Yadkin Project (FERC No. 2197)
Water Quality Monitoring
Final Study Plan
August, 2003

Background

Alcoa Power Generating Inc. (APGI) is the licensee for the Yadkin Hydroelectric Project. The Yadkin Project is currently licensed by the Federal Energy Regulatory Commission (FERC) as Project No. 2197. This license expires in 2008 and APGI must file a new license application with FERC on or before April 30, 2006 to continue operation of the Project.

The Yadkin 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. The Project generates electricity to support the power needs of Alcoa's Badin Works, to support its other aluminum operations, or is sold on the open market.

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 are needed to address relicensing issues. To further assist in the identification of issues and data/study needs, APGI has formed several Issue Advisory Groups (IAGs) to advise APGI on resource issues throughout the relicensing process. IAGs will also have the opportunity to review and comment on Draft Study Plans. A Draft Study Plan was developed in response to comments on the ICD and through discussions with the Water Quality IAG, to provide additional necessary information for consideration in the relicensing process. Comments on the draft study plan were obtained in writing from several reviewers and during an IAG meeting on May 20, 2003. These comments have been addressed to the extent possible in this document.

Overview

The Yadkin Division of APGI (Yadkin) has begun the process of preparing for the relicensing of the Yadkin Hydroelectric Project (FERC Project Number 2197-038), located on the Yadkin River in North Carolina. The watershed area above the lowest dam in the Project encompasses 4,200 square miles. This river is a part of the larger Yadkin/Pee Dee River Basin that extends from the eastern slopes of the Blue Ridge Mountains to the Atlantic coast. In preparation for the relicensing effort, Yadkin has been collecting baseline water quality data in the Project reservoirs and tailwaters since 1999. In response to comments on the ICD, this plan addresses the continued collection of baseline water quality data as well as the monitoring of dissolved oxygen and temperature conditions in the Project tailwaters.

As noted above, the Yadkin Project consists of a system of four dams and reservoirs. From upstream to downstream the reservoirs and dams include, High Rock Reservoir, Tuckertown Reservoir, Narrows Reservoir and Falls Reservoir. The High Rock Reservoir covers approximately 15,180 acres and has a shoreline length of 360 miles. It is the largest of the four reservoirs. Tuckertown Reservoir covers 2,560 acres and has a shoreline length of 75 miles. Narrows Reservoir covers 5,355 acres and has a shoreline length of 115 miles. Falls Reservoir, the smallest of the four reservoirs covers 204 acres and has a shoreline length of 6 miles. Both High Rock and Narrows Reservoirs and to a lesser

extent Tuckertown are highly dissected with numerous side channels and bays. Forest and residential land uses predominate the shorelines of High Rock and Narrows reservoirs while the shoreline zone of Tuckertown and Falls reservoirs is mostly undeveloped and forested. There are 31 National Pollutant Discharge Elimination System (NPDES) permitted discharges to High Rock Reservoir or tributaries to High Rock, 5 NPDES discharges to Tuckertown Reservoir or its tributaries, 2 discharges to Narrows Reservoir or its tributaries and 1 discharge to Falls Reservoir or its tributaries. These discharges range from small to medium sized wastewater treatment systems to industrial discharges, and are significant sources of nutrients and other pollutants to the Yadkin Project. In addition, the reservoirs provide source water for several communities.

Historic water quality throughout the Yadkin Project has been evaluated through several studies conducted by the North Carolina Division of Water Quality (NCDWQ). These data are summarized in more detail in the Yadkin Project ICD (September 2002) Water quality collected by NCDWQ and data collected by Normandeau Associates from June 1999 to the present support trophic classifications of eutrophic for High Rock and Tuckertown reservoirs and mesotrophic for Narrows and Falls reservoirs (Normandeau Associates 2000, Normandeau Associates 2002). Water quality in each of the impoundments is influenced by upstream water quality, discharges to the reservoirs and tributaries, hydropower operations, and processes within each reservoir.

Issues

The following issues were raised during initial consultation regarding water quality at the Yadkin Project:

- Current status of Yadkin Project reservoir and tailwater quality
- Effects of Yadkin Project operations/reservoir fluctuations on reservoir and tailwater water quality

Objectives

On March 13, 2003 the Water Quality IAG met and discussed objectives for the reservoir and tailwater water quality monitoring study. Over the course of those discussions the following objectives were identified for the study.

