Yadkin Project
FERC No. 2197 NC

WETLAND AND RIPARIAN HABITAT ASSESSMENT

Final Study Report

JUNE 2005

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SUMMARY

The Wetlands and Riparian Habitat Assessment Final Study Report presents the results of a survey of wetland habitats at the Yadkin Project. The study was conducted by Normandeau Associates, Inc. (NAI) as part of the Federal Energy Regulatory Commission (FERC) relicensing process for the Yadkin Project. The study was conducted in accordance with the Final Study Plan that was developed by Alcoa Power Generating, Inc. (APGI) in consultation with the Wetlands, Wildlife and Botanical Issue Advisory Group (IAG). Specific objectives identified in the Final Study Plan included:

- Identify and map vegetated wetlands and riparian habitats within the influence of reservoir water levels, including aquatic beds, emergent and shrub-wetlands and some forested wetlands.
- Evaluate effects of current Project operations, including reservoir water level fluctuations, on these wetlands and riparian habitats.
- Evaluate how significant changes in Project operations, including both increasing and decreasing short-term and long-term reservoir drawdowns would impact existing wetlands, or would allow for additional wetland development.
- Qualitatively assess the effects of reservoir facilities (such as piers, boat ramps, beaches, bulkheads and other forms or shoreline hardening) on wetlands and riparian habitats, with a particular emphasis on the potential impact of piers on water willow (*Justicia americana*) at Narrows Reservoir.

In accordance with the study plan, Normandeau mapped all of the wetlands located within the study area which included all of the Project reservoirs as well as the shoreline within 200 feet of the reservoirs. Wetland delineation and mapping was done using aerial photography and field surveys. Wetlands were categorized into six categories: forested wetland; forested floodplain wetland; scrub-shrub wetland; sparse scrub-shrub wetland; emergent marsh; and aquatic bed. The remainder of the study area was categorized into seven upland cover types.

Of the four Yadkin Project reservoirs, High Rock supports the greatest total acreage of wetland habitat with a total of 3268 acres. The vast majority of the wetland acres found at High Rock are concentrated in the upper end of the reservoir, where extensive areas of forested floodplain wetlands exist and where sizeable scrub-shrub wetlands have developed on deltas and islands formed by sediment deposits. Elsewhere in the reservoir, wetlands are noticeably absent, and there are almost no stands of emergent marsh or aquatic bed wetlands.

The concentration of wetlands in the upper end of High Rock reservoir is primarily the result of colonization by wetland vegetation on large areas of sediment deposition which has created a complex of islands, deltas and sand bars. These wetlands provide the most abundant riparian habitat on High Rock reservoir and are important to the reservoir as fish spawning and rearing habitat. These delta wetlands appear to be relatively unaffected by fluctuating reservoir water levels, but are clearly affected by high river flows which cause flooding in the floodplain and can generate flow velocities that dislodge vegetation and remobilize the deposited sediments.

The paucity of wetlands in the lower portion of the reservoir is due to the current operation of the reservoir which is characterized by a period of reservoir drawdown of between 10-15 feet during the

fall and winter. In addition, drawdowns of 5 feet or more late in the summer growing season also adversely impact wetland formation. Few native emergent or aquatic species can tolerate the combined effects of the conditions created in the reservoir drawdown zone: flooding for periods in the spring, followed by drying as the water levels drop in the late summer and fall. Exposure to freezing and desiccation in the winter further stresses any overwintering plant material. Annuals are the best strategists for taking advantage of regeneration opportunities, as was observed during the drought of 2002 when entire sections of the reservoir that were exposed by the prolonged drawdown were colonized in the late summer by a grass or sedge.

Tuckertown Reservoir supports 253.8 acres of wetlands. The wetlands at Tuckertown are a mix of all six wetland types. Within each of the wetland types found at Tuckertown, the species composition of the wetlands is very diverse. In particular, the emergent marsh and aquatic bed wetlands contain a diverse mix of species and exhibit a classic pattern of zonation that is a characteristic of a healthy wetland system. The extensive development of emergent marsh and aquatic bed wetlands at Tuckertown is attributed to its relatively stable water levels, quiet water, and fine, gently sloping substrates.

Narrows Reservoir supports 333.1 acres of wetlands. The most prevalent wetland type at Narrows is emergent marsh which accounts for 178 acres of the total. In contrast to Tuckertown, emergent marsh wetlands on Narrows are not species diverse but are instead dominated by water willow. In some cases beds of emergent vegetation were found to be made up entirely of water willow. The existence of large stands of water willow on Narrows suggests that growing conditions are very suitable for this species which is particularly tolerant of alternating periods of inundation and exposure.

Falls Reservoir supports only 3.2 acres of wetlands. This reservoir is characterized by steep, rocky slopes and substrates and a riverine nature. These natural features along with very frequent fluctuations in reservoir water levels serve to limit additional wetland development on Falls Reservoir. The Falls Tailrace, which extends approximately 1 mile into Tillery Reservoir, was estimated to have 8.1 acres of wetlands.

Summary of Wetland Acres at the Yadkin Project Reservoirs

Wetland Type	*High Rock*	*Tuckertown*	*Narrows*	*Falls*	*Falls Tailrace*	*Project Total*
Forested Wetland	*234.2*	*64.3*	*51.2*	*0.3*	*5.8*	*355.8*
Forested Floodplain Wetland	*2194.1*	*87.0*	*39.8*	*0*	*0.3*	*2321.2*
Scrub-Shrub Wetlands	*324.6*	*40.4*	*3.9*	*0.3*	*0.3*	*369.5*
Sparse Scrub-Shrub Wetlands	*484.4*	*4.4*	*0*	*0*	*0*	*488.8*
Emergent Marsh	*28.1*	*44.7*	*178.2*	*2.6*	*1.7*	*250.1*
Aquatic Bed	*2.9*	*14.3*	*60.0*	*0*	*0*	*77.2*
Reservoir Total	*3268.3*	*253.8*	*333.1*	*3.2*	*8.1*	*3866.5*

A second objective of the Wetlands and Riparian Habitat Assessment was to evaluate qualitatively the potential impact to reservoir wetlands that would occur under alternative water level regimes. To address this issue, NAI examined three different water level scenarios for High Rock Reservoir, and one each at Tuckertown and Narrows reservoirs.

The High Rock alternatives evaluated included: Alternative 1) maintaining the reservoir "near-full" (within 3 feet of full) year round, Alternative 2) extending the season during which the reservoir was maintained "near-full" and reducing the total magnitude of the winter drawdown, and Alternative 3) increasing the winter drawdown and maintaining summer water levels within 5 feet of full in order to use additional storage. The results of this analysis can be summarized as follows:

- *Alternative 1* – "Near-Full Year Round" - a stable water level would result in the development of emergent wetlands and aquatic beds along much of the shoreline of High Rock, probably similar in zonation and species diversity to Tuckertown. A stable water level is also likely to have the adverse impact of eliminating much of the black willow (*Salix nigra*) that has colonized the delta area, particularly in the deeper areas. Emergents could colonize some of the areas, but the area would be more vulnerable to riverine high flow events.
- *Alternative 2* – "Extended Near-Full Season" - a shorter winter drawdown would likely enhance wetland development around the perimeter of High Rock, probably similar to Narrows with water willow dominating the emergent wetlands. The black willow beds in the delta area would decline similar to Alternative 1.
- *Alternative 3* – "Additional Use of Storage" - would be most detrimental to existing wetlands around High Rock. While the black willow stands on the delta area would probably thrive and expand, the in-pond wetlands around the periphery of the reservoir would be less stable. The combination of a longer winter drawdown, a lower average water level, and periodic full pond levels would create a difficult environment for emergent wetlands to persist or colonize.

At Tuckertown, increases in short-term water level fluctuations by several feet could reduce the species diversity and alter the zonation of the emergent wetlands now prevalent on the reservoir. Water willow would be likely to expand, because of its tolerance of water level fluctuations. Aquatic beds could also decline if the fluctuations were prolonged enough for them to dehydrate. Combined, these two effects would degrade the wetlands to the more monotypic vegetation found on Narrows.

At Narrows, any change in project operation that would result in a greater winter drawdown and/or more routine and deeper draws in the summer would likely have an adverse impact on the water willow beds. While water willow is clearly tolerant of the current summer water level fluctuations, the combination of a winter drawdown and greater summer fluctuations could exceed this species' tolerance and result in a decline.

Finally, the wetlands study examined the impacts of piers on water willow at Narrows Reservoir. Results of this part of the investigation showed that water willow is generally capable of growing close to and around piers, even piers that are situated low to the water. However, associated uses of the pier for boating, jet skis, swimming and other activities clearly can disturb and destroy these beds. Other human disturbance activities along the shoreline such as the addition of sand and the intentional removal of aquatic plants were also observed to have a detrimental effect on water willow located along developed portions of Narrows Reservoir.

1.0 INTRODUCTION

Alcoa Power Generating Inc (APGI) is applying to the Federal Energy Regulatory Commission (FERC) for a new license for the Yadkin Hydroelectric Project. The Project consists of four reservoirs, dams, and powerhouses (High Rock, Tuckertown, Narrows, and Falls) located on a 38-mile stretch of the Yadkin River in central North Carolina (Figure 1-1). The Project generates electricity to support the power needs of Alcoa's Badin Works and its other aluminum operations, or is sold on the open market.

In this study, wetland and riparian habitats were mapped, inventoried, and characterized throughout the study area. The effects of existing Project operations, including reservoir operations and tailwater flows, were assessed, and potential changes to these habitats due to altered Project operations were considered. In addition, at Narrows Reservoir, the impacts of piers on water willow (*Justicia americana*) were assessed. Water willow is the dominant emergent aquatic vegetation throughout the Yadkin Project, and is important for shoreline stabilization and fish habitat. The North Carolina Wildlife Resources Commission (NCWRC) expressed particular concern for the impact of piers on this species in Narrows Reservoir, which is the only one of the four reservoirs to have both an abundance of water willow and piers.

2.0 BACKGROUND

As part of the relicensing process, APGI prepared and distributed, in September 2002, an Initial Consultation Document (ICD), which provides a general overview of the Project. Agencies, municipalities, non-governmental organizations and members of the public were given an opportunity to review the ICD and identify information and studies that were needed to address relicensing issues. To further assist in the identification of issues and study needs, APGI formed Issue Advisory Groups (IAG) to advise APGI on resource issues throughout the relicensing process. Through meetings, reviews and comments, the IAGs assisted in developing the Study Plans for the various resource issues, and will further review and comment on the findings resulting from the implementation of the study plans. The Wetlands, Wildlife and Botanical IAG was interested in the evaluation of wetlands and riparian habitats under existing conditions, assessing how these habitats could be affected by existing Project operations, and any changes that may occur as a result of altered Project operations, if proposed. A draft study report was provided to the WWB IAG for review and comments. Comments on the draft study report and how they were addressed in the final report are summarized in Appendix C. This Final Study Report presents the findings of the Wetlands and Riparian Habitat Assessment studies, following implementation of the Final Study Plan, dated June 2003.

In addition to a general assessment of Project wetlands, the NCWRC is also concerned with the impact of piers on emergent wetlands and aquatic beds, particularly at Narrows Reservoir, which are typically dominated by the species water willow. The NCWRC requested that this issue be a secondary focus of this study, and Narrows Reservoir was selected as the appropriate study area. Narrows Reservoir has an abundance of both water willow and piers, whereas the other three reservoirs may have an abundance of one but not both. In a study conducted for APGI by NC State University (Touchette et al. 2001), data on water willow growing under and adjacent to piers were collected for one growing season. The purpose of this portion of the study is to conduct a follow-up investigation, building on the information previously collected, to assess the relationship between piers and water willow.

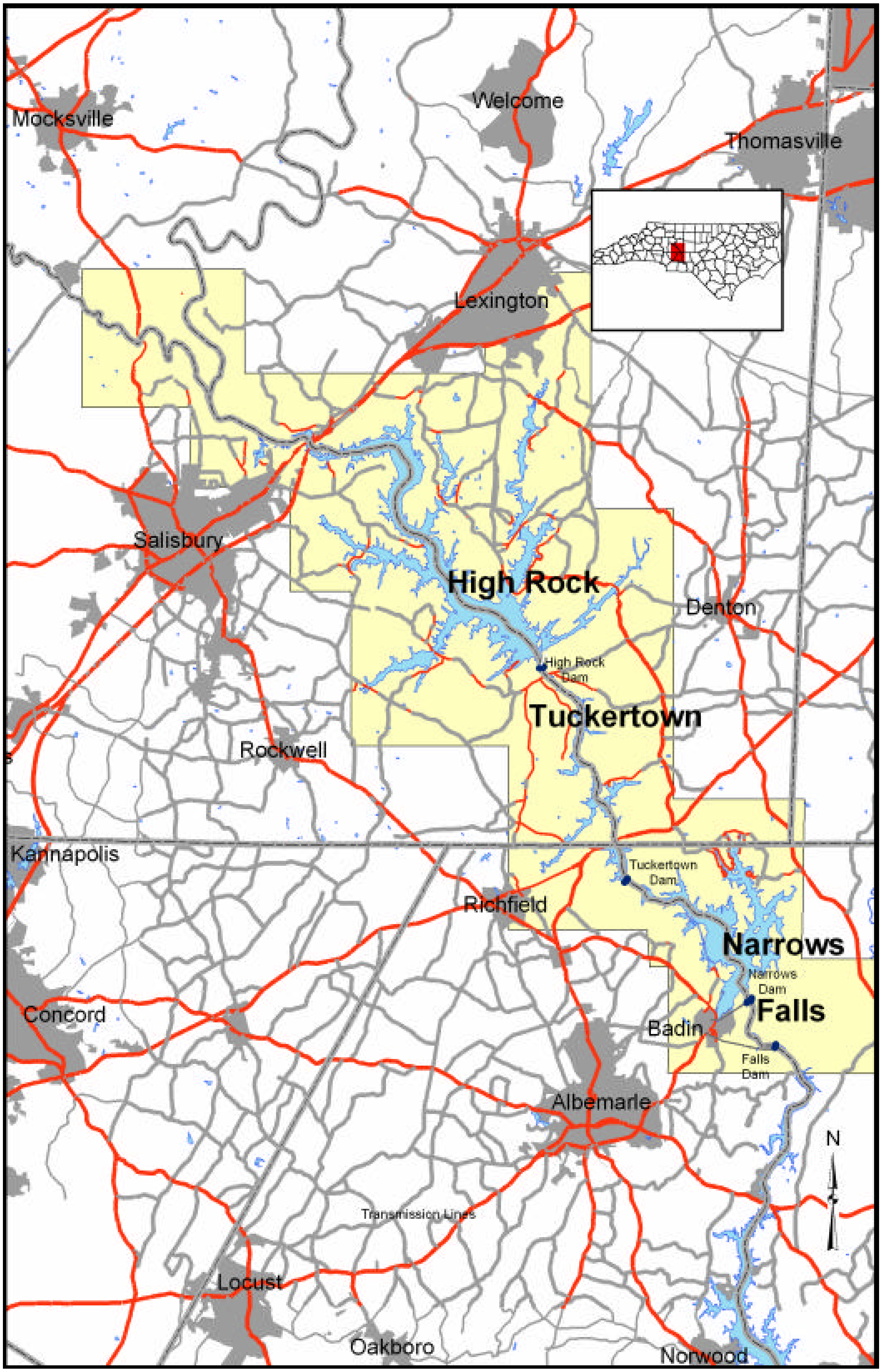

Figure 1-1. Locus of Yadkin Project.

3.0 STUDY AREA

The wetlands study area encompasses all four reservoirs under APGI management: High Rock, Tuckertown, Narrows, and Falls (Figure 1-1). Upstream, the study area extended to the upstream limit of the FERC Project boundary, approximately 1 mile north of Boone's Cave State Park on the Yadkin mainstem. Similarly, on the South Yadkin River, the study area extended to the upstream limit of the FERC Project boundary, approximately 6 miles from its confluence with the Yadkin River. Downstream the study area extended approximately 1 mile below Falls Dam, which was estimated to be the maximum extent of riverine flow in the Falls dam tailrace during low water on Tillery Reservoir. In accordance with the study plan, all wetlands and riparian habitats within the FERC Project boundary as well as all lands within 200 feet of the reservoir shorelines were included in the study area. In addition, the study area was extended to include the zone of influence of reservoir operations, which in a few places extended the study area beyond 200 feet.

The emergent wetlands on Narrows were assessed according to the distribution of piers constructed since 1997. While the entire shoreline of Narrows was reviewed, the pier study focused on Heron Bay and the northeastern arms of the reservoir where much of the new development has occurred.

4.0 STUDY PURPOSE AND OBJECTIVES

On March 13, and April 25, 2003 the Wetlands, Wildlife and Botanical IAG met and discussed objectives for the wetlands and riparian habitat study. Over the course of those discussions the following objectives were identified for the study.

- Identify and map vegetated wetlands and riparian habitats within the influence of reservoir water levels, including aquatic beds, emergent and shrub-wetlands and some forested wetlands.
- Evaluate effects of current Project operations, including reservoir water level fluctuations on these wetlands and riparian habitats.
- Evaluate how significant changes in Project operations, including both increasing and decreasing short-term and long-term reservoir drawdowns would impact existing wetlands, or would allow for additional wetland development.
- Qualitatively assess the effects of reservoir facilities (such as piers, boat ramps, beaches, bulkheads and other forms or shoreline hardening) on wetlands and riparian habitats, with a particular emphasis on the potential impact of piers on water willow at Narrows Reservoir.

The final study plan was distributed to the IAG in June 2003.

5.0 STUDY METHODS

5.1 HYDROLOGIC REGIME

To better understand the current hydrologic regime of the four Yadkin Project reservoirs, NAI determined the minimum, mean and maximum daily water level elevations in each of the four Yadkin reservoirs over a period of one year based on long-term records, as well as annual, monthly, weekly and daily minima, means, maxima and ranges in water level elevations based on the same long-term data record. The resulting summary of hydrologic conditions was used to assess the potential impact of water level fluctuations on the aquatic and riparian habitats contained within each reservoir.

The reservoir elevation data for this investigation were provided by PB Power in the form of Excel spreadsheets. Daily data were provided for the period of January 1, 1986 through December 31, 2003. The water level data for Narrows from November 21 through December 26, 2003 were excluded from the analysis because the reservoir was lowered 17 feet for the aquatic habitat survey (NAI 2004a). The daily values do not represent a daily mean, but simply a "snapshot" view of water levels on each day. Hourly data were provided for January 1, 1997 through December 31, 2003. The hourly data provide the best resolution for this type of analysis, particularly when evaluating daily statistics, but the seven-year period of record was not sufficient to adequately represent long-term averages. A preliminary analysis to see how well the daily values match a daily mean calculated from the hourly records was therefore conducted. For High Rock, Narrows and Tuckertown reservoirs, daily data from January 1, 1997 through December 31, 2003 matched daily means calculated from hourly data for that same time period extremely well[1]. In the Falls Reservoir, however, the relationship was significant but with a weaker correlation (R^2=0.51). The reason for this appears to be the greater degree to which water levels fluctuate in the Falls reservoir on a daily basis compared to the other reservoirs.

Since the annual, monthly and weekly statistics are based on a daily value (generally a daily mean), these were generated using the longer period of record (1986-2003) using the daily values, which were shown to provide a reasonable surrogate for daily means calculated from hourly values in three of the four reservoirs. This same approach was used for the Falls Reservoir despite a weaker correlation between hourly and daily data. An additional, more detailed comparison of each statistic using daily and hourly data for just 1997-2003 was then conducted for the Falls reservoir, to provide some judgment in interpreting the statistics generated from the long term daily records.

The 2004 water level data were processed separately from the 1986-2003 data to depict the water levels during the time of the botanical and wildlife field work. Provided by PB Power, the values were taken from the hourly data collected for midnight for each day. The 2004 data were compared to the long-term daily mean, and the driest year for the period of record, 2002. Because 2004 was extraordinarily wet during the latter part of the growing season, these years provide a broad spectrum of reservoir water levels and environmental conditions.

5.2 MAP OF WETLANDS AND RIPARIAN HABITATS

5.2.1 Photointerpretation

In late July of 2003, true color aerial photographs were taken of the of the four-reservoir Project area. The aerials for the Upper Yadkin were flown on August 28, 2003. The resulting stereopairs, at a scale of 1:9,600, showed aquatic and terrestrial vegetation at full leaf and water levels at or near full pond in all four reservoirs. A total of 311 individual 9-inch by 9-inch photographs covered the Project area in stereo at this scale, and delineations were made on approximately half of these.

A team of four scientists delineated upland and wetland cover types on these photographs using a Sokkisha MS-27 mirror stereoscope with a 3X binocular and an Old Delft ODSS III mirror

[1] A simple linear regression of Y=X, where Y is the mean daily elevation based on hourly records and X is the daily elevation from the daily records, resulted in R^2 values of 0.88 to 0.99 for the High Rock, Narrows and Tuckertown reservoirs.

stereoscope with 1.5 to 4.5 magnification. Cover types were marked on clear acetate overlaid on the photographs. On each photo, the delineators marked the apparent extent of full pond (shoreline), represented by the edge of water or edge of woody or upland herbaceous vegetation along the reservoir.

Wetlands were classified following the U.S. Fish and Wildlife Service method (Cowardin, et al. 1979). Mapping unit size for wetlands was ¼ acre, or 100 ft by 100 ft (1/8 inch square on the photos), and the labeled types included:

- **PFO1** – palustrine forested deciduous wetland,
- **PFO1c** – palustrine forested floodplain wetland, highly dependent on reservoir water levels,
- **PSS1** – palustrine scrub-shrub wetland,
- **PSS1p**– sparsely vegetated palustrine scrub-shrub wetland,
- **PEM** – palustrine emergent wetland,
- **PUB** – palustrine pond, unknown bottom,
- **LEM** – lacustrine emergent wetland (herbaceous wetland shoreline plants),
- **LAB** – lacustrine aquatic bed (submerged or floating leaved wetland plants),
- **REM** – riverine non-persistent emergent wetland,
- **RAB** – riverine aquatic bed, and
- **OW** – open water (reservoir or influenced by reservoir levels).

Several of these were combined into a common cover type in the final map. For instance, LAB and RAB are depicted as AB (Aquatic Bed) because the microhabitat in which this cover type occurred was more similar to a lacustrine condition (still water within the full pond line) even though several beds occurred within riverine habitat. The same applies to PEM, LEM and REM which were ultimately combined into a single EM (Emergent Marsh) cover type.

Terrestrial land use types within 200 feet of the shoreline and at least 400 feet long along the shoreline (1/2 inch on the photos) were classified as follows:

- **F -** forest – including forestland in any stage of succession from recently cut to mature, and including deciduous, coniferous and mixed forests,
- **S** – shrub, including areas, typically under powerlines, permanently maintained in the shrub/sapling stage,
- **G** – urban/recreational grasslands – including parks, golf courses and very large maintained lawns,
- **Ap** – agriculture, pasture – with no evidence of mowing or row crops,
- **Ac** – agriculture, crops – including row crops and hayfields,

- **R** – residential, including small mowed yards, outbuildings, and small patches of natural vegetation between houses,
- **C** – commercial/industrial, including adjacent parking areas, and
- **M** – bare soil or rock, mining, quarries, gravel pits.

Additional notations were made on each photo, including match lines, flightline and photo number, control points (road intersections or other landmarks for matching to base maps), and question marks for difficult areas where ground-truthing was deemed necessary.

During photo-interpretation, other resources were consulted for supporting information including hydric soil maps, National Wetland Inventory maps, field notes and photos, and a set of black and white stereo photos at a scale of 1:6,000 flown in March 1997. These photos were useful for discerning conifers from deciduous trees and shrubs; persistent emergent vegetation from non-persistent vegetation; soil drainage and topography under the canopy of forested wetlands; and other details revealed at the larger scale.

5.2.2 Image Transfer and Mapping

Completed delineations were subjected to the Quality Control Procedure (see below), photocopied, scanned, rubbersheeted/stiched together by a computer graphics expert and overlayed on electronic color orthophotos flown in March 2002 of the Project area. The Project limits and the shoreline within 200 feet of the reservoirs were established using a lakeshore polygon provided by PB Power and based on the March 2002 orthophotos. Printouts of this product were then reviewed prior to digitizing the cover type boundaries and developing a database using ArcView GIS versions 8.3 and 9.

APGI provided Normandeau with a GIS map of the reservoirs that had the shallow bathymetry depicted in 2-foot contours. The contour limit for High Rock was approximately 12 feet below full pond, 2 feet on Tuckertown, 17 feet on Narrows, and 2 feet on Falls. These contours were overlain on the vegetation map. However the field assessment indicated that almost all of the vegetated wetlands fell within the upper 3-5 feet of the reservoir beds, so the bathymetric contours were not used. The contours were used as part of the estimate for the potential acreage of additional in-pond vegetation during the analysis done to evaluate potential changes in reservoir water level regimes.

5.2.3 Office Quality Control Methods

Quality control (QC) was applied at several stages in the photo-interpretation process. As cover type delineations of a photo flightline were completed, 30% to 100% of the flightline was reviewed by one of the other delineating scientists for consistency and completeness. As errors, inconsistencies, or differences of opinion were encountered, notations were made on the photos for review, discussion and final modifications by the original delineator or a third delineator. Unresolved areas were marked for ground-truthing.

After acetates were scanned and electronically stretched to the base map, a printout was reviewed by a Senior advisor for completeness and consistency with delineation protocols. Cover-type boundaries were traced and digitized, and a database and legend developed for each cover type. Each delineator reviewed the portion of the printed cover type map for which he/she was responsible, and further ground-truthing commenced.

5.3 FIELD SURVEY

Photointerpreted wetland cover types and locations were verified in the course of field work. Areas of questionable identity were visited and the mapped lines and cover types evaluated and adjusted if necessary. General wetland cover types were characterized by visiting multiple wetlands within a given cover type and describing the plant community species composition and structure, soil characteristics, soil moisture, and ground features such as amount of litter, rockiness, and microtopography. Photointerpreted upland cover types were verified from the boat. These cover types were not groundtruthed in detail, with the exception of upland forests in the vicinity of several rare species habitats.

Ground-truthing visits were made to the Project area on several occasions, as listed below.

