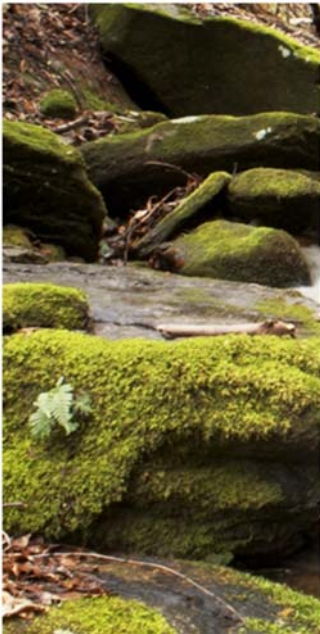


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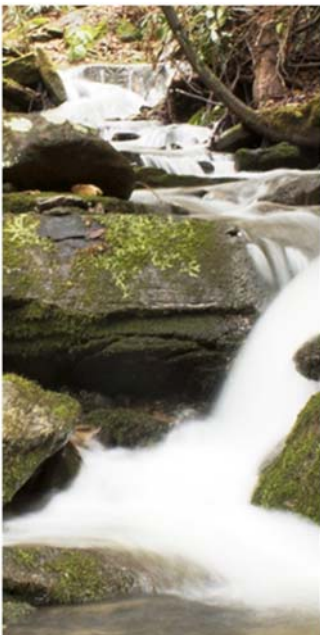
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Lake Adger Dredging Feasibility Study Report

Polk County, North Carolina

May 20, 2015



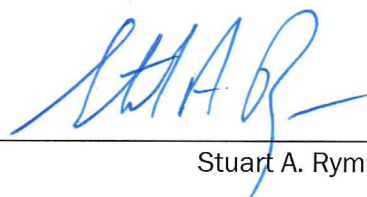
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Lake Adger Dredging Feasibility Study Report

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May 20, 2015



Stuart A. Ryman, P.G.

Table of Contents

Executive Summary	v
1.0 Introduction and Background	1
1.1 Background of Sediment Accumulation at Lake Adger	1
1.2 Feasibility Study.....	2
2.0 Feasibility Study Tasks and Methods.....	3
2.1 Define Sedimentation Problem Areas in Lake Adger and the Green River	3
2.2 Determine Permitting Requirements	3
2.3 Evaluate Potential Dredging Procedures, Phasing, and Area Requirements	3
2.4 Perform Market Study and Interview Potential Dredging Contractors and Operators.....	4
2.5 Cost Estimate for Dredging.....	4
2.6 Potential Funding Sources.....	4
3.0 Findings.....	5
3.1 Sedimentation Problem Areas in Lake Adger and the Green River	5
3.2 Potential Additional Sources of Ongoing Sedimentation	5
3.3 Permitting Requirements.....	5
3.3.1 Dredging Permits.....	5
3.3.2 Sand and Gravel Operation Permits.....	7
3.4 Potential Dredging Procedures, Phasing, and Area Requirements.....	7
3.4.1 Dredging Options.....	7
3.4.1.1 Hydraulic Dredging	7
3.4.1.2 Excavation Dredging.....	7
3.4.1.3 Mechanical Excavation from Barge.....	8
3.4.2 Sediment Dewatering, Staging Areas, and Storage/Disposal	8
3.4.3 Alternative for Minimizing Ongoing Sedimentation to Lake	8
3.5 Recommendations of Potential Dredging Contractors and Operators	10
3.5.1 Tim Edwards Landscaping Recommended Approach.....	10
3.5.2 Alexander & Associates Recommended Approach	10
3.5.3 JND Thomas Company Recommended Approach.....	10
3.6 Cost Estimate for Dredging.....	10
3.7 Potential Funding Sources.....	11
4.0 Summary and Conclusions	12

Figures

1. Lake Adger & Green River Watershed Vicinity Map
2. Lake Adger & Tributaries Map

Drawings

- C1.0 Existing Topography
- C2.0 Sediment Sample Locations
- C3.0 Elevation Analysis (Existing)
- C4.0 Elevation Analysis (5-Foot)
- C5.0 Elevation Analysis (10-Foot)
- C6.0 Elevation Analysis (12-Foot)
- C7.0 Green River

Tables

1. Dredging Methodologies and Cost Comparisons

Appendices

- A. Water Resources Development Project Grant Program Electronic Application
- B. Scope of Services
- C. Gentry Geotechnical Engineering Report of Laboratory Testing
- D. Green River Watershed Assessment
- E. U.S. Army Corps of Engineers Application for Department of the Army Permit
- F. Lake Adger Marina and Marina Boat Ramp Facility Public Access Agreement

Executive Summary

Lake Adger, which is located near the community of Mill Spring in Polk County, North Carolina, is a freshwater man-made lake (see Figure 1). The lake is fed by the Green River, Panther Creek, a much smaller stream, and other lesser tributaries. The lake was created in 1925 by the construction of Turner Shoals Dam, an 85-foot-high hydroelectric dam. Both the Green River and Panther Creek discharge into the western end of the lake (see Figure 2). The lake is used primarily for recreation but plans call for the lake to serve as a drinking-water reservoir at some point in the future.

The Green River, and to a lesser extent Panther Creek, have deposited sediment into the western portion of the lake. Shoreline erosion and sediment discharge from other tributaries is a secondary source of sediment throughout the lake. A public boat launch and marina are located at the western end of the lake near the mouth of the Green River. Sediment buildup in the western end of the lake severely restricts boat access and recreational usage of the lake.

Polk County officials and residents are concerned that the sediment buildup may eliminate access to the lake from the public marina and may reduce the effective storage capacity of the water-supply reservoir.

Polk County Soil and Water Conservation District (PCSWCD) contracted Altamont Environmental, Inc. (Altamont) to perform a feasibility study to evaluate options for dredging the lake and a portion of the Green River upstream of the lake. The following is a summary of the study's findings and recommendations.

Summary of Findings

- The west end of the lake, from the mouth of the Green River to a point approximately 800 feet east, is severely compromised by sediment accumulation.
- At normal lake level, the water depth at the west end of the lake (as described above) ranges from less than 6 inches to about 5 feet.
- Review of historical documents and interviews suggest that the historical water depth in this area of the lake was probably 15 feet or more.
- Further east, at a point approximately 2,000 feet from the mouth of the Green River, the lake depth increases rapidly to 20 feet and then increases steadily to a maximum depth of approximately 80 feet adjacent to Turner Shoals Dam.
- Sediment deposition has also occurred in the channel of the Green River, and the river is extremely shallow (less than 1 foot deep) for 1 mile or more upstream of the lake.
- Dredging the west end of the lake to a uniform depth of 5 feet would require removing approximately 150,000 cubic yards of sediment.
- Dredging the west end of the lake to a uniform depth of 10 feet would require removing approximately 450,000 cubic yards of sediment.
- Dredging the same area to a uniform depth of 12 feet would require removing approximately 630,000 cubic yards of sediment.
- Dredging the Green River to a depth of 5 feet for 1 mile upstream of the lake would require removing about 20,000 cubic yards of sediment.
- Interviews with dredging operators who are familiar with lake sediments indicate that some portion of the dredged material may be suitable for reuse, but the majority of the dredge spoils will not be suitable for reuse and will need to be disposed of at an on-shore location.

- The cost to dredge, handle, and dispose of sediment (exclusive of land acquisition [for disposal], permitting, and contract administration) is estimated to range from \$15 to more than \$30 per cubic yard, depending upon the methods utilized.
- Based on these unit rates, dredging the west end of the lake and 1 mile of the Green River to a depth of 5 feet will cost from \$2,550,000 to \$5,100,000.
- The Green River will continue to transport sediment and, unless a permanent sand-and-gravel-removal operation is established upstream of the lake, sediment will continue to accumulate in the lake.
- Dredging contractors indicated that if material is dredged from the river before being discharged in the lake (where it becomes mixed with organic debris) the dredge spoils can be sorted and reused.
- A nearby lake of similar size and geographic setting (Lake Lure) does not have a sand-and-gravel-removal system upstream of the lake and sections of the lake are dredged annually at a cost of approximately \$400,000 to \$500,000.
- The State of North Carolina Department of Environment and Natural Resources (DENR) has a grant program for lake dredging. The grant requires a 50-percent match and can be submitted at any time (i.e., it operates on an open application cycle). See Appendix A.
- Any dredging activities must be permitted by the State of North Carolina Department of Natural Resources and the United States Army Corps of Engineers. Two permitting options are available. Permitting will be more time consuming and expensive if dredged materials are stockpiled in the lake rather than removed.

Summary of Recommendations

Based upon the assessment and interviews documented in this report, Altamont recommends that PCSWCD or Polk County:

- Enter into contract to secure an upland property in relatively close proximity to the lake to serve as a long-term disposal area for sediments removed from the lake.
- Perform pre-purchase property assessment. Potentially apply for grant funding to assist with assessment.
- Develop construction details to support permitting and grant applications.
- Apply for permits for dredging operation. Altamont recommends that Polk County remove dredged materials from the lake if possible, to allow a more streamlined permitting process.
- Apply for grant funding to assist with the cost of dredging.
- Promote and facilitate the establishment of a sand-and-gravel dredging operation on the Green River, upstream of Lake Adger. The operation should be designed, permitted, and operated in a manner that is consistent with all environmental regulations and that results in relatively minimal environmental impact.
- Define specific goals for a dredging project (e.g., 5-foot target depth, 10-foot target depth, etc.).
- Select a preferred dredging methodology.
- Define a specific, possibly multi-year phased approach for dredging the lake and meeting the defined goals.

1.0 Introduction and Background

This report describes a feasibility study completed by Altamont Environmental, Inc. (Altamont) under contract to the Polk County Soil and Water Conservation District (PCSWCD). The objectives of the feasibility study were to:

- Evaluate the extent of sediment accumulation in Lake Adger (see Drawings C1.0 through C6.0)
- Develop a short list of options for removing the sediment
- Estimate the costs associated with sediment management

1.1 Background of Sediment Accumulation at Lake Adger

Lake Adger, located near the community of Mill Spring, Polk County, North Carolina, is a freshwater man-made lake (see Figure 1). According to the US Geological Survey, the lake is approximately 371 acres in surface area with more than 14 miles of shoreline. Its normal surface elevation varies from 902 to 907 feet mean sea level (msl).

Lake Adger was created in 1925 with the construction of the Turner Shoals Dam, an 85-foot-high hydroelectric dam. Polk County purchased the lake and dam in 2009 with the intention of eventually using the lake as a potable water supply reservoir. Currently, the lake is only used for recreational purposes.

The lake is fed by the Green River, which enters the lake from the west. The Green River watershed encompasses approximately 245 square miles. Panther Creek, a much smaller water body located within the same watershed, provides a secondary source of recharge to the lake. Other smaller tributaries also discharge into the lake.

A recreational marina and a public boat launch are situated in the western portion of the lake near the mouth of the Green River. A second, private marina is located approximately 2,000 feet east toward the dam from the recreational marina.

The Green River, and to a lesser extent Panther Creek, have deposited sediment into the lake. Shore erosion and smaller tributaries are secondary sources of sediment throughout the lake. The sediment discharge from the Green River has formed a delta in the lake, and a portion of the delta near the mouth of the Green River is so shallow that wetland-like areas have formed. Some of these areas may be considered jurisdictional wetlands, if assessed.

Anecdotal evidence, such as stories from longtime Polk County residents, indicates that the upper portion of the lake near the mouth of the Green River and the Green River itself were once deep enough to accommodate water skiing and permanent boat houses. Currently, the sediment buildup near the mouth of the Green River and the recreational marina is severely restricting boat access and recreational usage of the lake.

Polk County officials and residents of the lake community are concerned that the sediment buildup will eventually completely block access to the lake from the public marina. In addition, Polk County officials have expressed concern that the sediment buildup is negatively impacting the effective storage capacity of the water-supply reservoir.

1.2 Feasibility Study

PCSWCD contracted Altamont to perform a feasibility study to estimate the amount of sediment in the lake and evaluate options for dredging the lake and a portion of the Green River roughly 1 mile upstream from the mouth of the river. The scope of services for the feasibility study is provided in Appendix B.

2.0 Feasibility Study Tasks and Methods

The feasibility study performed by Altamont comprised the following tasks. Results are discussed in Section 3.0.

2.1 Define Sedimentation Problem Areas in Lake Adger and the Green River

To estimate the magnitude and nature of sedimentation in Lake Adger and the Green River, Altamont performed a bathymetry survey of the lake on December 9, 2014. The bathymetry survey extended from the mouth of the Green River to Turner Shoals Dam. The survey was completed using a weighted tape and locations were identified using global positioning system (GPS) data. Water depth was measured at 13 cross-section locations along the length of the lake. An additional 228 discrete depth measurements were collected throughout the western portion of the lake to refine data density. The depth and location data were used to generate a map of water depths in the western portion of the lake (see Drawing C1.0).

During the bathymetry fieldwork, Altamont collected 10 sediment samples from various locations around the public marina and the mouth of the Green River (see Drawing C2.0). The sediment samples were sent to Gentry Geotechnical Engineering (Gentry), a geotechnical engineering laboratory. The samples were analyzed for natural-moisture content and grain size. A copy of the geotechnical report is included as Appendix C.

As part of the field study Altamont evaluated potential additional sources of ongoing sedimentation. Specifically this included other streams, creeks, and rivers that are part of the Green River Watershed and that flow into Lake Adger. The report entitled *Green River Watershed Assessment* (Altamont 2013) was used to support this evaluation. A copy of that report is included as Appendix D.

2.2 Determine Permitting Requirements

Before sediment can be removed from the lake or river, permits must be obtained from state and federal regulatory agencies. To determine specific permitting requirements Altamont contacted the following agencies:

- US Army Corps of Engineers (USACE)
- NC Department of Environment and Natural Resources (DENR)
 - Division of Water Resources
 - Division of Land Quality
- North Carolina Wildlife Resources Commission (WRC)

2.3 Evaluate Potential Dredging Procedures, Phasing, and Area Requirements

Altamont evaluated the feasibility of dredging Lake Adger by analyzing and studying other comparable dredging projects including both permanent operations and seasonal operations. Altamont contacted six dredging contractors and requested technical and cost information regarding the applicability of three primary dredging methods:

- Hydraulic dredging
- Drain and excavate
- Mechanical excavation from a barge with the use of an excavator

Each of the six contractors was provided detailed information regarding the nature and extent of sediment in the lake (see Appendix C and Drawings C4.0 through C6.0). Three of the six contractors declined to respond to the request for information. Three contractors provided detailed information.

A significant challenge involved with any dredging project is determining where to dewater, stage, and dispose of the dredge spoils. As part of this task Altamont explored methods used for other dredging projects and researched various options, including the use of private and public property within close proximity of the lake and the use of the Polk County Route 9 Landfill site.

2.4 Perform Market Study and Interview Potential Dredging Contractors and Operators

Altamont completed in-depth interviews with the following dredging contractors to discuss methods and requirements for dredging. Two of the three interviews were completed on-site at the lake. One interview was completed by phone. The contractors interviewed were:

Tim Edwards Landscaping

109 Post Office Road
Mill Spring, NC 28756
828.817.1814

Alexander & Associates

17 Williams Road
Taylors, SC 29687
864.517.0476

JND Thomas Company

12001 Research Parkway
Suite 236
Orlando, FL 32836
954.683.5229

As part of this task, Altamont also visited two operating sand-and-gravel operation businesses (Edwards Landscaping [Broad River] and Harrins Sand & Gravel [French Broad River]) to observe the operations and evaluate the applicability with respect to a long-term, permanent dredging operation on the Green River.

2.5 Cost Estimate for Dredging

One of the goals of the feasibility study was to provide an “order-of-magnitude” cost estimate for dredging, transporting, processing, and handling the dredged material based on the impacted area map and proposed methods. The three dredging contractors Altamont interviewed each provided cost data. All of the contractors indicated that current uncertainties regarding items such as target depth of dredging, staging and disposal areas, etc., affect the cost. However, the cost information provided by the contractors is sufficient for planning purposes.

A cost comparison was developed for planning purposes and for potential grant applications.

2.6 Potential Funding Sources

Altamont reviewed potential funding sources with the DENR’s Division of Water Resources and Division of Land Quality, USACE, and the WRC.

3.0 Findings

3.1 Sedimentation Problem Areas in Lake Adger and the Green River

Altamont's bathymetry survey shows that the lake ranges in depth from less than 1 foot at the western end to around 80 feet at the Turner Shoals Dam (east end).

In the vicinity of the boat launch and marina at the western end of the lake the water levels are very shallow due to sedimentation accumulation (see Photos 1 through 5). Water depth in this area of the lake ranges from 6 inches to about 5 feet. Drawings C1.0 and C3.0 provide a depiction of water depth at normal lake level. The bathymetry survey determined that the depth of water increases rapidly and steadily to the east to a point approximately 2,000 feet from the mouth of the Green River.

The Green River feeds into Lake Adger from the west. The river appears to be the main source of sediment deposition in the lake. The main channel of the Green River is filled with sediment for a distance of 1 mile or more upstream of the lake. Water depth in the channel appears to be 1 foot or less (see Drawing C7.0).

The Green River has developed a braided channel through the sediment deposits at the confluence with the lake. Vegetation has established on some of the accumulated sediment, and these shallow, vegetated areas might be classified as jurisdictional wetlands if they were to be formally assessed by a regulatory agency.

A volumetric calculation of the western portion of the lake indicates that dredging the west end of the lake to a uniform depth of 5 feet above would require removing approximately 150,000 cubic yards of sediment. Dredging the same area of the lake to a uniform depth of 10 feet would require removing approximately 450,000 cubic yards of sediment and dredging to a uniform depth of 12 feet would require removing approximately 630,000 cubic yards of sediment.

Dredging the Green River to a depth of 5 feet for 1 mile upstream of the lake would require removing about 20,000 cubic yards of sediment.

Gentry's analysis of 10 sediment samples collected from the western end of the lake determined the material could be used for common fill in non-structural fill applications. The soils also may be suitable for possible agricultural applications. The material does not appear suitable for specialized reuse.

3.2 Potential Additional Sources of Ongoing Sedimentation

A review of the *Green River Watershed Assessment* dated September 30, 2013 indicates that Panther Creek is a limited source of additional and potentially ongoing sediment deposits into the lake. Altamont considers the sedimentation risk from Panther Creek minimal because of its relatively small size and watershed. Ostin Creek, another small stream, also contributes some sediment to the lake. However, because the mouth of Ostin Creek is distal from the public marina it was not taken into consideration in this report.

Localized erosion of the lake shoreline throughout the lake contributes sediment to the lake but shoreline erosion does not appear to be a major contributor to the sediment in the western end of the lake (see Photos 6 through 9).

3.3 Permitting Requirements

3.3.1 Dredging Permits

Permitting options for dredging operations were discussed in a meeting with USACE, DENR, and WRC on April 14, 2015. All agencies were in agreement that dredging is warranted at Lake Adger. Any dredging operations will need to be permitted with the USACE in conjunction with DENR. Mr. David Brown of the Asheville Regulatory Field Office of USACE reported that there may be two options for permitting. Once the

extent of the work and the dredging techniques have been determined, the USACE will assess what sections of 404/401 permits are appropriate. It may be that the General Permit 30 (GP-30), which is a more streamlined process, might be appropriate for the lake dredging operations, or it may be that the USACE would require an individual permit (IP).

