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Black & Veatch International Company

Charlotte-Mecklenburg Utilities
City of Mount Holly
Regional Wastewater Treatment

B&V Project 148017
B&V File A
June 27, 2007

Ms. Chrys Baggett
Environmental Policy Act Coordinator
North Carolina Department of Administration
State Clearinghouse
1301 Mail Service Center
Raleigh, NC 27699-1301

Subject: Scoping for Environmental Impact Statement for Long Creek Regional Wastewater Treatment

Dear Ms. Baggett:

Charlotte-Mecklenburg Utilities and the City of Mount Holly are working together on a project to evaluate how the growing wastewater demands in both service areas can be met. In 2006, Charlotte-Mecklenburg Utilities and Mount Holly cooperated in a feasibility and preliminary planning study for regional wastewater treatment. The study identified a number of alternatives that could satisfy future wastewater treatment projections. The report found that several regional treatment scenarios are conceptually feasible and favored the construction of a new facility. A new regional wastewater treatment plant could potentially provide a single discharge of high quality effluent that would replace the existing Mount Holly discharge.

Charlotte-Mecklenburg Utilities and Mount Holly have decided to continue this project by evaluating the identified alternatives through an Environmental Impact Statement Process (EIS). We have enclosed 17 copies of the scoping document, which includes a detailed description of the proposed project alternatives and location maps. We are requesting preliminary comments regarding the proposed project from any agencies that would review the Environmental Impact Statement. We understand you will submit this letter for publication in the North Carolina Environmental Bulletin and to the SEPA coordinator for circulation.

Please contact me at (704) 510-8424 if you have any questions.

Ms. Chris Baggett
NC State Clearinghouse

B&V Project 148017
June 27, 2007

Very truly yours,

BLACK & VEATCH
INTERNATIONAL COMPANY

Mary Knosby

Mary Knosby, P.E.

Enclosures
cc: Barry Gullet, CMU
Barry Shearin, CMU
Kit Eller, CMU
Jackie Jarrell, CMU
Ed Munn, City of Mt Holly
James Friday, City of Mt Holly
Brent Reuss, Black & Veatch
Paul Leonard, ENTRIX
Lauren Elmore, ENTRIX

Charlotte Mecklenburg Utilities and the City of Mount Holly Long Creek Regional Wastewater Treatment Plant

Scoping Document for Environmental Impact Statement

1. Introduction

Continued economic development and growth within the Charlotte Metropolitan Area is projected to require additional wastewater treatment capacity in northwest Mecklenburg County and the eastern portion of Gaston County. Charlotte-Mecklenburg Utilities (Utilities) and the City of Mount Holly (Mount Holly) are working together on a project to evaluate how the growing wastewater demands in both service areas can be met. In 2006, Utilities and Mount Holly cooperated in a feasibility and preliminary planning study for regional wastewater treatment (Black & Veatch, 2006). The study identified a number of alternatives that could satisfy future wastewater treatment projections. The report found that several regional treatment scenarios are conceptually feasible and favored the construction of a new facility. Scenarios identified in the study included a new regional wastewater treatment plant (WWTP) adjacent to the existing Long Creek Pump Station in western Mecklenburg County as well as combinations of expansion and new construction on the Gaston side of the Catawba. Mount Holly's existing WWTP is located directly across the Catawba River (Lake Wylie) from the confluence of Long Creek on the Mecklenburg side and the existing Long Creek wastewater lift station as shown in Figure 1. A new regional wastewater treatment plant could potentially provide a single discharge of high quality effluent that would replace the existing discharge.

Utilities and Mount Holly have decided to continue this project by evaluating the identified alternatives through an Environmental Impact Statement Process (EIS). The purpose of this scoping document is to present information related to the proposed project and solicit feedback for preparation of the draft EIS. The EIS will also evaluate the direct, secondary, and cumulative impacts throughout the two service areas related to the construction of a new regional WWTP. The alternatives in the proposed project include construction of a force main across the Catawba River.

2. Purpose and Need

The project area is located in eastern Gaston County and western Mecklenburg County along the Catawba River. The western Mecklenburg County portion of Utilities' service area includes the Long Creek, Gar Creek, Catawba Creek, and Lower Mountain Island Creek watersheds. Utilities will also evaluate the potential to pump wastewater produced in the Paw Creek watershed to a new WWTP in the project area in the future. The Mount Holly service area includes wastewater flows from within Mount Holly, its extraterritorial jurisdiction (ETJ), and a portion of the Town of Stanley. The total service area is shown in Figure 2.

jurisdiction (ETJ), and a portion of the Town of Stanley. The total service area is shown in Figure 2.

For the Utilities service area, including Paw Creek, the population is projected to grow to approximately 75,000 in 2020, increasing to approximately 115,000 by 2030. For the Mount Holly service area, the population is projected to grow to approximately 25,000 in 2020, increasing to approximately 40,000 by 2030. Including industrial wastewater flows, the 2030 maximum month wastewater flow projections are 17 million gallons per day (mgd) and 8 mgd for Utilities and Mount Holly, respectively (Table 1).

Table 1
Long Creek Regional WWTP Project Area
Maximum Month Wastewater Flow Projections

	Population Served				Wastewater Flows (mgd)			
	2000	2010	2020	2030	2000	2010	2020	2030
Utilities Service Area	23,297	43,371	74,098	115,580	3.34	6.47	10.90	16.86
Mt Holly Service Area	9,000	14,515	24,382	39,322	3.32	4.10	5.50	7.62
Total	32,297	57,886	98,480	154,902	6.66	10.57	16.40	24.48

Figure 3 illustrates the flow projections for the combined service areas. The proposed project is a key element in Utilities' plan to provide system-wide municipal wastewater treatment and is compatible with planned and anticipated growth. Based on population growth and wastewater flow projections, the capacity of the existing 4-mgd Mount Holly WWTP will be exceeded by 2020. Utilities' transmission line to the McAlpine WWTP is limited by the capacity of the Coffey Creek interceptor where it crosses Runway 2 at the Charlotte-Douglas International Airport. The Coffey Creek interceptor is currently nearing its maximum capacity.

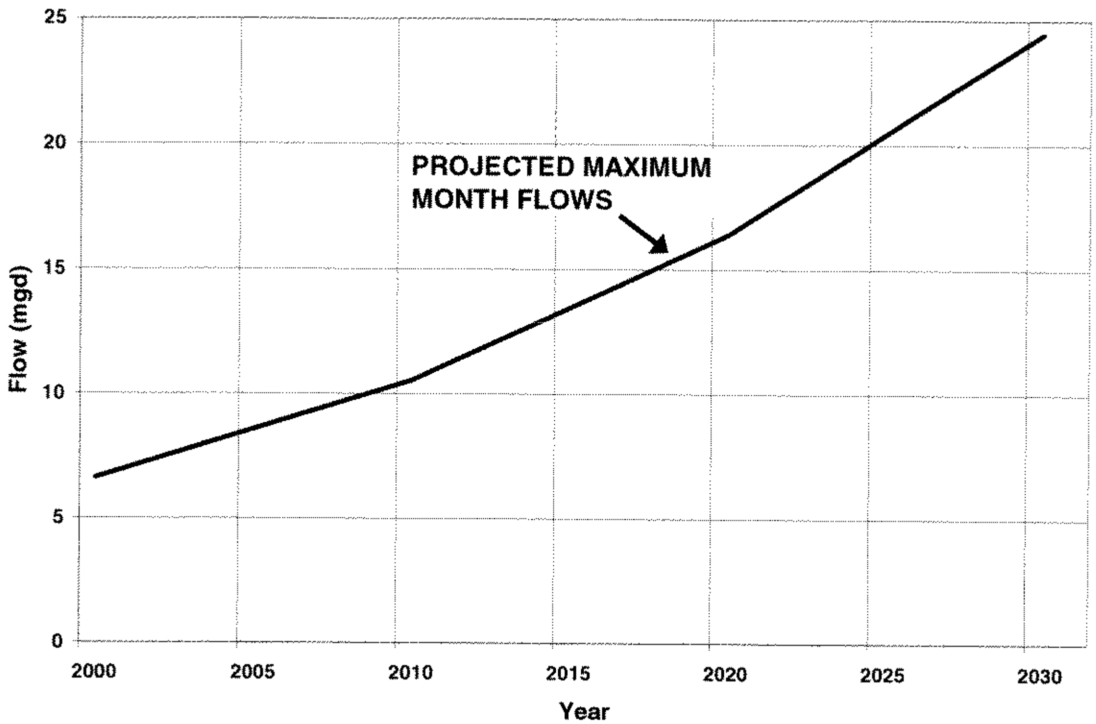


Figure 3. Combined Wastewater Flow Projections

3. Proposed Project and Proposed Project Site

The planning study (Black & Veatch, 2006) describes the initial evaluation of potential alternatives for the municipalities to accommodate their combined wastewater treatment needs, including continuing to operate separately. The study evaluated six possible alternatives (see Section 5 below) and included a preliminary recommended alternative. The preliminary recommended alternative was selected based on the most favorable combination of minimizing environmental impacts and maximizing the cost effectiveness of permitting, construction, and operation. The 2006 study was based on conceptual and high-level analysis. The EIS process will provide more detailed evaluation of these alternatives and could result in the same or a different conclusion.

Portions of several of the potential sites associated with these alternatives involve property along Lake Wylie within the area covered by the Shoreline Management Plan (Catawba Wateree SMP) for Duke Energy's Catawba Wateree Hydro Project (FERC Project No. 2232) and approval through Duke's Catawba Wateree SMP Conveyance Program will be required. The project is consistent with existing zoning and the surrounding land use. The proposed facility would be constructed outside of the 100-year floodplain and aligned on the property to avoid impacting site wetlands and required buffers.

Though the specific details of the proposed project have yet to be determined, Figure 4 provides a conceptual site plan for Alternative 5 described below (at 25 mgd). The facility would be designed to be constructed in phases as flows increase over time. The first phase would be designed for a capacity of 11 to 17 mgd in 2020 followed by expansions in approximately 2030. Site improvements that would be made during construction of the project include earthwork, landscaping, construction of roads, operations and maintenance facilities, and permanent stormwater management facilities.

A new regional WWTP would be expected to consist of the following facilities:

- Headworks (screening and grit removal)
- Flow equalization
- Primary clarifiers
- Biological nutrient removal (BNR) basins
- Secondary clarifiers
- Deep bed denitrification filters
- UV Disinfection
- Reaeration
- Solids Handling
- Influent pumping
- Piping to transport flow across the Catawba River
- Outfall structure in Long Creek or the Catawba River

4. Project Alternatives Considered

Various alternatives for a new regional facility or continuing to operate separate wastewater facilities were considered in the 2006 planning study. The study identified multiple reasons for focusing on a single regional facility. These included:

1) The State of North Carolina and the Division of Water Quality (DWQ, 2004) favor a regional approach to wastewater treatment and may be more supportive of a new regional plant over other alternatives.

2) Placement of a single WWTP is preferable to other alternatives in terms of compatibility with existing and future land uses, establishment and protection of riparian buffers, and minimization of impacts to critical areas such as wetlands.

3) The proposed project provides regional wastewater treatment with a single discharge, efficiency in planning, design, and permitting, minimizes shoreline and wetland impacts, and cost-effectively achieves project goals.

A summary of alternatives considered in the 2006 planning study included:

- Alternative 1 – Continue to operate separately and with existing facilities. This scenario requires Mount Holly to upgrade to and expand their existing plant to 8 mgd and Utilities to provide conveyance and treatment capacity for 17 mgd at McAlpine Creek WWTP and/or at Irwin Creek WWTP.

- Alternative 2 – Continue to operate separately with additional facilities. This scenario requires Mount Holly to upgrade and expand their existing plant to 8 mgd and Utilities to construct a new 17-mgd plant located at Long Creek to treat wastewater from within Mecklenburg County.

- Alternative 3 – Provide treatment for Mount Holly and Utilities flows at the Mount Holly WWTP site by upgrading and expanding the existing plant to 25 mgd. Utilities flows would be pumped across the Catawba River.

- Alternative 4 – Provide treatment for Mount Holly and Utilities flows in Mount Holly by constructing a new 25-mgd WWTP on land adjacent to the existing Mount Holly WWTP. Utilities flows would be pumped across the Catawba River.

- Alternative 5 – Provide treatment for Mount Holly and Utilities flows on the Mecklenburg side of the Catawba River by constructing a new 25 mgd WWTP on vacant land surrounding the Long Creek Pump Station. Mount Holly flows would be pumped across the Catawba River.

- Alternative 6 – Continue to operate the Mount Holly WWTP at 4 mgd. Provide treatment for Mount Holly and Utilities flows on the Mecklenburg side of the Catawba River by constructing a new 21 mgd WWTP on vacant land surrounding the Long Creek Pump Station. Dutchman's Creek (Mount Holly) flows would be pumped across the Catawba River.

These alternatives will be further evaluated and addressed in the EIS, in addition to the Non-Discharge and No Action alternatives. Non-discharge options will also be evaluated according to NC DWQ guidelines. Under the No Action alternative, Utilities and Mount Holly would not expand municipal wastewater treatment capacity to serve the growing population of western Mecklenburg County and Mount Holly. The population of the area would continue to grow necessitating the implementation of on-site wastewater treatment practices such as septic tank systems or smaller package wastewater treatment plants. Such systems would not achieve the level of reliability, advanced treatment levels, or monitoring required of the alternatives being considered.

5. Environmental Analysis & Regulatory Compatibility

The potential environmental effects related to the proposed project include direct and secondary and cumulative impacts (SCI). These impacts will be addressed in the EIS. The categories of potential impacts that will be addressed in the EIS include:

- Topography
- Soils
- Land Use and Land Cover
- Wetlands
- Floodplains
- Prime or Unique Agricultural Lands
- Public lands and Scenic Recreational and Significant Natural Areas
- Areas of Archeological or Historic Value
- Air Quality
- Noise Levels
- Water Resources (Surface Water and Groundwater)
- Forest Resources
- Shellfish or Fish and Their Habitats
- Wildlife and Natural Vegetation
- Introduction of Toxic Substances

The environmental analysis to be conducted during the EIS process will include site-specific surveys, review of existing environmental data and ordinances, water quality monitoring and modeling, consultation with agencies, and other means to evaluate the potential environmental impacts and mitigation. The secondary and cumulative impacts will be analyzed using available information primarily from Mecklenburg County's Land Use and Environmental Services Agency (LUESA), Charlotte Storm Water Services, Mount Holly, and others. Future land use information developed for previous studies will be the basis for the SCI analysis. Specific attention will be directed towards water quality because of the complexity of water quality issues within the Catawba River system.

Water Quality

Water bodies present in the vicinity of the potential regional project sites include the Catawba River downstream of the Mountain Island Lake Dam, and Long Creek near its confluence with the Catawba River. In these areas, both waterbodies are classified as critical areas (CA) within WS-IV water supply waters (WS-IV; CA) (DWQ BIMS Database, May 14, 2007). Water supplies in moderately to highly developed watersheds are classified as WS-IV waters. Watershed areas within one-half mile of a water supply and waters within one-half mile of a water supply intake are designated as critical areas. Discharges are allowed in WS-IV; CA areas, but effluent must meet standards established by the North Carolina Department of Environmental Health (DEH). Expanded wastewater discharges to water supply waters must be approved by NC DEH. Within water supply watersheds, the North Carolina Department of Environment and Natural Resources (NC DENR) also requires minimum buffer widths as well as control of nonpoint sources and stormwater discharges.

As part of this project, water quality modeling will be performed to support the evaluation of water quality effects and the development of speculative NPDES limits by NC DWQ for the plant discharge into Lake Wylie. Already developed for the Catawba River by Duke Energy for the FERC relicensing process, the CE-QUAL-W2 water quality model will be used. DWQ indicated their support of the use of the Duke CE-QUAL-W2 model and provided recommendations for additional sampling for model calibration. Additional water quality monitoring within Lake Wylie and other project areas has already been initiated by Utilities and Mecklenburg County (LUESA). This supplemental water quality data will be used along with existing LUESA, Duke Energy and DWQ data for model calibration. In this area of Lake Wylie, flow conditions, current velocities, and circulation are dependent upon the amount of water being released at the Mountain Island Lake Dam and the elevation of the Lake Wylie.

Endangered or Threatened Species

According to the NC DENR Natural Heritage Inventory Database, May 14 2007, there are records of a few endangered or threatened species currently within the USGS quadrangle areas of Mountain Island Lake and Mount Holly near the proposed regional facility locations. The endangered species include Smooth coneflower (*Echinacea laevigata*), Schweinitz's sunflower (*Helianthus schweinitzii*) and Michaux's sumac (*Rhus michauxii*). These three species are also federally listed endangered species. Threatened species include the Georgia aster (*Symphyotrichum georgianum*).

The United States Fish and Wildlife Service (USFWS) list, May 15, 2007, for Gaston County mentions the following protected species with threatened status, the bald eagle (*Haliaeetus leucocephalus*) and the bog turtle (*Clemmys muhlenbergii*). The USFWS list for Mecklenburg County includes the bald eagle as threatened. Surveys will be performed to confirm the presence or absence of these species on all of the regional wastewater facility alternative sites.

6. Draft EIS Outline

Executive Summary
Section 1 – Proposed Project Description
Section 2 – Project Purpose and Need
Section 3 – Alternatives Evaluation

1. Operate separately with existing facilities
2. Operate separately with new Utilities Long Creek WWTP
3. Regionalize – Upgrade and expand existing Mount Holly WWTP
4. Regionalize – New WWTP adjacent to existing Mount Holly WWTP
5. Regionalize – New WWTP adjacent to existing Long Creek Pump Station
6. Regionalize – Maintain existing Mount Holly WWTP and construct new WWTP adjacent to existing Long Creek Pump Station
7. Non-Discharge Alternatives including reuse and alternative disposal options
8. No Action Alternative

Section 4 – Wastewater Treatment Plant Facilities
Section 5 – Existing Environment
Section 6 – Environmental Consequences
Section 7 – Mitigation
Section 8 – List of Preparers
Section 9 – Literature Cited
Section 10 – Appendices
Appendix A – Supporting Documents
Appendix B – Agency Involvement
Appendix C – Local Ordinances and Information

7. Public Involvement

As part of the EIS process, Utilities and Mount Holly will hold at least two public meetings to discuss the project and EIS with the public. These meetings will provide a forum to receive public comments on the project, discuss alternatives to be considered, environmental issues, and other comments regarding the scope and content of the EIS. To supplement these meetings, Utilities and Mount Holly plan to assemble a Steering Group and a Stakeholders' group that will identify major issues and public values and help to anticipate and address community issues and reaction to the proposed alternatives.

The Stakeholders' group will include members representing local environmental, land, regulatory, and economic development interests. This stakeholder group will meet periodically beginning in August of 2007. There will be a separate effort to provide regular updates and project information to local homeowner associations, Catawba Regional Council of Governments, and media.

The Steering Group will be formed by Utilities and Mount Holly to assist in carrying out the study. It will consist of Utilities staff, Mount Holly staff, and consultants working on the study. The Steering Group will combine the input of the Stakeholders' Group with the technical data produced by the study to form recommendations.

The Stakeholders' Group is planned to include a wide range of individuals with diverse community visions. The Stakeholders' Group will provide the Steering Group with feedback on the study as it progresses. The feedback or reaction to the information presented will reflect the various visions and thoughts of the group. The Steering Group will incorporate this feedback into its recommendations, balancing community visions, technical feasibility and economic reality.

8. State and Federal Permits Required

Several state and federal permits are required for activities associated with this project. The following permits and actions need to be completed prior to commencement of construction activities:

- State Environmental Policy Act review and Record of Decision (ROD);
- Clean Water Act Section 404 Permit from U. S. Army Corps of Engineers (USACE) Regulatory Branch (required for construction in jurisdictional wetlands and streams);
- Clean Water Act Section 401 Certification from DWQ Wetlands/401 Permitting Unit (required for construction in jurisdictional wetlands and streams);
- Air Emissions Permit from NCDAQ (may be required for emergency generators);
- A Sediment and Erosion Control Plan (must be approved by NCDENR Mooresville Regional Office, Land Quality Supervisor);
- Abandonment of wells, if applicable, (must be in accordance with 15A NCAC2C.0100).
- National Pollutant Discharge Elimination System (NPDES) Permit for new wastewater discharge to state surface waters.
- Land disturbance permits

In addition to state and federal permits, Utilities and Mount Holly need to obtain approval from Duke Energy for non-project use of project lands through Duke's Catawba Wateree SMP Conveyance Program for a new outfall to either Long Creek or the Catawba River, if located within the Catawba Wateree project boundary and a transmission line across the Catawba River.

9. References

Black & Veatch. August 2006. *Mount Holly/ Charlotte-Mecklenburg Utilities. Feasibility and Preliminary Planning Study for Regional Wastewater Treatment.*

Duke, 2001. *Shoreline Management Plan* (SMP). Duke Energy, Lake Management Division, Charlotte, NC.

North Carolina Division of Water Quality (DWQ). May 14, 2007. North Carolina Stream Classification Schedules from BIMS Database. Online database. http://h2o.enr.state.nc.us/bims/reports/reportsWB.html

North Carolina Natural Heritage Program. May 15, 2007. Database of North Carolina's Endangered and Threatened Species. Online Database. http://www.ncnhp.org/Pages/heritagedata.html

United States Fish and Wildlife North Carolina Ecological Services. May 15, 2007. North Carolina's Threatened and Endangered Species. Online database. http://www.fws.gov/nc-es/es/es.html

10. Figures

The following figures are attached.

Figure 1 – Proposed Regional Wastewater Treatment Plant Vicinity Map

Figure 2 – Service Area for Proposed Regional Wastewater Treatment Plant

Figure 4 – Proposed Regional Wastewater Treatment Plant Site Plan

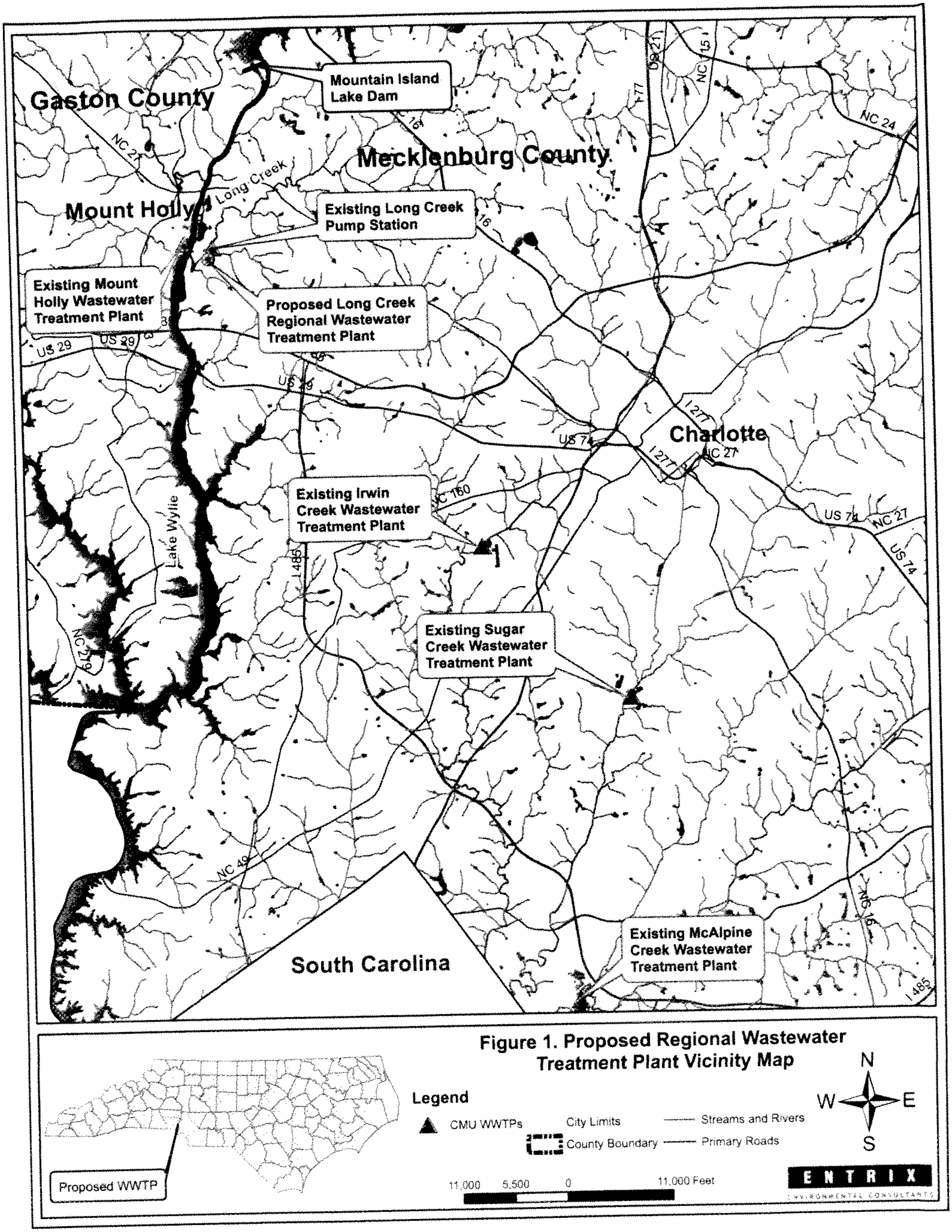


Figure 1. Proposed Regional Wastewater Treatment Plant Vicinity Map

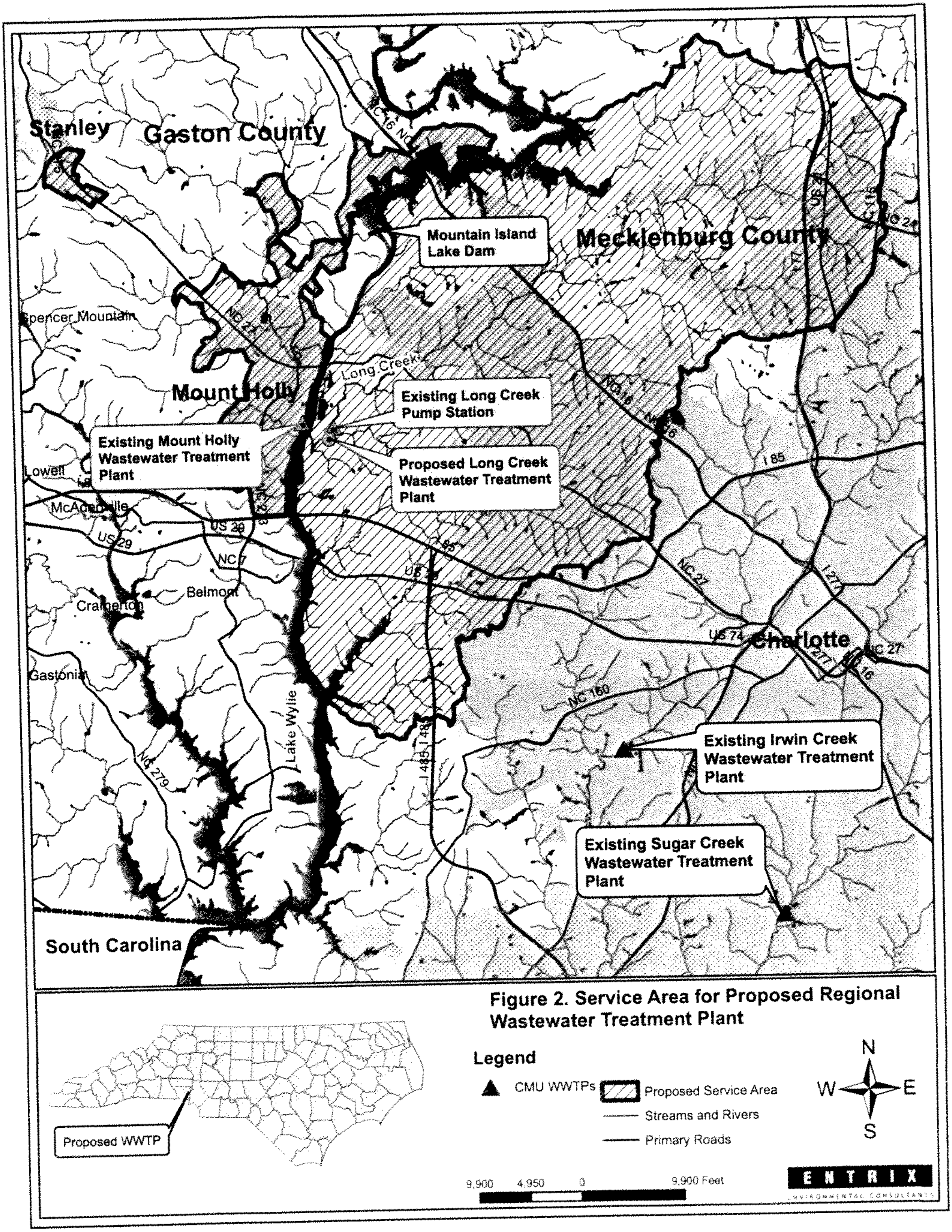


Figure 2. Service Area for Proposed Regional Wastewater Treatment Plant

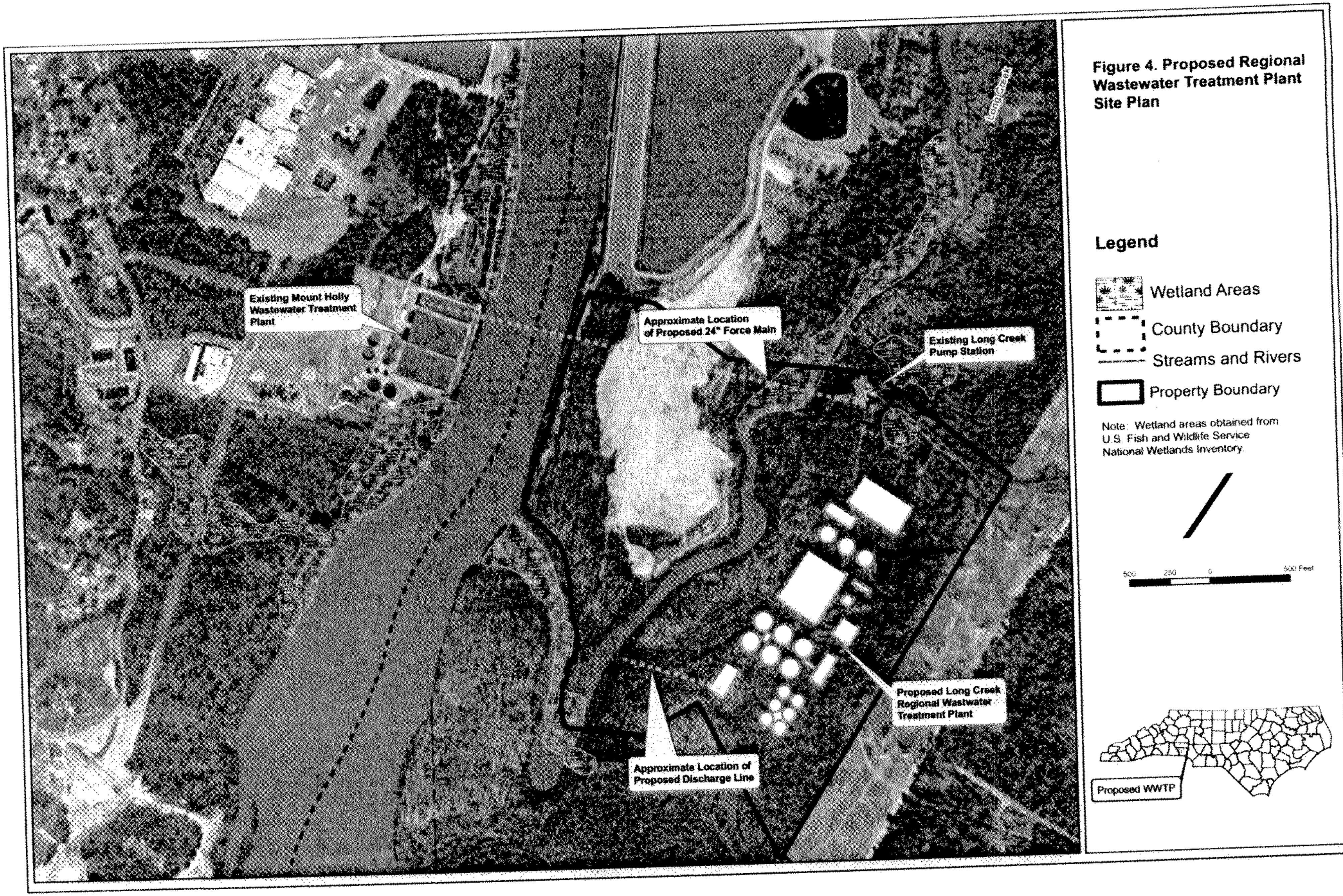


Figure 4. Proposed Regional Wastewater Treatment Plant Site Plan
Legend
Wetland Areas
County Boundary
Streams and Rivers
Property Boundary
Note: Wetland areas obtained from U.S. Fish and Wildlife Service National Wetlands Inventory.
500 250 0 500 Feet
Proposed WWTP
Existing Mount Holly Wastewater Treatment Plant
Approximate Location of Proposed 24" Force Main
Existing Long Creek Pump Station
Proposed Long Creek Regional Wastwater Treatment Plant
Approximate Location of Proposed Discharge Line

Charlotte Mecklenburg Utilities / Mount Holly Proposed Regional Wastewater Facility Stakeholder Meeting #1 August 23, 2007

Attendance

The following stakeholders attended the initial meeting held at the U.S. National Whitewater Center:

- American & Efird—John Bowyer, John Eapen, Craig Stover
- Catawba Lands Conservancy—Rich Holmes
- Catawba Riverkeeper Foundation—Donna Lisenby
- Clariant—Bill Archer
- CMUD Advisory Committee—George Beckwith
- Crosland—Bill Daleure, Rich Reichle
- Duke Energy—Jeff Lineberger
- Gaston County Chamber of Commerce—Elyse Hillegass
- Gaston County Planning Department—David Williams
- Lake Wylie Marine Commission—Pam Beck
- Mecklenburg County Park and Recreation—Don Morgan, Jason Pauling
- Mecklenburg County LUESA—David Caldwell
- Mount Holly Citizen's Group—Will Crist, Mike Legendre
- Mount Holly City Council—Jerry Bishop
- Mount Holly Community Development Foundation—Carlton Broome
- N.C. DENR—Mike Parker
- Quality of Natural Resources Commission—Pam Beck
- Riverfront Homeowners Association—Marc Soper, Charlotte Soper
- Rock Hill Utilities—Bill Yetman
- S.C. DHEC—Carol Copeland
- U.S. National Whitewater Center—Jeff Wise
- York County, S.C.—Mark Kettlewell, Chris Jackson, Becca Bowyer, John Moore

The following representatives from the project Steering Committee attended:

- Charlotte-Mecklenburg Utilities—Doug Bean, Barry Gullet, Jackie Jarrell, Barry Shearin, Ron Weathers, Kit Eller, Erin Culbert
- City of Mount Holly—Eric Davis, Danny Jackson, James Friday
- Black & Veatch—Brent Reuss, Mary Knosby
- ENTRIX—Lauren Elmore

The following stakeholder agencies were not able to attend the first meeting:

- City of Belmont (has met separately with Charlotte-Mecklenburg Utilities)
- N.C. Fish and Wildlife
- Sierra Club
- Town of Stanley

Meeting Discussion

Charlotte-Mecklenburg Utilities presented general background to the group regarding Mecklenburg County and Mount Holly's need for additional wastewater capacity. The presentation included findings of two studies, one on Mecklenburg County's wastewater capacity needs through 2030 and one exploring the feasibility of a regional wastewater plant that would serve both Mount Holly service area and western Mecklenburg County.

Stakeholders were invited to ask questions or bring up issues that concerned them. Many of these topics and others will be discussed in more detail in subsequent meetings.

- Status of Lake Wylie total maximum daily load (TMDL) for nutrients, including point and non-point sources
- Alternatives Analysis - Pros and cons for each alternative and potential plant location
- Air quality
- Impact/reduction on number of sanitary sewer overflows
- New/expanded discharge impact on water quantity/availability downstream
- Interbasin transfer (IBT): this project keeps all water in the Catawba Basin
- Use of current Mount Holly treatment plant if plant is located in Mecklenburg County
- Water Quality modeling: what model, how we establish a baseline, etc (CE-QUAL-W2 from Duke Energy re-licensing process)
- Proximity to 2,500 residential homes that are planned in the vicinity of Clariant land; use land zoned for industrial use for potential plant site
- Other wastewater plants taken out of service with regional plant
- City of Belmont's status in stakeholder process
- Existing capacity available in Belmont to assist Mount Holly
- Belmont's drinking water intake is located downstream of potential discharge
- Location of discharge – Long Creek vs. Catawba River
- Speculative water quality permit limits (modeling ongoing)
- Project contact for stakeholders – Erin Culbert, CMU
- Water Quality Model – inputs, outputs, discharge location (modeling ongoing)
- Parks and Rec opportunities with project – parks, trails, wetlands, etc.; conservation efforts, mitigation
- 7Q10 Flow for Lake Wylie

The group discussed future meeting dates and determined it would continue to meet the fourth Thursday of the month. Any stakeholders who wish to add questions or concerns to the list of discussion topics may send comments to:

Erin Culbert
Environmental Outreach Coordinator
Charlotte-Mecklenburg Utilities
704.391.4685
eculbert@ci.charlotte.nc.us

Charlotte Mecklenburg Utilities / Mount Holly Proposed Regional Wastewater Facility Stakeholder Meeting #2 September 27, 2007

CHARLOTTE.
CHARLOTTE-MECKLENBURG UTILITIES

Attendance

The following stakeholders attended the second stakeholder meeting held at the Duke Energy Customer Resource Center:

- American & Efird—John Bowyer, John Eapen
- Catawba Lands Conservancy—Rich Holmes
- Catawba Riverkeeper Foundation—Donna Lisenby
- Clariant—Bill Archer
- CMUD Advisory Committee—George Beckwith
- Crosland—Bill Daleure
- Duke Energy—Jeff Lineberger
- Gaston County Planning Department—Patrick Armstrong
- Hawfield Road residents—Ed Hamer
- Lake Wylie Marine Commission—Sandy DuPuy, Bo Ibach
- Mecklenburg County LUESA—David Caldwell
- Mecklenburg County Park and Recreation—Jason Pauling
- Mount Holly Citizen's Group—Will Crist, Mike Legendre
- Mount Holly City Council—Jerry Bishop
- Mount Holly Community Development Foundation—Mike Legendre
- N.C. DENR—Mike Parker
- Quality of Natural Resources Commission—Pam Beck
- Riverfront Homeowners Association—Marc Soper
- Rock Hill Utilities—Nick Stegall
- S.C. DHEC—Carol Copeland
- Town of Stanley—Wilce Martin
- York County, S.C.—Becca Bowyer, John Moore

The following representatives from the project Steering Committee attended:

- Charlotte-Mecklenburg Utilities—Doug Bean, Jackie Jarrell, Barry Shearin, Ron Weathers, Kit Eller, Erin Culbert
- City of Mount Holly—Eric Davis, Danny Jackson, James Friday
- Black & Veatch—Brent Reuss, Mary Knosby
- ENTRIX—Lauren Elmore

The following stakeholder agencies were not able to attend this meeting:

- City of Belmont
- Gaston County Chamber of Commerce
- N.C. Wildlife Resources Commission
- Sierra Club
- U.S. National Whitewater Center

Presentation

Charlotte-Mecklenburg Utilities and the City of Mount Holly reviewed the general background information presented during the first Stakeholder Meeting regarding Mecklenburg County and Mount Holly's need for additional wastewater capacity. Population projections and wastewater flow projections for both the Long Creek basin (western Mecklenburg County) and the Mount Holly service area (Gaston County) were presented. In summary, Mount Holly's capacity needs are 4.5 mgd by 2012 and 7.8 mgd by 2030. Mecklenburg County's capacity needs are 7.0 mgd by 2012 and 16.9 mgd by 2030. A regional solution may be feasible, and six alternatives were identified for further evaluation in the Environmental Impact Statement (EIS) process. Additional alternatives (required as part of the EIS alternatives analysis) are "no action" and "non-discharge" alternatives.

An EIS is an extensive evaluation of the advantages and disadvantages of alternatives that discloses the direct, secondary and cumulative impacts. A project scoping letter was circulated through the Department of Administration's State Environmental Clearinghouse. Comments from agencies with expertise and the public will be addressed in the EIS.

Meeting Discussion

Stakeholders were invited to ask questions or bring up issues that concerned them. Many of these topics and others will be discussed in more detail in subsequent meetings.

- The questions and comments brought up during the first stakeholder meeting will be addressed during the appropriate meeting (see future meeting agenda). We are keeping a running list by topic, and we will set aside additional time if we do not address all of the questions.
- Detailed surveys for the EIS have been conducted for each alternative. More discussion on alternatives analysis in the next meeting.
- Direct Impacts are known environmental consequences as a direct result of the project.
- Secondary and Cumulative Impacts (SCIs) are environmental consequences that occur in the reasonably foreseeable future as a result of the project. Mitigation measures limit impacts of SCIs.
- Surface water and ground water are included as part of the Water Resources evaluation.
- Scoping document was submitted to the State in late June. Comments were received in early August.
- Public meetings will also be conducted. This stakeholder process is in addition to prescribed public notification and public meetings process.
- A request was made to share the scoping document with the stakeholder group. We will e-mail the scoping document.
- The potential location for a new regional wastewater treatment plant will be discussed in detail at the next meeting as part of the alternatives analysis.
- We will explore additional feasible alternatives if any others arise during this stakeholder process.
- All alternatives are evaluated and discussed in one EIS document.
- Concerns that process is moving too quickly. It was necessary for Utilities and Mount Holly to conduct a preliminary study to evaluate feasibility, budgetary options and basis for evaluation. This background information provided the foundation to get to this point in the process.
- Black & Veatch is assisting with the planning and technical portion of this project.

- Concerns regarding the City of Belmont's role in the stakeholder process. Belmont is well aware of the project, is a member of the stakeholder group and receives the same materials other members do.
- The alternatives will be thoroughly discussed in the next meeting. The steering group felt it was necessary to provide background information on the project and EIS process so everyone has a foundation prior to the discussion on alternatives.
- Suggestion that an alternative should include Belmont flow.
- Stakeholder group has diverse interests. We will continue to focus on all topics.
- Agendas are flexible to allow time to thoroughly address all topics. We are open to holding additional meetings if deemed necessary by the group.
- Water quality modeling is required for any of the discharge alternatives.
- Alternatives information will be provided prior to the next meeting.

The next meeting will be held October 25, 2007, 6:30 to 8:00, at the Duke Energy Customer Resource Center at 3201 International Airport Drive, Charlotte. Alternate dates for our November meeting will be sent to the group, since it conflicts with Thanksgiving. We will select a date based on the best attendance. Any stakeholders who wish to add questions or concerns to the list of discussion topics may send comments to:

Erin Culbert
Environmental Outreach Coordinator
Charlotte-Mecklenburg Utilities
704.391.4685
eculbert@ci.charlotte.nc.us

Charlotte Mecklenburg Utilities / Mount Holly
Proposed Regional Wastewater Facility
Stakeholder Meeting #3
October 25, 2007

Attendance

The following stakeholders attended the second stakeholder meeting held at the Duke Energy Customer Resource Center:

- American & Efird—John Bowyer
- ARCADIS—Jerry Hatton
- Catawba Lands Conservancy—Rich Holmes
- City of Belmont—Barry Webb
- Clariant—Bill Archer
- CMUD Advisory Committee—George Beckwith
- Duke Energy—Jeff Lineberger
- Gaston County Planning Department—Patrick Armstrong
- Hawfield Road residents—Ed Hamer
- Lake Wylie Marine Commission—Sandy DuPuy, Bo Ibach
- Mecklenburg County LUESA—David Caldwell
- Mount Holly City Council—Jerry Bishop
- N.C. DENR—Rob Krebs, Mike Parker
- Quality of Natural Resources Commission—Jim Burke
- Riverfront Homeowners Association—Marc Soper
- Town of Stanley—Wilce Martin
- York County, S.C.—John Moore

The following representatives from the project Steering Committee attended:

- Charlotte-Mecklenburg Utilities—Doug Bean, Jackie Jarrell, Ron Weathers, Kit Eller, Erin Culbert
- City of Mount Holly—Eric Davis, James Friday
- Black & Veatch—Brent Reuss, Mary Knosby

The following stakeholder agencies were not able to attend this meeting:

- Catawba Riverkeeper Foundation
- Crosland
- ENTRIX
- Gaston County Chamber of Commerce
- Mecklenburg County Park and Recreation
- Mount Holly Community Development Foundation
- Mount Holly Utilities Committee
- N.C. Wildlife Resources Commission
- Rock Hill Utilities
- S.C. DHEC
- Sierra Club
- U.S. National Whitewater Center

Presentation
Charlotte-Mecklenburg Utilities and the City of Mount Holly conducted a brief recap of the previous Stakeholder Meetings regarding Mecklenburg County and Mount Holly's need for additional wastewater capacity. Population projections and wastewater flow projections for both the Long Creek basin (western Mecklenburg County) and the Mount Holly service area (Gaston County) were presented. In summary, Mount Holly's capacity needs are 4.5 mgd by 2012 and 7.8 mgd by 2030. Mecklenburg County's capacity needs are 7.0 mgd by 2012 and 16.9 mgd by 2030. A regional solution may be feasible, and six alternatives were identified for further evaluation in the Environmental Impact Statement (EIS) process. Additional alternatives (required as part of the EIS alternatives analysis) are "no action" and "non-discharge" alternatives.

Stakeholders had received the alternatives and conceptual diagrams in advance of the meeting. Brent Reuss of Black & Veatch presented a summary of each of the eight alternatives and corresponding maps. Questions and comments were taken after each alternative was presented.

Meeting Discussion
Below is a summary of the questions/comments discussed after presentation of each alternative.

ALTERNATIVE #1

- How would Mecklenburg County flow be handled by Alternative #1?
  - The flow would continue to be pumped to the south plants, which would eventually need to be expanded.

ALTERNATIVE #2

- The maps show the new plant located in a wooded area, but B&V is working on layouts in the previously cleared area. This option would preserve the wooded area.
- Reclaimed water/ Reuse: Highly treated wastewater used for irrigation and other nonpotable activities.
- Could we phase out McAlpine Creek WWTP and just expand this new plant to accommodate that flow?
  - McAlpine is a 64-mgd facility that treats the southern portion of the drainage basin. It would not be feasible to pursue this option.
  - Other CMU plant capacities – McDowell Creek WWTP is 12 mgd, Mallard Creek WRF is 12 mgd, Irwin Creek is 15 mgd, Sugar Creek WWTP is 20 mgd (currently under design to expand).
- The existing Mt Holly WWTP is currently located in the floodplain. How often does the facility flood?
  - Mt Holly staff does not recall the tanks being submerged. The level of the river is controlled by the dam. The issue when the river is high is that hydraulically the discharge can't go into river it backs up in the plant.

ALTERNATIVE #3

- Four options to for the river crossing.
  - Tunnel well below river bottom – no disruption to river (common method)

- Lay pipe on bottom of river
    - Open trench–cut
    - Aerial crossing on bridge
- CMU has conducted some initial research to the river crossing. Tunneling or aerial crossings are preferred. Tunneling would be less expensive; however a pedestrian bridge might have more recreational benefits.
- How do you detect leaks under the ground?
    - Microtunnel, pipe with no joints, install tunnel and fill tunnel with concrete all around. Properly selecting pipe and process virtually eliminates possibility of leaks.
- Aerial – exposed to weather, temperature.
- Either type of river crossing can be designed to minimize the risks.
- We don't know geology of soil/rock under river. A geological survey would be conducted during design.
- Footprint of parcel?
    - Mecklenburg County ~150 acres
    - Mt Holly ~30 acres
- Was Paw Creek Pump Station taken into consideration in Alternatives 1 and 2? Paw Creek could operate as is (pumping to McAlpine), or flow could be reversed to Long Creek.

ALTERNATIVE #4

- Double pumping within the plant might be necessary because of parcel available for plant.
- Plant would be located closer to some existing homes.
- How will this alternative on the Mt Holly side impact the planned greenways?
    - Our design would accommodate the greenways and any other planned recreational areas. If we decommissioned the Mt. Holly plant, that land could be used for other purposes.
- 36-inch pipe across the river for Alternative #3
- 24-inch pipe across the river for Alternative #2
- Is redundancy needed for river crossing?
    - We will evaluate initial flows vs. build-out flows to properly size the pipe. This is a design detail.

ALTERNATIVE #5

- Scoping document feasibility study recommended Alternative #5. As we proceed with the EIS, this may or may not be recommended site.
- The maps show the new plant located in a wooded area, but B&V is working on layouts in the previously cleared area as well.
- Bridge will be necessary across Long Creek for access to the plant.
- Is it feasible to send reuse to Gaston County?
    - A parallel pipe could be installed.
    - Another option is a satellite plant at Mt Holly site – typically membrane treatment. This type of treatment will removes solids, treats sewage to high quality, and returns solids to the sewer. Effluent would be reuse water.

- How common, how expensive? Is more expensive, but may be cheaper than other options if you really want reuse as priority. Satellite facilities are becoming more common.

ALTERNATIVE #6

- Does not impact American & Efird site. This was a misplaced bullet in the presentation.
- The Mount Holly plant will still need to be upgraded, but will not need to be expanded.

ALTERNATIVE #7

- Non-discharge – Spray-irrigate plant effluent rather than discharge point.
- Would require 8,000 to 12,000 acres; this is the equivalent of 4-6 Lowe's Motor Speedways.
- Plant would still be built, just no discharge.
- Land availability and cost make this alternative not feasible.

ALTERNATIVE #8

- No action - no additional sewer services.
- The Mount Holly plant would still be upgraded but not expanded.

MATRIX

- All costs are within 10% so not a clear differentiator.
- Joint facility is less expensive to operate.
- More impact on environmental recreation.
- While cost is important, it's not the driving factor. Results of EIS and stakeholder feedback are also important elements.
- Water quality was not included in the matrix and will be covered in another meeting.

