SALUDA-REEDY WATERSHED PROJECT

SUMMARY OF MAJOR REPORTS AND STUDIES

SALUDA-REEDY
WATERSHED
CONSORTIUM

Prepared by Upstate Forever
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INTRODUCTION

This is a summary of the more than 50 major reports and studies conducted by members of the Saluda-Reedy Watershed Consortium from 2003 to 2008. The Consortium is a broad-based alliance of universities, state and local agencies, nonprofit organizations, and private firms committed to providing clean, healthy and abundant water throughout the Saluda-Reedy watershed. The watershed is a basin in upper South Carolina of approximately 1,160 square miles (measured from the Lake Greenwood dam).

The reports and studies are organized and presented under the following categories:

I. Water Quality
II. Impacts of Sediments and Dams
III. Management of Septic Systems
IV. Land Cover Change
V. Natural Resources Policy
VI. Flooding and Wetlands
VII. Stormwater Management and Erosion Control
VIII. Riparian and Tree Resources
IX. Low Impact Development
X. Education and Outreach
XI. Miscellaneous

The reports and studies are available in their entirety on the project website, www.saludareedy.org. The members of the Consortium are also listed on the website.

A financial report for the project is presented at the end.

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I. WATER QUALITY

Final Report on Characterization of Hydrologic Input into Lake Greenwood
Steve Klaine and John Smink, Clemson University

This study determined the flows of the Reedy and Saluda Rivers and the concentrations and loadings of key pollutants during storm events at monitoring stations close to where the rivers flow into Lake Greenwood. Samples were collected during 25 storm events between December, 2003 and June, 2005 and analyzed. The results showed that flows in the Saluda were three times greater than the Reedy, concentrations of pollutants were greater in the Reedy than the Saluda, and loadings of pollutants were about the same except for total suspended solids, where loadings were 8 to 9 times greater in the Saluda.

Peak Flow Sampling and Analysis of Sediment Release
Steve Klaine and John Smink, Clemson University

This study characterized the loadings of nutrient contaminants into Lake Greenwood from the Saluda and Reedy Rivers and quantified the extent to which these contaminants remained in the lake. The principal findings are that the Saluda River contributes more dissolved nitrogen, nitrate, dissolved phosphorous and suspended sediments to Lake Greenwood than the Reedy River; that on average, 89 per cent of all water leaving the lake comes from the two rivers; that the following percentages of loadings from the two rivers remained in the lake—total phosphorous (24), total nitrogen (28), nitrate (68), and total suspended sediment (80); and that during a 16 month period, approximately 84 million pounds of sediment were deposited in the lake.

National Pollution Discharge Elimination System (NPDES) Inventory and Analysis for the Saluda-Reedy Watershed
Katherine Sciera and Steve Klaine, Clemson University, and Dave Hargett, Pinnacle Consulting Group

This report provides an inventory of the 44 NPDES permitted dischargers in the Saluda-Reedy watershed using monitoring data from January 1989 to July 2004 and violations data from January 1989 to December 2005. The top nine dischargers by volume are analyzed. Six of those dischargers account for more than 95% of the total violations, having over 90 each. Seasonality did not influence violations, but large climatic variations, such as drought, resulted in fewer violations. The database provides an excellent opportunity for future analysis.

Determination of Limiting Nutrients in Lake Greenwood
Lynn Deanhardt, Lander University

This report identifies the limiting nutrients by algal biostimulation assay at three locations in Lake Greenwood. In all cases, the average chlorophyll level in samples spiked with phosphorus and nitrogen was greater than those spiked with only one nutrient. This indicates that both phosphorous and nitrogen are co-limiting nutrients in the lake.

Model Calibration Data for Dynamic Water Quality Simulations of a Eutrophic Reservoir
Hank McKellar and Jim Bulak, South Carolina Department of Natural Resources

This study involved one year of intensive sampling of Lake Greenwood in order to quantify key interactions among nutrients, algae and oxygen. The results were used to calibrate a dynamic water quality model for the lake (described below).

A Dynamic Water Quality Model of Lake Greenwood
Hank McKellar, Jim Bulak, and Barbara Taylor, South Carolina Department of Natural Resources

This model is able to simulate water quality conditions in Lake Greenwood and to predict the impacts of different levels of phosphorous loading on the lake. The model shows that a 25% increase in phosphorous loading from the Reedy and Saluda Rivers would likely cause algal blooms from the upper reaches of the lake downstream to the lake's middle section. Conversely, a 25% decrease in loadings would eliminate most algal blooms, while a 50% reduction would bring phosphorous levels into compliance with state water quality standards throughout the lake. The model also predicts patterns of oxygen depletion and fish habitat associated with different levels of phosphorous. For example, a 50% reduction in phosphorous from both rivers would result in a 31% decrease in hypoxic (oxygen depleted) conditions as well as a 10% increase in tolerable habitat for striped bass.

Assessing the Effects of Watershed Change on Phosphorous Loading to Lake Greenwood
Barbara Taylor, Jim Bulak and Hank McKellar, South Carolina Department of Natural Resources

This study involved a detailed assessment of all available data and information for the period 2002 to 2006 relating to the impact of phosphorous on Lake Greenwood. The report evaluated the impact of phosphorus released from nonpoint sources and the nine largest domestic wastewater treatment plants in the watershed (two on the Reedy and seven on the Saluda that discharge over 1

million gallons of effluent per day). The study concluded that the Saluda River contributes 55% of the total phosphorous load into Lake Greenwood, that the Reedy River accounts for 30%, and that the majority of the loading comes from the wastewater treatment plants. Nonpoint sources, however, contribute significant amounts of phosphorus and should be addressed.

