County Stream Water Quality: Year Sixteen* indicated that there was only one sample station (station 8) within the study area that had an exceedance above 2B standards for turbidity. The report indicated that conductivity increased over time at stations 13 and 18. Turbidity, TSS, conductivity, and zinc were shown to increase over time at station 13, which is located just downstream of the Lake Adger dam. Increases in TSS, and metals measured at this location indicate the GRW has increased sediment input to streams throughout the watershed.

Data collected from the EPA STORET Data Warehouse indicated water quality has remained fairly constant from 1969 to 1989. All sample results were within 2B standards except the following:

- Fecal coliform measured at station A21200000 on 6/18/1969, 6/15/1970, 10/21/1970, 3/30/1971,6/17/1971, 8/25/1971, 6/26/1972, and 6/14/1973
- Fecal coliform measured at station A2190000 on 3/3/1975 and 5/20/1975
- Iron measured at station A2190000 on 5/20/1975

10.2 Interviews

Doug Besler, David Yow, and David McHenry of the WRC were interviewed during this investigation. They indicated the WRC had limited involvement with Lake Adger other than the maintenance of the public access marina. Mr. McHenry indicated some small-scale dredging of the public marina in 2000 was conducted by Lake Adger Developers, Inc.

DENR officials, Ed Williams with the Asheville Regional Office, and Melanie Williams with the Basinwide Planning Unit, were interviewed herein. According to Mr. Williams, no WAT projects or ambient water quality sites exist within the GRW. Additionally, a LWP has not been conducted in the GRW and no WAT projects have occurred in the GRW. Mr. Williams stated that several macroinvertebrate monitoring sites exist within the GRW and the data is accessible via the DENR website. Ms. Williams indicated that the River Basin Plans were scheduled to be updated on a 5-year cycle, but that the cycle has been augmented to a 10-year cycle. Therefore, the next Broad Basinwide Plan is projected to be completed in 2018 instead of 2013.

Lake Adger residents, Sue Rothemick, and Glenn and Lynn Duelkan, were interviewed to gain historic local knowledge of the GRW. Ms. Rothemick stated she has been a Lake Adger resident for over 25 years and has seen erosion increase dramatically since the Lake Adger Development began roughly 15 years ago. The Duelkans stated they purchased their property on Lake Adger in 1998 and that the property has receded due to erosion approximately 5 to 6 feet since that time. The Duelkans's property overlooks the entrance of Ostin Creek to Lake Adger, and according to the Duelkans Ostin Creek has filled with sediment over the past 15 years. Additionally, the Duelkans stated that the Lake Adger depth near their property was approximately 25 feet in 1998, and is now measured at approximately 5 feet. Additionally, Sky Conard, founder of the GRWA and a resident of Lake Adger was interviewed and indicated that the suspended sediment in Lake Adger has increased and is noticeable while swimming. Ms. Conard stated that due to sediment deposition, boat navigation through Lake Adger is difficult. Ms. Conard stated that the Lake Adger Community recently started a Lake Management Planning Committee to work on management of the lake. Ms. Conard indicated she had considerable relationships with local and regional agencies interested in preserving and protecting the water resources of the GRW.

10.3 Watershed Site Reconnaissance

Sites 3, 4, 6, 7, 8, 9, 12, 13, 14, 16, 17, 18, 21, 22, 23, 24, 26, 27, 28, 29, 30, and 31 exhibited signs of erosion, incision, sediment accumulation, and the potential for downstream sediment impacts. Large depositional islands were observed at the Ostin Creek entrance to Lake Adger. Stressors to Ostin Creek include exposed soil hillside erosion and a sediment laden inline pond (Site 22), lack of riparian buffers, and eroding banks along the stream (Site 14 and proximate to Site 15). Moreover, the abrupt change in channel morphology (i.e., decrease in longitudinal slope) near the entrance to Lake Adger causes Ostin Creek to lose stream power and the ability to transport sediment. Therefore, sediment is readily deposited near the entrance to Lake Adger.

Large depositional islands were also observed at the Panther Creek entrance to Lake Adger. Some stressors to Panther Creek include an eroding roadside ditch (near Site 6), livestock access to the creek, and lack of riparian buffer (Site 27). Additionally, the Brights Creek Development appears to have cleared some land and installed roads near Panther Creek, which serve as service roads, stockpile areas, and construction entrances to the Brights Creek Development. The construction staging areas and past construction activity could be a potential source of sediment to Panther Creek.

The Brights Creek construction staging areas also affect Rash Creek, which is just west of Panther Creek. Stressors to Rash Creek include construction activities and lack of riparian buffer (Site 26).

Some sediment accumulation was observed at the Rotten Creek entrance to Lake Adger. Rotten Creek was observed to be largely impacted by sediment pollution. Stressors to Rotten Creek include agriculture (Site 12), lack of riparian buffer (Site 12 and 31), and clear-cut land (Site 12).

Lake Adger was observed to be shallow in multiple locations and have actively eroding banks. Depositional islands were also observed throughout the lake. The sedimentation buildup in Lake Adger is attributed to cumulative watershed effects of sediment inputs to the Green River, which leads to Lake Adger.

11.0 Recommendations

The GRW is a valuable resource, particularly the Green River Game Land area is utilized by hunters, and the Green River is a truly spectacular resource for fishermen, kayakers, and tubers. As recreational use of the Green River increases, it would be beneficial to adopt BMPs throughout the GRW to preserve the water quality of the streams and also preserve the Green River as a recreational resource. BMPs could include items such as bioretention basins, stormwater wetlands, installing cattle exclusion fencing along streams, stabilizing exposed and vulnerable soil slopes, restoring eroding streambanks, and restoring riparian buffers The recent stream restoration project on Ostin Creek (Site 15) is a good demonstration site to illustrate the benefits of streambank stabilization projects in the watershed.

The stressors identified throughout this report could be investigated further, along with potential stressors to the Green River from upstream sources in Henderson County. If property owners are responsive and wish to improve water quality, they could potentially partner with local non-profits, Polk County Soil and Water Conservation District, and the DENR Division of Water Resources, to implement BMPs that would remediate erosion and benefit the water quality of the GRW.

Additionally, Lake Adger has not been thoroughly dredged to remove accumulated sediment since it was constructed in 1925. When the dam was constructed in 1925, the contributing creeks and rivers lost their natural ability to transport sediment from the contributing watershed to areas downstream of the dam. Therefore, sediment has accumulated in the lake for almost 90 years, which directly reduces the water storage capacity of Lake Adger and has become a nuisance to residents and recreational users of the lake. An analysis of dredging requirements should be conducted to determine optimal locations throughout the lake to remove excess sediment. It is not likely the entire lake could be dredged at once, and critical areas like the public marina, Marina Cove, where Panther Creek enters Lake Adger, and Island Cove, where Ostin Creek enters Lake Adger should be considered primary priorities for dredging. Low impact development strategies should be practiced in future development around Lake Adger, and sustainable shoreline stabilization techniques should be implemented on the Lake Adger shoreline to improve water quality and reduce further sedimentation to Lake Adger.