- What are most important aspects?
    - State thinks regional alternative is preferable.
    - Reuse should be incorporated into the project.
    - Water quality will be the same for all alternatives.
    - Air quality – odors, proximity to housing – additional encroachment currently on Mt. Holly side; Whitewater center and new housing plans on Mecklenburg County side.
    - NPDES permit limits probably comparable to existing McAlpine Creek WWTP permit limits, but may be more stringent; definitely more stringent than existing Mt. Holly plant.
    - Duke Energy requested to add Lake Wylie water availability (quantity) to matrix. Alt 1 (out of the Alts 1-6) is the only alternative that does not add quantity to Lake Wylie.
    - Is there an impact to river itself? Has Duke looked into this?
    - If discharge is located near existing Mt Holly WWTP discharge, this would help Lake Wylie in terms of water quantity.
    - If flow goes to McAlpine, it bypasses Lake Wylie.

- McAlpine Creek WWTP is currently permitted at 64 mgd and is currently treating about 50 mgd.
- Some QNRC members liked overhead/aerial pipe crossing. Connections for recreational tourism.
- Look at access for canoe launch into Long Creek.
- WQ modeling – samples taken through December helps determine permit limits.
- Can access be provided to plant property from Clariant? Possibly, but operators will need quicker access.
- Reuse – could industries use it? Possibly, if it meets the water quality that they require for their processes.

The next meeting will be held November 27, 2007, 6:30 to 8:00, at the City Café in Mount Holly. Any stakeholders who wish to add questions or concerns to the list of discussion topics may send comments to:

Erin Culbert
Environmental Outreach Coordinator
Charlotte-Mecklenburg Utilities
704.391.4685
eculbert@ci.charlotte.nc.us

Charlotte Mecklenburg Utilities / Mount Holly
Proposed Regional Wastewater Facility
Stakeholder Meeting #4
November 27, 2007

<u>Attendance</u>

The following stakeholders attended the second stakeholder meeting held at the City Café in Mount Holly:

- American & Efird—John Bowyer, John Eapen
- ARCADIS—Jerry Hatton
- City of Belmont—Barry Webb
- Catawba Lands Conservancy—Rich Holmes
- Clariant—Bill Archer
- CMUD Advisory Committee—George Beckwith
- Crosland—Bill Daleure
- Duke Energy—Jeff Lineberger
- Gaston County Planning Department—Patrick Armstrong
- Hawfield Road residents—Ed Hamer
- Lake Wylie Marine Commission—Sandy DuPuy, Bo Ibach
- Mecklenburg County LUESA—David Caldwell
- Mecklenburg County Park and Recreation—Jason Pauling
- Mount Holly Citizen's Group—Will Crist
- Mount Holly City Council—Jerry Bishop
- N.C. DENR—Mike Parker
- Quality of Natural Resources Commission—Pam Beck
- Rock Hill Utilities—Nick Stegall, Bill Yetman
- S.C. DHEC—Carol Copeland
- Town of Stanley—Wilce Martin

The following representatives from the project Steering Committee attended:

- Charlotte-Mecklenburg Utilities—Doug Bean, Barry Shearin, Barry Gullet, Kit Eller, Erin Culbert
- City of Mount Holly—Danny Jackson, James Friday
- Black & Veatch—Brent Reuss, Mary Knosby, Sara McMillan
- ENTRIX—Lauren Elmore

The following stakeholder agencies were not able to attend this meeting:

- Catawba Riverkeeper Foundation
- Gaston County Chamber of Commerce
- Mount Holly Community Development Foundation
- N.C. Wildlife Resources Commission
- Riverfront Homeowners Association
- Sierra Club
- U.S. National Whitewater Center
- York County, S.C.

Doug Bean of Charlotte-Mecklenburg Utilities opened with a discussion regarding recent news coverage of the federal investigation at the McAlpine Creek WWTP. He said Utilities is cooperating fully with investigators and emphasized this and other plants' outstanding environmental performance. He noted that many of the allegations described in the news are not physically possible at the plant and offered to answer any questions.

Presentation and Discussion

Brent Reuss of Black & Veatch presented a brief recap of the previous Stakeholder Meetings regarding Mecklenburg County and Mount Holly's need for additional wastewater capacity. The six alternatives identified by the feasibility study were presented in detail at the previous month's meeting. The focus of this meeting was a presentation of the potential environmental impacts associated with the proposed project. The goal is to have the Environmental Impact Statement completed by January, and a recap of its findings will be discussed in the February stakeholder meeting.

Examples of direct and secondary/cumulative environmental impacts were presented and questions were taken throughout the presentation. The summary of the comments and questions is presented below.

Direct Impacts: The direct environmental impacts would be located on the project site itself and associated with construction and/or operation of the new facility. Examples of these types of impacts include loss of open space from facility construction, increased impervious area on the project site and disturbance of riparian buffers due to pipeline construction. Direct impact reductions already in place were presented along with potential mitigation measures that would be implemented if the project were to move forward.

- The discharge location was discussed with DWQ personnel who recommended the outfall be located in the Catawba River as opposed to Long Creek.
- If Mount Holly decided to stay on its own, the potential for direct impacts due to the pipeline crossing would be reduced. There are various scenarios for each alternative regarding the pipe crossings, and these will be addressed in more detail at the design stage of the project.
- The project team met with DENR last week to discuss the ongoing modeling effort and present initial results. The modeling will help provide more information and will help guide water quality limits. Results from the Lake Wylie water quality model will be presented at the January stakeholders meeting, once December data has been included.
- There is no TMDL for this section of the Catawba River; however a TMDL for chlorophyll-a is in place for Lake Wylie.
- Questions were asked about the current Mount Holly discharge concentrations and the river flow in this location. Mount Holly currently does not have nutrient limits, but is required to monitor for total nitrogen and phosphorus on a monthly basis. These data, along with the modeling results, will be presented at the January meeting.
- Black & Veatch discussed at the October meeting that if Alternative #5 (regional plant on Mecklenburg side) were selected, the plant could be relocated to a portion of the property that is already disturbed. This would reduce impacts to tree cover and buffers. Brent presented a new diagram to show stakeholders this option.
- If Alternative #5 is selected, it would be constructed in phases with the final capacity of 25 mgd as the 30-year projected capacity. The plant site would accommodate further expansion if necessary and would be designed with this in mind. Larger plants have

been constructed on much smaller sites. This would be addressed in the design phase of the project as well. Clariant currently owns this property.

- Sludge currently is being anaerobically digested at other CMU facilities and subsequently land applied. The decision has not yet been made regarding how the sludge will be handled, and that aspect would be addressed in the design phase.
- If a new plant were to be constructed, there would need to be access between the plant site and the existing Long Creek pump station. It would be more advantageous for the plant operators to have a direct access across Long Creek versus the Clariant entrance. The pump station is not currently manned 24-7, but the WWTP would be and operators would need to access the pump station 2-3 times per shift.

Secondary and Cumulative Impacts: These impacts would be located off-site and would be an indirect result of the project. They can occur later in time, and the effects can be magnified when combined with other activities in the region. Examples include urbanization and increased stormwater runoff, resulting from increased impervious landscape. Potential mitigation measures for these examples were presented.

- The Charlotte City Council recently adopted a post-construction ordinance.
- Low Impact Development (LID) ordinance is not in place in this area, but the project will incorporate many of the LID approaches to site design.
- Water reuse would be subject to DENR specifications.

Doug Bean presented several sustainable design elements that are explored for the project, including LEED-certified buildings, open space preservation, reclaimed water reuse and rain gardens for stormwater management. Suggestions for those approaches that were important to the stakeholders were taken and summarized below:

- Rainwater harvesting – capture and incorporate rain water to enhance reuse
- Solar energy
- Methane capture – electricity generation, heating. CMU currently uses methane to heat digesters and is conducting a study about how to capture more.
- Reuse water users – evaluate potential customers now for reuse. The ideal reuse customers would be big users with constant, year-round usage. One drawback of reuse is it reduces water replenishing streams and waterways, which has become especially important during drought conditions.
- Greenway system – connect to other greenways and recreational areas; pedestrian bridge can connect the two counties.
- Security – if a trail is in close proximity to plant, there would need to be fencing or other security measures in place.
- Odor control – CMU expectation is to contain odor to plant site. Similar technology would be considered that has been implemented at the Sugar Creek WWTP to significantly reduce odor problems.
- Partner with Whitewater Center for recreational and educational uses of the open space.
- Joint use – ample space at the plant for community meetings, tour groups and educational uses.
- Water quality – consider phosphorus-removal technologies (including membranes) for high level treatment. CMU anticipates stringent nutrient limits and will evaluate the advanced treatment options available to meet those.

Future Meetings
The fifth meeting will be held Jan. 24, 2008, 6:30 to 8:00, at the Duke Energy Customer Resource Center near the airport. The stakeholder group will not meet in December.

In advance of the Jan. 24 meeting, Utilities and Mount Holly will host an additional meeting for those interested in a more detailed, technical discussion of the water quality modeling and data. Any stakeholders who wish to participate should contact Erin Culbert. A date and time will be set soon and an email will be sent to the group. We expect the meeting to take place in mid-January so it can include December data.

Any stakeholders who wish to add questions or concerns to the list of discussion topics may send comments to:

Erin Culbert
Environmental Outreach Coordinator
Charlotte-Mecklenburg Utilities
704.391.4685
eculbert@ci.charlotte.nc.us

Charlotte Mecklenburg Utilities / Mount Holly Proposed Regional Wastewater Facility Stakeholder Meeting #5 January 24, 2008

Attendance

The following stakeholders attended the fifth stakeholder meeting held at the Duke Energy Customer Resource Center:

- American & Efird—John Bowyer
- ARCADIS—Jerry Hatton
- Clariant—Bill Archer
- CMUD Advisory Committee—George Beckwith
- Duke Energy—Mark Oakley
- Gaston County Chamber of Commerce—Bill Gary
- Gaston County Planning Department—Patrick Armstrong
- Lake Wylie Marine Commission—Sandy DuPuy, Bo Ibach
- Mecklenburg County LUESA—David Caldwell
- Mount Holly City Council—Jerry Bishop
- N.C. DENR—Mike Parker
- Quality of Natural Resources Commission—Boo Robinson
- York County, S.C.—Becca Bowyer, John Moore

The following representatives from the project Steering Committee attended:

- Charlotte-Mecklenburg Utilities— Barry Gullet, Barry Shearin, Ron Weathers, Kit Eller, Erin Culbert, Dawn Padgett
- City of Mount Holly—Eric Davis, Danny Jackson
- Black & Veatch—Brent Reuss, Beth Quinlan, Mary Knosby, Sara McMillan

The following stakeholder agencies were not able to attend this meeting:

- Catawba Lands Conservancy
- Catawba Riverkeeper Foundation
- City of Belmont
- Crosland
- Hawfield Road residents
- Mecklenburg County Park and Recreation
- Mount Holly Community Development Foundation
- Mount Holly Utilities Committee
- N.C. Wildlife Resources Commission
- Riverfront Homeowners Association
- Rock Hill Utilities
- S.C. DHEC
- Sierra Club
- Town of Stanley
- U.S. National Whitewater Center

Barry Gullet of Charlotte-Mecklenburg Utilities welcomed the stakeholders and discussed the technical stakeholder meeting held on Wednesday, where interested stakeholders heard a more technical, detailed explanation of the water quality modeling data.

January 23, 2008
All stakeholders were invited to attend a technical water quality meeting hosted Jan. 23 at Charlotte-Mecklenburg Utilities for presentation of more detailed results of the water quality modeling of Lake Wylie. Graphs of the modeling results were presented comparing the existing conditions to several different modeled scenarios. The attendees included:

ARCADIS—Jerry Hatton
Duke Energy—Bill Foris, Mark Oakley
ENTRIX—Paul Leonard
Mecklenburg County LUESA—David Caldwell
S.C. DHEC—Carol Copeland, Wayne Harden
Black & Veatch—Brent Reuss, Beth Quinlan, Mary Knosby, Sara McMillan
Charlotte-Mecklenburg Utilities— Barry Gullet, Ron Weathers, Kit Eller, Erin Culbert, Dawn Padgett

January 24, 2008
Presentation and Discussion

Brent Reuss of Black & Veatch presented a brief recap of the previous stakeholder meetings, particularly the status of the Environmental Impact Statement and potential environmental impacts associated with the regional WWTP. The focus of this meeting was a discussion of historical water quality in Lake Wylie and a detailed presentation of the water quality modeling results of the lake.

Historical Water Quality

- Land use in the Lake Wylie watershed has predominantly been agricultural/forested but is converting to more urban land uses (residential and commercial)
- Algal blooms, elevated nutrients and low dissolved oxygen led DENR to classify the lake as impaired and a total maximum daily load (TMDL) for chlorophyll-*a* was approved in 1991
- Water quality is improving since implementation of the TMDL due to nonpoint source load reductions in watershed (e.g. post-construction stormwater ordinances) and improved technology for nutrient removal at point sources.
- To continue these improvements and protect water quality, advanced treatment technologies will be included in the proposed regional WWTP design

Ambient Water Quality Monitoring

- Samples from the lake have been collected by several different federal, state and local agencies, including LUESA, EPA, USGS and DWQ
- Existing sampling is conducted by LUESA and DWQ on a generally monthly basis
- Sampling locations primarily are in the coves and were expanded to include main channel stations as well
- Trends in water quality data:
    - Chlorophyll-*a* lowest upstream and highest near the dam
    - Nutrient concentrations were highest at upstream stations and generally decreased over time

Water Quality Modeling

- The purpose of the modeling is to assist NC DWQ in developing speculative limits for proposed regional WWTP discharge and to evaluate impacts on water quality in Lake Wylie from the proposed regional WWTP discharge.
- CE-Qual-W2 model was developed and calibrated by Duke Energy
- Existing and future conditions were simulated to investigate effects of regional WWTP
- Modeling results showed that the effects of the proposed regional WWTP were minimal and limited to the area upstream of the South Fork branch
- Changes in water quality at the dam were insignificant
- Chlorophyll-*a* concentrations were well below the water quality criteria
- Concentrations of total phosphorus (TP) and total nitrogen (TN) in South Carolina waters were below the criteria

Proposed Regional WWTP Summary

- Advanced treatment processes would be included in the design to achieve low concentrations of TN and TP and protect water quality in the lake
- State-of-the-art treatment technologies will be incorporated in the design
- A new regional plant will provide enhanced reliability of treatment and would eliminate one or more existing wastewater discharges
- By discharging treated effluent to Lake Wylie instead of diverting it for treatment farther south, the water volume in the lake will be increased.

Questions:

Would there be any impact on Sugar Creek if the flow from Long Creek is no longer pumped to McAlpine?

> ➢ No impact would be expected because of the low proportion of flow from the Long Creek Basin currently being treated at McAlpine Creek WWTP. Average influent flow at McAlpine is 45 mgd, and flow from Long Creek now is just 3 mgd.

Are wastewater spills a concern for the plant?

> ➢ Spills at the plant are unlikely but are possible under a range of circumstances, including increased flow during wet weather, loss of electricity and mechanical problems. Spills are prevented with redundancy in the design of the plant: flow equalization basins, backup generators, preventative maintenance, computer gauges to indicate problems. Most importantly, the plant would be staffed 24 hours a day, 7 days a week so if a spill were to occur, the problem would be corrected immediately. Wastewater spills are more common in the collection system. Those that occur as overflows at manholes are highly visible and get reported and remedied quickly; we might not be aware of those off-street as quickly.

Does the model account for nonpoint sources of pollution, now and in the future?

> ➢ Yes. Anticipated growth and land use changes in the service area and surrounding Lake Wylie watershed was estimated through data collected by county and municipal planning agencies. The predicted changes in nutrient loads accompanying growth were added to the model and had minimal impact on the results because the Lake Wylie watershed is largely rural with the exception of a small portion of the basin in Mecklenburg County. The model was run during a year of low rainfall so nonpoint sources (those associated with stormwater runoff) were minimal. This scenario is a good test because potential impacts from the regional WWTP would be greatest during low flow conditions.

Would the modeling change based on which alternative is chosen for plant location?

- No. All alternatives are located on the same sites and would ultimately discharge the same amount of treated water to the lake. From a modeling perspective this translates into all alternatives being located in the same modeling segment.

The next meeting will be held February 28, 2008, 6:30 to 8:00, at the Duke Energy Customer Resource Center. We will discuss the findings of the EIS, wrap up stakeholder questions and discuss the next steps in the project.

Any stakeholders are encouraged to send questions or outstanding issues in advance so these can be answered at this next meeting. Please send any questions or concerns to:

Erin Culbert
Environmental Outreach Coordinator
Charlotte-Mecklenburg Utilities
704.391.4685
eculbert@ci.charlotte.nc.us

Water Quality Modeling Report
Supplemental Report

Long Creek Regional Wastewater Treatment Plant

CHARLOTTE
CHARLOTTE-MECKLENBURG UTILITIES

CITY of MOUNT HOLLY N.C. INCORPORATED 1879

Charlotte Mecklenburg Utilities
Charlotte, NC

City of Mount Holly

Prepared by:
Black & Veatch International Company
8520 Cliff Cameron Drive, Suite 210
Charlotte, NC 28269
(704)-510-8461

June 2008

Table of Contents

1. Introduction

In 2006, Charlotte Mecklenburg Utilities (CMU) and the City of Mount Holly cooperated in a Feasibility and Preliminary Planning Study which evaluated the growing wastewater demands in both service areas and identified a number of alternatives that would meet future wastewater projections. Alternatives identified in the study included a new regional WWTP adjacent to the existing Long Creek Pump Station in western Mecklenburg County as well as combinations of expansion and new construction on the Gaston County side of the Catawba River. Each of six action alternatives as well as the No Action and Land Application alternatives considered for this project are included in the Environmental Impact Statement (EIS). The proposed regional wastewater treatment plant was identified as the recommended alternative.

As part of the evaluation of environmental impacts, a water quality modeling study of Lake Wylie was conducted to evaluate the potential impacts that increased wastewater discharge would have on the lake. Current conditions and many future scenarios were modeled to determine the potential water quality impacts from the proposed regional WWTP. Results of the initial modeling were included in a report submitted to the NC Division of Water Quality (DWQ) (Black & Veatch 2008).

After initial review of that report DWQ had some additional questions and requests for information which are addressed in this report. Specifically, the additional information in this supplemental report includes:

- A review of the March 2008 report
- A discussion of the original calibration of the Lake Wylie model
- Results of the verification of the model using data from 2007
- Results of additional modeling using an alternative set of speculative limits where total nitrogen (TN) was limited to 3.5 mg/L and total phosphorus (TP) was limited to 0.5 mg/L.

2. Review of March 2008 Report

A water quality modeling study was conducted as part of the EIS for the Long Creek Regional WWTP. Water quality modeling of Lake Wylie was performed to assist in the evaluation of water quality impacts from the proposed facility and to support the development of speculative NPDES limits by NC DWQ for the plant discharge into Lake Wylie. The previously calibrated Lake Wylie model was used to evaluate the effects of increased wastewater discharges to the upper section of Lake Wylie. Many scenarios were simulated to evaluate existing and potential future conditions. For both existing and future conditions both normal operating conditions and permit conditions were simulated. Increases in future nonpoint source (NPS) loads were also simulated. Wastewater treatment plant point sources to Lake Wylie included the Mount Holly WWTP and the Belmont WWTP. Results of that modeling were described and presented in a report titled "Water Quality Modeling Report – Long Creek Regional Wastewater Treatment Plant", dated March 2008. Results from that report are summarized in this section.

The water quality parameters that were simulated in the model included phosphorus, nitrogen, biochemical oxygen demand (BOD_5), dissolved oxygen (DO) and chlorophyll *a*. For normal operating conditions, the concentrations used represented the highest loads that could be discharged without exceeding any permit limits. Water quality concentrations for the proposed regional WWTP under permit limit conditions were calculated based on assumed permit limits for TN, TP, and BOD_5 based on plant capacity. The fourteen scenarios simulated represented variations in effluent flow and quality as well as river conditions.

Model results indicated the following conditions would occur:

- Dissolved oxygen concentrations under the future scenario of a new WWTP would not vary greatly from existing conditions. In the area downstream of the junction with the South Fork Branch, the different scenarios exhibited virtually no differences in DO concentrations throughout the water column. In the lower section of the lake, concentrations would be slightly reduced in the upper portions of the water column in the future scenarios.

- During an average flow year, low DO concentrations would likely occur about 0.5 - 1 meter higher in the water column downstream of the Belmont WWTP. Only minor differences in DO concentrations were predicted to occur in the area downstream of the South Fork Branch while virtually no differences were expected in the lower section of the lake.
- Predicted TP concentrations would be higher in the upper reaches of the lake under the future condition with a new WWTP discharge.
- There were virtually no differences in TP concentrations between existing and future conditions in the lower section of the lake. Differences were further reduced during the average flow year.
- Predicted TP concentrations in the South Carolina portion of the lake would be below the instream water quality criteria of 0.06 mg/L throughout the average flow year. However, during a dry flow year, under all existing and future conditions, it was estimated that the TP criteria would be exceeded for a few days early in the year.
- Predicted TN concentrations would be higher in the upper reaches of the lake under the future conditions scenario. There were virtually no differences in TN concentrations between existing and future conditions in the lower section of the lake. Differences were further reduced during the average flow year.
- Total nitrogen concentrations in the South Carolina portion of the lake would be below the instream water quality criteria of 1.5 mg/L for all conditions modeled.
- Chlorophyll *a* concentrations were very low in the upper section of the reservoir and generally increase in a downstream direction under both existing and future conditions scenarios.
- Only minor differences between the scenarios were apparent downstream of the junction with the South Fork Branch. Virtually no differences in chlorophyll *a* concentrations were seen between scenarios run using average flow conditions.
- In all cases the predicted chlorophyll *a* concentrations were well below the water quality criteria of 40 μg/L.

- The largest source of nutrients for both the existing and future cases was estimated to be the South Fork Branch.
- Under the future scenario, the new Regional Long Creek WWTP could contribute a slightly higher load than the Belmont WWTP although the flow would be five times greater. Similar patterns were shown in the comparison of TN load contributions.

Overall, the modeling indicated that the effects of the new regional Long Creek WWTP would have minor impacts on water quality in Lake Wylie. Effects would be mostly confined to the upper reaches of the lake. Water quality criteria for TN and chlorophyll *a* would be met under all conditions. Criteria for TP could be exceeded for a few days during a low flow year under both existing and future conditions.

3. Lake Wylie Model Calibration

CE-QUAL-W2 is a two-dimensional, hydrodynamic and water quality model for reservoirs and rivers. It is assumed that lateral variations across a lake or reservoir can be ignored. Because of this assumption, the model is best suited to reservoirs that are relatively long and narrow like Lake Wylie. The hydrodynamic module predicts water surface elevations and velocities in the horizontal and vertical directions. The hydrodynamic module is directly linked to a water quality module that predicts time-varying concentration of water quality parameters.

The base CE-QUAL-W2 model was developed by the US Corps of Engineers (Cole and Wells, 2002) and the Lake Wylie application was developed by Resource Environmental Management Inc. (REMI) at the request of Duke Energy. The bathymetry for the model was developed by dividing the reservoir into branches and then segmenting the branches longitudinally and vertically. The model configuration is shown on Figure 1.

The CE-QUAL-W2 model represents Lake Wylie as a single water body containing nine branches and ten tributaries. Branch 1 is the mainstem of the lake while the other branches are simulated arms of the lake. The ten tributaries enter the lake as point sources and include natural streams and discharges from WWTPs and power plants. The tributary inflows enter the lake at a specific location or segment within the model. As seen on the figure, segment lengths vary through the lake. Vertically, each layer is 1 meter thick.

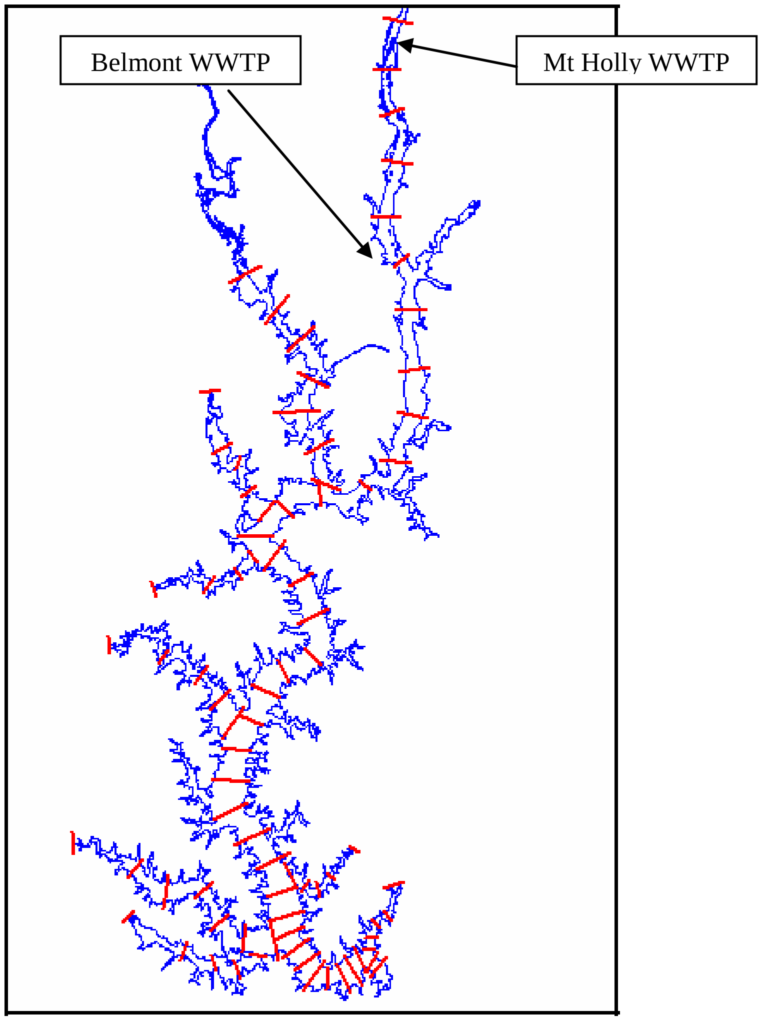


Figure 1. Model Configuration for Lake Wylie

Information on the model application to Lake Wylie and the detailed calibration were provided by Ruane and Hauser (2006) and Sawyer and Ruane (2006). As described by Sawyer and Ruane (2006), the model was calibrated using data from 1998 and 2002. The primary calibration year was 2002 and was the driest year on record. During 2002, Duke Power conducted an intensive study of water quality and flows on the lake. In 1998, tributary inflows were relatively high during the first part of the year and low for the remainder of the year making it an average flow year overall. In addition, 1998 had a good database of measured flow and water quality constituents to use in the calibration process. The model was originally calibrated for 2002 conditions then model settings were applied to 1998 conditions and the model performed well.

The calibration for 2002 showed that predicted water surface elevations closely matched observed values except for the last two months of the year when differences of up to 0.5 m were observed. The close calibration of the water balance indicated that the model was accounting for all inflows, withdrawals and other losses such as seepage and evaporation.

The temperature and DO calibrations were evaluated using two statistical measures: absolute mean error, and root mean square. The absolute mean error (AME) is the sum of the differences between observed and predicted values divided by the number of pairs compared. Root mean square (RMS) indicates that 67 percent of the model results verses observed data are within the value of the RMS. Comparisons between modeled and observed values of temperature and DO during 2002 were made at five (5) main channel stations. The overall AME for temperature and DO were 0.69 and 0.9, respectively. The overall RMS for temperature and DO were 0.88 and 1.30, respectively. As a check on the calibration, these statistical parameters were calculated for the location at the dam. These statistical measures for the 1998 flow year were very similar although slightly higher than the values calculated for the same location in 2002. According to Sawyer and Ruane (2005) many modelers consider calibration to be acceptable when the AMEs for temperature and DO are less than 1.0 ^{o}C and 2 mg/L, respectively.

Nutrient calibration was performed at two locations in the lake. A comparison of modeled to observed values of total phosphorus showed a good comparison especially in the surface layer. The model tended to over predict total phosphorus in the bottom waters except during the summer months of July and August when total phosphorus was under predicted. The model calibration for inorganic nitrogen showed good agreement between measured and modeled values especially in the surface waters. The model tended to under predict inorganic nitrogen during summer months.

Chlorophyll *a* calibration was performed at five locations in the lake. According to Sawyer and Ruane (2005) model predicted algae concentrations were considered to be representative of algal concentrations in the lake considering the amount of data available for calibration and modeling objectives. At all locations the model tended to under predict concentrations of chlorophyll *a* during the early part of the year 2002. During this time, the model predicted concentrations in the range of 2 to 5 μg/L while most observed values were in the range of 3 to 20 μg/L with a few values of almost 30 μg/L. During the rest of the year, the model results showed good agreement with observed values.

4. Simulation of 2007 Conditions

The Lake Wylie Model was previously developed by Duke Energy in support of the Federal Energy Regulatory Commission (FERC) relicensing process (Sawyer and Ruane, 2006). At that time, the Lake Wylie Model went through an extensive calibration process that included review and collaboration with several federal and state agencies. The calibration used flow and quality data from 1998 and 2002 which represented average and low flow years, respectively. Until 2007, 2002 represented the lowest flow year on record. Although additional data were collected during 2007, these data were not considered sufficient to warrant a recalibration of the model. Through discussions with the DWQ, it was agreed that the model would not be recalibrated as part of this project. To evaluate the effects of the proposed regional Long Creek Plant, the model would be run for the same two years used for calibration (1998 and 2002) and would incorporate changes that would occur with a new regional wastewater treatment plant. In addition, the model would be run to simulate 2007 conditions as a check on the model calibration.

The Land Use and Environmental Services Agency (LUESA) of Mecklenburg County sampled several stations Lake Wylie on a monthly basis. Routine stations are located primarily at cove entrances. Determination of model requirements and preliminary discussions with DWQ staff members resulted in the addition of four mainstem sampling sites located adjacent to samples currently being collected in the coves. Figure 2 shows the nine sampling locations, with the added sites designated with an "A" (e.g. LW4A).

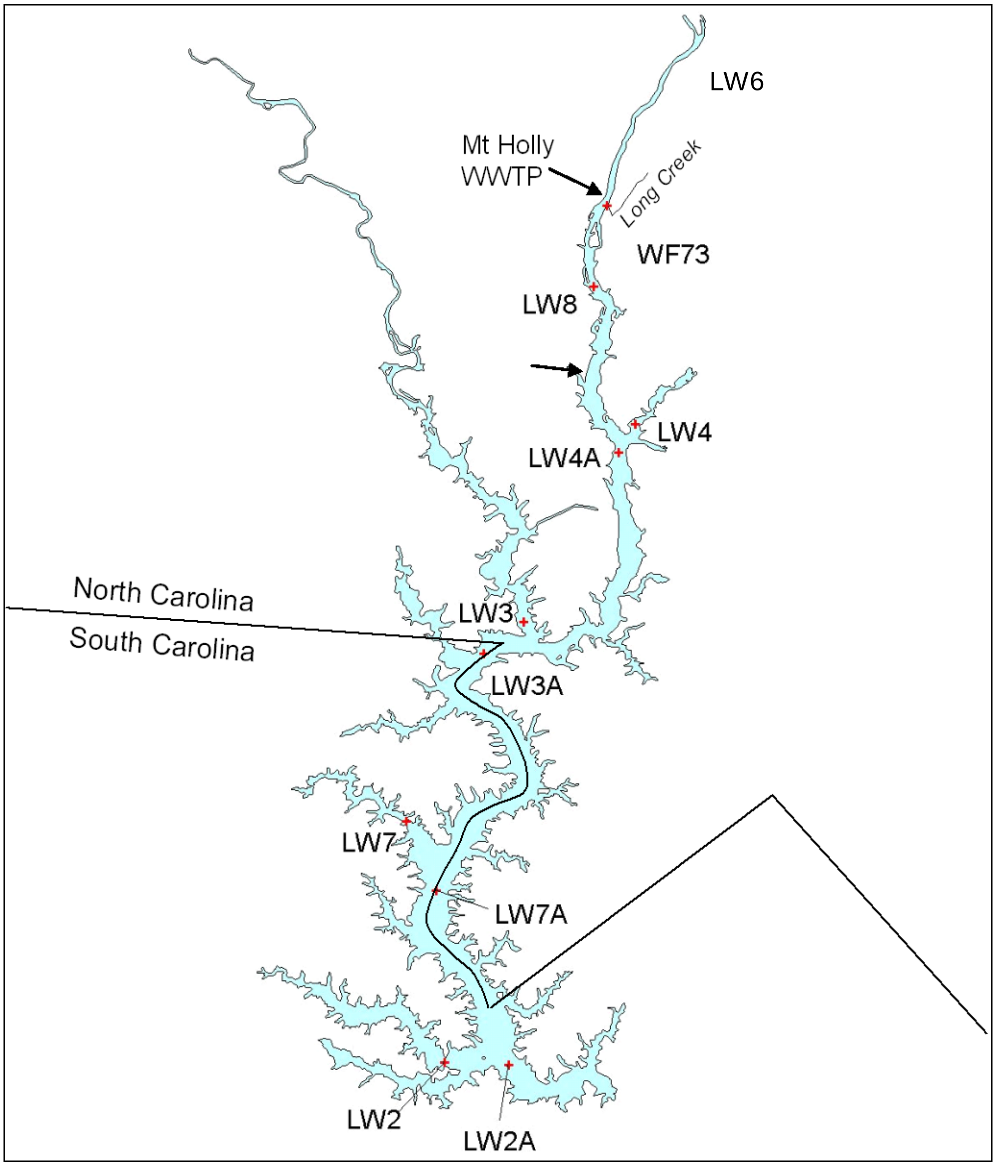


Figure 2. LUESA Monitoring Stations on Lake Wylie.

All sites were sampled on a monthly basis from May through December 2007; twice-monthly samples were collected July – September 2007. Samples were collected from the surface and near the lake bottom and analyzed for the following parameters:

- Water temperature
- Depth
- Dissolved oxygen
- Conductivity

- pH
- Total suspended solids, total solids, turbidity
- Chlorophyll *a*
- Nutrients (total phosphorus, orthophosphate, total Keldahl nitrogen, nitrate-nitrogen, ammonia-nitrogen)
- Fecal coliform

4.1 Model Inputs

The Lake Wylie W2 model used for the 1998 and 2002 model runs was used to create the 2007 Lake Wylie model. The bathymetry and control files were not modified. Only the input files were modified to represent 2007 conditions. Simulations were run through September 2007 due to data limitations, primarily flow information.

All 2007 inflow, outflow, and meteorological data files were received from Duke through their consultant REMI. The distributed flow was adjusted to achieve a water balance. This same procedure was used during the original calibration of the model. The model-predicted water surface of the lake and the measured lake elevations are shown on Figure 3. The files were limited to Julian day 272 (September 29).

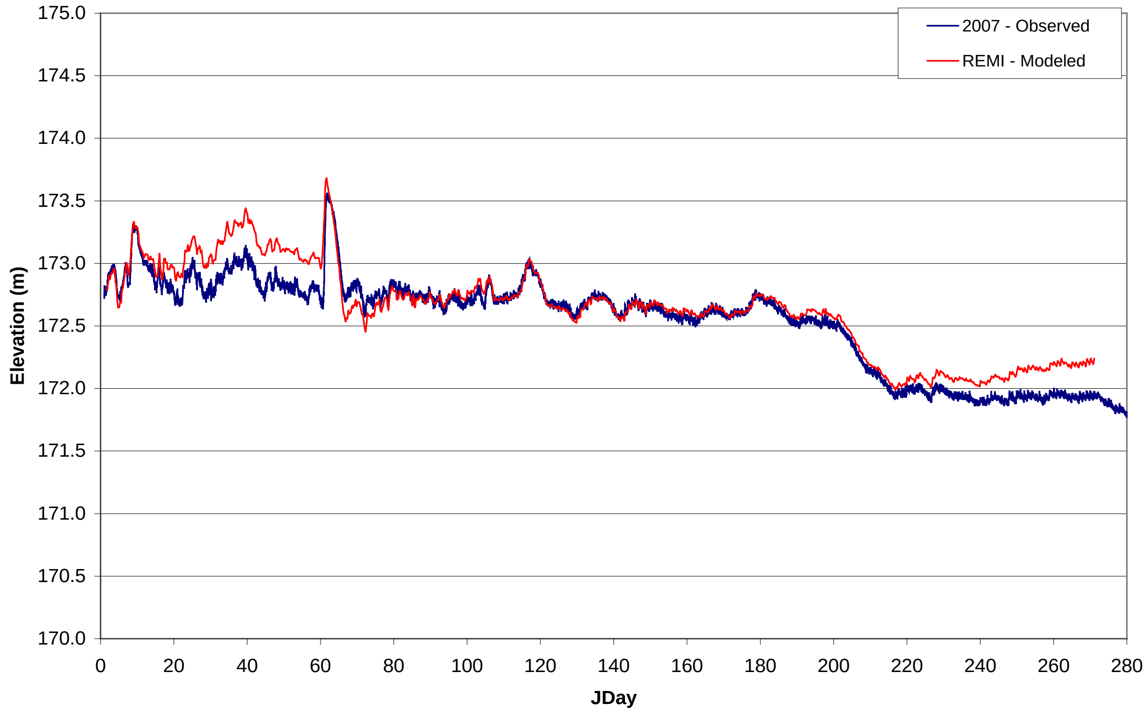


Figure 3. Lake Wylie Observed and Modeled Water Surface Elevations

The temperature of the inflows into the Lake Wylie model were determined by measured temperature data collected at monitoring stations in Lake Wylie and throughout the Lake Wylie watershed. However, not all inflows are monitored and therefore it was necessary to obtain data from a monitored source to represent other inflows. Table 4.1 lists the sources of all temperature inflow files (Tin) and distributed inflow files (Tdt). It is important to note that the temperatures of inflow from Mountain Island Lake were not monitored during 2007. To represent inflow temperature and other water quality parameters, data collected from LUESA station LW6 were used. Station LW6 was moved downstream in May 2007 to just above the confluence with Dutchman's Creek. Sampling was discontinued at this station in July because of low lake levels. Temperature is an important water property that has a significant effect on mixing of lake waters. The lack of temperature data can be one factor contributing to discrepancies between model simulations and observed data.

Table 4.1. Temperature Inflow Files

		Tin	Tdt
Branch 1	Mountain Island	LW6B & LW6A*	LW6B & LW6A*
Branch 2	South Fork Catawba	South Fork Catawba	South Fork Catawba
Branch 3	Catawba Creek	South Fork Catawba	South Fork Catawba
Branch 4	Mill Creek	Crowder's Creek	Crowder's Creek
Branch 5	Crowder's Creek	Crowder's Creek	Crowder's Creek
Branch 6	Torrence Branch	-	Crowder's Creek
Branch 7	Allison Creek	Crowder's Creek	Crowder's Creek
Branch 8	Unnamed	-	Crowder's Creek
Branch 9	Little Allison Creek	Crowder's Creek	Crowder's Creek
Tributary 1	Dutchman's, LC (eastside)	Dutchman's Creek	-
Tributary 2	Paw Creek	Long Creek	-
Tributary 3-7	Allen Steam Plant	2007 Duke Data	-
Tributary 8	Catawba Nuclear Plant	2007 Duke Data	-
Tributary 9	Mount Holly WWTF	2007 DMR Data	-
Tributary 10	Belmont WWTF	2007 DMR Data	-

Table 4.2. Water Quality Inflow Files

		Cin	Cdt
Branch 1	Mountain Island	LW6B & LW6A*	LW6B & LW6A*
Branch 2	South Fork Catawba	South Fork Catawba	South Fork Catawba
Branch 3	Catawba Creek	South Fork Catawba	South Fork Catawba
Branch 4	Mill Creek	Crowder's Creek	Crowder's Creek
Branch 5	Crowder's Creek	Crowder's Creek	Crowder's Creek
Branch 6	Torrence Branch	-	Crowder's Creek
Branch 7	Allison Creek	Crowder's Creek	Crowder's Creek
Branch 8	Unnamed	-	Crowder's Creek
Branch 9	Little Allison Creek	Crowder's Creek	Crowder's Creek
Tributary 1	Dutchman's, LC (eastside)	Dutchman's Creek	-
Tributary 2	Paw Creek	Long Creek	-
Tributary 3-7	Allen Steam Plant	Modeled	-
Tributary 8	Catawba Nuclear Plant	Modeled	-
Tributary 9	Mount Holly WWTF	2007 DMR Data	-
Tributary 10	Belmont WWTF	2007 DMR Data	-

4.2 Model Outputs

An excel program was created to graph the vertical profiles of the modeled and sampled values for each water quality constituent, location, and date. As previously stated, due to data limitations the simulations were made through September, therefore vertical profile comparisons were made for all sampling dates through September 26, 2007.

The sampling data include vertical profiles for DO and discreet samples for TN, TP and chlorophyll *a* collected at the top and bottom of the water column. The top sample is a composite collected through the photic zone which was assumed to be equal to two times the Secchi depth. The bottom samples were collected at 1 to 2 meters above the bottom.

The figures presented for DO include profiles simulated by the model and the individual sampling points observed by LUESA. The figures presented for TN, TP and chlorophyll *a* include the profile simulated by the model and two points that represent the top and bottom sample. The top sample is plotted at the bottom of the range sampled while the bottom point is plotted at 1.5 m above the bottom. On each figure, the sampled data (Sample) is compared to the model outputs for three days including the day of sampling (Ck2007), the day after (Ck2007+1) and the day before (Ck2007-1) to show the variability that is expected to occur over short periods of time. The observed data are depicted by the red lines or dots while the same day profiles are shown by the purple lines. Before and next day profiles are shown by a series of blue and green dots, respectively.

4.3 Results and Conclusions

Vertical profiles of measured and simulated DO concentrations for each of the four mainstem stations and each sampling date are shown on Figures 4 through 27, at the end of this document. In general, the model tended to under predict the concentration of DO. The largest discrepancies occurred at times when the model predicted that bottom waters were depleted of DO when observed values indicated that DO values were significantly higher. The AME and RMS values calculated for DO were 1.15 and 1.28 which are similar to the values calculated for the original calibration of the model.

Vertical profiles of measured and simulated TN concentrations for each of the four mainstem stations and each sampling date are shown on Figures 28 through 51, at the end of this document. There is more variability between measured and modeled concentrations of TN than there was for DO. About half of modeled surface concentrations of TN were very close to the observed values while the other half were less than the observed values. For bottom concentrations, about half of the values were very close to the model concentrations while the other half was split between being under and over predicted by the model. The AME and RMS values calculated for TN were 0.15 and 0.19 compared to an overall average concentration of 0.55 mg/L. The largest discrepancies between modeled and observed values were due to overprediction of TN concentrations in bottom samples.

Vertical profiles of measured and simulated TP concentrations for each of the four mainstem stations and each sampling date are shown on Figures 29 through 75. In general, the model tended to over predict TP concentrations especially in the bottom samples. Modeled values of surface concentrations were either very close to or higher than the observed value. The AME and RMS values calculated for TP were 0.029 and 0.035 compared to an overall average concentration of 0.043 mg/L. The largest discrepancies were due to overprediction of bottom concentrations.

Vertical profiles of measured and simulated chlorophyll *a* concentrations for each of the four mainstem stations and each sampling date are shown on Figures 76 through 99. There was considerable variation in chlorophyll *a* concentrations throughout the sampling period. For most of the sampling days and locations, the model concentrations were very close to or higher than the observed values. On a few occasions, the modeled concentrations were significantly less than the observed concentration. The AME and RMS values calculated for chlorophyll *a* were 5.5 and 5.1 compared to an overall average concentration of 15.1 μg/L.

The lack of rain during 2007 produced lower inflows and lake levels than in previous years. There was some concern that the model might not be able to accurately predict water quality under these conditions because were significantly different than the conditions used for model calibration. A comparison of model simulations to sampling data showed that the model performed reasonably well during these unusual conditions. DO concentrations were very well simulated by the model. The AME and RMS values were reasonable for TN, TP and chlorophyll *a* especially considering that the largest differences between observed and simulated values occurred when the model over predicted concentrations particularly in bottom samples. The tendency to over predict, rather than under predict, concentrations provides assurance that the model can be a useful tool to examine future conditions and make planning decisions. Relative differences between scenarios are probably more accurate that absolute differences for all constituents.

5. Cases Simulated for Alternative Speculative Limits

5.1 Cases Simulated

The March 2008 Water Quality Modeling report included results of modeling 14 different scenarios representing four existing and ten potential future conditions. These conditions included both permit limit conditions and normal operating conditions, flows of 17 mgd and 25 mgd and low and average flow years (2002 and 1998, respectively). All future conditions assumed that the new regional facility would be operating with permit limits of TN = 6.0 mg/L and TP = 1.0 mg/L. At the request of DENR additional modeling was conducted to examine the effects of alternative speculative limits of TN = 3.5 mg/L and TP = 0.5 mg/L.

To investigate this alternative set of speculative limits an additional five future scenarios were simulated. The existing conditions did not change but results are still included in the outputs for comparisons. The five new future scenarios are described in Table 5.1. The only changes made to these scenarios was the effluent quality from the new regional plant all other inputs for flows and quality remained the same as previous model runs with the same name.

The procedure to calculate the data set for normal operating conditions was fully described in the March 2008 report. This condition simulates the types of variations in effluent discharge typical for this type of facility. Using data from the McDowell WWTP a set of daily effluent data was simulated that represents the largest load that the plant could discharge without violating the permit while still experiencing variations in effluent flow and quality. In contrast, under permit limit conditions, it is assumed that WWTPs discharge at the same flow and effluent quality every day.

The March 2008 report also described the adjustments made to the Belmont effluent quality for future conditions. The Belmont WWTP does not have permit limits for nutrients. At present, this facility discharges TP in concentrations that are significantly higher that domestic wastewater. For the future permit limits for this facility it was assumed that an increase in flow from the actual existing flow up to the permitted flow would have a TP concentration typical of domestic wastewater.

5.2 Model Outputs

For each scenario simulated, the model outputs include estimated concentrations of each parameter at one meter depth intervals in each segment and for each day of the year. To summarize the model results and provide a method to compare scenarios, three types of plots were produced to graphically present the results of the modeling. These included vertical profiles, time series plots and contour plots of DO, TP, TN, and chlorophyll *a*. Vertical profiles illustrate how these parameters change with depth in the water column. The vertical profiles are shown at selected locations and for three days during the year to highlight seasonal and spatial differences. Time series plots were produced to show how concentrations at one location changed throughout the year. Time series plots were produced at several elevations and for several segments. Contour plots show a longitudinal and vertical slice through the lake. These were produced for three days for each scenario and for the four parameters. The additional graphical outputs produced for this study are listed in Table 5.2. Selected graphs are included at the end of this report. However, all of the outputs were presented in electronic format to NC DWQ staff in the Modeling and TMDL Unit.

Table 5.1 Lake Wylie Model – Case Descriptions

Case ID	Case Description	Discharge Inputs				Lake Inputs	
		Belmont		Long Creek			
		Flow	Quality	Flow	Quality	Flow	Quality
FN252002_v2	Future Normal Operations, 25 MGD	2006 measured	2006 measured	varies, typical for 25 MGD limit	Based on other WWTP, consistent with limits of TN = 3.5, TP = 0.5, BOD = 6	2002 flow	2002 quality
FP252002_v2	Future at Permit Limits with Belmont at Existing Loads	2006 measured	2006 measured	25 MGD	TN = 3.5, TP = 0.5, BOD = 6	2002 flow	2002 quality
FP251998_v2		2006 measured	2006 measured	25 MGD	TN = 3.5, TP = 0.5, BOD = 6	1998 flow	1998 quality
FP252002 Bel_v2	Future at Permit Limits with Belmont at Permit Limits	5 MGD	2006 adjusted	25 MGD	TN = 3.5, TP = 0.5, BOD = 6	2002 flow	2002 quality
FP251998 Bel_v2		5 MGD	2006 adjusted	25 MGD	TN = 3.5, TP = 0.5, BOD = 6	1998 flow	1998 quality

Table 5.2 Lake Wylie Model Graphical Outputs

Vertical Profiles

Segment	Locations	Parameters	Dates (Julian day)
3	DS WWTP	DO, TP, TN, Chla	141, 228, 269
4		DO, TP, TN, Chla	141, 228, 269
5		DO, TP, TN, Chla	141, 228, 269
6	Belmont	DO, TP, TN, Chla	141, 228, 269
7		DO, TP, TN, Chla	141, 228, 269
8		DO, TP, TN, Chla	141, 228, 269
9		DO, TP, TN, Chla	141, 228, 269
10		DO, TP, TN, Chla	141, 228, 269
11	US S. Fork	DO, TP, TN, Chla	141, 228, 269
13	DS S. Fork	DO, TP, TN, Chla	141, 228, 269
30	Dam	DO, TP, TN, Chla	141, 228, 269

Time Series

Segment	Locations	Parameters	Layers	Elevation
3	DS WWTP	DO, TP, TN, Chla	2, 3,4,5,9	173,172,171,170, 166
4		DO, TP, TN, Chla	2, 3,4,5,9	173,172,171,170, 166
5		DO, TP, TN, Chla	2, 3,4,5,9	173,172,171,170, 166
6	Belmont	DO, TP, TN, Chla	2, 3,4,5,9	173,172,171,170, 166
7		DO, TP, TN, Chla	2, 3,4,5,9	173,172,171,170, 166
8		DO, TP, TN, Chla	2, 3,4,5,9	173,172,171,170, 166
9		DO, TP, TN, Chla	2, 3,4,5,9	173,172,171,170, 166
10		DO, TP, TN, Chla	2, 3,4,5,10	173,172,171,170, 165
11	US S. Fork	DO, TP, TN, Chla	2, 3,4,5,11	173,172,171,170, 164
13	DS S. Fork	DO, TP, TN, Chla	2, 3,4,5,11	173,172,171,170, 164
30	Dam	DO, TP, TN, Chla	2, 3,4,5,11,17	173,172,171,170, 164,158

Contour Plots

Parameters	Dates
DO, TP, TN, Chla	141, 228, 269

Groups - for vertical and time series plots

Normal Operating Conditions

EM2002, FN252002_v2

Permit Conditions

EPMHB2002, FP252002_v2, FP252002Bel_v2
EPMHB1998, FP251998_v2, FP251998Bel_v2

Segment 3 includes the discharge for the Mt Holly/Long Creek WWTP
Segment 6 is where Belmont WWTF is located
Segment 11 is upstream of the South Fork Branch
Segment 13 is downstream of the South Fork Branch
Segment 30 is in the downstream portion of Lake Wylie

6. Water Quality Impacts

The five additional future scenarios presented in this report represent an alternative set of speculative limits to those previously modeled. These scenarios were arranged into four groups for comparison, including normal operating conditions at low and average river flows and permit limit conditions at low and average river flows. Results of the CE-QUAL-W2 model were extracted from the output files and plotted using Excel. Over one thousand plots were generated as listed in Section 5. Selected plots (Figures 100 through 147) are included at the end of this report for discussion. The discussion below focuses on the permit limits condition because that is considered by DWQ to be the critical condition.