- Continue the collection of reservoir water quality data at sampling stations used in previous years in order to characterize the baseline water quality of the four Project reservoirs and four tailwater areas.
- Evaluate effects of current Project operations, including reservoir water level fluctuations on reservoir water quality.
- Conduct continuous monitoring of dissolved oxygen and temperature conditions in all four Project tailwaters during the months of warm water temperatures (May through November) in order to evaluate existing water quality conditions in the tailwaters and how these conditions may be affected by Project operations.

Sampling Stations

Sampling stations associated with each reservoir are described below. At the request of the North Carolina Division of Water Quality (NCDWQ), the area between the High Rock Dam and Lick Creek will be evaluated in more detail (described below) starting in July of 2003. Other stations will remain in historic locations so that data are comparable and trends can be detected.

High Rock Reservoir

Sampling will be conducted monthly at ten water quality stations (H1-H10) shown in Figure 1. These stations have been sampled monthly by Normandeau since the inception of Yadkin's water quality monitoring program in June 1999. These stations represent locations in each of the major arms of the reservoir as well as three locations along the main stem of the reservoir distributed from the upper end of the reservoir (H1) to a station just above the dam (H10). Tailrace sampling will be conducted at station T1 that also serves as the upstream station of the Tuckertown reservoir. Monthly sampling will continue through the 2003 field season. The inclusion of monitoring data over three growing seasons should ensure that the data collected reflect a range of hydrometeorlogic conditions. In addition, the influence of operational changes over that time span can be evaluated.

Tuckertown Reservoir

Sampling will be conducted at three sampling locations along the main stem of the Tuckertown Reservoir (stations T1-T3) shown in Figure 1. Station T4 has been added at the request of NCDWQ for sampling from July 2003 forward. This station has been added to address the possible contribution of Lick Creek to the low dissolved oxygen concentrations observed in Tuckertown Reservoir. The station will be located at the South Main Street Bridge over Lick Creek. In addition, dissolved oxygen and temperature profiles will be measured monthly at five locations between the High Rock Dam and the mouth of Lick Creek. One profile station will be located approximately ¼ mile downstream of the mouth of Lick Creek. Tailrace sampling will occur at station N1 that also serves as the upstream station in the Narrows Reservoir. These stations have been monitored monthly since June 1999. Monthly sampling will continue through the 2003 field season.

Narrows Reservoir

Sampling will be conducted at four sampling locations in the Narrows Reservoir (stations N1-N4) shown in Figures 1 and 2. These stations include one in the major tributary arm (N3) and three along the mainstem. Tailrace sampling will occur at station F1 that also serves as the upstream station in the Falls Reservoir. Monthly sampling was initiated in June of 1999 and will continue through the 2003 field season.

Falls Reservoir

Sampling will be conducted at two stations in the Falls Reservoir (stations F1 and F2 shown in Figure 2) and one station in the Falls tailrace (F3). Monthly sampling was initiated in June of 1999 and will continue through the 2003 field season.

All sampling stations will be located and identified with Global Positioning System (GPS) coordinates.