- October 20-24, 2003 – Investigation of “new” emergent vegetation on High Rock Reservoir; supplementary ground-truthing of all High Rock Reservoir wetlands as viewed from the water, and incidental ground-truthing of Narrows Reservoir.
- December 17-19, 2003 – Ground-truthing survey (primarily by boat) of wetlands around Narrows Reservoir during drawdown to calibrate the signatures observed on the photographs with the vegetation observed in the field, with particular attention to aquatic bed and emergent communities. Also a survey of the riverine and bottomland reaches of High Rock Reservoir was done.
- 2004 –Ground-truthing survey by boat and on foot of examples of all natural cover types within the Project area to verify accuracy of the cover type map. Most shorelines of the reservoirs were reviewed at least once during ground-truthing. Representative locations for all cover types were intensively surveyed to determine the structure and composition of the habitat. Three site visits were performed within the 2004 growing season to capture a broad range of conditions:
    - April 26 to May 4
    - June 14 to June 22
    - September 20 to October 3

Ground-truthing was performed by three senior field ecologists from Normandeau, who were periodically accompanied by a local botanist, Dr. Peter Diamond, from the North Carolina Zoological Park. Normandeau spent a total of 55 person-days in the field visiting representative cover types, verifying the cover type map, and collecting water willow data. At the representative cover types, data collected included plant species composition and abundance, wildlife observations, hydrologic evidence (scour, sediment deposition, flood marks, saturation), and surficial substrate features (stoniness, litter depth, coarse woody debris). Submerged aquatic vegetation was sampled using a rake to determine presence and species composition. The extents of beds of submerged aquatic vegetation were estimated in the office based on field notes and bathymetry because water clarity prohibited aerial photo interpretation or mapping in the field.

In the office, the cover type maps were revised to reflect the ground-truthing results of the field work. The final maps were subjected to another round of QC by an independent scientist reviewing sections of each reservoir and comparing the field note annotations to the cover type map. The approved maps were then analyzed in GIS (Arc View 9) to provide acreages of the various cover types in each reservoir.

5.4 ANALYSIS OF PROJECT OPERATION

A combination of hydrologic information, reservoir bathymetry, and shoreline inspection were used to assess the effects of current Project operations on natural resources around the reservoirs. Of particular interest to the Wetlands, Wildlife and Botanical IAG were

- the effects of water level fluctuations on vegetation communities,
- erosion from boat wakes on bordering wetlands in coves,
- the impact of a sand-and-gravel extraction facility at the upper end of High Rock on nearby wetland and riparian habitats, and
- the impacts of reservoir facilities and shoreline development on wetland and riparian habitats.
- a special emphasis was placed on the impact of piers on water willow beds in Narrows Reservoir.

Water Willow

In the 2004 NAI study, the distribution of water willow on Narrows was delineated as part of the cover type mapping. As described in the vegetation mapping methods section (Section 5.2), emergent and submergent vegetation communities were mapped on all four reservoirs from true color aerial photographs flown in mid-summer 2003, at a scale of 1:9600. Field verification of the mapped limits and species composition of the cover types occurred throughout the growing season in 2004. While the aerial photography was suitable for identifying the larger beds, it was less effective for detecting small or narrow stands of emergent vegetation. These are beds that were typically less than 6 feet wide, or occurred under trees overhanging the shoreline. To compensate for this difficulty, the cover type maps were supplemented in the field by a more qualitative assessment that estimated the percentage of the shoreline which supported water willow. As the shoreline was traveled, the percentage of the shoreline that supported water willow was noted in general categories: 0%, 1-20%, 21-40%, 41-60%, 61-80% and >80%. Almost 80% of the shoreline of Narrows was reviewed for this purpose. In the office, the perimeter of the shoreline falling into each category was measured. The beds were assumed to be 5 feet wide, and therefore the acreage of water willow formed by these small beds could be estimated. These small beds are not shown on the cover type maps, but add approximately 92 acres of emergent wetland on Narrows, or slightly more than the total mapped from aerials.

The Wetland and Riparian Habitat Study Plan (2003) called for sampling a set of 15 “old” piers, including the 5 studied by Touchette et al, (2001) and 15 “new” piers. The old piers were defined as those piers constructed prior to 1997 as delineated by PB Power on a black-and-white orthophoto dated March 1997. This delineation was laid over a true color orthophoto dated March 2002. Piers that were not delineated were assumed to have been constructed after 1997 and therefore were defined as new. The new piers were overlain on the cover type map and those that fell within water willow beds were identified as potentially suitable for the water willow site work. Approximately 20 piers were identified in the office prior to field work. All of these piers were located in Heron Bay, Gladys Fork and Reynolds Creek.

The field work for the water willow pier study occurred in late September 2004. The new piers identified in the office were visually located from the boat using shoreline configurations and other piers. Only piers which were located in beds of water willow or in potential water willow habitat were sampled. In many instances, some or all aquatic vegetation had been cleared adjacent to the dock and in front of other shoreline structures (retaining walls, boat launch ramps, boat houses, etc). These docks were kept in the study if water willow beds were robust on at least one side of the pier. Fifteen new piers were studied. At each pier, the study area was defined as within 20 feet of both sides of the pier, which is similar to the 8-m width of the study area of Touchette et al. 2001. Data collection included many features of the water willow bed, the dock and the adjacent shoreline. A sample form is provided in Figure 5.4-1. Key parameters included the length, width and water depth of the water willow bed on either side of the pier, the height and width of the pier within the water willow bed, land use features such as shoreline structures, if any, and management of the aquatic bed, if apparent. The permit number for each dock was recorded, which allowed us to collect information from APGI on the history of the pier, thus the date the pier was built or modified was available as a final check on the age of the pier. The permits for two piers indicated that they had been built or substantially modified before 1997, however the photos and field indicators suggested that recent disturbance or construction had occurred so these piers were retained as new in the study.

For the old piers (constructed prior to March 1997) and several additional new piers encountered after the fifteen were completed, data collection was more qualitative. The percent cover of water willow adjacent to, and under, the pier was estimated visually. The permit number and photodocumentation were taken, and the pier, other shoreline structures and impacts to water willow were described. In some instances, water willow bed characteristics such as width, percent cover and water depths were measured.

5.5 EFFECT OF ALTERED PROJECT OPERATION

One of the objectives of this study was to evaluate the potential impact to Project wetlands associated with altered reservoir water level regimes. The wetlands likely to be most affected by changes in the hydrologic regime are those that are strongly influenced by the current hydrology of the reservoirs. These include all wetlands occurring within the full pond limit of the reservoirs, and those bordering the shoreline that are low enough in elevation to be seasonally affected by changes in reservoir water levels. The cover types included aquatic beds, emergent wetlands, sparse scrub-shrub swamps, scrub-shrub swamps that occur along the edge of the reservoirs, and forested floodplain wetland. The only wetland cover type excluded from this analysis was the forested wetland, because this wetland type typically had a hydrologic regime that was less influenced by reservoir hydrology than by groundwater or other surface water (tributary streams or small ponds). All upland cover types were assumed to be unaffected.

The analysis was conducted using several simplified water level regimes that were developed to encompass the range of operational alternatives that are being considered in the relicensing. The water level alternatives evaluated included:

Yadkin Water Willow/Dock Survey Form

Date______________

Sample Label_____________________ Permit No.______________

Location ____

Water Willow Bed

Width: L________________________ Length: L________________________________

R________________________ R________________________________

Exposure bearing _____________ Fetch_________________________

%Cover: L____________________________ Height: L________________________________

R____________________________ R______________________________

Water depth:

Inner L________________Outer: L_______________________Average: L_________________

R__________________ R______________________ R_________________

Substrates____

Shoreline morphology ____

Other species ____

Dock

Length _________________Width_________________Height above full pond ______________

Shoreline structures ____

Shallow water use____

Shoreline vegetation: Canopy closure & structure______________________________________

Understory____

GPS coordinates: N___________________W_________________ Photos__________________

Sketch

Figure 5.4-1. Data collection form for water willow study.

- ***High Rock*** – three alternative water level regimes (Figure 5.5-1):
  - *Alternative 1 – Near-Full Year Round*; reservoir maintained within 3 feet of full year round;
  - *Alternative 2 – Extended Near Full Season*; a 10-foot average drawdown, similar to existing conditions but a longer full pond period, refilling in March rather than April and drawing down in November rather than mid-September;
  - *Alternative 3 – Additional Use of Storage*; drawing down 20 feet on average, with the same refill and drawdown schedule as existing, but refilling to within 5 feet of full pond (618.9 feet USGS, 650.0 feet Yadkin datum).
- ***Tuckertown*** – *Increased Short Term Fluctuations* - short-term reservoir fluctuations are increased to 3-5 feet, compared to the current 1-2 feet.
- ***Narrows*** – *Additional Use of Storage* - no large water level changes, but winter drawdown increased to 15 feet, and summer fluctuations more routine and deeper (5-10 feet).
- ***Falls*** – No water level changes were examined

While all of the existing wetlands were observed to occur within the upper 5-6 feet in all the reservoirs, the acreage of additional potential wetlands under the various hydrologic alternatives were estimated from the 2-foot bathymetric contour intervals. These data were evaluated for potential changes in species composition, structure and function, particularly to fish and wildlife for each cover type for the three hydrologic alternatives on each reservoir.

6.0 LANDSCAPE SETTING

6.1 VEGETATION

According to the ecoregion classification of the USDA Forest Service (1994), the Yadkin Project area lies within the Southern Appalachian Piedmont Section of the Southeastern Mixed Forest Province, Subtropical Division of the Humid Temperate Domain. The Piedmont landscape constitutes an irregular plain of ancient, chiefly pre-Cambrian and Palaeozoic rock that has disintegrated in place and received additional unconsolidated material from higher ground to the west. This plain ranges in elevation between about 250 feet and 1,100 feet in the Project area and immediate environs, the result of differential erosion that has produced occasional isolated heights (e.g. Bald Mountain) and moderately incised waterways. Erosion of the generally deep soils has been greatly accelerated by the past two centuries of intensive agriculture, chiefly for cotton. Average annual precipitation ranges from 45 to 55 inches. Temperature averages about 60 degrees F. The growing season lasts over 200 days. Natural vegetation in a relatively undisturbed condition supports deciduous and evergreen trees in roughly equal proportions. The Yadkin River is one of the principal rivers of this geographic Section.

6.2 SUBSTRATES

Within the reservoirs, the vast majority of the substrates exposed during drawdown were classified as mud/sand/clay during the aquatic habitat surveys performed as part of the FERC relicensing effort (Normandeau 2004a). This was consistent with field observations in which mineral fines were the

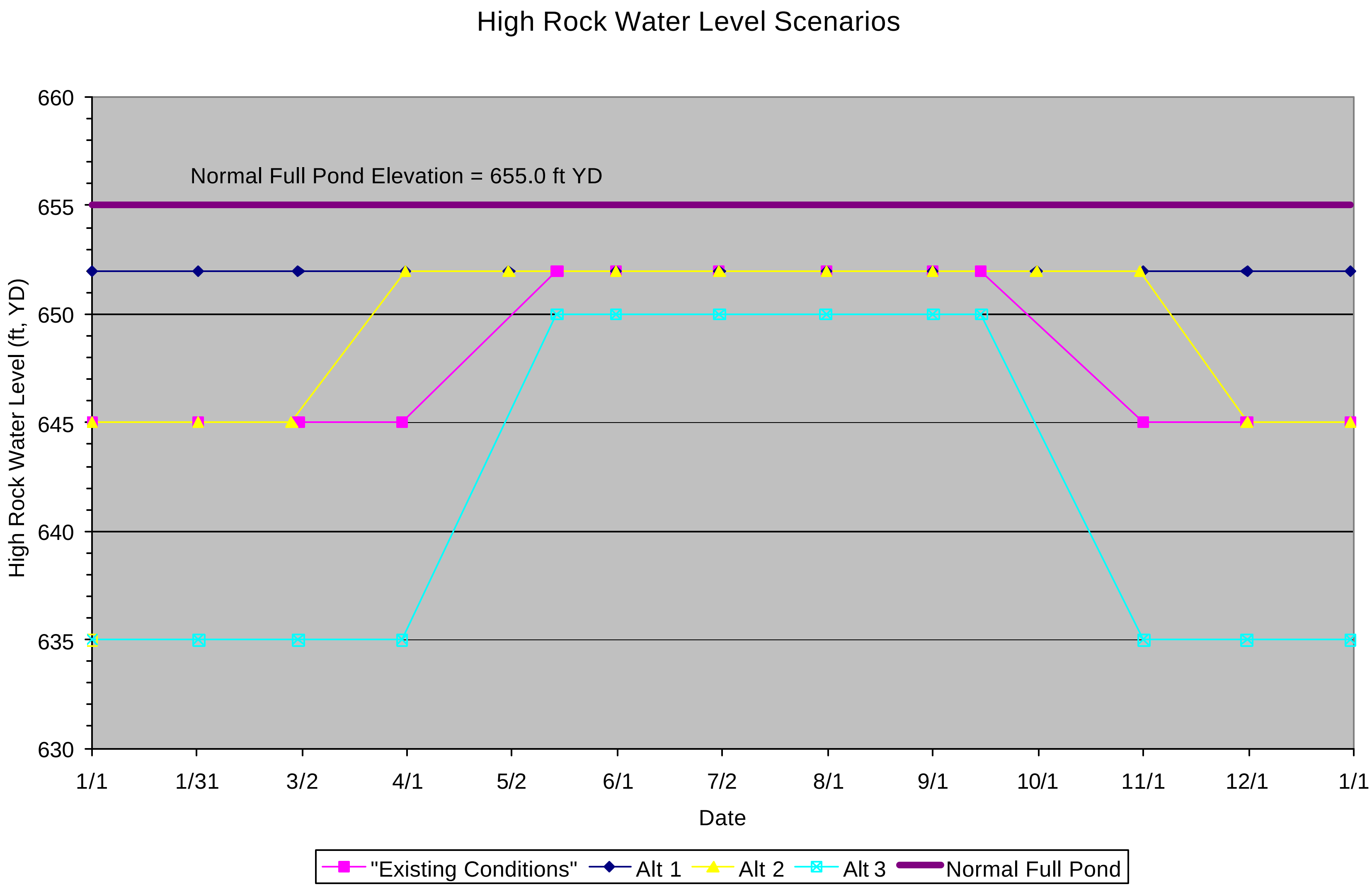

Figure 5.5-1. High Rock water level scenarios provided by APGI.

dominant substrate type in both the vegetated and unvegetated shallows. Several notable exceptions occur on Tuckertown and Falls where ledge and rock were the prevalent shallow substrate along steep shoreline sections. On High Rock, boulders, ledge, cobble and gravel collectively composed less than 2% of the substrate in the drawdown zone. Artificially-placed items such as trees, stumps, and tires which are placed by agencies and home owners to provide fish habitat as well as docks, riprap and other shoreline structures occupied another 2.5% of High Rock's drawdown zone.

Within 200 feet of the reservoirs, the soils are primarily formed from residuum weathered from fine-grained metamorphic rock or igneous pyroclastic rocks such as Carolina slate, phyllite or sericite schist. The riverine system upstream of the reservoirs is dominated by moderately broad, nearly level floodplains adjacent to the river. The side slopes of the reservoirs are generally steep with slopes ranging from 8 to 45%. Depth to bedrock is variable ranging from exposed outcrops to greater than 40 inches in depth. Common soils within the uplands include Appling sandy loam, Enon fine sandy loam, Wedowee sandy loam, Pacolet sandy loam, and Pacolet sandy clay loam. The degree of surface boulders varies within the Study Area with the majority of soils having few surface boulders compared to the Uwharrie stony silt loam, which has slopes ranging from 15 to 45%, and is very bouldery.

Table 6.2-1 provides a summary of hydric soils that potentially may occur within the Project Area. "A hydric soil is a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part" (Federal Register, July 13, 1994, http://soils.usda.gov/use/hydric/ntchs/tech_notes/note1.html, December 14, 2004). Hydric soils are used as one of the parameters in defining wetlands according to the 1987 *Corps of Engineers Wetlands Delineation Manual*.

Table 6.2-1. Summary of hydric soils that may occur within the Project Area.

Map Unit Name	**Hydric inclusions[1]**	**Normal Location**	**Flood Frequency**
Altavista sandy loam	1	Depressions adjoining uplands	Occasionally
Armenia silt loam[2]	**1,3**	**Depressions**	**Occasionally**
Chewacla loam	1	Adjoining upland sideslopes	Frequently
Cid-Lignum Complex	1	Depressions, along drainageways	
Helena sandy loam	1	Depressions, along drainageways	
Iredell loam	1,3	Depressions	
Kirksey-Cid Complex	1	Depressions	
Lignum silt loam	1	Depressions, along drainageways	
Oakboro silt loam	1	Depressions, along drainageways	Frequently
Roanoke loam	**1**		**Occasionally**
Sedgefield fine sandy loam	1	Depressions, along drainageways	
Wahee loam	1,3	Depressons, along drainageways	Occasionally

[1] Hydric codes:

1. Hydric soils only because of saturation for a significant period during the growing season.
2. Hydric soils that are frequently flooded for long or very long periods during the growing season.
3. Hydric soils that are ponded for long or very long periods during the growing season.

[2] Bolded map units are all hydric or have hydric soils as a major component. Plain text map units have inclusions of hydric soils or have wet spots.

6.3 HYDROLOGIC REGIME

6.3.1 Long-term Water Levels

High Rock Reservoir

Daily water levels in the High Rock reservoir over the18-year period of record are plotted in Figure 6.3-1. Full-pond elevations have occurred during all months of the year, though more frequently during late winter and early spring. Water levels in the reservoir were generally highest during the spring and declined as summer progressed, with the lowest daily values observed in July and August. Out of the four reservoirs in the Yadkin system, High Rock exhibited the greatest range in elevation on an annual basis (Table 6.3-1). On the shorter time scales, however, elevations varied to a similar or lesser extent than in the other reservoirs, and declined to zero at the weekly and daily time scales.

Tuckertown Reservoir

Daily elevations in the Tuckertown reservoir exhibited a less distinct seasonality compared to the High Rock reservoir (Figure 6.3-2), although minimum elevations on the monthly, weekly and daily time scales also occurred during July (Table 6.3-1). Overall, elevations within the Tuckertown reservoir were the most stable and exhibited the smallest range of variation of each of the four reservoirs, on all time scales except for the daily range.

Narrows Reservoir

The Narrows reservoir showed a greater degree of seasonal change compared to Tuckertown and Falls, but less than that observed in High Rock (Figure 6.3-3). On average the reservoir water levels were highest in late March through April, then declined to a September low. Refill occurred through the fall and early winter. Minimum water levels were observed in late winter and late summer, with reservoir maxima at full pond almost continuously from mid-January through early May.

Falls Reservoir

Although water levels in the Falls reservoir showed the highest degree of daily, weekly and monthly variability (Table 6.3-1), overall there was no discernible seasonal pattern apparent in the long term daily records (Figure 6.3-4). Extreme low water events in March 1998, September 1993 and mid-October in 1988 were the source of the most of the minimum values observed on each time scale examined. A further analysis of how well results using the daily values compared to those generated from daily means based on hourly data for the Falls reservoir was conducted, since initial analyses indicated that the relationship between the two was not as strong as for the other three reservoirs. Looking just at 1997-2003, there were few differences in the results using the two different sets of records on an annual, monthly and weekly basis (Table 6.3-2). In fact, results for the shorter period of record, whether for daily or hourly data, were not substantially different than those based on the 18 year period of daily records.

6.3.2. 2004 Water Levels

Most of the field work for the wetland and terrestrial habitat evaluations was performed in 2004. To provide some perspective on the hydrologic conditions observed during field work, the daily water levels in 2004 (January to October) were overlain on the historical daily mean water levels for the period January 1986 to October 2004, along with the daily water levels recorded in 2002 (Figures 6.3-5 to 6.3-8). 2002 data were included because of the extremely low flows observed in that year compared to the above-average flows of 2004. Water levels in the Yadkin Project reservoirs varied in response to changes in their storage, which is dependent upon changes in their inflow and outflow.

Table 6.3-1. Summary of water elevations (feet USGS) statistics in the Yadkin reservoirs based on daily data (1986-2003)[a] and hourly data (1997-2003)[b].

Time Scale	RESERVOIR (Normal Full Pond Elevation)							
	High Rock (623.9 FT)		Tuckertown (564.7 FT)		Narrows (509.8 FT)		Falls (332.8 FT)	
	Statistic	Date(s)	Statistic	Date(s)	Statistic	Date(s)	Statistic	Date(s)
Annual Range[a]								
Minimum	8.83	1990	1.60	1988	2.19	1989	2.60	1994
Mean	13.49		2.42		4.09		5.90	
Maximum	23.62	2002	3.30	2000	11.92	2002	17.83	1998
Monthly Range[a]								
Minimum	0.88	Jun-99	0.25	*	0.30	Feb-98	0.57	Jul-87
Mean	4.38		1.22		1.50		2.01	
Maximum	15.66	Feb-89	2.90	Mar-91	8.07	Oct-95	17.67	Mar-98
Monthly Elevation[a]								
Minimum	599.86	Jul-02	561.38	Jul-00	497.82	Aug-02	314.80	*
Mean	618.87		563.75		508.23		331.47	
Maximum	623.90	*	564.70	*	510.30	Oct-90	332.80	*
Weekly Range[a]								
Minimum	0.00	*	0.00	*	0.00	*	0.00	*
Mean	1.62		0.60		0.59		1.13	
Maximum	10.35	29-31 Dec-96	2.90	3-9 Mar-91	8.07	1-7 Oct-95	17.51	1-7 Mar-98
Weekly Elevation[a]								
Minimum	599.86	14-20 Jul-02	561.38	2-8 Jul-00	497.82	25-31 Aug-02	314.80	*
Mean	618.84		563.75		508.22		331.47	
Maximu m	623.90	*	564.70	*	510.30	14-20 Oct-90	332.80	*
Daily Range[b]								
Minimum	0.00	*	0.00	*	0.00	*	0.00	*
Mean	0.38		0.32		0.20		1.09	
Maximum	4.02	15 Feb-97	2.68	14 Jun-00	1.60	21Mar-03	17.51	6 Mar-98
Daily Elevation[b]								
Minimum	599.82	20 Jul-02	561.38	8-9 Jul-00	497.71	31 Aug-02	314.80	*
Mean	618.28		563.70		508.22		331.54	
Maximum	623.90	**	564.77	10 Jan-00	509.91	29 Aug-02	332.90	20 Mar-03

* Occurred more than once during period of record.

** Occurred multiple times between 24 April and 4 May 1997, 28-31 January 1998, 5-7 February 1998, 10-13 March 1998, 18-25 April 1998, 8-12 May 1998, and on several dates in March, April, July, August and September of 2003.

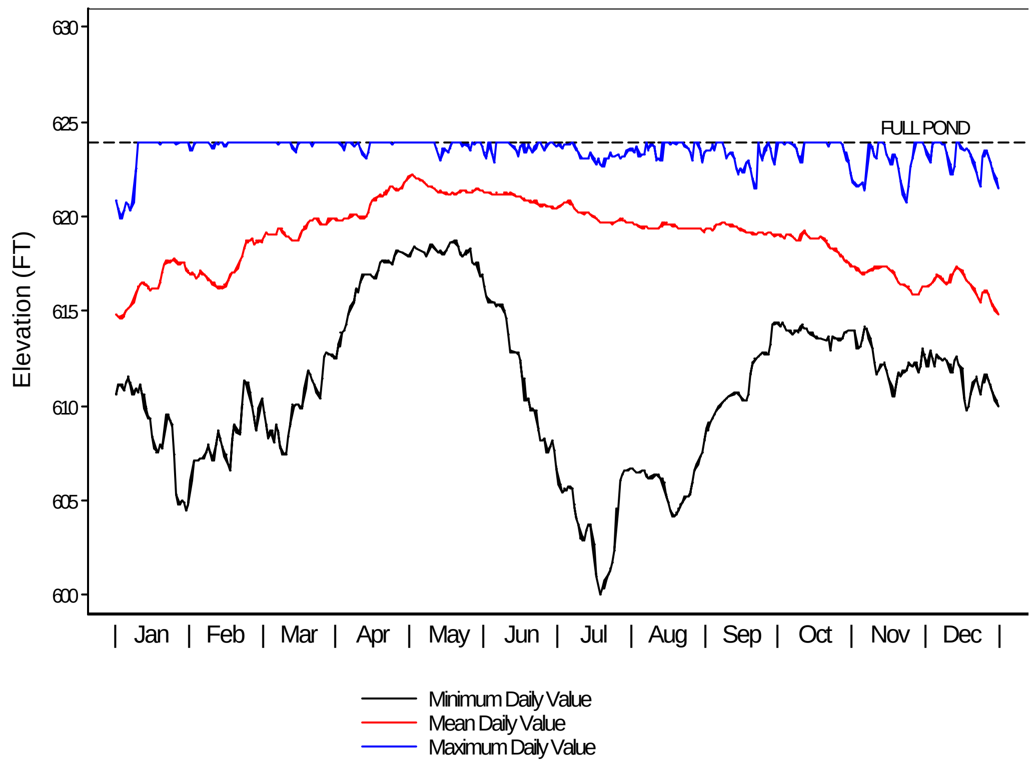

Figure 6.3-1. Minimum, mean and maximum daily water level elevations (USGS datum) in High Rock Reservoir for the period of January 1, 1986 to December 31, 2003.

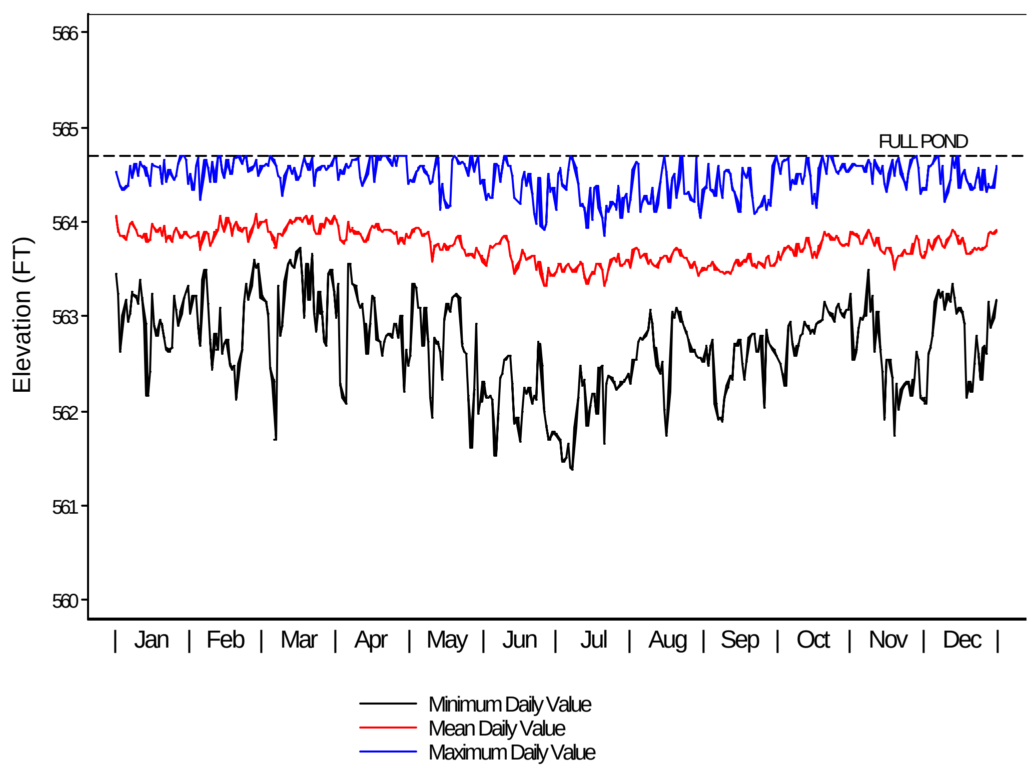

Figure 6.3-2. Minimum, mean and maximum daily water level elevations (USGS datum) in Tuckertown Reservoir for the period of January 1, 1986 to December 31, 2003.