Impact of Point Sources on Phosphorus Loading to Lake Greenwood: A Supplement to Assessing the Effects of Watershed Change on Phosphorous Loading to Lake Greenwood
Barbara Taylor and Jim Bulak, South Carolina Department of Natural Resources

This study, a follow-up investigation to the one discussed above, quantified the relative contributions of point source and nonpoint sources of phosphorus to the lake. The study found that wastewater treatment plants account for 35 to 71% of the annual phosphorus load delivered to Lake Greenwood by the Saluda River and 45 to 73% of the annual load delivered by the Reedy River. The wide range in percentages is due to the influence of rainfall – wastewater treatment plants account for higher percentages in dry years, while stormwater runoff from nonpoint sources accounts for higher percentages in wet years.

The report also found that reducing phosphorus discharges from wastewater treatment plants by half would reduce the annual phosphorus load from the Saluda River to Lake Greenwood by 18 to 37% and from the Reedy River to the lake by 23 to 46% and that between 40 and 60% of the phosphorus discharged to the rivers by these plants ended up in the lake.

Watershed Water Quality and Source Water Vulnerability Assessment
Dave Hargett and Steve Springs, Pinnacle Consulting Group

The purpose of this project was to develop a GIS-based inventory of sites, activities, infrastructure and activities that may pose a threat to water quality and potable water sources in the Saluda-Reedy watershed. The first phase of the project was completed with development of the GIS database structure and a form for transferring relevant DHEC information into the database. Unfortunately, the anticipated funding for the project from Greenwood County did not materialize, and the project could not be completed.

Water Quality and Housing Values on Lake Greenwood: A Hedonic Study of the Impact of the 1999 Algal Bloom on Housing Prices
Robert Carey and Wayne Leftwich, Clemson University

This study evaluated whether the 1999 algal bloom and chlorophyll-a levels in Lake Greenwood significantly affected the prices of houses and land located on the Greenwood County shore of the lake. Using hedonic modeling, the researchers wanted to determine whether there was any difference in the impact of visible (algae bloom) and invisible (chlorophyll-a levels) environmental

conditions on home values. Using home sale values from 1980 to 2006 as a basis for their models, the researchers found no significant correlation between either the algae bloom and prices or chlorophyll-a levels and prices.

Reservoir Sedimentation and Property Values: A Hedonic Valuation for Waterfront Properties Along Lake Greenwood, South Carolina
Wayne Leftwich, Clemson University

This is a masters thesis by a Clemson University student that was not funded by the Saluda-Reedy project. The study is notable, however, because it addressed the same issue as the above study but focused primarily on home and property sales during the two years immediately following the algae bloom. The thesis's regressional analysis model showed a loss of value of $22,000 per home among the 75 homes sold in the two years following the 1999 algal bloom and a loss of $7,800 to $10,000 in individual property values due to accumulated sediment in the lake. The thesis estimated a total loss of value of $1.6 million due to the algal bloom (assessed only for 2000 and 2001) and a permanent loss of $5 to $6 million due to sedimentation.

II. IMPACTS OF SEDIMENTS AND DAMS

Sedimentation in the Upper Reaches of Lake Greenwood
Kim Kroeger, Natural Resources Conservation Service

This study determined that 310 acres of water in the upper reaches of Lake Greenwood have filled in with sediment and become dry land over the last 60 years. The amount of sediment deposited in these reaches is the equivalent of 10 Clemson University football stadiums filled to the top with sediment.

Review of Major Dams and an Examination of Watershed Fragmentation
Dave Hargett and Steve Springs, Pinnacle Consulting Group

This study determined that as many as 3,200 dams exist in the watershed—an astonishing rate of one dam for every half mile of river. Only 164 of the dams are subject to state or federal regulatory authority. The study recommends several dams for modification or removal.

Sedimentation in Major Saluda-Reedy Watershed Impoundments
Dave Hargett and Steve Springs, Pinnacle Consulting Group

This project studied the amount of sedimentation in the following major lakes in the Saluda-Reedy Watershed—Table Rock Reservoir, Poinsett Reservoir, Lake Conestee, Saluda Lake, Boyd Mill Pond, Lake Rabon, Tumbling Shoals, Ware Shoals, and Lake Greenwood. The study found the following losses of

lake capacity due to sedimentation: Table Rock and Poinsett Reservoirs (none); Lake Conestee (95% of initial capacity lost); Saluda Lake (30% of initial capacity lost); Boyd Mill Pond (data not available from 1909 (year of construction) to 1954; one acre lost from 1954 to 1999); Lake Rabon (16 acres lost from 1989 to 1999); Tumbling Shoals (13 of the initial 48 acres lost; dam was removed in 1970); Ware Shoals (14 of the initial 88 acres lost from 1989 to 1999); and Lake Greenwood (310 acres in the upper reaches lost—see report noted above). The study confirms the enormous impact that upstream development has on sedimentation of lakes. The Table Rock and Poinsett Reservoirs were constructed in 1925 and 1956, respectively, and yet there has been no significant sedimentation because their watersheds are completely undeveloped. On the other hand, Lake Conestee is located immediately downstream from the City of Greenville and has almost totally filled in with sediment.

Animation of Lake Conestee Sediment Accumulation from 1892 to 2003
John Tynan and Steve Springs, Pinnacle Consulting Group

This animation shows the location and rate of sediment accumulation in Lake Conestee from 1892 to 2003. During this period, sedimentation caused a loss of approximately 92% of the lake's original volume from approximately 2 million cubic yards in 1892 to approximately 172,000 cubic yards in 2003. Sedimentation occurred most rapidly between 1955 and 1980 as the result of upstream development, the construction of Interstate 85, and the operation of two landfills near the lake.
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Prediction and Modeling of Sediment Sources, Loading Rates, and Deposition in the Saluda-Reedy Watershed
Dave Hargett and Steve Springs, North Wind, Inc.