For use of the GP-30 the proposed work would need to meet all the terms and conditions of that permit, particularly the following items:

1. The excavated material is placed & retained on high ground.
2. Dredged or fill material cannot be discharged into wetlands.
3. Dredging limited to channelward of the normal pool elevation.
4. The temporary placement or double handling of excavated or fill material waterward of the normal pool elevation is not authorized.

At the USACE's discretion, any time during the processing cycle, the Wilmington District Engineer may determine that GP-30 will not be applicable to a specific proposal. In such case, the procedures for processing an IP in accordance with 33 Code of Federal Regulator (CFR) 325 will be available.

The individual permit application is much more complicated, expensive and would take much longer to acquire than the GP-30. IPs are issued for all activities that have more than minimal adverse impacts to waters of the United States, and the evaluation of each IP application involves a more thorough review of the potential environmental and socioeconomic effects of the proposed activity. An IP requires a full public-interest review, including public notices and coordination with involved agencies, interested parties and the general public. Typically the IP process takes 3 to 6 months. However, due to the uniqueness and/or complicated issues surrounding any particular project, additional permit review and processing time may be warranted.

The IP process is generally as follows:

1. Pre-application process
2. Application submittal (with supporting documents)
3. Joint public notice for the Section 404 permit and Section 401 water quality certification
4. 15-day to 45-day public-notice comment period
5. Opportunity for public hearing (if USACE deems a hearing is in public's best interest)
6. Review of comments (with applicant's involvement)
7. Decision to either issue, issue with conditions, or deny

The applicant for an IP is responsible for providing the USACE with the majority of the information needed for the USACE to make its decision.

The USACE permit application can be found at:

<http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits/ObtainPermit.aspx>

Also see Appendix E.

Matters for which the USACE might consider elevating this proposed project to an IP would be public interest in the project, not meeting General Permit 30 terms and conditions, an external agency's (e.g., DENR, WRC, US Fish and Wildlife Service [USFWS], Federal Energy Regulatory Commission [FERC], North Carolina State Historic Preservation Officer [NCSHPO], etc.) concerns, or significant impacts to high quality water resources.

An individual State of North Carolina Water Quality Certification is also required and must be issued before a final USACE decision is provided. DENR's Division of Water Resources conducts this certification as a requirement of Section 401 of the Clean Water Act.

An Erosion and Sediment Control Permit will also need to be acquired through DENR under the Division of Energy, Mineral and Land Resources.

It should be noted that WRC expressed concern that with any proposed activities, attention should be given to any listed species habitat within the Green River.

3.3.2 Sand-and-Gravel Operation Permits

The dredging contractors stated that a permanent sand-and-gravel dredging operation in the Green River upstream of the lake would significantly reduce long-term sedimentation problems in the lake (see Section 3.4.3 for more details). Mr. Brown of USACE indicated that a separate IP would need to be issued for either a temporary or a permanent sand-and-gravel operation on the Green River upstream of the lake.

Any permitting for this operation would be the responsibility of the sand-and-gravel operator.

3.4 Potential Dredging Procedures, Phasing, and Area Requirements

3.4.1 Dredging Options

3.4.1.1 Hydraulic Dredging

One option for removing sediment from the lake and a portion of the Green River is hydraulic dredging. This type of dredge floats on the water and excavates and pumps sediment as a slurry (consisting of approximately 40-percent solids and 60-percent water) through a temporary pipeline to a temporary staging area that is usually located in an upland area, often several thousand feet away. The hydraulic dredge acts like a floating vacuum cleaner, and operators report that the dredge can remove sediment in a very precise manner.

With a hydraulic dredge, the dredge discharge line and return line are the only obstructions in the environment. The lines are usually floated on the water surface and laid across the ground surface. Other than this, the dredge (which is not much larger than a boat) is the only equipment necessary. Hydraulic dredging is a relatively unobtrusive dredging method and does not require disturbing the shoreline.

Assuming the sediment slurry can be discharged directly to its final disposal location, the hydraulic dredging operation requires minimal mobilizations to put the dredge in the water and remove the dredge when the project is complete.

Hydraulic dredging generally provides the cleanest and least obtrusive method for sediment removal and typically results in the least amount of damage to sensitive environments.

3.4.1.2 Excavation Dredging

Another dredging option involves lowering the water level in the lake and using an excavator to remove accumulated sediment. This method allows the sediment to dewater where it lies. Haul roads are built atop the drained sediment and the sediment, once “dry” or “dewatered”, is loaded directly onto trucks for transport.

Excavation dredging is often the least expensive dredging option, because the contractor does not have to handle the material twice before it is loaded onto haul trucks. However, permitting agencies are sometimes reluctant to permit excavators and trucks in the lake bed because of the risk of contamination to the lake and its ecosystem—water quality, plant life, and wildlife. If this method of dredging is utilized, the lake level will need to be lowered a minimum of 5 feet, although lowering the level by 10 feet or more would be preferable. In addition, the Green River (and possibly Panther Creek) would have to be channeled through the dry lake bottom area while the sediment is being excavated.

This method would also prevent any use of the marina and its boat ramp access during dredging operations.

3.4.1.3 Mechanical Excavation from Barge

Yet another option is mechanical excavation from a barge. Rather than drain the lake, the excavator is positioned on a barge on the water. A staging area to temporarily place the sediment and allow it to dewater is required. This method typically is the most time-consuming dredging approach.

3.4.2 Sediment Dewatering, Staging Areas, and Storage/Disposal

All of the dredging methods will require a material staging, dewatering, and disposal area. If the dredging utilizes either hydraulic dredging or mechanical excavation from a barge, the staging area will need to be located in close proximity to the lake to accommodate efficient handling of the wet sediment. If excavation dredging is utilized, the staging area can be located further from the lake and trucks can be used to transport the drier sediment to the staging/disposal area. Altamont estimates that the material staging, handling, and disposal area is dependent on the amount of material dredged. For example, in order to store 150,000 cubic yards of material stacked 10 feet high, an 11-acre parcel (at minimum) would be required.

Option 1—Marina Parking Area: Upland areas surrounding Lake Adger are all privately held. The marina parking lot is privately owned by Lake Adger Property Owners Association Inc., which has a deeded recreational easement across it per Deed Book 321, page 1719-1729. The easement through the marina parking lot is the only public access to the lake. It is uncertain whether some or all of the parking area could be used as temporarily staging area for dredge material. Even if a portion of the marina were available, it is Altamont's opinion that the site is too small to accommodate the volume of material that will be generated and dewatered. Storage in the marina parking area would also disrupt all recreational activities while the dredging operations were taking place.

Option 2—West End of Lake Adger: Altamont evaluated an in-lake area as an option for staging and handling the dredged sediment. The property is located roughly 500 feet southwest of the marina boat ramp on the left side of Lake Adger Road at the far west end of the lake (see Drawing C1.0). This area appears to be owned by Polk County. If the area were utilized for staging and drying the sediment, it would mean temporarily placing the material in a portion of the lake itself, and this use would have to be approved by the permitting agencies. In addition, the use of this location would require the material to be handled twice, extending the contractor's work. It would likely cause temporary traffic obstructions on Lake Adger Road.

Option 3—Remote Private Parcel: Altamont evaluated one remote parcel located approximately 1 mile from the Lake Adger marina boat ramp. This parcel, which is approximately 56 acres, is situated between Ridgeview Road and the Green River. The property is not currently listed for sale but has been for sale in the past. This site appears to be well suited to accommodate material handling, sorting, and disposal, provided excavation dredging is utilized. If either hydraulic dredging or mechanical dredging from a barge is utilized, Option 1 or 2 would have to be integrated with Option 3 to allow for short-term draining and handling of the material at or near the lake.

3.4.3 Alternative for Minimizing Ongoing Sedimentation to Lake

As discussed in Section 2.4, Altamont evaluated two sand-and-gravel mining operations to determine whether similar operations would be viable in the Green River to reduce ongoing sedimentation to Lake Adger. According to Marche Pittman, Polk County Manager, a sand-and-gravel business operated upriver from the lake until the early 1990s.

One of the sand-and-gravel operations evaluated by Altamont is situated on the Broad River, downstream from Lake Lure. The Broad River at that location is similar in size to the Green River at Lake Adger. The property utilized by the sand-and-gravel operation consists of approximately 12 acres. The actual dredging/sand-and-gravel operation takes up about one-third of the parcel (see Photos 10 through 14). A

trackhoe excavator is used to dip sediment from the river channel, and the dredged materials are drained adjacent to the river. Dredged materials are sorted for size and sold to local contractors, residents, and the North Carolina Department of Transportation.

The second sand-and-gravel operation that Altamont evaluated is situated on the French Broad River in Asheville. The French Broad River at this location is larger than the Green River at Lake Adger. The property utilized by the sand-and-gravel operation consists of approximately 1.4 acres. The actual dredging/sand-and-gravel operation takes up about 90 percent of the parcel. At this location, a small hydraulic dredge is used to pump sediment from the river channel, and the dredged materials are temporarily staged in a contained area for drainage. Dredged materials from this operation are sorted for size and sold to local contractors, residents, and the North Carolina Department of Transportation.

The operators of both of these sand-and-gravel mining operations stated that their businesses were viable, and they believe the business could be replicated elsewhere. Both operators stated that the market for the dredged and sorted material would ultimately determine the viability of the business venture if a similar operation were started on the Green River. The operators were not familiar with the local market in the Lake Adger area and so could not predict the actual viability of a sand-and-gravel operation on the Green River.

Both operators indicated they believed that the Green River will continue to transport sediment and, if a permanent dredging operation is not established upstream of Lake Adger, the portion of the lake near the mouth of the Green River will simply refill with sediment after it is dredged. In their opinion, a permanent mining operation upstream of the lake would significantly reduce the frequency at which the lake needs to be dredged.

3.5 Recommendations of Potential Dredging Contractors and Operators

Altamont's overall determinations about dredging requirements were outlined in Section 3.3. The cost breakdown estimates for each method are described in Table 1. In this section, the recommendations of individual contractors are presented.

3.5.1 Tim Edwards Landscaping Recommended Approach

Tim Edwards Landscaping recommends that a Lake Adger dredging operation utilize excavation dredging and transport the dredged material to a remote location away from the lake for sorting and/or disposal. It recommends lowering the water level in the lake by up to 10 feet. Edwards would build temporary access roads across the drained lake sediments. The company would work from the deepest point back toward the shore using long-reach excavators. It would then move the dredged material into haul trucks to be deposited at a predetermined location away from the lake. The access roads would be excavated once they are no longer needed.

3.5.2 Alexander & Associates Recommended Approach

Alexander & Associates also recommends using the excavated dredging method. The company would lower the water level in the lake and build a temporary access road into the lake as far as the dredging operations would require. The company would work from the deepest existing point back to the shore using long-reach excavators. It would then move the dredged material into haul trucks to be deposited at a predetermined location.

3.5.3 JND Thomas Company Recommended Approach

JND Thomas Company's recommendation is to dredge the lake and river hydraulically. A mechanical dewatering system (MDS) would be mobilized at an on-shore site near the marina. The parking lot for the marina is large enough to facilitate the operation and still allow for lake access.

The hydraulic dredge and MDS would operate continuously—that is, around the clock during the operation—and likely dredge between 500 and 1,000 cubic yards of material per day.

The MDS would need to flush 2,500 gallons of fresh water per minute through its system to sort the dredged material. It would separate sand and debris, producing a dry, stackable, and transportable material in a 45-minute cycle. Once the material is dredged, it can be transported off-site in a matter of minutes.

JND Thomas Company estimates that 500 to 1,000 cubic yards of material could be processed per day utilizing the hydraulically excavated dredging approach.

The consultation with JND Thomas Company occurred via phone. A company representative did not visit the site.

3.6 Cost Estimate for Dredging

The contractors interviewed by Altamont indicated that, based on their experience on previous projects, the cost to dredge may vary from \$9 to \$15 per cubic yard. Transporting cost can vary greatly depending on various factors. Cost-impacting factors include equipment and vehicle access, the amount of material to be dredged, and the distance materials need to be transported. In general, the contractors agreed that the combined dredging and transportation project could cost between \$15 and \$30 per cubic yard.

For comparison, Lake Lure spent \$2 million after the flood of 1996 removing sediment from the lake. According to Clint Calhoun, a certified lake manager and the environmental management officer of the town of Lake Lure, Lake Adger might need to dredge twice the amount as at Lake Lure. The Lake Lure advisory

board has estimated the cost of staying even with the amount of sediment entering the lake at \$400,000 to \$500,000 annually. Lake Lure has an accessible area to deposit dredged materials. Tim Edwards Landscaping, one of the contractors interviewed in this report (Section 2.4.1), has been performing some of the dredging operations at the lake.

Another example, provided by JND Thomas Company is a hydraulic dredging project in Florida that is currently pumping 800,000 cubic yards of material from a freshwater lake and transporting it to a nearby landfill. The projected cost of the project in its entirety is \$30 million.

The various dredging options, including a summary of cost projections and a list of the pros and cons associated with each option, is presented on Table 1.

3.7 Potential Funding Sources

The Lake Adger dredging project may qualify for funding through the water resources development project grant program sponsored by DENR's Division of Water Resources. The amount of funds available for the fall grant cycle will be determined by the current session of the legislature. The application deadline for the fall grant cycle is July 1. North Carolina had \$102,400 to award for water-quality planning projects in 2014.

The WRC is contractually responsible, per the Lake Adger marina and marina boat ramp facility public access agreement filed in the Polk County Register of Deeds Book 321, pages 1719 to 1729 (Appendix F), for maintaining an access channel from the Lake Adger marina and marina boat ramp facility to the main body of Lake Adger so that watercraft can access the waters of Lake Adger marina from the marina boat ramp facility. Altamont assumes that the agreement obligates the WRC to dredge the channel as necessary to maintain access to the waters of Lake Adger for watercraft. The recommended depth for boat access is 5 feet, according to Mr. Mark Hamlett of the WRC. Mr. Hamlett is not aware of any dredging previously performed at Lake Adger.

4.0 Summary and Conclusions

Based on the feasibility study, Altamont has determined that the primary area of concern with respect to sediment deposition is the west end of the lake extending approximately 800 feet to the east of the marina. The channel of the Green River is choked with sediment, and deposition from the Green River has now formed what may be considered wetlands. It is Altamont's opinion that sedimentation accumulating in the lake has been building since the lake was created in 1925 but the rate of deposition increased after the sand-and-gravel operation in the Green River was decommissioned in the 1990s.

Altamont estimates that a sediment shelf stretches roughly 2,000 feet into the lake from the mouth of the Green River. The Lake Adger marina has been impacted and constrained by the sedimentation buildup, and is now accessible only via the channel that was created by boat traffic and localized dipping of sediment by homeowners.

There is a second marina, which is private, in the lake approximately 2,000 feet toward the dam from the public marina where the lake bottom depths begin to drop dramatically. In this area, depths drop from 10 feet to 20 feet in less than 700 feet horizontally across the estimated original stream channel before the dam was built.

Dammed lakes are essentially man-made traps for sediment. One way to help control sediment washing into lakes that are fed by substantial rivers, as the Green River feeds into Lake Adger, is to control the sediment before it reaches the lake. The most cost-effective approach to long-term management of the lake would be to address the sediment input from the Green River before or concurrently with any lake dredging project.

Altamont recommends that Polk County first identify and enter into a contract to purchase an upland property in relatively close proximity to the lake to serve as a long-term disposal area for sediments removed from the lake. Ideally, the parcel would be located upstream of Lake Adger on the Green River. This might allow a sand-and-gravel operator to be on the same parcel as that used for sediment dispersal. It is Altamont's opinion that a sand-and-gravel operation similar to the one on the Broad River would likely require a minimum of 3 to 5 acres, depending on the topography of the land used and the size of the sand-and-gravel operation, in order to manage the sediment entering the lake. Such a site, again depending on the topography of the land, would likely suffice for the dredging operation and an area for processing the dredged material, as well as stockpiling it for sale or other uses.

A pre-purchase property assessment should be completed to ensure that the property can be utilized for disposal of the material and what, if any, additional permitting requirements there may be. An endangered species evaluation, utilities assessment and a Phase 1 Environmental Site Assessment should also be included as a part of the pre-purchase property assessment. As this process may take time and additional funding, it will be important to identify and secure this property early on. The acquisition of this property adjacent to the river would enable the facilitation of a permanent sand-and-gravel operation upstream from Lake Adger on the Green River to help control the amount of sediment entering the lake. The material dredged from the river may be suitable for sale, and the sand-and-gravel operation may be a viable business opportunity.

Once a property is secured for sediment disposal, the western portion of the lake, for a distance at least 800 feet east of the marina should be dredged. The recommended depth for boat access, according to the WRC is 5 feet.

Determining which dredging method make the most sense should be determined by questions such as:

- What depth should the lake be dredged to?
- Is there a suitable location to dispose of the material?
- How much funding can be awarded?

In order to acquire permits to complete the dredging operation, a preliminary set of construction details will need to be developed. It is recommended that the GP-30 be sought over the individual permit with USACE, as it is less costly and will take less time. Permitting requirements from DENR's Division of Water Resources and Division of Land Quality can only be determined once the dredging techniques have been determined. DENR will determine which divisions are relevant to permitting at that time. Permitting from WRC is not applicable.

After permits are acquired and a location for disposal of dredged material is secured, the County should identify and contract with a long-term sand-and-gravel operator to operate upstream along the Green River. The operation would require an IP from the USACE. This would be the responsibility of the sand-and-gravel operator. It should be noted that obtaining an IP for a sand-and-gravel operation can be a lengthy process. However, in some cases, this type of permit only needs to be reissued every 10 years. Harrins Sand & Gravel's dredging on the French Broad River in Asheville is an example of work done under an IP.

The dredging operation of Lake Adger will require the acquisition of various funding sources. Grant funding opportunities may require detailed construction documents in order to identify project phasing, schedule, and overall project cost.

Once funding is secured, the lake dredging operation can commence. It will be important for the county to continue to support the sand-and-gravel operation into the future to reduce the amount of sediment that enters the lake.



Photo 1: View of accumulated sediment in the marina basin, facing south.



Photo 2: View of accumulated sediment west of the marina basin along Lake Adger Road, facing west.



Photo 3: View of accumulated sediment in the marina basin, facing southeast.



Photo 4: View of accumulated sediment in the marina basin, facing southwest.



Photo 5: View of accumulated sediment in the marina basin, facing south.



Photo 6: View of shoreline erosion.



Photo 7: View of shoreline erosion.



Photo 8: View of shoreline erosion.



Photo 9: View of shoreline erosion.



Photo 10: View of sand-and-gravel operation on the Broad River.



Photo 11: View of sand-and-gravel operation on the Broad River.



Photo 12: View of sand-and-gravel operation on the Broad River.



Photo 13: View of sand-and-gravel operation on the Broad River.



Photo 14: View of sand-and-gravel operation on the Broad River.



Photo 15: View of the Green River approximately 6,000 feet upriver.



Photo 16: View of the Green River approximately 6,000 feet upriver.



Photo 17: View of the Green River approximately 5,500 feet upriver.



Photo 18: View of the Green River approximately 5,500 feet upriver.



Photo 19: View of the Green River approximately 5,500 feet upriver.