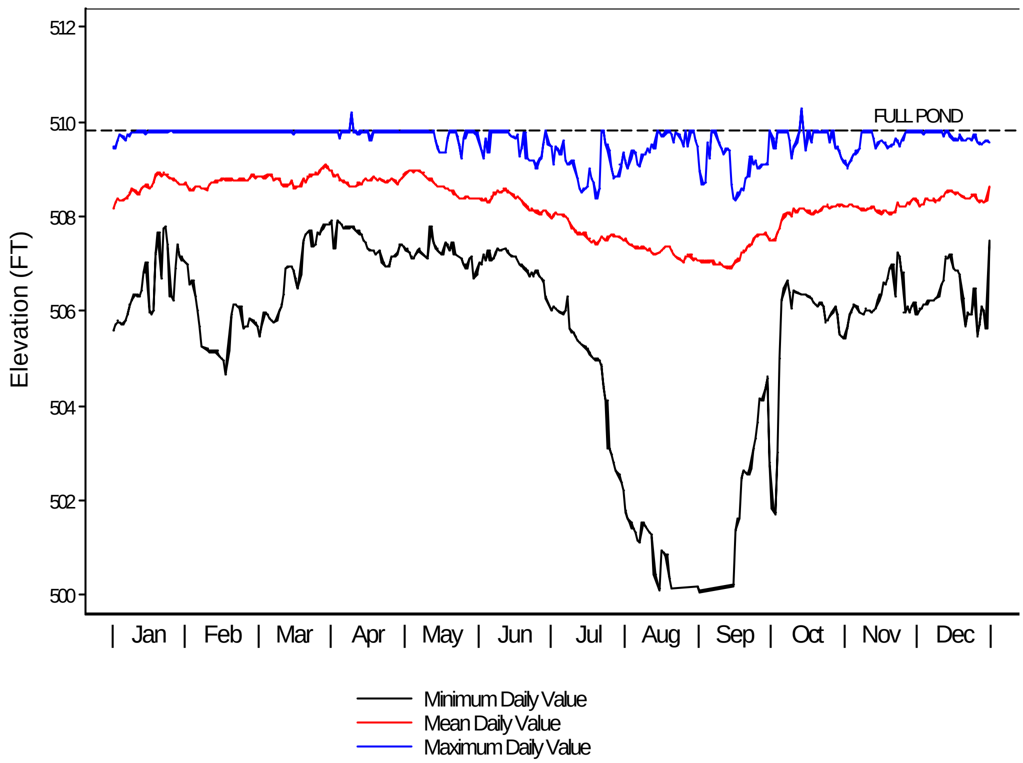

Figure 6.3-3. Minimum, mean and maximum daily water level elevations (USGS datum) in Narrows Reservoir for the period of January 1, 1986 to December 31, 2003.

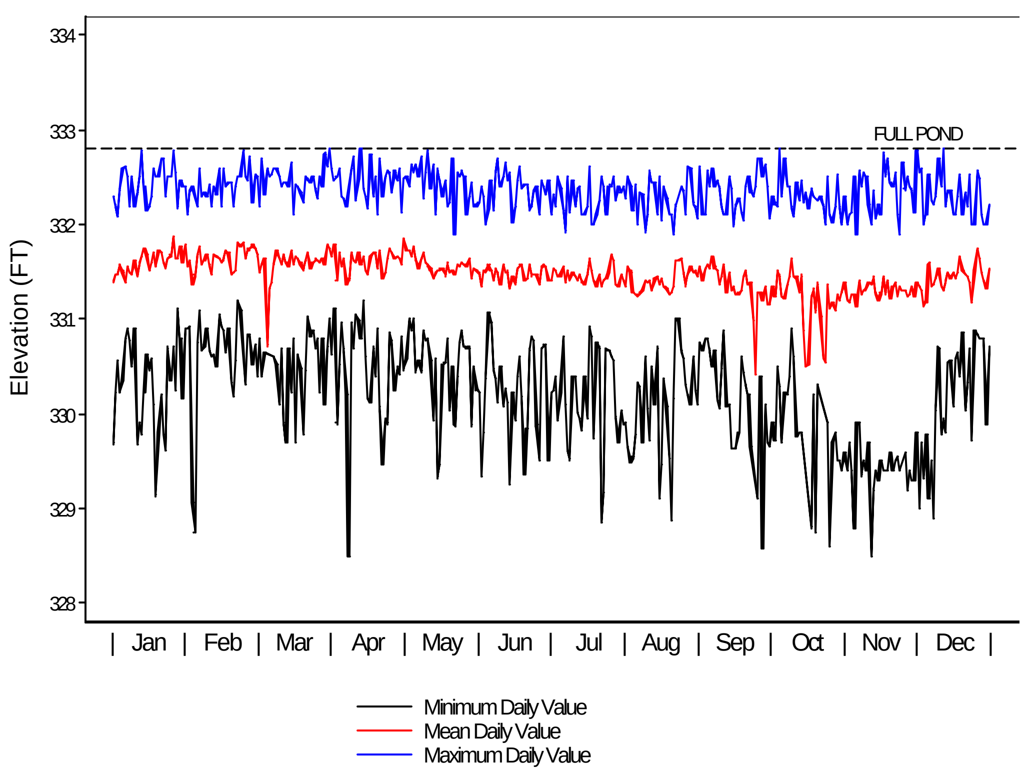

Figure 6.3-4. Minimum, mean and maximum daily water level elevations (USGS datum) in the Falls Reservoir for the period of January 1, 1986 to December 31, 2003.

Table 6.3-2. Comparison of water elevation analyses for Falls Reservoir using daily and hourly data for the period of 1997-2003.

Time Scale	DATA SOURCE			
	Daily Records		Hourly Records	
	Statistic	Date(s)	Statistic	Date(s)
Annual Range				
Minimum	2.86	1997	3.33	1997
Mean	5.63		6.10	
Maximum	17.83	1998	17.99	1998
Monthly Range				
Minimum	0.62	Mar-97	1.00	Jan-97
Mean	2.35		3.19	
Maximum	17.67	Mar-98	17.94	Mar-98
Monthly Elevation				
Minimum	314.80	Mar-98	314.80	Mar-98
Mean	331.53		331.55	
Maximum	332.80	Apr-01	332.90	Mar-03
Weekly Range				
Minimum	0.15	26 Jan – 1 Feb-97	0.15	26 Jan – 1 Feb-97
Mean	2.28		2.28	
Maximum	17.66	1-7 Mar-98	17.66	1-7 Mar-98
Weekly Elevation				
Minimum	314.80	1-7 Mar-98	314.80	1-7 Mar-98
Mean	331.54		331.54	
Maximum	332.90	16-22 Mar-03	332.90	16-22 Mar-03

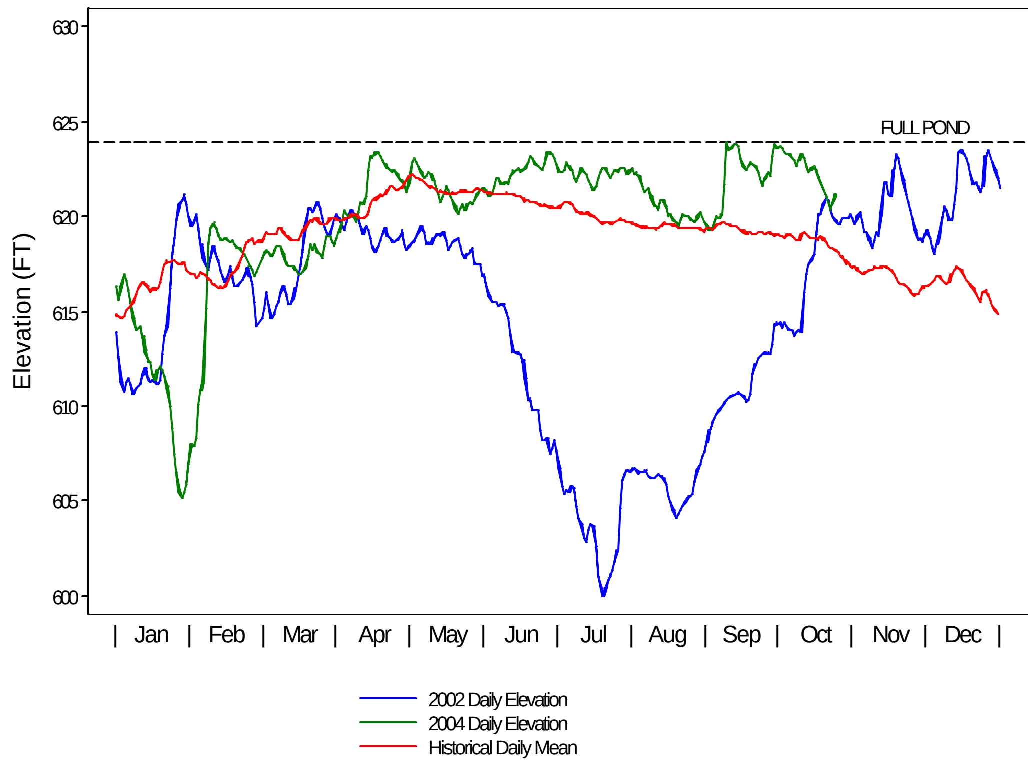

Figure 6.3-5. Comparison of 2004 water level elevations (USGS datum) with long-term mean, and 2002 drought at High Rock Reservoir.

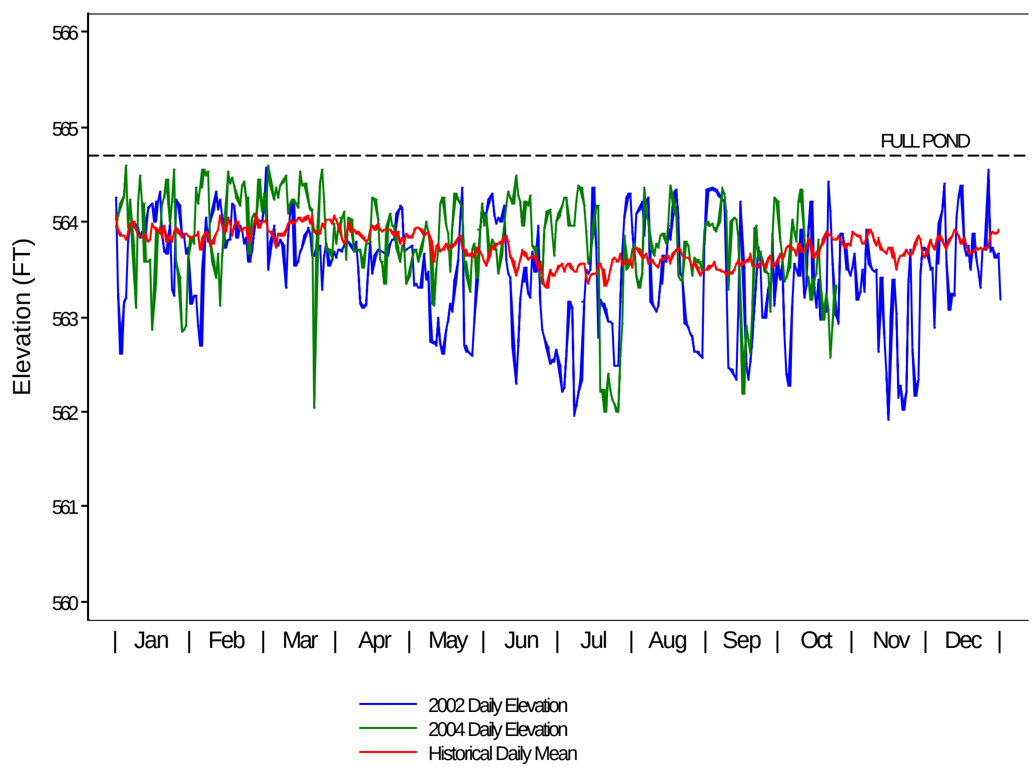

Figure 6.3-6. Comparison of 2004 water level elevations (USGS datum) with long-term mean, and 2002 drought at Tuckertown Reservoir.

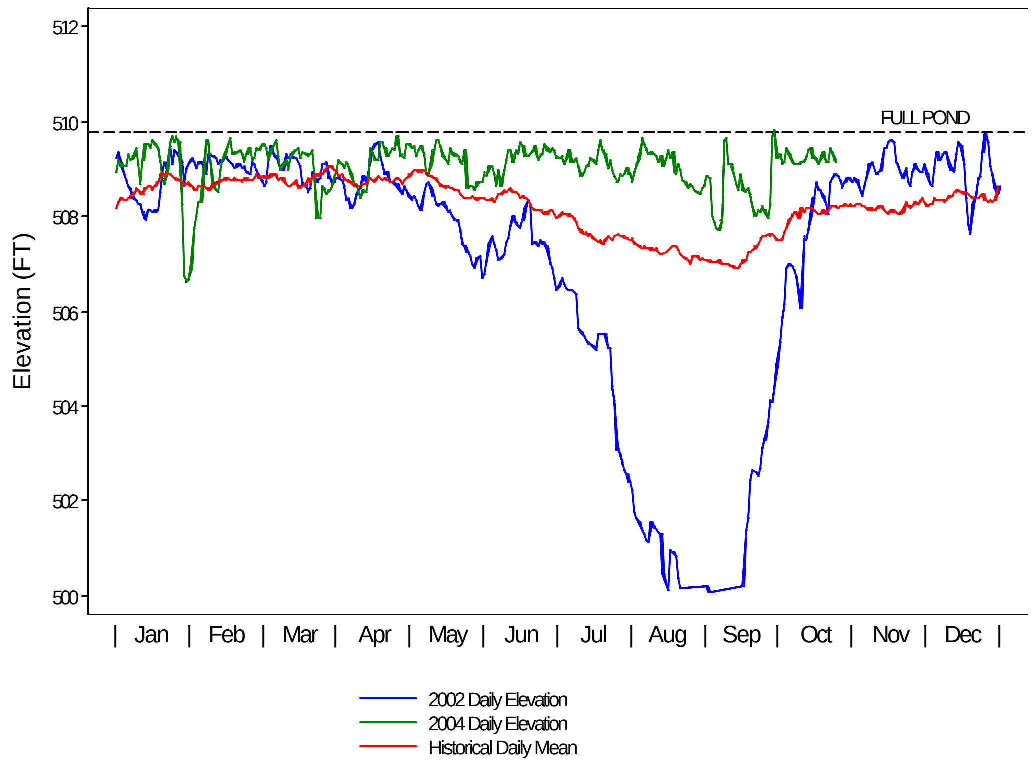

Figure 6.3-7. Comparison of 2004 water level elevations (USGS datum) with long-term mean, and 2002 drought at Narrows Reservoir.

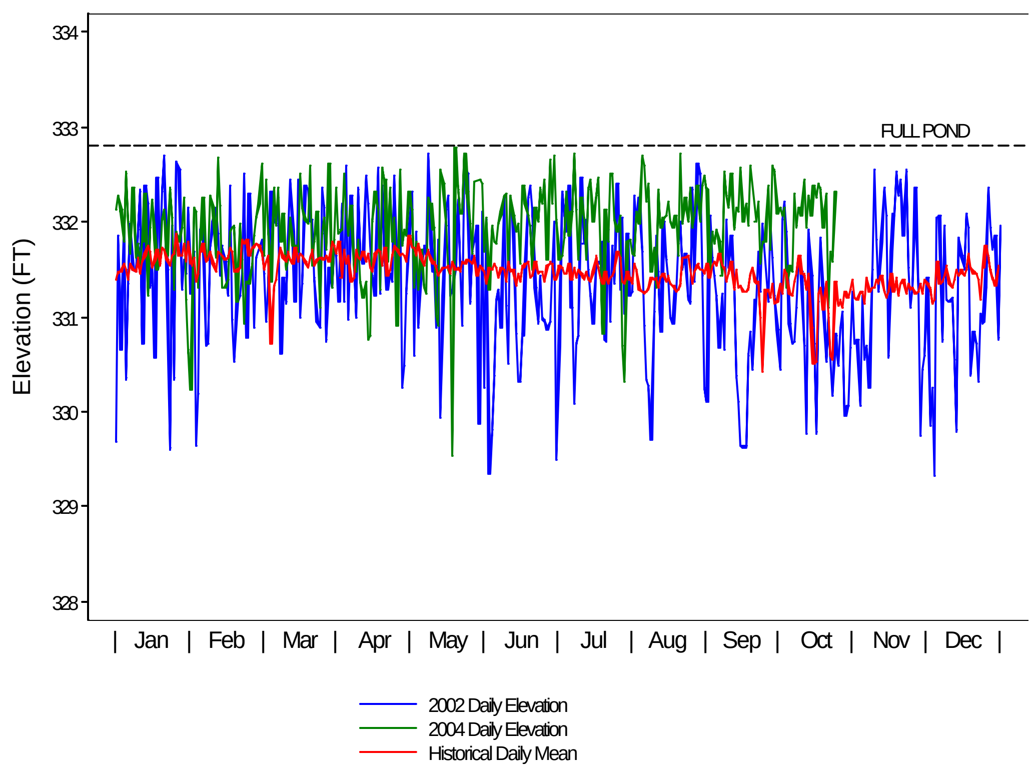

Figure 6.3-8. Comparison of 2004 water level elevations (USGS datum) with long-term mean, and 2002 drought at Falls Reservoir.

Factors controlling inflow included streamflow from tributary streams and for the three downstream reservoirs, the hydropower operations, which also controls the outflow from each of the reservoirs.

When compared with the three downstream reservoirs, High Rock has experienced the greatest range in daily mean water levels over the period of a year (Figure 6.3-5). This is due to its dependence on inflows from the Yadkin River and its large storage volume (234,100 ac-ft.) for hydropower production. During the study period (June 1999 to October 2004), below normal inflows to High Rock Reservoir were experienced from mid-1999 to the beginning of 2003. The USGS (2003) has noted that streamflow conditions in North Carolina were below normal for the water years 1998 to 2003, when below average precipitation was recorded in drainages across the state. The lowest water levels recorded in High Rock Reservoir, during the study period, occurred during the summer months of 2002, with water levels up to 19.5 feet lower than the historical daily mean. The decline in water levels beginning in May 2002 and into July 2002 reflects the decline in inflow from its major contributing drainages, the South Yadkin River and the Yadkin River. During the 2002 water year (October 2001 to October 2002) historical low annual mean flows were recorded for both of these drainages. The annual mean flows for both the South Yadkin River and the Yadkin River in 2002 were roughly one third their period of record annual means. The water levels slowly rebounded in late 2002 to above average in response to increased precipitation and inflows.

In 2004, when the wetlands and terrestrial studies were performed, water levels in High Rock Reservoir were, for the majority of the year first quarter of the year, at or below the historical daily mean (Figure 6.3-5). This was in response to lower than average inflows. From May to October, in response to higher inflows, water levels in the High Rock Reservoir were higher than average.

Of the three remaining reservoirs, only Narrows experienced prolonged below normal water levels in 2002 (Figure 6.3-7). While only half the size of High Rock Reservoir, Narrows storage volume (129,100 ac-ft) is 19 times larger than Tuckertown (6,700 ac-ft) and 31 times larger than Falls (4,190 ac-ft). Lower than average water levels were experienced at Narrows in the summer of 2002. Water levels during this period were up to 6.5 feet lower than the historical daily mean. As mentioned previously, these low water levels were in response to below normal streamflow conditions in the drainage basin and the required downstream releases in accordance with the Drought Contingency Plan.[2] In 2004, water levels at Narrows were generally above the historical daily mean, except for short periods in the winter months (January through March).

The Tuckertown and Falls Reservoirs are relatively small impoundments and have minimal storage compared with High Rock and Narrows. As a result, the water levels in these reservoirs vary over a limited range, four feet or less at Tuckertown and three feet or less at Falls (Figures 6.3-6 and 6.3-8). In addition, extended periods of below or above average water levels are absent, although the frequency of water level changes is much greater at both of these reservoirs.

7.0 SUMMARY OF EXISTING STUDIES AND INFORMATION ON THE PROJECT AREA

In the last several decades, natural areas inventories for Rowan County (Baranski 1994) and for the Yadkin River corridor (Baranski 1993) have occurred. These studies have included floristic studies and descriptions of portions of the Yadkin Reservoirs, as did a management plan for the Uwharrie

[2] APGI in cooperation with NC, SC and Progress Energy prepared and implemented a Drought Contingency Plan during the summer of 2002.

National Forest (USFW 1986). The Uwharrie National Forest also recently completed a botanical survey (Sharp, 2004)

Three previous studies of water willow on Narrows Reservoir have occurred since 1997. The first is a study by Boaze (1997) which characterized the distribution of water willow on Narrows, on the basis of one map in 1991 and a second survey later in the 1990's. A second study was completed as part of the Narrows and Falls Reservoirs Shoreline Management Plan (Yadkin 1999). This study included a less detailed map of "emergent/submergent wetlands", which one can assume were dominated by water willow. In a third study performed by North Carolina State University, water willow was field mapped and sampled for productivity, water quality parameters, distribution relative to exposure and adjacent shoreline land use, and the effects of boat docks and piers (Touchette et al. 2001). This study also included an assessment of fish communities within and immediately adjacent to the water willow beds.

Of key interest to the present assessment are the water willow distribution results of the three studies. While all three studies yielded similar results, Touchette et al (2001) gave the most detailed breakdown of the distribution of water willow on Narrows. These authors identified three areas supporting the largest stands of water willow: Heron Bay, the southwestern cove of Narrows, and the Yadkin River below Tuckertown dam. Other areas of abundant water willow include Garr Creek, Gladys Fork and Reynolds Creek. The shoreline along the Uwharrie National Forest supported relatively small stands of water willow, primarily due to its steep slope.

The effects of piers on water willow were examined by Touchette et al. (2001) at five piers that had well developed water willow beds on both sides of the pier. Parameters measured included dock height, dock width, percent light transmission, shoot density, above- and below-ground plant biomass, and mean plant weight. Light transmission and the plant characteristics were measured adjacent to the dock, and at 2-m intervals to 8 m distance on both sides of the piers. Their study found that water willow occurrence could be strongly correlated with light availability. On average, light transmissivity was 10% of full intensity underneath the piers, increased to 70% at 2 m from the piers, and was up to 80-90% at 4-8 m from the piers. Plant productivity followed the trends in light availability, with no plants occurring under the docks, and the highest productivity at 4-8 m. At 2 m, the productivity was somewhat less than at 4-8 m. The authors estimated that little water willow growth occurred at light transmission of less than 60%.

8.0 EXISTING CONDITIONS

8.1 VEGETATION CHARACTERIZATION

The cover types around the four reservoirs were very similar in species composition and structure. Slope, aspect and surficial geology were more important determinants than water body, with the exception of the riverine sections above High Rock. Here, river processes are the dominant influence on the formation of wetlands, and have resulted in a sub-type of floodplain wetland distinct from those of the reservoirs. This distinction aside, in general, the cover type descriptions are common to the entire Project Area (Figures 8.1-1 through 8.1-5; Table 8.1-1).

8.1.1 Palustrine Forested Wetlands

This wetland type occurred above the full pond line, typically small in area and associated with small streams or the upper reaches of larger streams. Often linear in shape as they bordered a stream, the hydrology of these wetlands within 200 feet of the reservoir was a combination of groundwater,

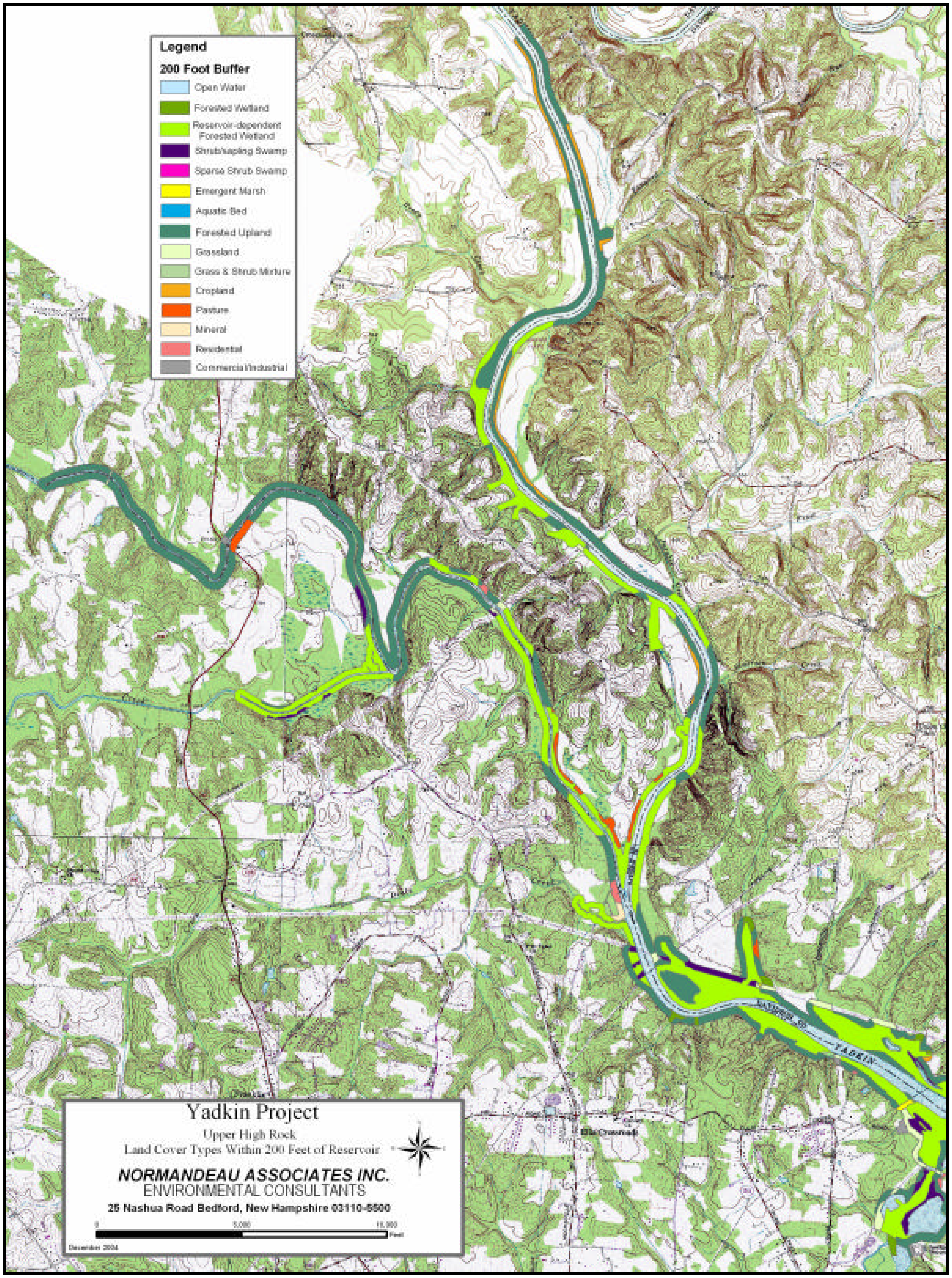

Figure 8.1-1. Cover types within the 200-foot Project Area on Upper High Rock Reservoir.