This study used the Long-Term Hydrologic Impact Assessment Model to evaluate the impact of past and predicted land use changes on the sources, rates and deposition of sediment in the Saluda-Reedy Watershed. The land cover change studies done by the Strom Thurmond Institute (see item IV below) were incorporated in the model. The study predicts that if current development patterns continue through 2030, total sediment loading will increase from 16.3 million pounds per year in 2000 to 32.2 million pounds per year in 2030, with runoff from residential development accounting for 75% of the total. Among the eight Upstate counties, Greenville accounts for 55% of the total increase in sediment load, followed by Laurens (15%), Pickens (14%), and Anderson (10%). The study concludes with a list of recommendations for reducing future sediment loadings and a discussion of the techniques and costs of removing sediments already deposited in Lake Conestee and Lake Greenwood. The recommendations include: (1) utilize low impact development techniques; (2) minimize tree canopy loss; (3) minimize the extent of mass clearing and

grading; (4) utilize natural site topography and minimize cut and fill operations; (5) minimize the time of exposure of disturbed and unstabilized soils; (6) provide good temporary stabilization, particularly vegetative stabilization during construction; (7) provide good permanent stabilization across disturbed areas, particularly slopes; and (8) use stormwater management techniques that provide good water quality treatment and protect downstream channels from erosion.

Economic Valuation for the Saluda-Reedy Watershed
Jeff Allen, Robert Carey, Brian Hock, and Bob Becker, Strom Thurmond Institute of Government and Public Affairs at Clemson University

This study quantified the economic subsidy provided by downstream environmental processes for upstream pollution. According to DHEC water quality data, nutrient levels in the Reedy River steadily decrease from Greenville to Lake Greenwood due to dilution, the binding of phosphorus to sediment, and the loss of nitrogen to the atmosphere. Thus, Laurens and Greenwood Counties are, in effect, treating much of Greenville County's waste. Using information and data from the Western Carolina Regional Sewer Authority about the marginal cost of nutrient removal, the researchers estimated that the value of the treatment provided by these natural processes for nitrogen is $15.9 million per year. They were unable to determine a reasonable estimate for phosphorous. The report concludes with a discussion of three policies that could be used to address the inequity of the downstream subsidy—tradable permits, fees on pollutants, and a combination of permits and fees.

III. MANAGEMENT OF SEPTIC SYSTEMS

Lake Greenwood Sanitary Survey
Dave Hargett and Steve Springs, Pinnacle Consulting Group

This project is the preliminary phase of a survey of on-site wastewater treatment systems (commonly known as septic tanks and referred to in this summary as "OWTS") surrounding Lake Greenwood. One interesting finding is that in Greenwood County in 2003, there were 1,428 structures within 1,000 feet of the lake, the vast majority of which were single family residences. This project provided the framework for the GIS inventory and performance analysis study described below.

Lake Greenwood On-Site Wastewater System GIS Inventory and Performance Analysis
Dave Hargett and Steve Springs, North Wind, Inc.

This study expanded on the Lake Greenwood sanitary survey report (noted above) by identifying areas within 2,000 feet of Lake Greenwood that are suitable, marginal, and potentially problematic for OWTS. Several factors were evaluated in making this assessment, including slope, depth to seasonal high groundwater, depth to bedrock, soil type, and proximity to surface water. The evaluation showed that there are 25,271 acres within 2,000 feet of Lake Greenwood and that 57% of this area is potentially problematic for OWTS, 26% is marginal, and 17% is preferred. In addition, the study made a more detailed assessment of structures and OWTS within 2,000 feet of the lake in Greenwood County where more information and data are available. As of 2004, there were 969 structures in this area with the following rankings: 54% potentially problematic, 37% marginal, and 9% preferred. (The discrepancy between this number and the 1,428 discussed above is due to the use of more precise GIS analysis in this study). Limited field inspections were conducted on 40 OWTS within the 2,000 foot area. A few sites with potential problems were noted, but in general OWTS appeared to be properly maintained. Under current state regulations, a permit is required only for the original installation of an OWTS. The report recommends that the regulations be strengthened so that inspection and maintenance of the system are required and that the state and/or local government is notified when the OWTS is sold or transferred to another owner.

Effect of Failing On-Site Wastewater Treatment Systems on Lake Greenwood Water Quality
Daniel Pardieck, Lander University

There are more than 4,000 housing structures located within only a few hundred feet of the shore of Lake Greenwood. Most of these structures use OWTS, and many of the systems are more than 30 years old. This has led to concern that some of the OWTS might be failing and causing adverse impacts on the lake's water quality. The basic purpose of this study was to determine whether this is a valid concern. First, based on a variety of factors, the researcher identified developments along Lake Greenwood that are most likely to have failing OWTS. Then, water samples were collected from both the lake and tributaries at points near these developments. An analysis of the samples did not reveal any adverse water quality impacts. The study points out, however, that this does not mean that such impacts have not previously occurred or will not occur in the future.

IV. LAND COVER CHANGE

Land Cover Classification in Upstate South Carolina and the Saluda-Reedy Watershed

Jeff Allen, Stephen Sperry, Arvind Pasula, Vrunda Patki, and Kang Shou Lu, Strom Thurmond Institute of Government and Public Affairs at Clemson University

Using satellite multispectral imagery, this study determined the basic land covers in eight Upstate counties, including the entire Saluda-Reedy watershed, in 1985 and 2000. The covers include open water, wetlands, forested (deciduous, evergreen and mixed), pasture, transitional/barren, and developed (low, medium, and high intensity). The most significant changes were a loss of forested cover (from 871 to 773 square miles) and an increase in the aggregate amount of developed land (from 121 to 248 square miles).