FIGURES

DRAWINGS

TABLES

Table 1
Dredging Methodologies and Cost Comparisons
Lake Adger Dredging Feasibility Study
February 2015

Method	Estimated Range in Cost (per cubic yard)	Total Estimated Price (For 150,000 cubic yards)	Advantages	Disadvantages
Drain and Mechanically Excavate-- Permanent Disposal in West End of Lake	\$9.00 to \$14.00	\$1,350,000 to \$2,100,000	Price. Do not have to haul material to dewatering site. Marina would be accessible during dredging.	A portion of the west end of the pond would be permanently filled. The stacked material can release odors and be unsightly during dredging. Possible impact to wetland areas. May be difficult to permit.
Drain and Mechanically Excavate-- Transport to Off-site Disposal Location	\$15.00 to \$25.00	\$2,250,000 to \$3,750,000	Price. Does not require a material dewatering site. Off-site disposal area can be distal from the lake.	The lake level must be lowered during dredging. Marina will be temporarily unavailable. Possible disturbance to the ecosystem associated with draining the lake and building temporary structures within the lake bed. Possible localized damage to shoreline. Permitting can be difficult. Requires off-site disposal area.
Excavate from Barge--Transport to Off-site Disposal Location	\$19.00 to \$30.00.	\$2,850,000 to \$4,500,000	Low price. Lake level would not be lowered. Marina would be accessible. Off-site disposal area can be distal from the lake.	Requires temporary storage in west end of lake during dewatering. The stacked material can release odors and be unsightly during dewatering. Requires handling of the material multiple times. Lengthy process. May be difficult to permit temporary storage in within the lake. May impact wetlands. Requires off-site disposal location.
Hydraulic Dredge with Mechanical Dewatering System	\$33.00 to \$50.00	\$4,950,000 to \$7,500,000	Relatively unobtrusive method as the floating dredge is the only machine seen. Does not require lowering the water level. Does not disturb the shoreline. Does not require material dewatering site. Marina would be accessible. Material can be hauled off less than an hour after being dredged.	Requires nearby material disposal area. Expensive.

Notes:

Cost estimates based on sight unseen, cubic yard estimates derived from other projects of similar nature.

Cost estimates include unit price assumptions regarding transportation and disposal. Actual costs will vary.

Cost estimates do not include purchase, permitting, preparation, or restoration of offsite disposal area. Actual costs depend upon disposal area selected.

Cost estimates do not include specialized permitting or mitigation of impacts to wetlands. These costs can not be estimated until the preferred method of dredging is determined.

Standard permitting, including sediment and erosion control, is estimated to cost between \$15,000 and \$25,000.

Construction management and documentation could range from 5 percent to 7 percent of total construction cost.

APPENDICES

APPENDIX A
Water Resources Development Project Grant
Program Electronic Application

Water Resources Development Project Grant Program
Electronic Application

Instructions: Download and complete this form through Item I. Email the form as an attachment, along with Items II through V, to jeff.bruton@ncdenr.gov.

Date:

Project Name: _____

Water Body: _____

County:

River Basin:

Coordinates in WGS-84 (-EW d.ddd, NS d.ddd) _____

Eligible Purpose:

Amount Requested: \$ _____ Is the amount being requested the same as the amounts provided in the: Resolution ? Budget ?

I. Sponsor and Primary Contact Information - *(It is the applicant's responsibility to update this information as necessary.)*

Project Sponsor *(from Resolution)*

Unit of Local Government _____

Signatory *(Name and Title)* _____

U.S. Postal Mailing Address _____

Ten-digit Telephone Number _____

Email Address _____

Primary Contact

Name _____

U.S. Postal Mailing Address _____

Ten-digit Telephone Number _____

Email Address _____

II. Official Resolution:

III. Project Narrative:

IV. Project Plan and Location Map:

V. Project Budget:

APPENDIX B

Scope of Services

Proposed Scope of Services for Lake Adger Dredging Study

(From *Proposal for Lake Adger Dredging Study*, Altamont Environmental, Inc., October 7, 2014)

- Define the Sedimentation Problem Areas in Lake Adger and the Green River
 - Perform a bathymetry survey of the lake in the vicinity of the marina and the downstream portion of the Green River where it enters the lake.
 - Prepare a map of the impacted areas and included measured depths from the bathymetry survey.
 - Collect 10 representative sediment samples for a sieve analysis to determine the nature and potential end use of the accumulated sediment.
 - Confirm potential sources of ongoing sedimentation.
- Review Permitting Requirements

Correspond with the United States Army Corps of Engineers (USACE), North Carolina Department of Environment and Natural Resources (DENR) Division of Water Resources and Division of Land Quality, and the North Carolina Wildlife Resources Commission to determine permitting requirements associated with dredging activities.
- Determine Potential Dredging Procedures, Phasing, and Area Requirements
 - Evaluate the feasibility of hydraulic dredging and/or lowering lake levels for excavation dredging.
 - Research sediment dewatering/staging areas both in the lake and onshore.
 - Explore staging areas for sediment storage (e.g., Polk County landfill, parcels proximate to lake, etc.) and transportation and access requirements.
 - Research alternatives for minimizing ongoing sedimentation to the Lake (e.g., private dredging operation on the Green River).
 - Determine area requirements for a permanent dredging operation on the Green River, material handling area, and sediment processing area.
- Market Study and Interview Potential Dredging Contractors and Operators
 - Meet three or more potential dredging contractors on-site to discuss various methods for dredging. Determine the cost-benefit of various dredging options. Develop recommendations regarding the most feasible approach for Lake Adger based on area of impact, access, potential staging areas, handling, and transportation.
 - Analyze viability of a private dredging operation on the Green River. At a minimum, this study shall explore the nature of the dredged material, permitting requirements, processing requirements, markets for processed materials, estimated quantities of processed materials, and potential profitability of dredging and processing operations.
- Cost Estimate for Dredging

Provide an order-of-magnitude cost estimate for dredging, transporting, processing, and handling the dredged material based on the impacted area map and proposed methods. The cost estimate can be used for Polk County planning purposes and for potential grant applications. The estimated costs will not be based on final design or actual bids.
- Review Potential Funding Sources

Research potential local, state, and/or federal funding sources for the proposed dredging activities.

APPENDIX C
Gentry Geotechnical Engineering Report of
Laboratory Testing



(828) 545-3416
WILL@GENTRYGEOTECH.COM
GENTRYGEOTECH.COM
17 SAND HILL RD.
ASHEVILLE, NC 28806

January 7, 2015

Altamont Environmental, Inc.
231 Haywood Street
Asheville, North Carolina 28801

Attention: Mr. Brad Howell

**Subject: Report of Laboratory Test Results
Lake Adger Dredging Study
Mill Spring, Polk County, North Carolina
Gentry Project No. 14G-0121-01
Gentry License No. P-1170**

Dear Mr. Howell:

Gentry Geotechnical Engineering, PLLC (Gentry) is pleased to present this report of laboratory testing of soil samples obtained from Lake Adger as part of the Dredging Study being performed by Altamont Environmental, Inc.

LABORATORY TEST RESULTS

We were provided with 10 zip-lock bag soil samples labeled Sed-1 through Sed-10. We subcontracted ECS Carolinas, LLP to perform the laboratory testing. A natural moisture content (ASTM D2216) and grain size analysis (ASTM D6913) was performed on all 10 soil samples. An organic content (ASTM D2974) was performed on soil samples Sed-1, Sed-4 and Sed-8. The laboratory test results are attached to this report. We have retained the zip-lock bag soil samples at our office.

The soils generally consisted of dark brown, silty fine to medium sand with trace organics to fine to medium sandy silts with trace organics. The soil samples were all saturated with natural moisture contents ranging from 61.8 percent to 137.6 percent moisture content with an average of 96.6 percent. The fines content (Percent Passing a No. 200 Sieve) ranged from 12.7 percent to 64.5 percent with an average of 39.2 percent. The organic content for samples Sed-1, Sed-4 and Sed-8 ranged from 0.51 percent to 2.21 percent with an average of 1.41 percent.

SOIL ANALYSIS AND RECOMMENDATIONS

The silty fine to medium sand soil samples with a fines content less than 50 percent (less than 35 percent preferred) and less than 5 percent organic content would generally be considered suitable for re-use as structural fill. However, significant de-watering and drying of the soils would be required prior to re-use as structural fill. The soils could also be used as common fill in non-structural fill applications, but would also require significant de-watering and drying.

The soils may be suitable for agricultural applications. However, the soils would need to be specifically tested for their pH value and nutrient content. The soil samples could be submitted

locally to the Buncombe County Cooperative Extension for agricultural soil testing. It is typical that the soils would require the addition of lime and fertilizer to make it suitable for agricultural purposes.

LIMITATIONS

This report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to this project. The conclusions and recommendations contained in this report are based on applicable standards of our practice in this geographic area at the time this report was prepared. No other warranty, express or implied, is made.

CLOSING

We appreciate the opportunity to provide professional geotechnical engineering services on this project. Please contact the undersigned if there are questions concerning the report or if we may be of further service.

Very truly yours,

GENTRY GEOTECHNICAL ENGINEERING, PLLC

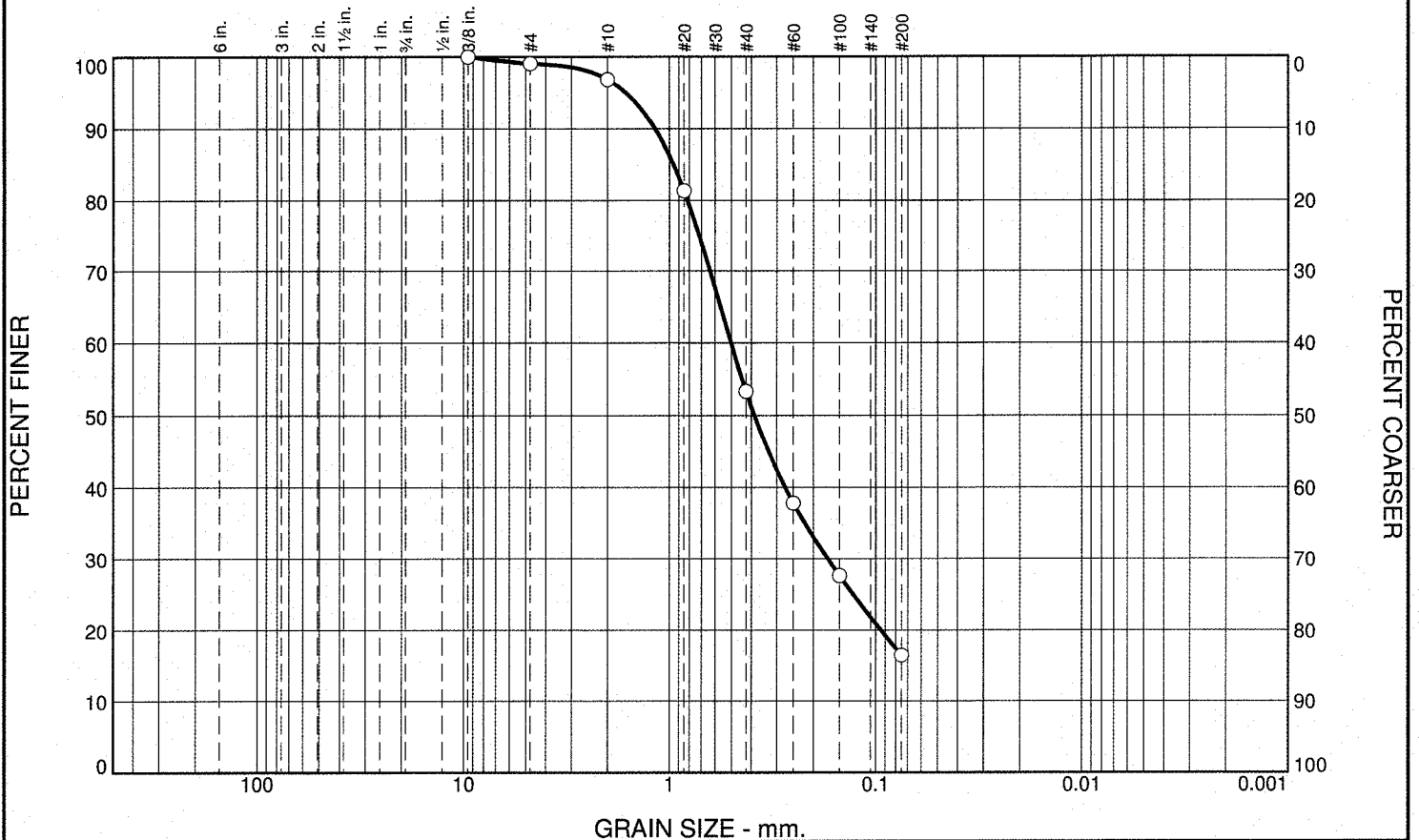
William T. Gentry III, P.E.
President
Registered, NC No. 033927



Attachments: Particle Size Distribution Reports (10 Pages)
Organic Content of Soils (1 Page)



Particle Size Distribution Report



GRAIN SIZE - mm.

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.9	2.2	43.5	37.0		16.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100.0		
#4	99.1		
#10	96.9		
#20	81.3		
#40	53.4		
#60	37.9		
#100	27.6		
#200	16.4		

(no specification provided)

Soil Description

Dark Brown Silty Fine to Medium SAND - saturated, visible organics

Atterberg Limits

PL= NP

LL= NP

PI= NP

Coefficients

D₉₀= 1.1729

D₈₅= 0.9559

D₆₀= 0.5024

D₅₀= 0.3866

D₃₀= 0.1710

D₁₅=

D₁₀=

C_u=

C_c=

Classification

USCS= SM

AASHTO= A-2-4(0)

Remarks

Natural Moisture: 61.8%

Source of Sample: Lake Dredging
Sample Number: SED-1

Depth: 0.00-0.00

Date: 12/17/2014



ECS CAROLINAS, LLP
1900 Hendersonville Road, Suite 10
Asheville, NC 28803
Phone: (828) 665-2307
Fax: (828) 665-8128

Client: Gentry Geotechnical Engineering, PLLC
Project: Lake Adger Dredging Study

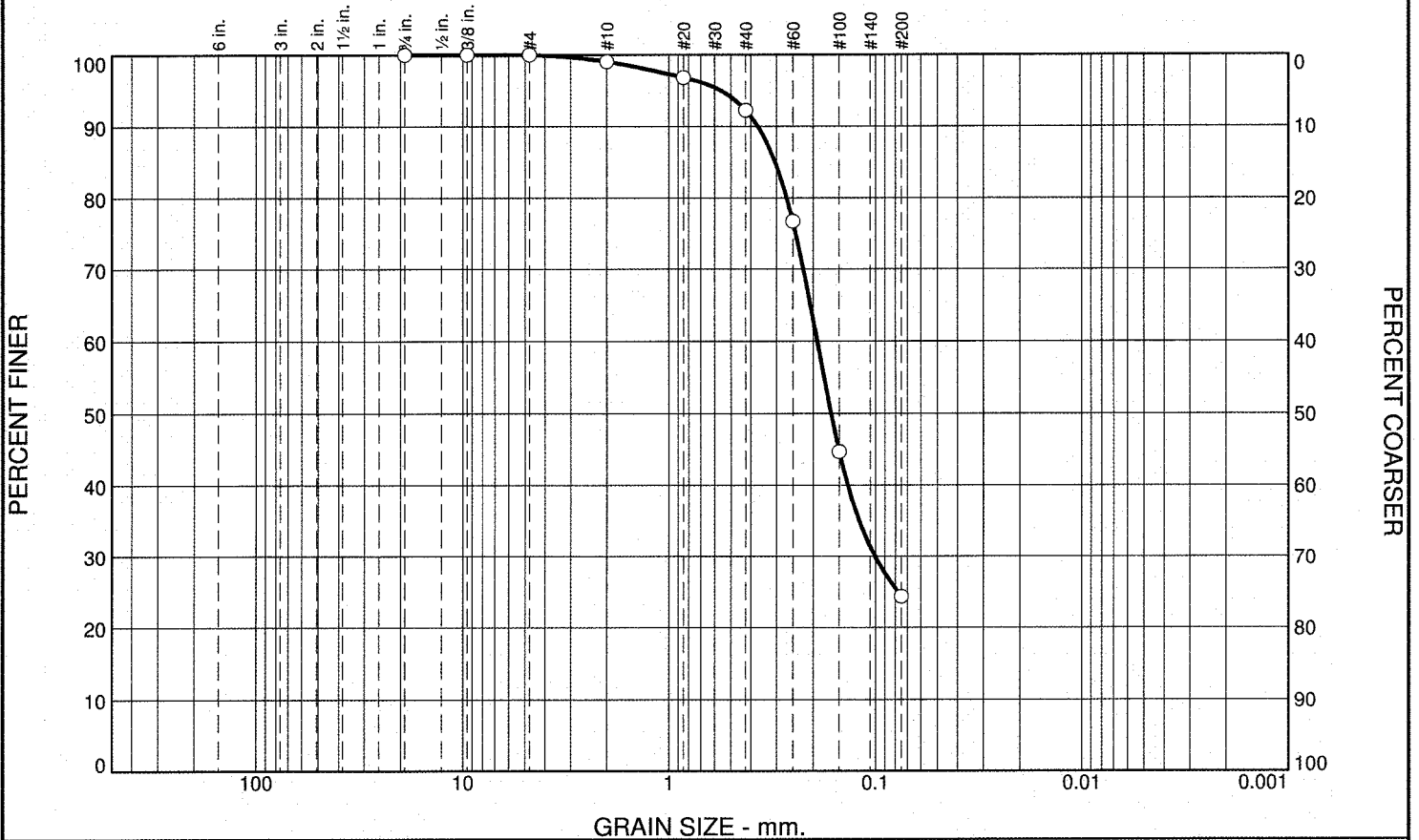
Project No: 2261-Y

Figure

Tested By: JDK

Checked By: SVS

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.9	6.9	67.8	24.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
3/8"	100.0		
#4	100.0		
#10	99.1		
#20	96.8		
#40	92.2		
#60	76.7		
#100	44.7		
#200	24.4		

* (no specification provided)

<u>Soil Description</u>		
Dark Brown Silty Fine SAND - saturated, visible organics		
<u>Atterberg Limits</u>		
PL= NP	LL= NP	PI= NP
<u>Coefficients</u>		
D ₉₀ = 0.3704	D ₈₅ = 0.3045	D ₆₀ = 0.1913
D ₅₀ = 0.1643	D ₃₀ = 0.1007	D ₁₅ =
D ₁₀ =	C _u =	C _c =
<u>Classification</u>		
USCS= SM	AASHTO= A-2-4(0)	
<u>Remarks</u>		
Natural Moisture: 70.4%		

Source of Sample: Lake Dredging
Sample Number: SED-2

Depth: 0.00-0.00

Date: 12/17/2014



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Client: Gentry Geotechnical Engineering, PLLC
Project: Lake Adger Dredging Study