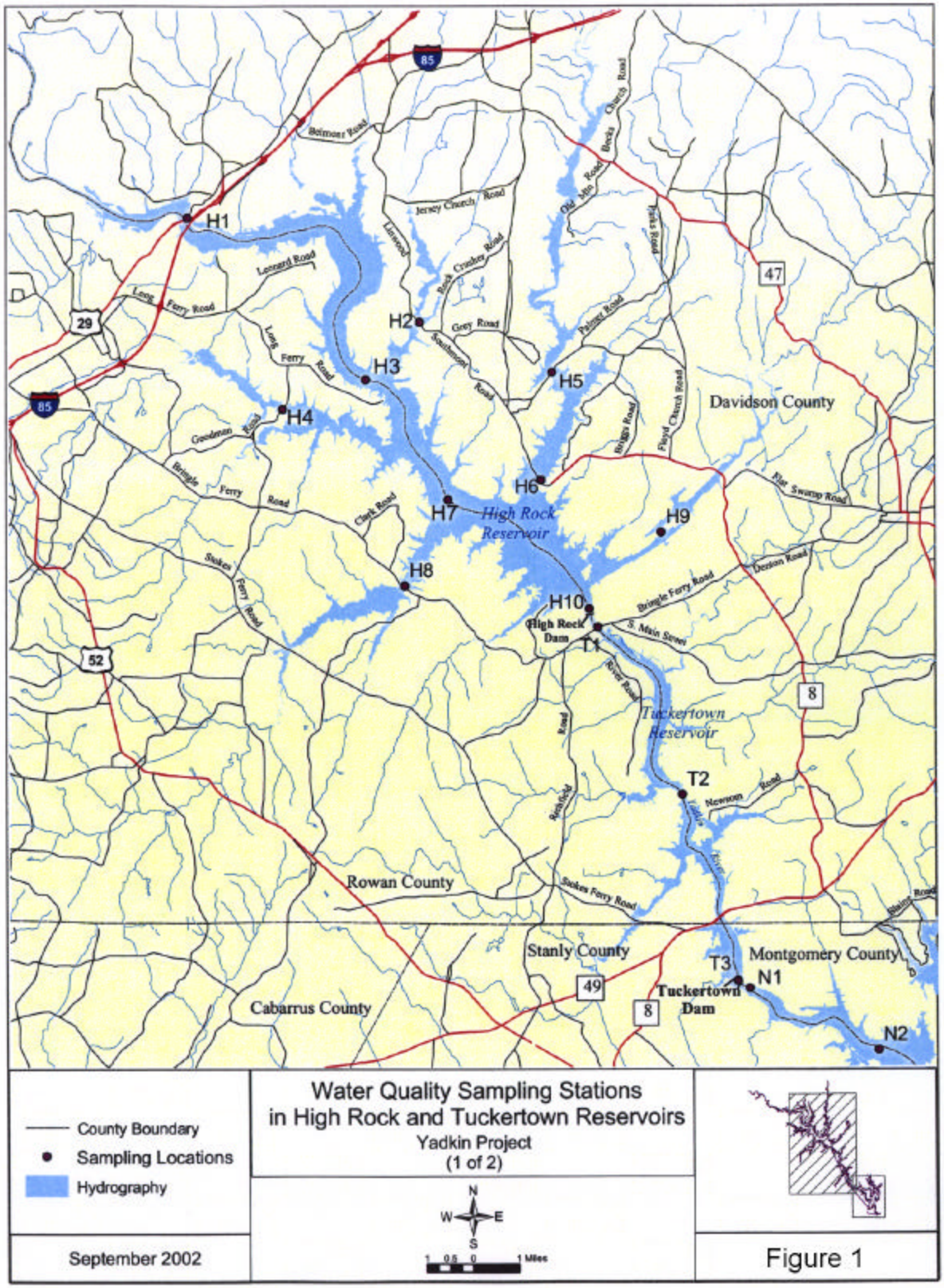

Figure 1. Upper Impoundments and Sampling Stations.