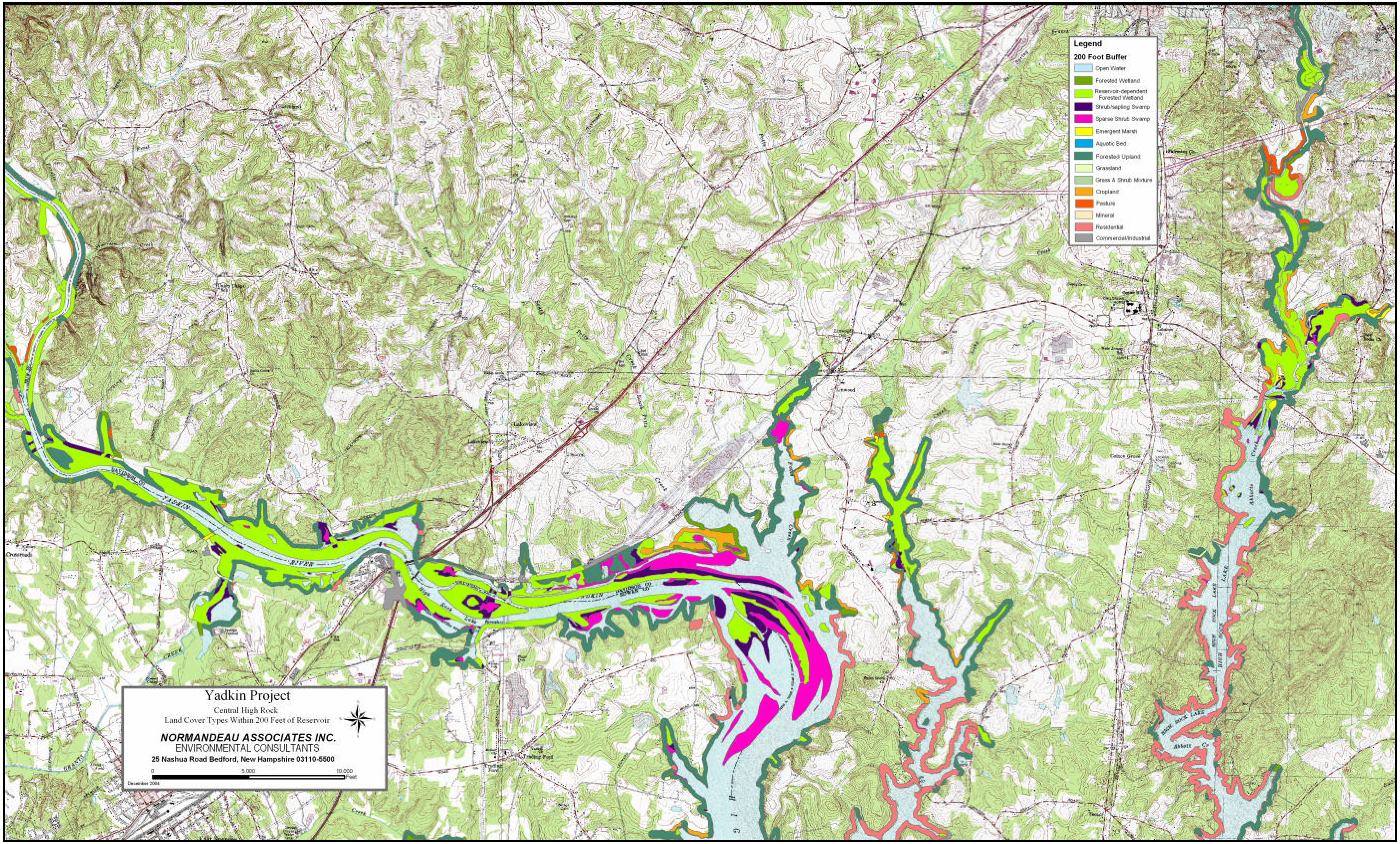

Figure 8.1-2. Cover types within the 200-foot Project Area on the Central Section of High Rock Reservoir.

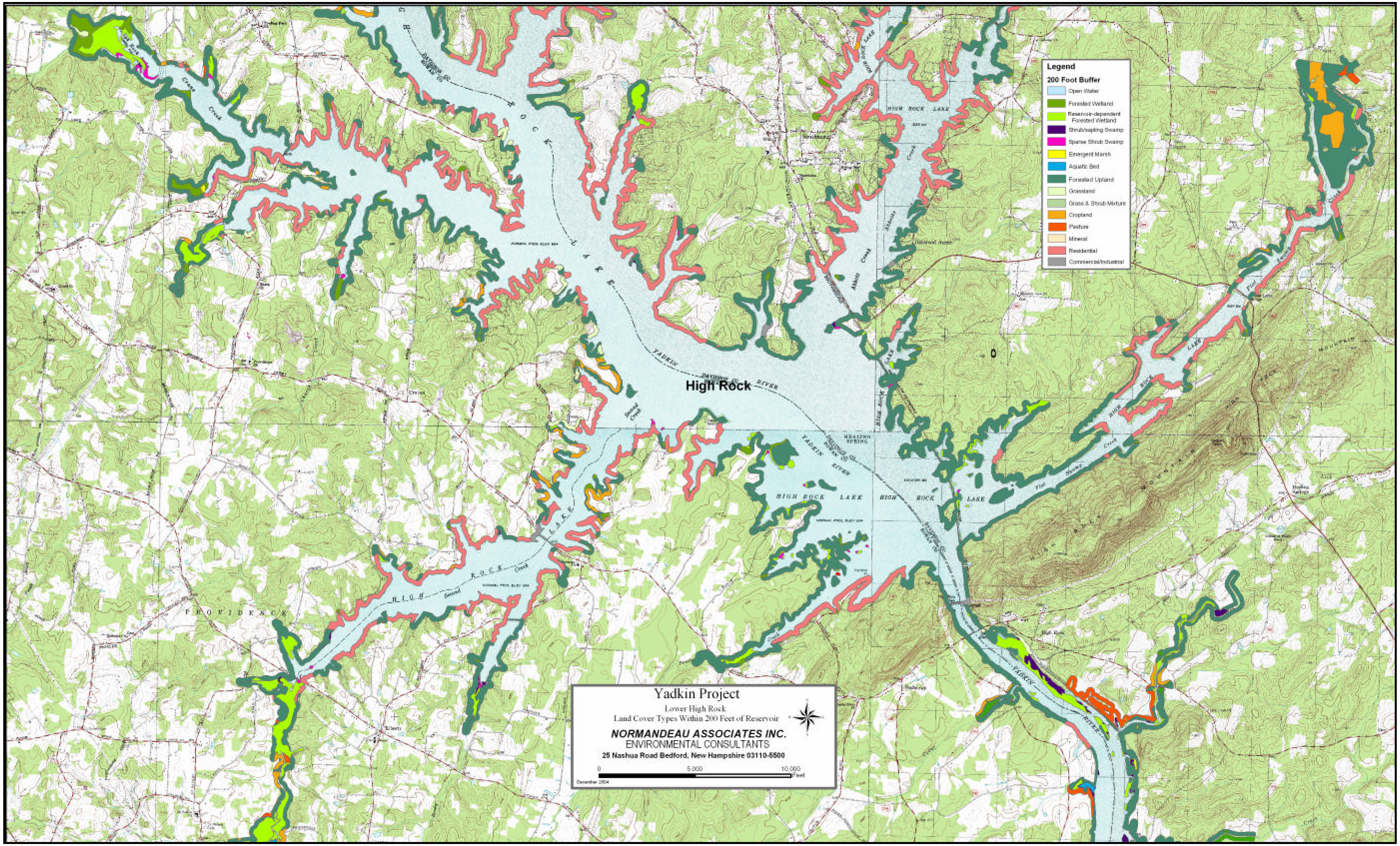

Figure 8.1-3. Cover types within 200-foot Project Area on Lower High Rock Reservoir.

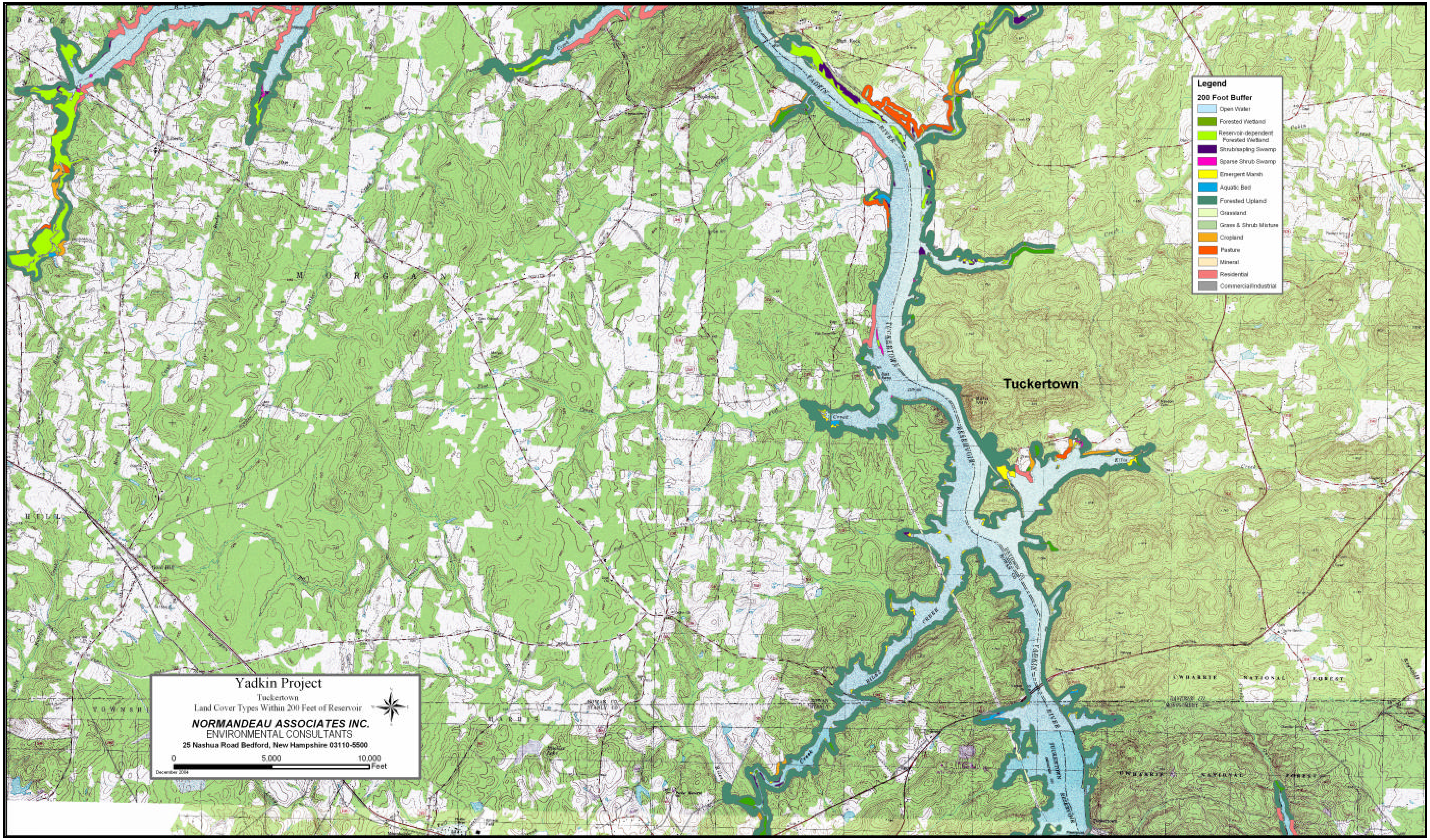

Figure 8.1-4. Cover types within 200-foot Project Area on Tuckertown Reservoir.

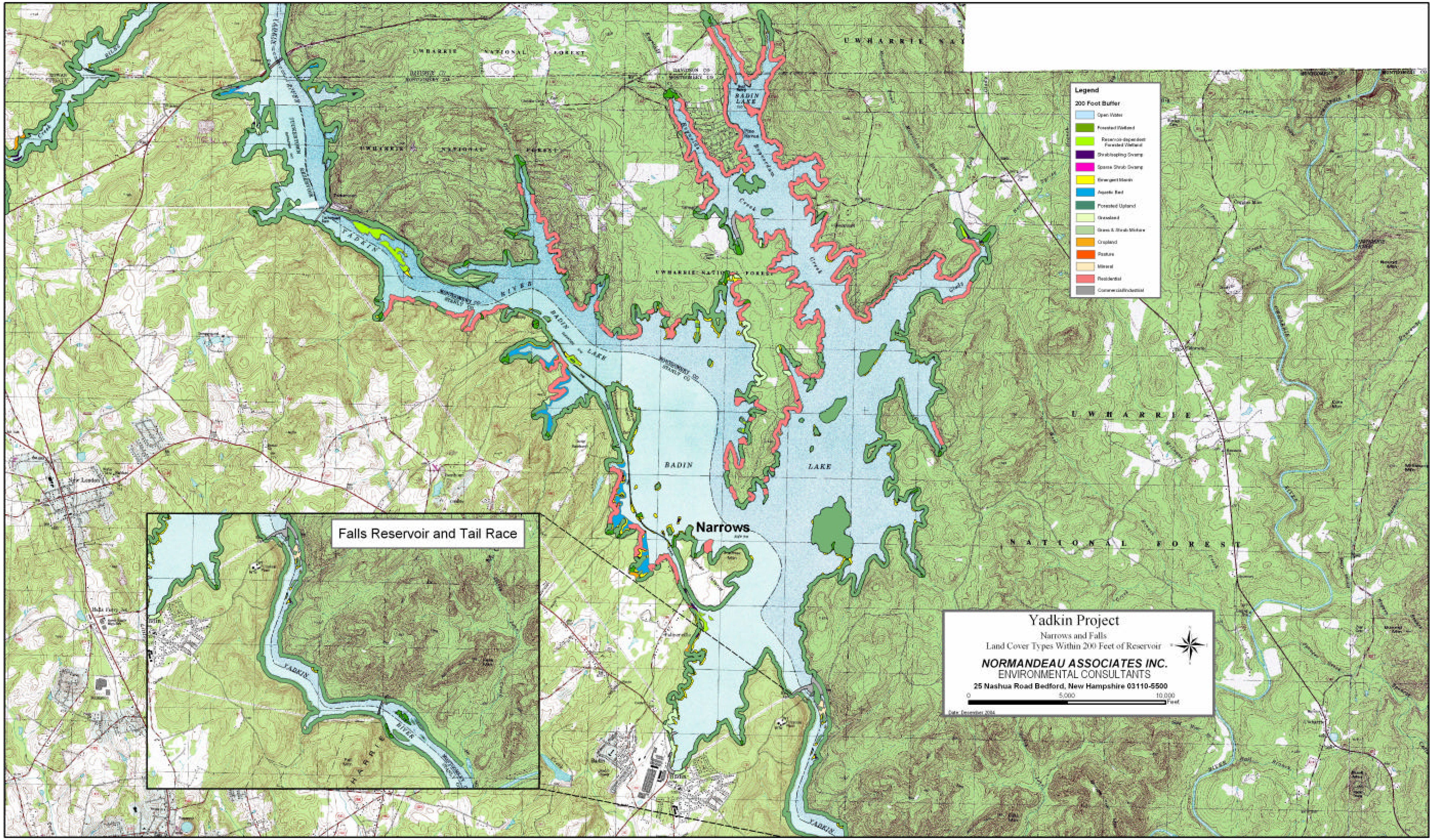

Figure 8.1-5. Cover types within 200-foot Project Area on Narrows and Falls Reservoirs.

Table 8.1-1. Summary of acreages for cover types within 200 feet of Yadkin reservoirs.

	High Rock		Tuckertown		Narrows		Falls		Falls Tailrace	
	acres	**%**	**acres**	**%**	**acres**	**%**	**acres**	**%**	**acres**	%
Wetland										
Forested wetland	234	2.1%	64	3.2%	51	2.2%	<1	0.2%	6	8.7%
Forested floodplain wetland	2194	19.7%	86	4.3%	40	1.7%			<1	0.4%
Scrub-shrub wetland	325	2.9%	40	2.0%	4	0.2%	<1	0.2%	<1	0.5%
Sparse scrub-shrub wetland	484	4.3%	4	0.2%		0.0%				
Emergent marsh	28	0.3%	45	2.2%	179	7.5%	3	1.5%	2	2.6%
Aquatic bed	3	0.0%	14	0.7%	60	2.5%				
Upland										
Forested	4796	43.0%	1597	79.6%	1242	52.2%	159	93.0%	59	87.3%
Grassland	106	1.0%	16	0.8%	50	2.1%				
Agricultural cropland	372	3.3%	34	1.7%	4	0.1%				
Agriculture pasture	84	0.8%	72	3.6%		0.0%				
Mineral	9	0.1%	3	0.2%	<1	0.0%	5	2.8%	<1	0.5%
Residential	2401	21.5%	27	1.3%	731	30.7%				
Commercial/Industrial	107	1.0%	5	0.2%	20	0.9%	2	1.2%		
Total	11143	100.0%	2008	100.0%	2381	100.0%	170	98.9%	68	100.0%

*includes 86.2 acres of photointerpreted emergent marshes, and 92 acres estimated during field surveys.

streamflow, and reservoir water levels. Within the wetland a strong moisture gradient was evident, running from annual floodplain along the stream bank and reservoir edge to a transitional wetland on the upland edge. In areas of steep topography, this gradient occurred within a short distance, creating high variability within the wetland plant community. This cover type was common around all of the reservoirs and was a dominant cover type, with the exception of High Rock where the floodplains on the upper portion of the reservoir formed the vast majority of all wetlands (Table 8.1-1).

Despite the variability in terrain and drainage, the dominant tree species in the palustrine forested wetland were fairly uniform: sweet gum (*Liquidambar styraxiflua*), sycamore (*Platanus occidentalis*), red maple (*Acer rubrum*), river birch (*Betula nigra*) and overcup oak (*Quercus lyrata*), among others (Table 8.1-2). The understory structure was more variable, responding to light availability, soil moisture and soil chemistry. The shrub layer was often sparse, with common shrub species including silky dogwood (*Cornus amomum*), and the invasive bush honeysuckle (*Lonicera X bella*). Poison ivy (*Rhus radicans*) and yellow jessamine (*Gelsemium sempervirens*) were dominant lianas (vines). Species variability was highest in the herb layer as this layer is even more responsive to microsite conditions. Dominants included lizards tail (*Saururus cernuus*) at the water's edge, several sedges (*Carex crinita, C. lupulina* and *C. tribuloides*), spotted touch-me-not (*Impatiens capensis*), and the invasive browntop (*Microstegium vimineum*). Indian sea oats (*Chasmantheum latifolium*) frequently dominated the transitional area to upland if sufficient light was available.

8.1.2 Palustrine Forested Floodplain Wetlands

This cover type had two distinct habits in the study area. The most abundant was confined to the deltaic section of upper High Rock reservoir where large quantities of sediment are deposited (Figure 8.1-2; Table 8.1-1). Large deposits of silt and sand have been accreting in this area for decades, on which vegetation colonizes when the elevation and stability of the bar is adequate. Without vegetation, the bars are very dynamic, changing shape and location with storm and water levels. With vegetation, the bars become more stable, which establishes a positive feedback cycle of more accretion and stability which allows vegetation to expand and mature, which further enhances sediment accretion and stability. In this wetland type, black willow (*Salix nigra*) was the sole dominant in both the tree layer and the shrub layer as a young sprout. Occasional sycamore and red maple were also observed. The herb layer was also limited in both diversity and distribution, developing a tenuous hold on the unstable and wettest downstream tips of newly forming bars. Annuals dominate here, including smartweeds (*Polygonum lapathifolium* and others) and beggar's ticks (*Bidens frondosa*).

A second variation of the forested floodplain wetland occurred along low-lying lands adjacent to the reservoirs. These were often associated with historic stream terraces which still flood during high flow events. The hydrologic forces of deposition, and occasionally scour, were visible as sediment deposits and a thin litter layer over stratified mineral soils. Along the larger streams, frequent overbank flooding has resulted in the formation of levees. These features were most pronounced along the Upper Yadkin mainstem and the South Yadkin River where the levees were several feet higher in elevation than the surrounding floodplain wetland, and supported upland plant communities. (Because of their narrow, linear nature, the levees were included in the dominant cover type behind them). Clearly significant flood events still occur during periods of high river flows on these two rivers within the Project Area. Water stains and flood debris were visible in trees 10 feet above the floodplain floor. Evidence of this level of flooding was not observed on the lacustrine portions of the

Table 8.1-2. List of dominant plant species by habitat on Yadkin Project Area.

Plant Layer & Species	Common Name	Forested Wetland	Forested Floodplain Wetland	Scrub-Shrub Wetland	Sparse Shrub Wetland	Emergent Marsh	Aquatic Bed	Upland
TREES								
Acer rubrum	Red Maple	D	X	X				X
Acer saccharinum	Silver Maple	D	D		X			
Acer saccharum leucoderme	Chalk Sugar Maple							D
Aesculus sylvatica	Painted Buckeye	X						D
Betula nigra	River Birch	D	X		X	X		X
Carpinus caroliniana	American Hornbeam	X	X					D
Carya cordiformis	Bitternut Hickory		X					D
Carya glabra	Pignut Hickory							D
Carya tomentosa	Mockernut Hickory							D
Cornus florida	Flowering Dogwood	X	X					
Fraxinus pennsylvanica	Green Ash	D	D	X				X
Liquidambar styraciflua	Sweet Gum	D	D		X			X
Liriodendron tulipifera	Tulip Tree	X	X					D
Nyssa sylvatica	Black Gum							D
Oxydendrum arboreum	Sourwood	X						D
Pinus echinata	Short-leaf Pine							D
Pinus taeda	Loblolly Pine							D
Pinus virginiana	Virginia Pine	X						D
Platanus occidentalis	American Sycamore	D	D					X
Populus deltoides	Cottonwood	D	X		X	X		D
Prunus serotina	Black Cherry							D
Quercus alba	White Oak	X	D					D
Quercus falcata	Southern Red Oak	X	X					D
Quercus lyrata	Overcup Oak	D	D					X
Quercus phellos	Willow Oak	D	D					X
Quercus prinus (Q. montana)	Chestnut Oak		X					D
Salix nigra	Black Willow	X	D	D	D	X		X
Ulmus alata	Winged Elm							X
SHRUBS								
Cephalanthus occidentalis	Buttonbush	X	X	D	D	X		
Cornus amomum	Silky Dogwood	D	X	D				X
Ligustrum sinense	Chinese Privet	X	D					X
Lonicera x bella	Bush Honeysuckle	D						D
Rosa wichuraiana	Memorial Rose							D
Vaccinium arboreum	Farkleberry							D
Vaccinium stamineum	Deerberry							D
LIANAS								
Campsis radicans	Trumpet Creeper	X				X		D
Gelsemium sempervirens	Yellow Jessamine	D						D
Lonicera japonica	Japanese Honeysuckle	X	X					D
Parthenocissus quinquefolia	Virginia Creeper	X	D					X
Pueraria lobata	Kudzu							D
Rhus radicans	Poison Ivy	D	D					X
Vitis sp.	Grape species	X	D					X

(continued)

Table 8.1-2. (Continued)

Plant Layer & Species	Common Name	Forested Wetland	Forested Floodplain Wetland	Scrub-Shrub Wetland	Sparse Shrub Wetland	Emergent Marsh	Aquatic Bed	Upland
HERBS								
Hexastylis arifolium	Arum-leaved Heartleaf							D
Aneilema keisak	Marsh Dewflower					D		
Arisaema cf. triphyllum	Swamp Jack-in-the-Pulpit	D				X		X
Arundinaria gigantea	Cane	X						X
Asplenium platyneuron	Ebony Spleenwort							D
Aster cf. lateriflorus	Calico Aster	X				X		X
Aster cf. vimineus	Small White Aster					X		D
Bidens frondosa	Devil's Beggar-ticks					D		
Boehmeria cylindrica	Small-spike False Nettle		D					
Carex crinita	Fringed Sedge	D						X
Carex lupulina	Hop Sedge	D	X				D	
Carex pensylvanica	Pennsylvania Sedge							D
Carex tribuloides	Blunt Broom Sedge	D	X					X
Chasmanthium latifolium	Indian sea oats		X					
Chimaphila maculata	Spotted Wintergreen		X					X
Coreopsis verticillata	Verticillate Tickseed							D
Eleocharis obtusa	Blunt Spikerush					D		
Elymus virginicus	Virginia Wild Rye		D			X		X
Eupatorium rugosum	White Snakeroot	X	X					X
Glechoma hederacea	Gill-over-the-ground		D					X
Heterotheca (Pityopsis) graminifolia	Grass-leaved Golden-aster							D
Hibiscus moscheutos	Swamp Rosemallow	X		X		D		
Hieracium venosum	Veined Hawkweed							D
Houstonia caerulea	Bluets		X					D
Impatiens capensis	Spotted Touch-me-not	D	D			X		
Juncus effusus	Smooth Rush					D		X
Justicia americana	Water Willow	X				D		
Laportea canadensis	Canada Wood Nettle		D					X
Lemna minor	Lesser Duckweed					D		
Ludwigia uruguayensis (L. hexapetala)	Uruguay Water Primrose	X		X		D	D	
Microstegium vimineum	Nepalese Browntop	D	D					X
Oxalis violacea	Violet Wood Sorrel							D
Panicum stipitatum	Stipitate Panic Grass					D		
Polygonum lapathifolium	Willow-weed					D		
Polystichum acrostichoides	Christmas Fern	X	X					D
Pteridium aquilinum	Bracken							D
Salvia lyrata	Lyre-leaf Sage	X						D
Saururus cernuus	Lizard's Tail	X	X					D
Schoenoplectus tabernaemontani	Soft-stemmed bulrush					X		
Sisyrinchium angustifolium	Blue-eyed-grass	X						X

D = dominant, X = common or frequent in occurrence.

reservoir, and appeared to dissipate in the delta area of High Rock between the I-85 bridge and the Potts Creek area.