12.0 References

Intensive Survey Unit, Environmental Sciences Section Division of Water Quality. May 31, 2011. *Lake & Reservoir Assessments Broad River Basin.*

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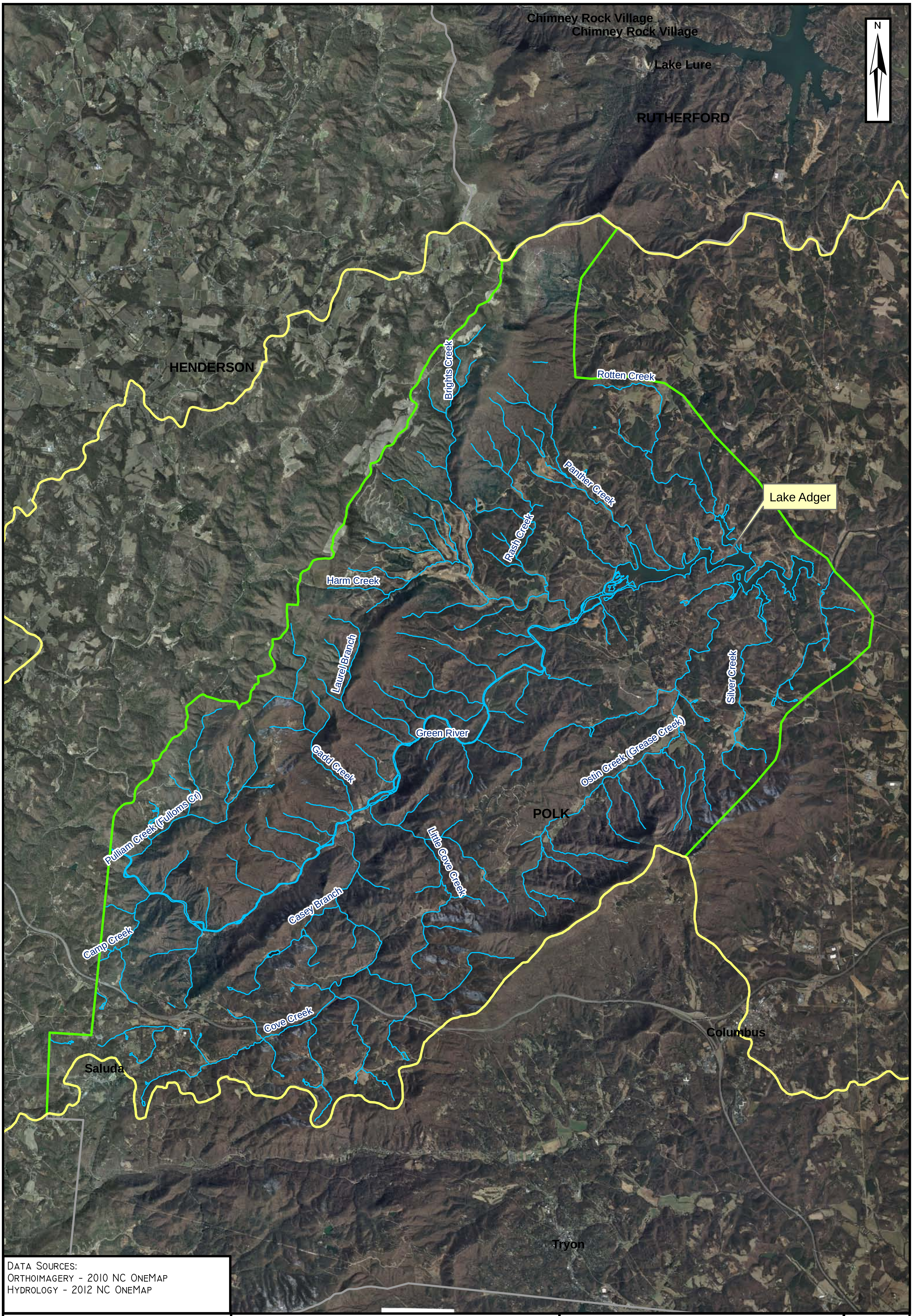
Westphal, M., Patch, S., and Traylor, A.M. 2009. *Polk County Stream Water Quality: Year Sixteen*. University of North Carolina at Asheville. Environmental Quality Institute.

FIGURES



Legend

- Green River Watershed
- Study Area
- County Boundaries
- Hydrology

Altamont Environmental, Inc.
Engineering & Hydrogeology
231 Haywood Street, Asheville, NC 28801
Tel. 828.281.3350 Fax. 828.281.3351
www.altamontenvironmental.com

Drawn By: Natalie Bouchard
Project Manager: Zan Price
Client: IPDC
Date: 07/18/2013

Scale
0 3,000 6,000 Feet

Green River Watershed
Study Area

Green River Watershed
Polk County, North Carolina

Figure
1

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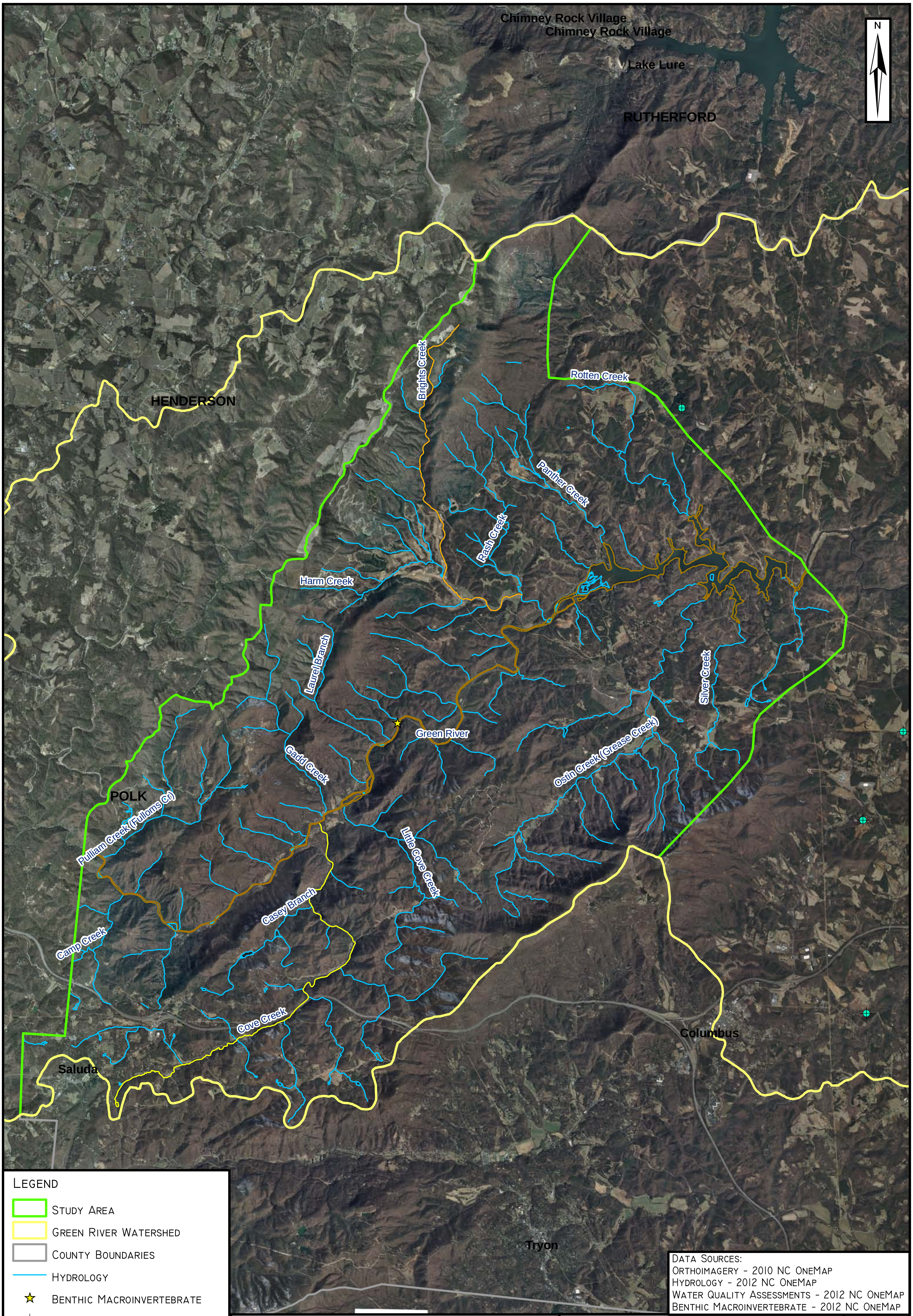

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Client: IPDC
Date: 07/18/2013