Vertical profiles of DO, TP, TN and chlorophyll *a* are presented at 2 to 4 important locations and for two days (August 16, 2002 and August 16, 1998). Time series plots are also presented at these same 2 to 4 important locations at one elevation. Time series for DO are presented at an elevation of 166 or 164 because this elevation is close to the thermocline and represents the location where low DO concentrations are typically experienced. Time series plots for TP, TN and chlorophyll *a* are presented at an elevation of 170 which is close to the surface. No contour plots are presented in this report but were included in the electronic files transmitted with the report.

The discussion below focuses primarily on the differences in the model runs as a result of lowering speculative limits from 6.0 to 3.5 mg/L for TN and from 1.0 to 0.5 mg/L for TP.

6.1 Dissolved Oxygen

Vertical and time series plots of DO concentrations are shown on Figures 100 to 103 and 112 to 115 for a low flow year and on Figures 124 to 127 and 136 to 139 for an average flow year. Lower nutrient loads could affect DO concentrations by reducing nitrogenous BOD and algae. A decrease in algae production could also reduce oxygen inputs and depletion through algae photosynthesis and respiration. However, simulations for the two sets of speculative limits indicate virtually no difference in expected DO concentrations. For example, a comparison of the time series plots for segment 30, in the downstream portion of the lake, and at an elevation of 166 m indicates that the largest difference for any day during a low flow year was 0.2 mg/L while the average difference was 0.03 mg/L.

6.2 Total Phosphorus and Total Nitrogen

Vertical and time series plots of TP concentrations are shown on Figures 104 to 105 and 116 to 119 for a low flow year and on Figures 128 to 129 and 140 to 143 for an average flow year. Vertical and time series plots of TN concentrations are shown on Figures 106 to 107 and 120 to 121 for a low flow year and on Figures 130 to 131 and 144 to 145 for an average flow year. Lower permit limits for nutrients would produce decreases in TN and TP concentrations especially near the point of discharge. In the segment downstream of the proposed discharge concentrations of TP and TN would be reduced by about 32 percent and 20 percent, respectively with the lower limits. However, in the downstream portion of the lake there is virtually no difference is expected concentrations when comparing the two sets of permit limits.

6.3 Chlorophyll *a*

Typically, chlorophyll *a* concentrations would be reduced with a decrease in nutrient loads. Vertical and time series plots of chlorophyll *a* concentrations are shown on Figures 108 to 111 and 122 to 123 for a low flow year and on Figures 132 to 135 and 146 to 147 for an average flow year. Chlorophyll *a* concentrations were very low in the upper portion of the reservoir and generally increase in a downstream direction under both existing and future conditions scenarios. However, the model results show that any differences in chlorophyll *a* concentrations between the two sets of limits would be small. Using the initial set of permit limits, model results showed that future concentrations would be only slightly higher than the existing condition. Using the second set of limits, model results indicate that future chlorophyll *a* concentrations would be lower than the existing conditions. In all cases the predicted chlorophyll *a* concentrations were well below the water quality criteria of 40 μg/L.

7. Flow and Nutrient Contributions

The contributions of flow and nutrient loads were calculated for the existing and future scenarios for flow conditions represented by 1998 and 2002. That information was presented in the March 2008 report for the first set of speculative limits. Load calculations were also made for the second set of speculative limits. Information for both sets of limits is presented in this section. The major contributors included:

- Mountain Island Lake
- South Fork Branch,
- Crowder's Creek,
- Dutchman's Creek and Long Creek (which are combined in a single input in the model),
- Mount Holly WWTP (existing) or Regional Long Creek WWTP (future),
- Belmont WWTP
- Combination of all other inflows, including distributed flows.

For purposes of this analysis inflows from the power plants were not included in the load calculations. The specific scenarios compared were the existing conditions assuming that WWTPs were operating at their permit limits (EPMHB2002) and the future scenarios assuming a new Regional Long Creek WWTP with a discharge of 25 mgd (FP252002Bel and FP252002Bel_v2). Two sets of permit limits were examined. The initial set of limits assumed that TP and TN for the new regional facility were 1 mg/L and 6 mg/L, respectively. The second set of limits assumed that TP and TN for the new facility were 0.5 mg/L and 3.5 mg/L, respectively. In the future scenarios, the Belmont plant was assumed to be operating at the current permit limits.

The contributions of flow from the major inputs to Lake Wylie are shown in Figure 148. Even in a dry year, the combined flows from Mountain Island Lake and the South Fork Branch were estimated to contribute over 80 percent of the flows to the lake.

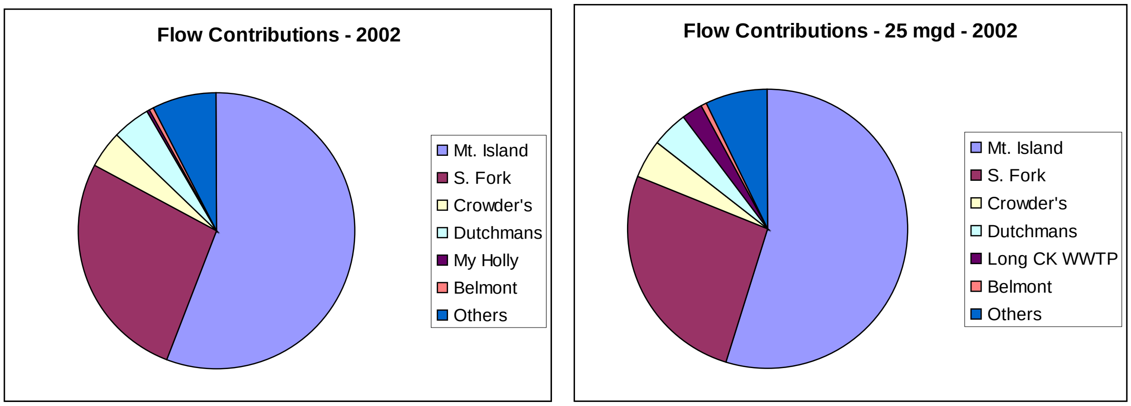


Figure 148. Comparison of Flow Contributions for Existing and Future Scenarios

Contributions of TP and TN for the existing condition scenario are shown on Figure 149. Contributions of TP and TN for the first and second sets of permit limits are shown on Figures 150 and 151, respectively. Even though Mountain Island Lake was estimated to contribute more than half of the flow it was estimated that this source would contribute less than 15 percent of the TP and about 20 percent of the TN under existing and future conditions.

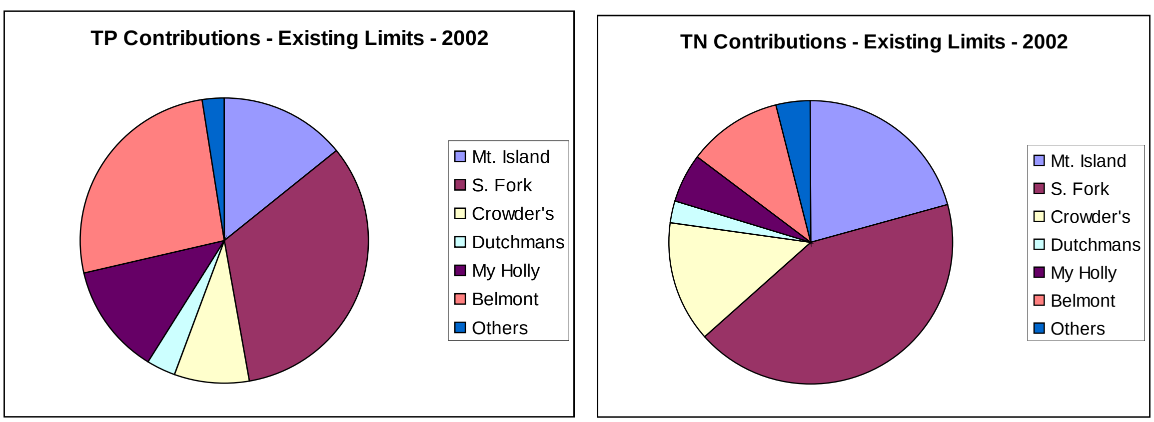


Figure 149. Contributions of TP and TN for the Existing Scenario

The largest source of nutrients for both the existing and future cases was estimated to be the South Fork Branch. The Belmont WWTP was estimated to contribute about 26 percent of the TP loads under existing permit conditions; about double the load contributed by the

Mount Holly WWTP. Using the first set of permit limits, the new Regional Long Creek WWTP could contribute a slightly higher load of TP than the Belmont WWTP although the flow would be five times greater. Using the second set of permit limits, the regional Long Creek WWTP would contribute about 14 percent of the TP load which is slightly higher than the load from the Mount Holly WWTP under the existing condition. The Long Creek WWTP would contribute 15 percent and 9 percent of the TN load under the first and second sets of limits, respectively.

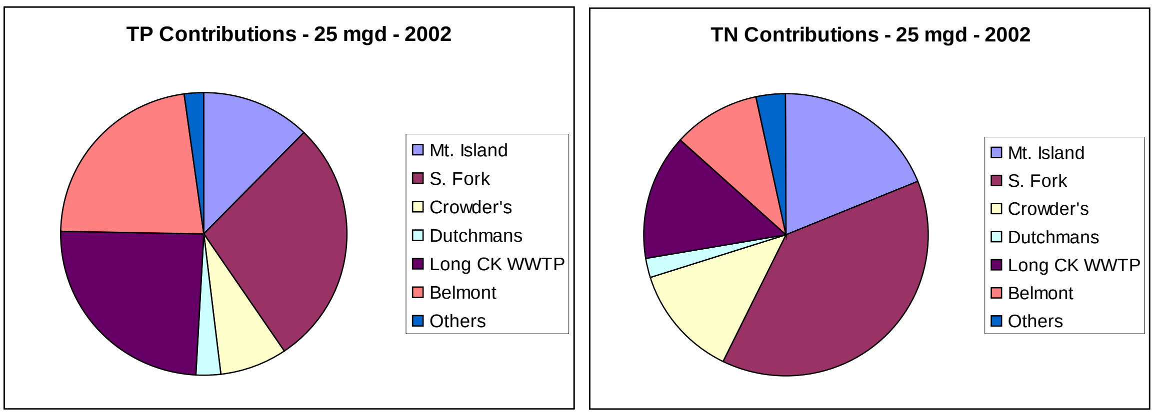


Figure 150. Contributions of TP and TN for the Regional WWTP assuming TN=6mg/L and TP=1mg/L

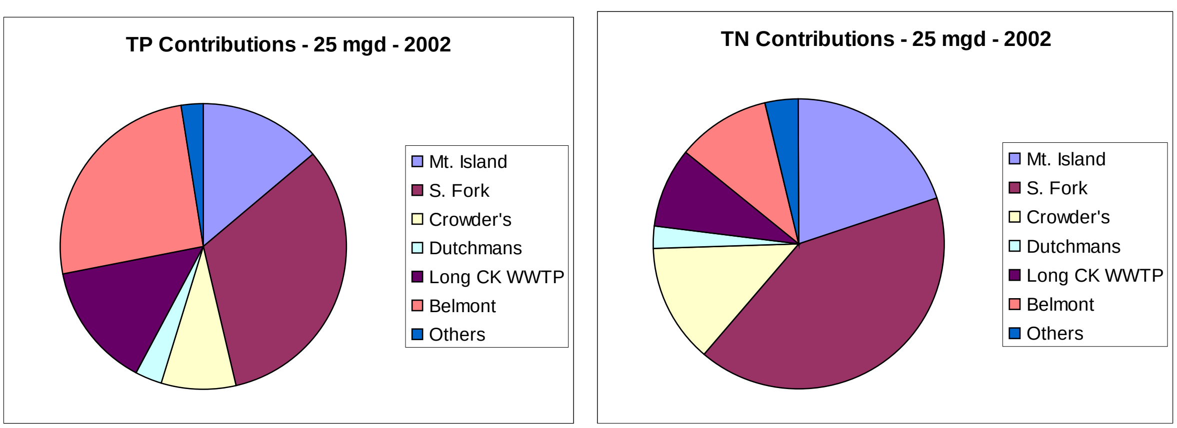


Figure 151. Contributions of TP and TN for the Regional WWTP assuming TN=3.5mg/L and TP=0.5mg/L

8. Findings and Conclusions

As part of the evaluation of environmental impacts, a water quality modeling study of Lake Wylie was conducted to evaluate the potential impacts that increased wastewater discharge would have on the lake. Results of the initial modeling were submitted to DWQ in March 2008 (Black & Veatch 2008). After initial review of that report DWQ had some additional questions and requests for information which are addressed in this report.

Conclusions about the original calibration of the model are:

- The original calibration indicated that the Lake Wylie model was well calibrated for lake elevation, temperature and DO, especially during the period from March through October.
- Phosphorus and chlorophyll a were well calibrated throughout the lake except in the water near the sediments in the forebay.
- The model was well calibrated for inorganic nitrogen showed good agreement in the surface waters. The model tended to under predict inorganic nitrogen during summer months.

The results of the 2007 simulations indicated the following:

- In general, the model tended to under predict the concentration of DO. The largest discrepancies occurred at times when the model predicted that bottom waters were depleted of DO when observed values indicated that DO values were significantly higher. Statistical measures of errors were similar to those for the original calibration of the model.
- The AME and RMS values were reasonable for TN, TP and chlorophyll *a* especially considering that the largest differences between observed and simulated values occurred when the model over predicted concentrations particularly in bottom samples.

- The tendency to over predict, rather than under predict, concentrations provides assurance that the model can be a useful tool to examine future conditions and make planning decisions.

Results of additional modeling using an alternative set of speculative limits indicated the following conditions would occur:

- Dissolved oxygen concentrations under the future scenario of a new WWTP would not vary greatly from existing conditions. Simulations for the two sets of speculative limits indicate virtually no difference in expected DO concentrations
- Predicted TP concentrations would be higher in the upper reaches of the lake under the future condition with a new WWTP discharge. There were virtually no differences in TP concentrations between existing and future conditions in the lower section of the lake.
- The lower permit limits scenario for TP (0.5 mg/L instead of 1.0 mg/L) would produce a decrease in TP concentrations about 32 percent in the segment downstream of the discharge. However, in the lower portion of the lake there is virtually no difference is expected concentrations when comparing the two sets of permit limits.
- Predicted TP concentrations in the South Carolina portion of the lake would be below the instream water quality criteria of 0.06 mg/L throughout the average flow year. However, during a dry flow year, under all existing and future conditions, it was estimated that the TP criteria would be exceeded for a few days early in the year.
- Predicted TN concentrations would be higher in the upper reaches of the lake under the future conditions scenario. There were virtually no differences in TN concentrations between existing and future conditions in the lower section of the lake.
- The lower permit limits scenario for TN (3.5 mg/L instead of 6.0 mg/L) would produce a decrease in TN concentrations of about 20 percent in the segment downstream of the discharge. However, in the lower portion of the lake there is virtually no difference is expected concentrations when comparing the two sets of permit limits.

- Total nitrogen concentrations in the South Carolina portion of the lake would be below the instream water quality criteria of 1.5 mg/L for all conditions modeled.
- Chlorophyll *a* concentrations were very low in the upper section of the reservoir and generally increase in a downstream direction under both existing and future conditions scenarios
- The model results showed that any differences in chlorophyll *a* concentrations between the two sets of limits would be small.
- In all cases the predicted chlorophyll *a* concentrations were well below the water quality criteria of 40 µg/L.
- The largest source of nutrients for both the existing and future cases was estimated to be the South Fork Branch.
- Using the first set of permit limits, the new Regional Long Creek WWTP could contribute a slightly higher load of TP than the Belmont WWTP although the flow would be five times greater. Using the second set of permit limits, the regional Long Creek WWTP would contribute about 14 percent of the TP load which is slightly higher than the load from the Mount Holly WWTP under the existing condition.
- The Long Creek WWTP would contribute 15 percent and 9 percent of the TN load under the first and second sets of limits, respectively.

Overall, the modeling shows that the effects of the proposed Long Creek Regional WWTP would have minor impacts on water quality in Lake Wylie. Effects would be mostly confined to the upper reaches of the lake. Water quality criteria for TN and chlorophyll *a* would be met under all conditions. Criteria for TP could be exceeded for a few days during a low flow year under both existing and future conditions. Verification of the model using data collected during 2007 showed that the model was well calibrated and could be used as an effective tool for water quality management. Evaluation of a lower set of permit limits indicated that nutrient concentrations in the upper arm of Lake Wylie could be reduced. However, the model results showed that water quality throughout most of the reservoir would be similar under either of the sets of permit limits examined.

9. References

Black & Veatch. 2008. "Water Quality Modeling Report, Long Creek Regional Wastewater Treatment Plant". Prepared for Charlotte-Mecklenburg Utilities and City of Mount Holly, March 2008.

Cole, T. and S. Wells. 2002. "CE-QUAL-W2: A Two-Dimensional, Laterally Averaged, Hydrodynamic and Water Quality Model, Version 3.1 – User Manual" *Instruction Report EL-2002-1*; U.S. Army Engineering and research Development Center, Vicksburg, MS.

Ruane, R.J. and G.E. Hauser. 2006. "Background document for Catawba-Wateree Water Quality Models". *New License Application to FERC for the Catawba-Wateree Project No. 2232*, Duke Energy, August.

Sawyer, A. and R. J. Ruane. 2006. "Calibration of the CE-QUAL-W2 Model for Lake Wylie". Prepared for Duke Energy. July.

Selected Figures for 2007 Flow
Comparison with Measured Data

Graphs Legend:

Sample – measured profile or data point (composite for surface)

Ck2007 – simulated profile for day of sampling

Ck2007-1 – simulated profile for day prior to sampling

Ck2007-1 – simulated profile for day after sampling

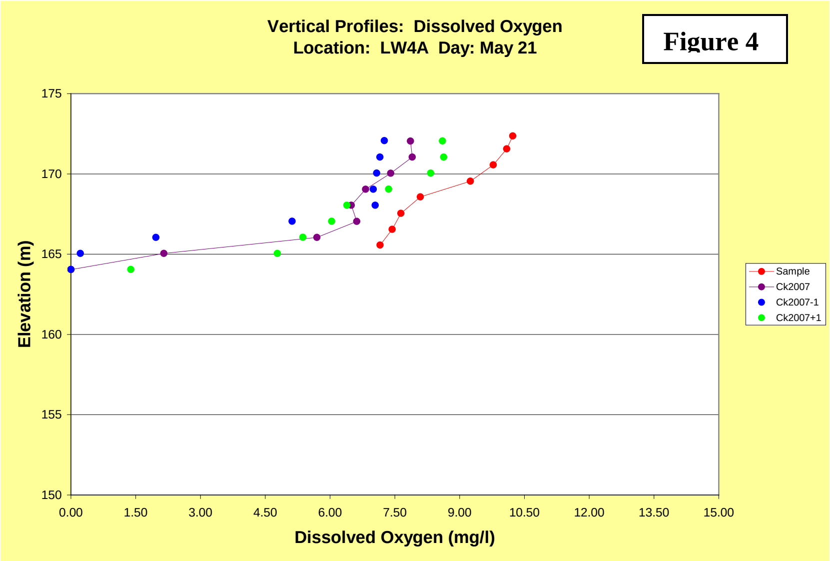
Vertical Plots:

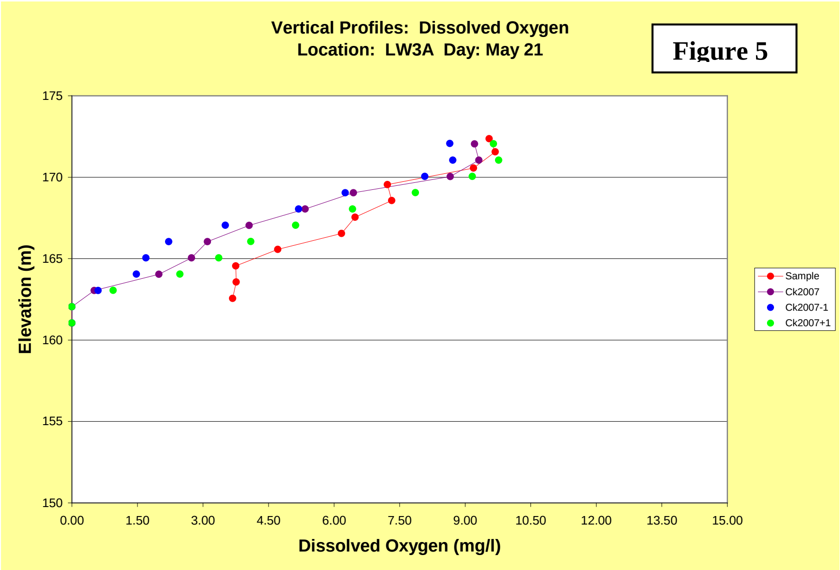
DO, TP, TN and Chlorophyll *a*

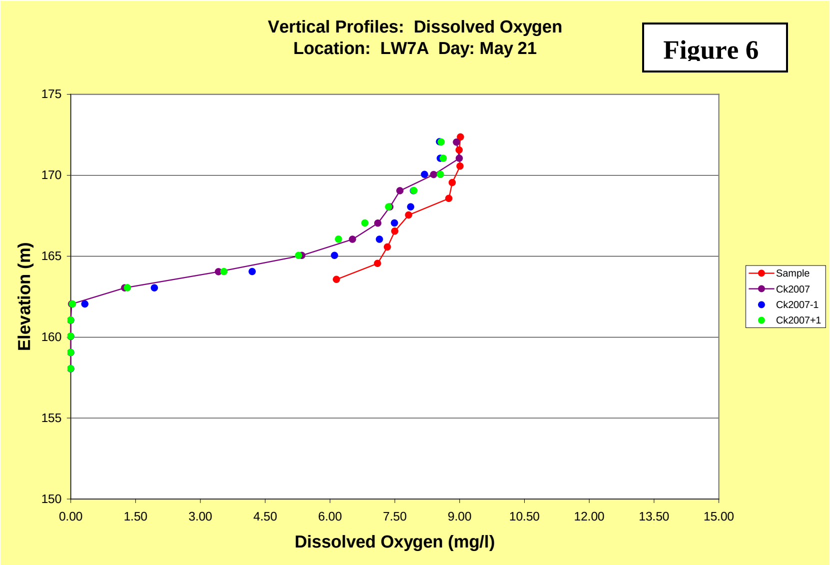
Segments 3, 7, 13 and 30

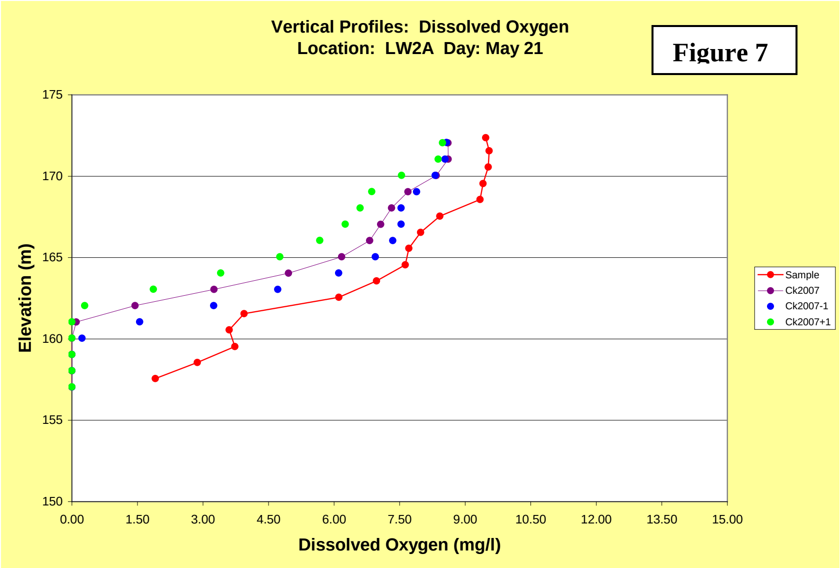
Sampling Dates:

- May 21, 2007
- June 18, 2007
- July 24, 2007
- August 16, 2007
- September 11, 2007
- September 26, 2007


Vertical Profiles: Dissolved Oxygen
Location: LW4A Day: May 21
Figure 4
Elevation (m)
Dissolved Oxygen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1


Vertical Profiles: Dissolved Oxygen
Location: LW3A Day: May 21
Figure 5
Elevation (m)
Dissolved Oxygen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1


Vertical Profiles: Dissolved Oxygen
Location: LW7A Day: May 21
Figure 6
Elevation (m)
Dissolved Oxygen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1


Vertical Profiles: Dissolved Oxygen
Location: LW2A Day: May 21
Figure 7
Elevation (m)
Dissolved Oxygen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

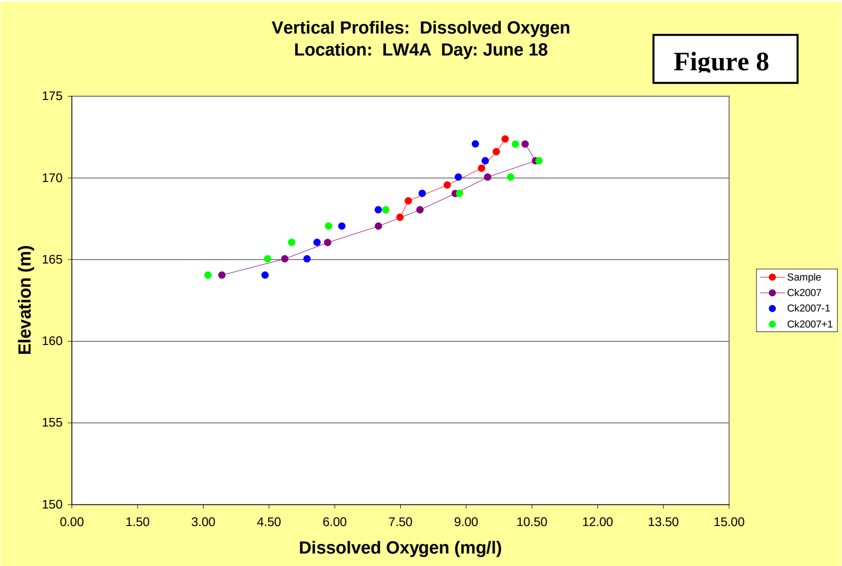


Figure 8

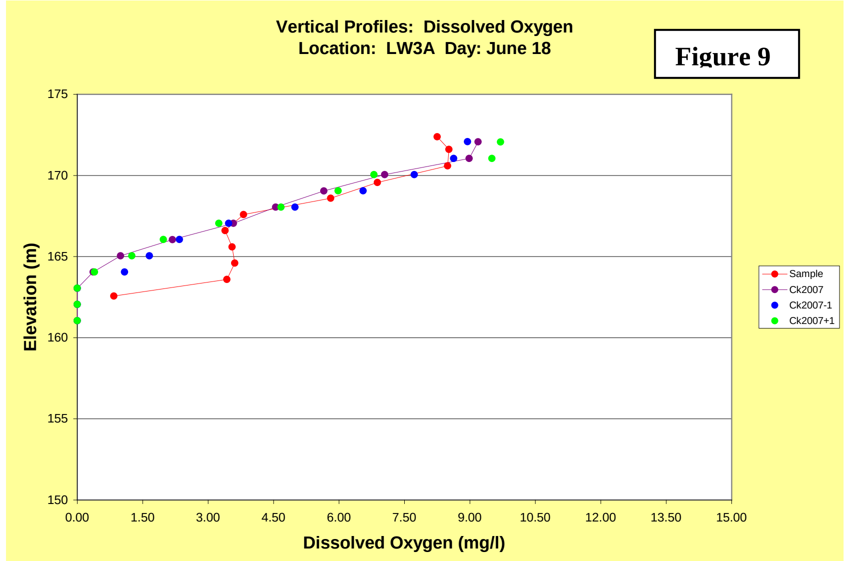


Figure 9

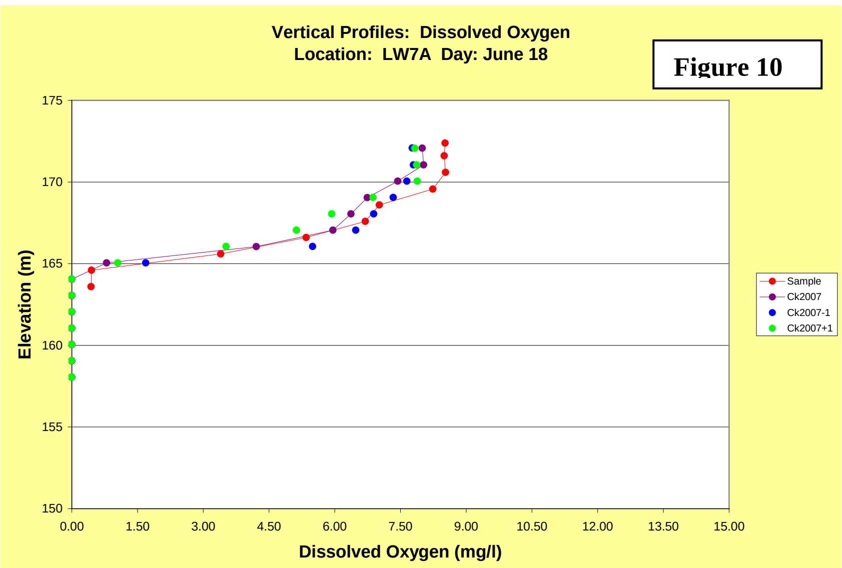


Figure 10

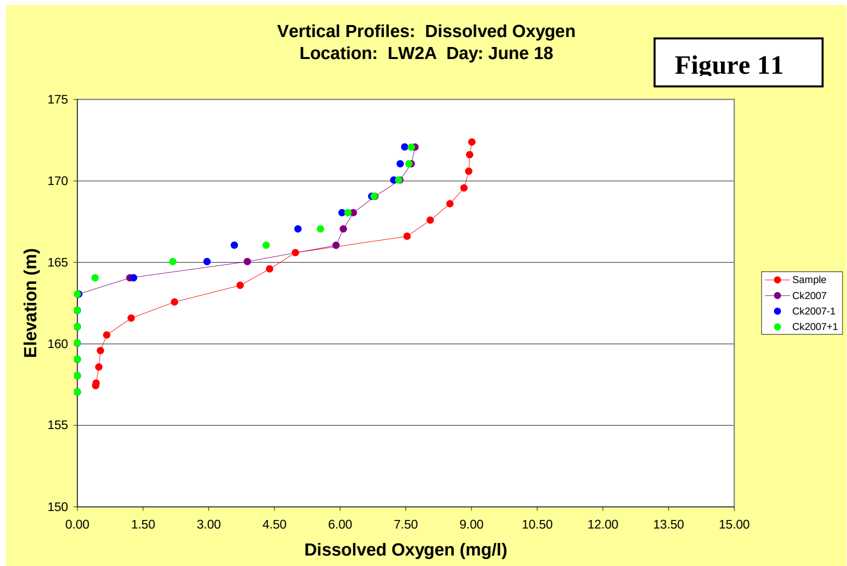
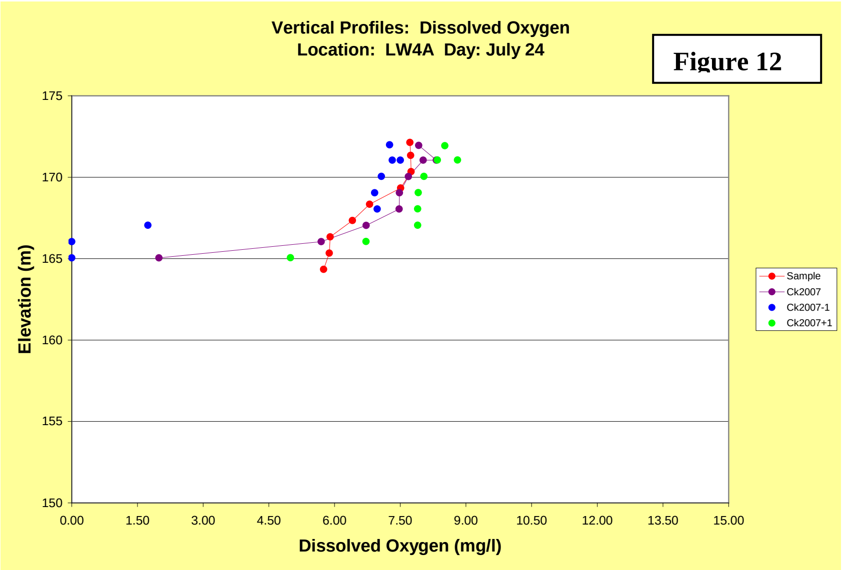
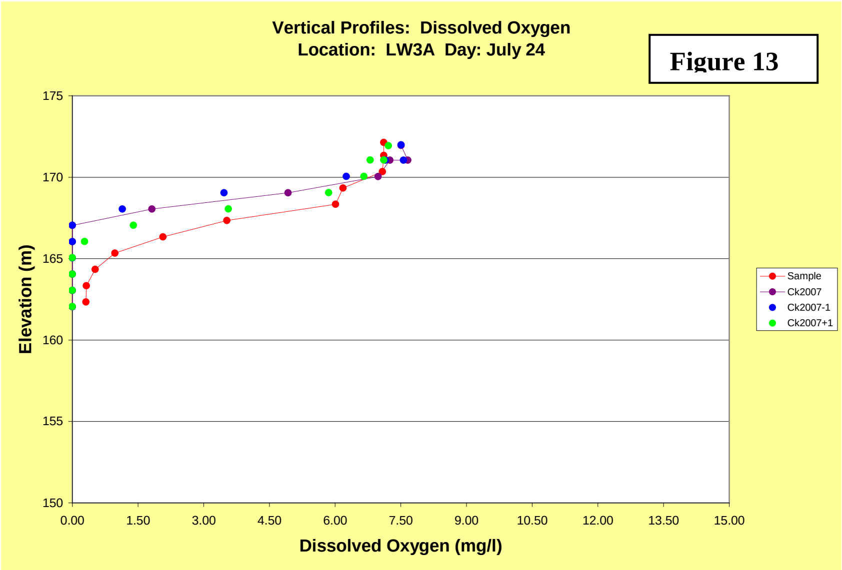
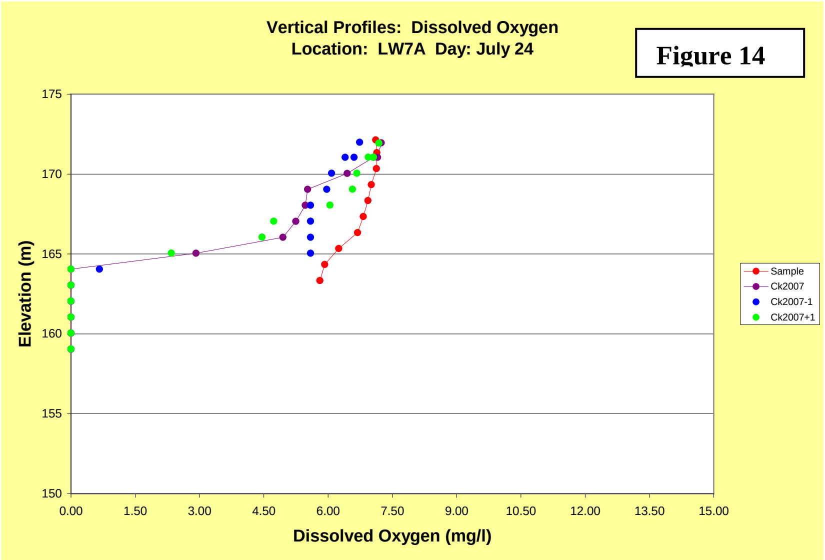
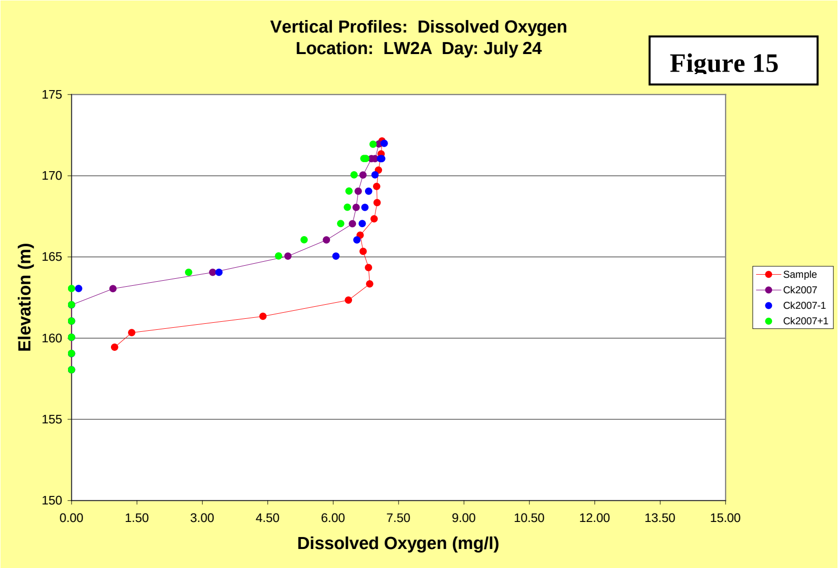


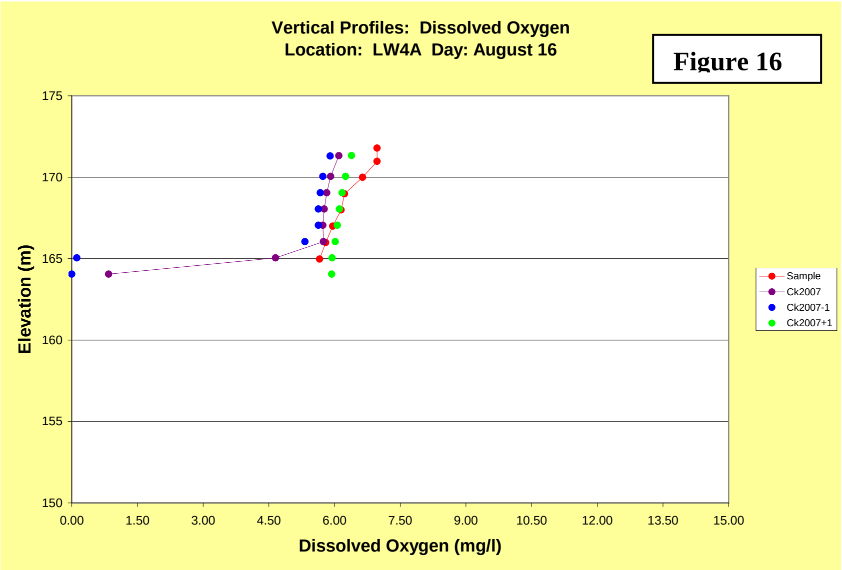
Figure 11

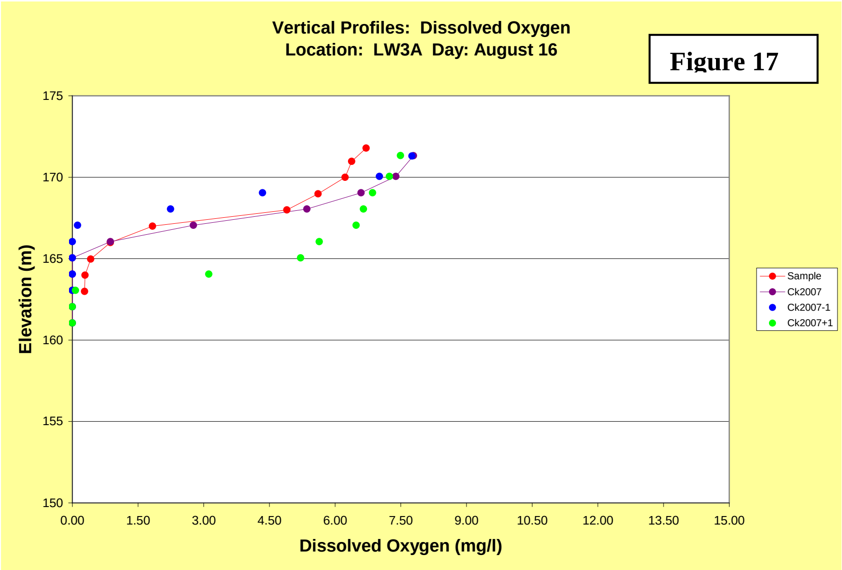

Vertical Profiles: Dissolved Oxygen
Location: LW4A Day: July 24
Figure 12
Elevation (m)
Dissolved Oxygen (mg/l)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Sample
Ck2007
Ck2007-1
Ck2007+1

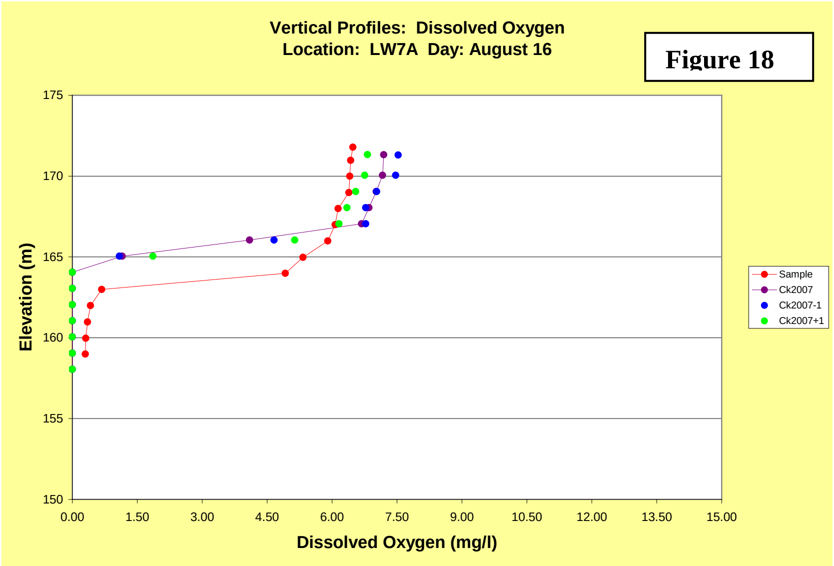

Vertical Profiles: Dissolved Oxygen
Location: LW3A Day: July 24
Figure 13
Elevation (m)
Dissolved Oxygen (mg/l)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Sample
Ck2007
Ck2007-1
Ck2007+1

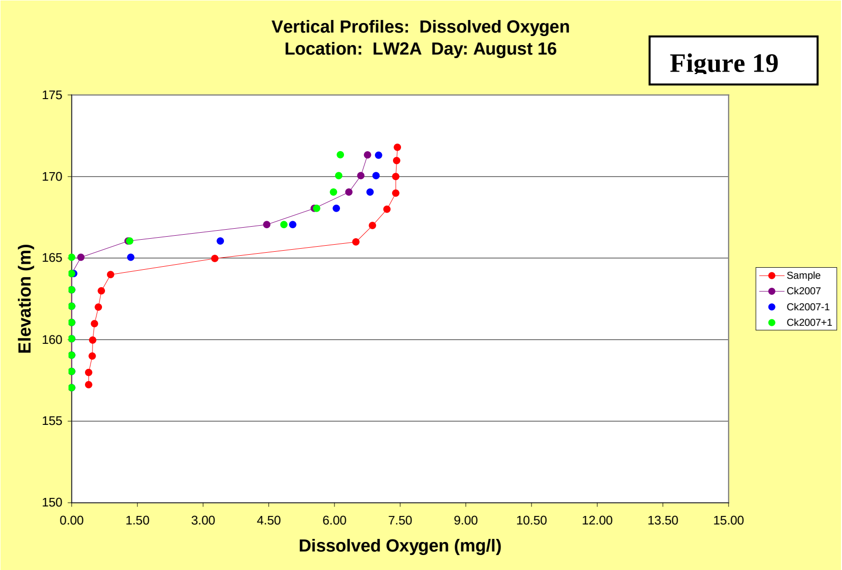

Vertical Profiles: Dissolved Oxygen
Location: LW7A Day: July 24
Figure 14
Elevation (m)
Dissolved Oxygen (mg/l)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Sample
Ck2007
Ck2007-1
Ck2007+1

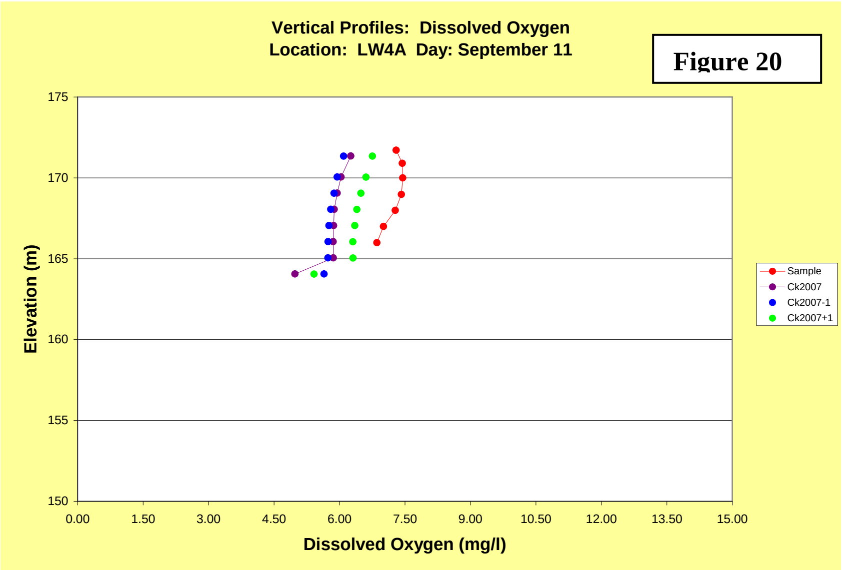

Vertical Profiles: Dissolved Oxygen
Location: LW2A Day: July 24
Figure 15
Elevation (m)
Dissolved Oxygen (mg/l)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Sample
Ck2007
Ck2007-1
Ck2007+1

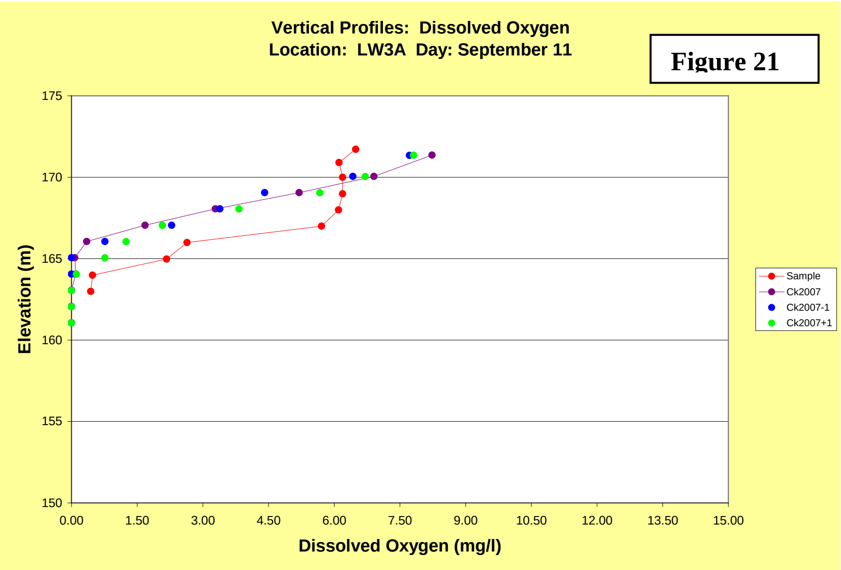

Vertical Profiles: Dissolved Oxygen
Location: LW4A Day: August 16
Figure 16
Elevation (m)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Dissolved Oxygen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

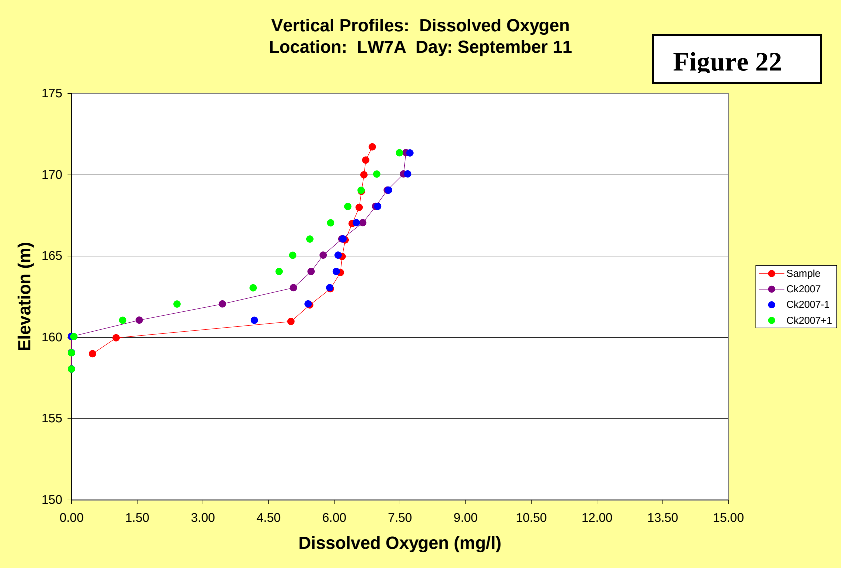

Vertical Profiles: Dissolved Oxygen
Location: LW3A Day: August 16
Figure 17
Elevation (m)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Dissolved Oxygen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

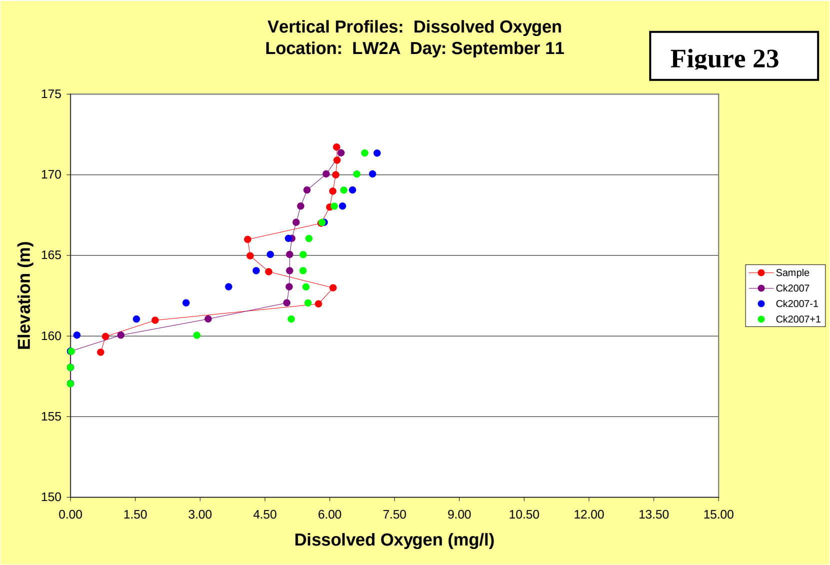

Vertical Profiles: Dissolved Oxygen
Location: LW7A Day: August 16
Figure 18
Elevation (m)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Dissolved Oxygen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1