Plant species diversity was higher in this type of floodplain wetland, with black willow still abundant in the tree canopy of low-lying areas, but also overcup oak, silver maple (*Acer saccharinum*), green ash (*Fraxinus pennsylvanica*) and American sycamore (*Platanus occidentalis*), plus many upland species on the levees (Table 8.1-2). Invasives were most abundant in this cover type, probably because of the frequent disturbance. Shrubs included buttonbush (*Cephalanthus occidentalis*), silky dogwood, and two invasive species, bush honeysuckle, and Chinese privet (*Ligustrum sinense*). The herbaceous layer was highly variable depending on level of disturbance and moisture regime. The nettles (*Laportea canadensis* and *Boehmeria cylindrica*), Virginia wild rye (*Elymus virginicus*), touch-me-nots (*Impatiens capensis* and *I. pallida*), and the invasive gill-over-the-ground and Nepalese browntop all dominated in many examples of this cover type, along with many other species (Appendix A). Vines were also an important structural component of many floodplain wetlands, including several grapes (*Vitis rotundifolia* and *V. vulpina*), poison ivy and Virginia creeper (*Parthenocissus quinquefolia*).

8.1.3 Scrub-Shrub Wetland

Scrub-shrub wetland occurred throughout the reservoir system, with the exception of Falls. They were most abundant on High Rock delta area, where they colonized slightly deeper sediment deposits than the forested floodplain wetlands (Figure 8.1-2; Table 8.1-1). In these areas, young black willow formed large stands of scrub-shrub wetlands immediately downstream of the forested wetlands, and unless a large flood event scours out the sediment, these shrub wetlands will quite rapidly evolve to forest. Very few other species occurred with the black willow, just the occasional buttonbush and sycamore.

Black willow, buttonbush and silky dogwood (*Cornus amomum*) dominated the remaining smaller scrub-shrub wetlands around the reservoirs. Most occurred in similar conditions as found in the larger delta wetlands primarily on sediment bars and shallow substrates associated with tributary mouths. Larger streams such as Abbotts Creek and Cranes Creek had more scrub-shrub wetland than the smaller tributaries, presumably due to the higher sediment loads, deposition and scour associated with the larger streams.

This wetland type is very dynamic due to the nature of its substrate source and type. Between high flood events which can scour out sediment and the associated vegetation, and drought (or prolonged drawdown) which can allow the vegetation to expand and solidify its grip on the substrate, scrub-shrub wetlands can shift, grow or shrink on an annual basis. Examples include the drought period which ended and was most pronounced in 2002, during which scrub-shrub wetlands on High Rock expanded on the substrates exposed by the low water levels. Many one-to-five-year old seedlings were observed in the 2003 field work at lower elevations than the adjoining forested and shrub wetlands. The combination of two years of above-average water levels and flood events in 2003 and 2004 greatly reduced the extent and survival of these young seedlings, as observed in 2004 field work. (Section 8.1.4)

8.1.4 Sparse Scrub-Shrub Wetland

This cover type was developed to describe the more tenuous of the scrub-shrub communities described above. In the aerial photographs, extensive beds of scattered woody seedlings occurred on sediment deposits approximately 2-3 feet below the full pool line on High Rock reservoir. Ground truthing in the fall of 2003 confirmed colonies of widely-spaced black willow seedlings. Additional ground truthing in 2004 found that many of these seedlings had died, presumably due to the near-full pond conditions that occurred at High Rock for two successive years. While black willow is tolerant of a wide variety of hydrologic conditions, including drought and flooding, it is intolerant for long periods of either. Because of this highly dynamic response, the sparse scrub-shrub wetland beds delineated on the cover type maps were modified in the field to better reflect 2004 conditions, on the assumption that seedlings which survived through 2004 were likely to persist in the future. With additional sediment trapping, these sparse scrub-shrub wetlands will quickly evolve into typical scrub-shrub wetlands, and when adequate height is attained, into forested floodplain wetland. Even when reduced during the 2004 ground truthing, this cover type remained the second most abundant wetland cover type in High Rock (Table 8.1-1).

8.1.5 Emergent Wetland

The distribution of emergent wetlands was defined by the slope and substrates of the littoral zones, and water level fluctuations of the reservoirs. On High Rock, emergent wetlands were very limited, composing only 0.3% of all wetlands (Table 8.1-1). Those that occurred were confined to a narrow zone near the full pond line, with the exception of the invasive Uruguay water primrose (*Ludwigia uruguayensis*) on Abbotts Creek (Figure 8.1-2). The large drawdown that occurs in most years is very likely the primary cause for the paucity of emergent marshes. Although 2004 had above average water levels and High Rock was within several feet of full pond during every field trip, no emergent marsh vegetation was observed more than 2-3 feet below the full pond line. Both Narrows and Tuckertown had much more extensive emergent marsh development than High Rock (Figures 8.1-4 and 5; Table 8.1-1). On Tuckertown, which has a relatively stable water level regime, emergent marshes were much more extensive along the shoreline, but remained confined within the top several feet of the lake bed. This relatively narrow zone was probably the result of stable water levels throughout most growing seasons. On Narrows, which typically experiences a moderate drawdown with considerable weekly variability, the emergent marsh extends 1 -2 feet deeper into the lake than High Rock and Tuckertown. These plants are most likely taking advantage of the additional growing space available for portions of the growing season, created by modest, short-term drawdowns. At full pond, the deeper plants are stressed, and at drawdown the higher plants are sustained by occasional wetting as the reservoir refills periodically. Because the emergent wetlands on Narrows are most prevalent on gradual shorelines, it is likely that groundwater is also an important component in maintaining dewatered emergents. On Falls, which experiences frequent minor drawdown, the emergent wetlands are limited by both the high water and the steep rocky shoreline. This reservoir had the lowest acreage of wetlands of the four reservoirs, although emergents formed the greatest percentage cover in this upland-dominated system.

The upland extent of the emergent marsh was limited typically by either a shoreline structure (retaining wall, riprap) or a natural bluff along the shore at the full pond line. In areas where the shoreline was gradual, the emergent marsh would frequently grade into a scrub-shrub wetland, or a forested wetland under which light limitation halted the dominance by emergent species.

In High Rock, the few emergent marshes that occurred were dominated by water willow or, in one case on Abbotts Creek, the invasive Uruguay water primrose. On Narrows and Falls, the emergent marshes were almost exclusively dominated by water willow, often with smaller components of lizards tail (*Saururus cernuus*) and swamp rose mallow (*Hibiscus moscheutos*). Emergent marshes were most diverse in Tuckertown, often forming broad bands with well defined zonation of plant species. While water willow continued to be a dominant component, other common species included lizards tail, pickerel weed (*Pontedaria cordata*), swamp rose mallow, soft rush (*Juncus effusus*), soft-stemmed bulrush (*Schoenoplectus tabernaemontani*), and spike rushes (*Eleocharis obtusa* and *E. quadrangulata*). In Ellis Creek cove, American lotus (*Nelumbo lutea*), an exotic species, formed two dense beds.

8.1.6 Aquatic Bed

Aquatic beds occurred in two of the reservoirs, Tuckertown and Narrows (Figures 8.1-4 and 5; Table 8.1-1). In Tuckertown, the beds typically occurred adjacent to emergent beds in the quieter coves and tributary arms. In Narrows, the beds were confined to the four backwater ponds created by the railroad bed on the west side of the reservoir. At all sites, gradual slopes and fine substrates provided a suitable habitat. The high nutrient levels in both reservoirs also enhance growth of aquatics (Normandeau 2004c). The lowest depth to which aquatic beds occurred in both reservoirs was 5-6 feet below full pond, probably due to light limitation in the water column. Secchi depth measurements are commonly used to assess the depth of the photic zone in lakes. Most submerged aquatic vegetation can persist at approximately 2-3 times the Secchi depth. Secchi depths ranges were 2.6 -5.9 feet in Tuckertown and 2.1-3.2 feet in Narrows. In Tuckertown, the relatively stable water levels provide a well defined zone for aquatics to establish. In Narrows, the backwater ponds are all connected to the main body of the reservoir and therefore draw down periodically. During drawdown the aquatic beds are exposed to desiccation, and freezing in the winter. The persistence of aquatic beds in the ponds suggests that effects of Narrows water level fluctuations are moderated by some other hydrologic factor (e.g., abundant groundwater) in some areas. It is likely that these beds decline during years of greater drawdown, and expand during periods of more frequent high water levels, such as 2003 and 2004. At High Rock, the large annual drawdown greatly limits the establishment and survival of aquatic beds. On Falls, the steep rocky slopes, rocky shoreline, strong currents and frequent water level fluctuations combine to minimize the potential for aquatic beds.

On Tuckertown and Narrows, aquatic species varied with location. Tuckertown had extensive beds of native elodea, primarily (*Elodea canadensis*), with common associates of coontail (*Ceratophyllum demersum*) and spike rush (*Eleocharis cf acicularis*). Hydrilla (*Hydrilla verticillata*), a potentially aggressive invasive, occurred near the River Road boat launch, but was not a dominant. In Narrows, the backwater ponds supported some elodea, as well as slender naias (*Naias gracillima*), a stonewort (*Chara zeylanica*) and leafy pondweed (*Potamogeton foliosus*).

8.1.7 Upland

With the exception of the Forested Upland, the Upland cover types received little scrutiny under the assumption that the developed cover types provided minimal natural resource value. The following descriptions provide composites of the various upland cover type categories.

***Forest* :** Typical forest vegetation of the Project area conforms closely with the Dry-to-Mesic Oak-Hickory Forest (Piedmont Subtype), described by Shafale (2003) as perhaps the most common forest association in the Piedmont. The acidic soil promotes dominance by heath species in the shrub understory, e.g. the blueberries *Vaccinium arboreum*, *V. stamineum*, and sourwood (*Oxydendrum arboreum*). The tree canopy usually comprises white oak (*Quercus alba*) and northern red oak (*Q. rubra*), and pignut hickory and mockernut hickory (*Carya glabra* and *C. tomentosa* (*alba*)). This forest type represents conditions midway between relatively dry and moist extremes of upland vegetation. It occupies mid-slope positions of an intermediate gradient, and seldom faces either full south or north.

At the drier end of the upland hydrosequence, on ridge tops and south-facing slopes, southern red oak (*Q. falcata*) replaces northern red oak, and black gum (*Nyssa sylvatica*) assumes more importance among the usual hickories and heaths. On exceptionally dry sites, e.g. root-restricting soils that are shallow to bedrock or constitute dense clay hardpan, blackjack oak (*Q. marilandica*), post oak (*Q. stellata*) and short-leaf pine (*Pinus echinata*) may predominate.

At the moist end of the upland hydrosequence, American beech (*Fagus grandifolia*) typically has a place, often dominant, along with sugar maple (*Acer saccharum* var. *saccharum* and *barbatum*), tulip tree (*Liriodendron tulipifera*) and water oak (*Q. nigra*). Such forest includes some alluvial bottomland and other low landscape positions, reaching upgradient in ravines and on north-facing slopes, with the addition notably of chestnut oak (*Q. prinus* (*montana*)), flowering dogwood (*Cornus florida*), loblolly pine (*Pinus taeda*) and Virginia pine (*P. virginiana*). Herbaceous dominants include arum-leaved heartleaf (*Hexastylis arifolium*) and Christmas fern (*Polystichum acrostichoides*). Soils relatively rich in exchangeable bases and organic matter generally coincide with these low-lying mesic forest types. Particularly rich sites may include hop hornbeam (*Ostrya virginiana*), red mulberry (*Morus rubra*), an occasional basswood (*Tilia americana*), maidenhair fern (*Adiantum pedatum*), and an abundance of several *Viburnum* species. Not all mesic sites are necessarily rich, however. Steep, north-facing bluffs often promote the dense growth of heath shrubs, e.g. mountain laurel (*Kalmia latifolia*) and *Vaccinium* species under chestnut oak, American beech and white oak.

When the natural upland forest succession is set back by periodic disturbance, typically logging and wildfire, the pines (loblolly, short-leaf and Virginia) are among the first forest trees to occupy the early tree seedling and sapling growth. Although fire of natural origins is no longer to be expected in a rapidly developing lakeshore environment like the Project area, logging will continue to favor the fast-growing softwoods. Wherever forest tracts are left undisturbed, and slower-growing but longer-lived tree species (notably several of the oaks) assume dominance on suitable sites, the overall proportion of pine as a canopy component may decline.

***Grassland*:** In the Piedmont, naturally occurring areas dominated by grasses (Family Poaceae) and forbs (most other herbaceous species, with typically broader leaves) result primarily from forest wildfire. Since wildfire is now suppressed in the Project area, this early-succession cover type occurs primarily as a deliberate product of vegetation management, wherever woody plant growth has to be routinely discouraged, i.e. most notably along electric power transmission lines (Normandeau 2004d). Golf courses and the landscaping around large buildings often create a particularly refined kind of grassland that deserves recognition as this cover type because of its great extent—a lawn on an institutional scale.

***Grassland-Shrubland*:** This cover type represents a slightly later stage in a plant community's succession as it reverts to forest. Tree and shrub seedlings that germinated along with herbaceous plants now begin to assert dominance as they rise to rival the height of the taller herbaceous plants and spread progressively over the shorter ones. In the Yadkin Project Area, this cover type was used only in areas where routine disturbance maintained this cover type for long periods of time, e.g, under powerlines. A description of the typical Yadkin maintenence program and schedule is provided in the Transmission Line and Project Facility Habitat Assessment (Normandeau 2004d).

***Agriculture (cropland*)**:** This land receives periodic tilling and planting treatments. It often comprises fields of soy, cotton and hay in the Project area and vicinity, typically in relatively low-lying, level terrain.

Agriculture (pasture): This cover type represents areas that are subject to grazing by livestock. Superficially, it resembles Agriculture cropland or Grassland, but the herbaceous plants comprise many species and grow to irregular heights owing to preferential selection by the livestock, and the terrain is often uneven, on poorer soil than that used for cultivation.

Residential: Around the reservoir shoreline, the residential pattern comprises chiefly individual houses or trailers separated from one another by small patches of lawn and scattered trees or, at a lower density, by the remnant natural forest. At extreme low density, where residential structures and activities disrupt or fragment the tree canopy and shoreline vegetation only minimally, they were included in the upland forest cover type.

Commercial: Included with this infrequent shoreline cover type is all commercial and industrial activity. In the Project area, the principal manifestations of both commercial and industrial land use are related to the generation, transmission and application of energy, including the dams. Other examples of commercial activities within the Project Area included marinas, and selected boat landings.

Mineral: Large expanses of unvegetated soil, usually the result of sand and gravel extraction and stockpiling or recent land development, constitute most of this minor cover type. Also included are extensive rocky outcrops and outcrop clusters, which often provide basking sites and safe underground shelters of importance to lizards and snakes.

8.2 WATER WILLOW ON NARROWS

On Narrows, water willow tends to form a near monoculture within the persistent emergent community. Table 8.2-1 includes a list of species occurring within emergent beds in Narrows. Every bed was dominated by water willow, frequently with no other species present. Lizards tail (*Saururus cernuus)* and marsh mallow (*Hibiscus moscheutos*) were common secondary herbaceous species within the marsh, as was the shrub buttonbush (*Cephalanthus occidentalis*). All other species occurred infrequently and in low densities. These results differ somewhat from those of Touchette et al. (2001), in which pickerelweed (*Pontederia cordata*), marsh purslane (*Ludwigia* sp), rice cutgrass (*Leerzia oryzoides*) and redroot cyperus (*Cyperus erythrorhizos*) were described as the dominants along with water willow in the emergent marsh. These species were present in 2004, but in low abundance. Part of the explanation for the discrepancy may lie in the variability inherent in emergent fringing marshes, especially following the severe drought years of 2001 and 2002, and the wet year of 2004. It is also possible that lizards tail was misidentified as pickerelweed in the 2001 report, because NAI observed lizards tail to be a common species throughout all four reservoirs and pickerelweed, which is similar in appearance, was mostly confined to quiet coves in Tuckertown.

Approximately 178 acres of water willow were recorded on Narrows (Table 8.1-1). Almost half of them (86 acres) occurred in beds large enough to be delineated from the aerial photographs. The remainder (92 acres) resulted from estimates of small and/or narrow beds fringing the edge of the reservoir. Some of these smaller beds were patches (probably temporary) colonizing pockets of sediment along rocky shores. Many others were more continuous bands that were 5-15 feet wide, partially hidden under the tree canopy. In total, 30% of the shoreline of Narrows was estimated to

Table 8.2-1. List of plant species observed in shallow marshes on Narrows Reservoir.

Species	*Common Name*	*Frequency*
Justicia americana	***Water willow***	***Abundant***
Saururus cernuus	***Lizards tail***	***Common***
Hibiscus moscheutos	***Swamp rose mallow***	***Common***
Cephalanthus occidentalis	***Buttonbush***	***Uncommon***
Leerzia oryzoides	***Rice cut grass***	***Uncommon***
Pontederia cordata	***Pickerelweed***	***Rare***
Ludwigia sp	***Marsh purslane***	***Rare***
Cyperus erythrorhizos	***Red-root cyperus***	***Rare***
Sagittaria latifolia	***Broad-leaved arrow-head***	***Rare***
Cuscuta *sp.*	***Dodder***	***Rare***
Rhexia *sp.*	***Meadow beauty***	***Rare***
Tradescantia *sp.*	***Spiderwort***	***Rare***
Pistia stratiotes	***Water lettuce***	***Rare***
Betula nigra	***River birch***	***Rare***
Polygonum lapathifolium	***Willow weed***	***Rare***
Echinochloa crusgalli	***Barnyard grass***	***Rare***
Glyceria *sp*	***Manna grass***	***Rare***
Panicum cf. stipitatum	***Panic grass***	***Rare***
Sacciolepis striatus	***American cupscale***	***Rare***

support water willow. This number is probably an underestimate because approximately 20% of the shoreline was not included in the survey.

The structural characteristics of the water willow beds were quite uniform throughout the Narrows reservoir. The width of the beds was determined by the slope of the shore and the corresponding water depths. During the 3 days of the pier study, water levels in Narrows were between 507.7 and 508.2 feet elevation USGS (539.0 and 539.5 feet Yadkin datum), which is approximately 1.5 to 2 feet below full pool. The maximum water depth in which water willow typically occurred was 3 feet (5 feet below full pool). In general, water willow was densest between approximately 1.5 and 2.5 feet below full pool. Plant heights ranged between 2.5 and 3.0 feet in the densest part of the bed. Plants became shorter towards the upland and were typically tallest in the deepest water (up to 4.5 feet).

The upland extent was typically limited by either a shoreline structure (retaining wall, riprap) or a natural bluff along the shore at the full pond line. In a few locations, the shoreline was gradual enough to allow a more diverse freshwater marsh community to develop. Dominant species included lizards tail, soft rush (*Juncus effusus*), rice cut grass (*Leersia oryzoides*), and shrubs such as buttonbush. Here the water willow mixed with the other species in a relatively narrow zone before quickly declining upgradient.

To evaluate pier effects on water willow, a total of 34 piers and their surrounds were studied (Figure 8.2-1 and Table 8.2-2). Fifteen were considered new piers (constructed after March 1997), and 16 were old piers (constructed before March 1997). Three additional new piers were visited because they provided good examples of either extreme of water willow impacts. The table is sorted in increasing order of percent cover by water willow within the study area for each pier (20 feet to either

Figure 8.2-1. Narrows Pier and Water Willow Study Area.

Table 8.2-2. Characteristics of water willow, piers and shorelines of ne w and old piers.

Sample # [1]	Year Constructed or Modified [2]	% Water Willow	% Water Willow Under Pier	Water Willow Impacts	Shoreline Type	Substrate Type	Comments
	1998	0	0	Clearing around ramp & on both sides	Retaining wall & ramp with float	Suitable	Dense water willow on natural substrates adj to lot
	1975	0	0	Clearing, beach?	Retaining wall, dock, not sure on right	Suitable fines	Good stand on edge of property, none in front, attempting to expand
	1983	0	0	Not sure if cleared or too deep	Retaining wall, dock	2' below full pond, otherwise suitable	
	1984	0	0	Not sure if cleared or too deep	Retaining wall, dock	2' below full pond, gravelly silt over bedrock	May be cleared originally & substrates too deep for recolonization
	1985	0	0	Clearing in front of ret wall	Retaining wall, dock - natural on adj lot	Not sampled but appear suitable	Water willow well established on natural side
	1987	0	0	Clearing in front of ret wall	Retaining wall, dock?	Gravel over bedrock, emersed	
	1995	2	5	Clearing, imported sand?	Retaining wall, dock w/ stairs, beach?	Suitable fines	Remnant water willow under dock
	1965	20	0	Clearing on both sides, brought in sand	Natural gentle bank w/ dock & jet ski ramp	Suitable	Dense water willow on natural substrates on both sides
	1999	25	0	Clearing in front of riprap	Riprap, dock, retain wall on adj prop	Not sampled but appears suitable	Newish dock with riprap, fine water willow in front of adj retaining wall
	1983	30	0	Clearing on east side, far west	Retaining wall, dock, unused boat ramp	Suitable coarse	Water willow bed confined by retaining wall
WW15	**2000**	34	0	Boat ramp, clearing on right side with retaining wall	1' bluff, gravel strand	Silt with gravel strand	
WW13	**2001**	40	0	Right side cleared, stairs	Retaining wall, stairs,	Gravelly silt	
	1962	40	0	Clearing around dock & on left side	Retain wall, dock, boat ramp & house	Suitable	Mod water willow bed on right side behind dock & along wall
	1968	40	0	Clearing, boat ramp	Retain wall, dock, wide boat ramp	Suitable fines	Narrow water willow bed on left of wall, stops abruptly at both ends
	1985	40	2	Clearing & old ways onto boathouse	Retaining wall, dock, old ways	Not sampled but appears suitable	Water willow well established on either side of clearing, attempting to recolonize
WW12	1991	42	0	Jet ski ramp, boat ramp, clearing	Retaining wall, 2.5', right side cleared	Rocky gravelly silt	Considered new in field–did not appear in 1997 photo and had new appearance. APGI records indicate no construction since 1991.

(continued)

Table 8.2-2. (Continued)

Sample # [1]	Year Constructed or Modified [2]	% Water Willow	% Water Willow Under Pier	Water Willow Impacts	Shoreline Type	Substrate Type	Comments
WW8	**2003**	45	0	Boat landings on both sides of comm dock	Eroding bank, 1', drfitwood at base	Fibric muck to 4"+	
WW14	**1998**	47	0	Jet ski ramp, other disturbance	24" Retaining wall	Silt	
WW1	**1998**	50	0	Foot/boat traffic	Eroding bluff, 4' with bedrock	Gravelly silt	
	2003	50	5	Major impacts from construction & clearing?	New dock & rock gabions	Suitable mostly coarse	Viable water willow patch on both sides
WW4	**1998**	51	0	Boat & foot traffic	Natural gentle bank	Silt loam	
WW2	**2003**	58	0	Clearing around dock, esp R side	Eroding bluff, 1-3'	Gravelly & sandy silts	
WW3	**2000**	67	13	Foot/boat traffic on R side, 60' "beach" cleared to R of study area	1'bluff	Gravelly silt	
WW11	**2002**	70	0	Stairs & path	Eroding bluff, 2.5'	Cobble, gravelly silt	
WW5	**1998**	74	0	2 dogs routinely swim from shore	4' bluff with 2' erosion	Gravelly silt	
WW9	**1999**	74	0	Light impacts from canoe landing on L side,	Low bank	Gravelly silt	
	1980	75	2	Clearing by dock	Retaining wall, dock w/ stairs	Suitable	Water willow on both sides of dock, narrowed by retaining wall
	1992	80	75	Clearing for boat ramp and by pier	Retaining wall, boat ramp	Suitable	Good water willow beds on both sides, good ex of low impact dock
WW7	**1998**	87	0	None at dock, 25' beach cleared further down	Eroding bluff, 3.5'	Silty clay	
WW10	**2002**	87	13	None	Eroding bluff, 2'	Gravelly silt	
WW6	**2004**	92	38	None	Riprap on W, eroding bluff on E	Gravelly sandy silt	
	1976	100	75	None - dense bed on both sides	Retaining wall, low dock	Suitable	Good narrow stand in front of ret wall
	1998	100	100	None - dense bed on both sides	Natural bluff with old low dock	Suitable	Excellent example of low impact dock
	2003	100	100	Slight productivity reduction under dock	Natural eroding forested bluff	Gr silt	New, high dock allows water willow underneath
Average		47.6	12.5				

[1] Piers with "WW" designation were part of the new pier study.
[2] Bolded dates are "new" piers that were constructed or modified after March 1997.

side of the pier plus the pier). On average, water willow cover was approximately 48% of the potential suitable habitat available, ranging the full spectrum of extremes between 0% and 100% cover. Within the new piers, the range was smaller, between 34% and 92% cover.

The amount of water willow under the piers was much lower than the total pier study area, with an average of 13% (Table 8.2-2). Only 11 of the 34 piers had any water willow under them at all. In some cases, available light may have been a limiting factor, but in many cases, the vegetation appears to have been removed. Most of the piers with 0% cover under the pier had considerably less cover within the entire study area. The maximum width of the piers studied was 10 feet, and many were 8 feet or less, therefore the maximum percentage of the water willow habitat within a pier study area that could be occupied by the pier (and potentially be unavailable to water willow) was 20%. Light impacts due to the pier on adjacent water willow could lower the productivity of the beds but not their presence. Therefore, any additional loss in percent cover above 20% can be attributed to land use and human activities. Observed shoreline management and other human activities included complete vegetation removal or mowing, importing sand for beaches, foot traffic from the shore to deeper water, small boat access, and jet ski and boat ramp traffic.