Scale
0 3,000 6,000 Feet

EXISTING WATER QUALITY DATA

Green River Watershed
Polk County, North Carolina

FIGURE 2

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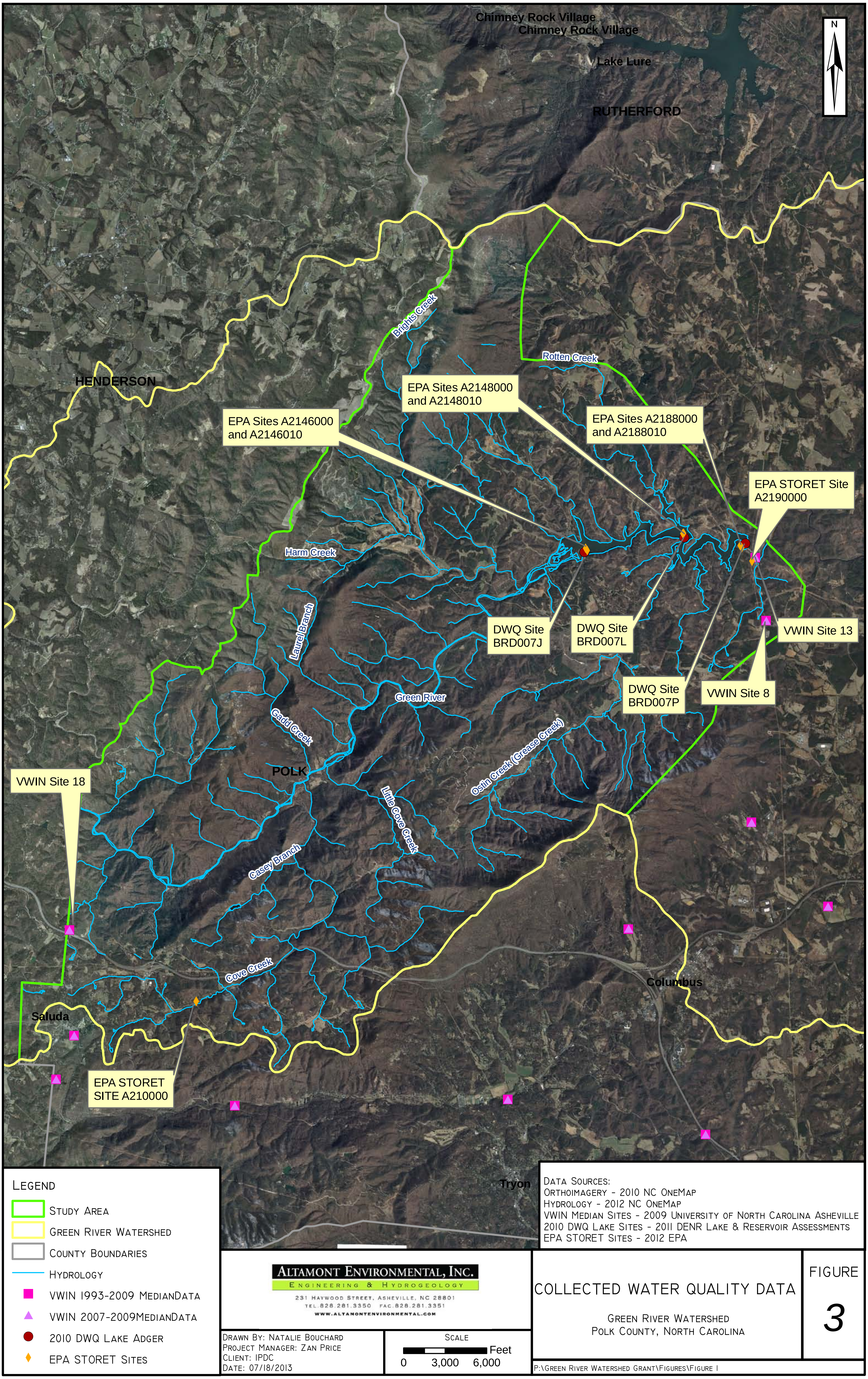
Chimney Rock Village
Chimney Rock Village
Lake Lure
RUTHERFORD
N
HENDERSON
Brights Creek
Rotten Creek
EPA Sites A2148000
and A2148010
EPA Sites A2146000
and A2146010
EPA Sites A2188000
and A2188010
EPA STORET Site
A2190000
Harm Creek
Laurel Branch
DWQ Site
BRD007J
DWQ Site
BRD007L
VWIN Site 13
DWQ Site
BRD007P
VWIN Site 8
Green River
Gadd Creek
POLK
Osin Creek (Grease Creek)
VWIN Site 18
Little Cove Creek
Casey Branch
Cove Creek
Columbus
Saluda
EPA STORET
SITE A210000
Tryon
Legend
Study Area
Green River Watershed
County Boundaries
Hydrology
VWIN 1993-2009 MedianData
VWIN 2007-2009MedianData
2010 DWQ Lake Adger
EPA STORET Sites
Data Sources:
Orthoimagery - 2010 NC OneMap
Hydrology - 2012 NC OneMap
VWIN Median Sites - 2009 University of North Carolina Asheville
2010 DWQ Lake Sites - 2011 DENR Lake & Reservoir Assessments
EPA STORET Sites - 2012 EPA
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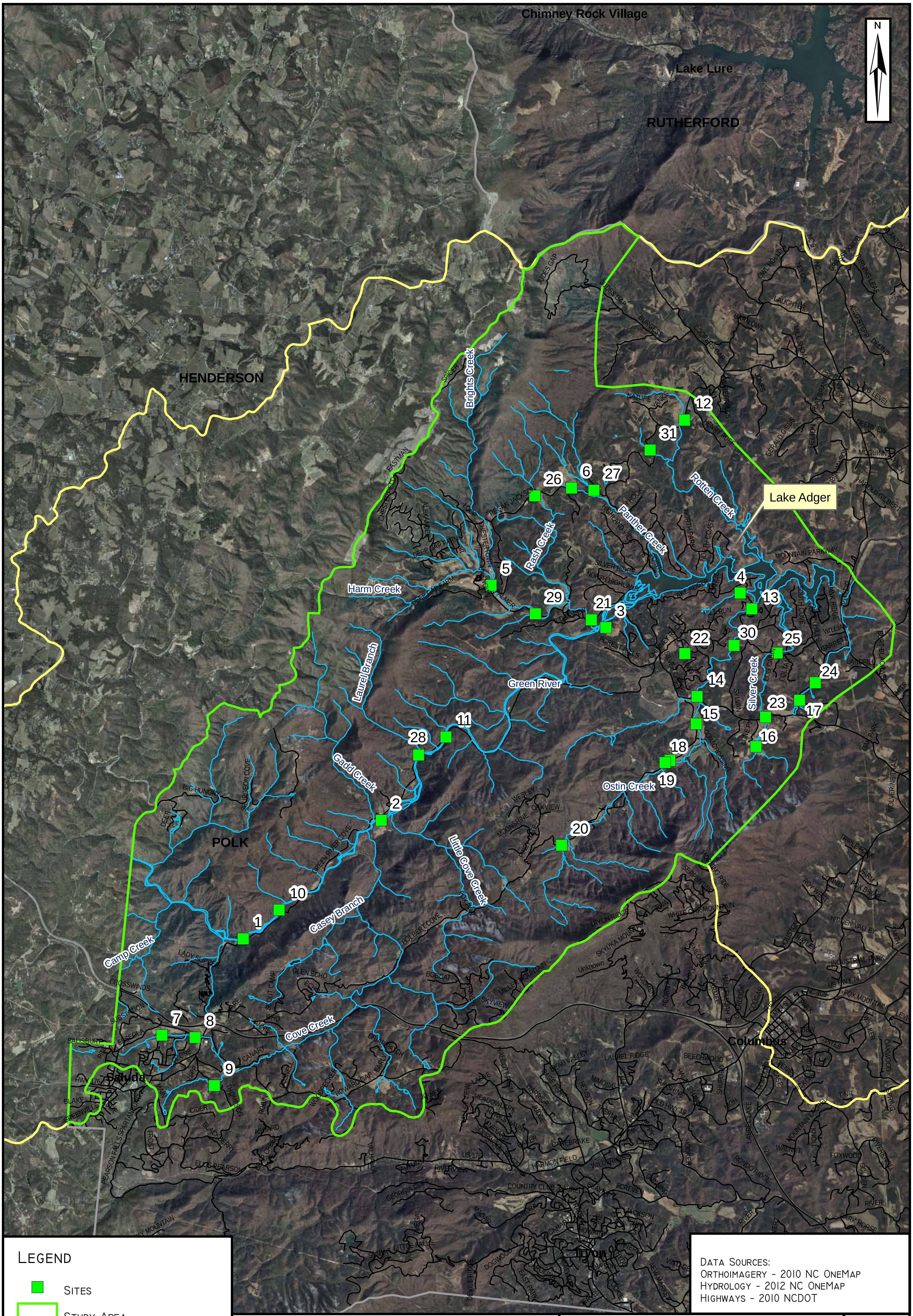
Collected Water Quality Data
Green River Watershed
Polk County, North Carolina
Figure
3
Drawn By: Natalie Bouchard
Project Manager: Zan Price
Client: IPDC
Date: 07/18/2013
Scale
Feet
0 3,000 6,000
P:\Green River Watershed Grant\Figures\Figure 1