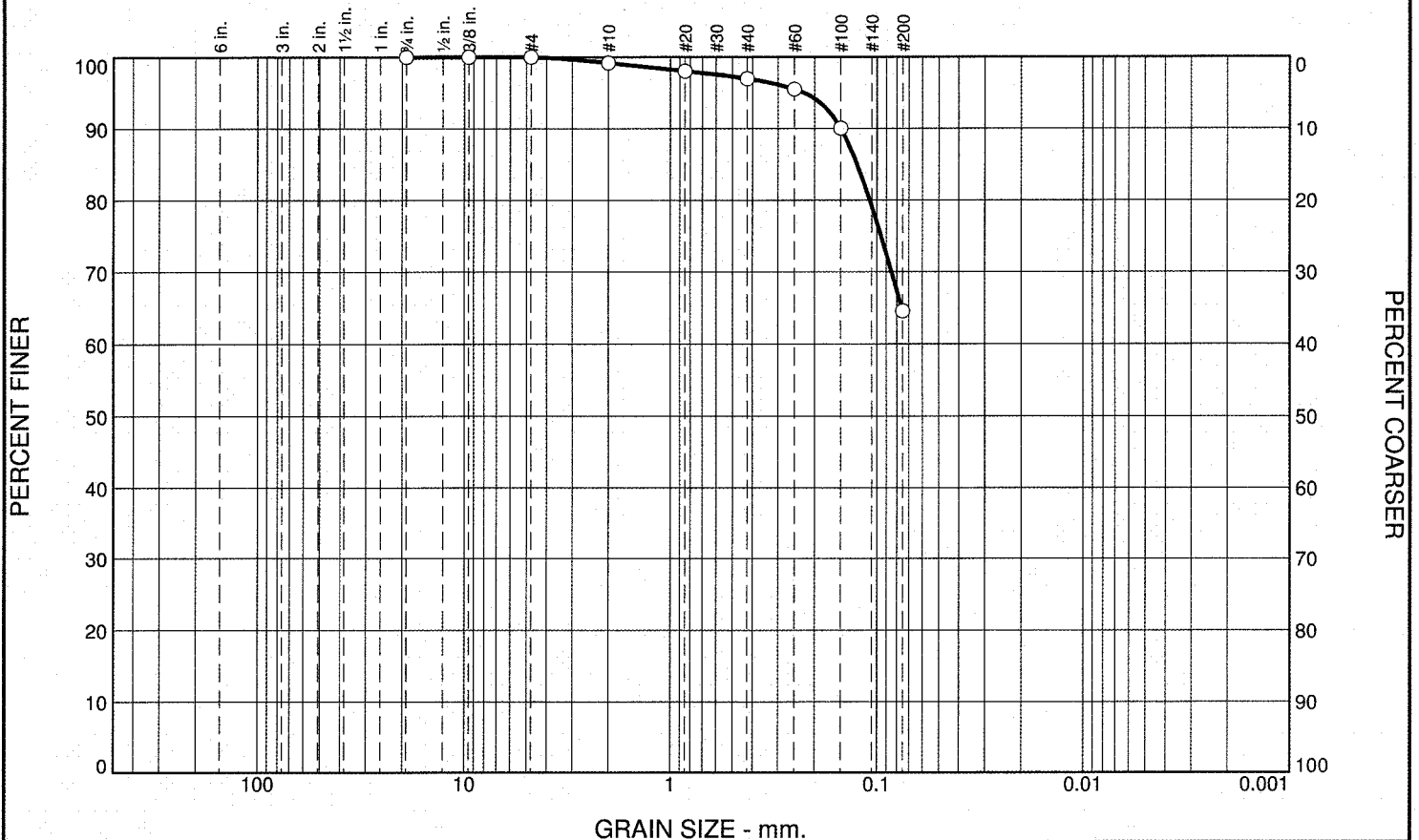
Project No: 2261-Y

Figure

Tested By: JDK

Checked By: SVS

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.8	2.2	32.5	64.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
3/8"	100.0		
#4	100.0		
#10	99.2		
#20	98.0		
#40	97.0		
#60	95.5		
#100	90.0		
#200	64.5		

* (no specification provided)

Soil Description

Dark Brown Fine Sandy SILT - saturated, visible organics

Atterberg Limits

PL= NP

LL= NP

PI= NP

Coefficients

D₉₀= 0.1499

D₈₅= 0.1249

D₆₀=

D₅₀=

D₃₀=

D₁₅=

D₁₀=

C_u=

C_c=

Classification

USCS= ML

AASHTO= A-4(0)

Remarks

Natural Moisture: 137.6%

Source of Sample: Lake Dredging
Sample Number: SED-3

Depth: 0.00-0.00

Date: 12/17/2014



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Client: Gentry Geotechnical Engineering, PLLC
Project: Lake Adger Dredging Study

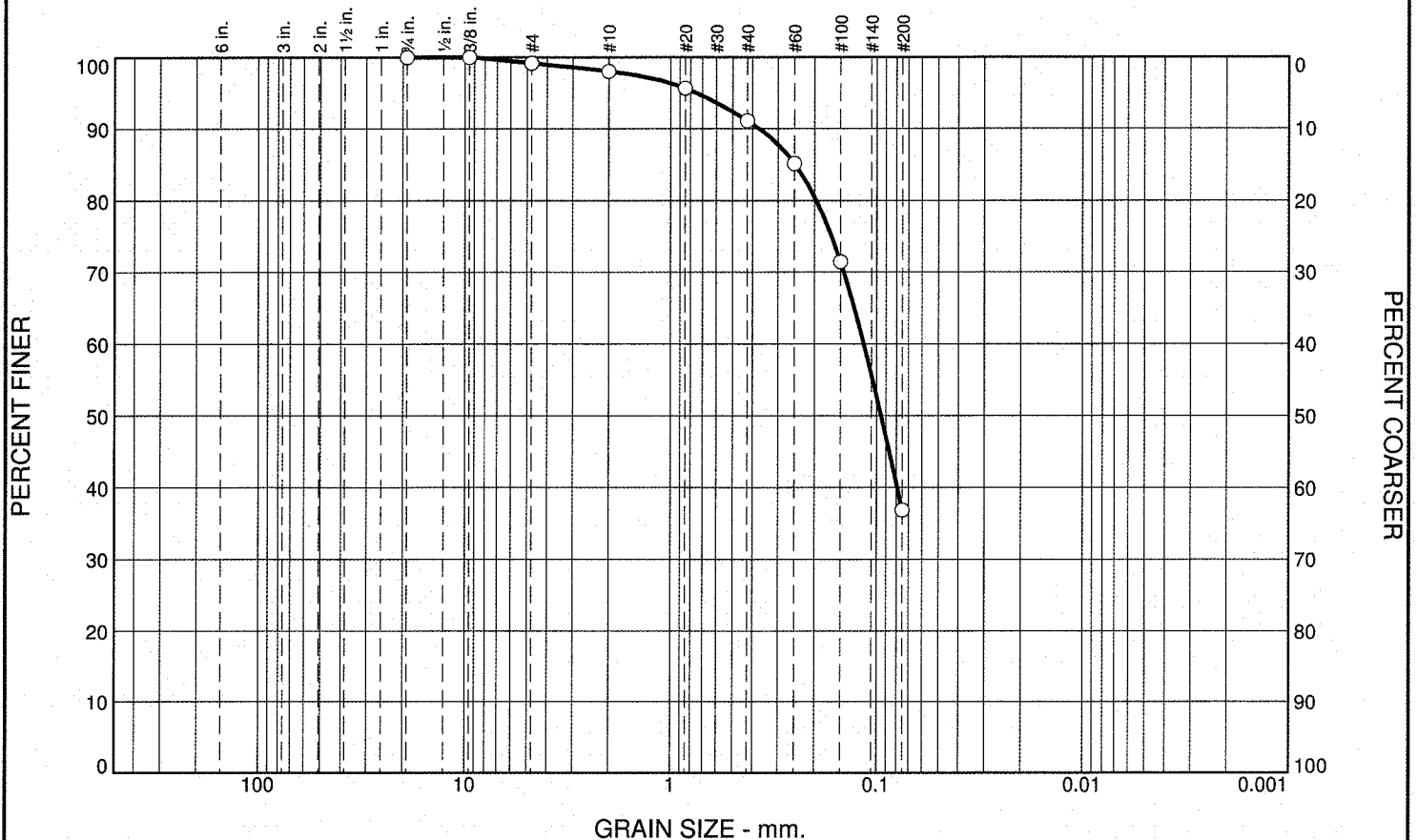
Project No: 2261-Y

Figure

Tested By: JDK

Checked By: SVS

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.8	1.1	7.0	54.2	36.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
3/8"	100.0		
#4	99.2		
#10	98.1		
#20	95.7		
#40	91.1		
#60	85.1		
#100	71.4		
#200	36.9		

* (no specification provided)

Soil Description

Dark Brown Silty Fine SAND - saturated, visible organics

Atterberg Limits

PL= NP

LL= NP

PI= NP

Coefficients

D₉₀= 0.3729

D₈₅= 0.2479

D₆₀= 0.1156

D₅₀= 0.0952

D₃₀=

D₁₅=

D₁₀=

C_u=

C_c=

Classification

USCS= SM

AASHTO= A-4(0)

Remarks

Natural Moisture: 125.0%

Source of Sample: Lake Dredging
Sample Number: SED-4

Depth: 0.00-0.00

Date: 12/7/2014



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Asheville, NC 28803
Phone: (828) 665-2307
Fax: (828) 665-8128

Client: Gentry Geotechnical Engineering, PLLC
Project: Lake Adger Dredging Study

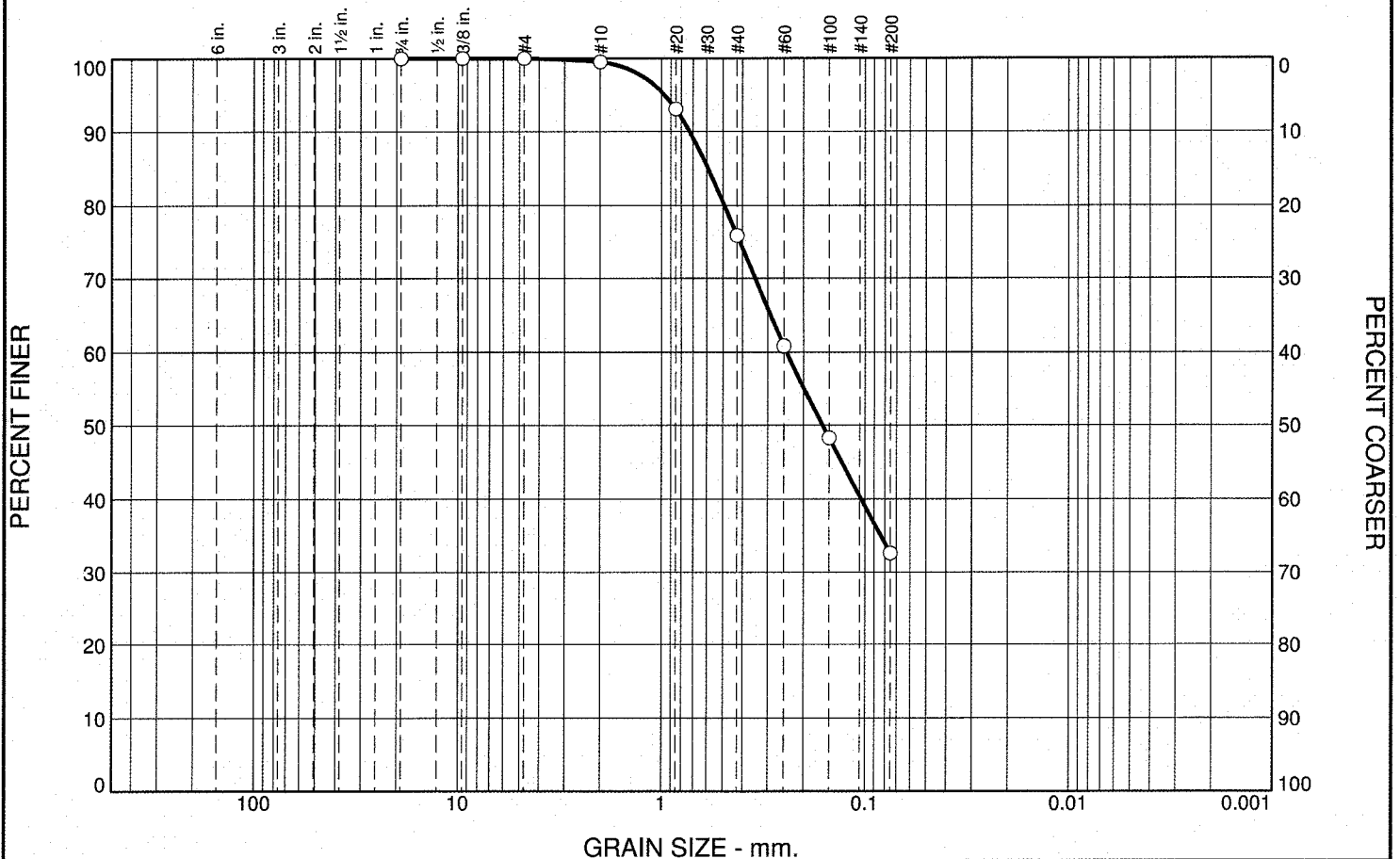
Project No: 2261-Y

Figure

Tested By: JDK

Checked By: SVS

Particle Size Distribution Report



GRAIN SIZE - mm.

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.5	23.6	43.3	32.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
3/8"	100.0		
#4	100.0		
#10	99.5		
#20	93.1		
#40	75.9		
#60	60.8		
#100	48.3		
#200	32.6		

* (no specification provided)

Soil Description

Dark Brown Silty Fine to Medium SAND - saturated, visible organics

Atterberg Limits

PL= NP

LL= NP

PI= NP

Coefficients

D₉₀= 0.7269

D₈₅= 0.5898

D₆₀= 0.2424

D₅₀= 0.1616

D₃₀=

D₁₅=

D₁₀=

C_u=

C_c=

Classification

USCS= SM

AASHTO= A-2-4(0)

Remarks

Natural Moisture: 78.7%

Source of Sample: Lake Dredging
Sample Number: SED-5

Depth: 0.00-0.00

Date: 12/17/2014



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1900 Hendersonville Road, Suite 10
Asheville, NC 28803
Phone: (828) 665-2307
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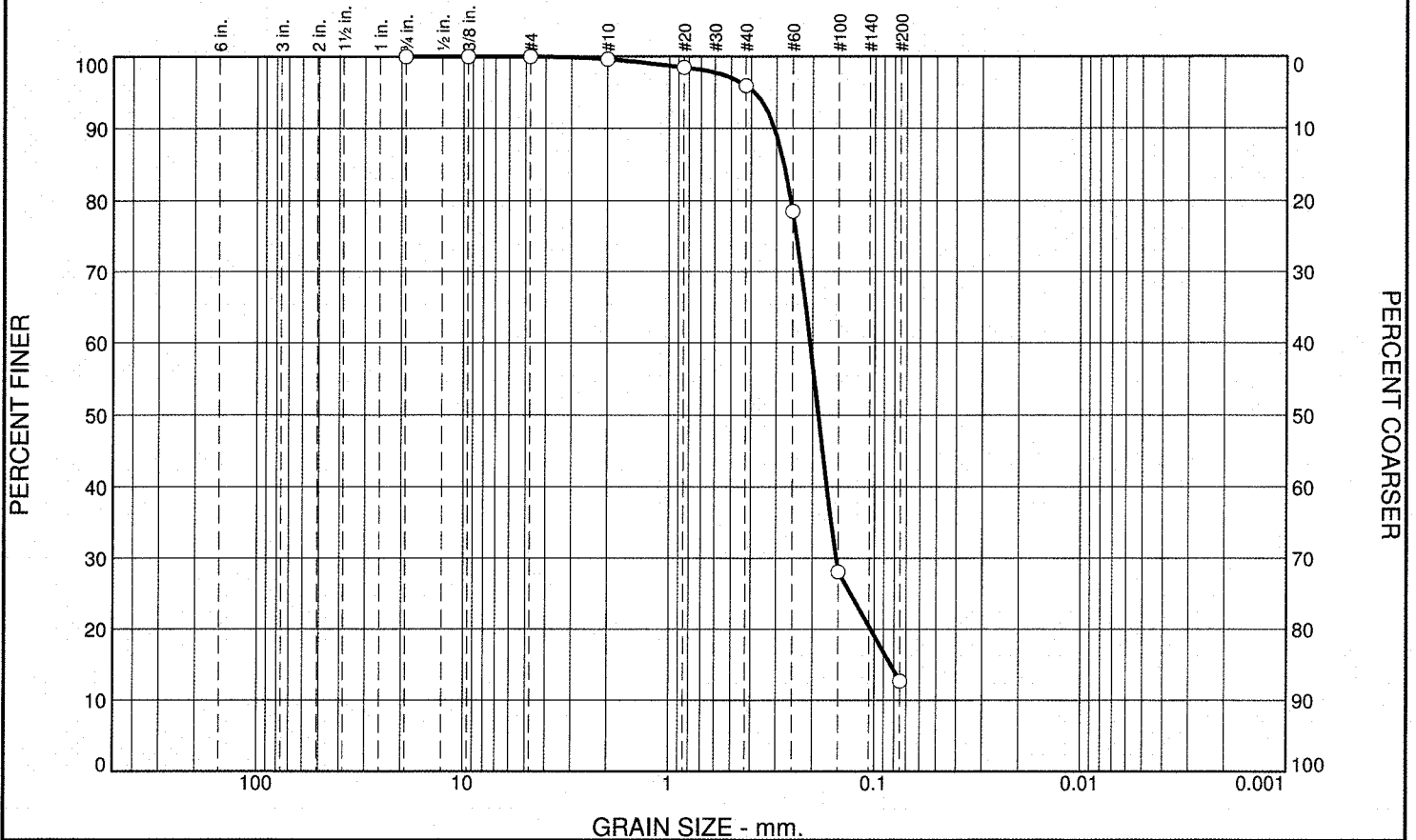
Client: Gentry Geotechnical Engineering, PLLC

Project: Lake Adger Dredging Study

Project No: 2261-Y

Figure

Particle Size Distribution Report



GRAIN SIZE - mm.