Impervious Cover Analysis for the Saluda-Reedy Watershed in Upstate South Carolina

Jeff Allen, Vrunda Patki and Arvind Pasula, Strom Thurmond Institute of Government and Public Affairs at Clemson University

This study analyzed the extent of impervious cover in 13 sub-watersheds within the Saluda-Reedy watershed in 1985, 1989, 1995 and 2000. In 1985, only one of these sub-watersheds had an impervious cover of more than 10%, which is generally considered the point when serious water quality degradation begins to occur. By 2000, however, six sub-watersheds exceeded 25%, three exceeded 20%, and one exceeded 15%; only three were below 10%.

Modeling Growth and Predicting Future Developed Land in Upstate South Carolina

Craig Campbell, Jeff Allen, and Kang Shou Lu, Strom Thurmond Institute of Government and Public Affairs at Clemson University

This study analyzed actual changes in land use and predicted the extent of future development in the following eight Upstate counties: Greenville, Spartanburg, Anderson, Pickens, Laurens, Abbeville, Newberry, and Greenwood. The entire Saluda-Reedy watershed lies within this region.

A key finding of the study is the "growth ratio"—the rate at which land is being developed compared to the rate at which population is increasing. From 1990 to 2000, the growth ratio in the Upstate was over 10 to 1. Using a conservative growth ratio of 5 to 1 and other relevant information, the study predicts what the Upstate will look like in the future up to the year 2030. In that year, the total amount of developed land in the region will exceed 1.5 million acres—an astonishing increase of 1.3 million acres since 1990.

The study also shows what the region will look like under different growth ratios (4:1, 3:1, 2:1, and 1:1). Each scenario accommodates the same number of people and the same amount of economic activity—the only difference is the amount of land that is being developed relative to population growth. The difference in the results is striking. For example, with a growth ratio of 1:1, the amount of land developed in 2030 is only 750,000 acres—half the amount developed under a 5:1 ratio.

The study dramatically reveals that the Upstate truly has a choice in the type of region it will become in the future.

Assessment of Trends in Forest Cover Change in the Saluda-Reedy Watershed and Impacts on Water Quality and Streamflow
Dave Hargett and Steve Springs, North Wind, Inc.

This study evaluated the impacts of forest cover change on both water quality and quantity in the Saluda-Reedy watershed. Using data obtained by the Strom Thurmond Institute for the regional land classification study (described above), the researchers determined that the entire watershed sustained a net loss of 57,100 acres in forest cover from 1985 to 2000. An analysis of subwatersheds revealed that those with the highest losses of forest cover experienced increased rates of flooding and reduced water quality.

V. NATURAL RESOURCES POLICY

Decision-Making for Natural Resources and Watershed Management: Current Thinking and Approaches
Brenda Vander Mey and Paul Pitts, Clemson University

The report consists of three major parts. The first part is an essay that discusses many of the key issues relating to natural resources and watershed management both at the national level and in South Carolina. The second part is an extensive annotated bibliography of relevant articles and studies, followed by a list of free publications and websites.

The third part is a report on a content analysis of county council and municipal governments' decisions in the area of natural resources and watershed management from 2001 through 2003, with a focus on the Saluda and Reedy Rivers and the Saluda-Reedy Watershed. Minutes from meetings of the following government bodies were obtained and reviewed: Anderson County Council; Greenville County Council; Greenwood County Council; Laurens County Council; Pickens County Council; Greenville City Council; Anderson County Land Use and Zoning Board of Appeals; Anderson County Planning

Commission; Greenville City Public Services Administration; Greenville County Council Committee on Public Service, Planning, and Development; Greenville Soil and Water Conservation District; Pickens County Stormwater Committee; Pickens County Soil and Water Conservation District; and the Appalachian Council of Governments. Generally, it was found that city and county governmental bodies tended to focus on specific local issues, such as land use, zoning and water infrastructure projects, but without reference to the larger social, economic, or environmental contexts. The entities with the greatest focus on the Saluda and Reedy Rivers and the watershed were the Greenville City Council and the Greenville County Council.

VI. FLOODING AND WETLANDS

Factors Contributing to Flooding in the Upper Reedy River Watershed
Dave Hargett and Steve Springs, North Wind, Inc.

This study evaluated changes in population, land cover, precipitation, peak flows and base flows in the upper Reedy River watershed (defined as the 65 square mile area draining to Lake Conestee). The study found dramatic increases in the amount of developed land (from 36% of the watershed being developed in 1985 to 69% in 2000), a significant increase in monthly peak flows over the period from 1942 to 2005, and a significant decrease in annual base flows over the same period. No significant change in precipitation was found during this time; thus, the change in peak flows and base flows is primarily the result of increased development in the watershed.

Assessment and Mapping of Current and Historical Wetlands in a Portion of the Saluda-Reedy Watershed
Dave Hargett and Steve Springs, North Wind, Inc.

This study evaluated the extent of historical and current wetlands in the portion of the Reedy River watershed that is located in Greenville County (approximately 69,000 acres) from 1975 to 1999. The study determined historical wetlands (1975) at 1,647 acres and current wetlands (1999) at 1,479 acres, representing a loss of 10.2%. The loss is attributable primarily to impoundments and development.

VII. STORMWATER MANAGEMENT AND EROSION CONTROL

Assessment of Erosion Control and Stormwater Regulatory Programs in the Saluda-Reedy Watershed: Greenville County and City of Greenville
Melanie Ruhlman and Dave Hargett, North Wind, Inc.