LEGEND

- Sites
- Study Area
- Green River Watershed
- County Boundaries
- Hydrology
- Roads

Data Sources:
Orthoimagery - 2010 NC OneMap
Hydrology - 2012 NC OneMap
Highways - 2010 NCDOT

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ASSESSMENT SITE LOCATIONS

Green River Watershed
Polk County, North Carolina

FIGURE 4

Drawn By: Natalie Bouchard
Project Manager: Zan Price
Client: IPDC
Date: 07/18/2013

Scale
0 3,000 6,000 Feet

P:\Green River Watershed Grant\Figures\Figure 1

TABLES

Table 1
EPA STORET Water Quality Data
Green River Watershed

Organization Name	HUC	Latitude	Longitude	Station ID	Sample Date	Sample Depth	Total Alkalinity	Aluminum	Ammonia	Arsenic	Barium	BOD	Cadmium	Calcium	Chloride	Chromium	Cobalt	Copper	Cyanide	Dissolved Oxygen	Dissolved Oxygen Saturation	Flouride	Total Hardness	Nitrate/Nitrite	Iron	Kjeldahl Nitrogen	Lead	Magnesium	Manganese	Mercury	Nickel	Orthophosphate as PO4	pH	Specific Conductance	Sulfate	Zinc	Secchi Depth	Water Temperature	Turbidity	Total Coliform	Fish Kill Severity	Sludge Severity	Odor Severity	Floating Debris Severity	Turbidity Severity
		Decimal Degrees				meter	mg/L	mg/L	ug/L	mg/L	ug/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L	ug/L	ug/L	mg/L	%	ug/L	mg/L	ug/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L		umho/cm	mg/L	ug/L	meter	°C	FTU	#/100 ml					
NCDENR-DWQ	3050105	35.242	-82.317	A2120000	6/18/1969	0.33	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8.7	91	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.8	N/A	N/A	N/A	N/A	28	N/A	400000	N/A	N/A	N/A	N/A	N/A
NCDENR-DWQ	3050105	35.242	-82.317	A2120000	6/15/1970	0.33	15	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9.1	91	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.4	N/A	N/A	N/A	N/A	25	N/A	50000	N/A	N/A	N/A	N/A	N/A
NCDENR-DWQ	3050105	35.242	-82.317	A2120000	9/17/1970	0.33	14	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8	87	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.3	N/A	N/A	N/A	N/A	31	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NCDENR-DWQ	3050105	35.242	-82.317	A2120000	10/21/1970	0.33	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9.2	90	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	ND	N/A	N/A	6.2	N/A	N/A	N/A	N/A	22	N/A	2000	N/A	N/A	N/A	N/A	N/A
NCDENR-DWQ	3050105	35.242	-82.317	A2120000	3/30/1971	0.33	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.6	95	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.3	N/A	N/A	N/A	N/A	17	N/A	1000	N/A	N/A	N/A	N/A	N/A
NCDENR-DWQ	3050105	35.242	-82.317	A2120000	6/17/1971	0.33	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9	90	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7	N/A	N/A	N/A	N/A	25	N/A	350	N/A	N/A	N/A	N/A	N/A
NCDENR-DWQ	3050105	35.242	-82.317	A2120000	8/25/1971	0.33	18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8	89	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.4	N/A	N/A	N/A	N/A	33	N/A	300	N/A	N/A	N/A	N/A	N/A
NCDENR-DWQ	3050105	35.242	-82.317	A2120000	4/19/1972	0.33	16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8.8	90	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.6	N/A	N/A	N/A	N/A	26	N/A	160	N/A	N/A	N/A	N/A	N/A
NCDENR-DWQ	3050105	35.242	-82.317	A2120000	6/26/1972	0.33	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8.8	88	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.6	N/A	N/A	N/A	N/A	25	N/A	1900	N/A	N/A	N/A	N/A	N/A
NCDENR-DWQ	3050105	35.242	-82.317	A2120000	1/11/1973	0.33	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.3	91	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.5	N/A	N/A	N/A	N/A	16	N/A	N/A	None	None	None	None	MILD
NCDENR-DWQ	3050105	35.242	-82.317	A2120000	6/14/1973	0.33	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8.1	83	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.7	N/A	N/A	N/A	N/A	26	N/A	2700	N/A	None	None	None	NONE
NCDENR-DWQ	3050105	35.242	-82.317	A2120000	11/1/1973	0.33	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.3	91	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.5	N/A	N/A	N/A	N/A	16	N/A	140	None	None	None	None	MILD
NCDENR-DWQ	3050105	35.334	-82.226	A2146000	8/1/1989	0.49	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8.4	102.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.6	24	N/A	N/A	1.35	26	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NCDENR-DWQ	3050105	35.334	-82.226	A2146010	8/1/1989	0.49	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.1	N/A	N/A	N/A	N/A	26	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NCDENR-DWQ	3050105	35.338	-82.203	A2148000	8/1/1989	0.49	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8.4	103.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.4	25	N/A	N/A	2	26	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NCDENR-DWQ	3050105	35.338	-82.203	A2148010	8/1/1989	0.49	11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NCDENR-DWQ	3050105	35.336	-82.189	A2188000	8/1/1989	0.49	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8.3	101.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7	4	N/A	N/A	2.1	26	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NCDENR-DWQ	3050105	35.336	-82.189	A2188010	8/1/1989	0.49	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NCDENR-DWQ	3050105	35.333	-82.186	A2190000	11/20/1973	0.33	17	N/A	N/A	N/A	N/A	0.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9.6	88.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.3	N/A	N/A	N/A	N/A	19	4.7	ND	None	None	None	None	MILD
NCDENR-DWQ	3050105	35.333	-82.186	A2190000	12/10/1973	0.33	12	N/A	N/A	N/A	N/A	0.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.6	93.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.6	N/A	N/A	N/A	N/A	16	19	N/A	None	None	None	None	MILD
NCDENR-DWQ	3050105	35.333	-82.186	A2190000	1/14/1974	0.33	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.2	91.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.6	N/A	N/A	N/A	N/A	11	14	N/A	None	None	None	None	MODERATE
NCDENR-DWQ	3050105	35.333	-82.186	A2190000	3/5/1974	0.33	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.3	101.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20	N/A	N/A	N/A	17	15	N/A	None	None	None	None	MILD
NCDENR-DWQ	3050105	35.333	-82.186	A2190000	5/7/1974	0.33	10	N/A	N/A	ND	N/A	0.8	ND	N/A	N/A	ND	ND	ND	N/A	9.2	97	N/A	N/A	0.17	N/A	ND	ND	N/A	ND	ND	N/A	N/A	7	25	N/A	ND	N/A	28	4.8	30	None	None	None	None	MILD
NCDENR-DWQ	3050105	35.333	-82.186	A2190000	6/12/1974	0.33	14	N/A	N/A	N/A	N/A	0.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.5	85	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.8	49	N/A	N/A	N/A	34	15	100	N/A	N/A	N/A	N/A	MILD
NCDENR-DWQ	3050105	35.333	-82.186	A2190000	7/11/1974	0.33	11	N/A	N/A	N/A	N/A	1.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.3	86	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.1	N/A	N/A	N/A	N/A	37	23	160	None	None	None	None	MODERATE
NCDENR-DWQ	3050105	35.333	-82.186	A2190000	8/1/1974	0.33	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5.5	N/A	N/A	N/A	N/A	N/A	N/A
NCDENR-DWQ	3050105	35.333	-82.186	A2190000	8/21/1974	0.33	11	N/A	N/A	N/A	N/A	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.5	86	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.7	49	N/A	N/A	N/A	36	N/A	10	N/A	N/A	N/A	N/A	MODERATE
NCDENR-DWQ	3050105	35.333	-82.186	A2190000	9/3/1974	0.33	12	N/A	N/D	ND	N/A	N/A	ND	N/A	N/A	ND	ND	ND	N/A	7	82	N/A	N/A	0.08	110	0.1	ND	N/A	ND	ND	N/A	N/A	7	N/A	N/A	ND	N/A	37	4.7	N/A	None	None	None	Mild	MILD
NCDENR-DWQ	3050105	35.333	-82.186	A2190000	9/30/1974	0.33	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8.1	88	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7	N/A	N/A	N/A	N/A	31	3.8	N/A	None	None	None	Mild	MODERATE
NCDENR-DWQ	3050105	35.333	-82.186	A2190000	11/25/1974	0.33	13	N/A	N/A	N/A	N/A	0.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10	88	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.9	N/A	N/A	N/A	N/A	16	4.8	10	None	None	None	Mild	MODERATE
NCDENR-DWQ	3050105	35.333	-82.186	A2190000	12/12/1974	0.33	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7	N/A	N/A	N/A	N/A	N/A	N/A
NCDENR-DWQ	3050105	35.333	-82.186	A2190000	12/12/1974	0.33	13	N/A	N/A	ND	N/A	0.4	ND	N/A	N/A	ND	ND	ND	N/A	11.6	99	N/A	N/A	0.14	360	0.1	ND	N/A	90	ND	N/A	N/A	6.7	41	N/A	ND	N/A	11	N/A	10	N/A	N/A	N/A	N/A	MILD
NCDENR-DWQ	3050105	35.333	-82.186	A2190000	1/29/1975	0.33	9	N/A	N/A	10	N/A	0.2	ND	N/A	N/A	ND	ND	ND	N/A	11.8	99	N/A	N/A	0.19	N/A	ND	ND	N/A	ND	ND	N/A	N/A	6.5	32	N/A	ND	N/A	12	N/A	10	N/A	N/A	N/A	N/A	MODERATE
NCDENR-DWQ	3050105	35.333	-82.186	A2190000	2/20/1975	0.33	16	N/A	N/A	N/A	N/A	0.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13.2	111	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.1	N/A	N/A	N/A	N/A	12	N/A	ND	None	None	None	None	MILD
NCDENR-DWQ	3050105	35.333	-82.186	A2190000	3/3/1975	0.33	15	N/A	N/A	N/A	N/A	0.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.5	88	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.6	N/A	N/A	N/A	N/A	6	N/A	620	N/A	N/A	N/A	N/A	MILD
NCDENR-DWQ	3050105	35.333	-82.186	A2190000	3/26/1975	0.33	15	N/A	N/A	N/A	N/A	0.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.6	98	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.8	N/A	N/A	N/A	N/A	19	N/A	70	None	None	None	None	MILD
NCDENR-DWQ	3050105	35.333	-82.186	A2190000	4/16/1975	0.33	10	N/A	N/A	N/A	N/A	0.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.6	98	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.6	N/A	N/A	N/A	N/A	19	N/A	10	N/A	N/A	N/A	N/A	MILD
NCDENR-DWQ	3050105	35.333	-82.186	A2190000	5/20/1975	0.33	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18	N/A	N/A	N/A	N/A	N/A	N/A
NCDENR-DWQ	3050105	35.333	-82.186	A2190000	5/20/1975	0.33	9	N/A	N/A	10	N/A	1	ND	N/A	N/A	ND	ND	ND	N/A	8.3	90	N/A	N/A	0.17	1400	0.1	ND	N/A	50	0.5	N/A	ND	6.4	N/A	N/A	ND	N/A	31	N/A	260	N/A	N/A	N/A	N/A	MODERATE
2B Standards							N/A	N/A	N/A	50	N/A	50	2	N/A	230	50	N/A	7	5	>5	N/A	N/A	*100*	*10*	1000	N/A	*25*	*N/A*	*200*	0.012	88	N/A	6 -9	N/A	*250*	50	N/A	N/A	50	*200*	N/A	N/A	N/A	N/A	N/A