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.4	3.6	83.3	12.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
3/8"	100.0		
#4	100.0		
#10	99.6		
#20	98.5		
#40	96.0		
#60	78.5		
#100	28.1		
#200	12.7		

* (no specification provided)

Soil Description

Dark Brown Silty Fine SAND - saturated, visible organics

Atterberg Limits

PL= NP

LL= NP

PI= NP

Coefficients

D₉₀= 0.3074

D₈₅= 0.2756

D₆₀= 0.2059

D₅₀= 0.1878

D₃₀= 0.1536

D₁₅= 0.0832

D₁₀=

C_u=

C_c=

Classification

USCS= SM

AASHTO= A-2-4(0)

Remarks

Natural Moisture: 84.8%

Source of Sample: Lake Dredging
Sample Number: SED-6

Depth: 0.00-0.00

Date: 12/17/2014



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Client: Gentry Geotechnical Engineering, PLLC
Project: Lake Adger Dredging Study

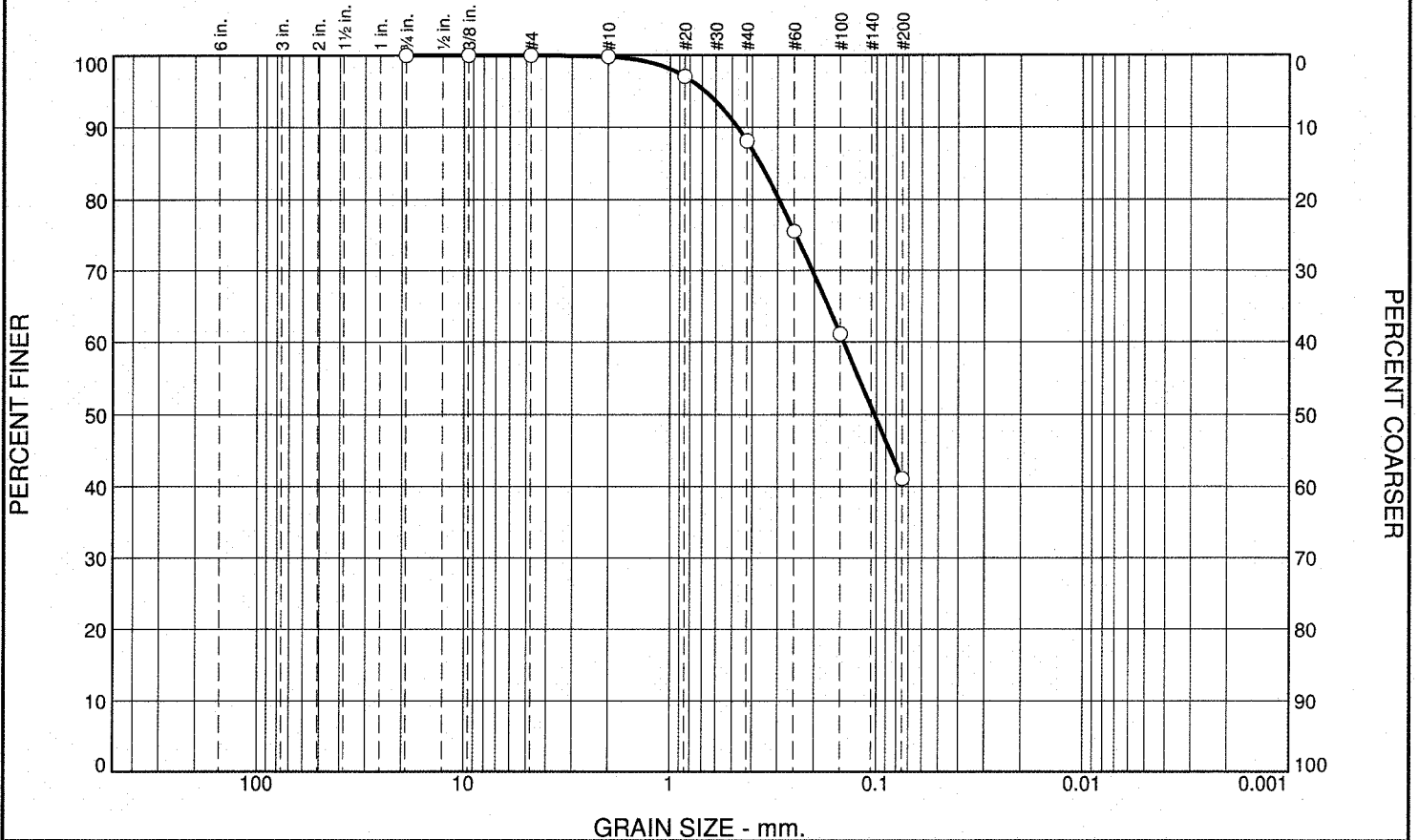
Project No: 2261-Y

Figure

Tested By: JDK

Checked By: SVS

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	11.7	47.0	41.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
3/8"	100.0		
#4	100.0		
#10	99.8		
#20	97.1		
#40	88.1		
#60	75.6		
#100	61.1		
#200	41.1		

* (no specification provided)

Soil Description

Dark Brown Silty Fine to Medium SAND - saturated, visible organics

Atterberg Limits

PL= NP

LL= NP

PI= NP

Coefficients

D₉₀= 0.4711

D₈₅= 0.3654

D₆₀= 0.1445

D₅₀= 0.1022

D₃₀=

D₁₅=

D₁₀=

C_u=

C_c=

Classification

USCS= SM

AASHTO= A-4(0)

Remarks

Natural Moisture: 84.4%

Source of Sample: Lake Dredging
Sample Number: SED-7

Depth: 0.00-0.00

Date: 12/17/2014



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Client: Gentry Geotechnical Engineering, PLLC
Project: Lake Adger Dredging Study

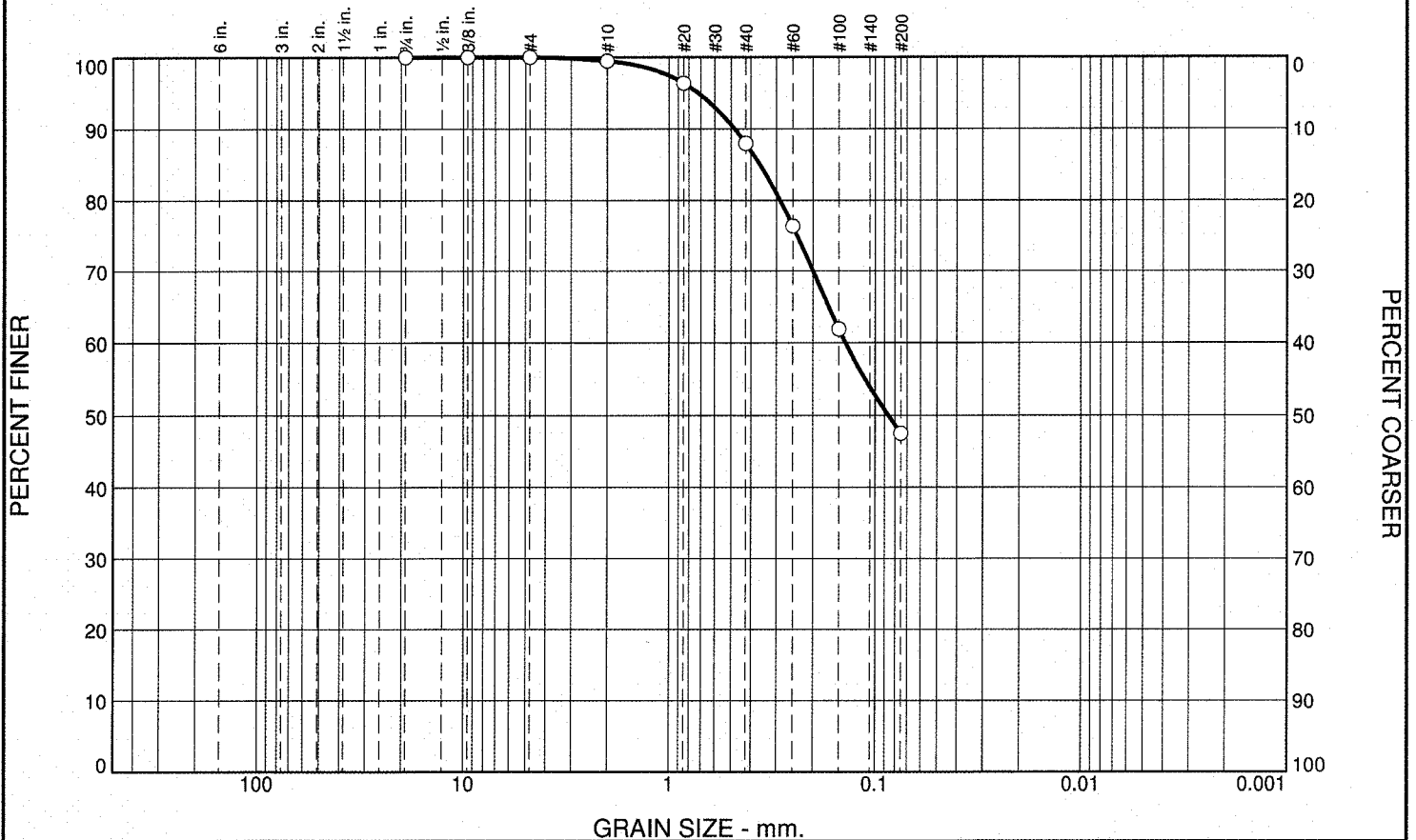
Project No: 2261-Y

Figure

Tested By: JKD

Checked By: SVS

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.5	11.5	40.5	47.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
¾"	100.0		
⅜"	100.0		
#4	100.0		
#10	99.5		
#20	96.4		
#40	88.0		
#60	76.4		
#100	61.9		
#200	47.5		

* (no specification provided)

Soil Description
Dark Brown Silty Fine SAND - saturated, visible organics

Atterberg Limits
 PL= NP LL= NP PI= NP

Coefficients
 D₉₀= 0.4811 D₈₅= 0.3617 D₆₀= 0.1394
 D₅₀= 0.0861 D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= SM AASHTO= A-4(0)

Remarks
 Natural Moisture: 94.3%

Source of Sample: Lake Dredging
Sample Number: SED-8

Depth: 0.00-0.00

Date: 12/17/2014



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Client: Gentry Geotechnical Engineering, PLLC
Project: Lake Adger Dredging Study

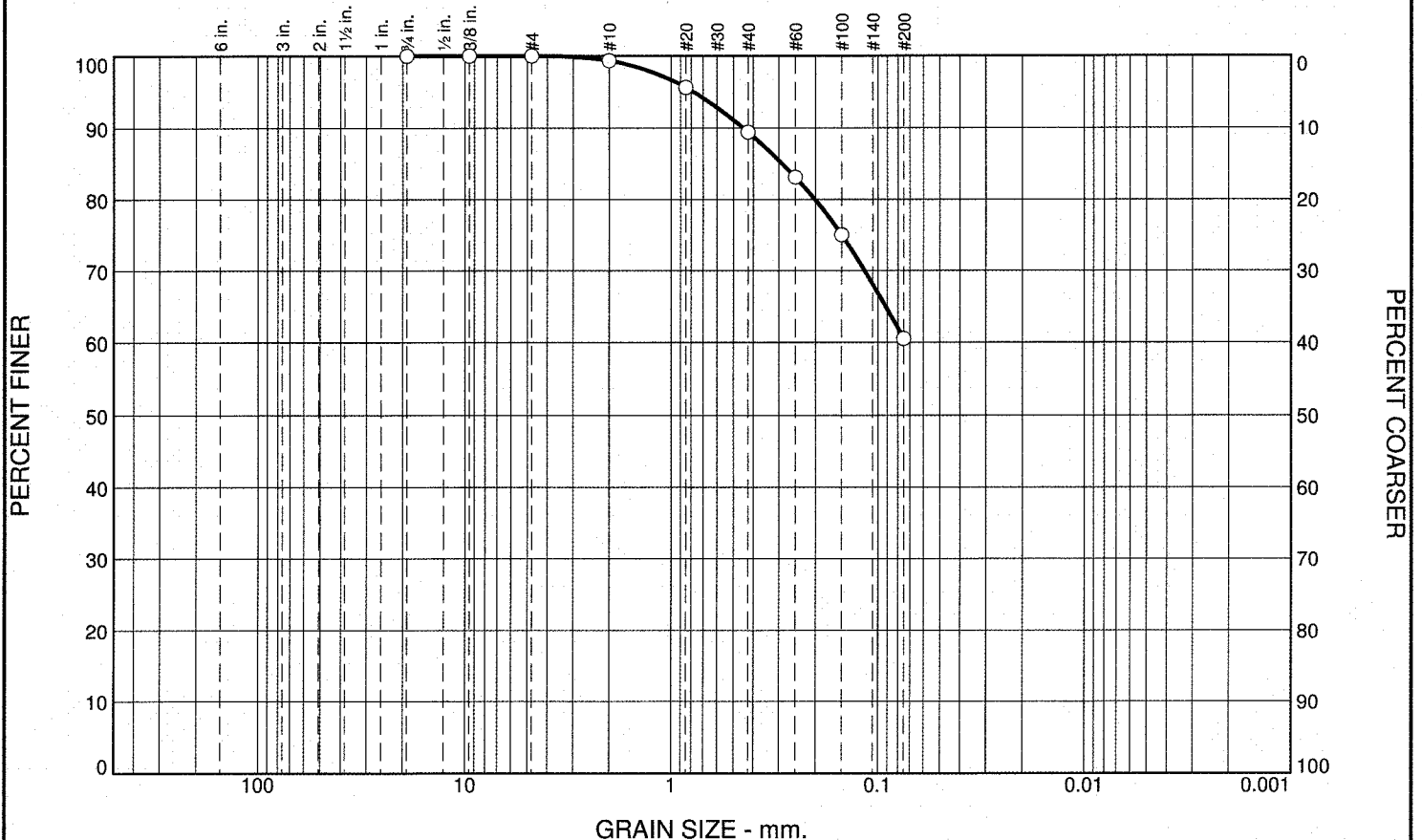
Project No: 2261-Y

Figure

Tested By: JDK

Checked By: SVS

Particle Size Distribution Report



GRAIN SIZE - mm.

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.6	10.0	28.9	60.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
3/8"	100.0		
#4	100.0		
#10	99.4		
#20	95.6		
#40	89.4		
#60	83.1		
#100	75.0		
#200	60.5		

* (no specification provided)

Soil Description

Dark Brown Fine Sandy SILT - saturated, visible organics

Atterberg Limits

PL= NP

LL= NP

PI= NP

Coefficients

D₉₀= 0.4489

D₈₅= 0.2884

D₆₀=

D₅₀=

D₃₀=

D₁₅=

D₁₀=

C_u=

C_c=

Classification

USCS= ML

AASHTO= A-4(0)

Remarks

Natural Moisture: 114.2%

Source of Sample: Lake Dredging
Sample Number: SED-9

Depth: 0.00-0.00

Date: 12/17/2014



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Client: Gentry Geotechnical Engineering, PLLC
Project: Lake Adger Dredging Study

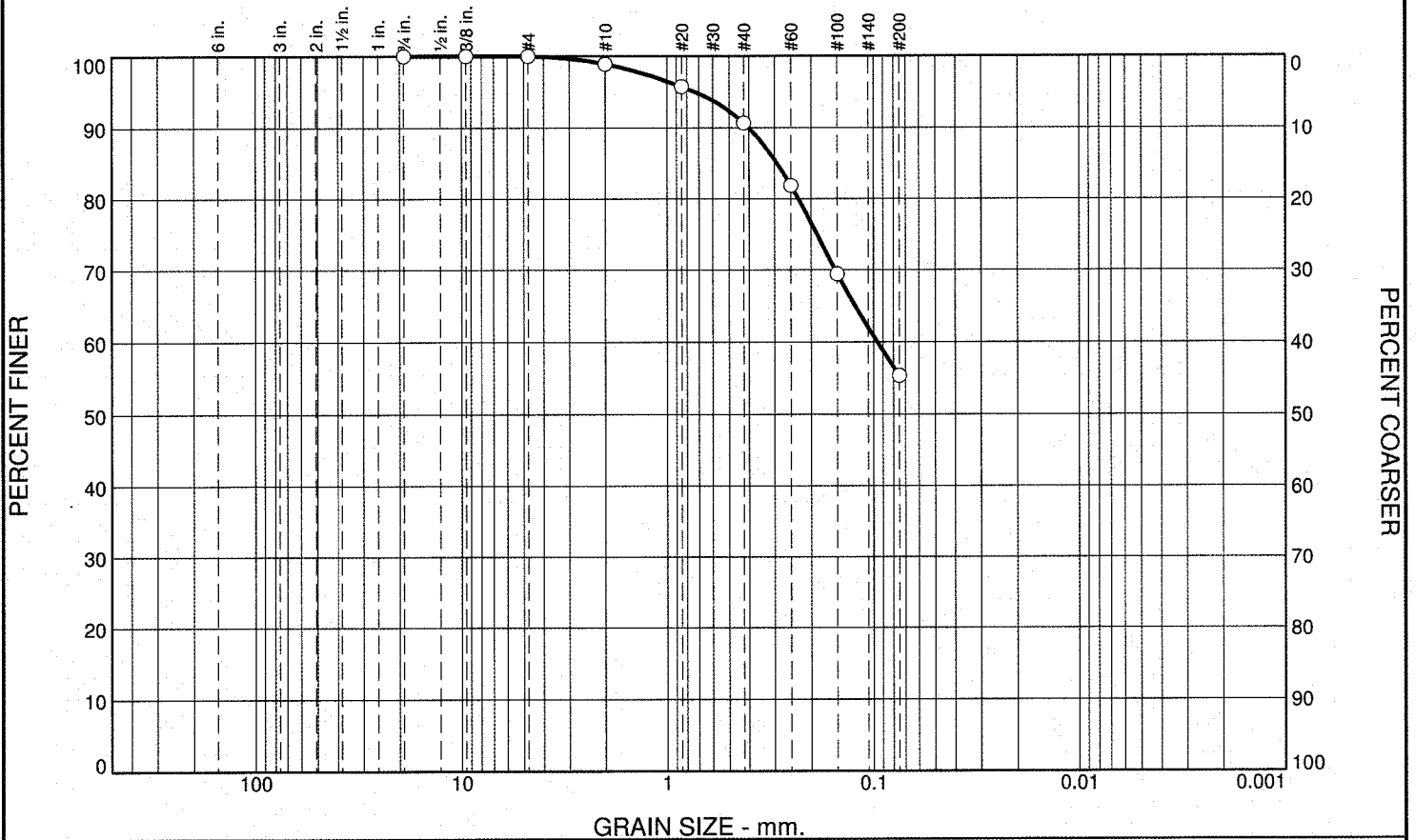
Project No: 2261-Y

Figure

Tested By: JDK

Checked By: SVS

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	1.1	8.2	35.3	55.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
3/8"	100.0		
#4	100.0		
#10	98.9		
#20	95.7		
#40	90.7		
#60	81.9		
#100	69.5		
#200	55.4		

Soil Description
Dark Brown Fine Sandy SILT - saturated, visible organics

Atterberg Limits
 PL= NP LL= NP PI= NP

Coefficients
 D₉₀= 0.4014 D₈₅= 0.2915 D₆₀= 0.0958
 D₅₀= D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Classification
 USCS= ML AASHTO= A-4(0)

Remarks
 natural Moisture: 115.0%

* (no specification provided)

Source of Sample: Lake Dredging
Sample Number: SED-10

Depth: 0.00-0.00

Date: 12/17/2014



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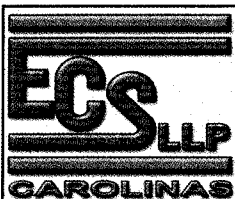
Client: Gentry Geotechnical Engineering, PLLC
Project: Lake Adger Dredging Study

Project No: 2261-Y

Figure

Tested By: JDK

Checked By: SVS



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ORGANIC CONTENT OF SOILS

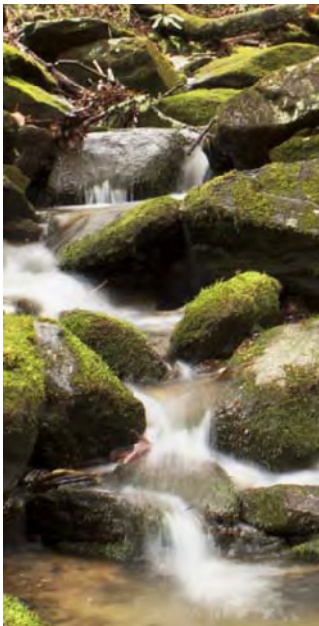
PROJECT INFORMATION

NAME	Lake Adger Dredging Study		
NUMBER	2261-Y		
DATE	12/22/2014		
REVIEWED	PM: SVS / PE: DM		

Organic Matter %

Sample	Location	Tare	Initial Weight	Final Weight	Organic %
1	Sed-1	87.39	193.98	189.79	2.21%
2	Sed-8	83.18	219.08	215.77	1.53%
3	Sed-4	83.18	161.64	160.82	0.51%

APPENDIX D
Green River Watershed Assessment

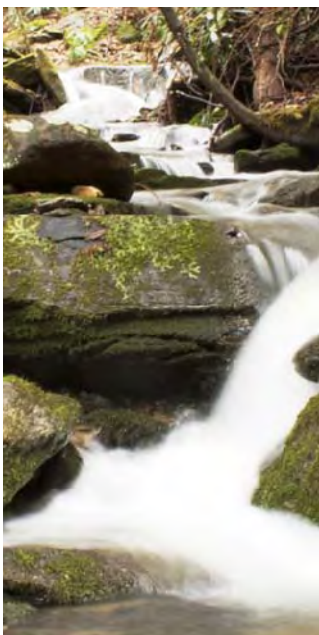
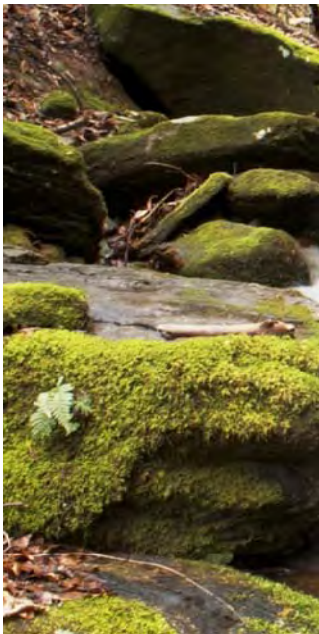


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E N G I N E E R I N G & H Y D R O G E O L O G Y

Green River Watershed Assessment
Isothermal Planning and Development
Commission

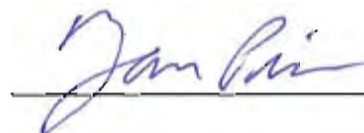
September 30, 2013



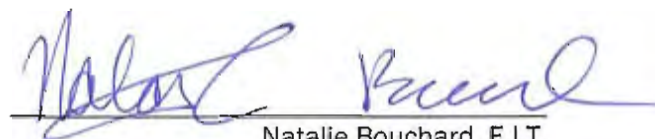
Prepared for
Isothermal Planning and Development Commission
111 West Court Street
Rutherfordton County, North Carolina 28139
Project Number 2354.03

Prepared by
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Green River Watershed Assessment
Isothermal Planning and Development
Commission
September 30, 2013



Zan Price, P.E.