Vertical Profiles: Dissolved Oxygen
Location: LW2A Day: August 16
Figure 19
Elevation (m)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Dissolved Oxygen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1


Vertical Profiles: Dissolved Oxygen
Location: LW4A Day: September 11
Figure 20
Elevation (m)
Dissolved Oxygen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1


Vertical Profiles: Dissolved Oxygen
Location: LW3A Day: September 11
Figure 21
Elevation (m)
Dissolved Oxygen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1


Vertical Profiles: Dissolved Oxygen
Location: LW7A Day: September 11
Figure 22
Elevation (m)
Dissolved Oxygen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1


Vertical Profiles: Dissolved Oxygen
Location: LW2A Day: September 11
Figure 23
Elevation (m)
Dissolved Oxygen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

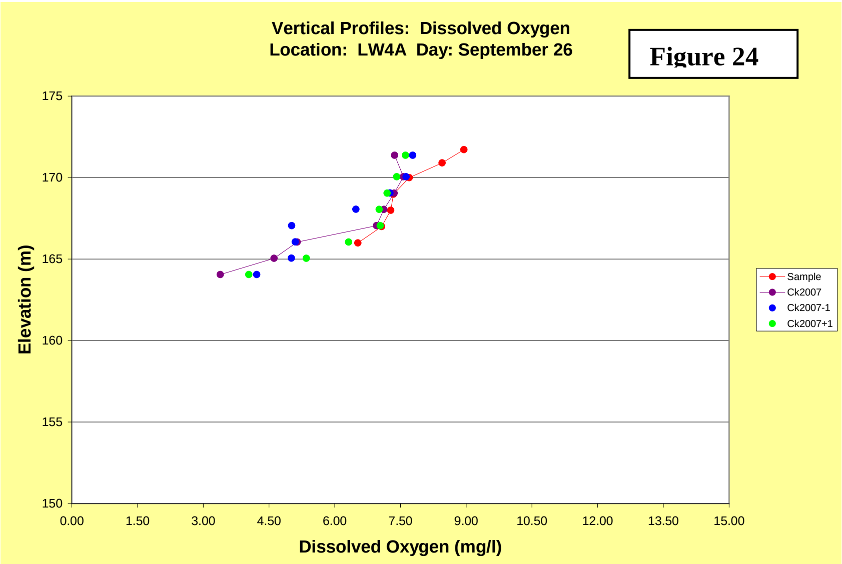


Figure 24

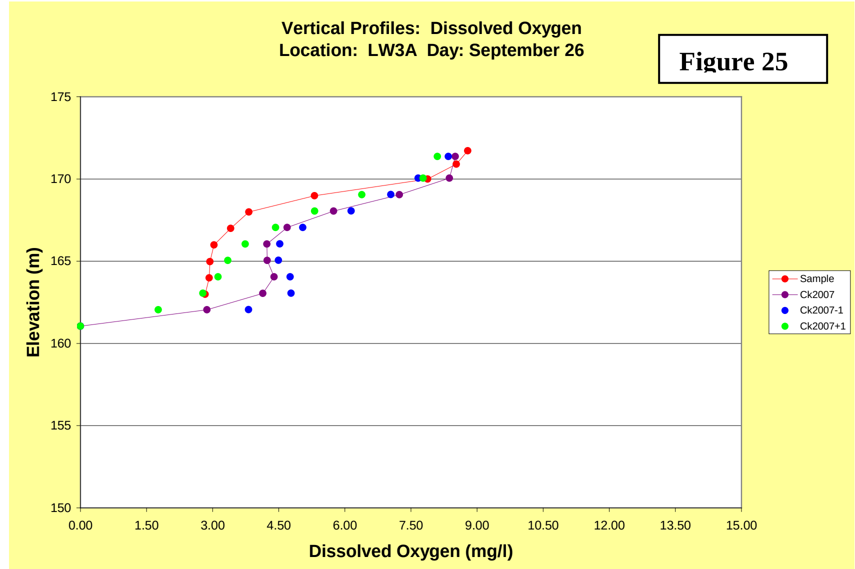


Figure 25

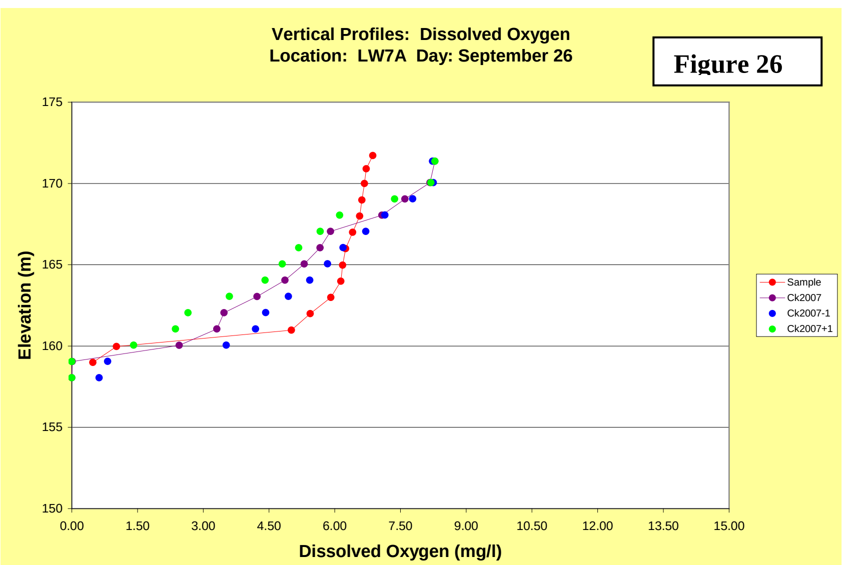


Figure 26

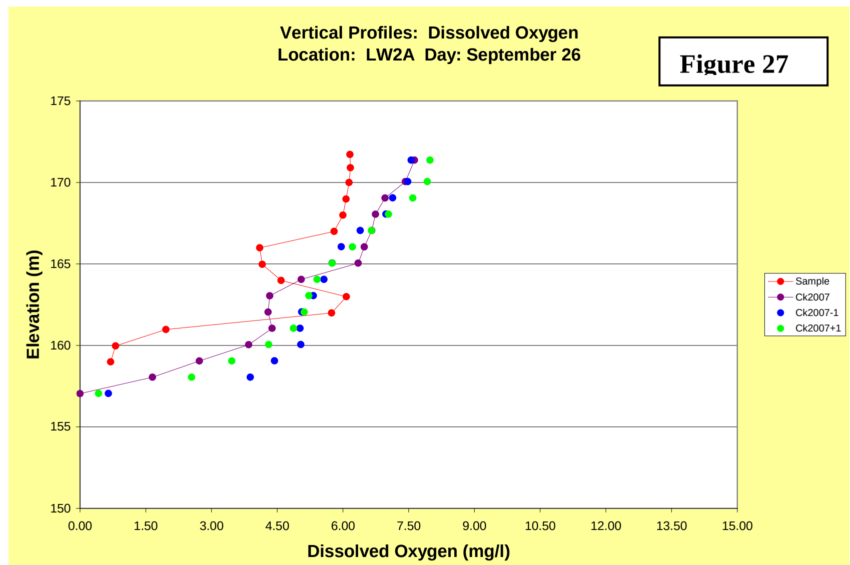
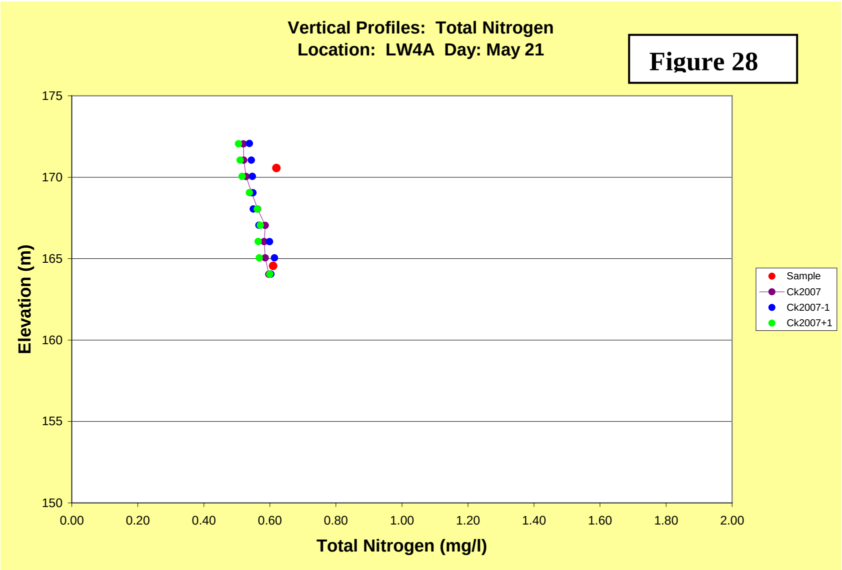
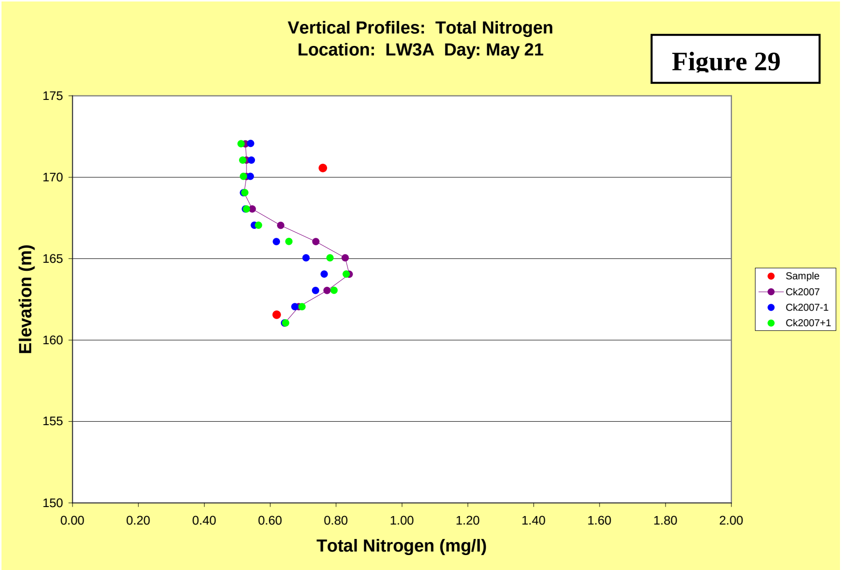
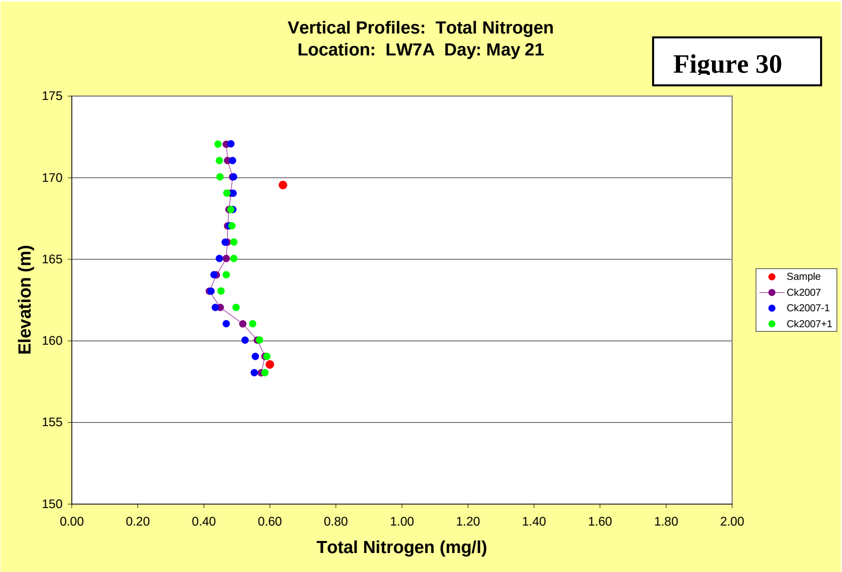


Figure 27


Vertical Profiles: Total Nitrogen
Location: LW4A Day: May 21
Figure 28
Elevation (m)
Total Nitrogen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1


Vertical Profiles: Total Nitrogen
Location: LW3A Day: May 21
Figure 29
Elevation (m)
Total Nitrogen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1


Vertical Profiles: Total Nitrogen
Location: LW7A Day: May 21
Figure 30
Elevation (m)
Total Nitrogen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

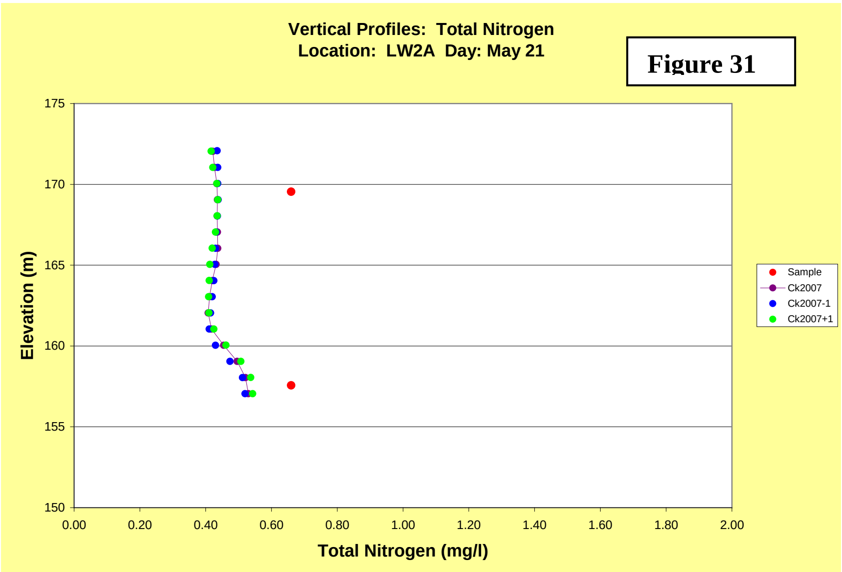

Vertical Profiles: Total Nitrogen
Location: LW2A Day: May 21
Figure 31
Elevation (m)
Total Nitrogen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

Figure 32

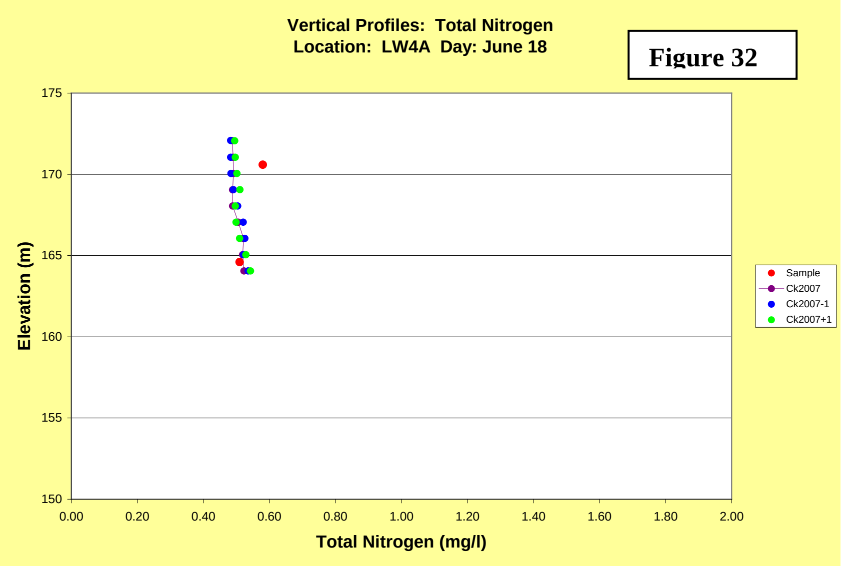


Figure 33

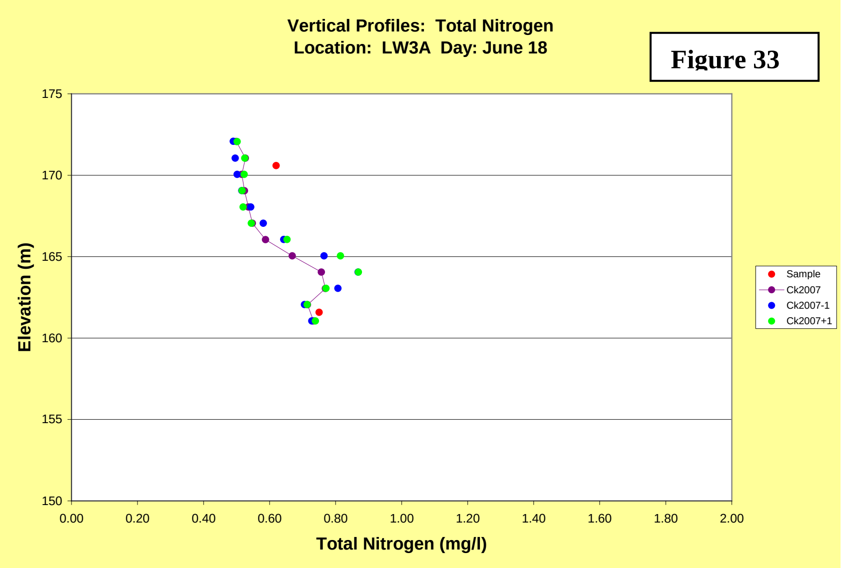


Figure 34

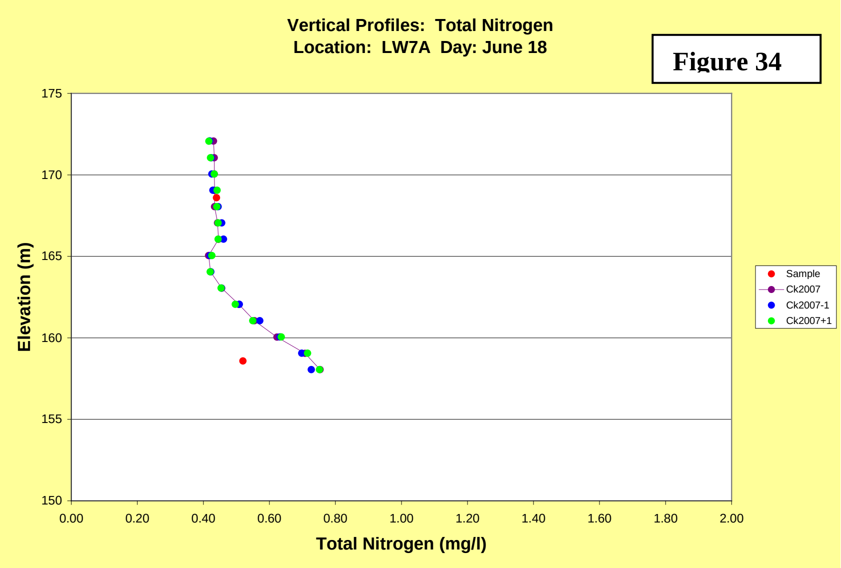
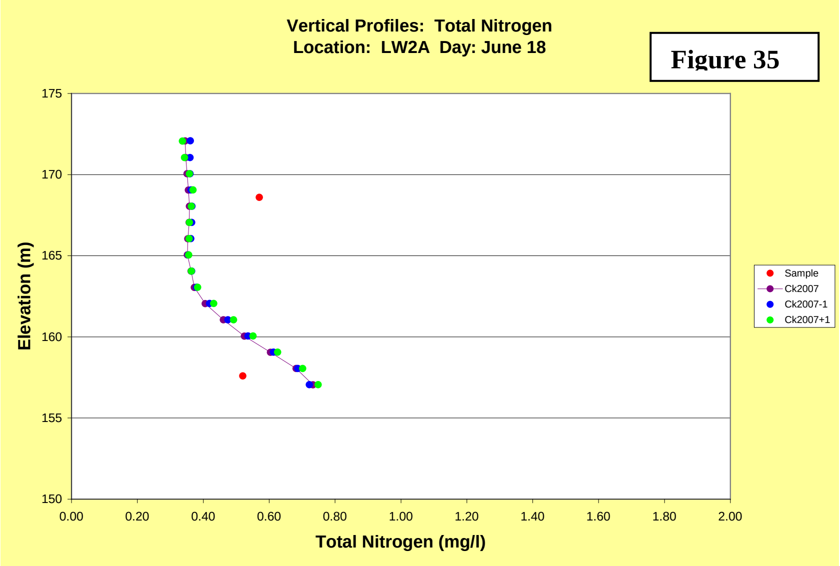


Figure 35



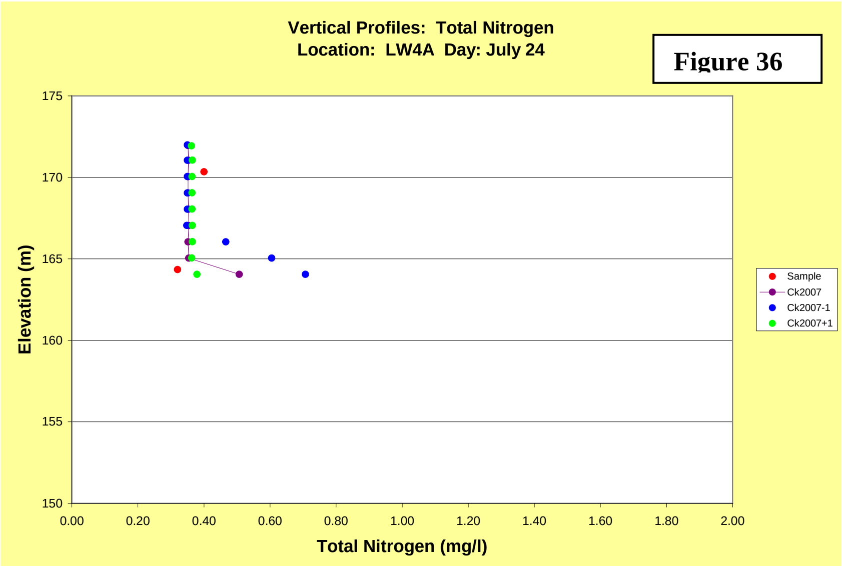


Figure 36

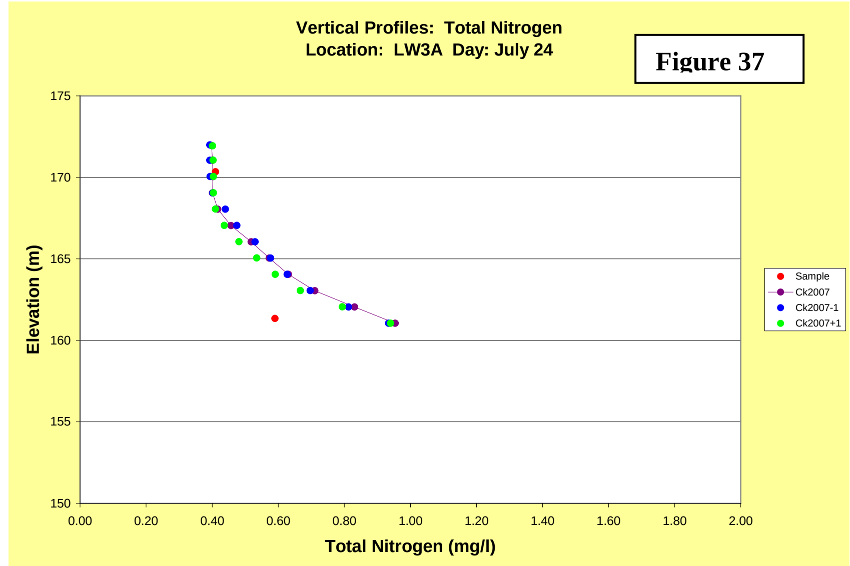


Figure 37

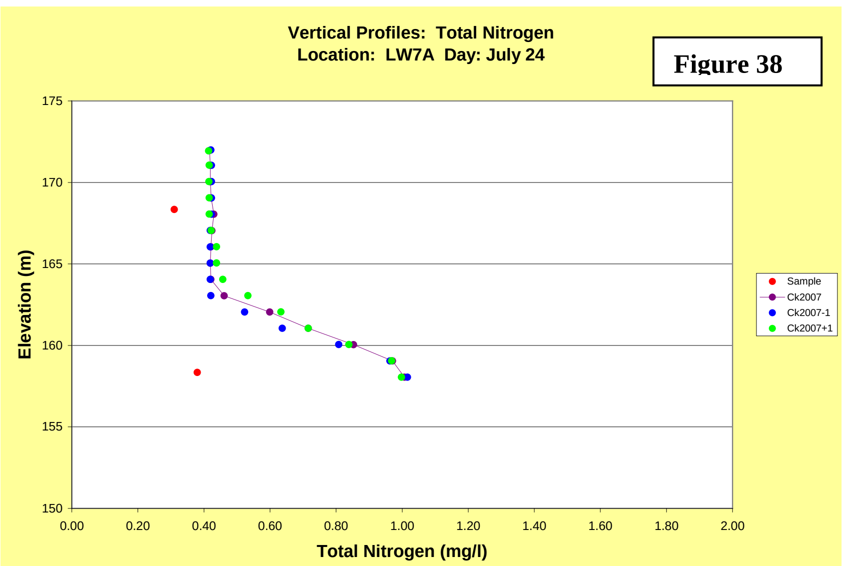


Figure 38

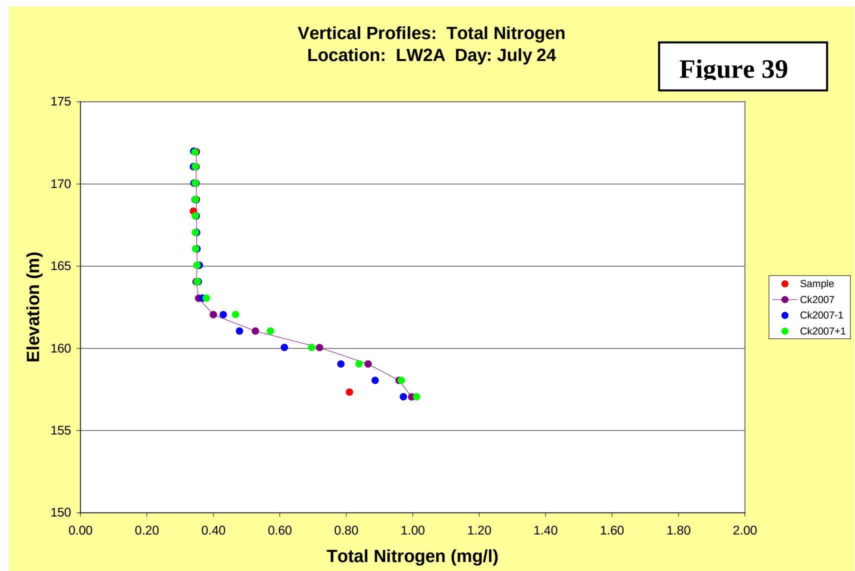
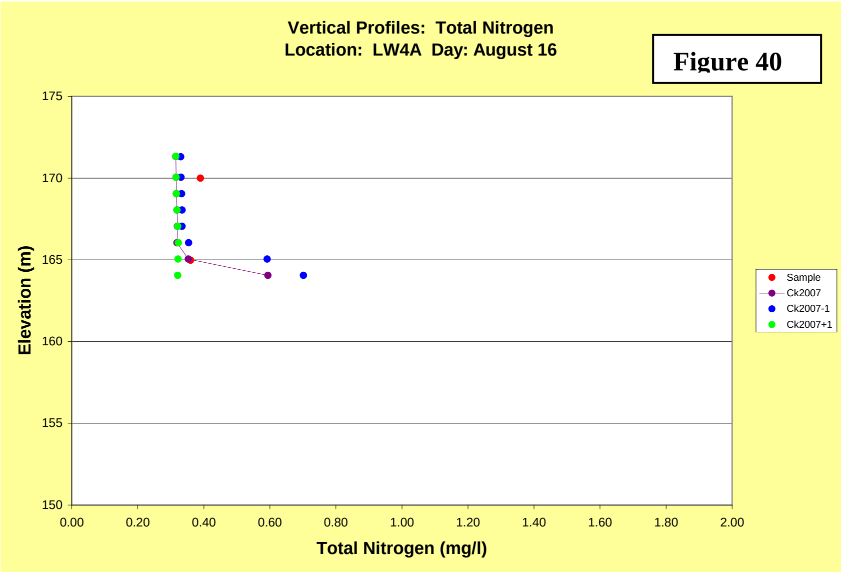
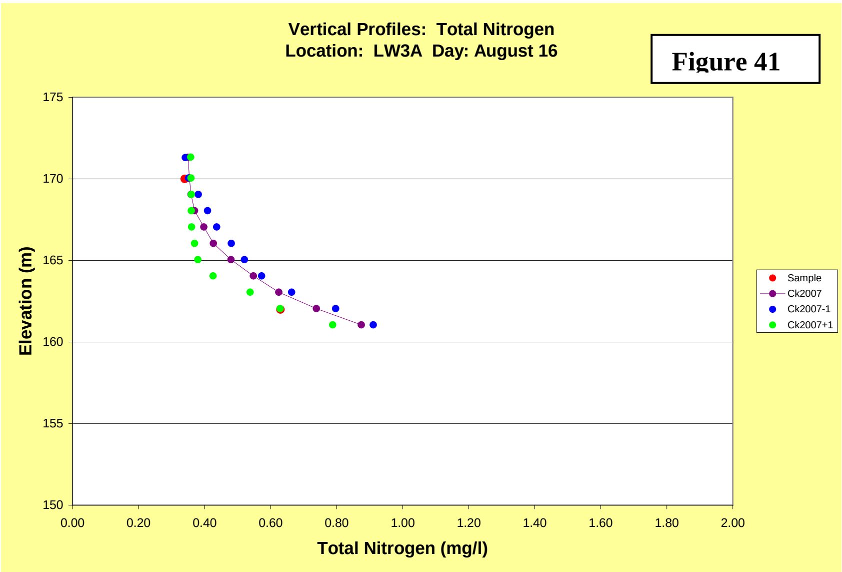
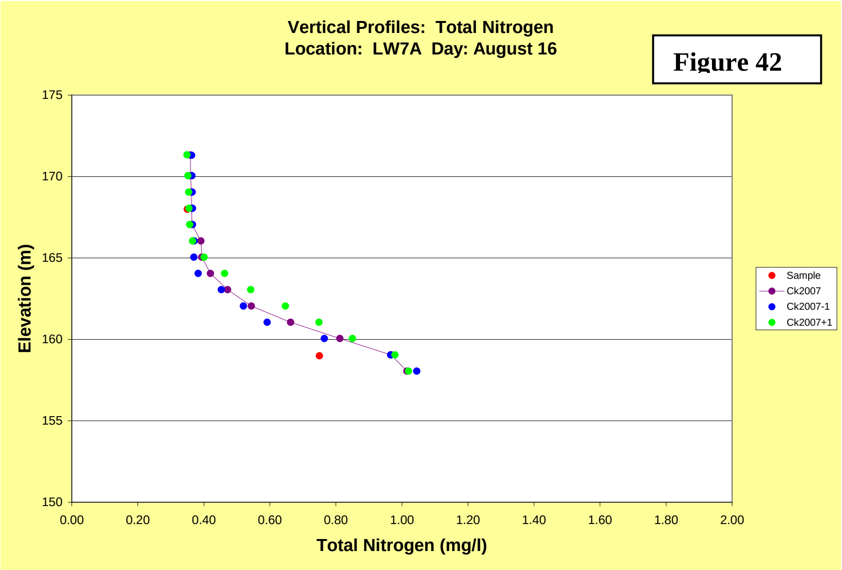
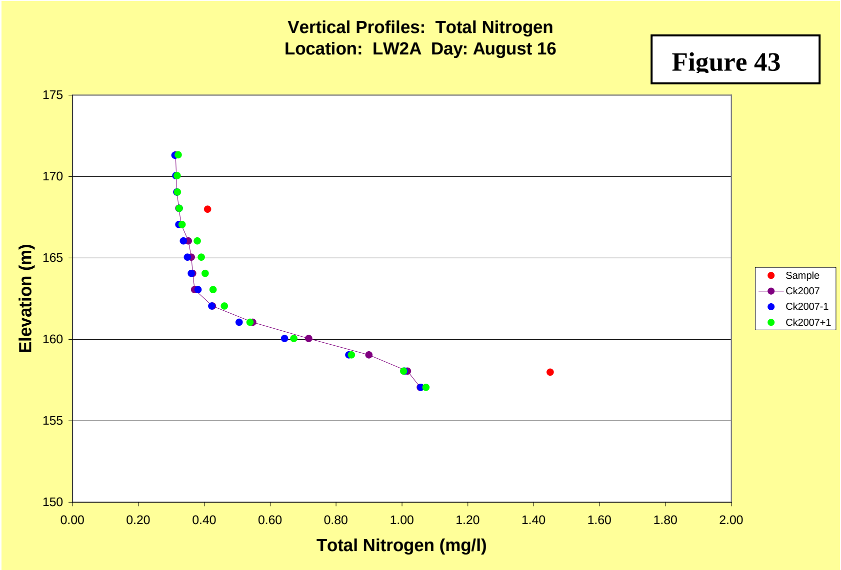


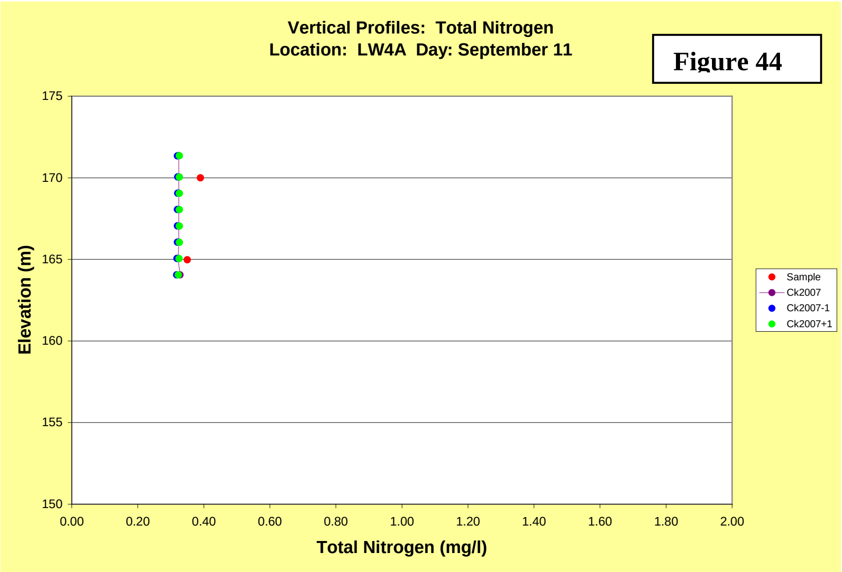
Figure 39

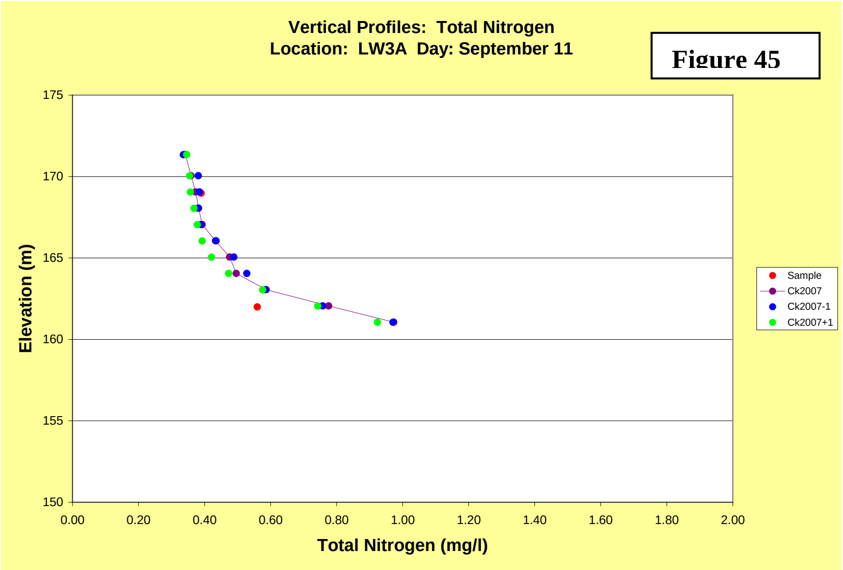

Vertical Profiles: Total Nitrogen
Location: LW4A Day: August 16
Figure 40
Elevation (m)
Total Nitrogen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

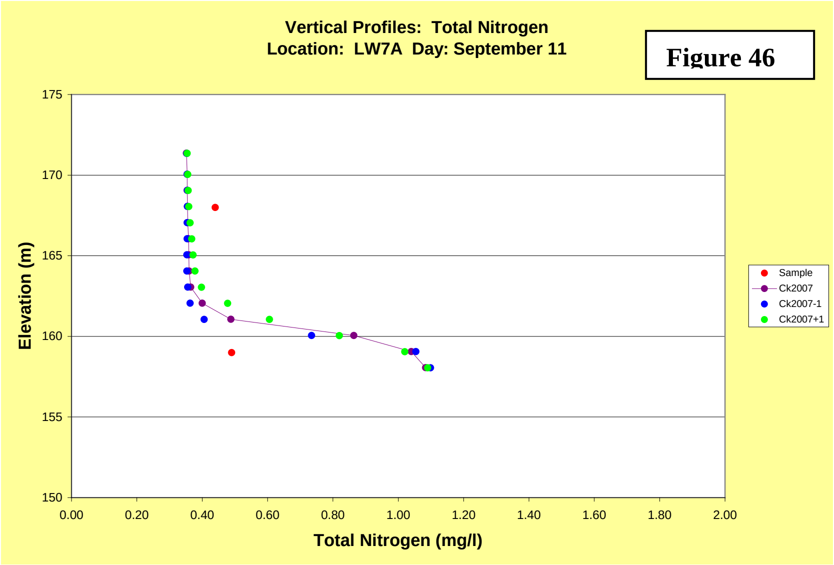

Vertical Profiles: Total Nitrogen
Location: LW3A Day: August 16
Figure 41
Elevation (m)
Total Nitrogen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

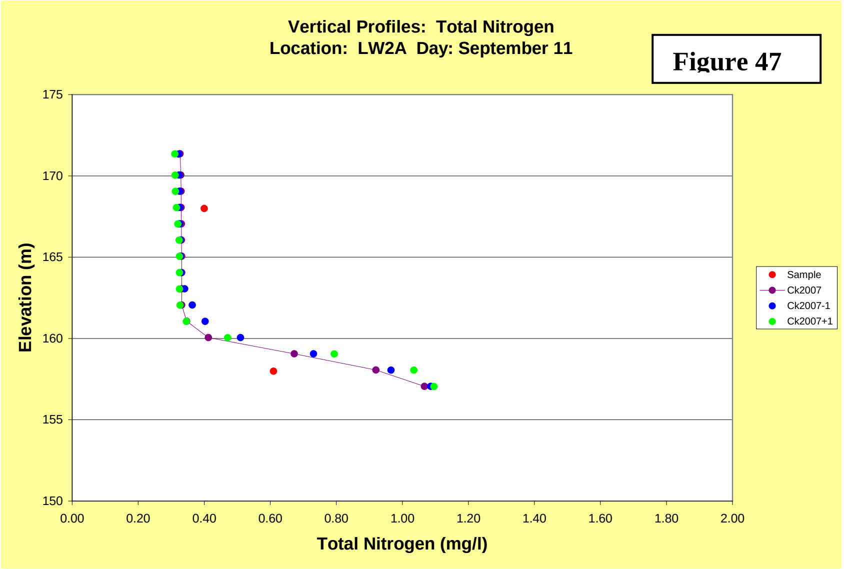

Vertical Profiles: Total Nitrogen
Location: LW7A Day: August 16
Figure 42
Elevation (m)
Total Nitrogen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

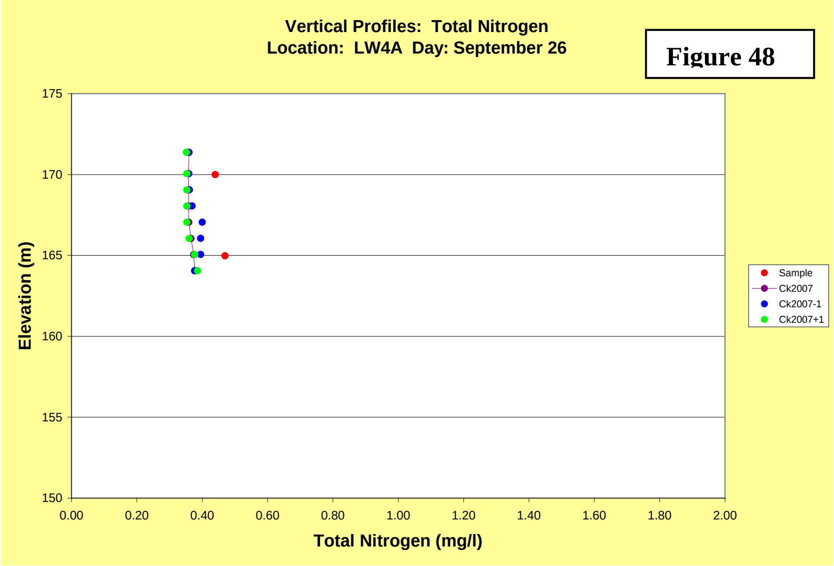

Vertical Profiles: Total Nitrogen
Location: LW2A Day: August 16
Figure 43
Elevation (m)
Total Nitrogen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

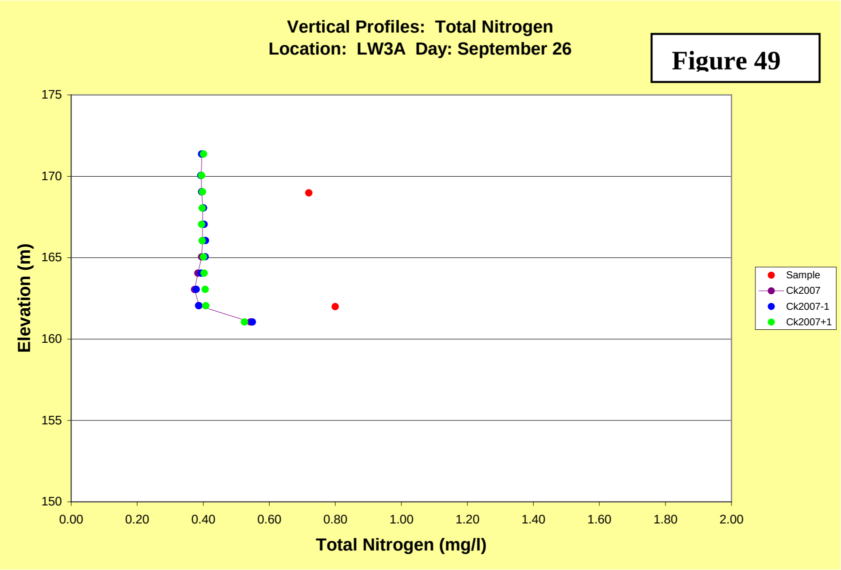

Vertical Profiles: Total Nitrogen
Location: LW4A Day: September 11
Figure 44
Elevation (m)
Total Nitrogen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

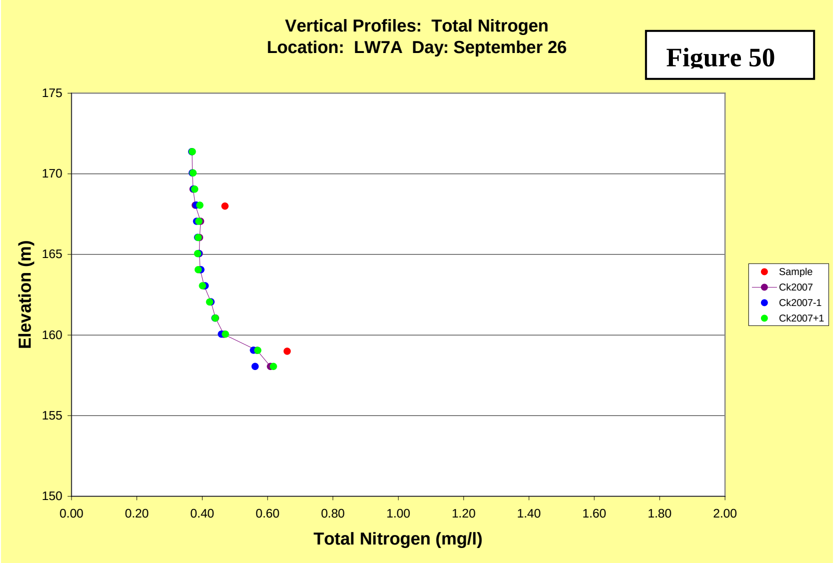

Vertical Profiles: Total Nitrogen
Location: LW3A Day: September 11
Figure 45
Elevation (m)
Total Nitrogen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

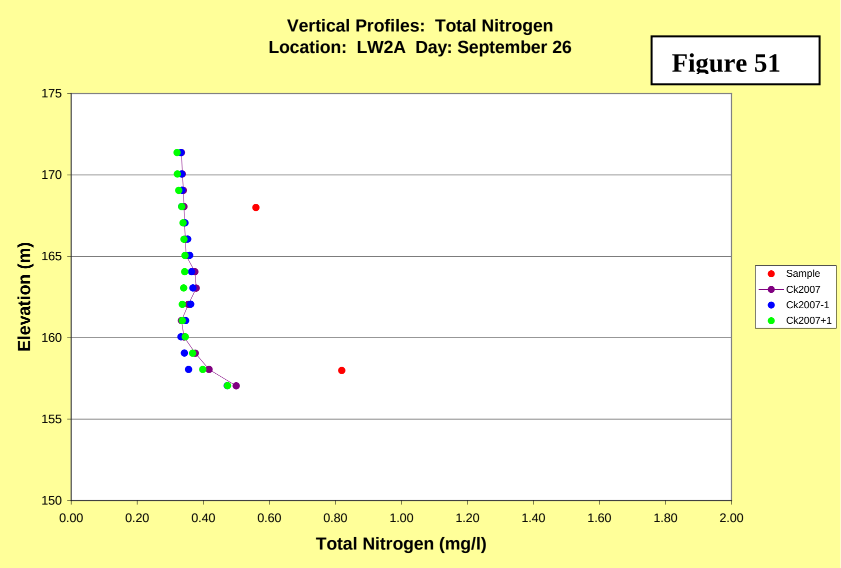

Vertical Profiles: Total Nitrogen
Location: LW7A Day: September 11
Figure 46
Elevation (m)
Total Nitrogen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

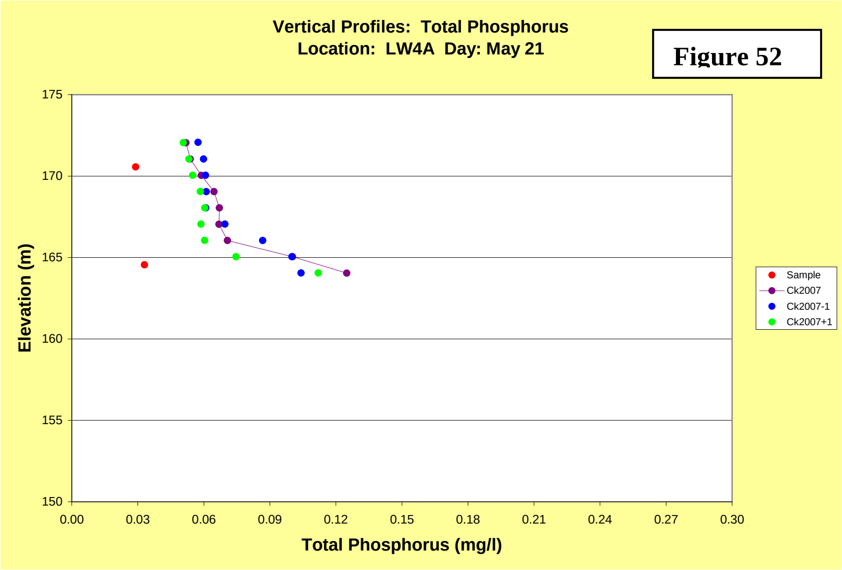

Vertical Profiles: Total Nitrogen
Location: LW2A Day: September 11
Figure 47
Elevation (m)
Total Nitrogen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

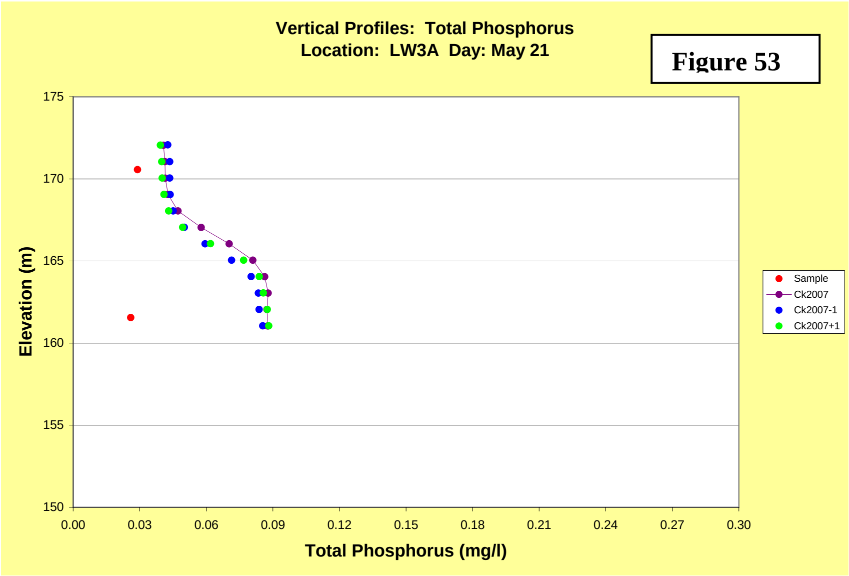

Vertical Profiles: Total Nitrogen
Location: LW4A Day: September 26
Figure 48
Elevation (m)
Total Nitrogen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