This report provides a comprehensive assessment of the erosion control and stormwater programs of both the City of Greenville and Greenville County and makes many recommendations for improving and strengthening the programs. For Greenville County, the recommendations include (1) reactivating the stormwater advisory committee; (2) establishing standards that require treatment of the "first flush" of stormwater runoff; (3) allowing the waiver for detention only for outfalls that discharge directly to a large river; (4) establishing performance standards for post-construction water quality treatment; (5) not allowing dry detention ponds to be accepted as water quality treatment systems unless used in conjunction with best management practices (BMPs) that meet water quality performance standards; (6) enacting a riparian buffer ordinance; (7) imposing controls on the mass grading of sites; (8) enacting a comprehensive tree protection ordinance; (9) requiring some level of detention and/or water quality treatment at redevelopment sites; (10) establishing specific criteria for granting or denying variances; (11) establishing incentives to encourage innovative site design and the use of low impact development methods; (12) establishing a program that allows the County to take over stormwater facilities that are not being properly maintained; (13) developing water quality BMP guidelines for businesses and industries; (14) establishing standards that prevent the over-design of stormwater detention basins; (15) providing stronger and more effective penalties and remedies for violations; (16) hiring an environmental/watershed coordinator; and (17) establishing partnerships with the City and various community organizations. The recommendations for the City are similar but place more emphasis on changes and improvements needed for managing erosion and stormwater at infill and redevelopment sites. All of the recommendations are found in chapter 7 of the report.

Assessment of Erosion Control and Stormwater Management Practices for Development Sites in the Saluda-Reedy Watershed: Greenville County
Melanie Ruhlman and Dave Hargett, North Wind, Inc.

This study evaluated the effectiveness of erosion control and stormwater management practices in Greenville County, the most populated and developed county in the watershed. The evaluation included 23 sites under active development and 47 sites that had already been developed. Depending on its location, the site was subject to the permitting authority of one of the following agencies: the City of Greenville, Greenville County, or DHEC. In all cases, the developer is required to submit a plan for erosion control and stormwater

management at the site and to implement the plan. The study used a comprehensive list of criteria for assessing and scoring both how well the plans complied with applicable laws and regulations and how well the erosion control and stormwater management measures were actually installed, operated and maintained at the sites.

The study concluded that (1) across all three jurisdictions, the average scores for the plan reviews were generally higher than the average scores for the field inspections; (2) plan review scores for sites subject to the authority of the County were generally good (average score of 82%), but field inspection scores were poor (average score of 61%); (3) plan review scores for sites subject to the authority of DHEC were generally good (average score of 82%), but field inspection scores were poor (average score of 59%); (4) both plan review and inspection scores were poor (63% and 52%, respectively) for sites subject to the authority of the City; (5) erosion problems at all active development sites were observed and in some cases were causing significant adverse impacts on adjacent wetlands, rivers and streams; (6) better enforcement of the regulations and the approved plans is needed, especially at large development sites; (7) consideration should be given to requiring phased clearing and grading of sites (i.e., no mass grading); (8) dry detention ponds are commonly used throughout the County but are not effective in protecting water quality; (9) post-construction performance standards are needed to protect water quality; (10) regulations that require the over-design of detention ponds should be changed; (11) the waiver for detention should be allowed only for outfalls that discharge directly to a large river; (12) some level of detention and water quality treatment should be required at all redevelopment sites; and (13) local permits for grading should not be issued until all state and federal permits and authorizations are obtained.

VIII. RIPARIAN AND TREE RESOURCES

Identification of Priority Riparian Sites in the Reedy River Watershed
Dave Hargett and Steve Springs, North Wind, Inc.

This study provides a detailed assessment of the condition and ownership of the riparian buffer zones in 15 different sections of the Reedy River (six urban, six suburban, and three rural). Seven "riparian zone management practices" (buffer protection, buffer augmentation, stream rehabilitation, stream stabilization, dechannelization, stormwater control, and education) are ranked by importance in four of the representative sections. The study can be used to establish a priority list of specific riparian buffer protection and restoration projects in the Reedy River watershed. The report also recommends a site screening matrix for the objective evaluation of 16 factors relating to riparian

buffer zones. The matrix was not applied in this study, but it would be useful in any watershed.

Building Awareness of the Importance of Tree Cover in the Upstate South Carolina
Diane Eldridge, Upstate Forever

This report describes the process that Greenville County Council followed in considering the enactment of a countywide tree protection ordinance. The process included the appointment of a tree policy advisory committee of 11 county residents representing a wide range of disciplines and views, bi-weekly meetings of the committee, inviting 18 persons to present their views to the committee, allowing time for public comments at the end of each committee meeting, and five public hearings. The report also describes the media coverage of the committee's work and the advocacy efforts of Upstate Forever for a strong and comprehensive ordinance. The report was issued before the committee submitted its final report and recommendations. Finally, in January, 2008, after over a year of rancorous debate, the County Council enacted a tree protection ordinance that included only some of the committee's recommendations.

IX. LOW IMPACT DEVELOPMENT

Audit of Pavement Standards in the Upper Saluda-Reedy Watershed
Upstate Forever Staff and John Cock, The Lawrence Group

This study provides a detailed review and assessment of the various standards and requirements relating to paving—streets, sidewalks, parking lots and driveways—in 11 municipalities located in Greenville and Pickens Counties and the counties themselves. More than 30 specific paving standards were compared with model low impact development standards and assigned points, with 100 being the highest score possible. The scores were: Greenville County (61), Pickens County (31), Central (34), Clemson (43), Easley (38), Fountain Inn (34), Greenville (33), Greer (49), Liberty (28), Mauldin (47), Pickens (31), Simpsonville (45), and Travelers Rest (47). The study is a blueprint for changing local standards and codes to reduce both infrastructure costs and water quality impacts. Using the same approach, Upstate Forever has completed pavement audits for five more Upstate counties: Spartanburg, Anderson, Oconee, Greenwood, and Laurens. Scores for these counties and their municipalities are similar to those found in the Greenville and Pickens study.