Natalie Bouchard, E.I.T.

Table of Contents

Executive Summary	1
1.0 Introduction.....	3
2.0 Background.....	4
3.0 Watershed Characteristics.....	5
4.0 Summary of DENR Reports.....	6
4.1 Green River Watershed Basin Plan	6
4.1.1 Data Results of the Green River Watershed Basin Plan.....	6
4.2 Lake & Reservoir Assessments Broad River Basin	6
4.2.1 Data Results of the Lake & Reservoir Assessments Broad River Basin.....	6
5.0 Summary of University Reports	8
5.1 Polk County Stream Water Quality: Year Sixteen	8
5.1.1 Data Results of the Polk County Stream Water Quality: Year Sixteen	8
6.0 Summary EPA STORET Data	9
6.1.1 Data Results of EPA STORET	9
7.0 Data Comparisons.....	10
8.0 Summary of Interviews.....	11
8.1 Summary of Interviews with North Carolina Wildlife Resources Commission.....	11
8.2 Summary of Interviews with DENR Officials	11
8.3 Interviews with Green River Watershed Residents	12
8.4 Interview with Sky Conard of the Green River Watershed Alliance	13
9.0 Watershed Site Reconnaissance.....	14
9.1 Brights Creek	15
9.2 Cove Creek.....	15
9.3 Green River	16
9.4 Ostin Creek	17
9.5 Panther Creek.....	18
9.6 Rash Creek.....	18
9.7 Rotten Creek.....	18
9.8 Silver Creek.....	19
9.9 Gadd Creek	19
9.10 Lake Adger	19
10.0 Conclusions.....	21
10.1 Watershed Data.....	21
10.2 Interviews.....	22
10.3 Watershed Site Reconnaissance.....	22

11.0	Recommendations	24
12.0	References.....	25

Figures

1. Green River Watershed Study Area
2. Existing Water Quality Data
3. Collected Water Quality Data
4. Assessment Site Locations

Tables

1. EPA STORET Water Quality Data
2. Lake Adger Dissolved Oxygen Results
3. Site Characteristics

Appendices

- A. Representative Photographs
- B. Historical Comparison Photographs

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 primary 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 exceedances 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 Quality Broad 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 Headwaters
- 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 primary 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, June 17, 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 ($\mu\text{g/L}$) in the Westphal et al. 2009 dataset, which is below the 2B standard of 7 $\mu\text{g/L}$.
- Lead was not detected in the EPA STORET dataset, and had a median value from 2007 to 2009 of 0.3 $\mu\text{g/L}$ in the Westphal et al. 2009 dataset, which is below the 2B standard of 25 $\mu\text{g/L}$.
- Zinc was not detected in the EPA STORET dataset, and had a median value from 2007 to 2009 of 1.6 $\mu\text{g/L}$ in the Westphal et al. 2009 dataset, which is below the 2B standard of 50 $\mu\text{g/L}$.

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 Rothemich was interviewed on May 8, 2013 and related the following details to Altamont:

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

Mr. Glenn Dulken and Ms. Lynne Dulken (the Dulkens) were interviewed on July 20, 2013 and related the following details to Altamont:

- The Dulkens purchased their property on Lake Adger in 1998.
- The Dulkens' property is situated on Island Cove and overlooks the entrance of Ostin Creek to Lake Adger.
- The Dulkens 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 Dulkens 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 Dulkens 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 macroinvertebrate 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 Rutherford 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 Rothemich, and Glenn and Lynne Dulken, were interviewed to gain historic local knowledge of the GRW. Ms. Rothemich 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 Dulkens 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 Dulkens's property overlooks the entrance of Ostin Creek to Lake Adger, and according to the Dulkens Ostin Creek has filled with sediment over the past 15 years. Additionally, the Dulkens 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

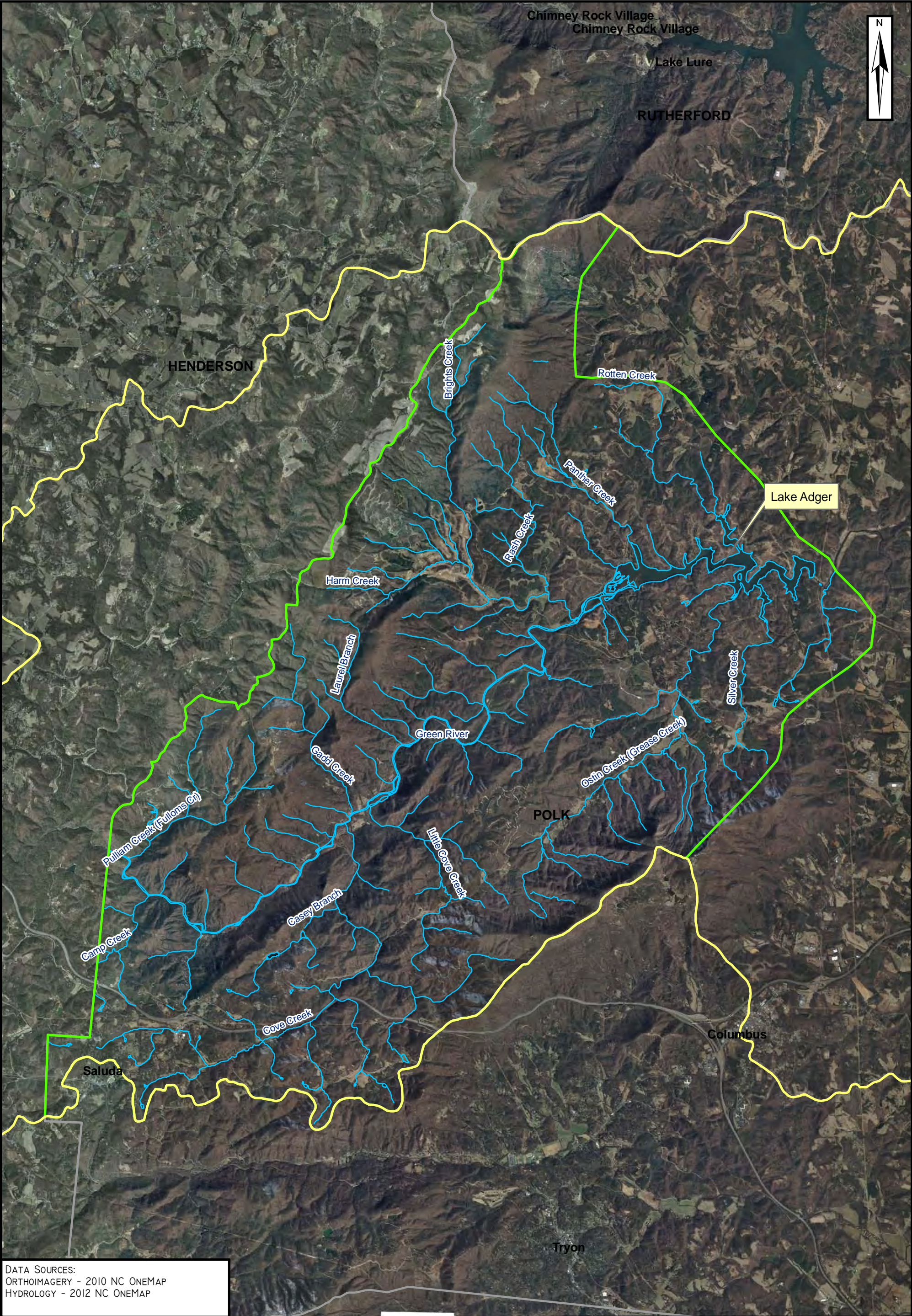
Intensive Survey Unit, Environmental Sciences Section Division of Water Quality. May 31, 2011. *Lake & Reservoir Assessments Broad River Basin*.

North Carolina Department of Environment and Natural Resources Department of Water Quality. 2008. *NC DWQ Broad River Basin Plan: Green River Watershed HUC's 0305010501 & 0305010502*.

U.S. Environmental Protection Agency. *Nonpoint Source Pollution: The Nation's Largest Water Quality Problem*. <http://water.epa.gov/polwaste/nps/outreach/point1.cfm>

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



DATA SOURCES:
ORTHOIMAGERY - 2010 NC ONEMAP
HYDROLOGY - 2012 NC ONEMAP

LEGEND

GREEN RIVER WATERSHED

STUDY AREA

COUNTY BOUNDARIES

HYDROLOGY

ALTAMONT ENVIRONMENTAL, INC.

ENGINEERING & HYDROGEOLOGY

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DRAWN BY: NATALIE BOUCHARD
PROJECT MANAGER: ZAN PRICE
CLIENT: IPDC
DATE: 07/18/2013

SCALE

0

3,000

6,000

Feet

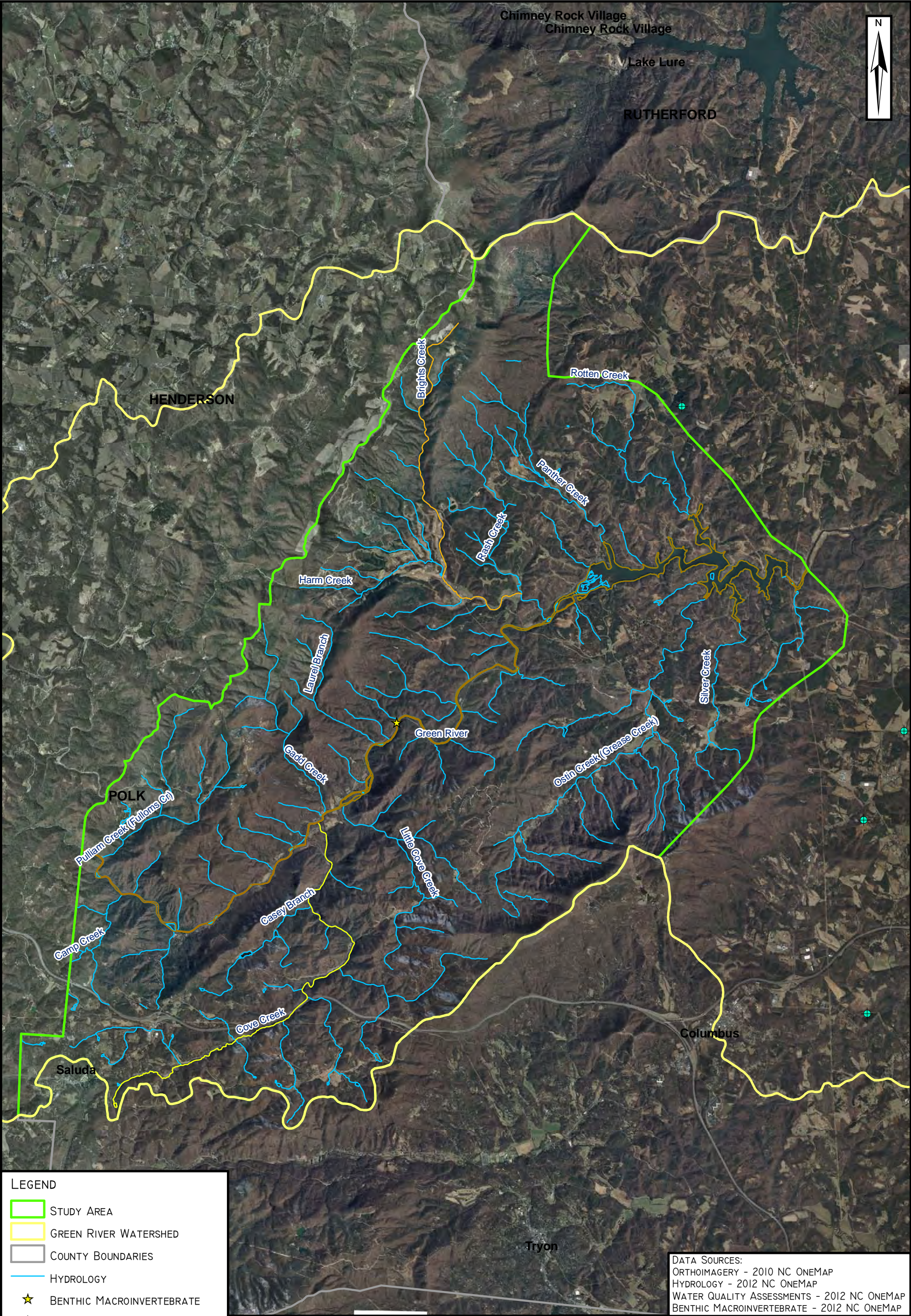
GREEN RIVER WATERSHED
STUDY AREA

GREEN RIVER WATERSHED
POLK COUNTY, NORTH CAROLINA

P:\GREEN RIVER WATERSHED GRANT\FIGURES\FIGURE 1

FIGURE

1



ALTAMONT ENVIRONMENTAL, INC.
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PROJECT MANAGER: ZAN PRICE
CLIENT: IPDC
DATE: 07/18/2013

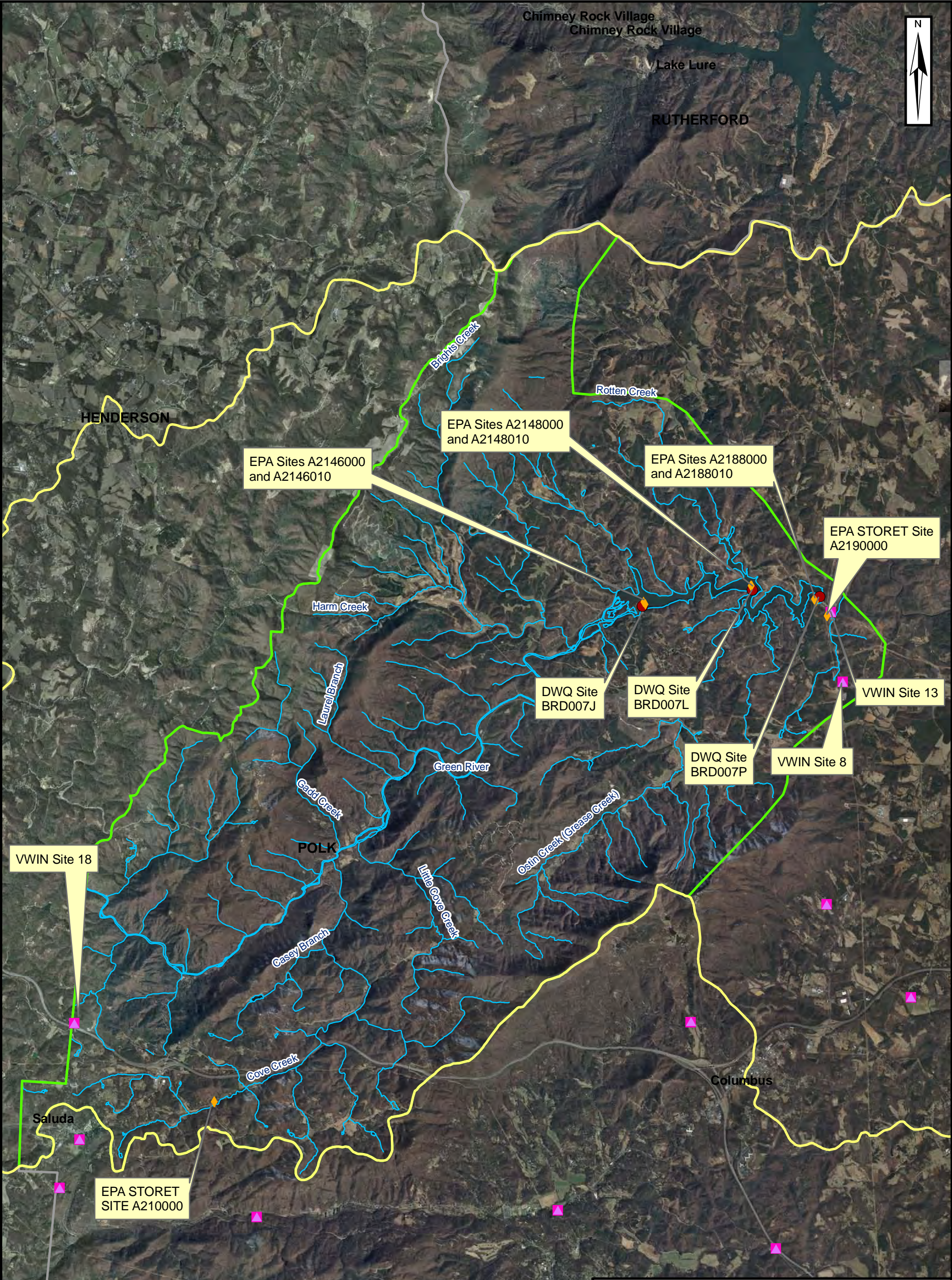
SCALE
0 3,000 6,000 Feet

EXISTING WATER QUALITY DATA

GREEN RIVER WATERSHED
POLK COUNTY, NORTH CAROLINA

P:\GREEN RIVER WATERSHED GRANT\FIGURES\FIGURE 1

FIGURE
2



LEGEND

- STUDY AREA
- GREEN RIVER WATERSHED
- COUNTY BOUNDARIES
- HYDROLOGY
- VWIN 1993-2009 MEDIAN DATA
- ▲ VWIN 2007-2009 MEDIAN DATA
- 2010 DWQ LAKE ADGER
- ◆ EPA STORET SITES