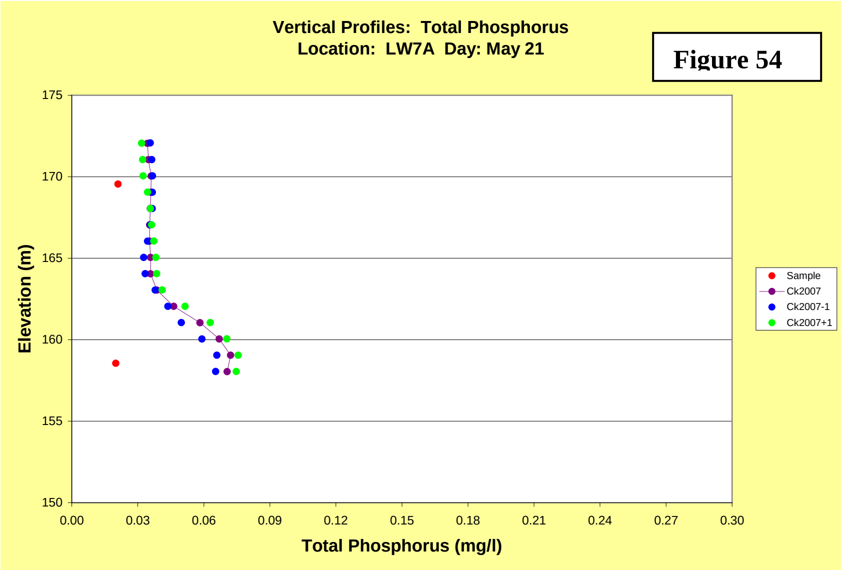

Vertical Profiles: Total Nitrogen
Location: LW3A Day: September 26
Figure 49
Elevation (m)
Total Nitrogen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

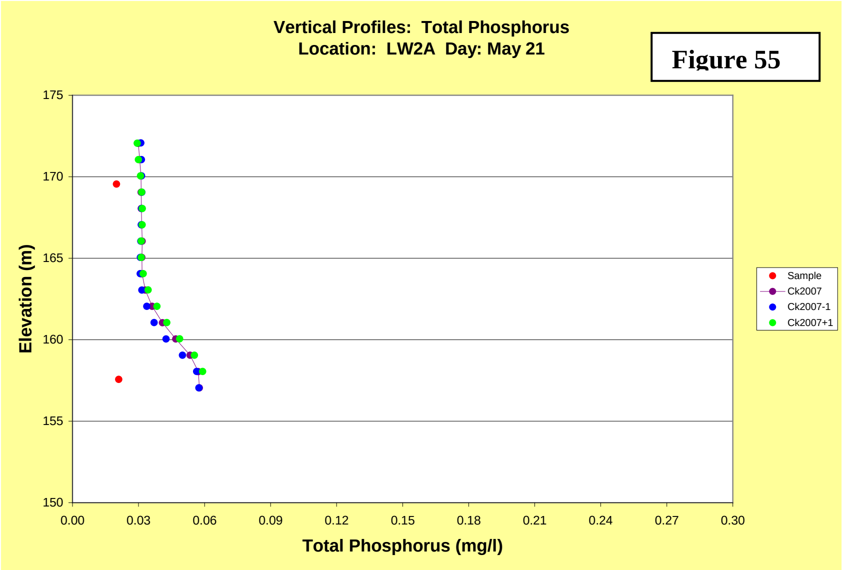

Vertical Profiles: Total Nitrogen
Location: LW7A Day: September 26
Figure 50
Elevation (m)
Total Nitrogen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

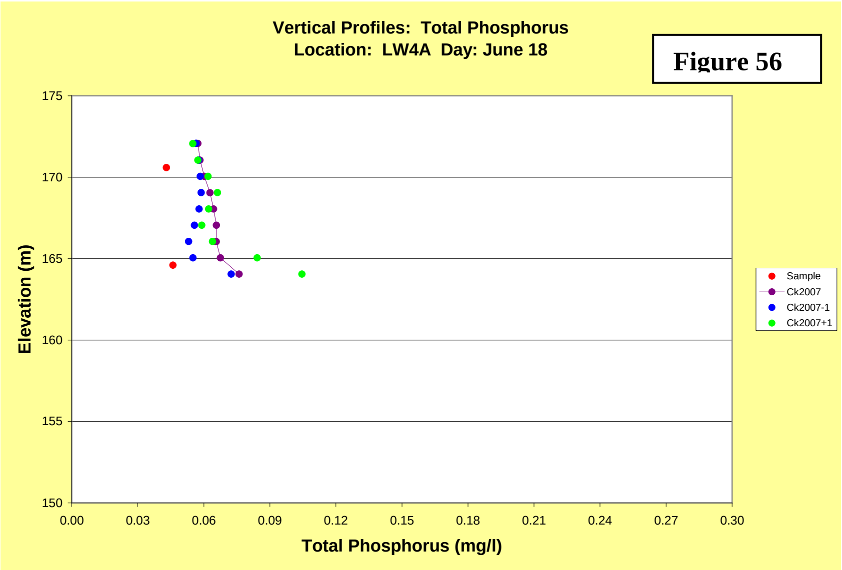

Vertical Profiles: Total Nitrogen
Location: LW2A Day: September 26
Figure 51
Elevation (m)
Total Nitrogen (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

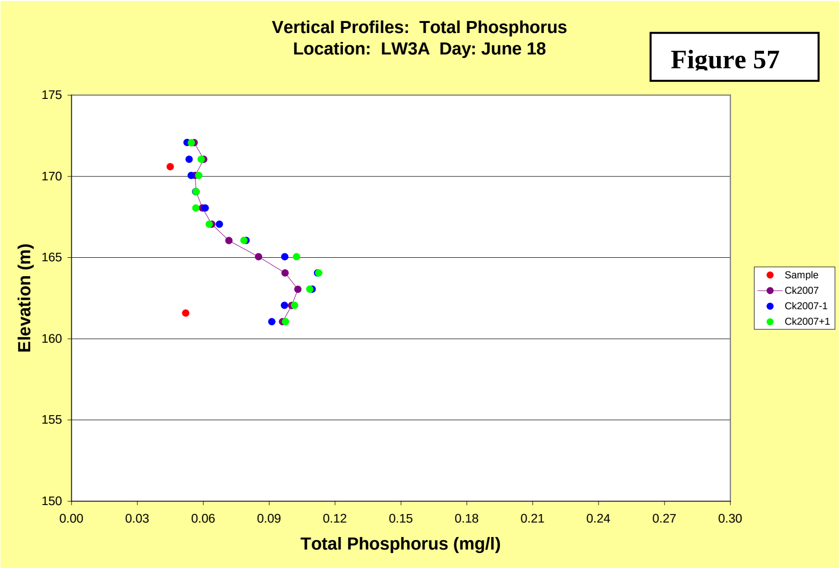

Vertical Profiles: Total Phosphorus
Location: LW4A Day: May 21
Figure 52
Elevation (m)
Total Phosphorus (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

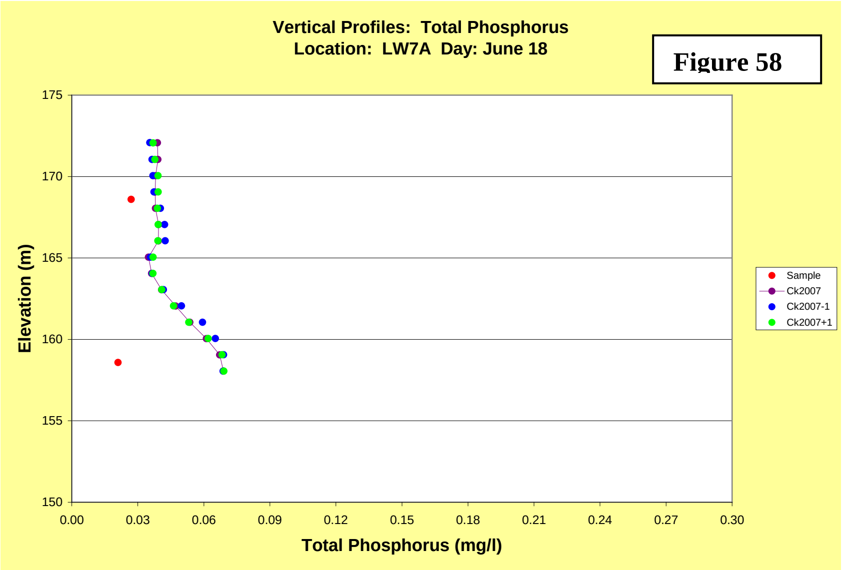

Vertical Profiles: Total Phosphorus
Location: LW3A Day: May 21
Figure 53
Elevation (m)
Total Phosphorus (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1


Vertical Profiles: Total Phosphorus
Location: LW7A Day: May 21
Figure 54
Elevation (m)
Total Phosphorus (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1


Vertical Profiles: Total Phosphorus
Location: LW2A Day: May 21
Figure 55
Elevation (m)
Total Phosphorus (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1


Vertical Profiles: Total Phosphorus
Location: LW4A Day: June 18
Figure 56
Elevation (m)
Total Phosphorus (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1


Vertical Profiles: Total Phosphorus
Location: LW3A Day: June 18
Figure 57
Elevation (m)
Total Phosphorus (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1


Vertical Profiles: Total Phosphorus
Location: LW7A Day: June 18
Figure 58
Elevation (m)
Total Phosphorus (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

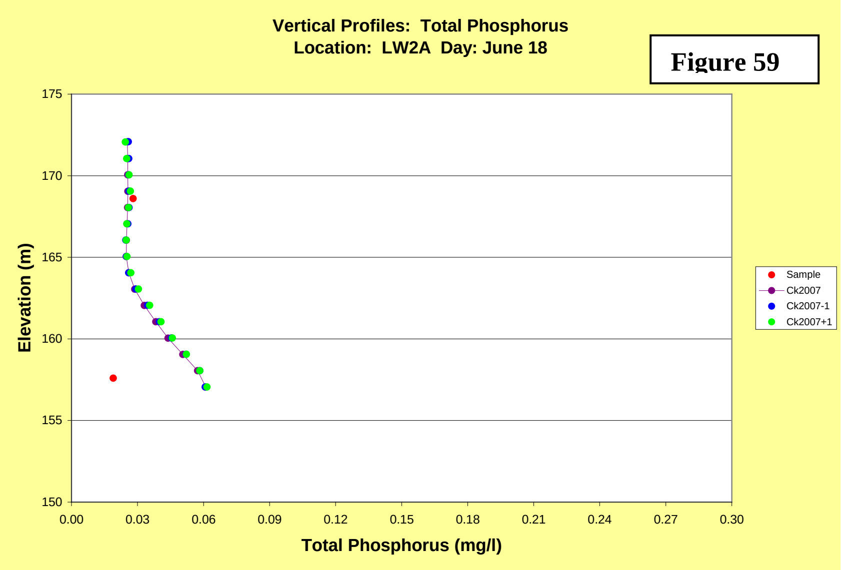

Vertical Profiles: Total Phosphorus
Location: LW2A Day: June 18
Figure 59
Elevation (m)
Total Phosphorus (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

Figure 60

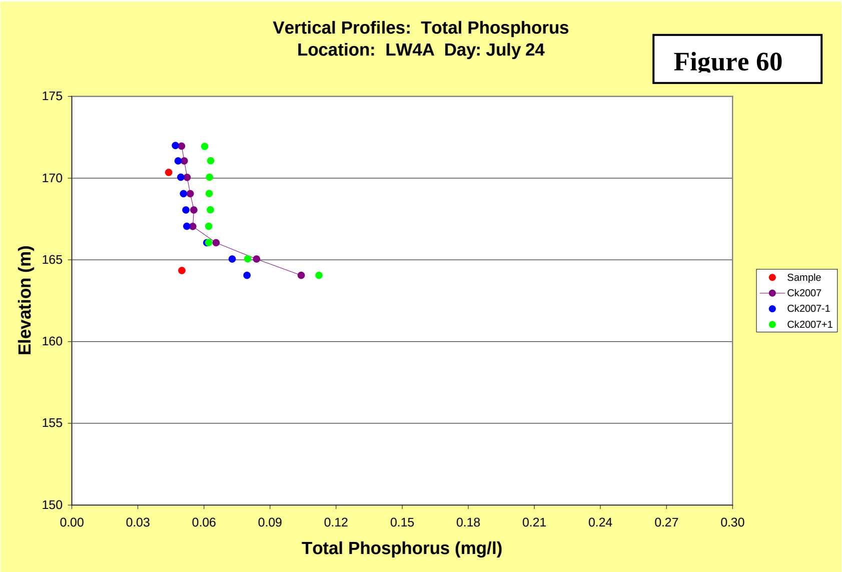


Figure 61

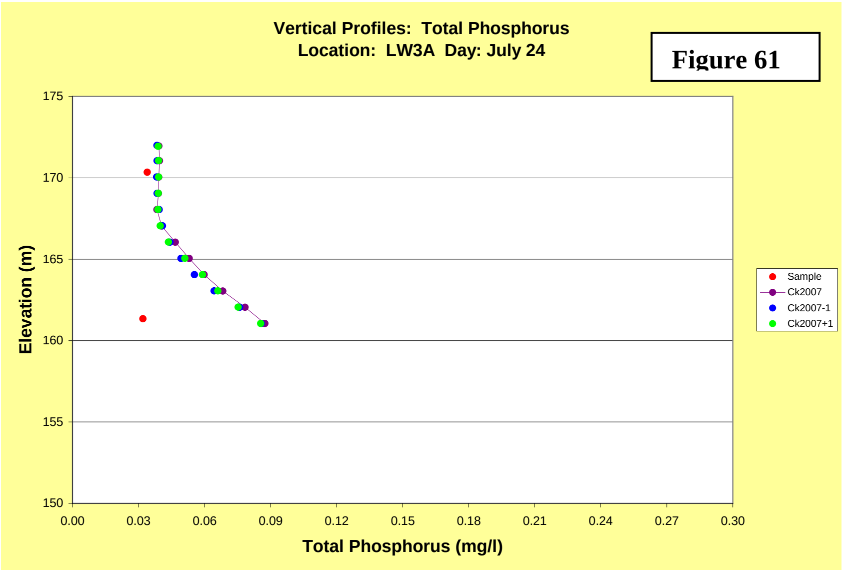


Figure 62

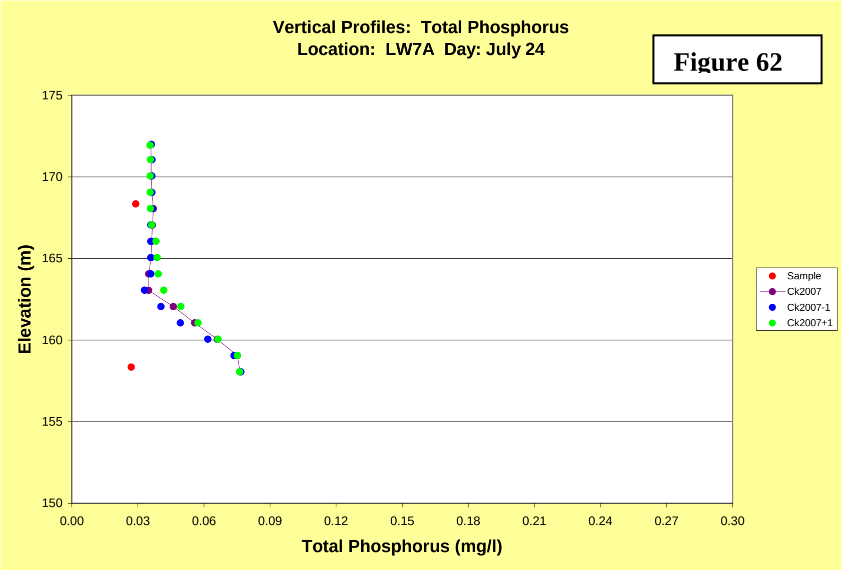
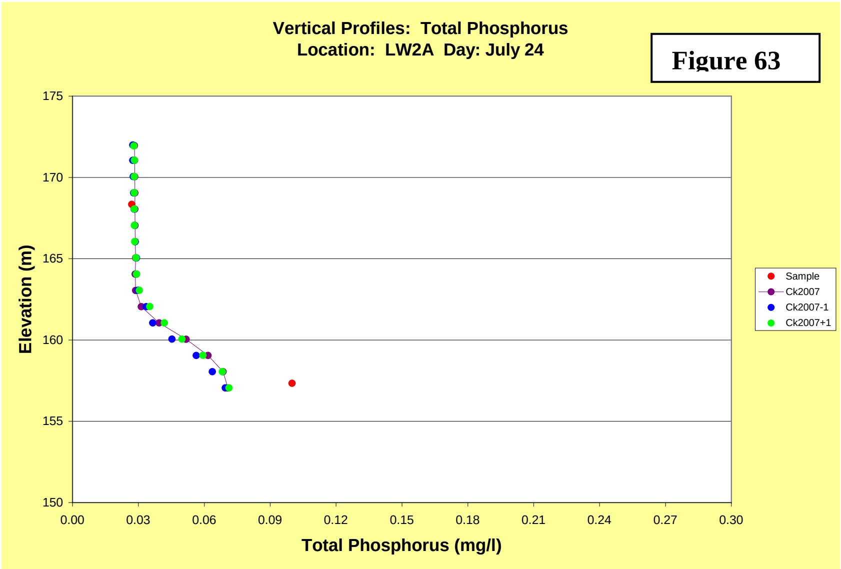
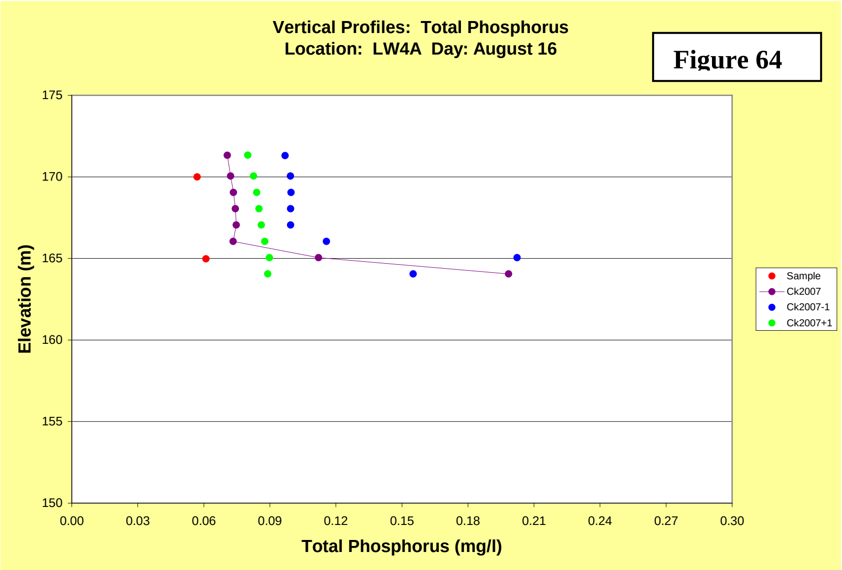
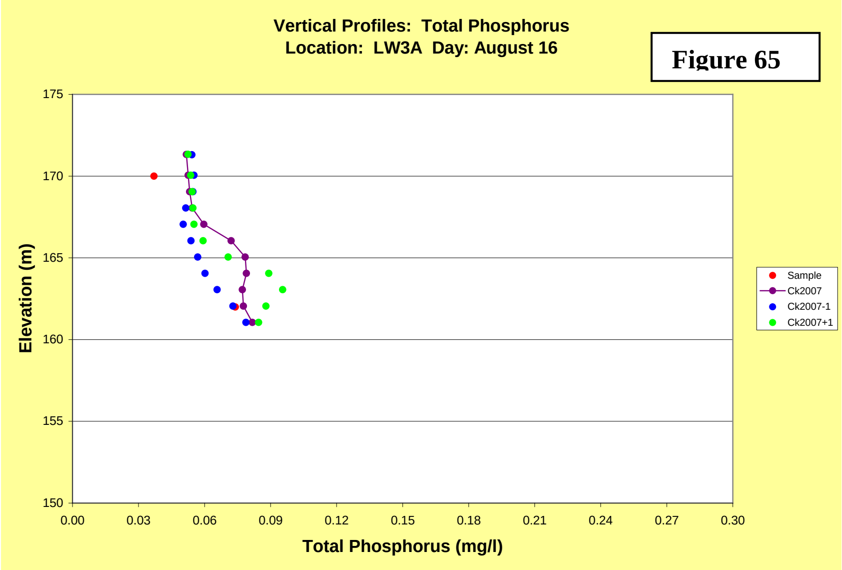
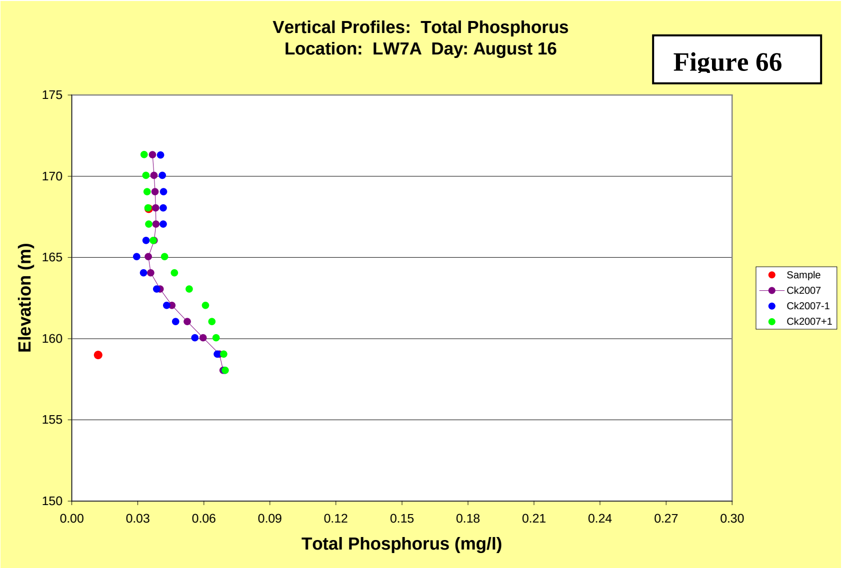


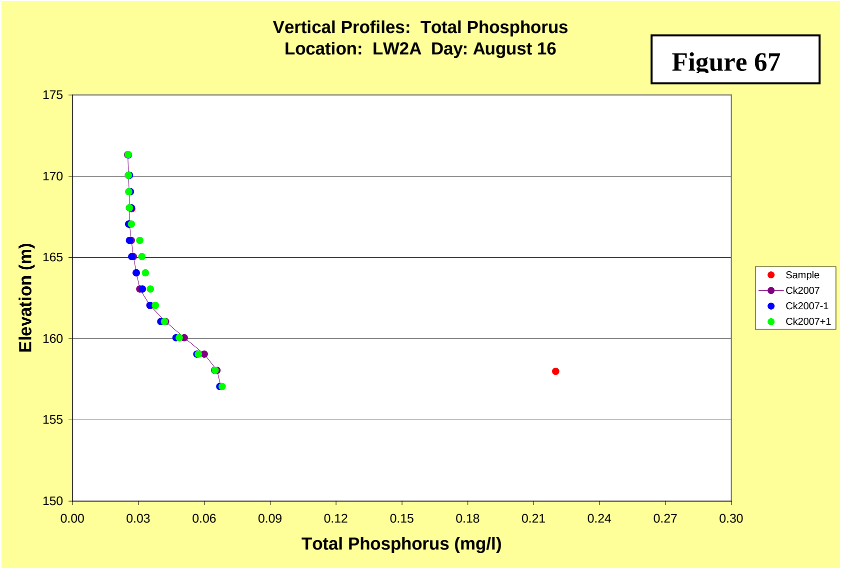
Figure 63

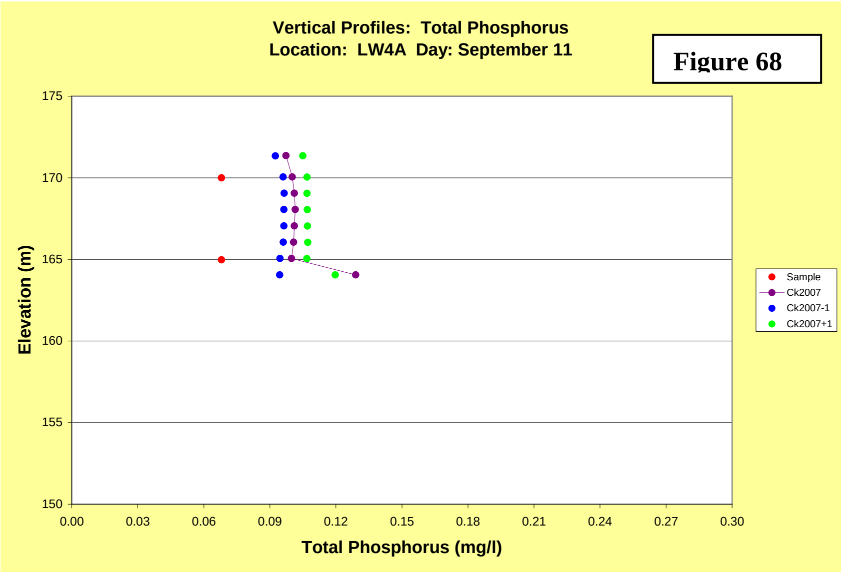


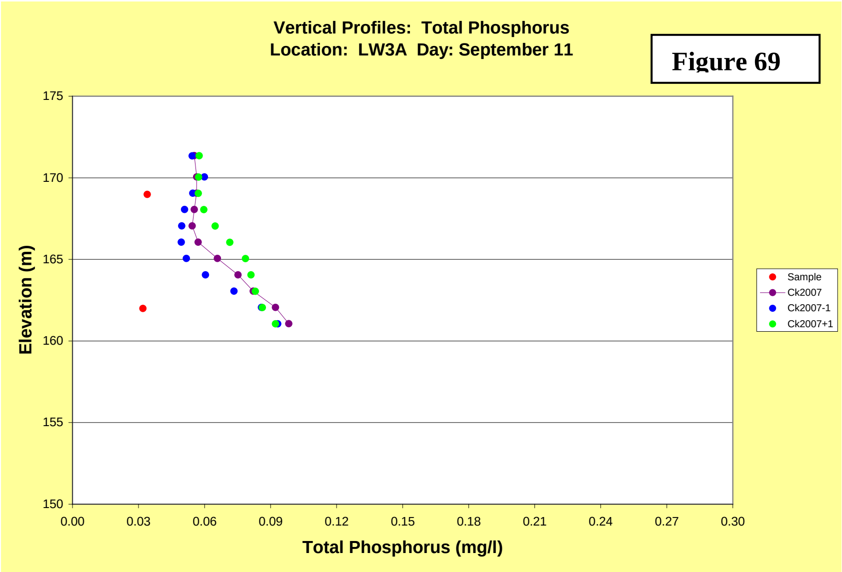

Vertical Profiles: Total Phosphorus
Location: LW4A Day: August 16
Figure 64
Elevation (m)
Total Phosphorus (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

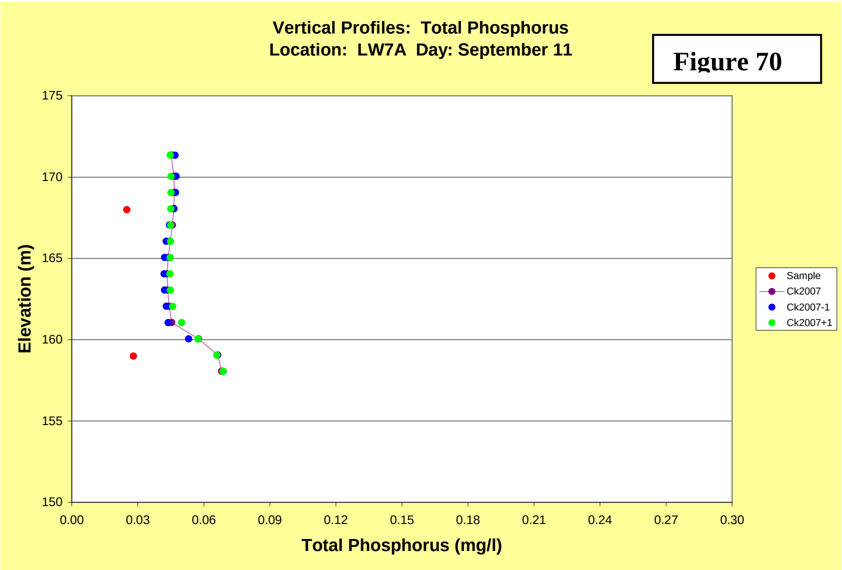

Vertical Profiles: Total Phosphorus
Location: LW3A Day: August 16
Figure 65
Elevation (m)
Total Phosphorus (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

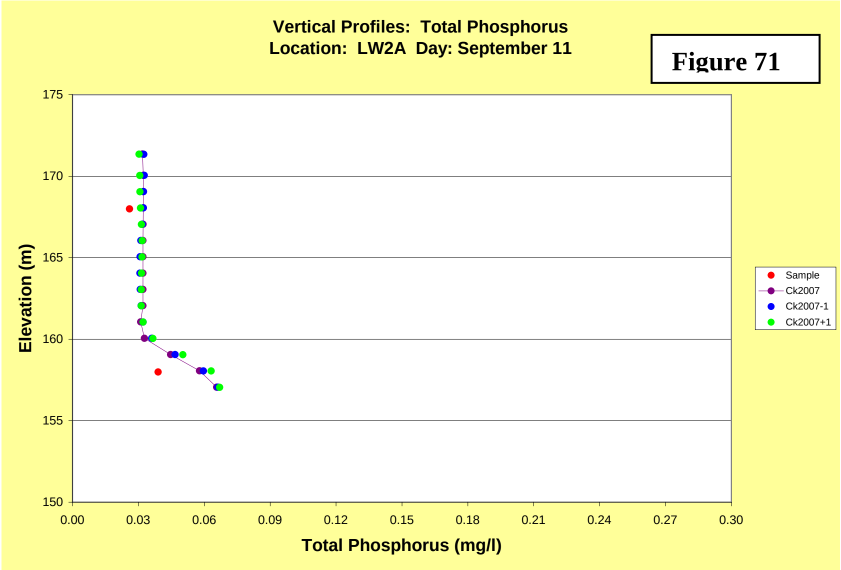

Vertical Profiles: Total Phosphorus
Location: LW7A Day: August 16
Figure 66
Elevation (m)
Total Phosphorus (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

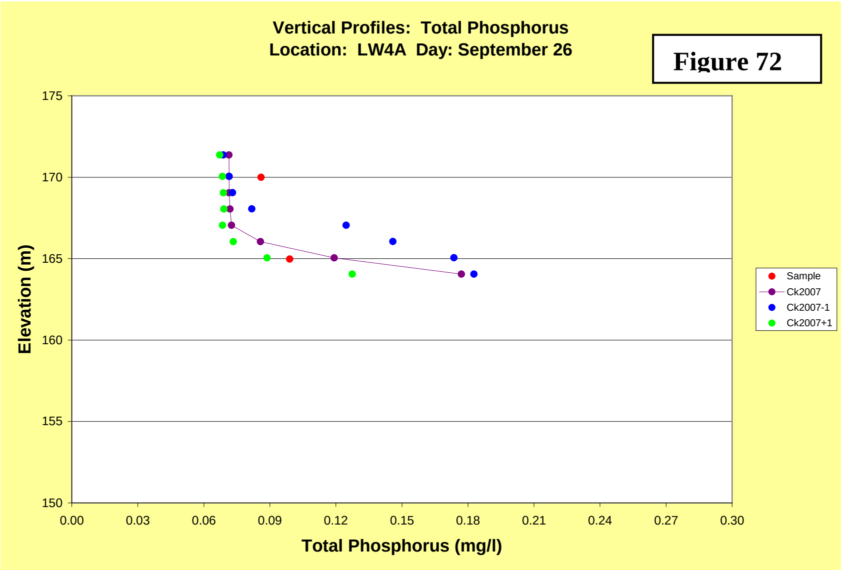

Vertical Profiles: Total Phosphorus
Location: LW2A Day: August 16
Figure 67
Elevation (m)
Total Phosphorus (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

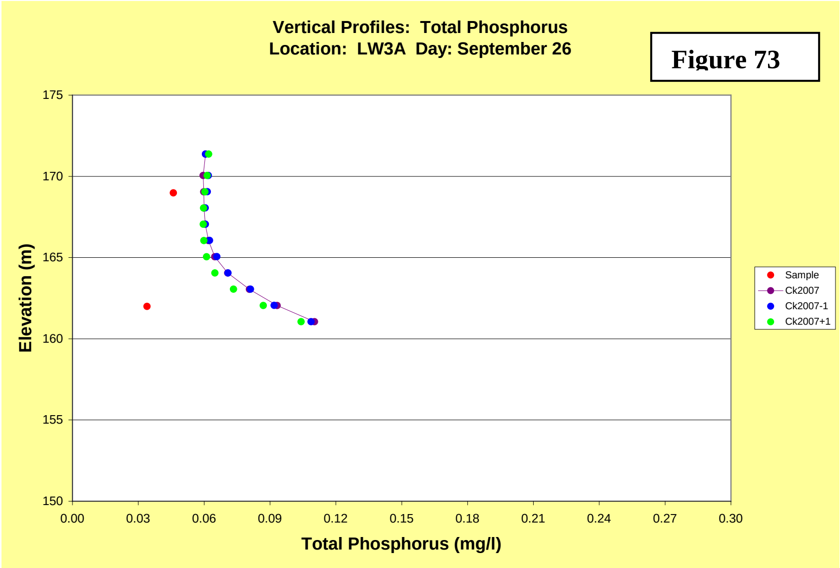

Vertical Profiles: Total Phosphorus
Location: LW4A Day: September 11
Figure 68
Elevation (m)
Total Phosphorus (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

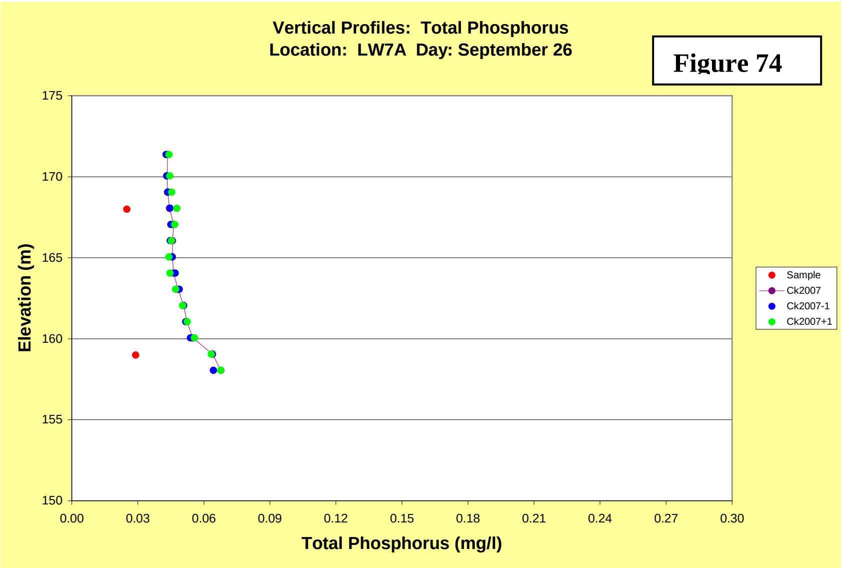

Vertical Profiles: Total Phosphorus
Location: LW3A Day: September 11
Figure 69
Elevation (m)
Total Phosphorus (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

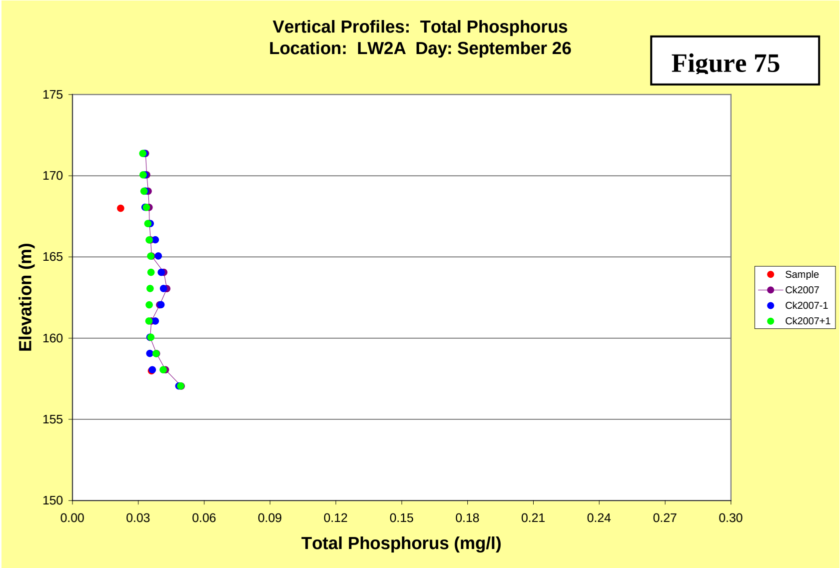

Vertical Profiles: Total Phosphorus
Location: LW7A Day: September 11
Figure 70
Elevation (m)
Total Phosphorus (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

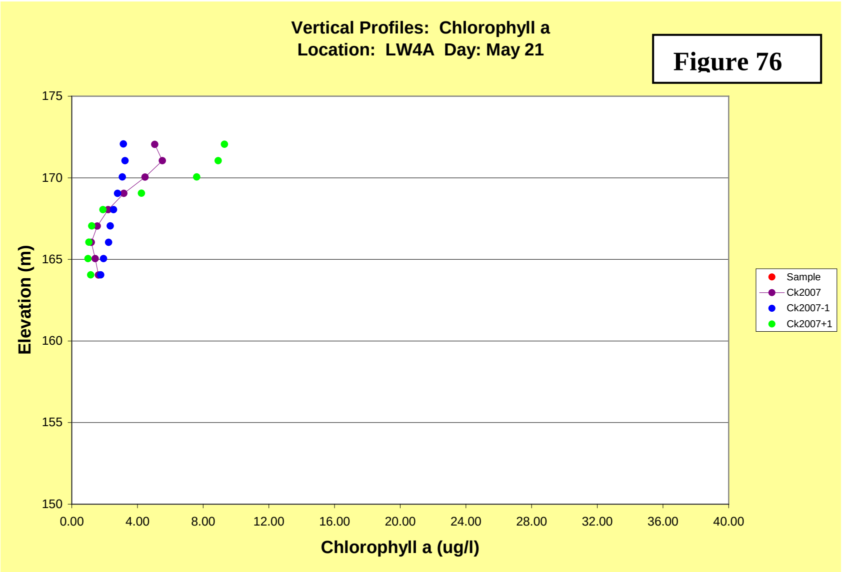

Vertical Profiles: Total Phosphorus
Location: LW2A Day: September 11
Figure 71
Elevation (m)
Total Phosphorus (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

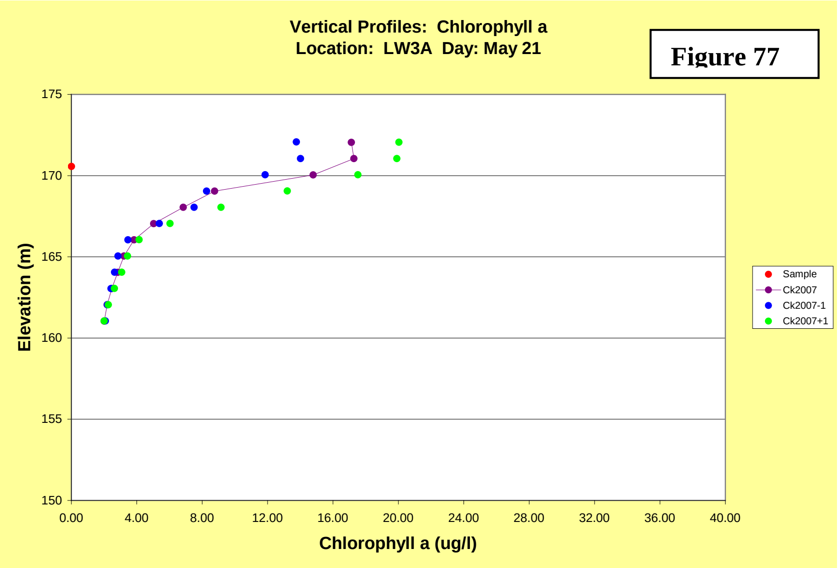

Vertical Profiles: Total Phosphorus
Location: LW4A Day: September 26
Figure 72
Elevation (m)
Total Phosphorus (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

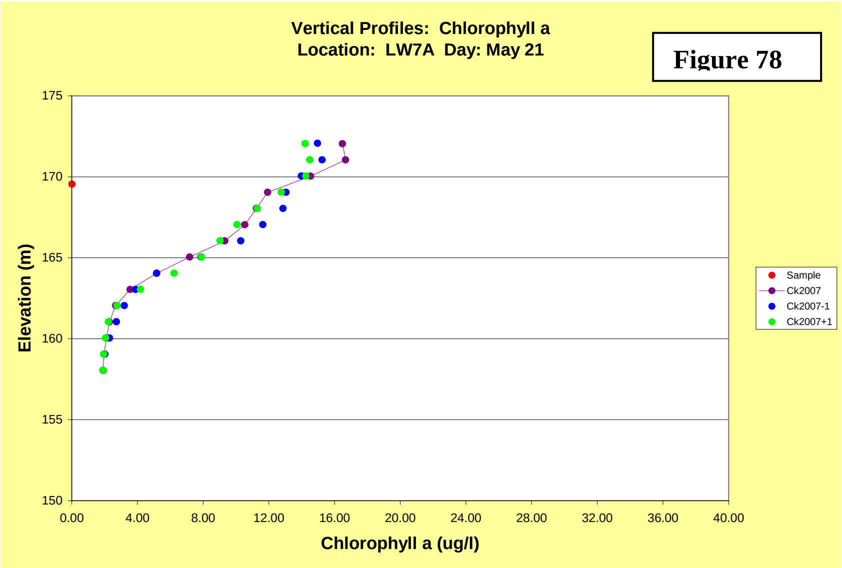

Vertical Profiles: Total Phosphorus
Location: LW3A Day: September 26
Figure 73
Elevation (m)
Total Phosphorus (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

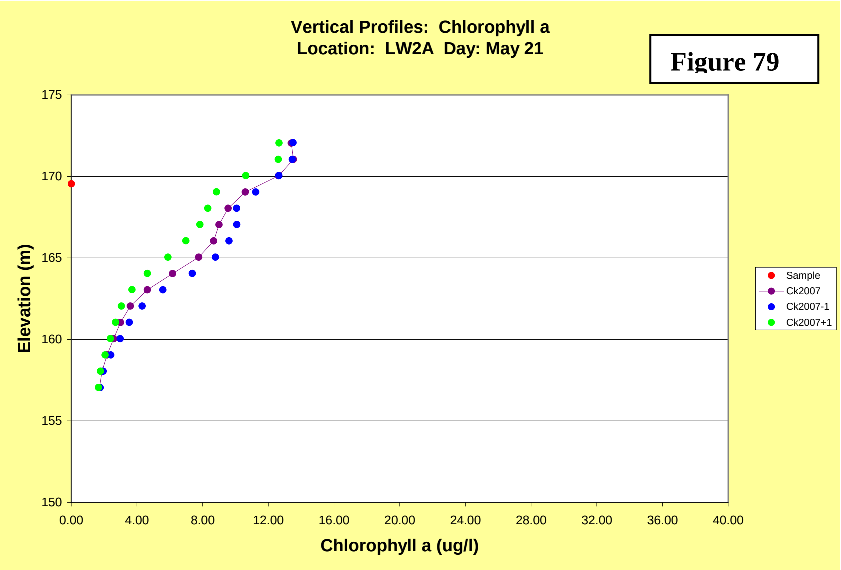

Vertical Profiles: Total Phosphorus
Location: LW7A Day: September 26
Figure 74
Elevation (m)
Total Phosphorus (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

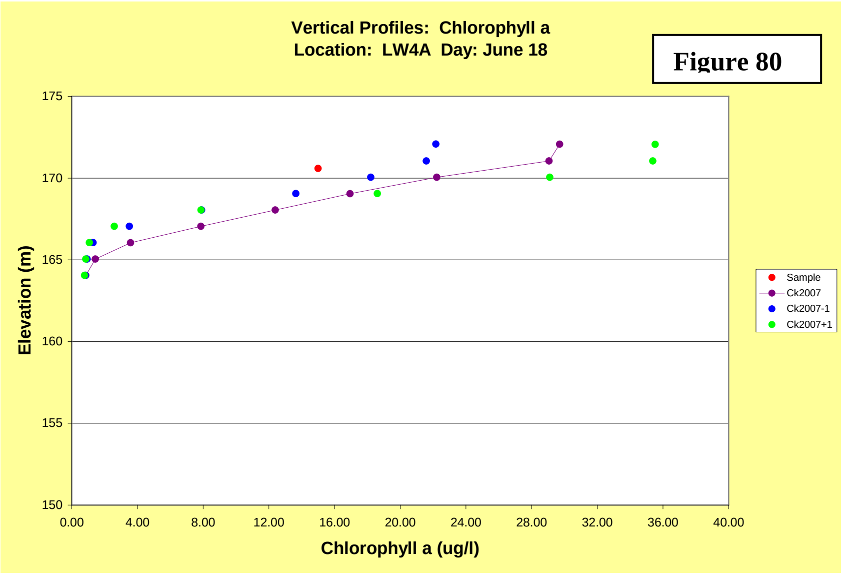

Vertical Profiles: Total Phosphorus
Location: LW2A Day: September 26
Figure 75
Elevation (m)
Total Phosphorus (mg/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

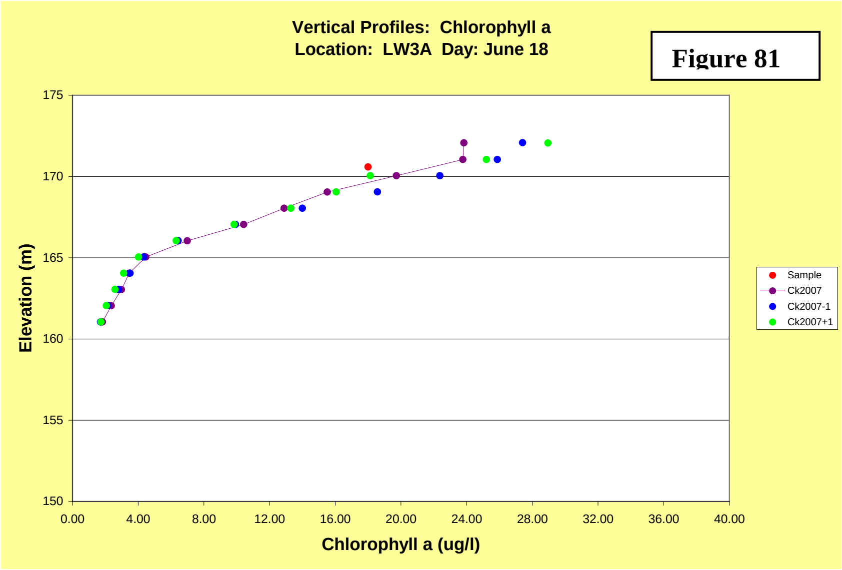

Vertical Profiles: Chlorophyll a
Location: LW4A Day: May 21
Figure 76
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

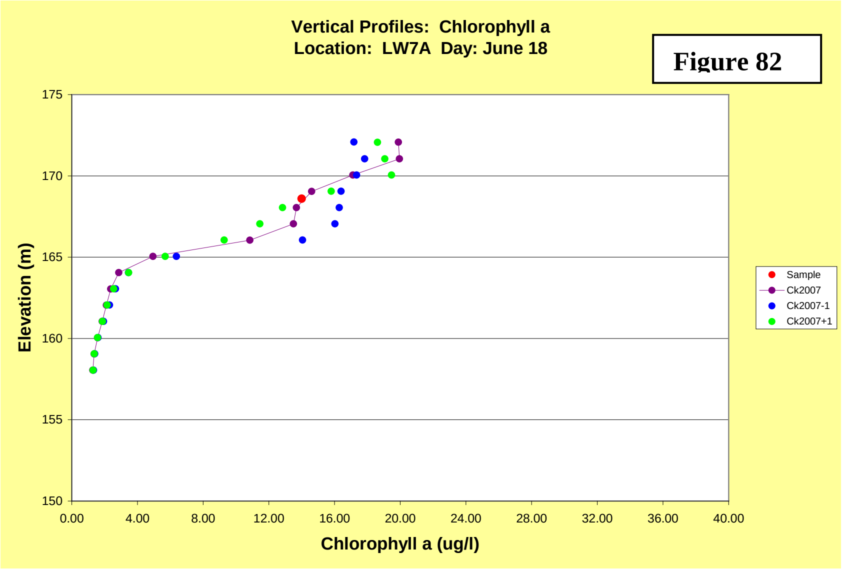

Vertical Profiles: Chlorophyll a
Location: LW3A Day: May 21
Figure 77
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

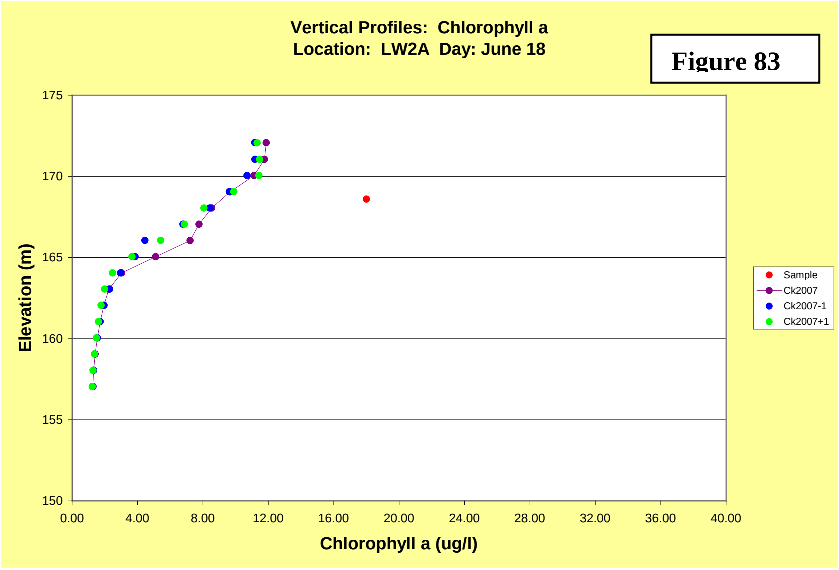

Vertical Profiles: Chlorophyll a
Location: LW7A Day: May 21
Figure 78
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