X. EDUCATION AND OUTREACH

State of the Watershed
Upstate Forever Staff

This report, issued in 2005, summarizes the work completed at the mid-way point of the project. Over 5,000 copies of the report were printed and distributed.

Watershed Map and Related Materials
Upstate Forever Staff

A large fold-out map of the watershed includes descriptions and photographs of many significant natural and historic sites. Over 10,000 maps were printed and distributed.

Watershed Insight Reports
Upstate Forever Staff and Others

This is a series of one-page reports summarizing the findings of specific studies. These reports were widely distributed and posted on the project website.

Website
Upstate Forever Staff

A website, www.saludareedy.org, was established at the outset and was actively and effectively used to inform the public about the work being done in the project. The website now houses most of the project's studies, reports and publications and is an invaluable resource for anyone interested in the watershed. The website has received over 62,000 visits to date and will be maintained indefinitely.

Field Trips and Newsletters
Upstate Forever Staff

Between 2004 and 2006, Upstate Forever published 7 newsletters about the watershed and hosted 40 field trips and seminars relating to water quality, with approximately 2,000 people attending.

"Discover Carolina" Water Quality Program
Bill Marrell, South Carolina Department of Parks, Recreation, and Tourism

This project created a water quality and watershed program for fourth grade classes in the Greenwood public schools which involved visits by students to

the Lake Greenwood State Recreation Area to collect and analyze water samples. Regrettably, principals and teachers in the Greenwood school districts declined to make a commitment to the program. In response to this lack of interest, Clemson University's S.C. Life program sponsored a graduate course in which approximately 33 teachers participated between 2005 and 2008, and which included, among other things, implementation of the fourth grade program. As a result, approximately 1,000 fourth grade students participated in the program from 2005 to 2008.

Public Opinion on the Saluda-Reedy Watershed: Knowledge, Attitudes, and Behaviors
Catherine Mobley and Jim Witte, Clemson University

The researchers conducted a telephone survey of 855 citizens who live in the Saluda-Reedy watershed on their knowledge, attitudes and behaviors related to water quality issues. The survey, which had a margin of error of 3.4%, found, among other things, that:

- 86% were concerned or somewhat concerned about water quality;
- 27% selected the correct definition of "watershed" (the area that drains to a specific river or lake). Of the remaining four choices given, 10% answered "a small building where water is stored," 49% answered "a reservoir that serves as a municipal water source," 8% answered "a low area that retains water," and 6% answered "none of the options mentioned";
- Only 30% correctly identified the water body that receives the runoff from their own home;
- 55% believe that water quality has worsened in the last 10 years; and
- 60% expressed a willingness to pay more on their water bill to improve water quality.

The study also included an important but not statistically valid web survey of citizens, local officials, environmental professionals, and developers.

Saving Lake Greenwood
Upstate Forever Staff

The final and seminal report of the project is *Saving Lake Greenwood: An Action Plan for Restoring and Protecting Water Quality,* which summarizes the major findings and conclusions of the studies relating to water quality and offers specific recommendations for the actions and policies needed to protect and improve Lake Greenwood. This report is serving as the cornerstone of advocacy efforts to reduce adverse impacts on the lake. Recommendations of the report include: (1) adopting responsible growth management policies, such as the 1:1 growth ratio as the guiding policy, establishing infrastructure and service boundaries, and establishing local conservation banks; (2) improving

stormwater enforcement by hiring additional inspectors, imposing substantial fines for violations, requiring fees for processing permit applications, and using stop-work orders; (3) promoting low impact development by revising development-related standards and ordinances; (4) creating and implementing forward-thinking floodplain management plans that incorporate greenway master plans and other property acquisitions; (5) systematically retrofitting "legacy" stormwater sites by enacting a stormwater fee based on impervious cover, prioritizing retrofit areas based on water quality impacts, requiring that redevelopment adhere to the same performance standards as new development, and implementing similar programs; (6) developing a lake management plan that includes the creation of a multi-county overlay district with enhanced standards, sets specific water quality targets for the lake, spurs joint actions to reach these targets, and creates an aggressive public awareness campaign to promote the plan; (7) managing lakeshore septic systems proactively and systematically by requiring inspection of septic systems as a condition of sale or transfer of land and by creating a septic management utility that collects fees from all users within a certain distance of the lake and uses the fees for maintenance, replacement, and repair of systems; (8) securing special protection for Lake Greenwood through existing or new regulations and using such a designation to develop an advisory committee and watershed master plan; (9) limiting phosphorus concentrations and loading from wastewater treatment plants; and (10) working together as a region by participating in the "Ten at the Top" regionalism initiative.

XI. MISCELLANEOUS

GIS Coordination and Standards Management
Steve Springs, North Wind, Inc.

This project involved the compilation of important state and local GIS-based information and the preparation of nearly 20 maps for use by members of the Saluda-Reedy Watershed Consortium on their respective projects. Lists of the specific information and maps are provided in the two appendices.

Regulatory Oversight
Dave Hargett and Steve Springs, North Wind, Inc.

This project established a process for learning about and evaluating proposed uses, activities and permits relevant to water quality in the Saluda-Reedy watershed for a three year period (2003 to 2005). The report describes specific cases where the Consortium itself or an individual member of the Consortium took action to protect water quality. One of the cases involved reporting and monitoring excessive sedimentation and lack of stormwater and erosion controls on a development site along Highway 276 adjacent to a mountain

headwater stream in the watershed. State resource agencies pursued enforcement actions against the developer as a result of our efforts. Two other cases involved commenting on the applications for the renewal of permits to discharge wastewater into a trout stream in northern Greenville County and into the Saluda River.