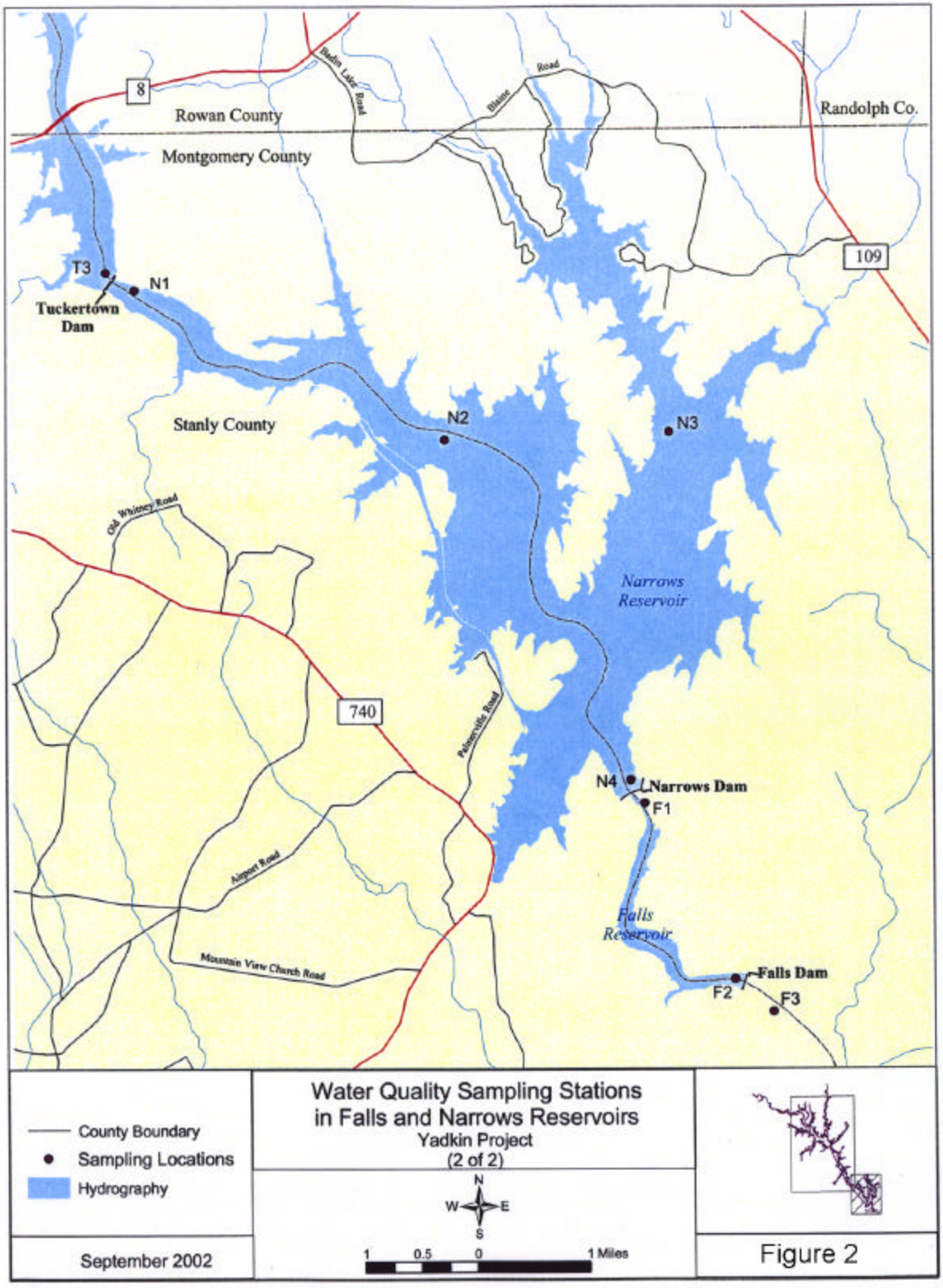

Figure 2. Lower Impoundments and Sampling Stations.

Sampling Schedule

Samples will be collected monthly through 2003. Monthly sampling has been ongoing throughout the Project since June of 1999.

Sampling Protocol

Reservoir sampling will follow North Carolina Division of Water Quality sampling protocols for lakes and reservoirs. In-situ profile measurements of temperature, turbidity, dissolved oxygen, pH, and conductivity will be taken at each station using a multi-parameter water quality instrument (Hydrolab Surveyor 4 or similar device). Secchi depth measurements will also be taken at each station. After determination of profiles and Secchi depth, water quality samples will be collected. Surface water samples will be collected from a composite sample of the photic zone, defined as twice the Secchi transparency depth for all samples except metals. The deep sample will be collected using a Van Dorn bottle or a water pump and hose. Chlorophyll a samples will be collected from the photic zone composite only. Alkalinity, solids (TS< TSS and TDS) and BOD samples will be placed on ice immediately after collection. Nutrient (TP, NO3, NH3, TKN and TN), COD and TOC samples will be preserved with sulfuric acid. Nitrite (NO2) samples will be analyzed in the field. Metals samples will be preserved with nitric acid and cyanide samples will be preserved with sodium hydroxide. All samples will be collected in appropriate containers, stored on ice after preservation, and transported to the lab for analysis under chain of custody forms.

Parameters

The following is a list of all parameters to be measured in the field or analyzed in the lab:

Field Measurement

Water Temperature - profile
Dissolved Oxygen - profile
pH - profile
Conductivity - profile
Turbidity - surface and bottom
Secchi Depth
Nitrite

In addition to these parameters field notes will be made which will include date, time of sample, air temperature, weather conditions, and other physical observations of importance. These notes will be recorded on data sheets for each sampling station.