Of the 6 piers with no water willow within the study area, all had suitable substrates and presence of water willow in adjacent undisturbed sites (Table 8.2-2). Two had water levels that may have been too deep at the foot of their retaining walls to support water willow, but the remaining four had either emersed shorelines or very shallow flooding, both of which fell within the typical hydrologic setting for water willow. In these cases, it is apparent that disturbance and possibly clearing are a factor in the lack of water willow. Eight piers had more than 75% cover by water willow. These eight included both old and new piers, with a range of pier heights and widths. Most had some amount of water willow under the pier, with the exception of one that was well shaded by trees. In this instance, the combination of shade from both the forest canopy and the pier may have provided too little light transmission to support water willow. Other factors such as fetch, substrate and age of pier or its modification had little discernible effect on predicting the presence or absence of water willow.

Within many of the pier study areas, robust water willow beds ended abruptly at the edge of activity areas such as boat ramps, property lines, jet ski ramps, and swimming areas (see examples in Figure 8.2-2a and 2b). In other locations, the demarcation was less clear, but human disturbance was evident as trampling and drag marks from boats (Figure 8.2-3). In the first instance, clearing was typically complete with no or few stems of water willow remaining. In the second case, broken stems and remnant root material were evident. Conversely, several docks were encountered in which vigorous water willow formed an unbroken band on both sides and underneath the docks (Figure 8.2-4). The construction date for these piers ranged from 1976 to 2003, indicating that height and age of the pier is of less influence on water willow than the management and activity level within the water willow bed.

8.3 MAJOR WETLAND FUNCTIONS

While many wetland functions were discussed in the characterization of the cover types (Section 8.1), it is worthwhile to summarize them to describe the overall contributions of wetlands to the Yadkin Project Area. No systematic wetlands functions and values assessment was applied in this study, but most assessment methods look at a similar suite of functions: flood control, sediment trapping, nutrient removal, fish and wildlife habitat, and social values. A summary of wetland functions based on observation of relevant physical and biological features of the four reservoirs is discussed below.

Figure 8.2-2a. Example of a lot with an intact water willow bed on left side of dock and clearing on right side.

Figure 8.2-2b. Example of clearing and sand imported within a water willow bed.

Figure 8.2-3. Example of trampling impacts in water willow bed.

Figure 8.2-4. Example of robust water willow beds co-existing with piers in Narrows Reservoir.

8.3.1 Flood Control

Wetlands have long been recognized for their ability to slow and retain flood waters, thereby reducing downstream damage by flooding. This is especially true in large river systems like the Yadkin. Evidence of overbank flooding along the riverine portions of the Yadkin River and South Yadkin River indicated that floods regularly occur up to 10 feet above normal. The floodplain and levee habitats observed in this area are a product of the floods, but are also very effective at storing floodwaters, therefore moderating flood events. These habitats are less common on the reservoirs, most having been submerged at the time of their creation. The steep rocky shores of many sections of the reservoirs are ineffective for flood storage. Yadkin operates High Rock Reservoir as a storage reservoir and therefore, to the extent possible, generally tries to "capture" high reservoir inflows. However, its size relative to the Yadkin River watershed limits its storage capacity during large floods.

8.3.2 Sediment Trapping

As has been discussed in the Sediment Fate and Transport draft report (Normandeau 2004b), a large sediment load enters High Rock from the Yadkin River and its tributaries. Much of this sediment settles out as it enters the quieter waters of the reservoir. Deposition is most visible in the delta area forming at the upper end of High Rock Reservoir. While substantial deposition was also apparent in the floodplain wetlands of the Upper Yadkin and along the reservoir shores, this deposition can only occur during flood periods and is probably minor compared to the sediment deposition that occurs within the reservoir itself in the course of a typical year

8.3.3 Nutrient Removal

Wetlands have long been known to provide nutrient removal, transformation and attenuation from surface and groundwater. All of the Yadkin reservoirs are eutrophic, and have high nutrient levels in the water column for many months (Normandeau 2004c). As with the sediments, most of the nutrients come from the larger watershed, although the dense development around sections of the shores of High Rock and Narrows also contributes locally. The wetlands within the full pond limits of the reservoirs have the ability to remove a portion of the nutrients. This would include most of the shrub swamps, emergent wetlands and aquatic beds, but the small percentage of these wetlands relative to the volume of water and quantity of nutrients in the collective system limit their effectiveness. The large deltaic wetlands at the top of High Rock provide the greatest potential for nutrient removal, but those are effective only during the portions of the growing season when water levels are within the root zone of the plants. Although the elevation of the sediment bars is not known, it is likely that they are exposed, and therefore unavailable for nutrient removal, for the latter half of the average growing season. Tuckertown and Narrows, though 6 and 3 times smaller than High Rock, respectively, have more acreage of emergent marsh and aquatic bed. The overall acreage of wetlands are lower in both Tuckertown and Narrows due to the extensive acres of floodplain forest and shrub swamp in the upper end of High Rock Reservoir, but the potential for nutrient removal by emergent marsh and aquatic beds is higher because they are inundated much longer than the shrub wetlands. On Falls, the low percentage of wetlands and low residence time for the water limit the ability of this reservoir to provide nutrient removal.

8.3.4 Fish Habitat

As has been noted in the fish habitat report (Normandeau 2004a), wetlands provide important fish habitat as breeding for many species, nursery habitat for young, cover for small resident species, and forage for larger fish. The structure of the cover appears to be more critical than the composition, as many lakeshore owners recognize in their creation of artificial cover with docks, trees, tires and other debris. However, a study of water willow and fish habitat (Touchette et al. 2001) identified 17 species that use emergent wetlands in the course of the year, more than any other shallow-water habitat. While fisheries in all four reservoirs appear to be healthy, the wetland structure and distribution of each reservoir surely affect the fish populations. On High Rock the low percentage of in-pond wetlands can have adverse impacts for centrarchid spawning. This family of fish, which includes large-mouth bass, black crappie and bluegills, require water levels in the late winter and spring that provide access to vegetated shallows to spawn (Normandeau 2004a). If the wetlands are only a small component of the available habitat or are unavailable due to low water, these fish experience a lower breeding success, and a loss of nursery and forage habitat. In High Rock, the bulk of the spawning habitat lies in the scrub-shrub wetlands in the delta area in the upper end of High Rock Reservoir. While this wetland type is one of the largest cover types in High Rock, it is concentrated in one area of the reservoir and the rest of the reservoir has relatively little in-pond wetlands available. A broader distribution and wider variety of in-pond wetlands would likely enhance the centrachid populations in High Rock. The other three reservoirs have more wetland habitat and/or smaller drawdowns, therefore access to wetlands during the spawning season is less of a limiting factor.

8.3.5 Wildlife Habitat

Wetlands function to provide breeding, feeding and shelter habitat for terrestrial wildlife species. In the Yadkin Project area, the large expanses of undeveloped lands that remain on all four reservoirs combine with the open water of the reservoirs themselves to provide habitat for a wide variety of wildlife species. Incidental observations of all wildlife during field work yielded more than 81 bird, 15 reptile, 16 amphibian and 5 mammal species or sign (Appendix B). Many of these were wetland-dependent, relying on wetlands for a critical part of their life cycle: wood ducks, herons, prothontary warblers, many reptiles, all amphibians, and beaver. The distribution of wildlife reflected the available habitats around the reservoirs, with herons and egrets, for example, being most prevalent on Tuckertown and Narrows, which had the most extensive emergent wetlands. Even the narrow water willow beds fringing much of Narrows frequently supported foraging herons and egrets, a brood of waterfowl or molting adult ducks. Turtles were abundant in all the reservoirs, with the possible exception of Falls, but were most commonly observed in the upper reaches of the tributaries and coves, where quiet water and ample cover was available. On High Rock, for example, turtles were plentiful on upper Flat Swamp Creek, the Eagle Point Preserve area, and similar areas, while being noticeably fewer on the more developed sections.

The American bald eagle is a protected wildlife species, listed as Threatened by the State and by the US Fish and Wildlife Service. This species regularly breeds on some or all of the reservoirs in any given year, using the open water for foraging and the adjacent forested habitat for nesting and roosting (Center for Conservation Biology, 2004). No other known rare, threatened or endangered terrestrial wildlife species occurs in the area that could be considered reservoir-dependent (Normandeau 2004e)

8.3.6 Social Values

Attributes of wetlands that pertain to human perceptions are considered social values, and include aesthetics, cultural (historic), active recreation (hunting and fishing), passive recreation (hiking, bird watching), and education. Almost all wetlands provide one or more of these functions, and on the Yadkin Project, this holds particularly true. The heavy use of the reservoirs and the Yadkin River demonstrates the recreational function of the open water of the reservoirs, and the wetlands contribute to both the active and passive forms by providing habitat for waterfowl and fish. The aesthetic component is somewhat more subjective. While most would agree that wetlands lend beauty to the landscape, wetland vegetation is sometimes perceived as an obstruction to recreation and the view of the water. The tendency for lakeshore owners to clear out woody and emergent vegetation in front of their homes has greatly diminished wetlands in those areas, especially on Narrows where the potential for wetland development remains high.

9.0 EFFECTS OF CURRENT PROJECT OPERATION

The effects of current operation of the four reservoirs on wetlands and riparian habitats fall into two general categories: direct effects from reservoir management, and secondary effects from reservoir development. The first category includes hydrologic conditions, such as water levels, sediment deposition and water quality. The second category relates to development, primarily residential, around the periphery of the reservoirs, and recreational use, primarily boating and fishing, on the reservoirs.

9.1 HYDROLOGY

As discussed in Section 6.3, the four reservoirs have significantly different hydrologic regimes based on their original design and Yadkin's current management strategy. High Rock is the primary storage reservoir for the system, and fluctuates the most seasonally (average 13.5 feet), monthly (average 4.38 ft) and weekly (average 1.62 feet). Narrows experiences less drawdown (average 4.09 feet) with lower monthly (average 1.5 feet) and weekly (average 0.59 feet) fluctuations than High Rock. Tuckertown and particularly Falls are operated on a run-of-river basis, and as a result have short-term fluctuations of 2.42 and 5.90 feet, respectively, with little discernible seasonal effect.

These varying hydrologic regimes, in combination with shoreline characteristics, affect the development of plant communities around the four reservoirs. Wetlands bordering and within the full pond limits of the reservoirs are most affected because they are so closely tied to hydrologic conditions. The upland communities within the Project Area are affected less by reservoir-related hydrology and more by soils, aspect, slope, and groundwater levels. At High Rock, two processes are fundamental to wetland development: water level fluctuation and sedimentation. Water level fluctuation impacts vary with location on High Rock. Because the reservoir is so large, with long arms following the various major tributary valleys, the center of the reservoir has developed conditions more similar to a lake, while the tributary arms retain more riverine characteristics.

The riverine condition is most pronounced along the Yadkin River and the South Yadkin Rivers within the upper portion of High Rock Project boundary. These are the largest rivers contributing to High Rock, and as such, flow slows gradually over several miles before entering the truly lacustrine portion of the reservoir. The length and magnitude of the gradient varies with river conditions, being most pronounced during periods of high flow. The well defined river bed continues southward until it begins to widen south of the I-85 bridge. North of the I-85 bridge, scouring appears to be the primary influence on the plant communities, with little in-river vegetation and well developed bordering forested floodplains in low-lying areas. South of the bridge, a depositional environment prevails, resulting in extensive sediment bars that are colonized with varying aged stands of black willow. This area forms the largest complex of wetlands in High Rock. The black willow ranges from 40-foot trees to young seedlings forming sparse scrub-shrub wetlands. Sediment carried in by the river is steadily accreting in this area, with shallow bars extending below Potts Creek that, while extremely dynamic, are continuing to expand. The black willow stands function to hasten sediment deposition by further slowing flow of the Yadkin. These processes are visible at a smaller scale on all of the tributaries to High Rock, with transition areas from riverine conditions to the reservoir, and sediment bars at the tributary mouths. Forested floodplain wetlands border the tributary banks and black willow trees and shrubs dominate the accreting sediment bars.

Reservoir water levels have relatively little influence on the riverine floodplain wetlands of the Yadkin River and the South Yadkin River within the Project area. Instead, these areas are most influenced by rivers flows. With the large volumes of floodwater that pass down both rivers in most years, in-river vegetation is scoured away, and the floodplain forested wetlands are replenished and maintained, probably producing conditions similar to those that existed prior to construction of High Rock dam.

The remaining wetlands on High Rock are much smaller in extent and more varied in composition. They have formed on low-lying lands adjacent to the edge of the reservoir, and thus are affected by a combination of reservoir water levels, groundwater and local surface water flow (runoff and small drainages). Reservoir water levels are most influential at full pond, when flooding or soil saturation occurs. When reservoir water levels drop, the wetlands continue to receive water from the other terrestrial sources, therefore the reservoirs contribute to less of the hydrologic budget of many of these wetlands. This wetland type was universal around all four reservoirs.

Noticeably lacking on High Rock are emergent wetlands and aquatic beds, composing only 0.6% of all wetlands. While many factors probably contribute to this paucity (high energy from currents and wave action, and low light penetration), the large seasonal water level drawdown is the primary one. Few native emergent or aquatic species can tolerate the combined effects of the extreme conditions created in the drawdown zone: flooding for prolonged periods in the spring, followed by drought as the water levels drop well below the rooting zone in the late summer and fall. Exposure to freezing and desiccation in the winter further stresses any overwintering plant material. Annuals are the best strategists for taking advantage of regeneration opportunities, as was observed during the extreme drought of 2002, when entire sections of the drawdown zone were colonized in the late summer by a grass or sedge. Although the species was not identified, the plants were surely annuals that seeded on the newly exposed lower substrates. These plants were killed later that fall when water levels recovered. In 2004, when water levels remained high for the entire growing season, the narrow drawdown zone was largely bare where perennial species (water willow, pickerel weed, elodea) would be expected.

The other extreme of wetland habitat development is illustrated by Tuckertown, where relatively stable water levels, quiet water, and fine, gently sloping substrates combine to allow extensive and diverse emergent wetland development. Located mostly along the arms of the flooded tributaries, the emergent marshes exhibited well defined zonation of pickerel weed, water willow, and cattail within the full pond limit, often grading to shrub swamp above full pond. Aquatic beds, primarily native elodea, formed in deeper water. The depth to which aquatics extended (approximately 5-6 feet) was probably governed by light limitation in the water column more than water level fluctuation.

The complexity of wetland development within Narrows reservoir fell between High Rock and Tuckertown, with emergent wetlands being more extensive but lower in species diversity than on Tuckertown. Water willow formed the vast majority of the emergent community, with other species being low in number and distribution (see section 9.2). Aquatic beds were abundant in the four small ponds west of the railroad bed on the west side of Narrows. These areas are connected to the main body of the reservoir and therefore fluctuate with the reservoir (NAI 2004a), but the aquatics appear able to persist in dry years and expand in wet years.

At Falls, the combination of frequent water level fluctuations, high flows and steep, rocky substrates limit the in-pond wetland development. Water willow beds have developed in a few areas where slopes, substrates and a lack of scour permit. Aquatic beds were completely absent and would unlikely ever be prevalent due to the high flows and lack of fines in this reservoir.

9.2 WATER WILLOW IN NARROWS

The distribution of water willow in Narrows underscores the tolerant, persistent nature of this plant. An early successional species, it is capable of exploiting a wide range of growing conditions, including moderate fluctuations in water levels. In undeveloped areas, the distribution of water willow appeared driven by a combination of substrate, light availability, shoreline slope, and shoreline use. The most extensive water willow beds were those established on fine (sand or silt) substrates, with high light availability, shallow sloping shores, water depths at full pond of less than 3 feet, and limited human activity within the bed. However, attesting to its highly tolerant nature, many other, albeit smaller, beds occurred under less than ideal conditions, such as rocky substrates, overhanging trees, and chronic or periodic stress from human activity. Exposure to wave action and currents typically prevents growth of many emergent species, but appeared to be a relatively unimportant factor on water willow at Narrows. For example, several shallow subsurface bars in Heron Cove supported extensive water willow beds but were highly exposed to wind, waves and boat wakes. These beds were well established and appeared on all of the vegetation maps cited above, and therefore are clearly able to withstand exposure for long periods of time.

The 2004 pier study underscored the tolerance of this species. Unlike the Touchette et al. (2001) study, the presence and density of water willow appeared to be more closely linked with land use than the influence of the pier on light availability. In general, percent cover of water willow ranged from 34 to 92% cover at the new piers (Table 8.2-2). In preparation for the field work, height and width of the piers were assumed to be significant factors in that lower, wider piers would reduce light availability to vegetation underneath the pier. This assumption was partially borne out in the field, in that the lower docks generally had less water willow. However, a stronger association between the distribution of water willow and piers appeared to be land use and shoreline use levels. Deliberate land clearing and incidental disturbance appeared to play a major role in limiting the distribution of water willow in the immediate vicinity of development.

As discussed in the Fisheries section (8.3.4), water willow is important for fish habitat, providing refuge and forage for minnows and the juveniles of many larger species. Touchette et al. (2001) captured 17 species in minnow traps and seines within, and adjacent to, water willow beds, which supported seven or more species than other shoreline types sampled. Fish species diversity and abundance were higher in sheltered water willow beds compared to exposed beds, and fish tended to use the beds more in the summer months. The Narrows hydrologic regime allows access to all or portions of the water willow beds for much of the growing season. In wet years such as 2004, water levels stay close to full pond for much of the growing season, allowing inundation of, and therefore fish access to, most of the water willow beds. In an average year, water levels typically remain within 2 feet of full pond, and thus continue to inundate the lower portion of the water willow beds. If water levels drop below approximately 5 feet in Narrows, most of the water willow observed in 2004 would be unavailable to fish. Water willow appears to be a very adaptable species, however, and may extend further down the littoral zone as the water level drops in dry years.

The loss of water willow due to development is potentially large. While this study did not attempt to estimate the acreage of habitat lost, the findings indicate more than half (52%), of the water willow associated with lake shore development is eliminated during and after construction. This estimate of loss is very likely an underestimate because the study only looked at piers where some water willow was evident nearby or on adjacent lots. Many piers were observed where all water willow appeared to have been eliminated on consecutive lots, therefore were ineligible for this study. Had they been included, the complete loss of water willow on these lots would have further raised the estimate of impact.

9.3 DEVELOPMENT

Human impact on the reservoirs can be viewed from two perspectives: the larger picture is watershed-wide, and includes the major impacts of sedimentation and eutrophication to the reservoirs, described in NAI 2004b and NAI 2004c, respectively. These are of such magnitude and regional significance as to be beyond the immediate influence of the Yadkin Project or its operation. More local issues include the use of the reservoirs and development along the shorelines. As described in the water willow discussion for Narrows (Section 9.2), human development around the reservoirs can have a profound effect on existing wetlands. Direct human impacts observed during field studies include physical development (piers, retaining walls, beaches), vegetation removal and disturbance, wave scour from boats and jet skis, and land management adjacent to the reservoirs. In the 2004 study of Narrows, over half of the water willow beds growing in front of developed shorelines had been intentionally cleared, or incidentally impacted through human-related disturbance. It is likely that plant species diversity in the remaining emergent marshes on Narrows is reduced by the impacts of wakes from boats and jet skis. Water willow appears capable of withstanding wave impacts from wakes and exposure as well as tolerating the drawdown. Species which are more prevalent on the quieter coves of Tuckertown, such as pickerel weed, cattail, and soft-stemmed bulrush, may be more vulnerable to wave action and less tolerant of a drawdown.

The effects of recreational use and development around High Rock are similar to those on Narrows. While the number of emergent beds on High Rock is currently low due in most part to the drawdown the impacts from human use observed on Narrows apply to High Rock as well. This would result in further inhibition of emergent wetland development. Boat wakes are likely an added aggravation to woody or emergent seedlings attempting to establish or persist on marginal habitats, including both naturally colonizing black willows and the on-going effort to re-establish buttonbush (Lexington Dispatch, November 21, 2003).

10.0 EFFECTS OF ALTERED PROJECT OPERATION

As described in Section 5.5, one objective of this study was to evaluate the potential effect on wetlands associated with alternative reservoir water level regimes, particularly at High Rock. While the riparian floodplains on the Yadkin River mainstem and South Yadkin River would be little affected by any changes in the current High Rock water level regime, the impacts to wetlands around the reservoir itself are potentially great. The following discussions evaluate potential changes in wetlands, and by necessity, make the assumption that no major changes in sediment transport and water quality occur.

The predictions of change in High Rock wetland vegetation are based on professional judgment derived from experience on other reservoirs and familiarity with local conditions. Vegetation distributions in Tuckertown and Narrows reservoirs were part of the evaluation, as was experience on other reservoirs. The time frame in which the change is considered could also have an impact on the estimate of acreage. In the short term, a sudden change in hydrologic regime may produce an immediate response in the vegetation that is not representative of the mature community, such as the quick flush of shrub seedlings, grasses and sedges observed in High Rock following the 2002 drought, or the dieback of those same species the following year when more typical water levels returned. Over the very long term, sediment accretion and changes in water quality could result in unforeseen increases or declines in vegetation. The estimates provided here are based on the anticipated response of the vegetation following stabilization after the initial disturbance from the new hydrologic regime, and under a long-term average of climatic conditions. Due to the lack of precision possible in such an assessment, the percent change in wetland acreage was rounded to the nearest quarter (25%, 50%, 75% and 100% relative to existing conditions). Because of the different responses anticipated for the woody wetlands dominating the sediment bars in Upper High Rock (Delta Area) and the largely unvegetated portions of the lower reservoir (Main Body), the two areas were analyzed separately (Figure 10-1). The more riverine section above the I-85 bridge was assumed to remain relatively unchanged under any of the reservoir water level alternatives considered and was, therefore, excluded from the analysis (Yadkin River). The acreages of change are intended to be representational only to provide the reader an estimate of the relative degree and distribution of change.

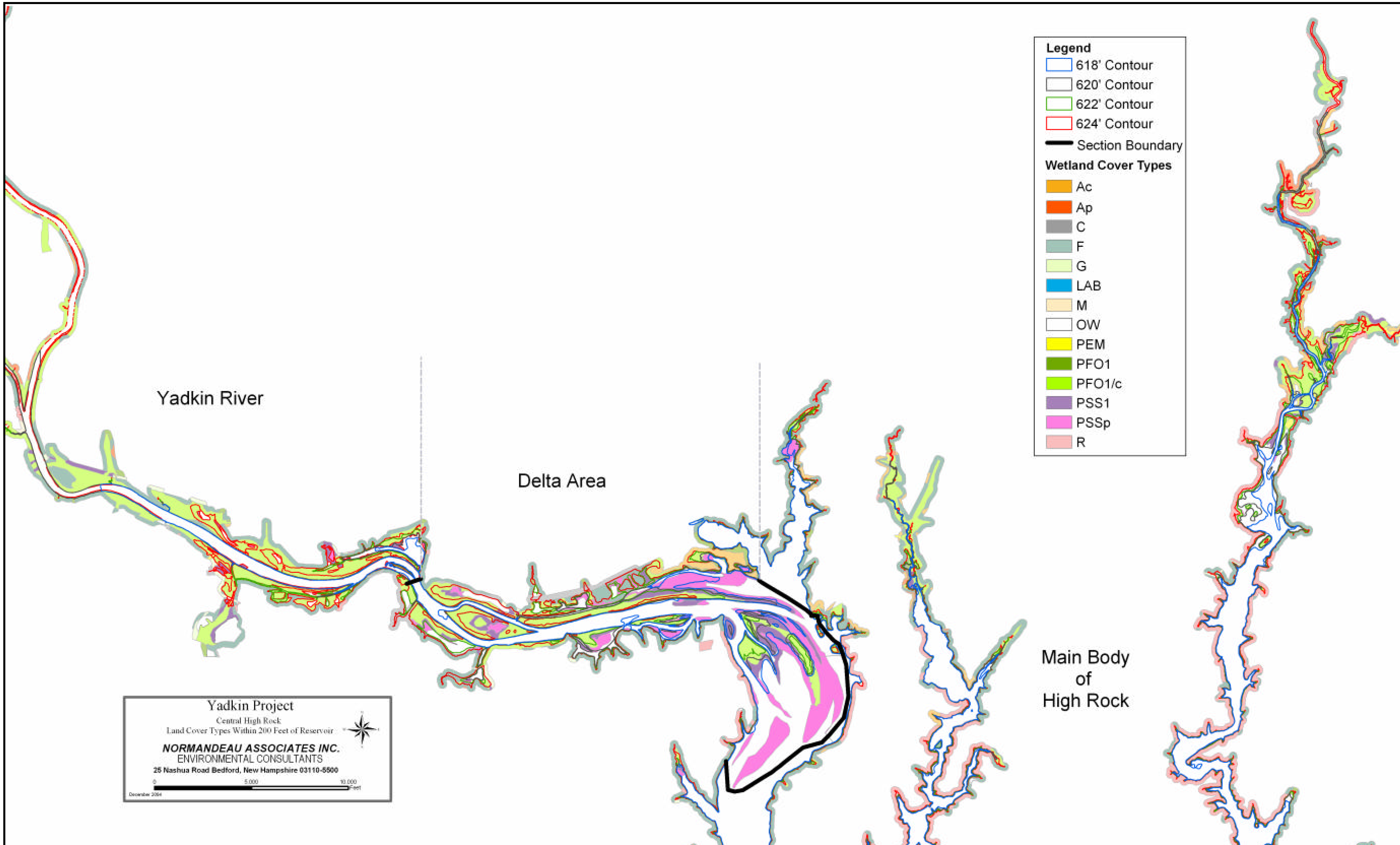

Figure 10-1. High Rock contour intervals from 624N – 618N and cover types, divided into hydrogeomorphic sections used in alternatives assessment.