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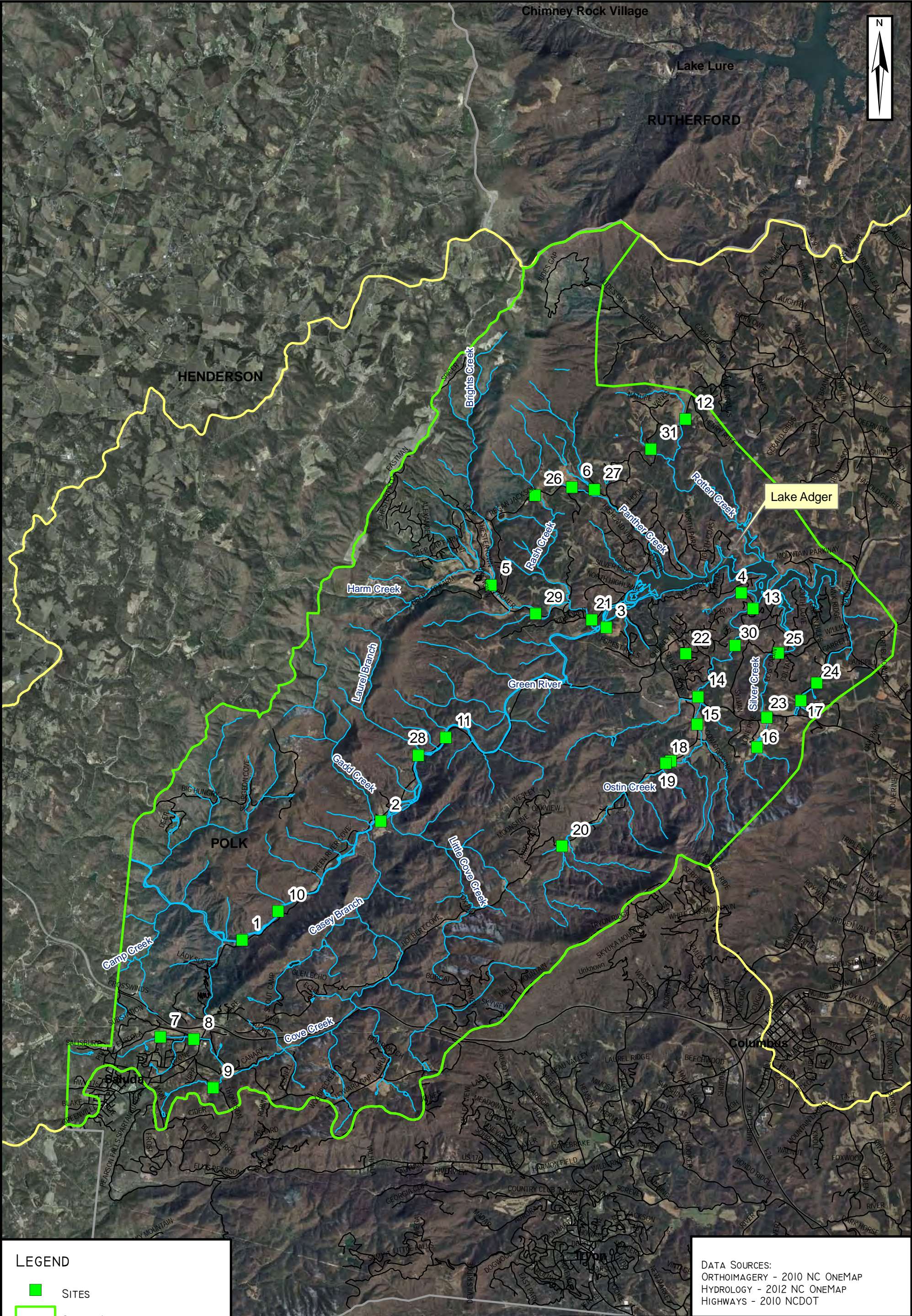
DRAWN BY: NATALIE BOUCHARD
PROJECT MANAGER: ZAN PRICE
CLIENT: IPDC
DATE: 07/18/2013

SCALE
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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

COLLECTED WATER QUALITY DATA

GREEN RIVER WATERSHED
POLK COUNTY, NORTH CAROLINA



LEGEND

- SITES
- STUDY AREA
- GREEN RIVER WATERSHED
- COUNTY BOUNDARIES
- HYDROLOGY
- ROADS

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DATE: 07/18/2013

SCALE
0 3,000 6,000 Feet

DATA SOURCES:
ORTHOIMAGERY - 2010 NC ONEMAP
HYDROLOGY - 2012 NC ONEMAP
HIGHWAYS - 2010 NCDOT

ASSESSMENT SITE LOCATIONS

GREEN RIVER WATERSHED
POLK COUNTY, NORTH CAROLINA

FIGURE

4

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	Kjeldah Nitrogen	Lead	Magnesium	Manganese	Mercury	Nickel	Orthophosphate as PO4	pH	Specific Conductance	Sulfate	Zinc	Secchi Depth	Water Temperature	Turbidity	Total Coliform #/100 ml	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	ug/L	mg/L		umho/cm	mg/L	ug/L	meter	°C	FTU							
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	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	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	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		
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	N/A	N/A	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	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	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	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	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	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	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	N/A	6.7	N/A	N/A	N/A	N/A	26	N/A	2700	N/A	None	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	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	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	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	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	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	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	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	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	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	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	6.6	N/A	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	ND	N/A	7	25	N/A	ND	N/A	28	4.8	30	N/A	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	N/A	6.8	49	N/A	N/A	N/A	34	15	100	N/A	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	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	6.6	N/A	N/A	N/A	N/A	5.5	N/A	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	N/A	6.7	49	N/A	N/A	N/A	36	N/A	10	N/A	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	ND	N/A	7	N/A	N/A	N/A	ND	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	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	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	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	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	ND	N/A	6.5	32	N/A	ND	N/A	12	N/A	10	N/A	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	N/A	6.6	N/A	N/A	N/A	N/A	6	N/A	620	N/A					

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.

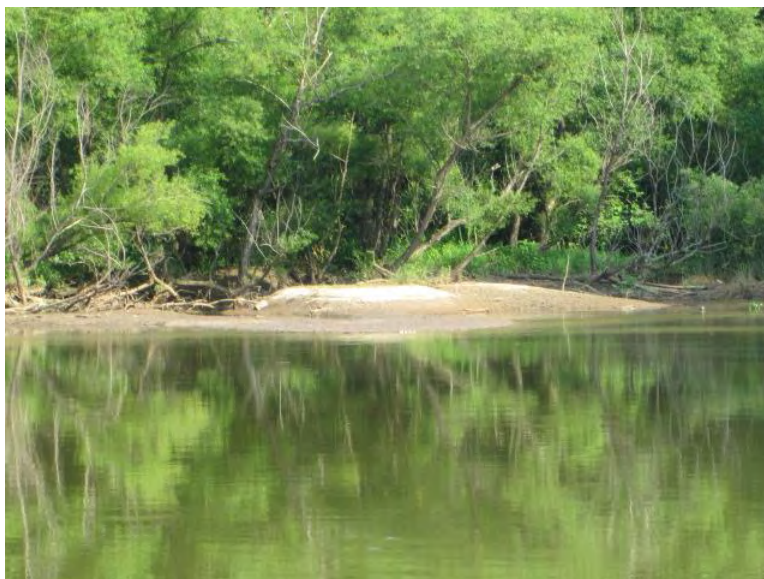
Lake Adger



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.



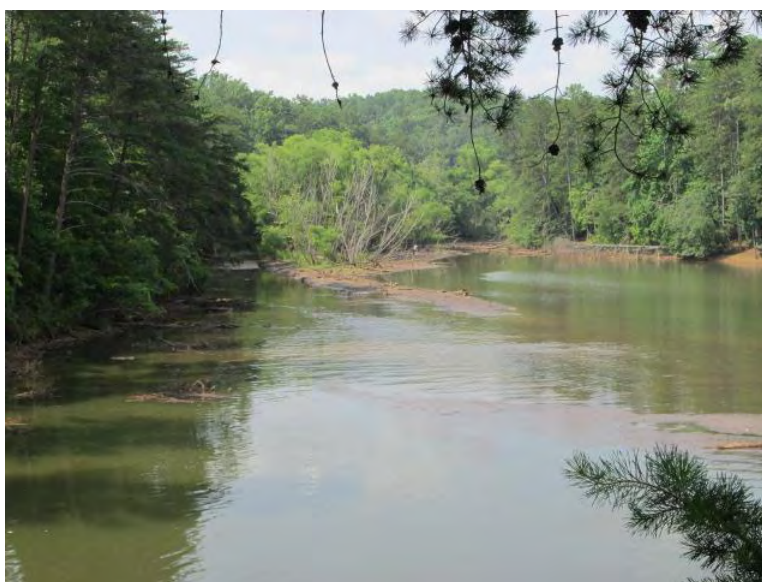
Photograph 85: View of Rotten Creek entrance to Jackson Cove on Lake Adger.



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.



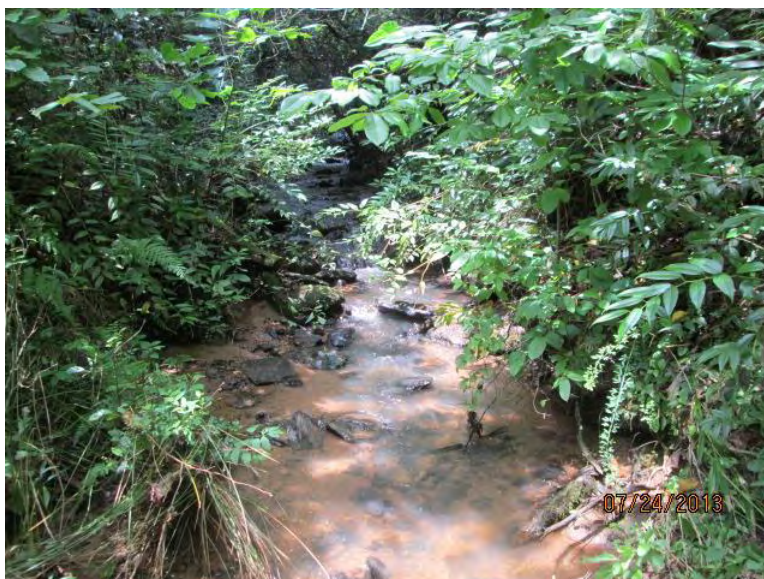
Photograph 91: View of exposed soil and stormdrain on Lake Adger development.



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.



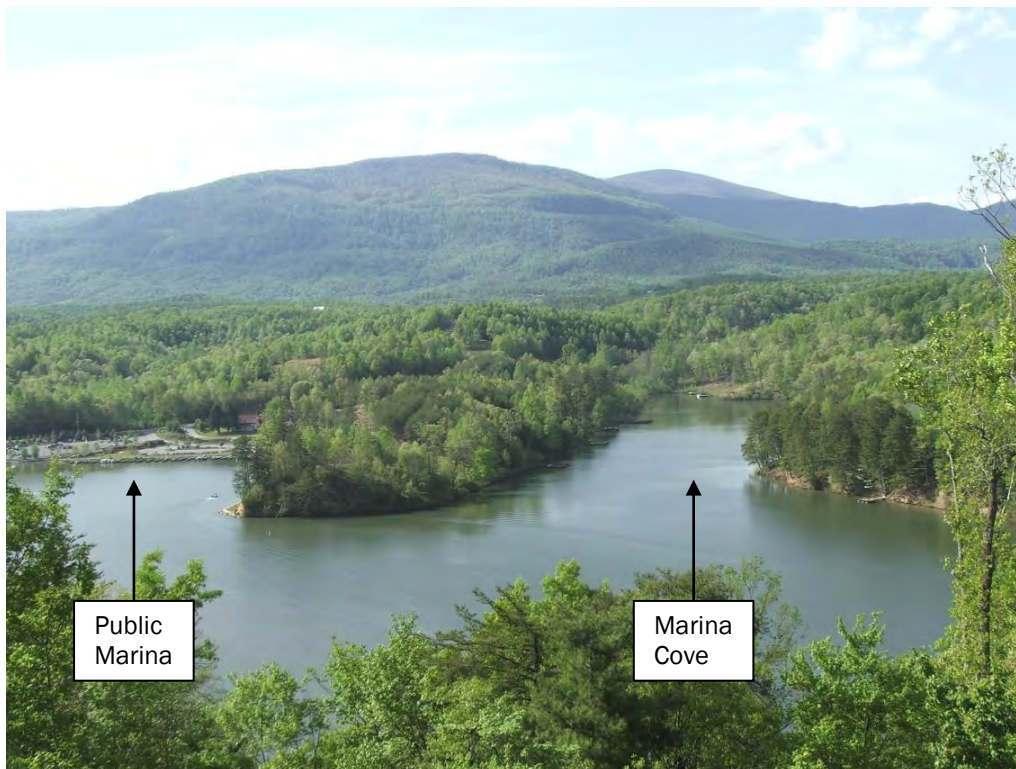
Photograph 94: View of tributary to Lake Adger at Site 4 facing upstream. This stream appeared stable, although the sediment observed in the stream was more turbid than other locations observed on the same day.



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).

APPENDIX E
U.S. Army Corps of Engineers Application for
Department of the Army Permit

U.S. ARMY CORPS OF ENGINEERS
APPLICATION FOR DEPARTMENT OF THE ARMY PERMIT
33 CFR 325. The proponent agency is CECW-CO-R.

Form Approved -
OMB No. 0710-0003
Expires: 30-SEPTEMBER-2015

Public reporting for this collection of information is estimated to average 11 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of the collection of information, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters, Executive Services and Communications Directorate, Information Management Division and to the Office of Management and Budget, Paperwork Reduction Project (0710-0003). Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. Please DO NOT RETURN your form to either of those addresses. Completed applications must be submitted to the District Engineer having jurisdiction over the location of the proposed activity.

PRIVACY ACT STATEMENT

Authorities: Rivers and Harbors Act, Section 10, 33 USC 403; Clean Water Act, Section 404, 33 USC 1344; Marine Protection, Research, and Sanctuaries Act, Section 103, 33 USC 1413; Regulatory Programs of the Corps of Engineers; Final Rule 33 CFR 320-332. Principal Purpose: Information provided on this form will be used in evaluating the application for a permit. Routine Uses: This information may be shared with the Department of Justice and other federal, state, and local government agencies, and the public and may be made available as part of a public notice as required by Federal law. Submission of requested information is voluntary, however, if information is not provided the permit application cannot be evaluated nor can a permit be issued. One set of original drawings or good reproducible copies which show the location and character of the proposed activity must be attached to this application (see sample drawings and/or instructions) and be submitted to the District Engineer having jurisdiction over the location of the proposed activity. An application that is not completed in full will be returned.

(ITEMS 1 THRU 4 TO BE FILLED BY THE CORPS)

1. APPLICATION NO.	2. FIELD OFFICE CODE	3. DATE RECEIVED	4. DATE APPLICATION COMPLETE
--------------------	----------------------	------------------	------------------------------

(ITEMS BELOW TO BE FILLED BY APPLICANT)

5. APPLICANT'S NAME First - Middle - Last - Company - E-mail Address -		8. AUTHORIZED AGENT'S NAME AND TITLE (agent is not required) First - Middle - Last - Company - E-mail Address -	
6. APPLICANT'S ADDRESS: Address- City - State - Zip - Country -		9. AGENT'S ADDRESS: Address- City - State - Zip - Country -	
7. APPLICANT'S PHONE NOs. w/AREA CODE a. Residence b. Business c. Fax		10. AGENTS PHONE NOs. w/AREA CODE a. Residence b. Business c. Fax	

STATEMENT OF AUTHORIZATION

11. I hereby authorize, _____ to act in my behalf as my agent in the processing of this application and to furnish, upon request, supplemental information in support of this permit application.

SIGNATURE OF APPLICANT

DATE

NAME, LOCATION, AND DESCRIPTION OF PROJECT OR ACTIVITY

12. PROJECT NAME OR TITLE (see instructions)			
13. NAME OF WATERBODY, IF KNOWN (if applicable)		14. PROJECT STREET ADDRESS (if applicable) Address	
15. LOCATION OF PROJECT Latitude: °N Longitude: °W		City - State- Zip-	
16. OTHER LOCATION DESCRIPTIONS, IF KNOWN (see instructions) State Tax Parcel ID Municipality Section - Township - Range -			

17. DIRECTIONS TO THE SITE

18. Nature of Activity (Description of project, include all features)

19. Project Purpose (Describe the reason or purpose of the project, see instructions)

USE BLOCKS 20-23 IF DREDGED AND/OR FILL MATERIAL IS TO BE DISCHARGED

20. Reason(s) for Discharge

21. Type(s) of Material Being Discharged and the Amount of Each Type in Cubic Yards:

Type Amount in Cubic Yards	Type Amount in Cubic Yards	Type Amount in Cubic Yards
-------------------------------	-------------------------------	-------------------------------

22. Surface Area in Acres of Wetlands or Other Waters Filled (see instructions)

Acres
or
Linear Feet

23. Description of Avoidance, Minimization, and Compensation (see instructions)

24. Is Any Portion of the Work Already Complete? ☐ Yes ☐ No IF YES, DESCRIBE THE COMPLETED WORK

25. Addresses of Adjoining Property Owners, Lessees, Etc., Whose Property Adjoins the Waterbody (if more than can be entered here, please attach a supplemental list).

a. Address-

City - State - Zip -

b. Address-

City - State - Zip -

c. Address-

City - State - Zip -

d. Address-

City - State - Zip -

e. Address-

City - State - Zip -

26. List of Other Certificates or Approvals/Denials received from other Federal, State, or Local Agencies for Work Described in This Application.

AGENCY	TYPE APPROVAL*	IDENTIFICATION NUMBER	DATE APPLIED	DATE APPROVED	DATE DENIED

* Would include but is not restricted to zoning, building, and flood plain permits

27. Application is hereby made for permit or permits to authorize the work described in this application. I certify that this information in this application is complete and accurate. I further certify that I possess the authority to undertake the work described herein or am acting as the duly authorized agent of the applicant.

SIGNATURE OF APPLICANT

DATE

SIGNATURE OF AGENT

DATE

The Application must be signed by the person who desires to undertake the proposed activity (applicant) or it may be signed by a duly authorized agent if the statement in block 11 has been filled out and signed.

18 U.S.C. Section 1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency of the United States knowingly and willfully falsifies, conceals, or covers up any trick, scheme, or disguises a material fact or makes any false, fictitious or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false, fictitious or fraudulent statements or entry, shall be fined not more than \$10,000 or imprisoned not more than five years or both.