Laboratory Analysis

Chlorophyll *a* - Analyzed from only the epilimnetic core sample
Total Alkalinity
Total Solids (TS)

Total Suspended Solids (TSS)
Total Dissolved Solids (TDS)
Total Phosphorus (TP)
Nitrate, Nitrogen (NO3)
Total Nitrogen (TN)
Ammonia, Nitrogen (NH3)
Total Kjeldahl Nitrogen (TKN)
Biochemical Oxygen Demand (BOD)
Chemical Oxygen Demand (COD)
Total Organic Carbon (TOC)
Lead
Cadmium
Copper
Mercury
Cyanide

Laboratory Analysis

All laboratory analyses will be conducted by North Carolina State certified laboratories. Aqua Tech Environmental Laboratories (NCDEH Certification No. 37742, NCDWQ Certification No. 372) will provide analyses of water quality samples. Chlorophyll a will be sent to the University of New Hampshire for analysis.

Continuous Dissolved Oxygen Monitoring

Dissolved oxygen and temperature will be monitored continuously below the High Rock, Tuckertown, Falls and Narrows developments from May through December. This period will encompass both a high temperature and a low flow period. Data from this effort will be used to evaluate the downstream dissolved oxygen dynamics. Monitors will be placed in the tailwaters of the four dams at the point where bypass, spillage and hydropower flows merge. These monitors will be YSI multiparameter sonde instruments or the equivalent. Monitors will be downloaded, serviced and recalibrated weekly throughout the deployment to prevent battery depletion and fouling. The monitors will log dissolved oxygen concentrations and temperature at 15-minute intervals. Continuous monitors have been in place below the Falls and Narrows dams for the May through November period since 2001. In 2003 the program will be expanded to include monitors below High Rock and Tuckertown. Monitor locations below these two dams will be determined through consultation with the resource agencies.

The mixing characteristics of the tailrace waters below the Narrows and Falls Dams were evaluated monthly from August through November 2001. The purpose of this effort was to confirm that the placement of the continuous dissolved oxygen and temperature monitors was representative of water quality downstream of the dams. Measurement of dissolved oxygen at 50 foot intervals along 6 transects showed little variability in dissolved oxygen concentrations or temperature and supported the conclusion that the locations were representative (Normandeau 2002). A similar demonstration will be conducted below High Rock and Tuckertown Dams in August and September of 2003. The continuous monitor location will be considered representative if readings at the continuous station are

within 0.5 mg/l of the mean of the spot measurements (approximately ±10% at 5mg/l). This effort will be coordinated with the lateral and longitudinal dissolved oxygen and temperature evaluations described in the section below.

Lateral and Longitudinal Investigation of Dissolved Oxygen in the Vicinity of the Dams

The extent and degree of stratification in behind the dams will be evaluated during two surveys. One survey will be conducted in August and one survey will be conducted in September. During each survey, dissolved oxygen and temperature will be measured by profile at the quarter points in each impoundment along transects spaced at ¼ mile intervals starting at the buoy line and proceeding upstream. If the reservoir is wider than ¼ mile, two additional sampling locations will be added to each transect for a total of 5 locations per transect. Additional transects will be added until two adjacent transects show similar profiles in terms of the depth of the thermocline and the extent of dissolved oxygen depletion at depth. Two scenarios will be evaluated. One scenario will be after a prolonged (> 6 hour) period with no generation or spill at the dam (measurements will be made prior to the onset of generation). The second scenario will be after a prolonged (> 6 hour) period of generation at the dam (measurements will be made prior to the cessation of generation). The surveys will be conducted with the maximum generation possible given the available water.

The dynamics of dissolved oxygen and temperature downstream of the dams will be evaluated in August and September in a similar fashion as the reservoir surveys. Starting at the continuous monitoring locations, dissolved oxygen and temperature will be measured by 0.5 m profiles at the quarter points in the channel along transects spaced at ¼ mile increments downstream. Additional transects will be added until temperature and dissolved oxygen conditions at consecutive transects are similar (< 0.5 mg/l difference in mean value from the previous transect) or the river channel becomes part of the next downstream impoundment.

Fish Tissue Analysis in Narrows Reservoir

At the request of NCDWQ, fish will be analyzed for mercury contamination in Narrows Reservoir. Fish will be obtained through the fisheries assessment to be conducted in the Tuckertown tailrace in August of 2003. Ten specimens each of largemouth bass, sunfish and catfish will be sent to a certified lab for mercury analysis. Fish will be of edible size and will be handled and analyzed according to USEPA protocols (USEPA 1994).

Water Quality Database and Report

Results of all water quality monitoring described above will be incorporated into an electronic database. The database will contain all information relevant to the monitoring task including sample time, date, air temperature, weather conditions, GPS coordinates, and other field observations. Data will be provided electronically at the conclusion of each sampling season. A summary report will accompany the data. The report will evaluate the effects of reservoir operations on reservoir water quality. The report will include a review of existing water quality data for the Project developments.