Notes:

1. mg/L = milligram per Liter
2. ug/L = microgram per Liter
3. umho/cm = microhos per centimeter
4. FTU = Formazin Turbidity Unit
5. °C = degrees Celcius
6. 2B Standards from "North Carolina Administrative Code, Title 15A: Department of Environment and Natural Resources, Subchapter 2B - Surface Water and Wetlands Standards," DENR based upon freshwater aquatic health, unless otherwise noted.
7. *2B Standards in italics* are those standards for Water Supply or Human Health
8. ND = Non-detected
9. N/A = Not Sampled
10. NCDENR-DWQ = North Carolina Department of Environment and Natural Resources, Department of Water Quality
11. Exeedances above 2B standards are indicated as:

Table 2
Lake Adger Dissolved Oxygen Results
Collected by North Carolina Wildlife Resources Commission

Site	1		2		3		1		2		3	
Lat (DD)	35.337993		35.338324		35.334246		35.337474		35.338237		35.334203	
Long (DD)	82.189706		82.204542		82.224871		82.188734		82.204731		82.225144	
Date	7/29/2010		7/29/2010		7/29/2010		9/15/2010		9/15/2010		9/15/2010	
Personnel	AB, ME		AB, ME		AB, ME		BR, WH		BR, WH		BR, WH	
Time	1000		1024		1040		1030		1046		1105	
Site Description	Adg-do 01		Adg-do 02		Adg-do 03		Adg-do 01		Adg-do 02		Adg-do 03	
Depth	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
meters	C	mg/L	C	mg/L	C	mg/L	C	mg/L	C	mg/L	C	mg/L
0	29.5	8.4	30.1	8.1	29.4	8.2	25.1	8.6	25.2	8.8	25.4	8.6
1	29.5	8.3	29.8	8.2	29.3	8.2	24.9	8.4	24.8	8.7	24.7	8.7
2	29.4	8.2	28.9	8.1	28.5	7.3	24.6	8.3	24.7	8.7	N/A	N/A
3	28.1	8.7	27.5	6.1	N/A	N/A	24.3	5.8	24.3	7.4	N/A	N/A
4	26.8	6.3	26.6	5.3	N/A	N/A	23.8	5.0	23.8	6.1	N/A	N/A
5	25.7	3.7	25.8	3.5	N/A	N/A	23.4	5.9	23.4	5.5	N/A	N/A
6	24.6	1.0	24.6	0.6	N/A	N/A	23.1	4.8	23.1	5.6	N/A	N/A
7	23.1	0.2	23.1	0.1	N/A	N/A	22.7	4.4	22.7	5.6	N/A	N/A
8	19.9	0.1	21.2	0.1	N/A	N/A	22.1	2.2	22.3	4.5	N/A	N/A
9	16.3	0.1	17.5	0.1	N/A	N/A	20.3	0.2	20.7	0.3	N/A	N/A
10	13.5	2.0	13.8	0.1	N/A	N/A	15.3	0.1	15.4	0.1	N/A	N/A
11	11.5	3.9	11.6	0.1	N/A	N/A	12.4	1.5	13.6	0.1	N/A	N/A
12	9.8	5.4	N/A	N/A	N/A	N/A	10.5	3.1	N/A	N/A	N/A	N/A
13	8.7	5.7	N/A	N/A	N/A	N/A	9.3	3.7	N/A	N/A	N/A	N/A
14	7.8	6.4	N/A	N/A	N/A	N/A	8.3	4.0	N/A	N/A	N/A	N/A
15	7.2	6.4	N/A	N/A	N/A	N/A	7.6	3.2	N/A	N/A	N/A	N/A
16	6.8	6.4	N/A	N/A	N/A	N/A	7.2	3.0	N/A	N/A	N/A	N/A
17	6.4	5.3	N/A	N/A	N/A	N/A	6.8	3.7	N/A	N/A	N/A	N/A
18	6.2	6.2	N/A	N/A	N/A	N/A	6.5	1.0	N/A	N/A	N/A	N/A
19	6.1	1.5	N/A	N/A	N/A	N/A	6.4	0.2	N/A	N/A	N/A	N/A
20	6.1	0.3	N/A	N/A	N/A	N/A	6.5	0.1	N/A	N/A	N/A	N/A
21	6.2	0.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Notes:
1. Data provided by North Carolina Wildlife Resource Commission.
2. N/A = not available.
3. Temp = Temperature
4. DO = dissolved oxygen
5. mg/L = milligrams per liter
6. DD = decimal degrees