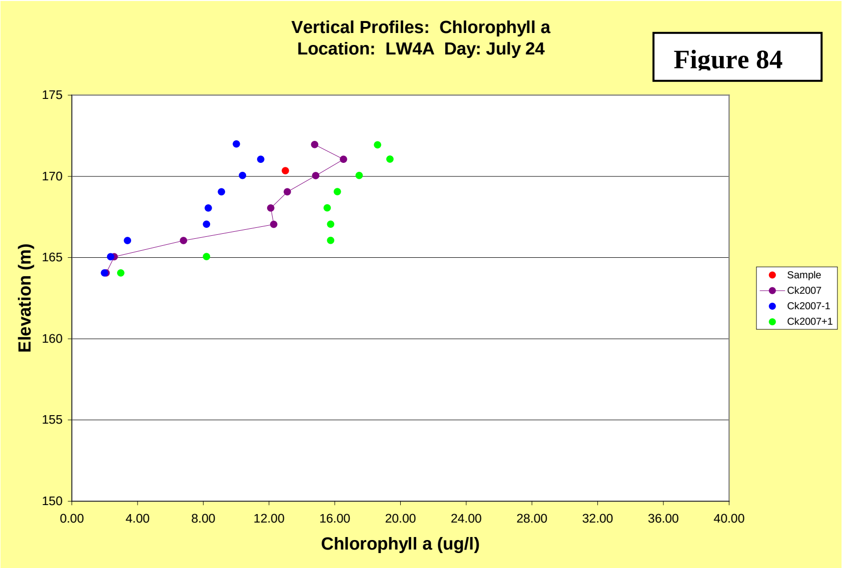

Vertical Profiles: Chlorophyll a
Location: LW2A Day: May 21
Figure 79
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

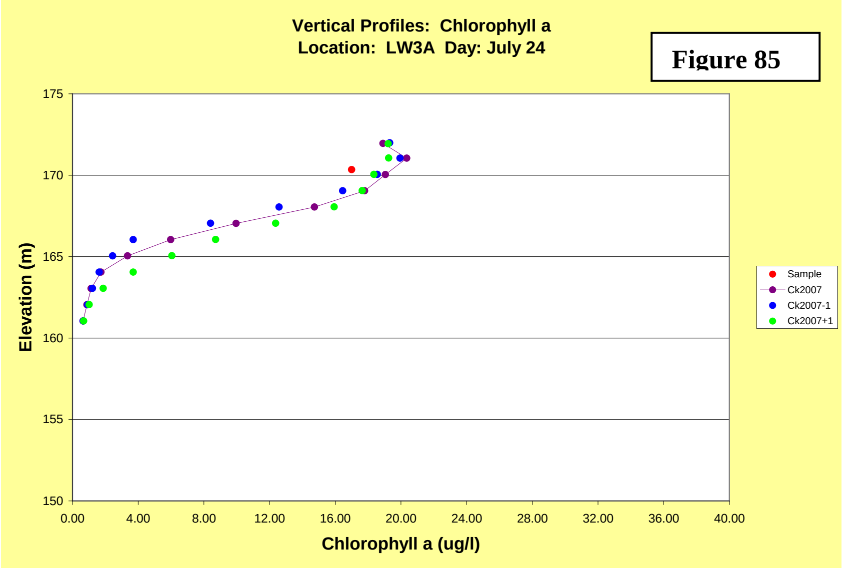

Vertical Profiles: Chlorophyll a
Location: LW4A Day: June 18
Figure 80
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

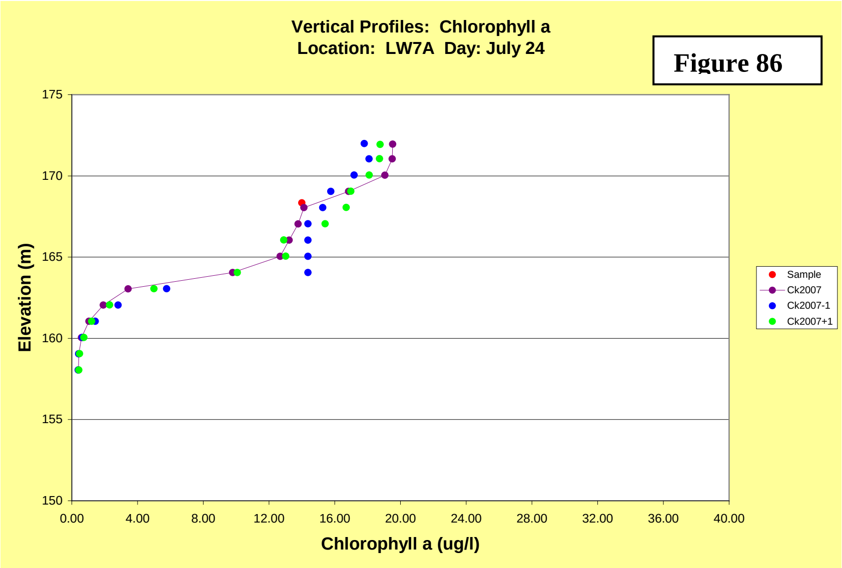

Vertical Profiles: Chlorophyll a
Location: LW3A Day: June 18
Figure 81
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

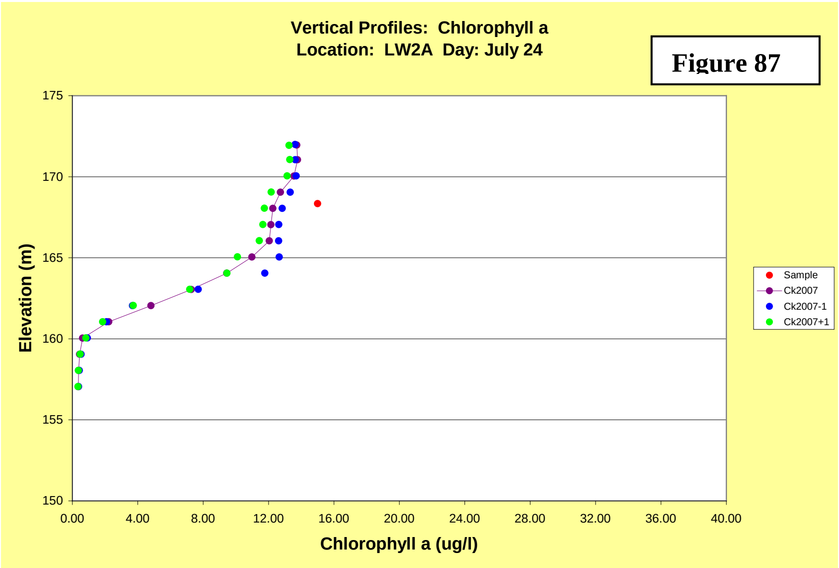

Vertical Profiles: Chlorophyll a
Location: LW7A Day: June 18
Figure 82
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

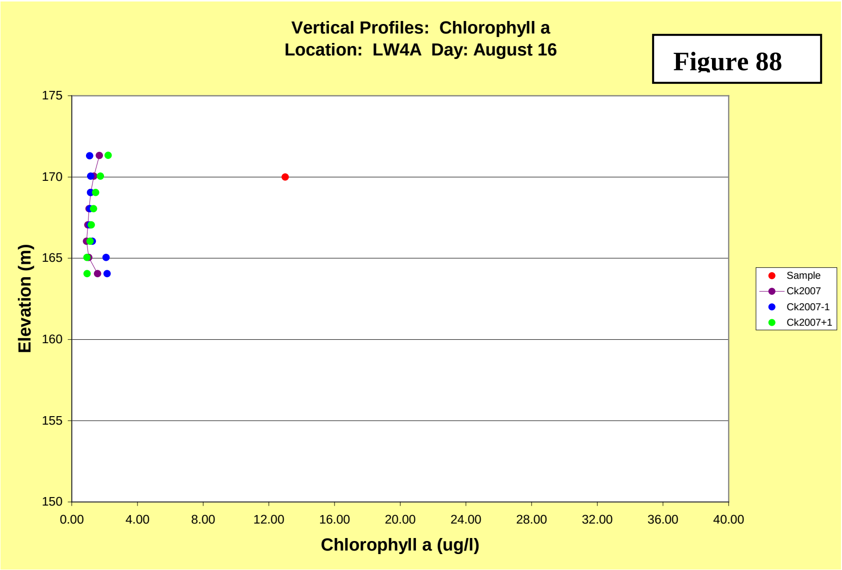

Vertical Profiles: Chlorophyll a
Location: LW2A Day: June 18
Figure 83
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

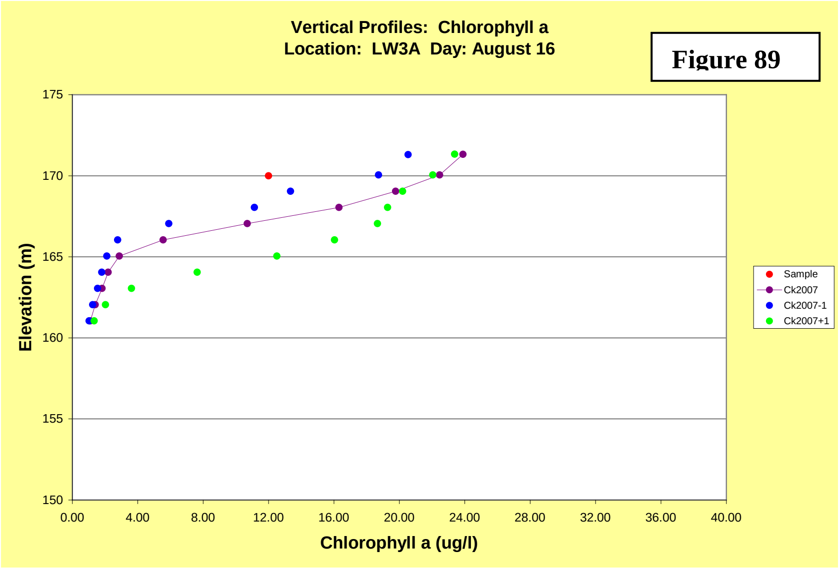

Vertical Profiles: Chlorophyll a
Location: LW4A Day: July 24
Figure 84
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

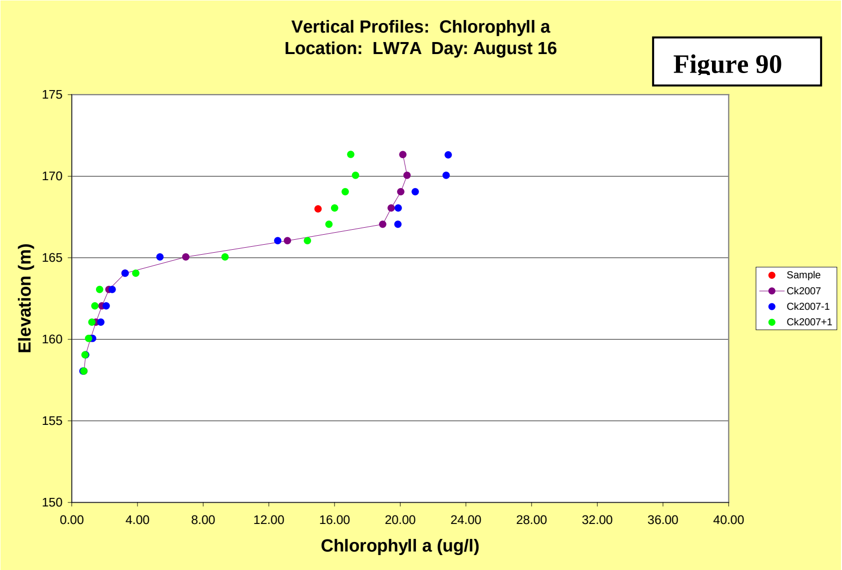

Vertical Profiles: Chlorophyll a
Location: LW3A Day: July 24
Figure 85
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

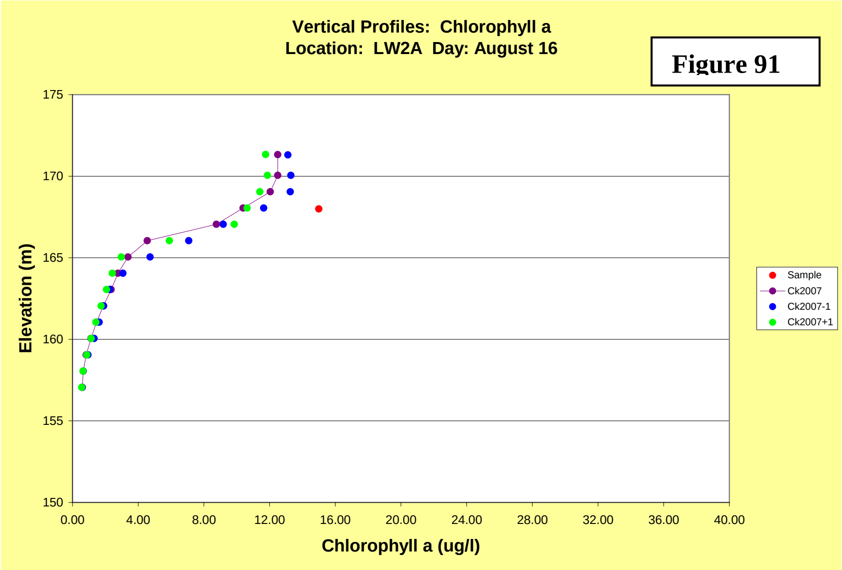

Vertical Profiles: Chlorophyll a
Location: LW7A Day: July 24
Figure 86
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

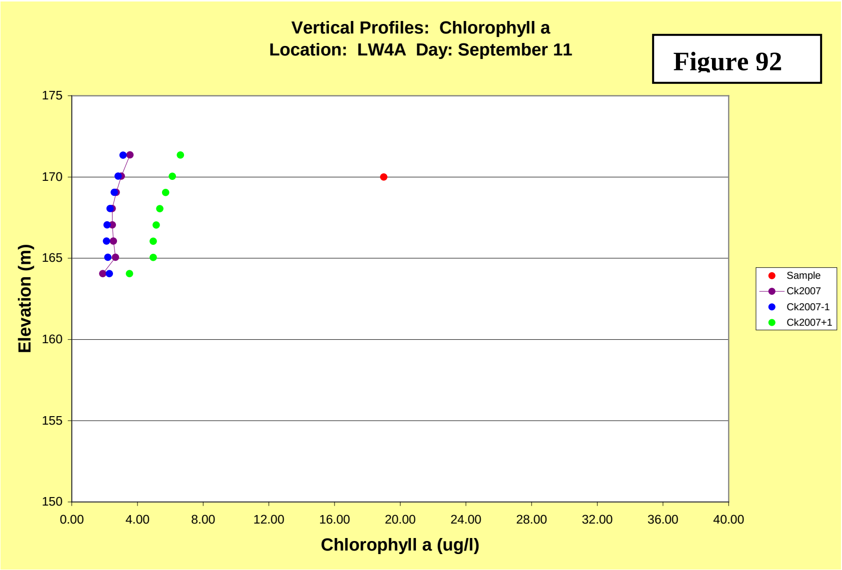

Vertical Profiles: Chlorophyll a
Location: LW2A Day: July 24
Figure 87
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

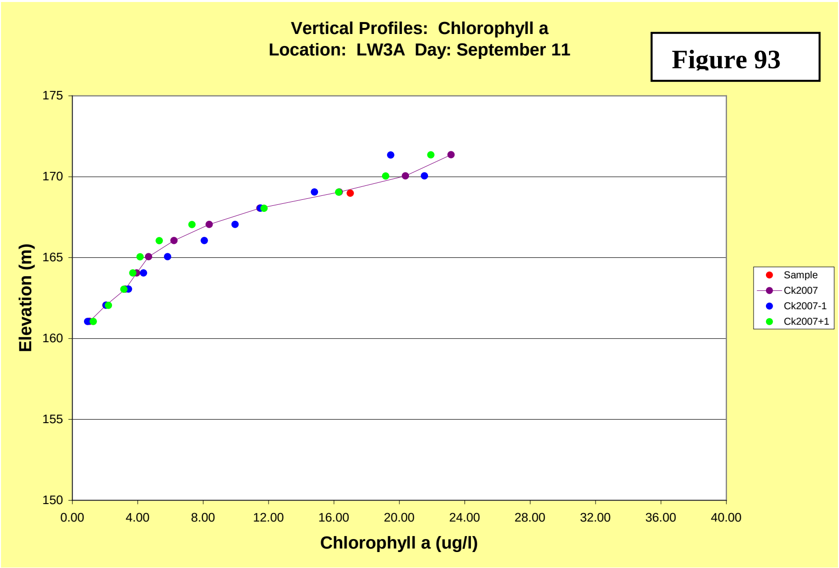

Vertical Profiles: Chlorophyll a
Location: LW4A Day: August 16
Figure 88
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

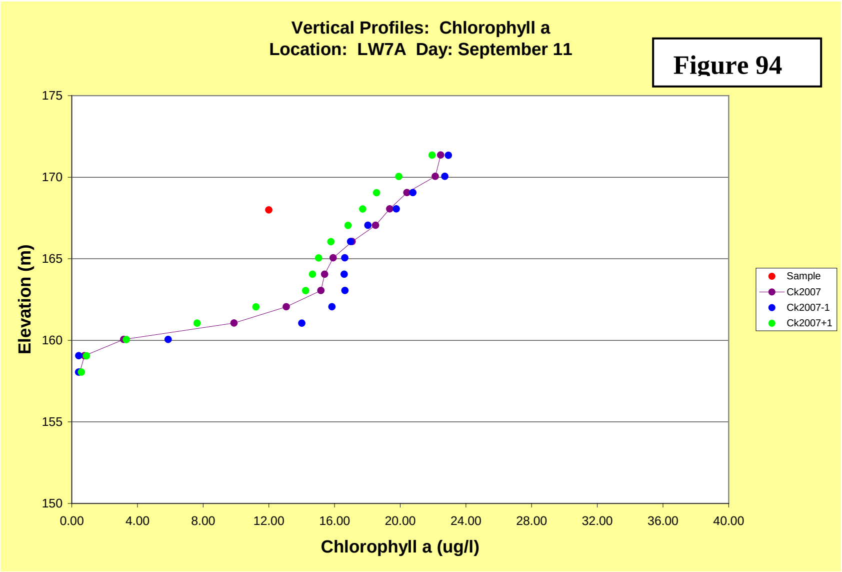

Vertical Profiles: Chlorophyll a
Location: LW3A Day: August 16
Figure 89
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

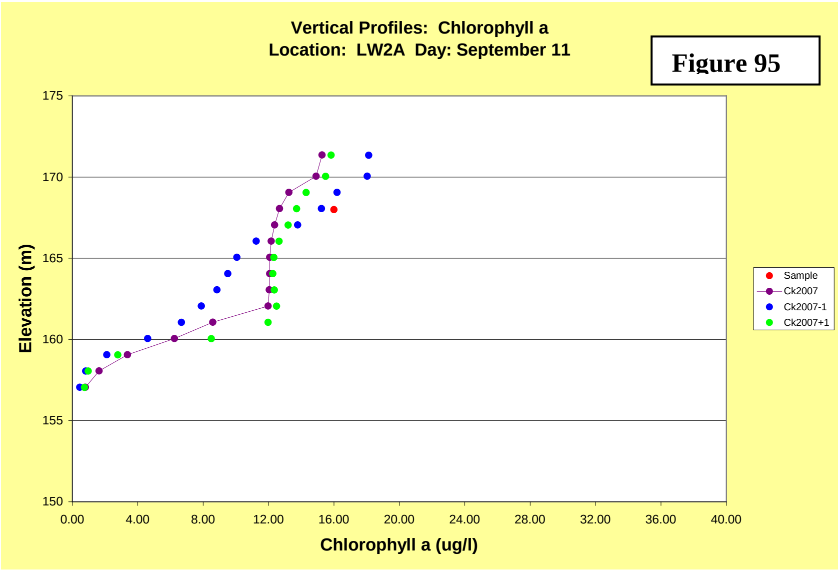

Vertical Profiles: Chlorophyll a
Location: LW7A Day: August 16
Figure 90
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

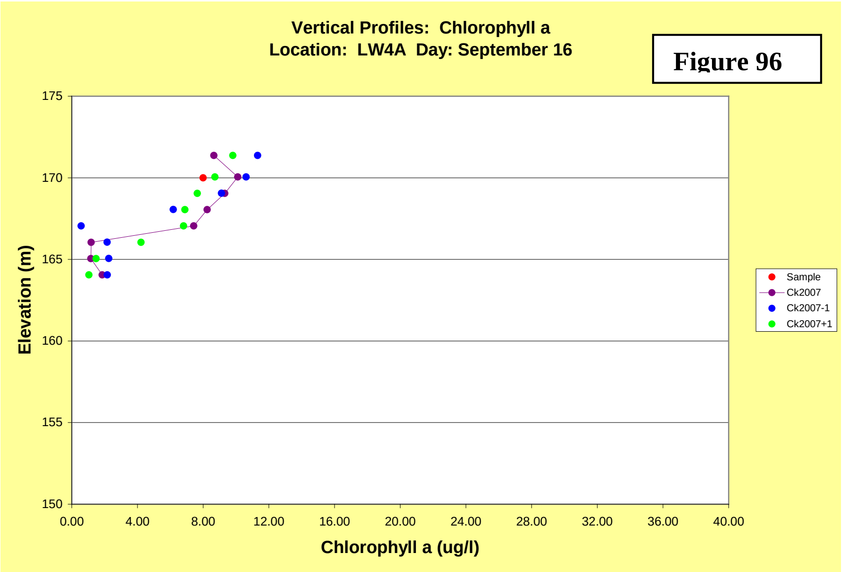

Vertical Profiles: Chlorophyll a
Location: LW2A Day: August 16
Figure 91
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

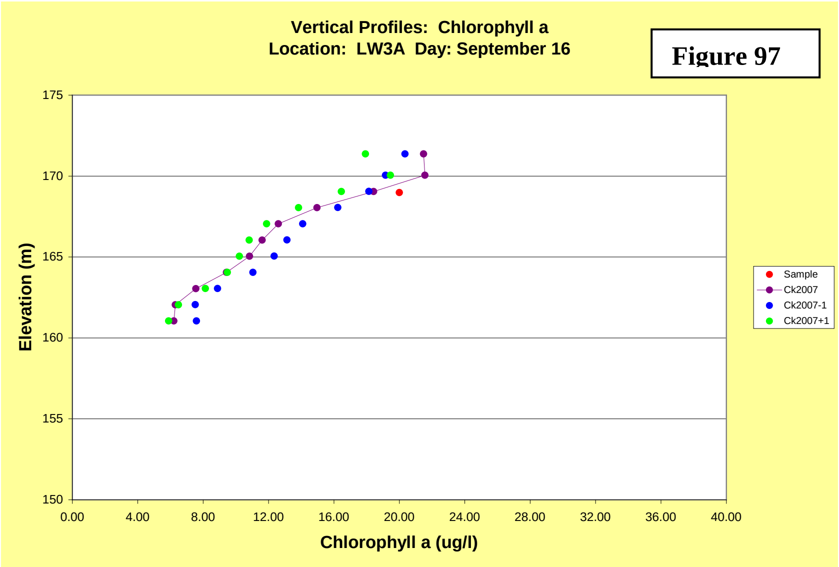

Vertical Profiles: Chlorophyll a
Location: LW4A Day: September 11
Figure 92
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

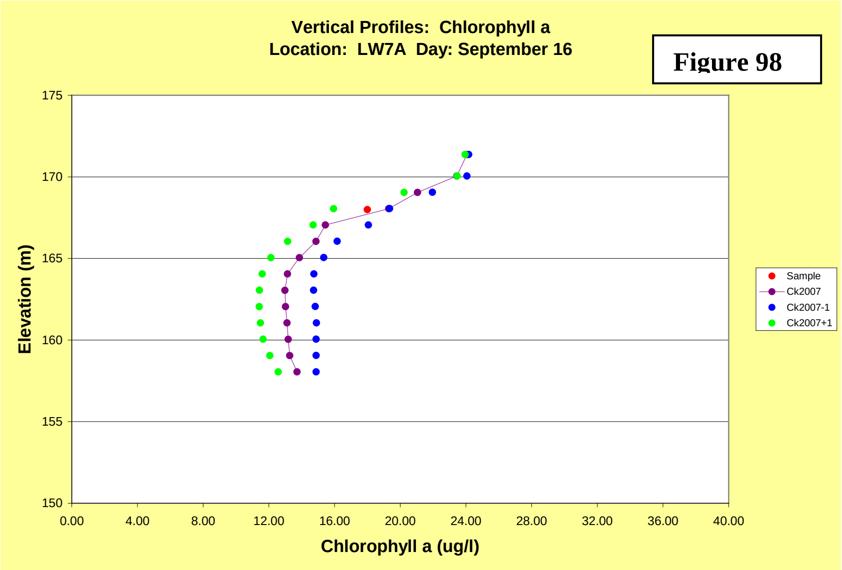

Vertical Profiles: Chlorophyll a
Location: LW3A Day: September 11
Figure 93
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

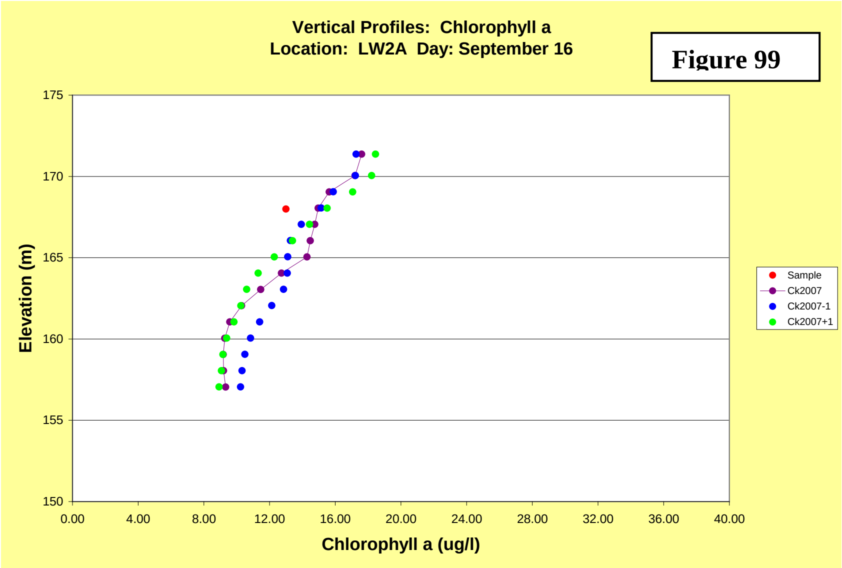

Vertical Profiles: Chlorophyll a
Location: LW7A Day: September 11
Figure 94
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1


Vertical Profiles: Chlorophyll a
Location: LW2A Day: September 11
Figure 95
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1


Vertical Profiles: Chlorophyll a
Location: LW4A Day: September 16
Figure 96
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1


Vertical Profiles: Chlorophyll a
Location: LW3A Day: September 16
Figure 97
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1


Vertical Profiles: Chlorophyll a
Location: LW7A Day: September 16
Figure 98
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1


Vertical Profiles: Chlorophyll a
Location: LW2A Day: September 16
Figure 99
Elevation (m)
Chlorophyll a (ug/l)
Sample
Ck2007
Ck2007-1
Ck2007+1

Selected Figures for Permit Conditions, 2002 Flow

Scenarios:

EPMHB2002 – permit limits, existing plants

FP252002_v2 – future permit limits at 25 mgd, with Belmont at existing loads

FP252002Bel_v2 – future permit limits at 25 mgd, Belmont at increased loads

Vertical Plots – August 16, 2002

DO and Chlorophyll *a* at Segments 3, 7, 13 and 30

TP and TN at Segments 3 and 30

Time Series Plots

DO at Elevation 166 or 164 (near thermocline) at Segments 3, 7, 13 and 30

TP at Elevation 170 (near surface) at Segments 3, 7, 13, and 30

TN at Elevation 170 (near surface) at Segments 3 and 30

Chlorophyll a at Elevation 170 (near surface) at Segments 3 and 30

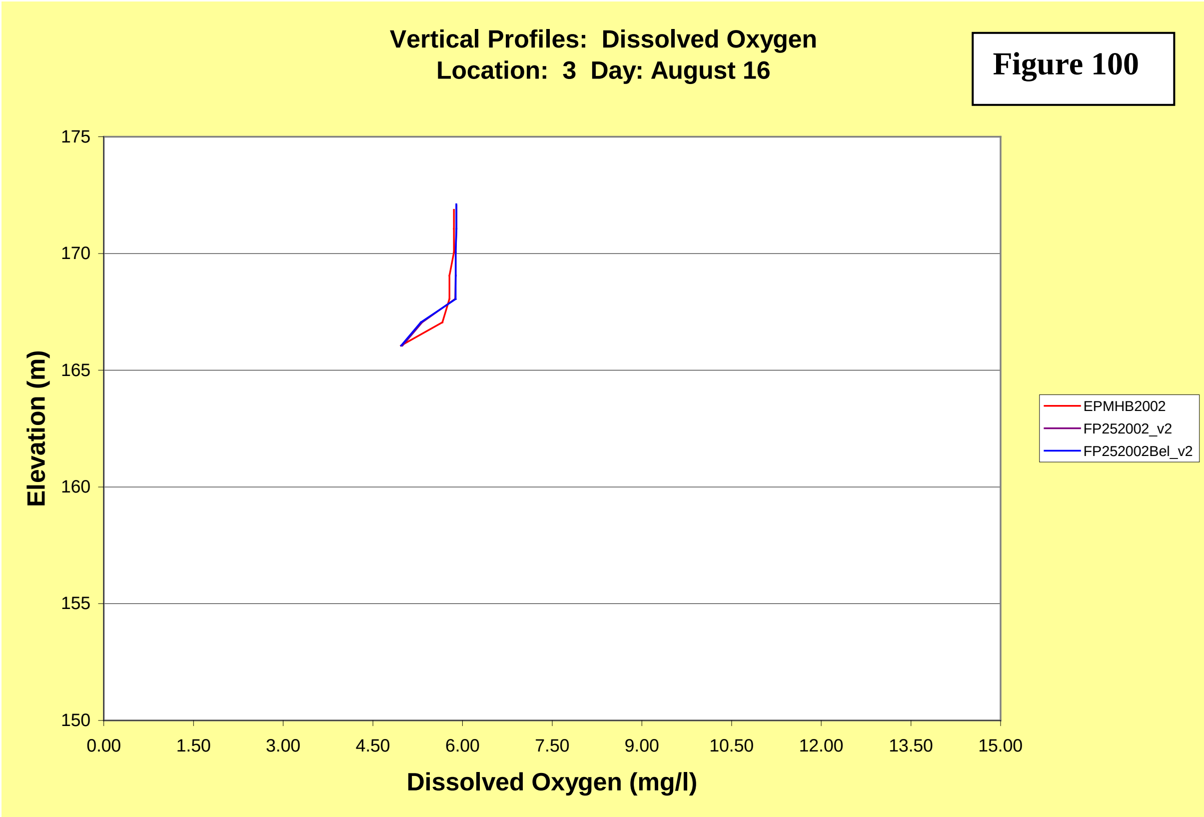
Segments

3 – downstream of Mount Holly/Long Creek Regional WWTP

7 – segment downstream of Belmont WWTP

13 – segment downstream of junction with South Fork Branch

30 – segment in lower portion of the lake near the dam


Vertical Profiles: Dissolved Oxygen
Location: 3 Day: August 16
Figure 100
Elevation (m)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Dissolved Oxygen (mg/l)
EPMHB2002
FP252002_v2
FP252002Bel_v2

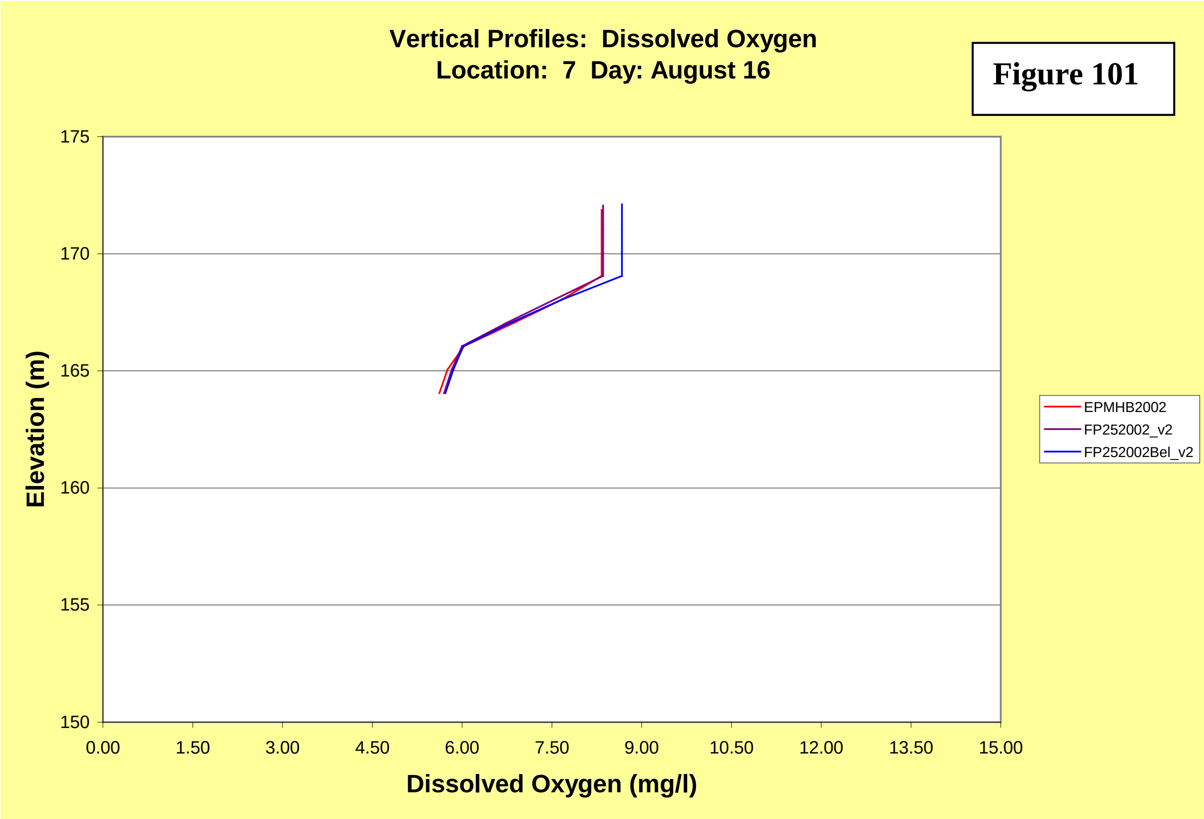

Vertical Profiles: Dissolved Oxygen
Location: 7 Day: August 16
Figure 101
Elevation (m)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Dissolved Oxygen (mg/l)
EPMHB2002
FP252002_v2
FP252002Bel_v2

Figure 102

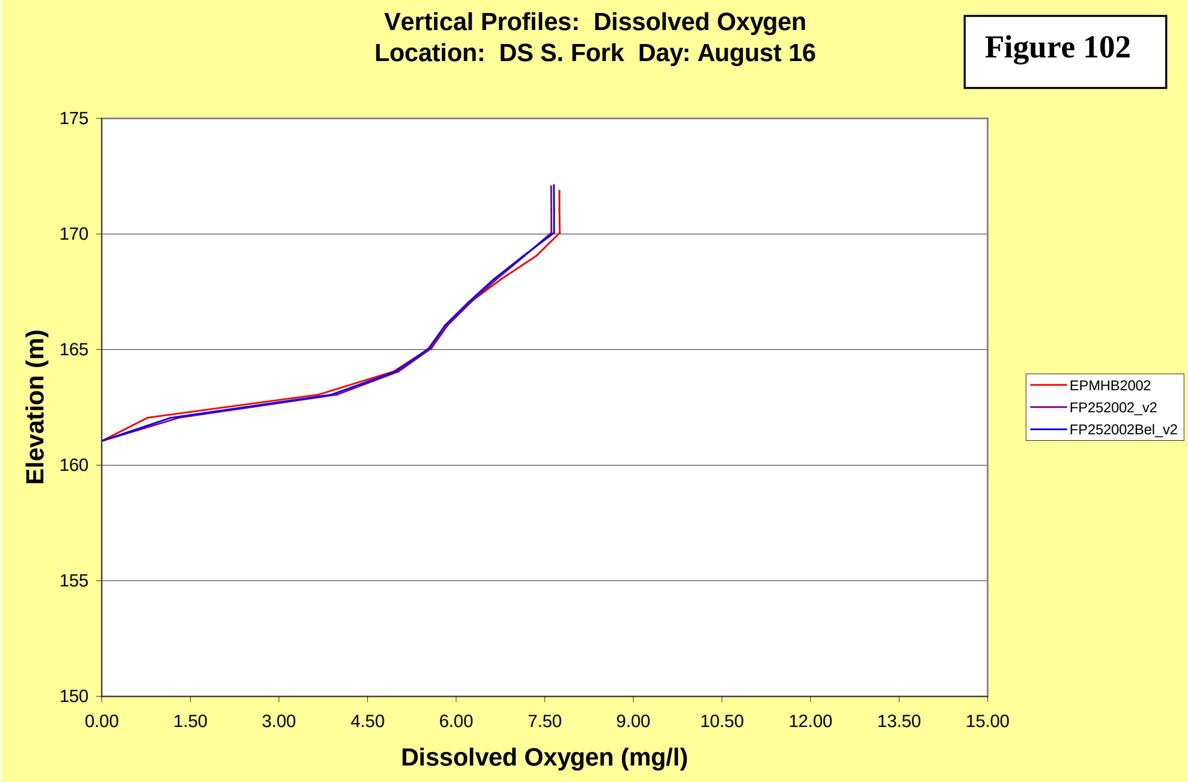


Figure 103

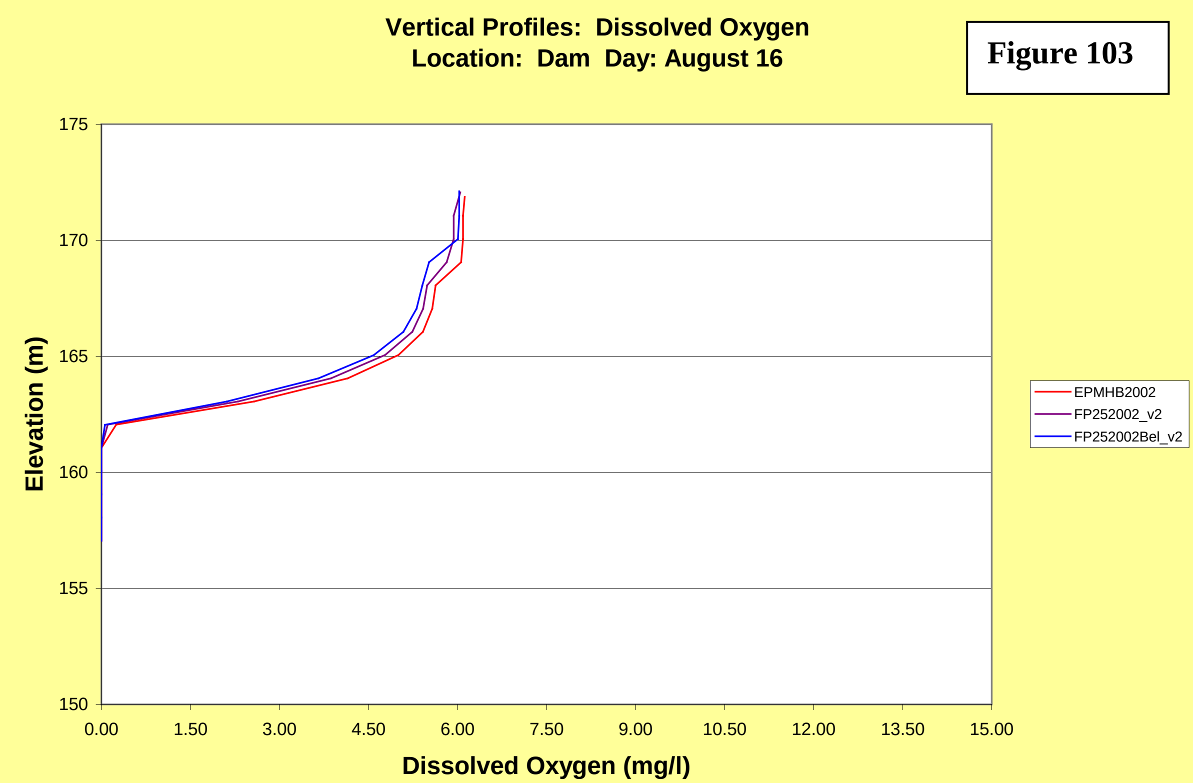


Figure 104

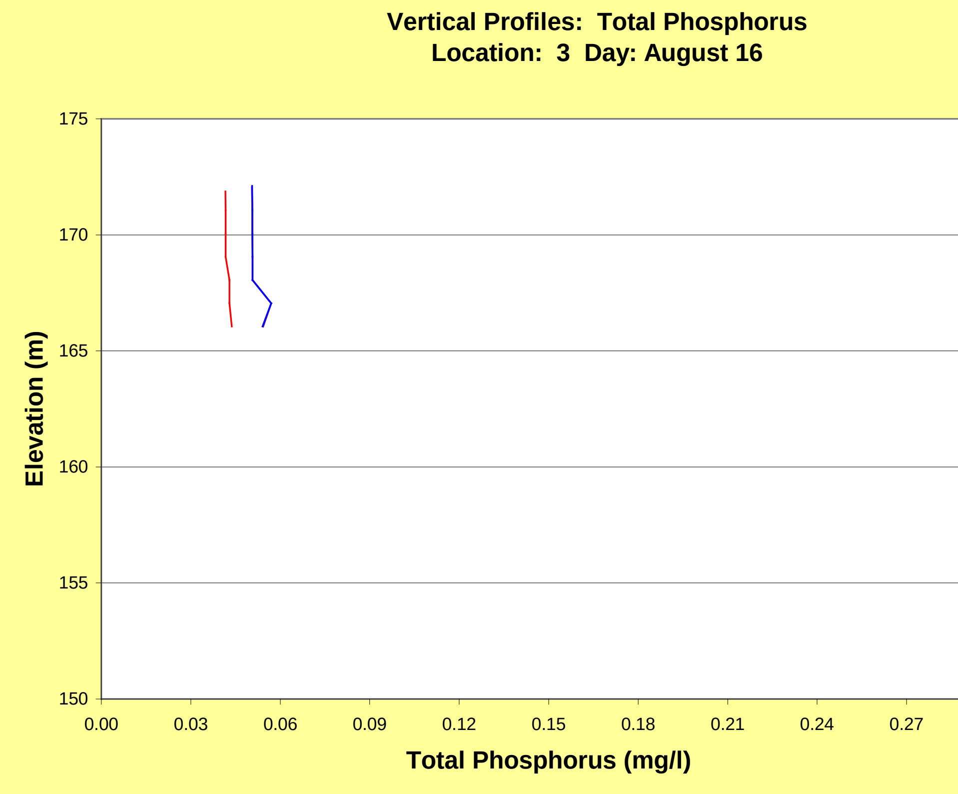
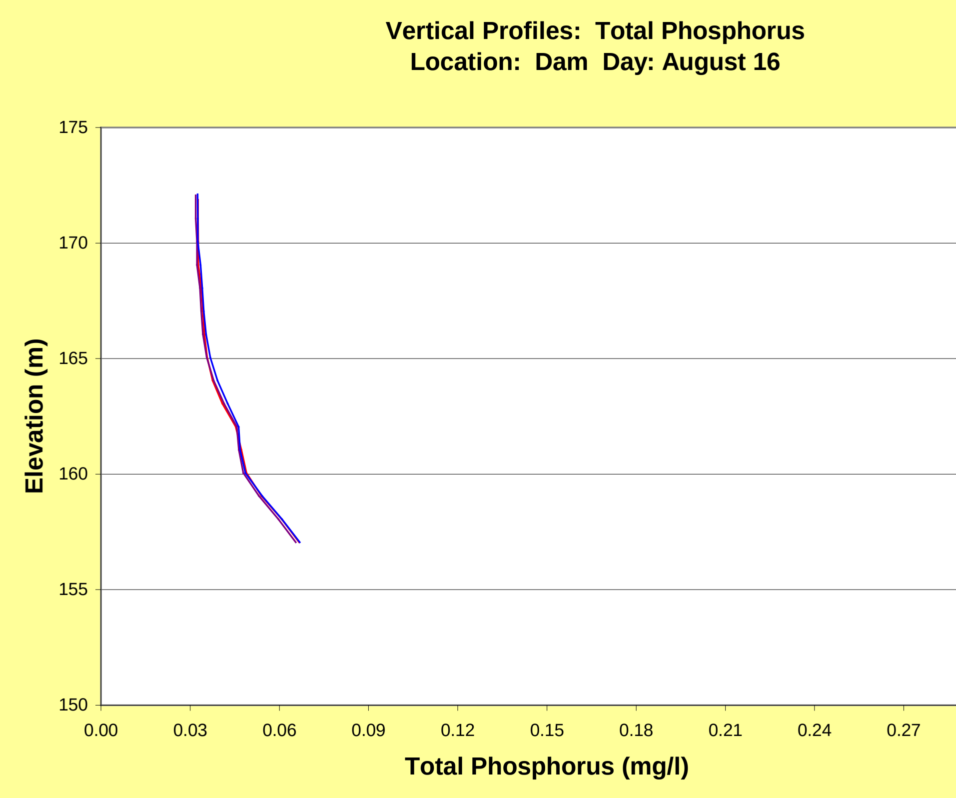
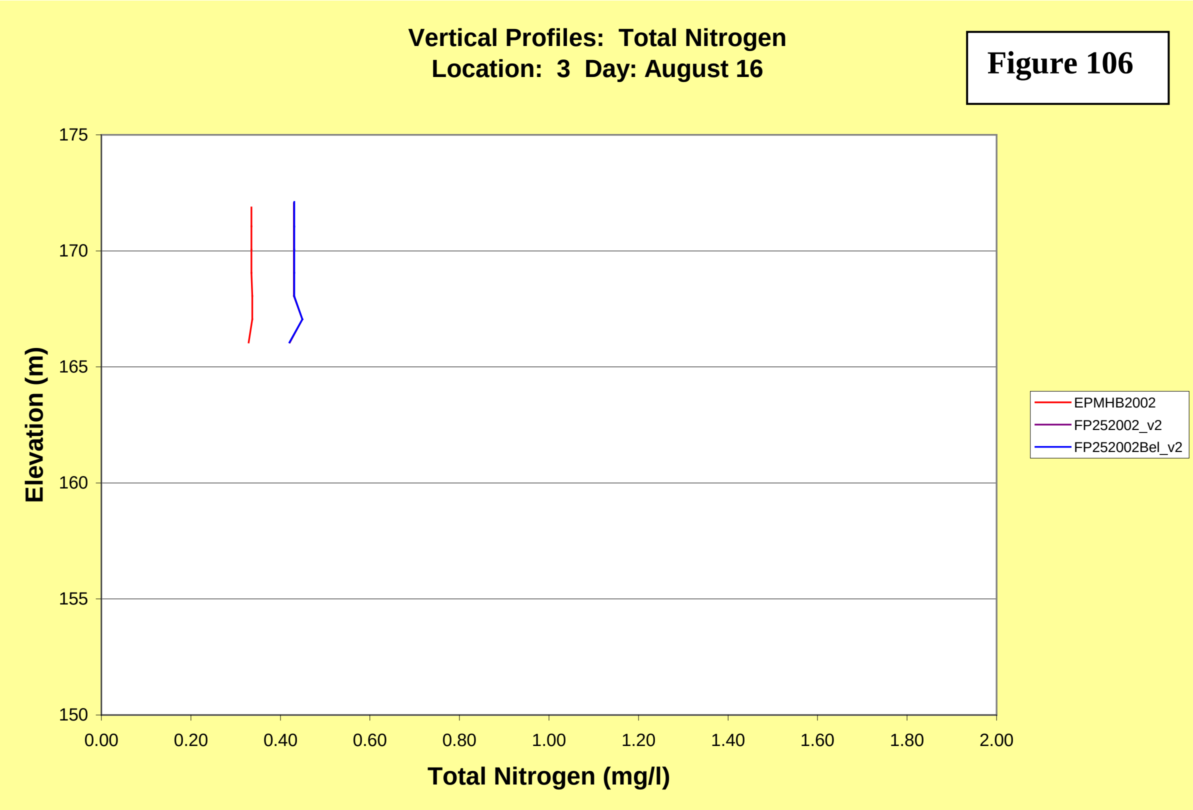
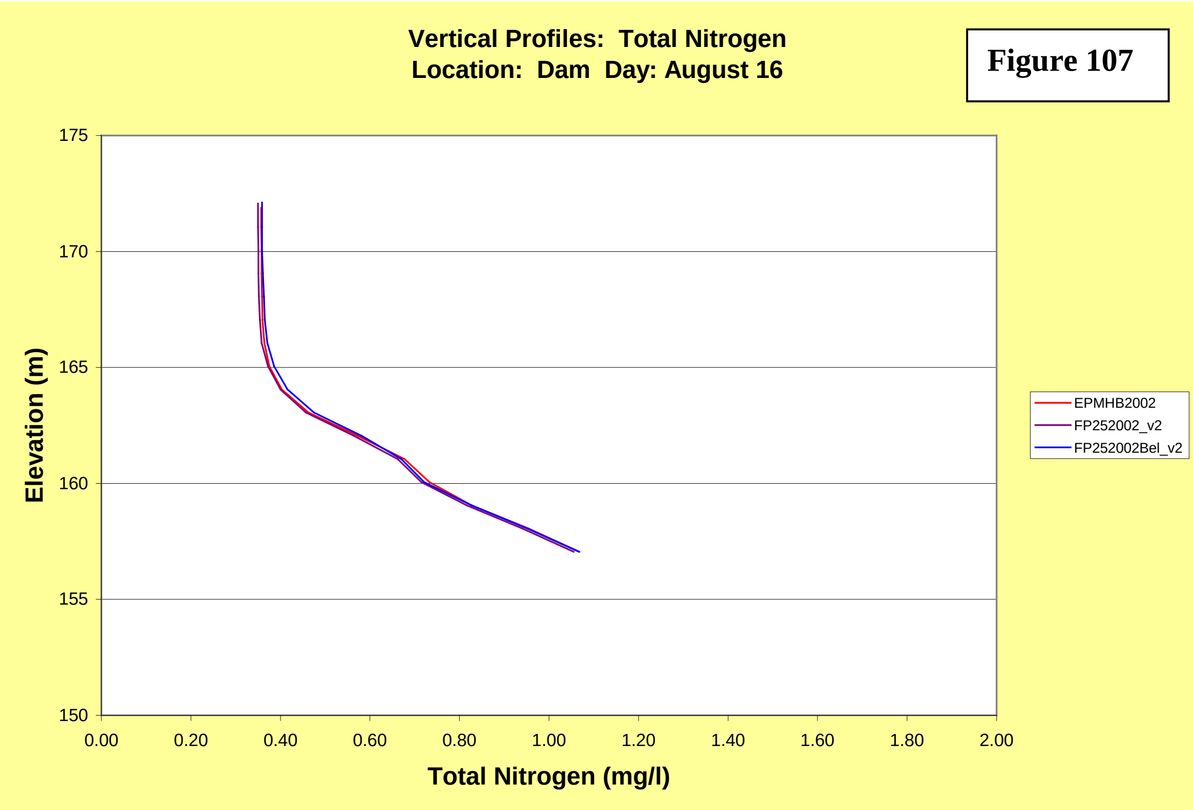
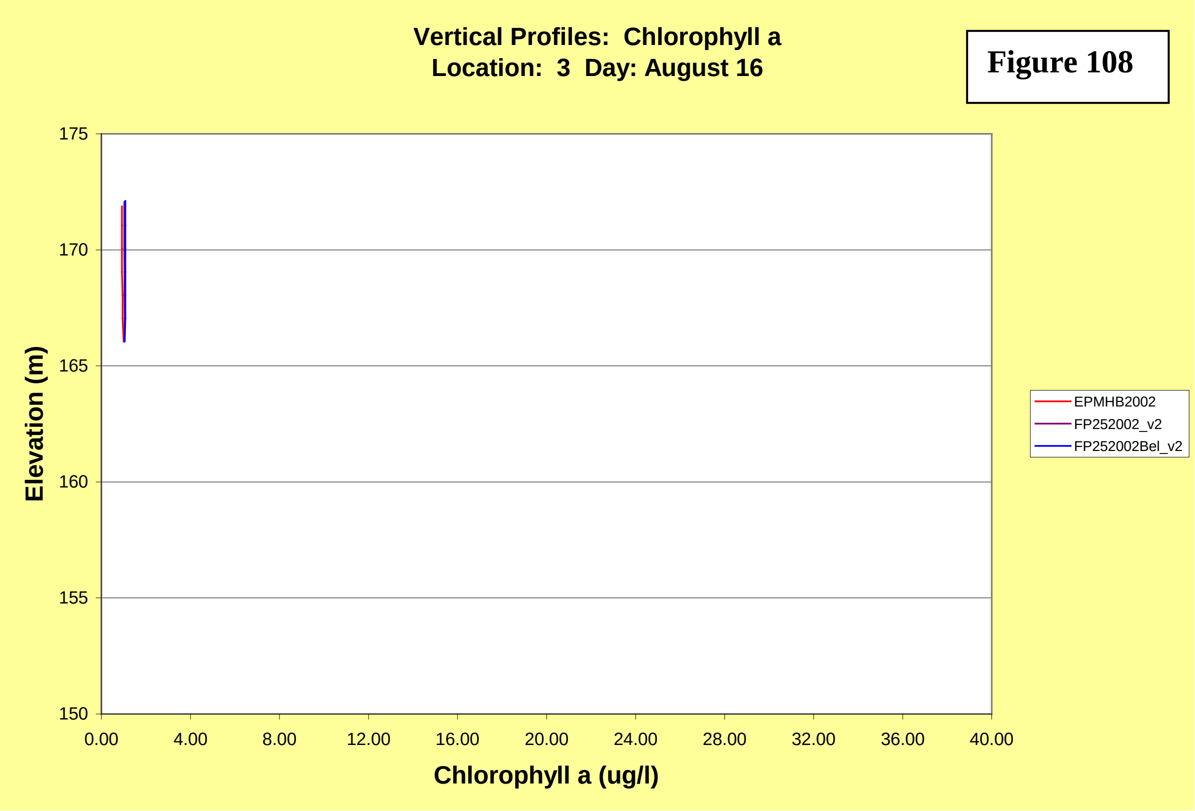