These data will be presented with operations data including flow, spill generation and reservoir water levels. Hourly data will be presented, where appropriate.

The discussion of reservoir operations influence on water quality will incorporate additional water quality data collected by State and Federal agencies as well as volunteer monitoring groups where appropriate. In particular, fecal coliform data collected by the state will be summarized. The potential influence of Project operations on the observed fecal coliform counts will be discussed. If the project operations are determined to be linked to observed fecal coliform counts, the issue will be presented to the IAG for further discussion. The influence of aquatic vegetation on water quality will also be discussed as will the impact of observed water quality on the biologic community in the project area. Additional information on the distribution of vegetation and the relationship between vegetation and water quality will be discussed as a part of the Wetlands, Wildlife and Botanical studies currently underway. This will include a discussion of vegetation in High Rock in response to comments by Larry Jones of the High Rock Lake Association. The collection of water quality data in 2002 will allow the evaluation of the impacts of an extreme low water event period on water quality in the impoundments and downstream. The relationship of observed water quality to water level will be discussed along with a summary of relevant literature regarding the influence of fluctuating water levels on water quality. The potential influence of any changes in Project operations on water quality will be discussed.

Outline of Quality Control/Quality Assurance Procedures

In recognition of the requirements for valid and reliable information as the basis for sound environmental management decisions concerning the Yadkin Project, Normandeau Associates intends to implement a Quality Assurance (QA) Plan that provides for the attainment of desired quality levels in field, laboratory and data reporting activities including the QA requirements of ASME NQA-1 and appropriate EPA and state QA requirements. The QA Plan has been designed to meet or exceed the guidance criteria of the U.S. Environmental Protection Agency (1979, 1980), and to be consistent with the intent of 10 CFR 50 which requires that quality assurance be separated from operational and budgetary concerns.

Project managers are responsible for conducting the project quality control program. These responsibilities include the following:

- monitor instrument maintenance, calibration, and reliability;
- monitor document control and conduct audits of documentation resulting from instrument maintenance and calibration, and data processing; and
- monitor training of technicians.

It is corporate policy to supply quality services, information, data, and products at minimum cost and with timely delivery, suitable for the purpose intended, and to the satisfaction of the client's requirements. It is the responsibility of the quality assurance organization to monitor the activities of all program personnel to demonstrate and verify the achievement of quality through all phases of the project. Once the proposal, program design, and SOP are complete, these responsibilities are accomplished primarily by audits, tests, and surveys which provide objective evidence that the quality control program and technical requirements, methods, and procedures as outlined in the project procedures manuals are being implemented. As a minimum, applicable elements of the projects are

subject to quality assurance surveys and audits at least once within the life of the activity. These surveys and audits are conducted by an audit team of technically qualified personnel familiar with, but independent of and not responsible for, the work or activities under evaluation. Surveys, which review the operations, specifications, plans, and objectives of the project, are made at the beginning and end of the project. A field audit, which includes a detailed examination of the acquisition and transfer of data from field to report, will be performed during the 2003 field season.

Audit results are presented orally to the appropriate project or facility management by the audit team after the audit has been completed. At this time, specific findings are presented and recommended courses of corrective action developed. Subsequently, the audit results are documented in a written audit report and reviewed by management having responsibility in the areas audited. These reports include a summary of audit results, observations made with a listing of nonconformances and program deficiencies, recommendations as to possible corrective action, and suggestions for the possible improvement of the quality program or its implementation.

Observations of nonconformities and program deficiencies are classified into four categories:

- Deficiencies that affect the data adversely;
- Deficiencies that might affect the data adversely;
- Deficiencies that cannot affect the data adversely;
- Paperwork deficiencies that cannot affect the data adversely

Class A deficiencies are resolved before that portion of the program can proceed. Class B deficiencies must have a determination as to the severity of the deficiency and whether or not corrective action is necessary. If corrective action is necessary, it is performed within a reasonable time frame agreed to by the program management and the Quality Assurance Department. Operations with either Class A or B deficiencies are subject to reaudit to determine the effectiveness of corrective action. Class C and D deficiencies must have corrective action accomplished before the next scheduled audit or end of the project whichever comes first.

References

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Wetzel, R. G. 1983. *Limnology* second edition. Saunders College Publishing. New York, New York, 767pp.

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