Table 3
Site Characteristics

Site ID	Waterbody	Channel	Riparian Vegetation	Buffer Width	Bed Material	Livestock	Notes
1	Green River	Stable	Excellent	Adequate	Cobble, large boulders	No	
2	Gadd Creek	Stable	Good	Adequate	Cobble	No	
3	Green River	N/A	N/A	N/A	N/A	N/A	Upland exposed soil area observed
4	UT to Lake Adger (near Ostin Creek Cove)	Stable	Good	Adequate	Sand and cobble	No	Turbid water observed
5	Brights Creek	Stable	Good	Adequate	Cobble and sand	No	
6	Panther Creek	Moderately Incised	Good	Adequate	Gravel, cobble, and sand	No	
7	Cove Creek (Trib)	Stable	Good	Adequate	Gravel and sand	Yes	Cattle with unrestricted access to the creek: potential source of sedimentation and poor water quality
8	Cove Creek (Trib)	Incised	Fair	Limited	N/A	No	Water quality stress from adjacent gas station
9	Cove Creek	Eroded	Poor	Limited	Cobble, gravel, and sand	No	
10	Green River	Stable	Good	Limited	Cobble, gravel, and sand	No	Tubing company adjacent to Green River
11	Green River	Stable	Excellent	Adequate	Cobble, gravel, and sand	No	
12	Rotten Creek	Eroded and Incised	Good	Limited	Sand and gravel	Yes	Very turbid water observed
13	Ostin Creek	Eroded	Good	Adequate	Sand and gravel	No	Sediment accumulation observed
14	Ostin Creek	Stable	Good	Limited	Sand and gravel	Unknown	Creek is adjacent to corn field; potential for agricultural runoff
15	Ostin Creek	Stable	Good	Adequate	Cobble, sand, and gravel	Yes	Livestock access limited by locked gate
16	Silver Creek	Eroded	Poor	Limited	N/A	No	Grass buffer mowed to water's edge
17	Green River (Trib)	Moderately Incised	Fair	Limited	Sand, cobble, gravel	No	
18	Ostin Creek	Eroded and Incised	Good	Adequate	Cobble, sand	Unknown	Road close to channel in places
19	Ostin Creek	Stable	Good	Adequate	Gravel, cobble, sand	Unknown	Gravel road crosses through channel
20	Ostin Creek	Stable	Excellent	Adequate	Cobble and sand	No	
21	Brights Creek	Sediment accumulation	Good	Adequate	Sand, gravel	No	Large amounts of sediment observed in the channel; some trees were falling in
22	Ostin Creek (Trib)	Eroded	Poor	Limited	Sand	No	Muddy pond observed to discharge to tributary
23	Silver Creek	Eroded	Good	Adequate	Sand and gravel	Yes	Livestock access likely limited by fence
24	Green River (Trib)	Eroded and Incised	Poor	Limited	Sand and gravel	No	Grass buffer mowed to edge
25	Silver Creek	Stable	Excellent	Adequate	Sand, cobble	No	Sand embedded in channel
26	Rash Creek	Moderately Incised	Fair	Limited	Sand and gravel	No	
27	Panther Creek	Stable	Fair	Limited	Gravel, sand, and cobble	Yes	Livestock access to creek; potential source of sedimentation and poor water quality
28	Green River	N/A	N/A	N/A	N/A	N/A	Exposed soil hillslope observed adjacent to Green River
29	Brights Creek	Moderately Incised	Good	Adequate	Cobble and gravel	No	
30	Ostin Creek	Stable	Excellent	Adequate	Large boulders and cobble	No	Some erosion noted along gravel trails flowing into creek
31	Rotten Creek (Trib)	Eroded	Fair	Limited	Sand and gravel	Unknown	

Table 3
Site Characteristics

Notes:

1. Channel condition based on:
   - Stable = no observed erosion and/or stressors
   - Mostly Stable = stable with areas of erosion
   - Eroded = eroded streambank
   - Incised = incised channel
2. Riparian vegetation condition based on:
   - Excellent = mix of shrubby and woody vegetation with mature trees
   - Good = mix of shrubby and woody vegetation, lacking mature trees
   - Fair = some shrubby vegetation
   - Poor = limited or lack of vegetation
3. Buffer width condition based on:
   - Adequate = at least approximately 30 feet in width directly adjacent to the stream
   - Limited = less than approximately 30 feet in width directly adjacent to the stream
4. Bed material = The main channel substrate (material abundance is listed in descending order)
5. Livestock = Presence of livestock adjacent to the stream
6. Observations are based upon visual inspections conducted on July 2, 8, 20, and 24, 2013.
7. N/A = Not available
8. (Trib) = Tributary to the waterbody

APPENDICES

APPENDIX A
Representative Photographs

Brights Creek

Photograph 1: View of Brights Creek headwaters.

Photograph 2: View of Site 5 at Brights Creek just downstream of the Brights Creek Development detention pond observed immediately following a rain event.

Photograph 3: View of turbid runoff from an unnamed tributary of Brights Creek, slightly downstream of Site 5, observed during a rainfall event.

Photograph 4: View of Brights Creek observed during a rainfall event on the Brights Creek Development.

Photograph 5: View of turbid unnamed tributary to Brights Creek observed during a rainfall event on the Brights Creek Development.

Photograph 6: View of turbid unnamed tributary to Brights Creek just downstream of the Bright's Creek Development.

Photograph 7: View at Site 29 at road crossing facing upstream on Brights Creek just outside the Bright Creek Golf Development.

Photograph 8: View of eroding bank on Brights Creek located just downstream of Site 29.

Photograph 9: View at site 21 at Palmer Road Bridge facing downstream onto Brights Creek. This reach of Brights Creek is close to the confluence of the Green River and appears to be overly wide and inundated with sediment.

Photograph 10: View at site 21 from Palmer Road Bridge facing upstream onto Brights Creek.

Photograph 11: View of Brights Creek confluence with the Green River.

Cove Creek

Photograph 12: Representative view unnamed tributary to the Green River at Site 7.

Photograph 13: View of unrestricted cattle access point along the leftbank at Site 7. Cows were observed on the property adjacent to the stream.

Photograph 14: Representative view at Site 8 of unnamed tributary to the Green River downstream from site 7.