Figure 105




Vertical Profiles: Total Nitrogen
Location: 3 Day: August 16
Figure 106
Elevation (m)
175
170
165
160
155
150
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
Total Nitrogen (mg/l)
EPMHB2002
FP252002_v2
FP252002Bel_v2


Vertical Profiles: Total Nitrogen
Location: Dam Day: August 16
Figure 107
Elevation (m)
175
170
165
160
155
150
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
Total Nitrogen (mg/l)
EPMHB2002
FP252002_v2
FP252002Bel_v2


Vertical Profiles: Chlorophyll a
Location: 3 Day: August 16
Figure 108
Elevation (m)
175
170
165
160
155
150
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
36.00
40.00
Chlorophyll a (ug/l)
EPMHB2002
FP252002_v2
FP252002Bel_v2

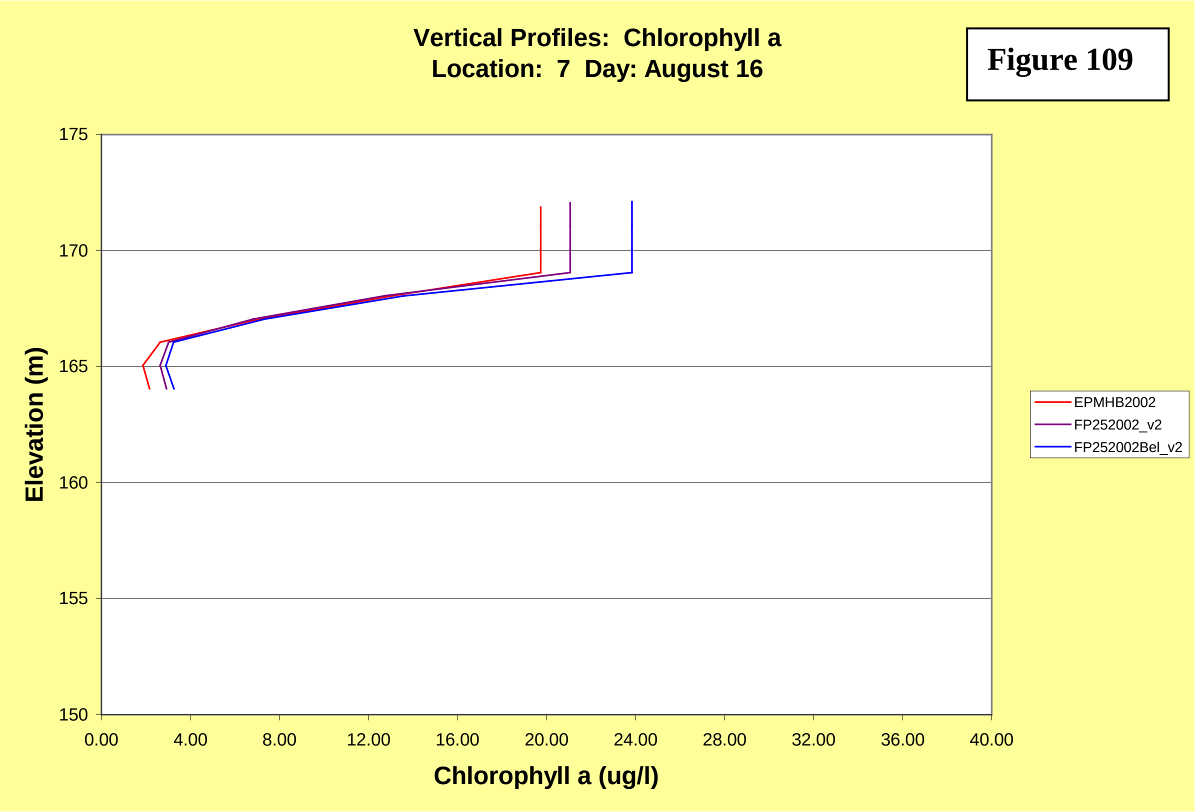

Vertical Profiles: Chlorophyll a
Location: 7 Day: August 16
Figure 109
Elevation (m)
175
170
165
160
155
150
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
36.00
40.00
Chlorophyll a (ug/l)
EPMHB2002
FP252002_v2
FP252002Bel_v2

Figure 110

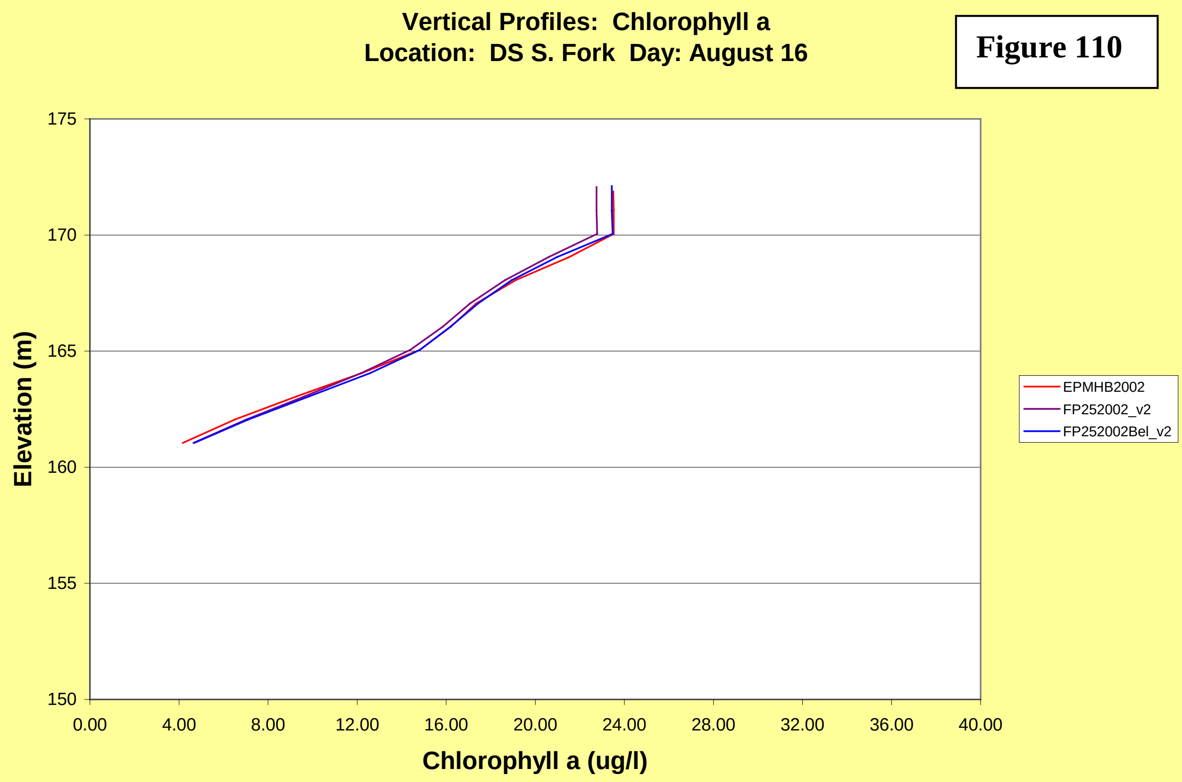
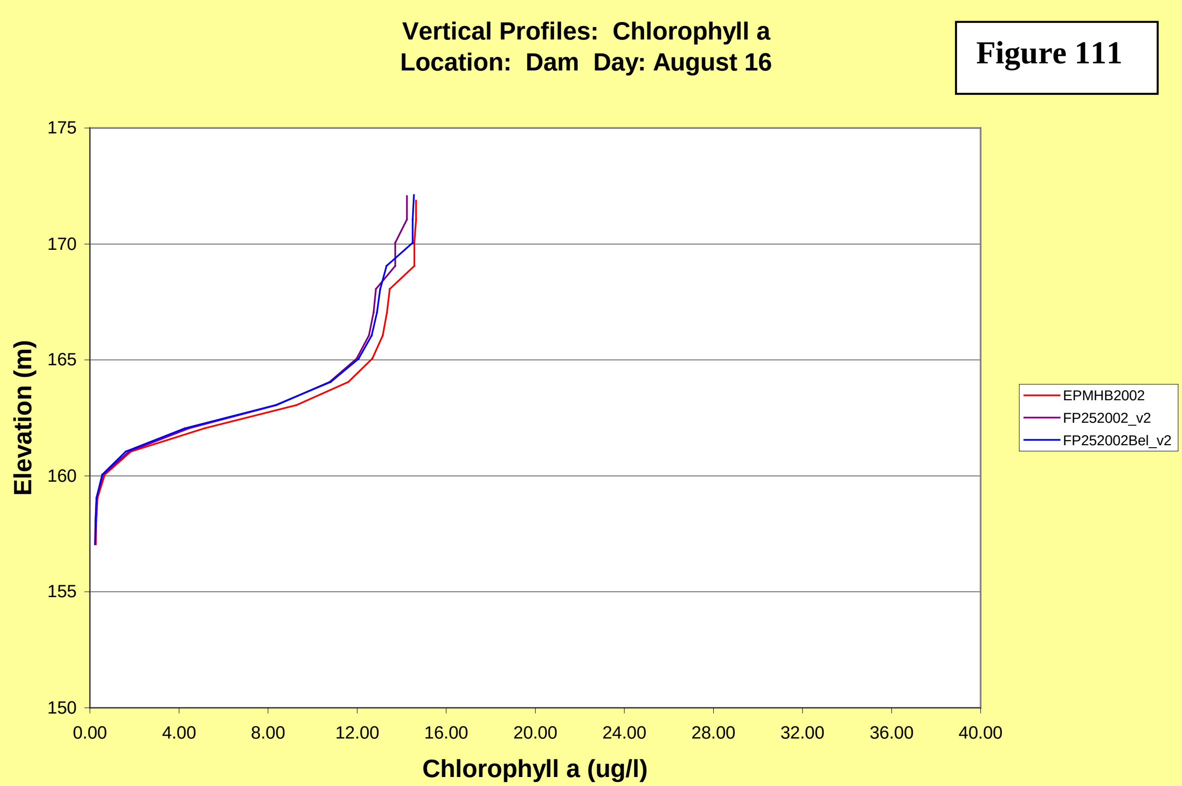
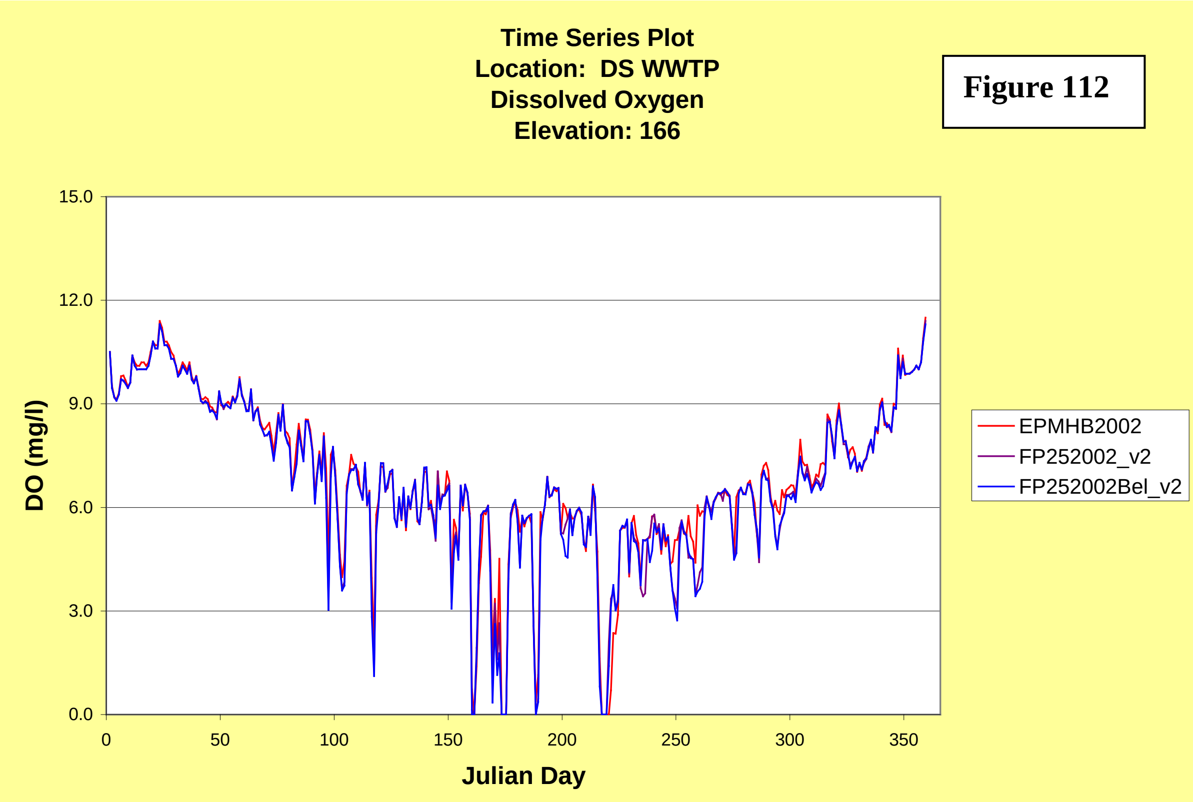
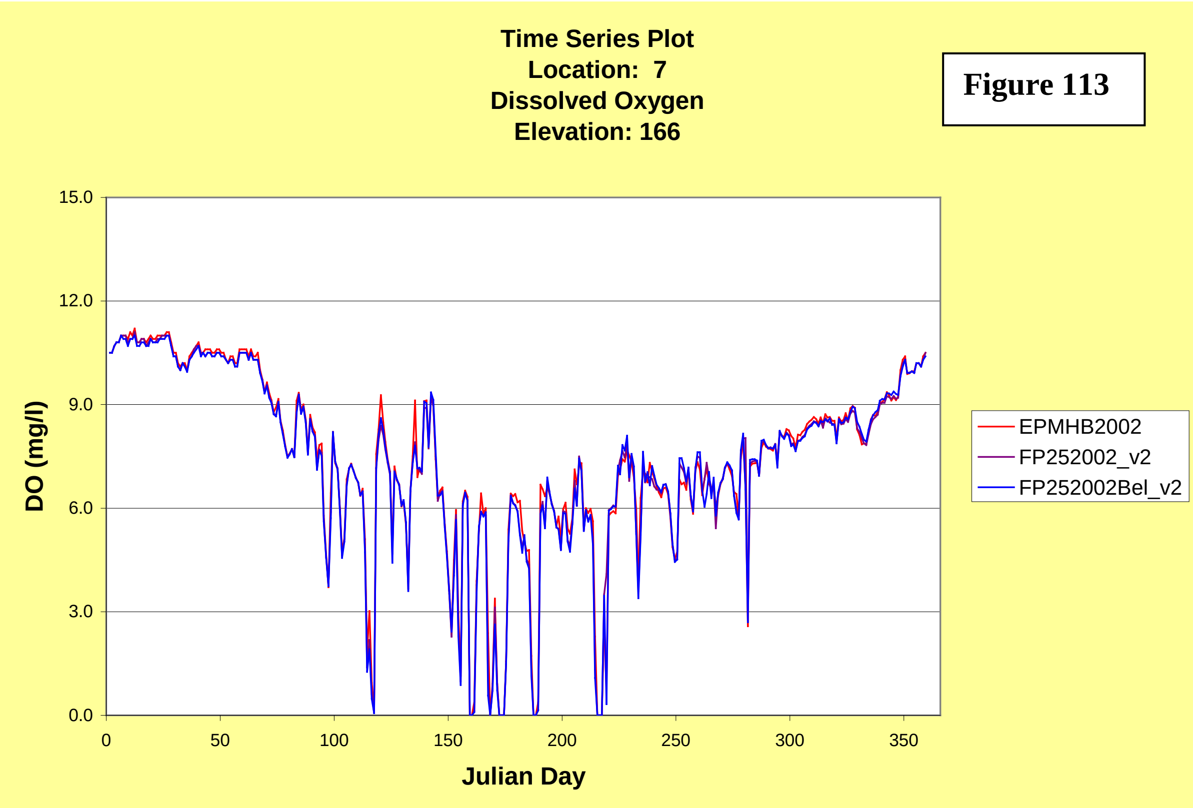
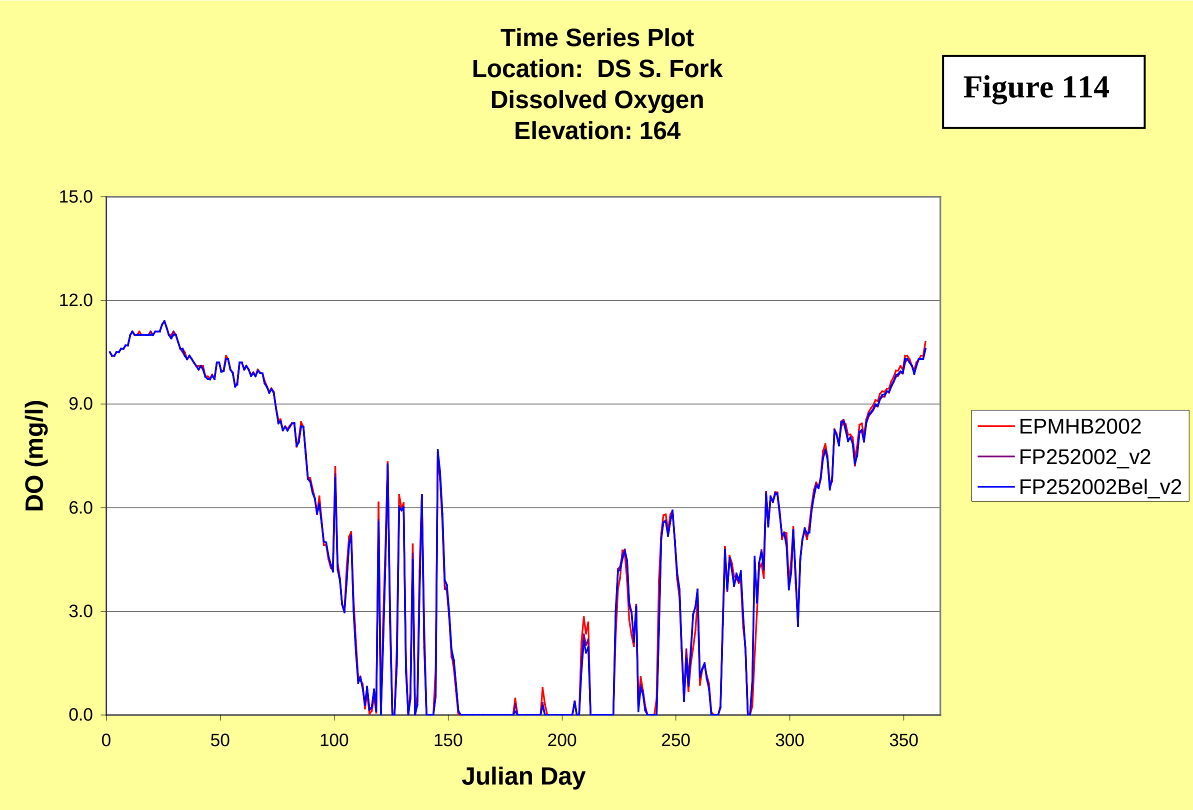


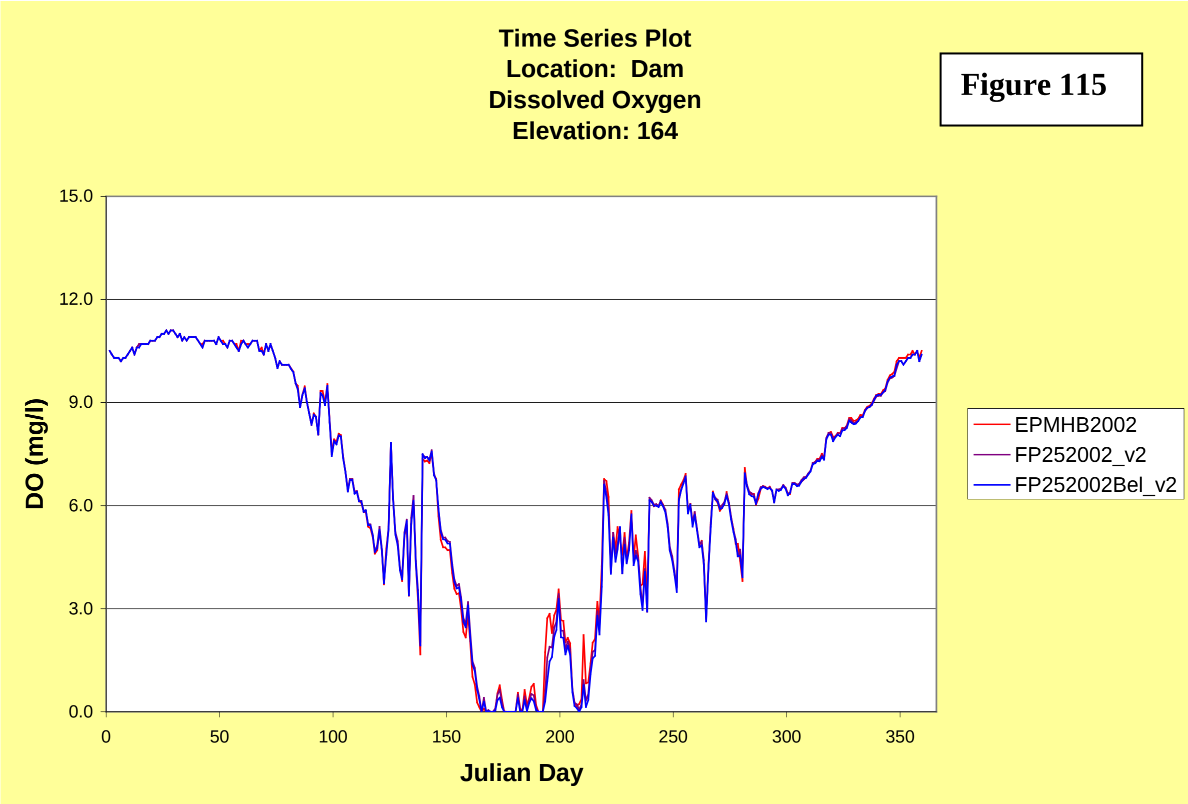
Figure 111

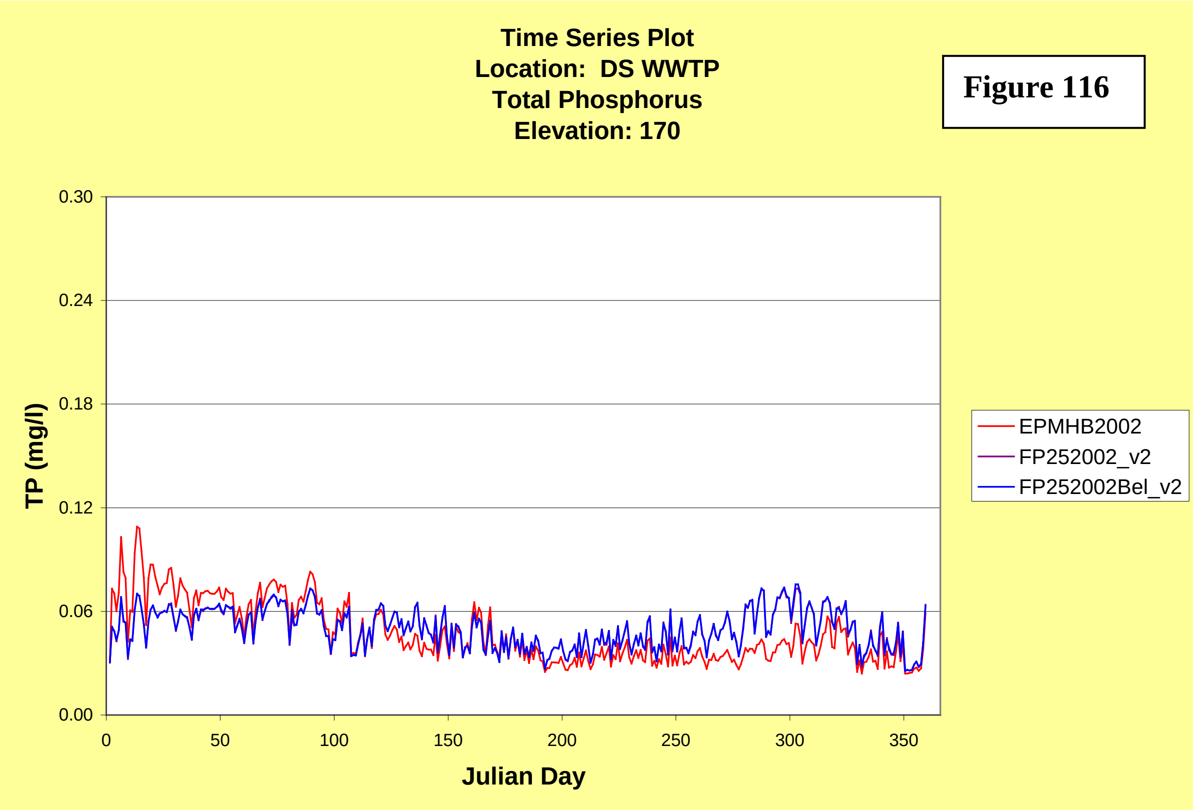


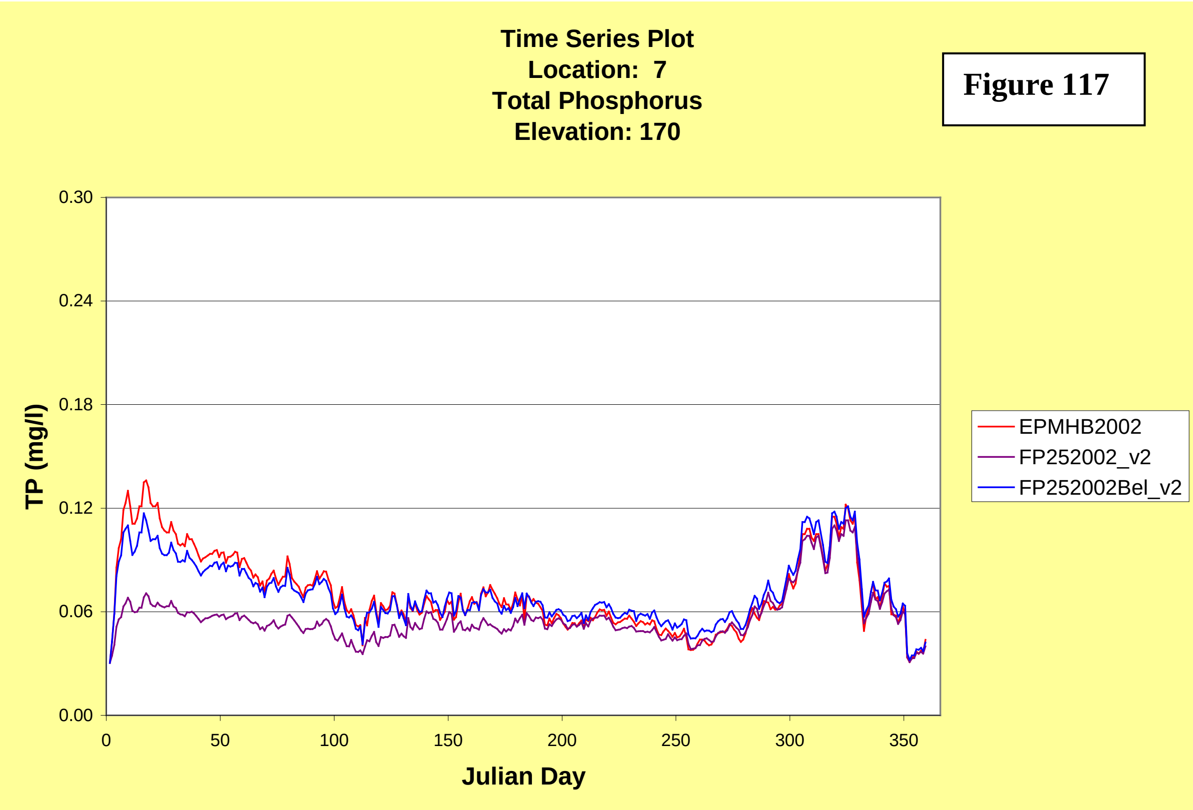

Time Series Plot
Location: DS WWTP
Dissolved Oxygen
Elevation: 166
Figure 112
DO (mg/l)
Julian Day
EPMHB2002
FP252002_v2
FP252002Bel_v2

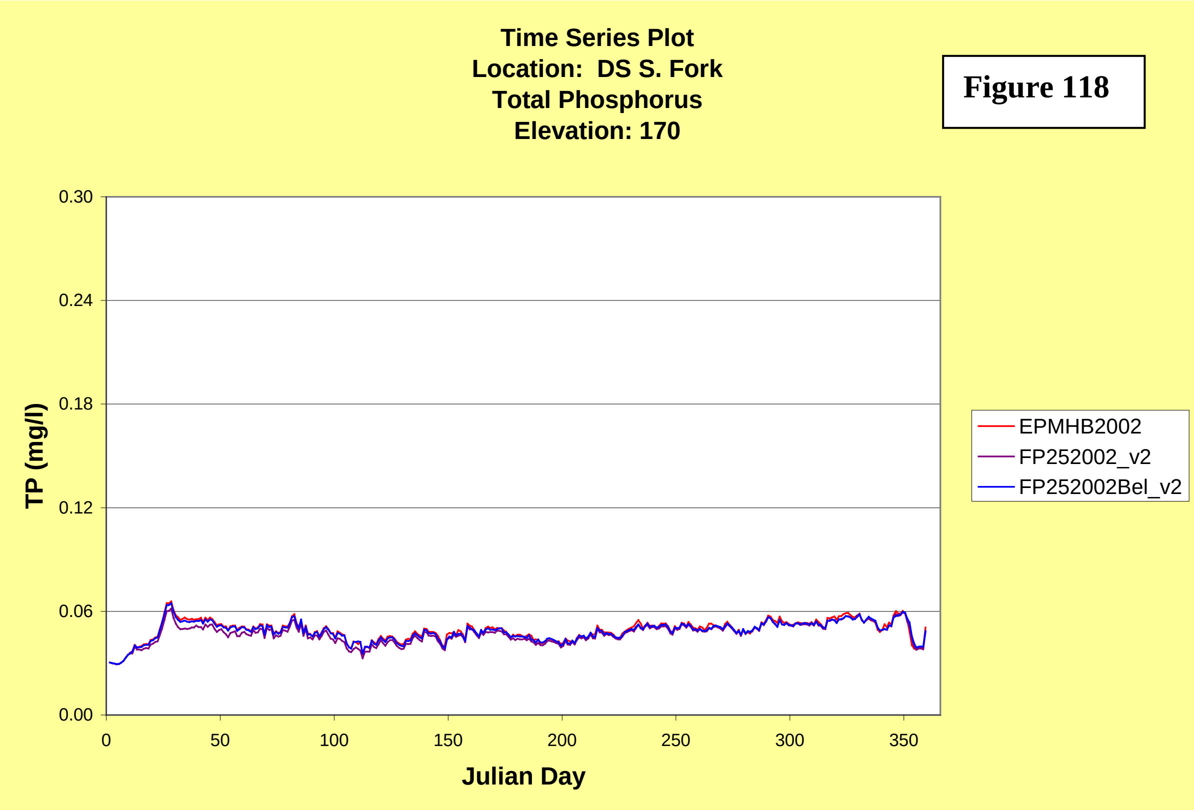

Time Series Plot
Location: 7
Dissolved Oxygen
Elevation: 166
Figure 113
DO (mg/l)
Julian Day
EPMHB2002
FP252002_v2
FP252002Bel_v2

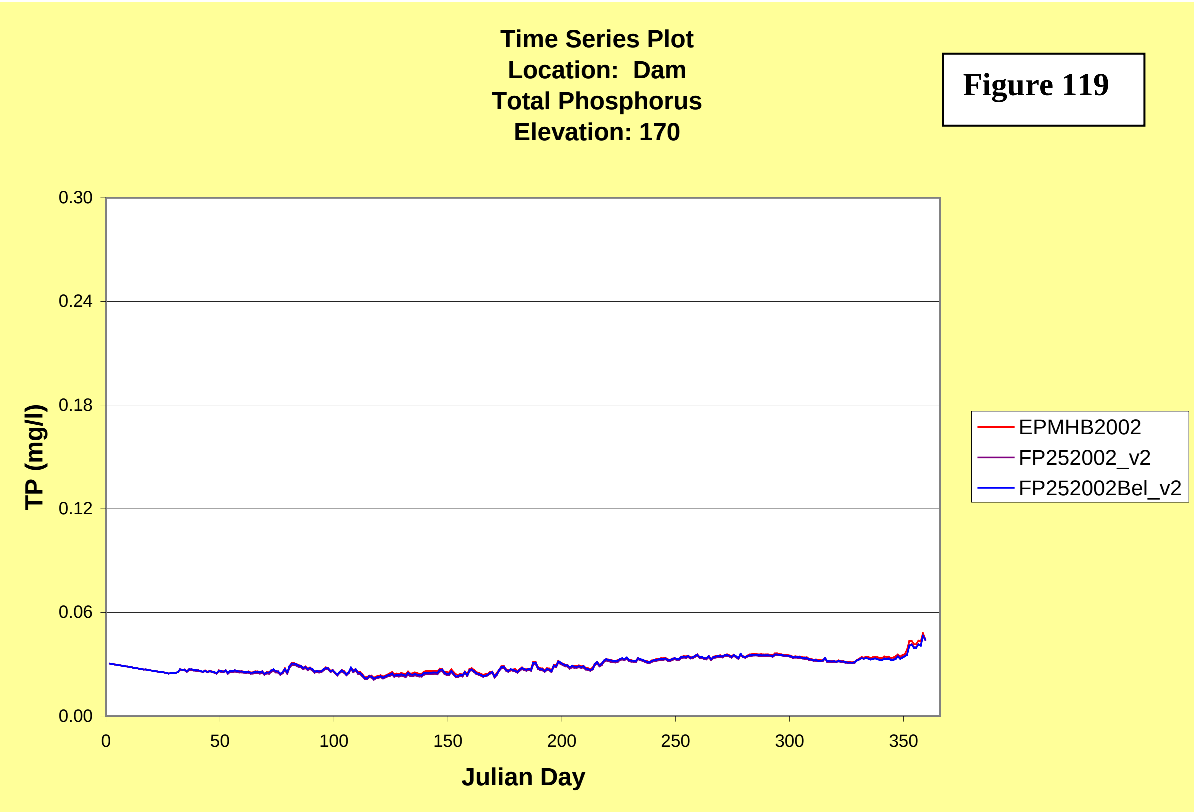

Time Series Plot
Location: DS S. Fork
Dissolved Oxygen
Elevation: 164
Figure 114
15.0
12.0
9.0
6.0
3.0
0.0
DO (mg/l)
0
50
100
150
200
250
300
350
Julian Day
EPMHB2002
FP252002_v2
FP252002Bel_v2

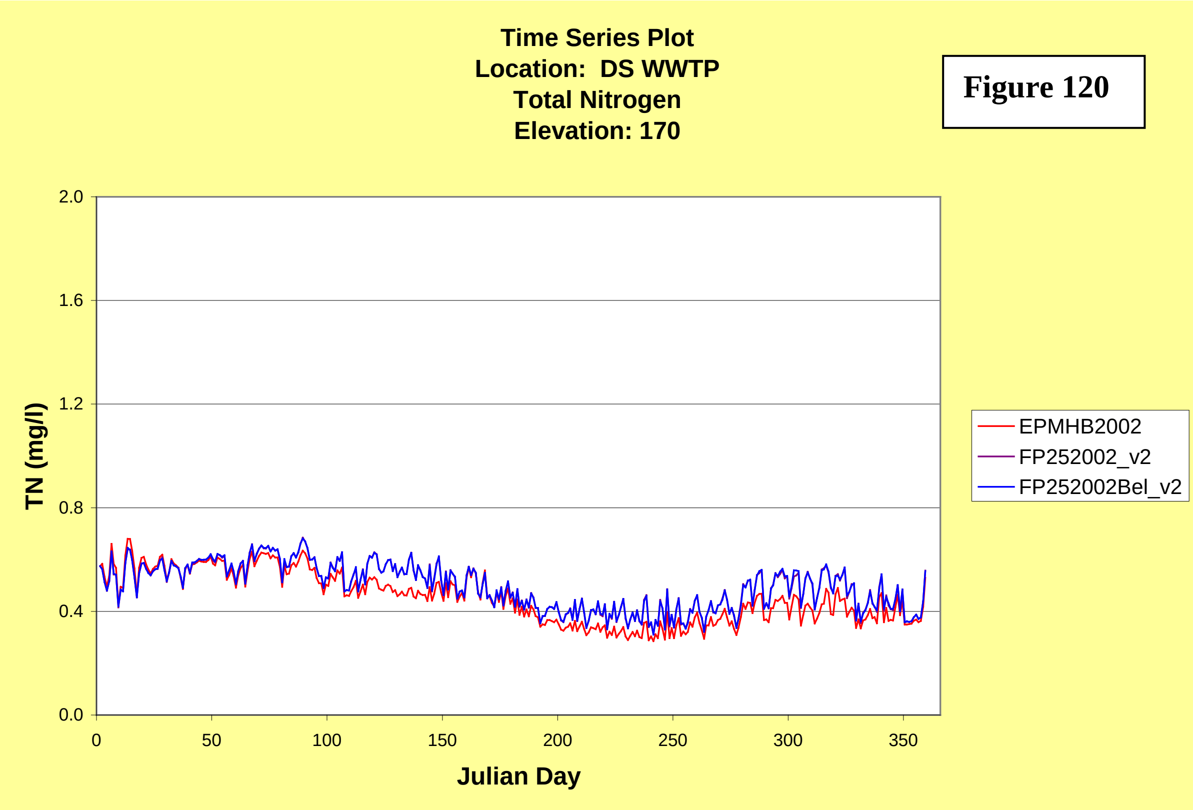

Time Series Plot
Location: Dam
Dissolved Oxygen
Elevation: 164
Figure 115
15.0
12.0
9.0
6.0
3.0
0.0
DO (mg/l)
0
50
100
150
200
250
300
350
Julian Day
EPMHB2002
FP252002_v2
FP252002Bel_v2

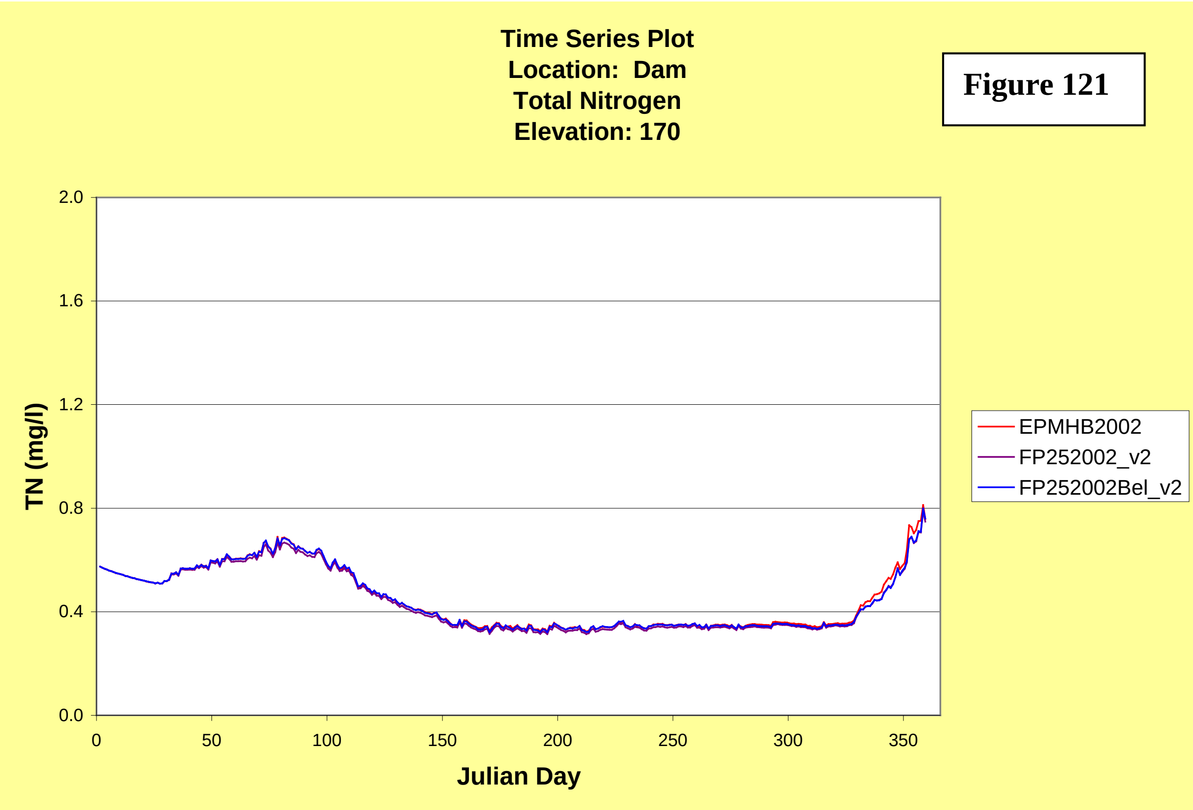

Time Series Plot
Location: DS WWTP
Total Phosphorus
Elevation: 170
Figure 116
TP (mg/l)
0.30
0.24
0.18
0.12
0.06
0.00
0
50
100
150
200
250
300
350
Julian Day
EPMHB2002
FP252002_v2
FP252002Bel_v2

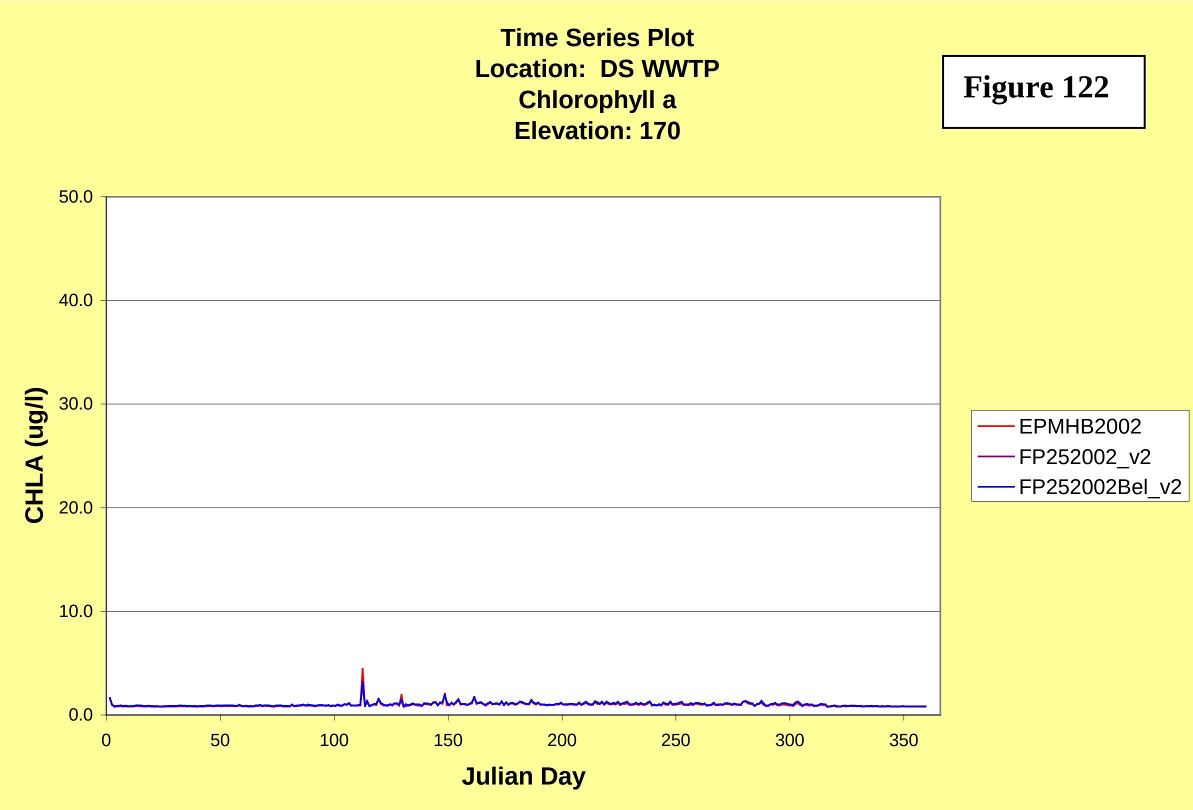

Time Series Plot
Location: 7
Total Phosphorus
Elevation: 170
Figure 117
TP (mg/l)
0.30
0.24
0.18
0.12
0.06
0.00
0
50
100
150
200
250
300
350
Julian Day
EPMHB2002
FP252002_v2
FP252002Bel_v2