Financial Report for SRWC Project

Summary

	2003	2004	2005	2006	2007	2008	TOTAL
VKRF and Fuji Grants	$600,000	600,000	660,000	550,000	100,000	0	$2,510,000
Interest Earned	6,074	11,635	10,013	19,141	26,654	0	73,517
Other Grants	0	10,000	0	97,500	1,663	11,250	120,413
Total Revenue	606,074	621,635	670,013	666,641	128,317	11,250	2,703,930
SRWC Partner Costs	235,711	497,124	435,463	586,086	119,000	89,380	1,962,764
Other Costs	0	9,217	22,444	8,486	162,447	108,568	311,162
Administration	48,000	48,000	60,000	50,000	45,345	38,214	289,559
Net	**$322,363**	**67,294**	**152,106**	**22,069**	**(198,475)**	**(224,912)**	**$140,445***

* With the approval of the V. Kann Rasmussen Foundation and Fujifilm Manufacturing USA, Inc., this balance was transferred to Upstate Forever for use in its Clean Air and Water Program.

Itemization of Project Costs

	Jan - Dec 03	Jan - Dec 04	Jan - Dec 05	Jan - Dec 06	Jan - Dec 07	Jan - Dec 08	TOTAL
Collaborative Team Project Website	23,000	3,500	1,500	0	0	0	28,000
GIS Coordination and Standards Management	13,000	14,000	3,800	0	0	0	30,800
Initial Project Administration	0	3,000	0	0	0	0	3,000
Public Website	5,000	0	0	0	0	0	5,000
Reedy River Paddling Guide	6,000	0	0	0	0	0	6,000
Saluda-Reedy Watershed Brochure	10,300	9,669	950	0	0	0	20,919
History of the Saluda-Reedy Watershed	2,958	26,618	(1,183)	0	0	0	28,393
Public Opinion Survey on Saluda-Reedy Watershed	0	26,970	7,946	0	0	0	34,916
Welcome to Your Watershed Workshops	0	14,491	371	0	0	0	14,862
Dealing With Dirt - Water Quality Conference	0	9,670	0	0	0	0	9,670
Watershed Signage and Public Awareness Campaign	0	5,500	500	0	0	0	6,000
Watershed Curriculum	0	2,000	0	0	0	0	2,000
Creation of a Portable Display	0	0	7,410	0	0	0	7,410
SRWC Public Relations/ Community Awareness Plan	0	0	2,500	0	0	0	2,500
Land Cover Classification and Land Cover Change Analysis	17,090	140,797	0	0	0	0	157,887
Economic Valuation of Water Use and Water Pollution	6,000	66,620	0	0	0	0	72,620
Analysis of Knowledge and Attitudes of Decision-Makers	10,641	9,654	0	0	0	0	20,295
Water Budget Analysis	0	14,000	1,900	0	0	0	15,900
Water Quality and Source Water Vulnerability Assessment	0	2,200	0	0	0	0	2,200
Regulatory Oversight	0	4,500	3,500	0	0	0	8,000
Compilation and Review of Water Quality, Sediment Quality, and Streamflow Data	67,556	7,500	4,944	0	0	0	80,000
Characterization of Hydrologic Inputs to Lake Greenwood	30,053	750	95,325	0	0	0	126,128
Review of Major Dams in Saluda-Reedy Watershed	17,650	5,000	9,450	0	0	0	32,100

Itemization of Project Costs

	Jan - Dec 03	Jan - Dec 04	Jan - Dec 05	Jan - Dec 06	Jan - Dec 07	Jan - Dec 08	TOTAL
Sedimentation in Saluda-Reedy Impoundments (part 1)	13,000	0	0	0	0	0	13,000
Determination of Limiting Nutrients in Lake Greenwood	13,463	12,616	(80)	0	0	0	26,000
Water Quality Data Mining, Analysis, and Trends Assessment	0	69,500	12,500	0	0	0	82,000
Sedimentation in Saluda-Reedy Impoundments (part 2)	0	15,000	2,000	0	0	0	17,000
Lake Greenwood Sanitary Survey	0	6,500	8,500	0	0	0	15,000
Model Calibration Data for Lake Greenwood	0	14,208	16,679	0	0	0	30,887
Audit of Pavement Related Ordinances	0	0	10,800	7,200	0	0	18,000
Cultivation of Support for LID Roundtable	0	0	3,500	3,500	0	0	7,000
Consensus Building for Changes to Local Pavement Standards	0	0	500	10,000	0	0	10,500
Organization of LID Field Trips and Events	0	0	0	8,000	0	0	8,000
Survey of Stormwater Facilities in Greenville County	0	0	5,000	18,000	2,000	0	25,000
Assessment of Stormwater Regulatory Programs in Greenville County	0	0	2,800	9,200	2,000	0	14,000
Report on Factors Contributing to Flooding in the Upper Reedy River Basin	0	0	8,600	6,400	2,500	0	17,500
Analysis of Change in Impervious Cover	0	0	4,000	36,000	(4,000)	4,000	40,000
Laying the Groundwork for Stormwater Demonstration Projects	0	0	3,000	3,000		0	6,000
Wetland Mapping	0	0	0	7,000	1,000	0	8,000
Developing and Publicizing a Network of Stormwater Demonstration Sites	0	0	0	23,700	0	0	23,700
Outreach and Consensus-Building for Improvements to Local Stormwater and Erosion Control Standards	0	0	0	1,800	0	0	1,800
Assessment of Benefits of Tree Protection	0	0	4,848	5,075	500	0	10,423
Land Cover Classification in the Upstate and Saluda-Reedy Watershed	0	0	4,898	18,500	1,650	0	25,048