Photograph 15: View of adjacent gas station to the stream at Site 8. Asphalt was observed to be eroding on the far side of the parking lot.

Photograph 16: View at Site 8 of eroding gully leading to an unnamed tributary to Cove Creek at the gas station.

Photograph 17: Representative view of Cove Creek on private property at Site 9; the bank was observed to be eroding.

Photograph 18: Representative view of eroding bank of Cove Creek on private property on Canary Road.

Photograph 19: Representative view of Cove Creek with no riparian buffer on private property observed from Aaybe road.

Green River

Photograph 20: View of Site 1 on the Green River facing upstream at Fish Top Access Area off Green Cove Road.

Photograph 21: View of exposed dirt area adjacent to Green River Cove Road parallell to the Green River. The open land appears to be under construction or in the process of being graded.

Photograph 22: View of Site 10, the Wilderness Cove Tubing Company is adjacent to the Green River.

Photograph 23: Representative view of Green River facing downstream accessed from North Carolina Western Regional Access Area downstream of Site 10 at Wilderness Cove Tubing.

Photograph 24: View of Green River Cove Tubing parking area along the Green River near confluence with Gadd Creek at Site 2. Sedimentation from parking area discharges directly to the Green River.

Photograph 25: View at the Green River Cove Tubing, facing downstream on the Green River. Banks were observed to be eroding.

Photograph 26: View of sediment erosion on the Green River at the Green River Cove Tubing.

Photograph 27: Representative view of Site 28 exposed soil along Green River Cove Road adjacent to the Green River.

Photograph 28: View facing upstream on the Green River at Site 11 Green River.

Photograph 29: View facing downstream on the Green River at Site 11 Green River.

Photograph 30: View of exit point for tubers; the riparian vegetation appeared in good condition.

Photograph 31: View of cleared grass at gas pipe-line right of way located just downstream of tuber exit location. Note the exposed dirt near the top of the hill that is likely draining to the Green River.

Photograph 32: View of stable tributary that flows under Green Cove Road.

Photograph 33: View from Silver Creek Road facing upstream on the Green River near the confluence to Lake Adger.

Photograph 34: View from Silver Creek Road facing downstream on the Green River.

Photograph 35: Typical view of Green River facing downstream observed via kayak.

Photograph 36: Representative view of open dirt area located at Site 3. This area is located in an upland area proximate to the Green River.

Photograph 37: View of unnamed tributary on river left of the Green River downstream of Big Rocks.

Photograph 38: View of Site 17 on a tributary to the Green River.

Photograph 39: View of Site 24, an unnamed tributary leading to the Green River downstream of Lake Adger. Streambanks incised and actively eroding.

Ostin Creek

Photograph 40: View of site 20 at Ostin Creek headwaters.

Photograph 41: View of ford crossing on site 19 on Ostin Creek. Channelized flow through crossing is a potential source of sediment.

Photograph 42: View of site 18 on Ostin Creek, with eroding banks near Holbert Cove Road upstream of Site 15.

Photograph 43: View of Ostin Creek and unnamed tributary confluence just upstream of Cow Crossing Lane.

Photograph 44: View of eroding bank on tributary to Ostin Creek upstream of confluence with Ostin Creek near Cow Crossing Lane.

Photograph 45: View of dirt road adjacent to tributary of Ostin Creek.

Photograph 46: Typical view of cattle exclusion fence along Ostin Creek on Site 15.

Photograph 47: Typical view of restored reach of Ostin Creek on Site 15. Log vane installed on leftbank to divert flow off leftbank.

Photograph 48: View of ford crossing on Ostin Creek on Site 15.

Photograph 49: View of Ostin Creek near intersection of Holbert Cove Road and Silver Creek Road (slightly upstream of Site 14). Sediment in the bed has the potential to migrate downstream.

Photograph 50: View of Site 14 at Ostin Creek on Silver Creek Road.

Photograph 51: View of Site 14 at Ostin Creek looking upstream from road crossing on Silver Creek Road.

Photograph 52: View of eroding left streambank proximate to Site 14 at Ostin Creek.

Photograph 53: View of tributary to Ostin Creek on private property. The buffer appears to have been mowed to the water's edge.

Photograph 54: View of Site 30 on Ostin Creek looking downstream from the Ostin Creek trailhead located on the Lake Adger Development.

Photograph 55: Representative view of erosion along the Ostin Creek trail near Site 30 on the Lake Adger Development.

Photograph 56: View of Site 13 on Ostin Creek looking downstream from the covered bridge on the Lake Adger Development.

Photograph 57: View of Site 13 on Ostin Creek looking upstream from the covered bridge on the Lake Adger Development.

Photograph 58: View of where Ostin Creek enters Ostin Cove on Lake Adger.

Photograph 59: View of pond at Site 22. The muddy pond discharges to an unnamed tributary of Ostin Creek near Hitching Post Road.

Photograph 60: View of discharge from pond at Site 22. The banks appear to be eroding, and the rip-rap also appears to be unstable.

Photograph 61: View of upland area near Site 22. The exposed soil is likely contributing sediment to the pond and Ostin Creek

Panther Creek

Photograph 62: View of Panther Creek at Site 6.

Photograph 63: Representative view of eroding ditch along Raegan Jackson Road near Panther Creek Site 6.

Photograph 64: View of Site 27 facing upstream on tributary to Panther Creek at the intersection of Rose Hollow Road and Raegan Jackson Road.

Photograph 65: View of Panther Creek just downstream of Site 27. Limited buffer width and livestock with unrestricted access to creek.

Rash Creek

Photograph 66: View at site 26 facing downstream on Rash Creek. The gravel pile in the foreground is actively eroding into the stream, although further downstream the channel appears to be fairly stable.

Photograph 67: View of culverts at site 26 leading to the Rash Creek. A third culvert is buried beneath the gravel.

Rotten Creek

Photograph 68: View of Rotten Creek at Site 12. The stream was observed to be very turbid, even though a recent rain event had not occurred.

Photograph 69: View of clear-cut area near Site 12.

Photograph 70: View of cattle farm adjacent to Site 12 and Rotten Creek. Limited access during site visit.

Photograph 71: View of tributary to Rotten Creek at Site 31. Sand was observed to be embedded in the channel.

Silver Creek

Photograph 72: View of Site 16 at the headwaters of Silver Creek on private property. No woody riparian buffer. Limited access due to private property.

Photograph 73: View of Site 23 on Silver Creek. A tight meander and eroding bank were observed.

Photograph 74: Representative view of erosion on gravel road near power station near the intersection of Sylvan Lane and Silver Creek Road. Runoff from this area drains to Silver Creek.

Photograph 75: View of Silver Creek at Site 25 facing downstream. The stream was observed to be clear and have some sand embedded in the channel, likely from upstream sources.

Photograph 76: View of Silver Creek entrance to South Cove on Lake Adger.

Gadd Creek

Photograph 77: View of Gadd Creek at Site 2 at confluence to Green River at Green River Cove Tubing facing upstream.

Photograph 78: View of Gadd Creek at Site 2 at confluence to Green River at Green River Cove Tubing facing downstream.

Lake Adger

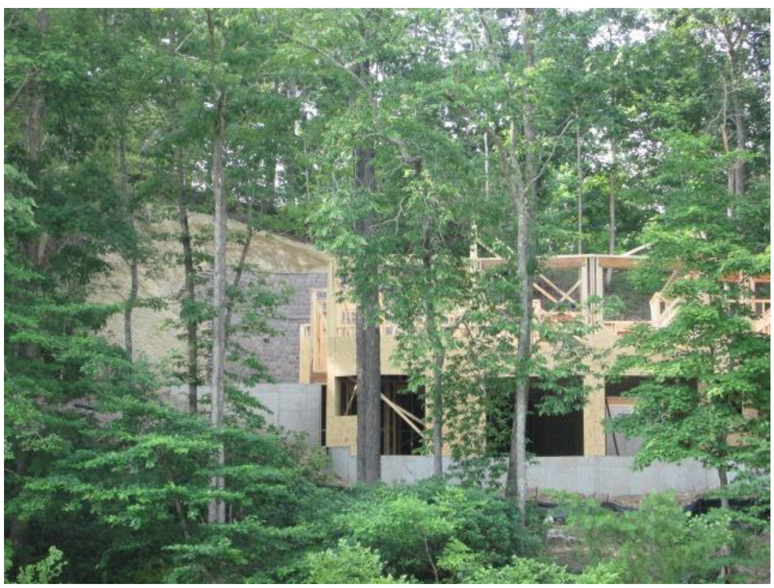
Photograph 79: View of public marina entrance to Lake Adger. Note the sediment build up in the background.