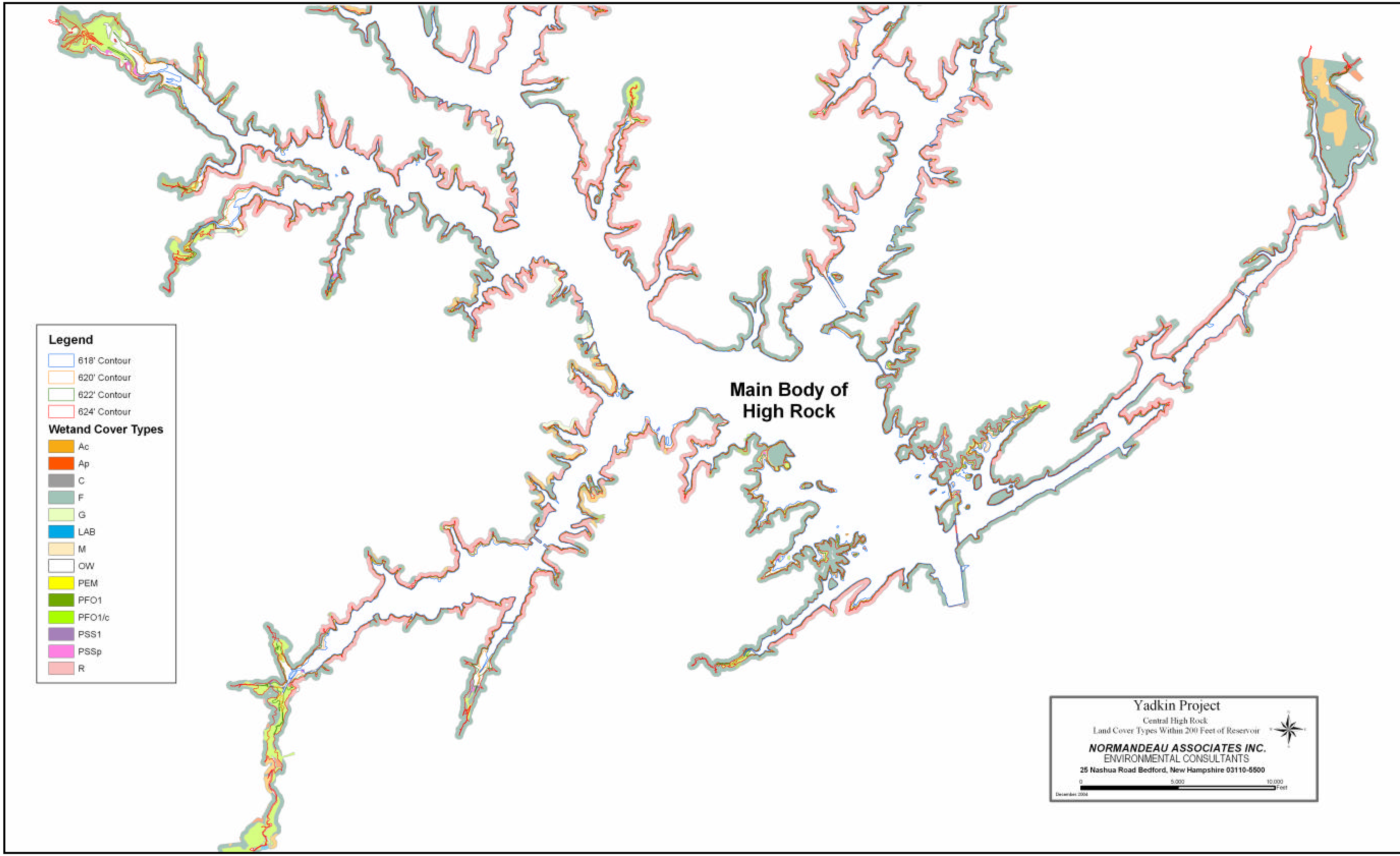

Figure 10-1. (Continued). High Rock contour intervals from 624N – 618N and cover types, divided into hydrogeomorphic sections used in alternatives assessment.

10.1 HIGH ROCK ALTERNATIVE 1 – NEAR-FULL YEAR ROUND

Maintaining the reservoir near-full (within 3 feet of full) year round would result in multiple changes to the in-pond wetlands. In the delta area at the upper end of High Rock Reservoir, the extensive black willow forested wetlands would likely decline. While this species can tolerate flooding for long periods of time, it can not survive permanent inundation. In the short term, the sediment bars would become more dynamic without the stabilizing effects of the black willow. Those that have elevations within 2 or 3 feet of full pond would be periodically colonized with emergent marsh species that can withstand high flows, possibly water willow. However, without woody vegetation, it is likely that major flood events would periodically scour away the vegetation and portions of the sediment to redeposit it further downstream. Over time, the elevation of some of the bars would likely accrete sufficiently to allow black willow to recolonize at a higher elevation, and allow some form of the current mid-stream woody wetlands to re-establish. Approximately 25% of the existing wetland acres in each of the contour intervals in the delta area of High Rock were estimated to remain as vegetative wetland under this alternative (Table 10-1), with the assumption that the remainder would be drowned under the permanent high water.

Table 10-1. High Rock estimates of wetland (acres) for the upper 6 feet of lake bottom under three hydrologic alternatives.

Location and Hydrologic Alternative	Contour Interval (acres)				Vegetation Total	% of Existing	Acres of Change
	624-622	622-620	620-618	<618			
Upper High Rock Delta		**(Total Acres)**					
Area of Contour Interval	416	201	243	714			
		(Wetland Acres)					
Existing*	340	164	198	368	1070	100%	0
Full Pond**	85	41	50	92	268	25%	-803
Extended***	85	41	50	92	268	25%	-803
Storage****	340	164	198	368	1070	100%	0
Main body of High Rock		**(Total Acres)**					
Contour interval	1001	578	723	10056			
		(Wetland Acres)					
Existing	543	0	0	0	543	100%	0
Full Pond	751	434	542	0	1727	318%	1184
Extended	501	289	0	0	790	145%	247
Storage	136	136	88	0	360	66%	-183
Combined		**(Wetland Acres)**					
Existing	883	164	198	368	1613	100%	0
Full Pond	836	475	592	92	1994	124%	381
Extended	585	330	50	92	1057	66%	-556
Storage	475	300	286	368	1430	89%	-183

* Delta - uses mapped PFO1c, PSS, and PEM numbers, distributed proportionately across 624-618 contours Main body - uses PFO1c, PSS & PEM acres in 624-622 contour only

** Delta - Uses 25% of existing, assuming rest drowns. Main body - assumes 75% of contour vegetated, rest unavailable due to exposure, slope & substrate

*** Delta - Uses same number as full pond, assuming flooded all growing season. Main body - uses 25% of 2 upper contours, assuming rest would not persist thru drawdown; no vegetation below 620 because of drawdown

Around the periphery of High Rock, maintaining a full pond regime would allow more extensive emergent and aquatic beds to develop. In areas of shallow substrates, species similar to those of Tuckertown would likely establish: water willow, pickerelweed, cattail, and square-stem spike rush. Aquatic beds may form immediately off-shore from the emergents, although light limitation in the water column is likely to continue in High Rock. However, similar to the shrub wetlands in Upper High Rock, the woody floodplain forests and shrub wetlands that are abundant at the upper ends of the larger tributaries will be pushed back by the stable full pond level, and replaced by emergent wetlands.

For the in-lake acreage estimate of near-full conditions in Table 10-1, 75% of the upper 6 feet of the reservoir (75% of the total acreage in each 2’ contour interval) were assumed to have the potential to develop a combination of emergent wetland and aquatic bed. The remaining 25% of the littoral zone would be unavailable due to exposure, slope and substrate. Below a depth of 6 ft (<618’ contour), it was assumed no wetlands would develop due to water depth and limited light penetration. These numbers were derived in part from observations in Tuckertown. While lacking in bathymetry below the top 2 feet, much of the Tuckertown shoreline in the tributary arms supported emergent wetlands and aquatic beds, while the mainstem had less, due mostly to steeper sides and rocky substrate. In High Rock, the slopes are frequently less steep, and have fine mineral substrates, but exposure to fetch and boat wakes may limit in-lake wetland development.

These anticipated changes would probably enhance fish populations on High Rock by improving in-lake wetlands for spawning, nursery and shelter habitat. The overall acreage of wetland is anticipated to increase, as well as the distribution of wetlands, so that fish species would have access to more extensive emergent and shrub wetlands around most of the periphery of the reservoir. An associated wildlife habitat improvement would also occur, as is seen at Narrows Reservoir. These same wetlands and aquatic beds have the potential to become an annoyance to boaters and lake shore owners, as well as locations for invasives to establish, especially in the high-nutrient environment now found at High Rock.

10.2 HIGH ROCK ALTERNATIVE 2 – EXTENDED NEAR-FULL SEASON

In this alternative, the extent of the drawdown would be similar to existing conditions, but the timing of the draw would allow the reservoir to refill sooner and delay the start of the winter drawdown from mid-September to November. This alternative would probably have a similar impact to the black willow beds in the upper High Rock delta as Alternative 1, because the willow would theoretically be inundated the entire growing season. The emergent beds would respond in an intermediate fashion between existing conditions and full pond. Alternative 2 would be beneficial to the establishment of some emergent species, but not the full suite found in Tuckertown. Pickerelweed and cattail are typically sensitive to winter drawdowns. Water willow would be the most likely species to expand, because it appears to be most tolerant of some fluctuations in water levels and may tolerate the winter drawdown better than other species. No increase in aquatic bed acreage would be anticipated, because aquatics, as their name suggests, can not withstand extended periods of dewatering. The resulting community would be most similar to that found in Narrows.

For estimating acreages in Upper High Rock, the same assumptions as for the near-full scenario were applied to the extended near-full season alternative: approximately 25% of the existing delta wetlands were estimated to remain, assuming that the remainder would be drowned under the continuous high water through the growing season (Table 10-1). For the main body of the reservoir, 50% of the upper 4 feet of lake bottom (50% of the total acreage in the 624-622 and 622-620 contour intervals) were assumed to have the potential to support emergent wetlands (Table 10-1). The lower depths were assumed to remain unvegetated because the aquatics could not tolerate the winter drawdown, and the low water clarity would probably limit water willow growth below 4 feet. The 50% estimate is higher than the 30% cover of emergents observed at Narrows in 2004, but is reasonable due to the significantly less rocky, more gradual shoreline at High Rock compared to many sections of Narrows.

Despite the loss of wetlands in the delta area, this alternative may have a beneficial impact for fish and wildlife species due to the expansion of wetlands around the periphery of the reservoir. By dispersing suitable habitat over a broader area, fish and wildlife would have a wider variety of habitat conditions available and be subject to less concentrated predator pressure. The winter drawdown may reduce the risk of aquatic invasives compared to the near-full alternative, because drawdown is a control technique for a number of these species.

10.3 HIGH ROCK ALTERNATIVE 3 – ADDITIONAL USE OF STORAGE

This alternative considers drawing down the water 20 feet on average, on the same schedule as existing conditions, but refilling to 5 feet below full pond. This would have substantial impacts to both the black willow delta wetlands and the remnant in-pond wetlands currently persisting in High Rock. The deeper drawdown is probably of little consequence, but not refilling to the current summer levels, which are frequently within 2-3 feet of full, would result in less flooding of the wetlands. On the delta, the current trend of black willow establishing as seedlings and ultimately growing to forested wetland would accelerate. The lower water levels would allow black willow and other species to establish and grow more rapidly, and expose more sand bar area for colonization. The existing bars would be more stable, requiring an even larger flood to impact them, and the hastening of woody growth would further deter erosion and increase deposition. Many of these species would be adversely impacted, possibly killed, during wet years such as 2003 and 2004 which will inevitably produce extended periods of full pond. The extent of emergent wetlands in the main body of the reservoir would probably remain little changed, although their position might change as they followed the water level down. Woody species would likely encroach on the available habitat created along the shore by the lower drawdown. However, these scrub-shrub species would be subject to the same high-water events as the delta areas, and many encroaching plants may periodically dieback.

The estimate of wetland in the delta area under the storage scenario was kept the same as the existing acreage of floodplain forest, shrub swamp and emergent wetland (Table 10-1). Under the storage scenario, however, the wetlands would be much more dynamic, expanding in dry years and being pushed back during wet years.

To estimate acreage of lake bottom supporting wetland vegetation, 50% of the existing vegetation was assumed to persist in the upper 4 feet of the reservoir (50% of existing wetland acreage in contour intervals 624-622 and 622-620, distributed equally between both contour intervals), with the rest periodically dying back during high water events (Table 10-1). Emergent wetland and shrub swamp vegetation is expected to re-establish at the lower fill line (5 feet below full pond; 520-518 contour), therefore the existing amount of those cover types (88 acres) was included in the estimate for this alternative. Woody species would also encroach on the available habitat created along the shore by the lower drawdown. However, these scrub-shrub species would be subject to the same high-water events as the delta areas, and most encroaching plants would periodically die back.

Functionally, this storage alternative would be the least beneficial of the three hydrologic alternatives to fish and wildlife species. Not only would the net availability of habitat be reduced, the anticipated instability and yearly variability of the wetlands would result in a decline in spawning and nursery success. Invasive aquatic plant species may have an advantage in this alternative because they are often able to tolerate variable hydrologic conditions better than native species.

10.4 TUCKERTOWN ALTERNATIVE – INCREASED SHORT TERM FLUCTUATIONS

There are no plans to make any changes to reservoir operations at Tuckertown. However, if changes in Project operations resulted in short-term water level fluctuations of 3-5 feet at Tuckertown, compared to the current 1-2 feet, it could have the effect of reducing the diversity and possibly the extent of emergent wetlands and aquatic beds in Tuckertown. Species diversity would be expected to decline because the zonation which currently exists within the emergent marsh would be disrupted. The species more tolerant of water level fluctuation, i.e., water willow, would likely expand to the detriment of the other species. Pickerelweed, for one, is relatively intolerant of frequent water level fluctuations, and would likely decline. Aquatic beds could persist if drawdowns during the growing season were brief enough to not dehydrate them completely and if drawdowns during the winter were brief enough to avoid freezing and desiccation. Some reduction in the aquatic bed productivity and possibly extent is to be expected, especially toward the upper limit of aquatic bed growth.`

10.5 NARROWS ALTERNATIVE – ADDITIONAL USE OF STORAGE

If Yadkin Project operations were altered in order to utilize the additional storage available at Narrows, more frequent drawdowns of 5-15 feet would result (as compared to the existing drawdown limit of about 6 feet). From a wetland perspective the primary concern with increasing the magnitude, frequency or duration of drawdowns at Narrows Reservoir would be the effect on emergent wetlands (predominantly water willow). As discussed previously, water willow is an early successional emergent that appears to withstand some level of periodic drawdown . However, increasing the drawdown at Narrows during the winter could have the effect of desiccating and freezing water willow beds that are mostly inundated under the current Project operation. This species appears able to tolerate the frequent fluctuations of the growing season water level that currently occurs on Narrows, so an increase in magnitude at that time of year may not be detrimental as long as refill continues at a similar frequency as current operations. Additionally, the combined effects of an increase in the frequency, duration or magnitude of water level fluctuation in the winter and summer could exceed water willow tolerance, and result in a decline.

10.6 FALLS ALTERNATIVE

Because Falls is so small and has such limited storage, no changes in the operation of Falls reservoir were evaluated and no changes in the plant community attributable to Project operations are anticipated.

11.0 CONCLUSIONS AND RECOMMENDATIONS

The wetland cover types around the four reservoirs are generally similar in species composition and structure, with the exception of the floodplain wetland forests lining the Yadkin and South Yadkin Rivers at the upper end of High Rock Reservoir. The forces maintaining these floodplain forests are primarily riverine, including regular flooding and scouring during periods of high precipitation and runoff within the Yadkin River watershed. The wetlands on the reservoirs have adapted over time to the hydrologic patterns of each reservoir, all of which are more lacustrine in nature than riverine, with the possible exception of Falls. Among the four reservoirs, the distribution of wetland cover types is varied. High Rock is dominated by forested floodplain wetlands, predominantly on the portions of the tributary streams that are influenced by reservoir water levels, and the delta area, where the Yadkin River deposits much of its sediment load as it enters the quieter waters of the reservoir. Forested floodplain wetlands dominated by black willow have established on the sediment bars, and function to stabilize the existing bars and trap additional sediment. Early scrub-shrub stages of black willow growth on the newly forming bars provide important fish habitat. On Tuckertown Reservoir, forested wetlands are the most abundant wetland cover type, occurring in scattered stands at the mouths of most tributaries. Narrows has relatively few wetlands overall (approximately 11%), of which the most abundant cover type is emergent, with almost all beds dominated by water willow. Falls has the fewest wetlands both in acres and percent (2%). Its steep, rocky sides and riverine nature preclude wetland formation adjacent to the reservoir, and in-pond wetlands are limited by the frequent water level fluctuations, and associated scour and currents resulting from its run-of-river mode of operation. Narrows and High Rock have the most human development. High Rock has over three times as much area in development as Narrows. Although NAI's estimate of the percentage of developed shoreline around High Rock is relatively low (20%), this number is misrepresentative because it includes the mostly undeveloped shorelines of the Yadkin and South Yadkin Rivers. Calculating the developed area for High Rock Reservoir only (below the I-85 bridge), the percentage rises to 25%. This number is more similar to that of Narrows, where almost one-third (31%) of the shoreline is developed.

Water willow is an important ecological feature on Narrows. Narrows is the only reservoir where emergent wetlands and shoreline development are extensive. High Rock and Falls have little emergent marsh development, and Tuckertown has little shoreline development. On Narrows, the emergent wetlands line 30% of the shoreline, mostly in beds too narrow or small to be mapped from aerial photographs. These beds, almost exclusively dominated by water willow, provide important fish and wildlife habitat, functioning as spawning grounds, forage and resident fish habitat, and thus providing forage for piscivorous wildlife, and cover for waterfowl. Shoreline development has adversely affected water willow by clearing and disturbance. Of the water willow beds studied in the vicinity of docks, more than half of the water willow no longer existed.

Key wetland functions provided by the wetlands surrounding the four Yadkin reservoirs include flood control and fish habitat. Flood control is most prevalent on the floodplain forests of the Yadkin River, the South Yadkin River, and the larger tributary streams, most of which drain into High Rock. These wetlands act to store flood waters and delay drainage, thereby reducing the flood crest. Habitat for fish spawning, nursery, and forage is provided by wetlands on all four of the reservoirs: mostly in the scrub-shrub wetlands of the delta area on High Rock, and the emergent wetlands on Tuckertown, Narrows and, to a limited extent, on Falls. This function is provided only when water levels are high enough to inundate the wetlands, which is generally limited to the early part of the growing season in High Rock, with the exception of wet years such as 2004, and sporadically all year in Narrows. On Tuckertown and Falls, both of which have more frequent, smaller fluctuations than High Rock or Narrows, the wetlands are available to fish for most of the year. Wildlife habitat is an important function on High Rock, Tuckertown and Narrows, providing forage and shelter for a variety of wetland-dependent terrestrial birds, reptiles, amphibians and mammals. On Falls this function is limited by the small area of wetlands relative to the reservoir. Other wetland functions, including sediment trapping, nutrient removal, and social value are limited by the small size of the wetlands relative to the size of the Yadkin River watershed and the large concentrations of sediment and nutrients entering the reservoir system from upstream. The wetlands are indirectly contributing to social values through recreation (fishing, hunting, and bird watching) by fish and wildlife enhancement. The aesthetic values of the wetlands appear to be appreciated from afar, but many shoreline landowners choose to clear wetlands and other vegetation to provide better access and views of the water.

The hydrologic regime of the reservoirs, as determined by current Project operations, is a major determinant in the distribution and type of in-pond wetlands. The wetlands adjacent to the reservoirs, but above the full pond elevation are typically less influenced by reservoir water levels because these wetlands frequently receive hydrologic inputs from other sources, such as groundwater and surface flows. On High Rock, the delta area is a result of sediment deposition occurring when flow down the Yadkin River is slowed by the impoundment sufficiently to drop some of the fines suspended in the water column. This delta area is vegetated by floodplain forested wetlands and scrub-shrub wetlands, all dominated by black willow. It is probably the primary spawning ground for many fish species in High Rock when inundated in the spring and early summer. The late summer drawdown that is typical on High Rock allows the black willow to persist, but at the same time is limiting to the development of more typical lake-shore emergent wetlands and aquatic beds. In contrast, Tuckertown Reservoir has the most stable water regime of the four reservoirs, and also has the most diverse emergent wetland development and aquatic beds. Narrows is intermediate in in-pond wetland quality between High Rock and Tuckertown, with more extensive emergents than Tuckertown, but less species diversity. The lower species diversity can probably be attributed to the greater drawdowns experienced on Narrows, which water willow alone appears to tolerate.

Changes in Project operations could alter the hydrologic regimes and thus could have significant impacts to the wetlands of the three largest reservoirs. This study evaluated the effects of three alternative reservoir water level regimes on High Rock:

- *Alternative 1* – "Near-Full Year Round" - a stable water level would result in the development of emergent wetlands and aquatic beds along much of the shoreline of High Rock, probably similar in zonation and species diversity to Tuckertown. A stable water level is also likely to have the adverse impact of eliminating much of the black willow that has colonized the delta area, particularly in the deeper areas. Emergents could colonize some of the areas, but the area is likely to be less stable and more subject to shifting sediment during large flood events. In general fish and wildlife habitat would be enhanced, although the risks of colonization by invasive aquatics would also increase.

- *Alternative 2* – "Extended Near-Full Season" - a shorter winter drawdown would likely enhance wetland development around the perimeter of High Rock, probably similar to Narrows with water willow dominating the emergent wetlands. Water willow is able to tolerate the fluctuating water levels on Narrows and may be able to persist in many areas through a winter drawdown on High Rock. The black willow beds in the delta area may decline somewhat, however they would probably persist given that periodic exposure during portions of the growing season occurs now in most years and would likely continue under Alternative 2. This occasional exposure and drainage would probably be sufficient to allow the established black willow stands to persist. Fish habitat may be improved under this alternative because of the wider distribution of wetlands around the periphery of the reservoir.

- *Alternative 3* – "Additional Use of Storage" - this alternative would be most detrimental to existing wetlands around High Rock. While the black willow stands on the delta area would probably thrive and expand, many of the remnant in-pond wetlands around the periphery of the reservoir would be less stable. The combination of a longer winter drawdown, a lower average water level, and periodic full pond levels would create a very difficult environment for emergent wetlands to persist or colonize. It is possible that woody species, primarily black willow and button bush, would tolerate the extremes of conditions created by this alternative and expand around the shoreline of the reservoir, but their potential to contribute to fish habitat would be limited by the lower average full pond line. Also, the risks of excessive flooding during wet years could result in considerable dieback of the encroaching woody species. Fish habitat would decline under this alternative due to a combination of less available wetland acreage and more seasonal and annual variability. Invasive aquatic plants would potentially be able to out compete native aquatics in this more variable environment.

At Tuckertown, increases in short-term water level fluctuations by several feet would likely reduce the species diversity and alter the zonation of the emergent wetlands now prevalent on the reservoir. Water willow would be likely to expand, because of its obvious tolerance of water level fluctuations on Narrows. Aquatic beds could also decline if the fluctuations were prolonged enough for them to dehydrate. Given that this reservoir has the highest quality in-pond wetlands of the four, based on both species diversity and zonation, the alternative regime could be detrimental by degrading the wetlands to the more monotypic vegetation found on Narrows.

At Narrows, utilization of more of the reservoir's storage capacity, which would result in a greater winter drawdown and more routine and deeper draws in the summer, could have an adverse impact on the water willow beds. While water willow is clearly tolerant of the current summer water level fluctuations, the combination of a winter drawdown and greater summer fluctuations could exceed this species tolerance and result in a decline. The abundance of fish and wildlife observed on Narrows depends in large part due to the habitat provided by the water willow, and would likely decline along with the loss of water willow.