Itemization of Project Costs

	Jan - Dec 03	Jan - Dec 04	Jan - Dec 05	Jan - Dec 06	Jan - Dec 07	Jan - Dec 08	TOTAL
Identification of Priority Riparian Sites in the Reedy River Watershed	0	0	3,900	6,900	2,200	0	13,000
Coalition Building for Completion of the Reedy River Greenway	0	0	0	5,500	0	0	5,500
Consensus Building for Completion of Greenville County Greenway Master Plan and Ordinance	0	0	0	10,000	0	0	10,000
Audit of Erosion Prevention and Sediment Control Ordinances and Enforcement	0	0	2,500	21,500	1,000	0	25,000
Assessment of On-the-Ground Erosion Prevention and Sediment Control Practices	0	0	2,500	21,500	1,000	0	25,000
Analysis of Legal, Institutional and Policy Considerations Affecting Watershed-Based Costshare Models of Sediment Management (canceled)	0	0	800	3,300	(4,100)	0	0
Prediction and Modeling of Sediment Sources, Transportation, Fate and Deposition	0	0	8,000	15,000	(3,000)	0	20,000
Development of Sediment Management Options and Scoping of a Sediment Management Plan	0	0	500	2,250	(2,750)	0	0
Economic Valuation	0	0	0	18,750	6,250	0	25,000
GIS Inventory of Onsite Wastewater Systems Infrastructure and System Performance around Lake Greenwood	0	0	9,000	11,000	2,500	0	22,500
Identification of Non-Compliant On-Site Wastewater System Infrastructure, Factors Contributing to Poor Performance, and Nature and Extent of Impacts	0	0	5,500	29,750	(7,750)	0	27,500
Reporting on On-site Wastewater Treatment System Performance Findings	0	0	0	5,000	15,000	0	20,000
Promotion of Lake Friendly Landscaping and Buffer Protection around Lake Greenwood	0	0	0	1,600	0	0	1,600

Itemization of Project Costs

	Jan - Dec 03	Jan - Dec 04	Jan - Dec 05	Jan - Dec 06	Jan - Dec 07	Jan - Dec 08	TOTAL
2005 Peak Flow Sampling and Analysis of Sediment Nutrient Release	0	0	55,000	55,000	0	0	110,000
Development and Calibration of Lake Greenwood Water Quality Model	0	0	20,000	15,000	5,000	0	40,000
Identification of NPDES Dischargers and Wet-Weather Overflows	0	0	29,400	12,600	0	0	42,000
2006 Peak Flow Sampling and Analysis of Sediment Nutrient Release	0	0	0	49,150	36,500	0	85,650
Model Development for Lake and Watershed Interactions: Land Use, Point Source, and Water Quality	0	0	0	0	24,000	36,000	60,000
Documentation and Analysis of NPDES Discharges	0	0	0	12,500	12,500	0	25,000
Watershed Leaders Forum Conceptual Plan	0	0	12,000	30,000	0	0	42,000
Watershed Tours and Field Trips	0	0	1,250	23,750	0	0	25,000
Planning and Fundraising for Grassroots Capacity Building	0	0	1,500	3,500	0	0	5,000
Lake Conestee Nature Park River Sweep	0	0	0	0	8,000	0	8,000
Water Quality Data Warehouse Maintenance and Management	0	0	6,740	12,000		0	18,740
Land Use Change Modeling	0	0	17,850	5,650	0	0	23,500
Economic Valuation	0	0	2,800	11,200	0	0	14,000
Saluda-Reedy Watershed History (extension)	0	0	6,200	10,000	(10,000)	0	6,200
Development of Watershed Insights Reports	0	0	0	0	6,000	0	6,000
Decision Making for Natural Resources and Watershed Management: Current Thinking and Approaches	0	0	0	5,076	0	0	5,076
Advisory Council Development and Consultation	0	0	500	2,000	0	0	2,500
Watershed Education Display and Public Participation	0	0	9,768	0	0	0	9,768
Printing for State of the Watershed Report and SRWC Newsletters	0	0	9,834	4,000	0	0	13,834

Itemization of Project Costs

	Jan - Dec 03	Jan - Dec 04	Jan - Dec 05	Jan - Dec 06	Jan - Dec 07	Jan - Dec 08	TOTAL
Lake Greenwood Discover Carolina Program Curriculum Development	0	0	2,500	2,500	2,500	0	7,500
Watershed Signage	0	0	0	500	0	0	500
Watershed Branding and Logo Development	0	0	0	4,200	0	0	4,200
Watershed Educational Exhibits	0	0	0	0	0	0	0
Watershed Materials & Public Presentations	0	0	0	10,000	0	0	10,000
Lake Greenwood Discover Carolina Implementation	0	0	0	2,500	3,750	(2,500)	3,750
Saluda-Reedy Website	0	1,000	0	0	0	0	1,000
Press Kit	0	8,289	0	0	0	0	8,289
Power Point Presentation	0	3,570	0	0	0	0	3,570
Piedmont Newsletter	0	0	500	0	0	0	500
Saluda-Reedy Website	0	0	463	0	0	0	463
Additional Audits of Pavement Standards	0	0	0	0	6,000	0	6,000
State of Upstate Waters	0	0	0	0	4,000	0	4,000
Saving Lake Greenwood Report	0	0	0	0	4,750	8,250	13,000
Lake Conestee Assessment	0	0	0	0	0	16,800	16,800
Middle Saluda Restoration	0	0	0	0	0	5,000	5,000
Cliffs at Mountain Park Collaboration and Appeal	0	0	0	0	0	6,621	6,621
Low Impact Development Graphics	0	0	0	0	0	3,000	3,000
Low Impact Development Speaker Series	0	0	0	0	0	4,807	4,807
Growth Study	0	0	0	0	0	4,688	4,688
Saluda-Reedy Coordination	0	0	0	535	0	0	535
Miscellaneous Project Expenses	0	0	0	5,000	0	2,714	7,714
	235,711	**497,124**	**435,463**	**580,551**	**119,000**	**45,750**	**1,962,764**