Photograph 80: View typical bank erosion on Lake Adger.

Photograph 81: View of Panther Creek entrance to Marina Cove on Lake Adger.

Photograph 82: View of eroding banks on Lake Adger.

Photograph 83: View of active construction site on Lake Adger.



Photograph 84: View of active construction site on Lake Adger. Note the large retaining wall and cut slope behind the building.

Photograph 85: View of Rotten Creek entrance to Jackson Cove on Lake Adger.

Photograph 86: View of completed shoreline stabilization on Lake Adger.

Photograph 87: Typical view of stable shoreline on Lake Adger.

Photograph 88: View from Duelkan's property facing Ostin Creek Cove on Lake Adger. Note the sediment accumulation in the background.

Photograph 89: View of sediment accumulation at the mouth of the Green River to Lake Adger.

Photograph 90: Typical view of Lake Adger observed from the streambank.

Photograph 91: View of exposed soil and stormdrain on Lake Adger development.

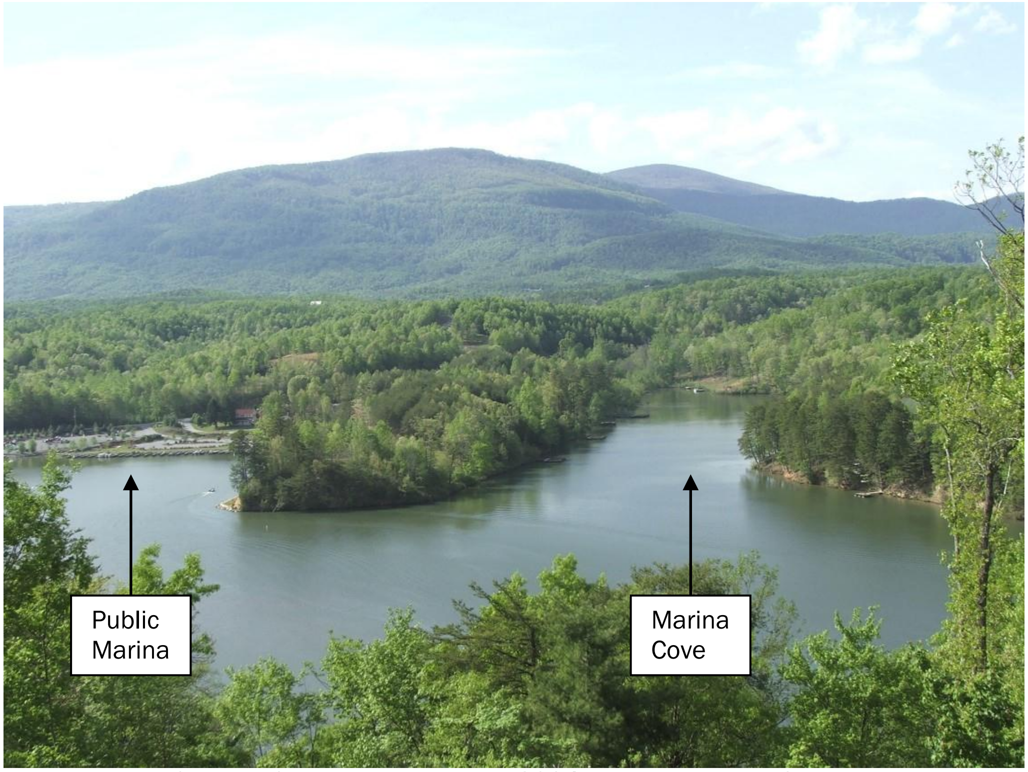
Photograph 92: View of street within Lake Adger Development following a rainfall event. Note the red sediment stained pavement indicative of sediment laden runoff.

Photograph 93: View of exposed dirt and sediment stained pavement within Lake Adger Development following a rainfall event.

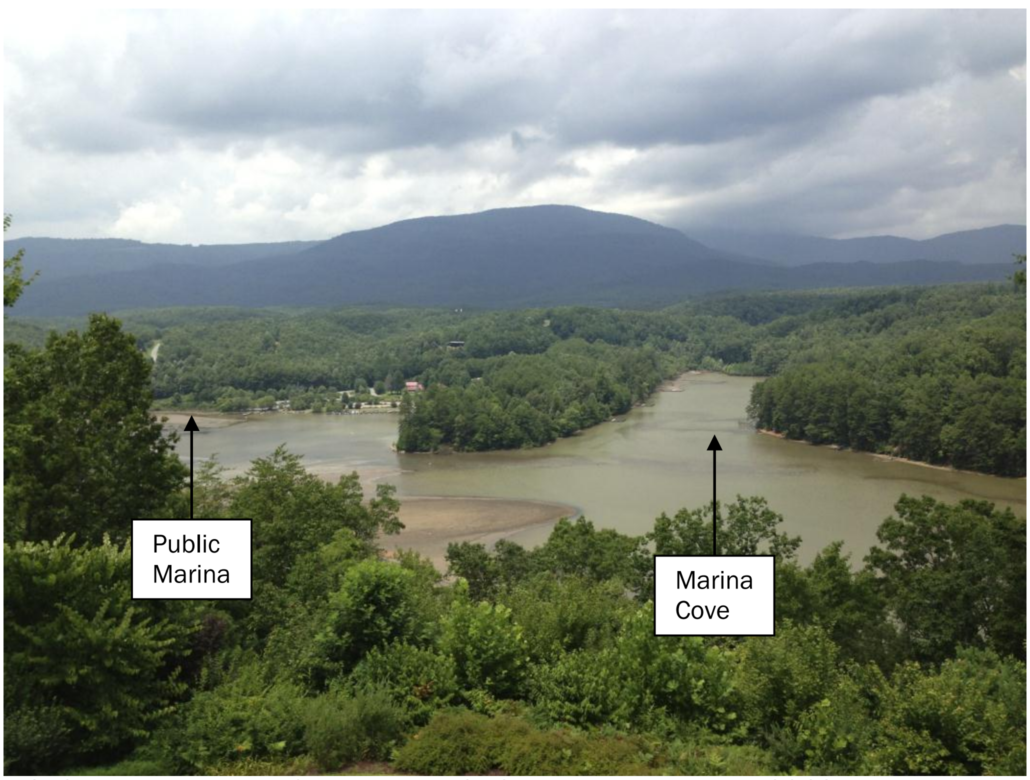
Photograph 94: View of tributary to Lake Adger at Site 4 facing upstream. This stream appeared stable, although the sediment observed in the stream was more turbid than other locations observed on the same day.

Photograph 95: View of Lake Adger dam facing upstream.

APPENDIX B
Historical Comparison Photographs



Photograph 1: View of Lake Adger taken in 2004 (photo courtesy of Donna Marcotte).



Photograph 2: Comparison view of Photograph 1 of Lake Adger taken in 2013 (photo courtesy of Donna Marcotte).

Photograph 3: View of Lake Adger near public marina and entrance of the Green River taken in 1953 (photo courtesy of Albert Cochran).

Photograph 4: Comparison view of Photograph 3 of Lake Adger near public marina and entrance of the Green River taken in 2013 (photo courtesy of Sky Conard).