APPENDIX F
Lake Adger Marina and Marina Boat Ramp Facility
Public Access Agreement

ROBERTS
&
STEVENS

ATTORNEYS AT LAW

RECEIVED JAN 03 2005

JOHN S. STEVENS
JAMES W. WILLIAMS
CARL W. LOFTIN
WALTER L. CURRIE
JOHN W. MASON
MARC RUDOW
SHERYL H. WILLIAMS
WILLIAM CLARKE
VINCENT D. CHILDRESS, JR.
MARJORIE ROWE MANN
GREGORY D. HUTCHINS
JACKSON D. HAMILTON
WYATT S. STEVENS
MARK C. KURDYS
JACQUELINE D. GRANT
CHRISTOPHER Z. CAMPBELL
PATSY BRISON

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Writer's Direct Telephone: (828) 258-6919
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DENNIS L. MARTIN, JR.
PETER B. MCGUIRE
ANNE W. FORD
KEVIN P. KOPP
REBECCA JOHNSTON REINHARDT
SCOTT W. LAMB
K. DEAN SHATLEY, II

OF COUNSEL
LANDON ROBERTS

FRANK P. GRAHAM
(1945-2003)

December 29, 2004

Lake Adger Developers, Inc.
c/o Mr. Jim Smith
Mr. Chuck Lowe
Post Office Box 4125
Spartanburg, SC 29305

Lake Adger Property Owners Association, Inc.
c/o Mr. Chuck Lowe
Post Office Box 4125
Spartanburg, SC 29305

C. Norman Young, Jr.
NC Department of Justice
P. O. Box 629
Raleigh, NC 27602-0629

Northbrook Energy, LLC
c/o Stephen J. Sinclair
20 N. Wacker Drive, Suite 3121
Chicago, IL 60606

Re: **Lake Adger Marina and Marina Boat Ramp Facility
Public Access Agreement**

Dear All,

Please find enclosed with this letter a recorded copy of the fully executed Access Agreement. Thank you all again for your cooperation and assistance in this matter.

Sincerely,

ROBERTS & STEVENS, P.A.


William Clarke

WC/skc
Enclosures
R&S:416862-1

FILED in POLK County, NC
on Dec 15 2004 at 12:03:34 PM
by: SHEILA W. WHITMIRE
REGISTER OF DEEDS
BOOK 321 PAGE 1719

LAKE ADGER MARINA AND MARINA BOAT RAMP FACILITY PUBLIC ACCESS AGREEMENT
[TYPE OF DOCUMENT]

~~GRANTOR(S)~~: BY AND BETWEEN LAKE ADGER PROPERTY OWNERS ASSOCIATION, INC.,
LAKE ADGER DEVELOPERS, INC., NORTH CAROLINA WILDLIFE
RESOURCES COMMISSION, POLK COUNTY, AND NORTHBROOK CAROLINA
HYDRO, LLC

~~GRANTEE(S)~~ _____

PREPARED BY: William Clarke, attorney at law

MAIL TO: * William Clarke
Roberts & Stevens, P.A.
P.O. Box 7647
Asheville, NC 28802

STATE OF NORTH CAROLINA
COUNTY OF POLK

LAKE ADGER MARINA AND
MARINA BOAT RAMP FACILITY
PUBLIC ACCESS AGREEMENT

This Agreement made this 13th day of December, 2004, by and between the Lake Adger Property Owners Association, Inc. ("POA") with an office and place of business at 135 Metro Drive, Post Office Box 4125, Spartanburg, South Carolina 29305, Lake Adger Developers, Inc. ("LAD") with an office and place of business at 135 Metro Drive, Post Office Box 4125, Spartanburg, South Carolina 29305, the North Carolina Wildlife Resources Commission ("WRC") an agency of the State of North Carolina with its principal office at 512 North Salisbury Street, Raleigh, North Carolina, Polk County, North Carolina ("Polk County") a body corporate and politic with its principal office at Womack Building, Columbus, North Carolina, 22722 and Northbrook Carolina Hydro, LLC ("Northbrook" or "Northbrook Carolina") with its principal office at 20 North Wacker Drive, Suite 3123, Chicago, Illinois 60606;

WHEREAS, LAD acquired from Duke Power Company in December, 1996, certain real property described in Deed Book 237 at Page 1876 Polk County Registry together with an appurtenant non-exclusive recreational easement (the "Recreational Easement") as set forth in a Special Warranty Deed from Duke Power Company to Northbrook Hydro, LLC recorded in Deed Book 237 at Page 1416 Polk County Registry;

WHEREAS, the real property described in Deed Book 237 at Page 1876 surrounds most of the waters of Lake Adger;

WHEREAS, the Recreational Easement allows for fishing, swimming, boating and other similar recreational activities on Lake Adger subject to certain restrictions and limitations all as set forth in Exhibit A, a true and accurate copy of the Recreational Easement;

WHEREAS, The Recreational Easement allows for the construction and operation of a marina for the storage and maintenance of boats and a boat dock;

WHEREAS, The Recreational Easement requires, as a condition of constructing and operating the marina, that a public access point for the launching and retrieving of boats (the "Marina Boat Ramp Facility") be provided and maintained;

WHEREAS, LAD has commenced development of the property around Lake Adger and formed the Lake Adger Property Owners Association, Inc. ("POA");

WHEREAS, LAD has constructed and operates a marina (the "Lake Adger Marina") including a public access point for the launching and retrieving of boats (the "Marina Boat Ramp Facility");

WHEREAS, the POA, LAD, WRC, Polk County and Northbrook all desire to clarify and define public access to Lake Adger via the Lake Adger Marina and the Marina Boat Ramp Facility;

WHEREAS, Polk County joins in this Agreement to indicate and signify its agreement with the provision of public access via the Lake Adger Marina and the Marina Boat Ramp Facility in accordance with the terms and conditions described herein;

WHEREAS, Northbrook joins in this Agreement solely to indicate and signify its agreement with the provision of public access via the Lake Adger Marina and the Marina Boat Ramp Facility;

It is Now Therefore, in consideration of the covenants, promises and conditions set forth herein, hereby agreed as follows:

1. The POA and LAD hereby convey to the North Carolina State Property Agency for the benefit of WRC and the public, a non exclusive perpetual permanent easement over that portion of the Lake Adger Marina property designated as Tract A on a plat recorded in Card File E, Page 803 Polk County Registry and the Marina Boat Launch Facility show on the same plat (hereinafter referred to as the " Lake Adger Marina and Marina Boat Launch Facility"). The easement shall be for members of the general public to make use of the Lake Adger Marina to park vehicles, including boat trailers and to make use of the Marina Boat Ramp Facility to launch boats and otherwise access the waters of Lake Adger for fishing, swimming, boating and other recreational purposes. The Scope of the Easement is limited to use consistent with the terms and conditions of the Recreational Easement and this Agreement.
2. The Marina Boat Ramp Facility and Lake Adger Marina shall be operated jointly by WRC, LAD and the POA. All of the parties hereto agree that this will be the only public access point to the waters of Lake Adger for the launching and retrieval of boats and for fishing, swimming and other recreational purposes.
3. Use of the Lake Adger Marina, the Marina Boat Ramp Facility and the waters of Lake Adger, pursuant to the easement granted herein to WRC by LAD and POA, shall be subject to all those restrictions, limitations and conditions set forth in the Recreational Easement including the prohibitions against personal watercraft, the horsepower limitation of sixty (60) horsepower for boats and 80 horsepower for pontoon boats and any other conditions set forth herein except there shall be no fee charged to individual members of the public for use of the Lake Adger Marina to access the waters of Lake Adger. LAD and the POA will be responsible for enforcing the restrictions, limitations and conditions set forth in the Recreational Easement and this Agreement at the Lake Adger Marina, the Marina Boat Ramp Facility and on the waters of Lake Adger. LAD and the POA reserve the right to exercise any and all lawful remedies against members of the public making use of the Lake Adger Marina and Marina Boat Ramp Facility not in accordance with the terms and conditions of the Recreational Easement and this Agreement including restricting or limiting access to and use of the Lake Adger Marina and Marina Boat Ramp Facility. WRC shall have no responsibility for the acts of LAD and POA in restricting or limiting access or use by members of the public of the Lake Adger Marina or Marina Boat Ramp Facility. Use of the Lake Adger Marina or the

Marina Boat Ramp Facility in violation of the Recreational Easement or this Agreement shall be considered a trespass.

4. Use of the easement across the Lake Adger Marina and Marina Boat Ramp Facility shall be only for access to the waters of Lake Adger for fishing, boating, swimming and other recreational activities all as defined in and limited by the terms and conditions of the Recreational Easement and this Agreement. The Lake Adger Marina and Marina Boat Ramp Facility shall be used only for the launching and retrieval of boats and parking vehicles and boat trailers. All other uses including swimming, skiing, camping or fishing are strictly prohibited.
5. All terms and conditions of the Recreational Easement remain in force and effect, and this Agreement shall have no effect on such terms and conditions except all the parties to this Agreement acknowledge and agree that the WRC will pay an annual fee of \$15,000 per year to LAD, the POA and their successors, in lieu of the individual fee(s) described in the Recreational Easement. WRC, its agents and employees shall advise members of the public that use of the Lake Adger Marina and Marina Boat Ramp Facility occurs pursuant to this Easement Agreement across private property and that use of Lake Adger is subject to the restrictions in the Recreational Easement and this Agreement.
6. No alcoholic beverages shall be permitted in the Lake Adger Marina or Marina Boat Ramp Facility at any time. No dogs, pets, or animals of any type shall be permitted in the Lake Adger Marina or Marina Boat Ramp Facility at any time unless properly restrained by leash or cage. All watercraft using the Lake Adger Marina and Marina Boat Ramp Facility must be properly licensed and equipped as required by any and all applicable laws and regulations governing watercraft. There shall be no loitering at the Lake Adger Marina or Marina Boat Ramp Facility.
7. Use of the Lake Adger Marina and Marina Boat Ramp Facility to access the waters of Lake Adger will be available 24 hours a day, 7 days a week, 365 days a year. Watercraft launched from the Marina Boat Ramp Facility and operated on the waters of Lake Adger after sunset & before sunrise will be encouraged to operate at a speed which creates no appreciable wake within 100 yards of the shoreline. WRC, LAD and the POA will work together to develop a boating safety plan for Lake Adger. Upon review and approval of such boating safety plan by LAD, POA and the WRC, the plan shall be implemented. Where required by the plan, rulemaking may be sought pursuant to G.S. 75A-15 and this Agreement, provided however implementation shall be only upon agreement by WRC, LAD and the POA. Buouys and signage shall be installed only upon agreement of WRC, LAD and POA.
8. The right of the WRC to jointly operate the Lake Adger Marina and Marina Boat Ramp Facility and the easement of public access across the Lake Adger Marina and the Marina Boat Ramp Facility shall be subject to payment of a fee of \$15,000 per year to the Lake Adger Property Owners Association. Such fee shall be payable in advance on or before the 5th day of January, each year. The fee described in this paragraph will be subject to

adjustment on or about January 1, of each year, based on the increase in the Consumer Price Index.

9. POA, LAD and WRC agree to provide staffing necessary for joint operation of the Lake Adger Marina and Marina Boat Ramp Facility. WRC and POA and LAD agree to split equally the cost of providing two portable toilets at the Lake Adger Marina and Marina Boat Ramp Facility. WRC's portion of the cost of providing such portable toilets will be billed with the fee described in paragraph 8. herein. WRC will be responsible for maintaining the access channel from the Lake Adger Marina and Marina Boat Ramp Facility to the main body of Lake Adger so that watercraft can access the waters of Lake Adger Marina from the Marina Boat Ramp Facility. Such responsibility will include the obligation to dredge the channel as necessary to maintain access to the waters of Lake Adger for watercraft. WRC will maintain the parking lot to its present standard. LAD and the POA shall provide one portable toilets for public use and WRC will provide one portable toilet for public use. LAD and the POA reserve the right to add fuel tanks, concessions or other amenities, provided however, such amenities shall be constructed and maintained in a good and workmanlike manner and shall not interfere with the use of the Lake Adger Marina and Marina Boat Ramp Facility for public access. There shall be no obligation on the part of LAD or the POA to install such amenities.
10. WRC will assume responsibility for liability claims by members of the public for injury to person or property arising out of the use of the Lake Adger Marina and Marina Boat Ramp Facility as a result of the alleged negligent acts of its agents or employees to the extent allowed by law. LAD and the POA will assume responsibility for liability claims by members of the public arising out of the alleged negligent acts of its agents or employees.
11. Suitable signage, subject to approval by LAD, consistent with the existing Lake Adger color scheme, in a location approved by LAD and the POA and two (2) feet by three (3) feet or smaller, will be installed at the Marina Boat Ramp area by WRC. The sign will include the following wording: *"Public Access to Lake Adger is provided through cooperation between the Lake Adger Property Owners Association, Lake Adger Developers and the North Carolina Wildlife Resources Commission."* If desired, the sign may include the logo of the North Carolina Wildlife Resources Commission. In addition, appropriate signage will be posted spelling out the restrictions in the Recreational Easement. Other than as set out herein, there shall be no other signage installed by WRC. Any other signage installed by LAD or the POA shall not be inconsistent with the Recreational Easement and this Agreement.
12. WRC will enforce North Carolina Boating Laws and Regulations at the Lake Adger Marina, the Marina Boat Ramp Facility and on the waters of Lake Adger.
13. Any reference to Lake Adger in WRC material including publications and website shall note that public access to Lake Adger is via an easement over private property and is subject to the restrictions, limitations and conditions in the Recreational Easement and this Agreement.

14. WRC, the POA, LAD and Polk County will meet annually to discuss public access via the Lake Adger Marina and the Marina Boat Ramp Facility. Northbrook shall be notified of such meetings and shall be entitled to attend.
15. Should WRC, LAD or POA commit a material breach of any condition of this Agreement and the material breach remain uncured for more than thirty days, then the non breaching party shall have the right to bring an action in the Superior Court for Polk County to enforce the terms and conditions of this Agreement or to extinguish the easement granted herein. LAD, POA and WRC agree that this provision of this agreement may be specifically enforced and that LAD may seek injunctive relief pending any final decision by the Court.
16. The POA and LAD reserve the right not to operate the Lake Adger Marina and the Marina Boat Ramp Facility, provided, however, the right of the public to use the Lake Adger Marina and Marina Boat Ramp Facility to access and use the waters of Lake Adger in accordance with the terms and conditions of the Recreational Easement and this Agreement shall continue uninterrupted.
17. Except as expressly set forth herein, neither the POA, LAD, WRC, Polk County, or Northbrook Carolina intends to waive any legal rights and all such rights are expressly reserved.
18. This Agreement shall be binding upon and inure to the benefit of the POA, LAD, WRC, Polk County and Northbrook Carolina and each of their successors and assigns.
19. This Agreement shall be governed by and under the laws of the State of North Carolina.
20. The original of this Agreement will be recorded in the Office of the Register of Deeds for Polk County.
21. The POA, LAD, WRC, Polk County and Northbrook Carolina each warrants and represents that it has the authority to enter into this Agreement.
22. Nothing herein shall be deemed to modify the terms and conditions of the Recreational Easement with respect to payments to Northbrook.

LAKE ADGER PROPERTY OWNERS
ASSOCIATION, INC.

By: Charles W. Lowe Jr. Pres.

STATE OF SOUTH CAROLINA

COUNTY OF Spartanburg

I, ANN E. IPOCK, a Notary Public of the County and State aforesaid, hereby certify that Charles W. Lowe Jr. personally appeared before me this day and, as President of Lake Adger Property Owners Association, Inc., and acknowledged the execution of the foregoing Lake Adger Marina and Boat Launch Facility Public Access Agreement.

Witness my hand and official stamp or seal, this the 13th day of December 2004.

Ann E. Ipock
Notary Public

My commission expires:

MY COMMISSION EXPIRES SEPTEMBER 4, 2008

[SEAL]

LAKE ADGER DEVELOPERS, INC.

By: James R. Smith, Pres.
Charles W. Lowe, Jr. V.P.

STATE OF SOUTH CAROLINA

COUNTY OF Spartanburg

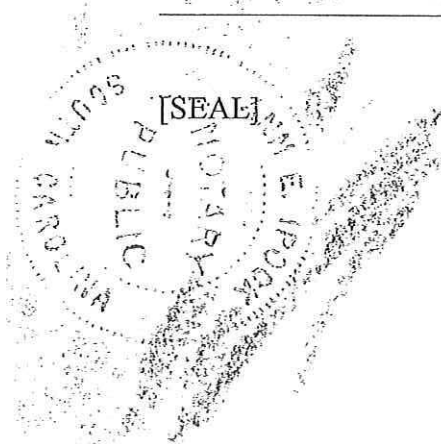
I, Ann I. Pock, a Notary Public of the County and State aforesaid, hereby certify that James R. Smith + Charles W. Lowe, Jr. personally appeared before me this day and, as President + V.P. of Lake Adger Developers, Inc., and acknowledged the execution of the foregoing Lake Adger Marina and Boat Launch Facility Public Access Agreement.

Witness my hand and official stamp or seal, this the 6th day of December 2004.

Ann I. Pock
Notary Public

My commission expires:

MY COMMISSION EXPIRES SEPTEMBER 4, 2008



NORTH CAROLINA WILDLIFE RESOURCES
COMMISSION

By: Richard B. Hamilton

STATE OF NORTH CAROLINA

COUNTY OF Wake

I, Angela F. Wainright, a Notary Public of the County and State aforesaid, hereby certify
that Richard B. Hamilton personally appeared before me this day and as executive director
of North Carolina Wildlife Resources Commission, and acknowledged the execution of the
foregoing Lake Adger Marina and Boat Launch Facility Public Access Agreement.

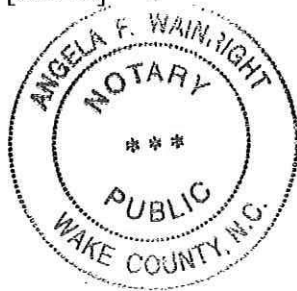
Witness my hand and official stamp or seal, this the 1st day of December, 2004.

Angela F. Wainright
Notary Public

My Commission Expires:

April 20, 2008

[SEAL]



POLK COUNTY

By: _____

Chair of County Commissioners

STATE OF NORTH CAROLINA

COUNTY OF Polk

I, Sheila S Ford, a Notary Public of the County and State aforesaid, hereby certify that Darryl Kim Talbot personally appeared before me this day and as Chairman of the County Commissioners of **Polk County**, and acknowledged the execution of the foregoing Lake Adger Marina and Boat Launch Facility Public Access Agreement.

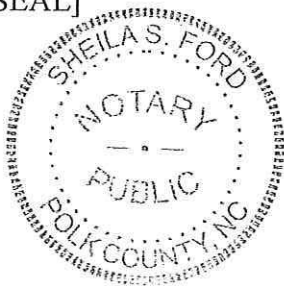
Witness my hand and official stamp or seal, this the 7th day of December, 2004.

Sheila S Ford
Notary Public

My Commission Expires:

6-13-05

[SEAL]



NORTHBROOK CAROLINA HYDRO, LLC

By: *Stephen J. Kinelair*

STATE OF ILLINOIS

COUNTY OF Cook

I, Lynne M. Trojanowski, a Notary Public of the County and State aforesaid, hereby certify that Stephen J. Kinelair personally appeared before me this day and as the Member of Omega Energy, LLC for Northbrook Carolina Hydro, LLC, and acknowledged the execution of the foregoing Lake Adger Marina and Boat Launch Facility Public Access Agreement.

Witness my hand and official stamp or seal, this the 1st day of Dec., 2004.

Lynne Trojanowski
Notary Public

My Commission Expires: **OFFICIAL SEAL:**
LYNNE M. TROJANOWSKI
NOTARY PUBLIC - STATE OF ILLINOIS
MY COMMISSION EXPIRES: 07/19/07
[SEAL]

NORTH CAROLINA, FOLK COUNTY

The foregoing instrument of *Ray E. Spork*
Angela S. Whittington of *Sheila H. Ford* and *Lynne M. Trojanowski*
Notary Public/Notarized Public is/are certified to be correct.
This instrument was filed for registration on the 15th day

of December, 2004 at 12:03 o'clock

17 M. and recorded in this office in Book 321

Page 1719

Sheila H. Whittington
Register of Deeds
by *James M. Arledge*