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APPENDIX A

Plant Species Observed in Cover Types Throughout the Yadkin Project Area

		Habitat Type						
		Forested Wetland	Forested Floodplain Wetland	Scrub-Shrub Wetland	Sparse Shrub Wetland	Emergent Marsh	Aquatic Bed Upland	Upland
Species	**Common Name**	**PFO1**	**PFO1c**	**PSS1**	**PSSp**	**PEM**	**AB**	**UPL**
TREES								
Acer saccharum barbatum								X
Acer saccharum leucoderme	Chalk Sugar Maple							X
Aesculus sylvatica	Painted Buckeye	X						X
Ailanthus altissima	Tree of Heaven							X
Albizia julibrissin	Mimosa							
Betula nigra	River Birch	X	X		X	X		X
Carpinus caroliniana	American Hornbeam	X	X					X
Carya carolinae-septentrionalis								X
Carya cordiformis	Bitternut Hickory		X					X
Carya glabra	Pignut Hickory							X
Carya ovata								X
Carya sp.	Hickory species							X
Carya tomentosa	Mockernut Hickory							X
Castanea dentata								X
Celtis laevigata		X						X
Cercis canadensis		X						X
Chionanthus virginicus				X				X
Cornus florida	Flowering Dogwood	X	X					X
Diospyros virginiana								X
Fagus grandifolia		X	X					X
Fraxinus americana		X						X
Fraxinus pennsylvanica	Green Ash	X	X	X				X
Fraxinus spp.	Ash species	X	X					X
Ilex opaca		X	X					X
Ilex sp.								X
Juglans nigra								X
Juniperus virginiana		X						X
Liquidambar styraciflua	Sweet Gum	X	X		X			X
Liriodendron tulipifera	Tulip Tree	X	X					X
Nyssa sylvatica	Black Gum		X					X
Ostrya virginiana			X					X
Oxydendron arboreum	Sourwood	X						X
Paulownia tomentosa								X
Pinus echinata	Short-leaf Pine							X
Pinus sp.	Pine species							X
Pinus taeda	Loblolly Pine							X
Pinus virginiana	Virginia Pine	X						X
Platanus occidentalis	American Sycamore	X	X					X
Populus alba								X
Populus deltoides	Cottonwood	X	X		X	X		
Prunus serotina	Black Cherry							X
Prunus sp.	Cherry species							X
Quercus alba	White Oak	X	X					X
Quercus coccinea		X						X

		Habitat Type						
		Forested Wetland	Forested Floodplain Wetland	Scrub-Shrub Wetland	Sparse Shrub Wetland	Emergent Marsh	Aquatic Bed Upland	Upland
Species	**Common Name**	**PFO1**	**PFO1c**	**PSS1**	**PSSp**	**PEM**	**AB**	**UPL**
Quercus falcata	Southern Red Oak	X	X					X
Quercus lyrata	Overcup Oak	X	X					X
Quercus marilandica			X					X
Quercus nigra		X						X
Quercus phellos	Willow Oak	X	X					X
Quercus prinus (Q. montana)	Chestnut Oak		X					X
Quercus rubra		X	X					X
Quercus spp.	Oak species	X	X					X
Quercus stellata								X
Quercus velutina								X
Robinia pseudo-acacia								X
Salix nigra	Black Willow	X	X	X	X	X		X
Salix sp.	Willow species	X	X					X
Sassafras albidum								X
Taxodium distichum		X	X					X
Ulmus alata	Winged Elm	X	X					X
Ulmus americana		X	X					X
Ulmus rubra								X
Ulmus sp.								X
SHRUBS								
Alnus serrulata		X	X	X				X
Amelanchier arborea								X
Amelanchier sp.								X
Amorpha fruticosa								X
Amorpha schwerinii	Piedmont Indigo-bush							X
Amorpha sp.								X
Calycanthus floridus								X
Ceanothus americanus								X
Cephalanthus occidentalis	Buttonbush	X	X	X	X	X		
Cornus amomum	Silky Dogwood	X	X	X				X
Crataegus uniflora								X
Euonymus americana								X
Gaylussacia frondosa								X
Hamamelis virginiana								X
Hypericum sp.				X				X
Ilex decidua		X						X
Ilex laevigata								
Itea virginica		X						X
Kalmia latifolia			X					X
Leucothoe racemosa								X
Ligustrum japonicum	Japanese Privet							
Ligustrum sinense	Chinese Privet	X						X
Lindera benzoin		X						
Lonicera								X
Lonicera sp.								X

		Habitat Type						
		Forested Wetland	Forested Floodplain Wetland	Scrub-Shrub Wetland	Sparse Shrub Wetland	Emergent Marsh	Aquatic Bed Upland	Upland
Species	**Common Name**	**PFO1**	**PFO1c**	**PSS1**	**PSSp**	**PEM**	**AB**	**UPL**
Lonicera x bella	Bush Honeysuckle	X						X
Magnolia acuminata								X
Rhododendron arborescens								X
Rhododendron maximum								X
Rhododendron nudiflorum		X						X
Rhus aromatica								X
Rosa multiflora	Multiflora Rose	X						
Rosa palustris				X				
Rosa wichuraiana	Memorial Rose							X
Rubus argutus	Blackberry							
Sambucus canadensis		X						X
Staphylea trifolia		X						X
Styrax grandifolia								X
Symplocos tinctoria								X
Vaccinium arboreum	Farkleberry							X
Vaccinium sp.								X
Vaccinium stamineum	Deerberry							X
Viburnum acerifolium								X
Viburnum dentatum		X		X				X
Viburnum prunifolium								X
Viburnum rufidulum								X
HERBS								
Actaea sp.								X
Agave (Manfreda) virginica								X
Agrostis sp.								X
Allium sp.								X
Amphicarpa bracteata		X						
Amsonia tabernaemontana								X
Andropogon virginicus (A. glomeratus)						X		X
Aneilema keisak	Marsh Dewflower					X		
Antennaria plantaginifolia								X
Anthoxanthum odoratum	Sweet Vernal Grass							
Apios americana								X
Arisaema cf. triphyllum	Swamp Jack-in-the-Pulpit	X				X		X
Arundinaria gigantea	Cane	X						X
Asarum canadense								X
Asclepias tuberosa								X
Asplenium platyneuron	Ebony Spleenwort							X
Aster		X				X		
Aster cf. lateriflorus	Calico Aster	X				X		X
Aster cf. vimineus	Small White Aster					X		X
Aster linariifolius								X
Aster sp.		X						X
Aureolaria pectinata								X
Aureolaria sp.								X

		Habitat Type						
		Forested Wetland	Forested Floodplain Wetland	Scrub-Shrub Wetland	Sparse Shrub Wetland	Emergent Marsh	Aquatic Bed Upland	Upland
Species	**Common Name**	**PFO1**	**PFO1c**	**PSS1**	**PSSp**	**PEM**	**AB**	**UPL**
Aureolaria virginica								X
Azolla caroliniana			X			X		
Bambusaceae	A bamboo							X
Baptisia alba	Thick-pod White Wild Indigo							X
Bidens aristosa		X						
Bidens discoidea						X		
Bidens frondosa	Devil's Beggar-ticks					X		
Boehmeria cylindrica	Small-spike False Nettle	X						
Boltonia caroliniana						X		
Botrychium sp.	Grape Fern species							X
Campsis radicans	Trumpet Creeper	X				X		X
Cardamine concatenata								X
Carex alata						X		
Carex baileyi						X		X
Carex comosa			X			X		
Carex crinita	Fringed Sedge	X						X
Carex folliculata		X						
Carex lupulina	Hop Sedge	X	X			X		
Carex lurida		X						
Carex muhlenbergii			X					
Carex pensylvanica	Pennsylvania Sedge							X
Carex rosea		X						
Carex scoparia						X		
Carex sp.		X				X		X
Carex tribuloides	Blunt Broom Sedge	X	X					X
Carex typhina		X	X			X		
Cf. Veronica sp.								X
Chasmanthium latifolium		X				X		X
Chenopodium sp.		X						
Chimaphila maculata	Spotted Wintergreen		X					X
Chrysogonum virginianum								X
Cirsium carolinianum	Carolina Thistle							X
Clitoria mariana								X
Comandra umbellata								X
Commelina sp.		X						X
Commelina virginica		X				X		
Coreopsis auriculata		X						X
Coreopsis major								X
Coreopsis sp.			X					X
Coreopsis verticillata	Verticillate Tickseed							X
Cunila oreganoides								X
Cuscuta sp.		X				X		X
Cyperus lancastriensis						X		
Cyperus ovularis						X		
Cyperus sp.						X		

		Habitat Type						
		Forested Wetland	**Forested Floodplain Wetland**	**Scrub-Shrub Wetland**	**Sparse Shrub Wetland**	**Emergent Marsh**	**Aquatic Bed Upland**	**Upland**
Species	**Common Name**	**PFO1**	**PFO1c**	**PSS1**	**PSSp**	**PEM**	**AB**	**UPL**
Cyperus strigosus						X		
Dichanthelium sp.								X
Dioscorea batatas								X
Diospyros virginiana								X
Dulichium arundinaceum		X						
Echinochloa crus-galli						X		
Eclipta alba						X		
Eleocharis obtusa	Blunt Spikerush					X		
Eleocharis quadrangulata				X		X		
Eleocharis sp.						X		
Elephantopus sp.								X
Elymus virginicus	Virginia Wild Rye	X				X		X
Epifagus virginiana								X
Epigaea repens								X
Erianthus brevibarbis		X				X		X
Erigeron cf. philadelphicus		X						
Erythronium americanum								X
Eupatorium capillifolium								
Eupatorium fistulosum		X						
Eupatorium rotundifolium								X
Eupatorium rugosum	White Snakeroot	X	X					X
Eupatorium serotinum								
Eupatorium sp.						X		
Euphorbia cf. corollata								X
Galax aphylla								X
Gelsemium sempervirens		X						X
Gentiana sp.								X
Geranium maculatum		X						X
Geum								X
Glechoma hederacea	Gill-over-the-ground	X						X
Glyceria						X		
Glyceria striata		X	X			X		
Gnaphalium cf. obtusifolium								
Goodyera pubescens								X
Helianthus								X
Helianthus cf. laevigatus	Smooth Sunflower							X
Helianthus cf. tuberosus		X						
Helianthus divaricatus								X
Hepatica americana			X					X
Heterotheca (Pityopsis) graminifolia	Grass-leaved Golden-aster							X
Hexastylis arifolium	Arum-leaved Heartleaf							X
Hibiscus militaris						X		
Hibiscus moscheutos	Swamp Rosemallow	X		X		X		
Hieracium sp.								X
Hieracium venosum	Veined Hawkweed							X
Houstonia caerulea	Bluets		X					X

		Habitat Type						
		Forested Wetland	Forested Floodplain Wetland	Scrub-Shrub Wetland	Sparse Shrub Wetland	Emergent Marsh	Aquatic Bed Upland	Upland
Species	**Common Name**	**PFO1**	**PFO1c**	**PSS1**	**PSSp**	**PEM**	**AB**	**UPL**
Houstonia purpurea								X
Houstonia sp.								X
Hypericum prolificum								X
Hypericum punctatum								
Hystrix patula		X						X
Impatiens capensis	Spotted Touch-me-not	X	X			X		
Impatiens pallida		X						
Iris cristata		X						X
Iris pseudacorus						X		
Iris sp.						X		
Juncus alata						X		
Juncus diffussimus						X		
Juncus effusus	Smooth Rush					X		X
Juncus spp.		X						
Justicia americana	Water Willow	X				X		
Lactuca sp.								X
Laportea canadensis	Canada Wood Nettle	X						X
Lathyrus venosus								X
Leersia oryzoides						X		
Lemna minor	Lesser Duckweed					X		
Lemna perpusilla						X		
Lemna sp.		X						
Lespedeza cuneata	Chinese Lespedeza							
Lespedeza sp.								X
Ligusticum canadense								X
Lilium michauxii								X
Lindernia dubia						X		
Lobelia sp.						X		
Ludwigia alternifolia						X		
Ludwigia cf. glandulosa						X		
Ludwigia decurrens						X		
Ludwigia peploides						X		
Ludwigia sp.						X		X
Ludwigia uruguayensis (L. hexapetala)	Uruguay Water Primrose	X		X		X	X	
Lycopus sp.		X				X		
Lysimachia nummularia		X						X
Lysimachia quadrifolia								
Mecardonia acuminata						X		
Melica mutica								X
Menispermum canadense								X
Microstegium vimineum	Nepalese Browntop	X	X					X
Mimulus ringens						X		
Muhlenbergia		X						
Nelumbo lutea						X	X	
Oxalis violacea	Violet Wood Sorrel							X
Panicum cf. clandestinum		X						

		Habitat Type						
		Forested Wetland	Forested Floodplain Wetland	Scrub-Shrub Wetland	Sparse Shrub Wetland	Emergent Marsh	Aquatic Bed Upland	Upland
Species	**Common Name**	**PFO1**	**PFO1c**	**PSS1**	**PSSp**	**PEM**	**AB**	**UPL**
Panicum sp.		X	X			X		X
Panicum stipitatum	Stipitate Panic Grass					X		
Parthenium integrifolium								X
Peltandra virginica		X				X		
Penstemon laevigatus								X
Phlox sp.								X
Phryma leptostachya								X
Phytolacca americana								X
Pilea pumila		X						X
Pistia stratiotes			X			X		
Plantago spp.						X		
Pluchea camphorata		X						
Poaceae								X
Podophyllum peltatum		X	X					X
Polygala curtisii								
Polygonatum biflorum								X
Polygonum hydropiperoides						X		
Polygonum lapathifolium	Willow-weed					X		
Polygonum punctatum		X						X
Polygonum sagittatum						X		
Polygonum scandens		X						
Polygonum setaceum		X				X		X
Polygonum spp.		X	X			X		
Polypodium polypodioides		X						X
Polypodium sp.								X
Polystichum acrostichoides	Christmas Fern	X	X					X
Polytrichum sp.	A haircap moss					X		
Pontederia cordata						X		
Porteranthus stipulatus	Indian Physic							X
Prenanthes sp.								X
Pteridium aquilinum	Bracken							X
Ptiliminium capillaceum						X		
Pycnanthemum incanum								X
Pycnanthemum tenuifolium								X
Ranunculus sp.		X						X
Rhexia sp.						X		X
Rhyncospora cf. glomerata						X		
Rhyncospora corniculata						X		
Rorippa islandica						X		
Rudbeckia triloba								X
Ruellia carolinensis		X						X
Ruellia virginica								X
Rumex acetosella								
Rumex sp.		X			X	X		
Rumex verticillata		X			X	X		
Sacciolepis striata	American Cupscale					X		

		Habitat Type						
		Forested Wetland	Forested Floodplain Wetland	Scrub-Shrub Wetland	Sparse Shrub Wetland	Emergent Marsh	Aquatic Bed Upland	Upland
Species	**Common Name**	**PFO1**	**PFO1c**	**PSS1**	**PSSp**	**PEM**	**AB**	**UPL**
Sagittaria						X		
Sagittaria latifolia						X		
Salvia lyrata	Lyre-leaf Sage							X
Sanicula cf. canadensis		X						
Saururus cernuus	Lizard's Tail	X	X			X		
Saxifragus michauxii								X
Scirpus cyperinus						X		
Scirpus sp.		X				X		
Scirpus validus (Schoenoplectus tabernaemontani)						X		
Scutellaria integrifolia								X
Sedum sp.								X
Sedum ternatum								X
Selaginella rupestris								X
Setaria sp.						X		
Silphium compositum								
Sisyrinchium angustifolium	Blue-eyed-grass	X						X
Smilacina (Maianthemum) racemosa								X
Smilax sp.		X						X
Solidago caesia								X
Solidago odora								
Solidago plumosa	Yadkin River Goldenrod							X
Solidago sp.	Goldenrod species							X
Sparganium americanum				X		X		
Spirodela polyrhiza						X		
Stellaria pubera								X
Stipa avenacea								X
Tephrosia cf. virginiana								
Thalictrum (Anemonel la) thalictroides								X
Thalictrum revolutum		X				X		
Thalictrum sp.								X
Thelypteris simulata		X						
Tiarella cordifolia		X						X
Tovara virginiana		X						
Tradescantia		X				X		
Tradescantia ohiensis								X
Trillium catesbaei								X
Tripsacum dactyloides								X
Typha latifolia						X		
Uvularia sessifolia		X						X
Verbena alternifolia								X
Verbena urticifolia						X		
Vernonia acaulis								X
Viola sp.		X						X
Woodsia obtusa								X
Zephyranthes atamasco			X					X
Zizia aptera								X

		Habitat Type						
		Forested Wetland	Forested Floodplain Wetland	Scrub-Shrub Wetland	Sparse Shrub Wetland	Emergent Marsh	Aquatic Bed Upland	Upland
Species	**Common Name**	**PFO1**	**PFO1c**	**PSS1**	**PSSp**	**PEM**	**AB**	**UPL**
Zizia aurea								X
LIANAS								
Clematis viorna								X
Cocculus carolinus								X
Dioscorea villosa		X						X
Euonymus sp.		X						X
Gelsemium sempervirens	Yellow Jessamine	X						X
Hedera helix	English Ivy							
Lonicera flava								X
Lonicera japonica	Japanese Honeysuckle	X	X					X
Lonicera sempervirens								X
Lonicera sp.	Honeysuckle species							X
Parthenocissus quinquefolia	Virginia Creeper	X	X					X
Pueraria lobata	Kudzu							X
Rhus radicans	Poison Ivy	X	X					X
Rosa sp.								X
Similax bona-nox	Saw greenbrier							X
Similax hispida	Bristly greenbrier							X
Smilax rotundifolia								X
Smilax sp.	Greenbrier species	X	X					X
Vitis rotundifolia								X
Vitis sp.	Grape species	X	X					X
Vitis vulpine	Frost grape		X					
Wisteria sp.		X						
SUBMERGED AQUATIC VEGETATION								
Algal scum							X	
Ceratophyllum demersum							X	
Chara zeylanica sejuncta							X	
Eleocharis cf. acicularis						X		
Elodea canadensis							X	
Elodea nuttallii							X	
Hydrilla verticillata	Hydrilla						X	
Naias gracillima							X	
Potamogeton foliosus							X	

APPENDIX B

Incidental Observations of Wildlife Species Observed Throughout the Yadkin Project Area

Birds		Forested Wetland	Reservoir Dependent Forested Wetland	Sapling/ Shrub Swamp	Sparse Shrub Swamp	Emergent Wetland	Aquatic Bed	Open Water	Upland
Blue jay	*Cyanocitta cristata*	x							x
Bluebird, eastern	*Sialia sialis*	x							
Cardinal, northern	*Cardinalis cardinalis*	x	x				x		x
Catbird, gray	*Dumatella carolinensis*	x					x		
Cedar waxwing	*Bombycilla cedrorum*		x						
Chickadee, Carolina	*Poecile carolinensis*	x	x				x		x
Chimney swift	*Chaetura pelagica*	x					x	x	
Coot, American	*Fulica americana*							x	
Cormorant, double crested	*Phalacrocorax auritus*						x	x	
Crow, American	*Corax brachyrhynchos*	x	x					x	x
Cuckoo, black-billed	*Coccyzus erythropthalmus*	x							
Cuckoo, yellow-billed	*Coccyzus americanus*	x	x				x		
Eagle, bald	*Halieetus leucocephalus*						x	x	
Egret, great	*Ardea alba*		x	x		x	x	x	
Egret, snowy	*Egretta thula*							x	
Flicker	*Colaptes auratus*	x	x						x
Flycatcher, Acadian	*Empidonax virescens*	x	x						x
Flycatcher, great crested	*Myiarchus crinitus*		x						x
Flycatcher, least	*Empidonax minimus*								x
Flycatcher, willow	*Empidonax traillii*		x						
Flycatcher, yellow-throated	*Empidonax flaviventris*		x						
Gnatcatcher, blue gray	*Polioptila caerulea*	x							x
Goldfinch, American	*Carduelis tristis*						x		x
Goldfinch, American	*Carduelis tristis*								x
Goose, Canada	*Branta canadensis*							x	
Grackle, common	*Quiscalus quiscula*	x	x				x		x
Grebe, pied-billed	*Podilymbus podiceps*							x	
Hawk, red-shouldered	*Buteo lineatus*	x	x						x
Hawk, red-tailed	*Buteo jamaicensis*	x	x				x	x	
Heron, great blue	*Ardea herodias*	x	x	x		x		x	
Heron, green	*Butorides virescens*		x	x		x		x	x
Indigo bunting	*Passerina cyanea*	x					x		x
Killdeer	*Charadrius vociferus*		x						x
Kingbird	*Tyrannus*	x	x				x		x
Kingfisher, belted	*Ceryle torquata*	x	x				x	x	x
Loon, common	*Gavia immer*							x	
Mallard	*Anas platyrhynchos*	x	x	x		x		x	
Martin, purple	*Progne subis*							x	
Merganser, hooded	*Lophodytes cucullatus*	x							
Mourning dove	*Zenaida macroura*	x							
Oriole, orchard	*Icterus spurius*	x							
Osprey	*Pandion haliaetus*		x				x	x	
Owl, barred	*Strix varia*	x							x
Phoebe, eastern	*Sayornis phoebe*	x	x						x
Pigeons	*Columba*						x		
Plover, semi-palmated	*Charadrius semipalmatus*							x	

Birds		Forested Wetland	Reservoir Dependent Forested Wetland	Sapling/ Shrub Swamp	Sparse Shrub Swamp	Emergent Wetland	Aquatic Bed	Open Water	Upland
Red-winged blackbird	*Agelaius phoeniceus*	x		x		x	x		
Robin, American	*Turdus migratorius*	x							x
Sandpiper, spotted	*Actitis macularia*								x
Sapsucker, yellow-bellied	*Sphyrapicus varius*		x						
Sparrow, chipping	*Spizella passerina*						x		
Sparrow, song	*Melospiza melodia*	x				x	x		x
Swallow, bank	*Riparia riparia*							x	
Swallow, barn	*Hirundo rustica*						x	x	
Swallow, cliff	*Petrochelidon pyrrhonota*						x	x	
Tanager, scarlet	*Piranga olivacea*	x							x
Tanager, summer	*Piranga rubra*	x					x		x
Teal, blue winged	*Anas discors*							x	
Teal, green winged	*Anas crecca*							x	
Tern, Caspian	*Sterna caspia*							x	
Thrasher, brown	*Toxostoma rufum*						x		
Thrush, wood	*Hylocichla mustelina*	x					x		x
Towhee	*Pipilo erythrophthalmus*						x		
Tufted titmouse	*Baeolophus bicolor*	x	x						x
Turkey	*Meleagris gallopavo*								x
Vireo, red-eyed	*Vireo olivaceus*	x	x			x	x		x
Vireo, yellow-throated	*Vireo flavifrons*								x
Vulture, black	*Coragyps atratus*		x				x		x
Vulture, turkey	*Cathartes aura*		x				x	x	x
Warbler, black and white	*Mniotilta varia*	x							x
Warbler, magnolia	*Dendroica magnolia*								
Warbler, ovenbird	*Seiurus aurocapillus*						x		
Warbler, Northern parula	*Parula americana*	x							x
Warbler, prothonotary	*Protonotaria citrea*	x	x	x				x	x
Warbler, yellow	*Dendroica petechia*								x
Warbler, yellowt hroat	*Dendroica dominica*	x	x						
Waterthrush	*Seiurus noveboracensis*	x							
Waterthrush LA	*Seiurus motacilla*	x							
Wood duck	*Aix sponsa*		x			x		x	x
Woodpecker, downy	*Picoides pubescens*	x							
Woodpecker, red-bellied	*Melanerpes carolinus*	x							x
Wren, Carolina	*Thyothorus ludovicianus*	x	x				x		x
Reptiles									
Anole, green	*Anolis carolinensis*								x
Anoles	*Anolis*						x		
Fence lizard	*Sceloporus undulatus*								x
Skink, five-lined	*Eumeces fasciatus*								x
Skink, ground skink	*Scincella lateralis*	x							x
Snake, "black"									x
Snake, black racer	*Coluber constrictor*								x
Snake, brown water	*Nerodia taxispliota*							x	
Snake, copperhead	*Agkistrodon contortrix*							x	x

Birds		Forested Wetland	Reservoir Dependent Forested Wetland	Sapling/ Shrub Swamp	Sparse Shrub Swamp	Emergent Wetland	Aquatic Bed	Open Water	Upland
Snake, eastern king	*Lampropeltis getula getula*								x
Snake, queen	*Regina semtemvittata*								x
Snake, ringneck	*Diadophis punctatus*								x
Turtle, box	*Terrepene carolina*	x							x
Turtle, painted	*Chrysemys picta*	x						x	
Turtle, snapping	*Chelydra serpentina*							x	
Turtle, spiny soft-shell	*Apalone spinifera*							x	
Turtle, yellow-bellied slider	*Trachemys scripta*	x					x	x	
Turtles						x	x	x	
Amphibians									
Bullfrog	*Rana catesbeiana*	x	x			x		x	
Chorus frog	*Pseudacris triseriata*	x							
Green frog	*Rana clamitans*	x	x					x	
Green tree frog	*Hyla cinerea*	x				x		x	
Northern cricket frog	*Acris crepitans*	x	x						
Spring peeper	*Hyla crucifer*								x
S. chorus frog	*Pseudacris nigrita*	x			x	x			
S. gray treefrog	*Hyla versicolor*							x	
S. leopard frog	*Rana sphenocephala*	x							
S.cricket frog	*Acris gryllus*	x	x			x			
unid Cricket frog chorusing	*Acris spp.*	x	x			x			
Salamander		x							
Salamander, N. dusky	*Desmognathus fuscus*	x							
Salamander, slimy	*Plethodon glutinosus*	x						x	
Toad tadpoles						x			
Toad, American	*Bufo americanus*	x				x			
Toad, Fowlers	*Bufo woodhousei*	x							
Toad, Southern	*bufo terrestris*	x				x			
Mammals									
Beaver	*Castor canadensis*	x	x			x			x
Muskrat	*Ondatra zibethica*					x			
Raccoon	*Procyon lotor*		x						
Red squirrel	*Tamiasciurus hudsonicus*		x						
White-tailed deer	*Odocoileus virginicus*	x	x						x

APPENDIX C

Comment Response Table

Appendix C: Comment Response Table

Copies of the Wetlands and Riparian Habitat Assessment Study Draft Report were distributed to the Wetlands, Wildlife and Botanical Issues Advisory Group (IAG) on February 18, 2005. The Draft Report was then summarized and discussed at a March 2, 2005 meeting, and comments and recommendations were made. Additionally, the IAG was given until April 1, 2005 to submit additional comments. Table 1 below is a summary of the comments received and responses to the comments.

Table 1: Summary of Comments and Responses

Source of Comment	Comment	Response
Wilson Laney, US Fish & Wildlife Service, comment at 3/2/05 IAG meeting	Include a table showing projected wetland changes under hydrologic alternatives.	NAI prepared a table showing projected wetland changes under several water level alternative scenarios. This table has been added to the Final Report as Table 10-1.
Chris Goudreau, NC Wildlife Resources Commission, comment at 3/2/05 IAG meeting	Qualitatively assess functional trade-offs of projected wetland changes under hydrologic alternatives.	A qualitative assessment of the functional tradeoffs of project wetland changes on various water level alternatives has been added to Section 10 of the Final Report.
Larry Jones, High Rock Lake Association, comment at 3/2/05 IAG meeting	The report fails to consider the gains that would be made at High Rock under the near-full, year round water level scenario. The report should include predicted quantitative increases in emergent wetlands under the various water level scenarios.	The Final Report has been modified to better describe areas and to estimate amounts of wetland vegetation that would be expected to develop under the near-full, year round and other water level scenarios. See Section 10.1 and Table 10-1.
Andy Abramson, The Land Trust for Central North Carolina, comment at 3/2/05 IAG meeting	Asked if GIS data layers for wetlands report would be made available to IAG members	APGI will make the GIS data layers available to IAG members on separate CD, upon request
Andy Abramson, The Land Trust for Central North Carolina, 3/24/05 email	The conclusion drawn in the Wetlands study is that the forces effecting the wetlands in and around the upper most areas of High Rock Reservoir are primarily riverine, including regular flooding and scouring. However, in the text of the RTE study, the 655' elevation is classified as that distance identified by APGI as the maximum influence of High Rock dam. This is a direct contradiction to the summary drawn by NAI in the Wetlands study.	The FERC Project boundary around High Rock Reservoir is generally the 655' contour (local datum). Because the 655' elevation is the basis for the FERC Project boundary, it is also generally considered to be the boundary of the influence of the Project or its operation. For this reason, the 655 boundary was chosen to represent the point of "maximum influence of High Rock Dam" for purposes of the most of the scientific studies done by APGI as part of the Project relicensing process. However, NAI's assessment of wetlands around High Rock Reservoir indicated that river flows and the hydraulic and hydrologic conditions associated with the Yadkin River, rather than reservoir operations (e.g., water

		levels), are the primary influence on wetlands found in the very upper reaches of the reservoir. Given the riverine, flowing water nature of these reaches (along the Yadkin and South Yadkin rivers and continuing down the Yadkin River through the upper end of the reservoir, in the vicinity of the I-85 bridge), this conclusion is neither contradictory nor surprising.
Todd Ewing, NC Wildlife Resources Commission, 4/15/05 email	Could stable lake levels improve the ecological function of wetlands on High Rock?	Fish and wildlife functions would most likely be enhanced, whereas risks of IEPP invasions would also increase. This issue is discussed in Section 10.1 of the Final Report.
Todd Ewing, NC Wildlife Resources Commission, 4/15/05 email	Is a shift from annuals to perennials an improvement that could be expected from stable lake levels on High Rock ?	There are few emergents currently occurring on High Rock, and stable lake levels would undoubtedly allow more emergents, mostly perennial, to establish. This issue is discussed in Section 10.1 of the Final Report.