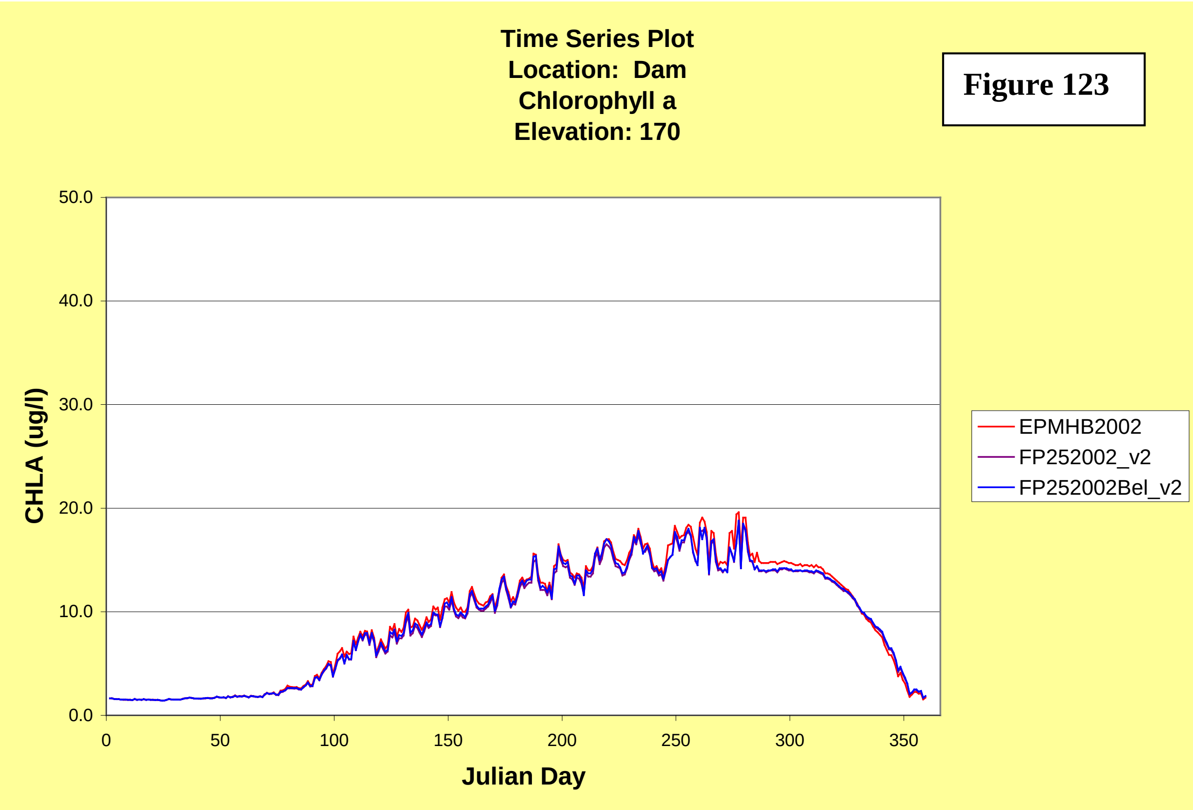

Time Series Plot
Location: DS S. Fork
Total Phosphorus
Elevation: 170
Figure 118
TP (mg/l)
0.30
0.24
0.18
0.12
0.06
0.00
0
50
100
150
200
250
300
350
Julian Day
EPMHB2002
FP252002_v2
FP252002Bel_v2


Time Series Plot
Location: Dam
Total Phosphorus
Elevation: 170
Figure 119
TP (mg/l)
0.30
0.24
0.18
0.12
0.06
0.00
0
50
100
150
200
250
300
350
Julian Day
EPMHB2002
FP252002_v2
FP252002Bel_v2


Time Series Plot
Location: DS WWTP
Total Nitrogen
Elevation: 170
Figure 120
TN (mg/l)
2.0
1.6
1.2
0.8
0.4
0.0
0
50
100
150
200
250
300
350
Julian Day
EPMHB2002
FP252002_v2
FP252002Bel_v2


Time Series Plot
Location: Dam
Total Nitrogen
Elevation: 170
Figure 121
TN (mg/l)
2.0
1.6
1.2
0.8
0.4
0.0
0
50
100
150
200
250
300
350
Julian Day
EPMHB2002
FP252002_v2
FP252002Bel_v2


Time Series Plot
Location: DS WWTP
Chlorophyll a
Elevation: 170
Figure 122
CHLA (ug/l)
Julian Day
0.0
10.0
20.0
30.0
40.0
50.0
0
50
100
150
200
250
300
350
EPMHB2002
FP252002_v2
FP252002Bel_v2


Time Series Plot
Location: Dam
Chlorophyll a
Elevation: 170
Figure 123
CHLA (ug/l)
Julian Day
0.0
10.0
20.0
30.0
40.0
50.0
0
50
100
150
200
250
300
350
EPMHB2002
FP252002_v2
FP252002Bel_v2

Selected Figures for Permit Limits Conditions, 1998 Flow

Scenarios:

EPMHB1998 – permit limits, existing plants

FP251998_v2 – future permit limits at 25 mgd, with Belmont at existing loads

FP251998Bel_v2 – future permit limits at 25 mgd, Belmont at future loads

Vertical Plots – August 16, 1998

DO and Chlorophyll *a* at Segments 3, 7, 13 and 30

TP and TN at Segments 3 and 30

Time Series Plots

DO at Elevation 166 or 164 (near thermocline) at Segments 3, 7, 13 and 30

TP at Elevation 170 (near surface) at Segments 3, 7, 13, and 30

TP at Elevation 170 (near surface) at Segments 3 and 30

Chlorophyll a at Elevation 170 (near surface) at Segments 3 and 30

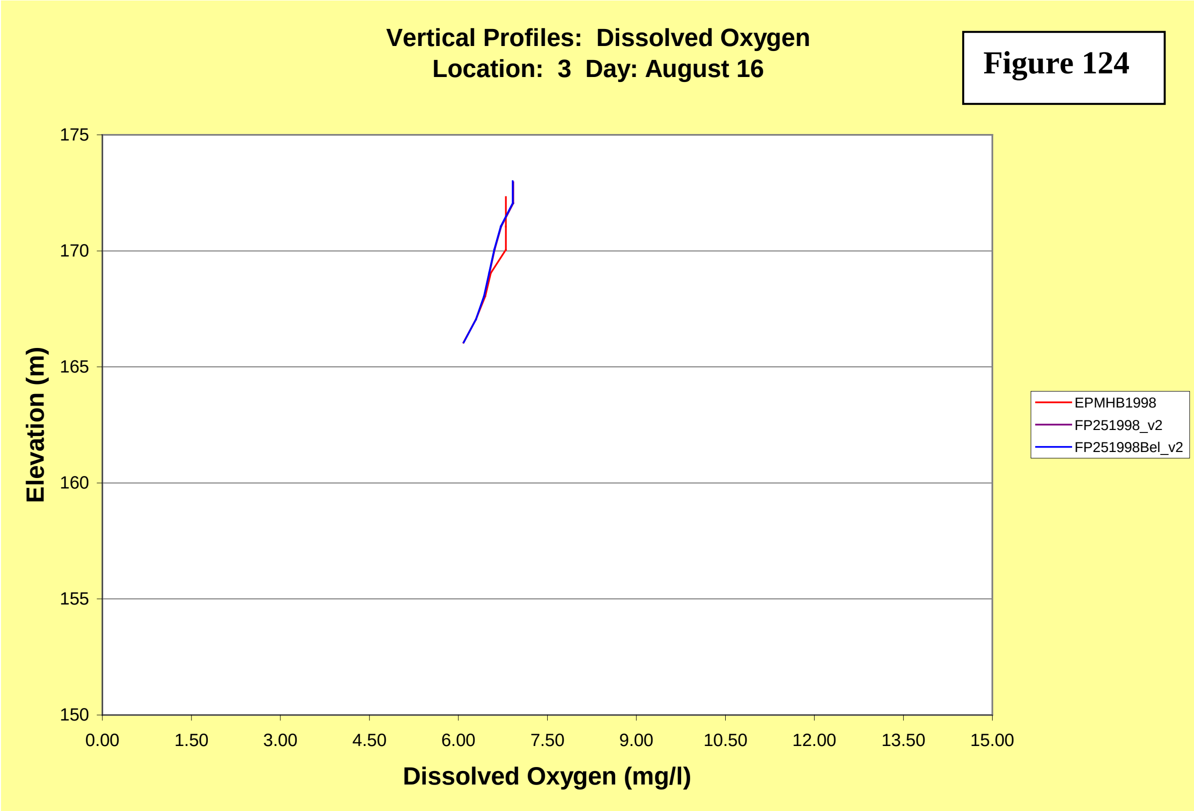
Segments

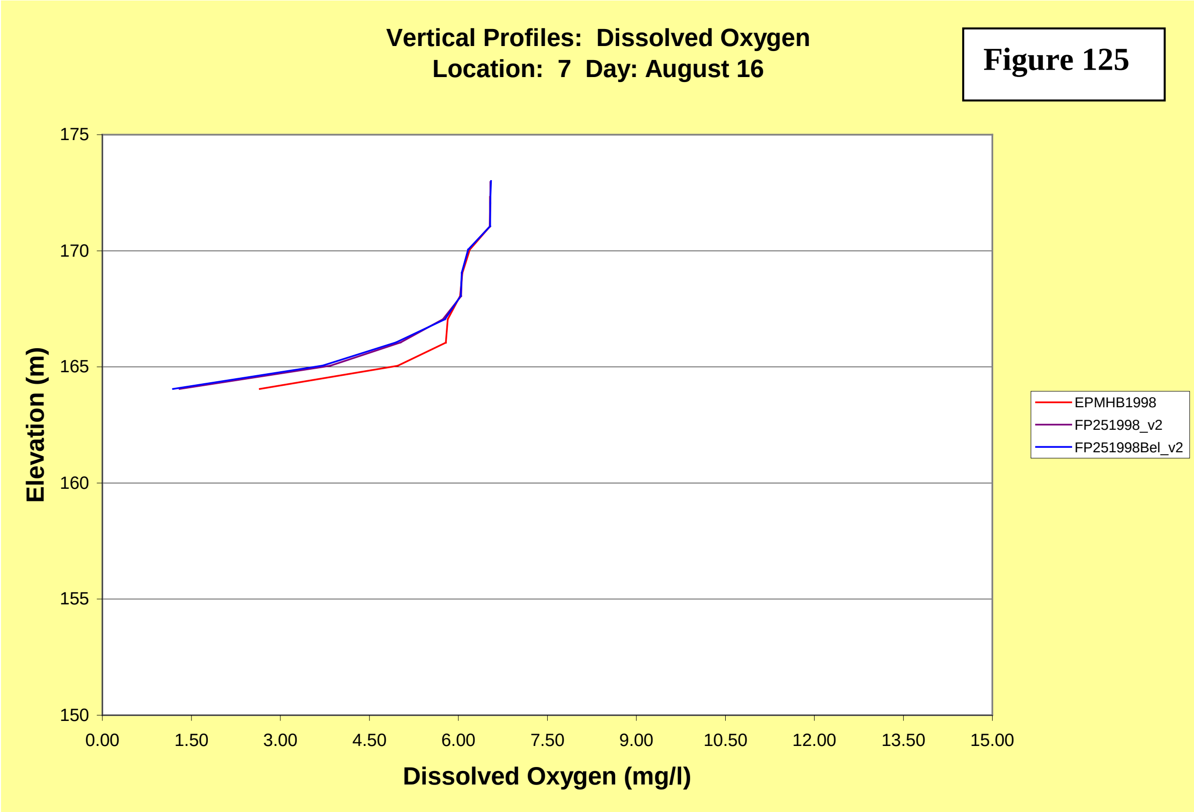
3 – downstream of Mount Holly/Long Creek Regional WWTP

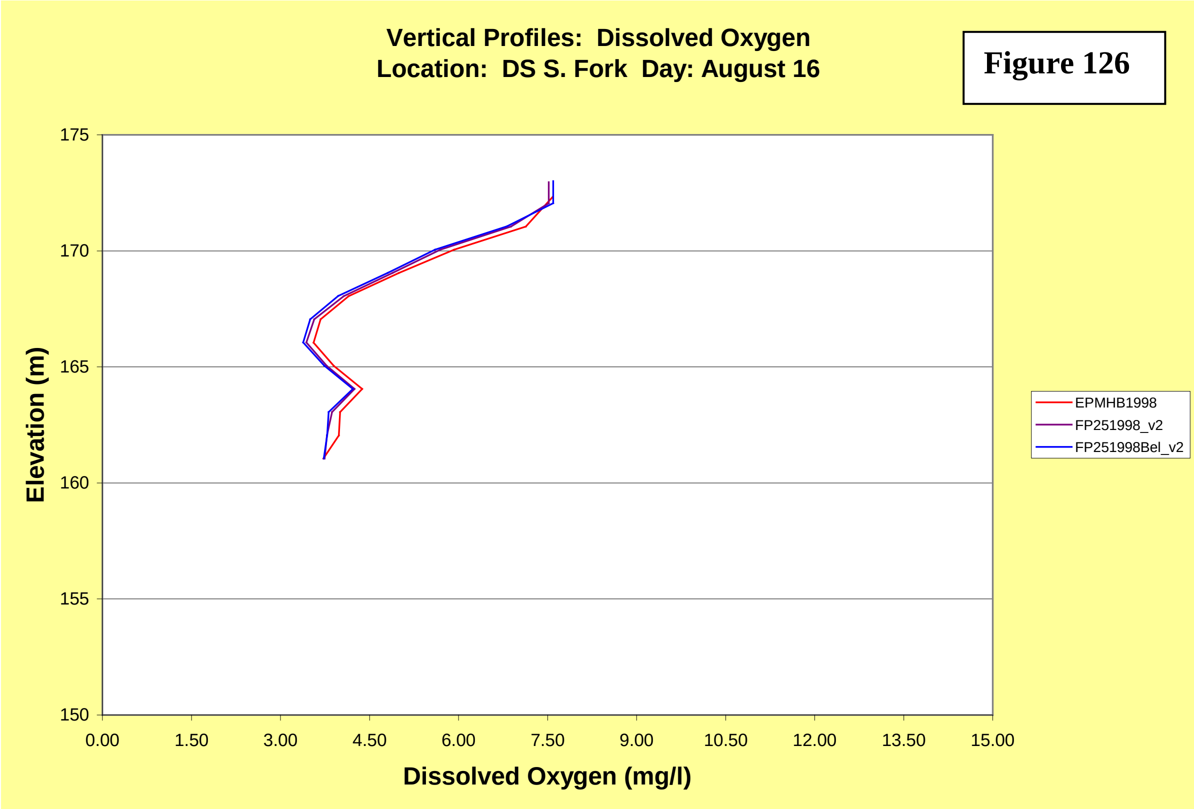
7 – segment downstream of Belmont WWTP

13 – segment downstream of junction with South Fork Branch

30 – segment in lower portion of the lake near the dam


Vertical Profiles: Dissolved Oxygen
Location: 3 Day: August 16
Figure 124
Elevation (m)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Dissolved Oxygen (mg/l)
EPMHB1998
FP251998_v2
FP251998Bel_v2


Vertical Profiles: Dissolved Oxygen
Location: 7 Day: August 16
Figure 125
Elevation (m)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Dissolved Oxygen (mg/l)
EPMHB1998
FP251998_v2
FP251998Bel_v2


Vertical Profiles: Dissolved Oxygen
Location: DS S. Fork Day: August 16
Figure 126
Elevation (m)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Dissolved Oxygen (mg/l)
EPMHB1998
FP251998_v2
FP251998Bel_v2

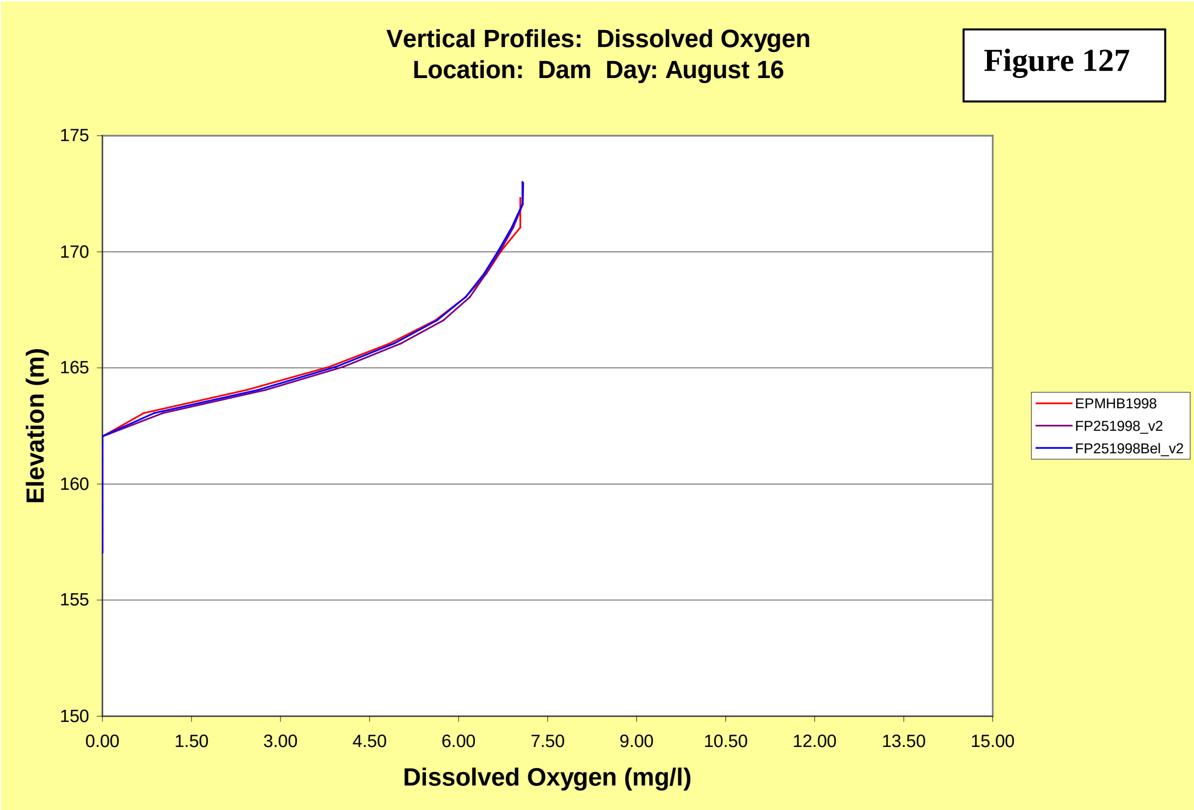

Vertical Profiles: Dissolved Oxygen
Location: Dam Day: August 16
Figure 127
Elevation (m)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Dissolved Oxygen (mg/l)
EPMHB1998
FP251998_v2
FP251998Bel_v2

Figure 128

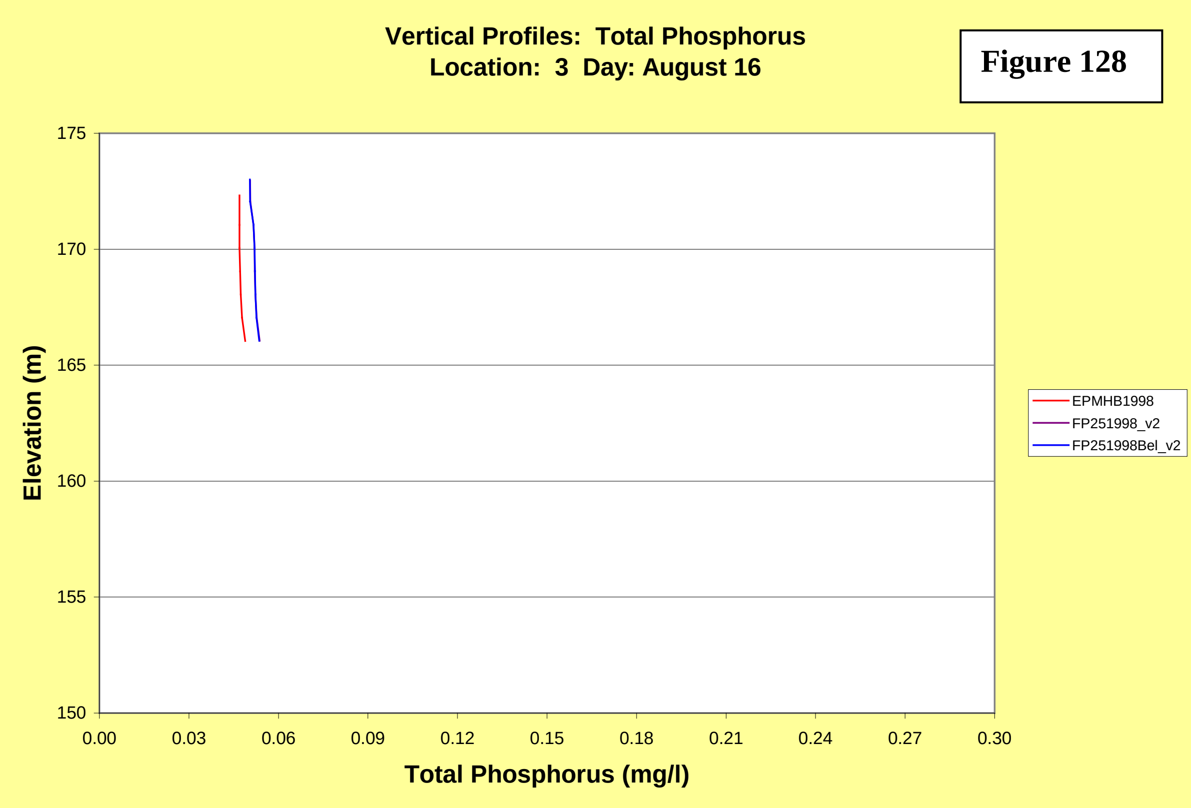


Figure 129

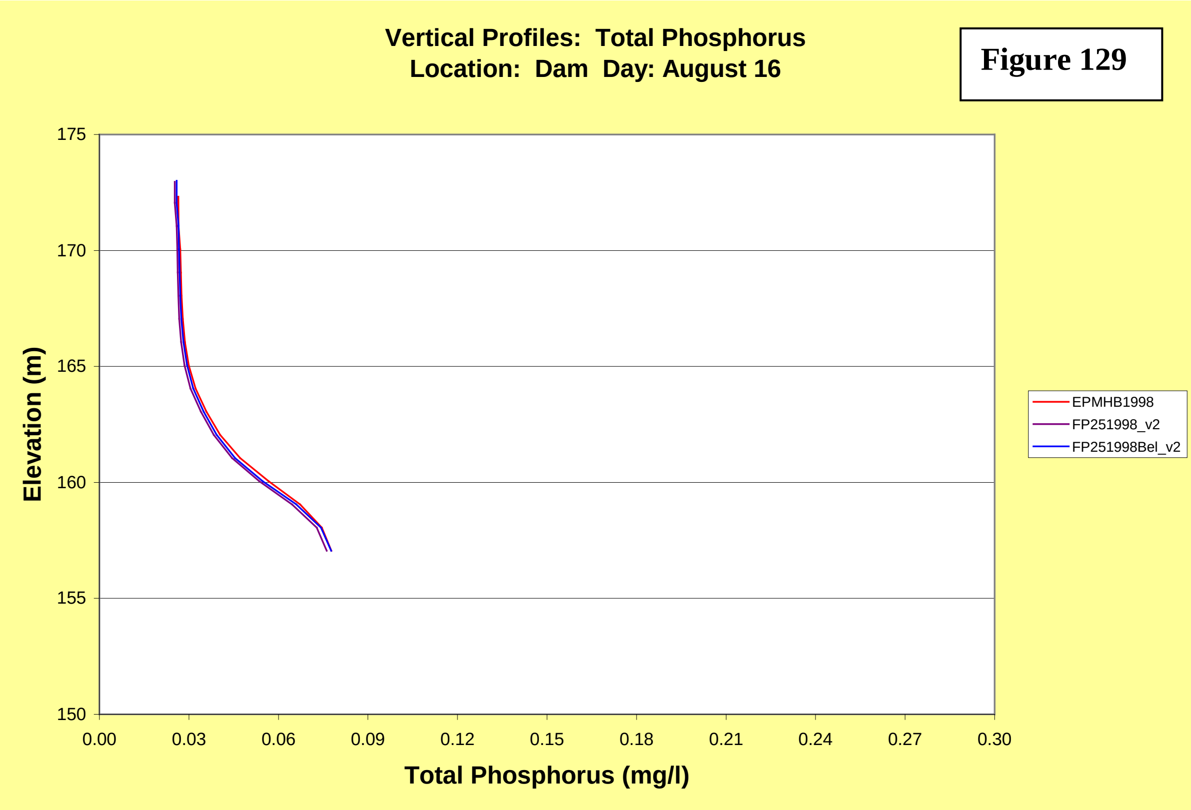


Figure 130

Vertical Profiles: Total Nitrogen
Location: 3 Day: August 16

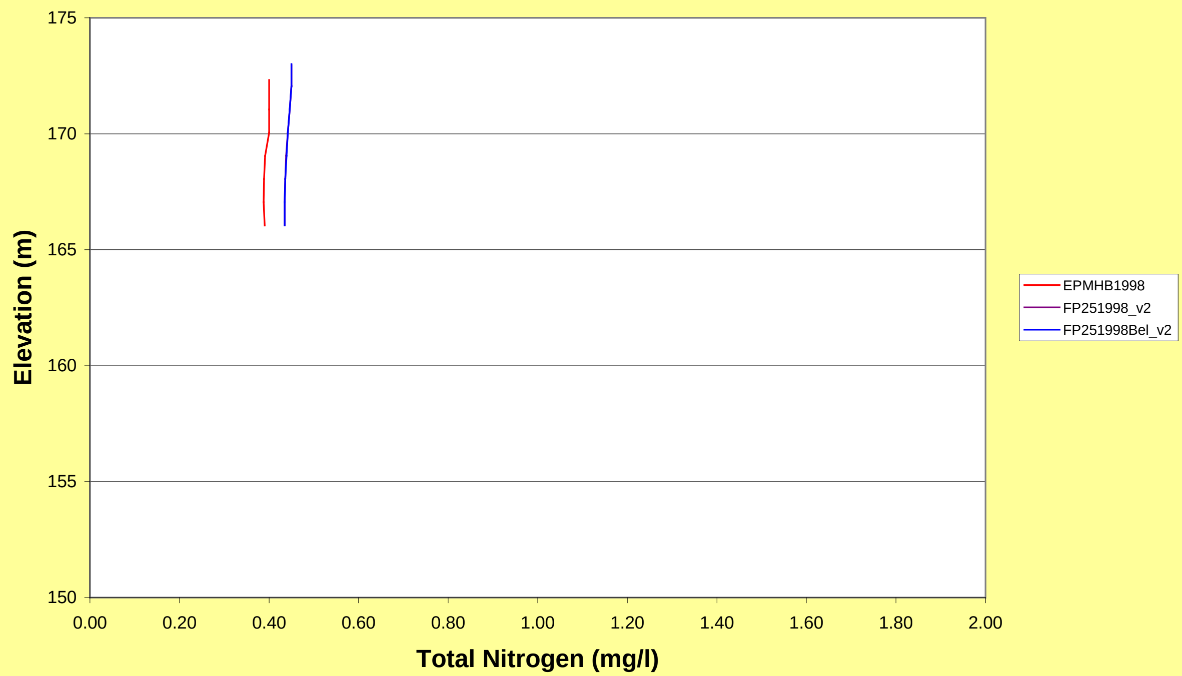
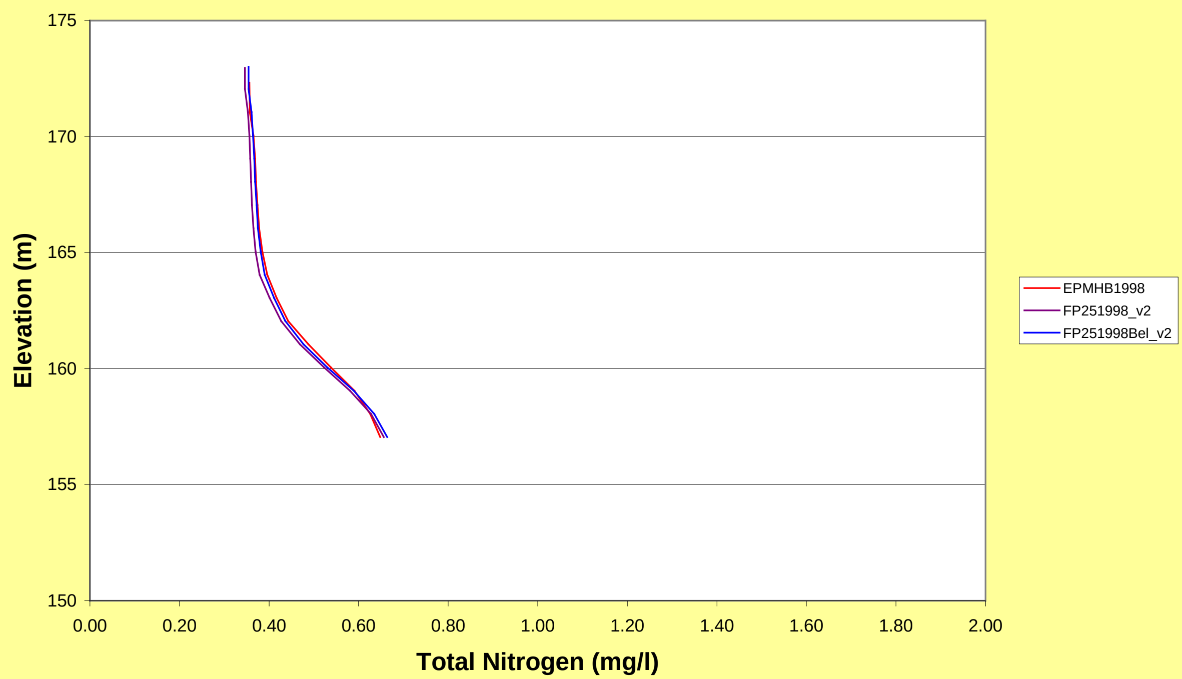
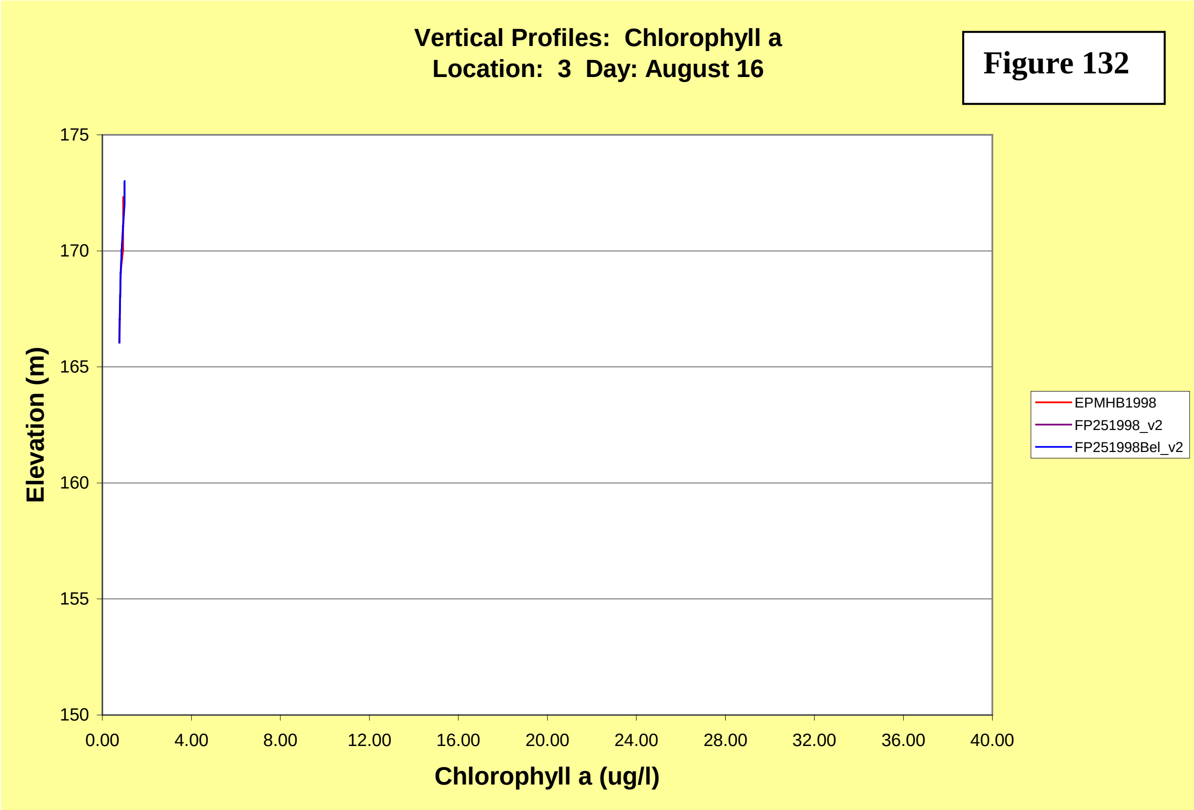


Figure 131

Vertical Profiles: Total Nitrogen
Location: Dam Day: August 16




Vertical Profiles: Chlorophyll a
Location: 3 Day: August 16
Figure 132
175
170
165
160
155
150
Elevation (m)
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
36.00
40.00
Chlorophyll a (ug/l)
EPMHB1998
FP251998_v2
FP251998Bel_v2

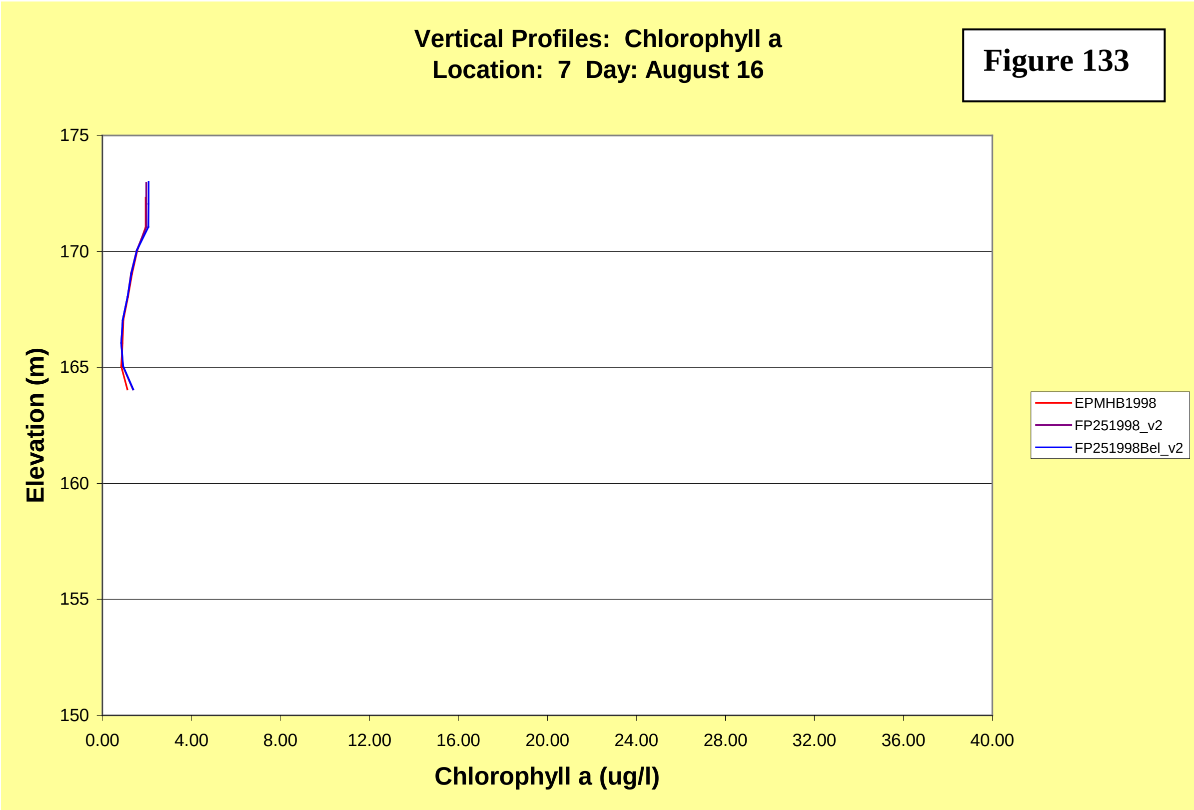

Vertical Profiles: Chlorophyll a
Location: 7 Day: August 16
Figure 133
175
170
165
160
155
150
Elevation (m)
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
36.00
40.00
Chlorophyll a (ug/l)
EPMHB1998
FP251998_v2
FP251998Bel_v2

Figure 134

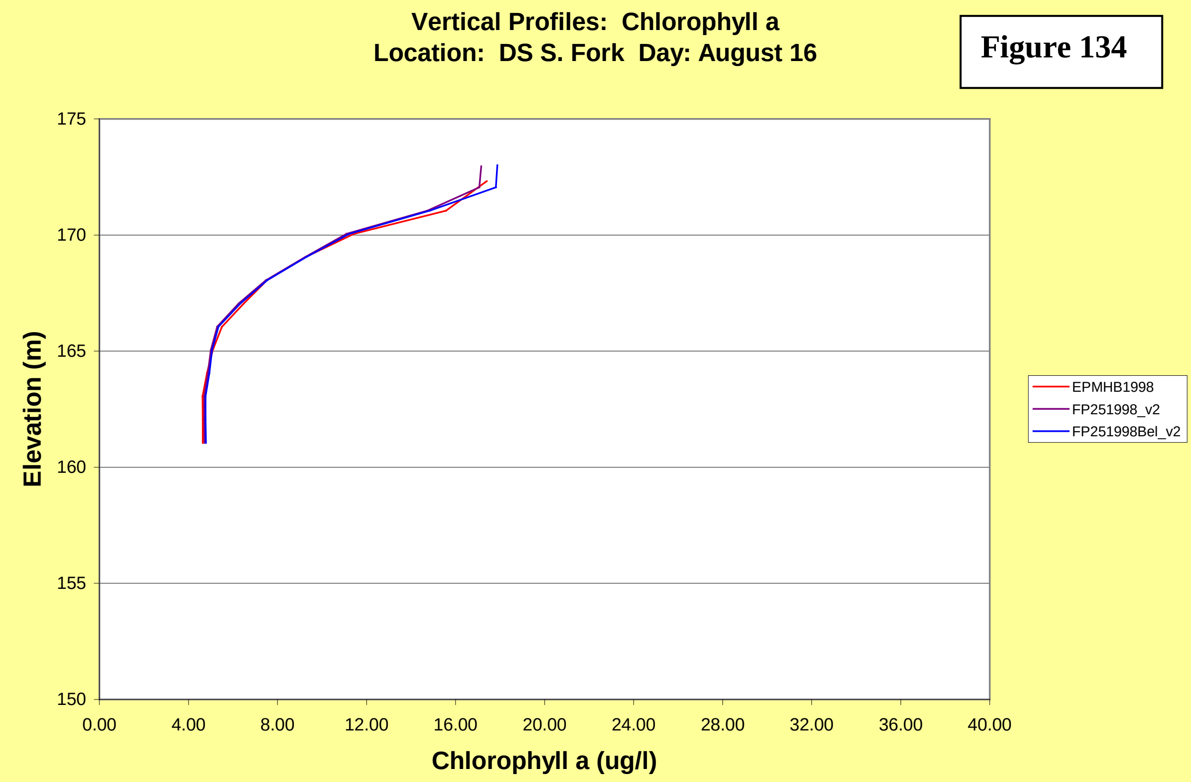
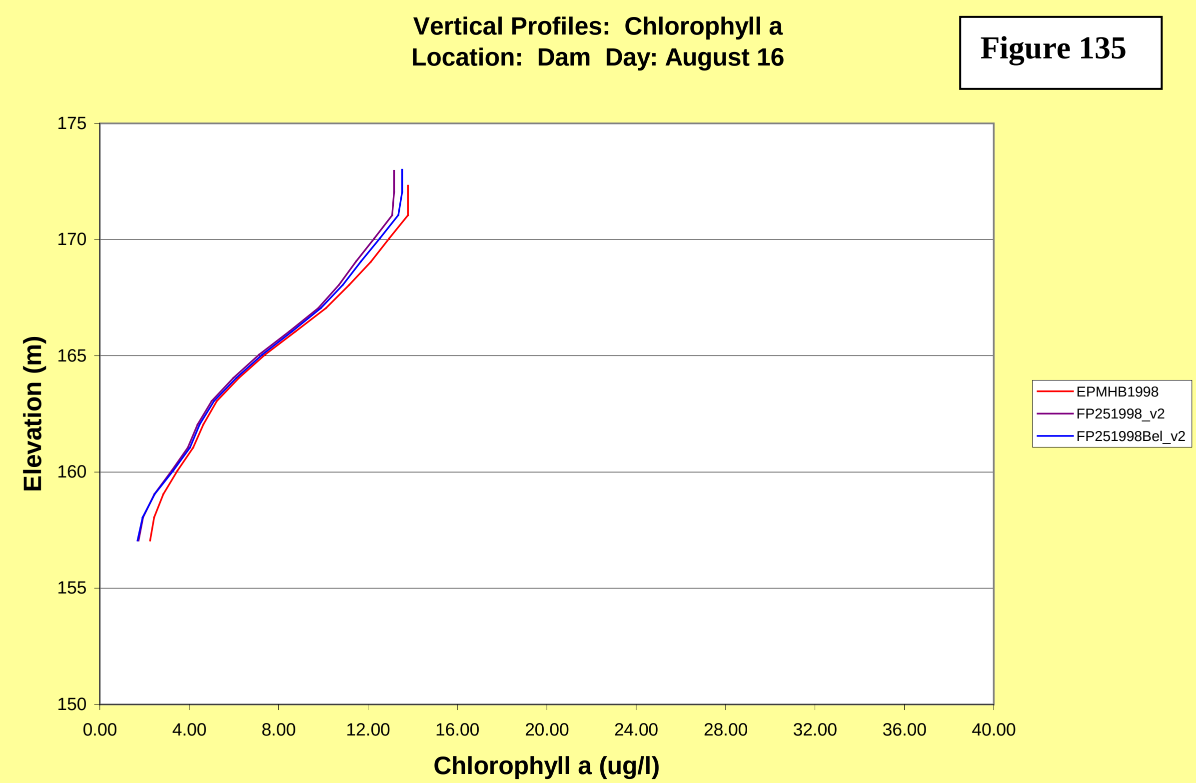
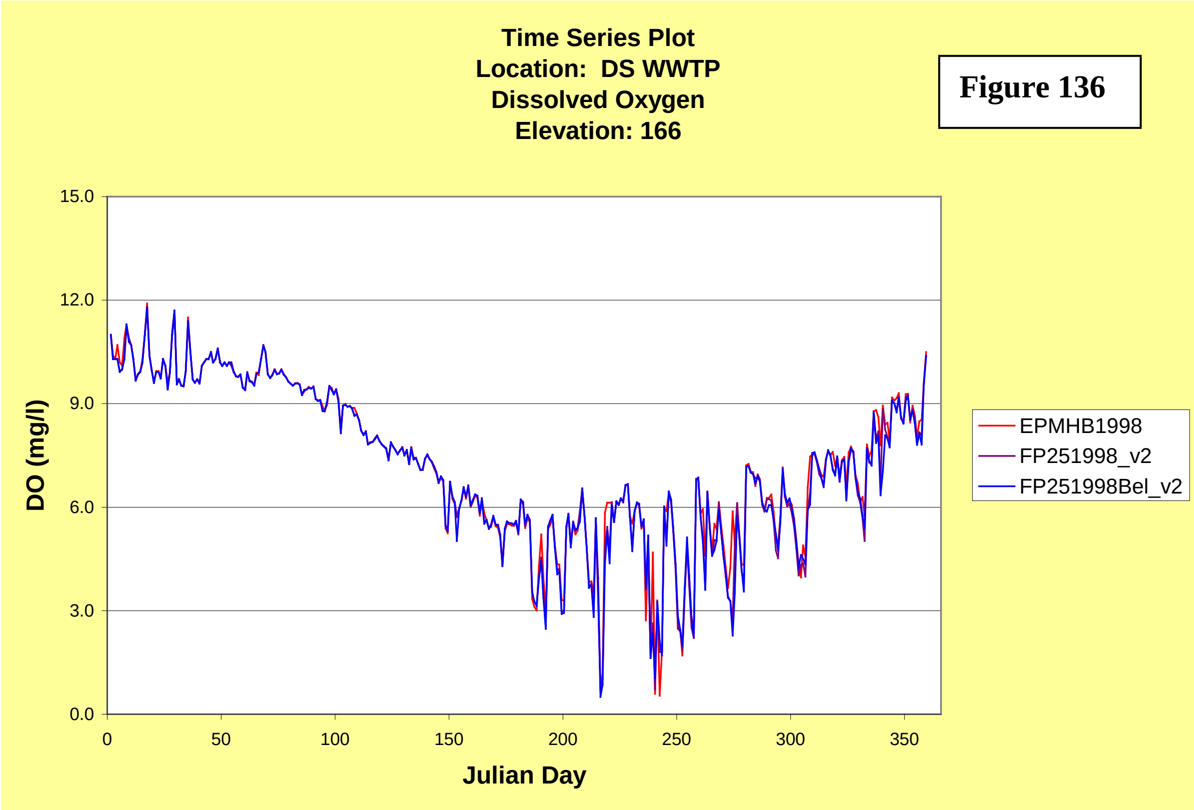
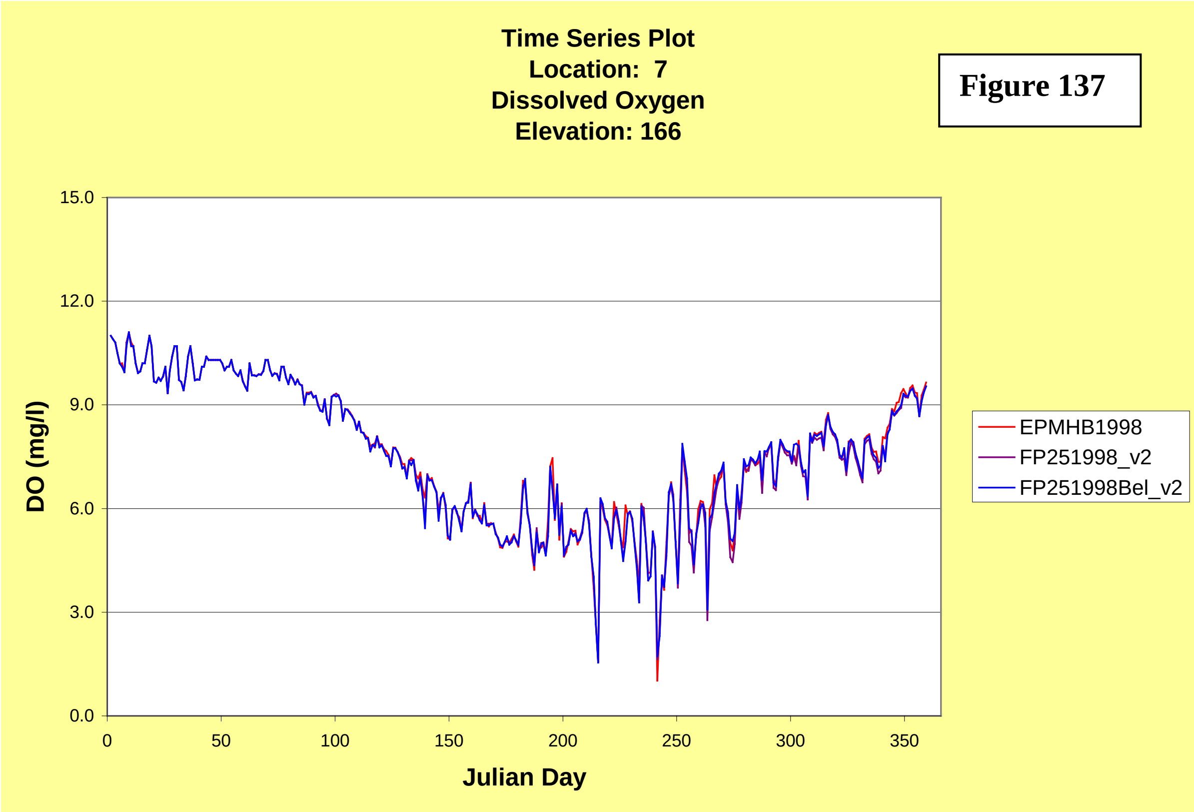
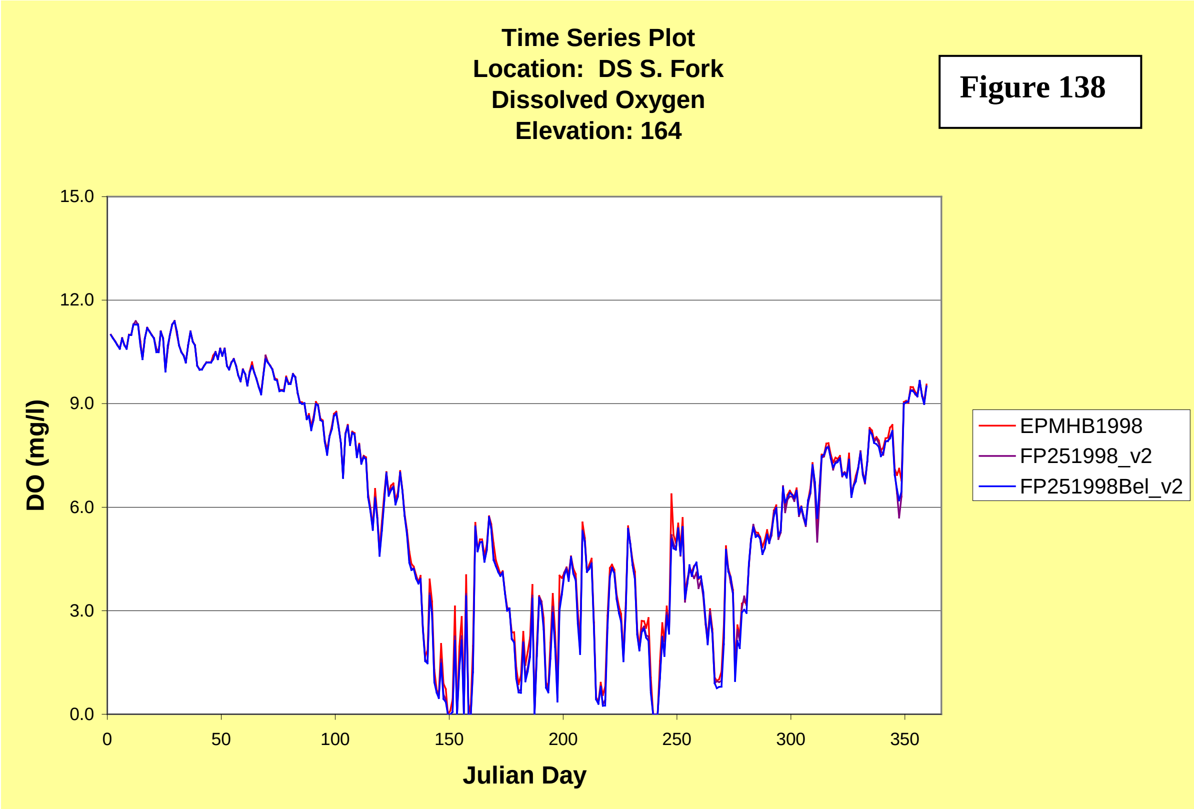


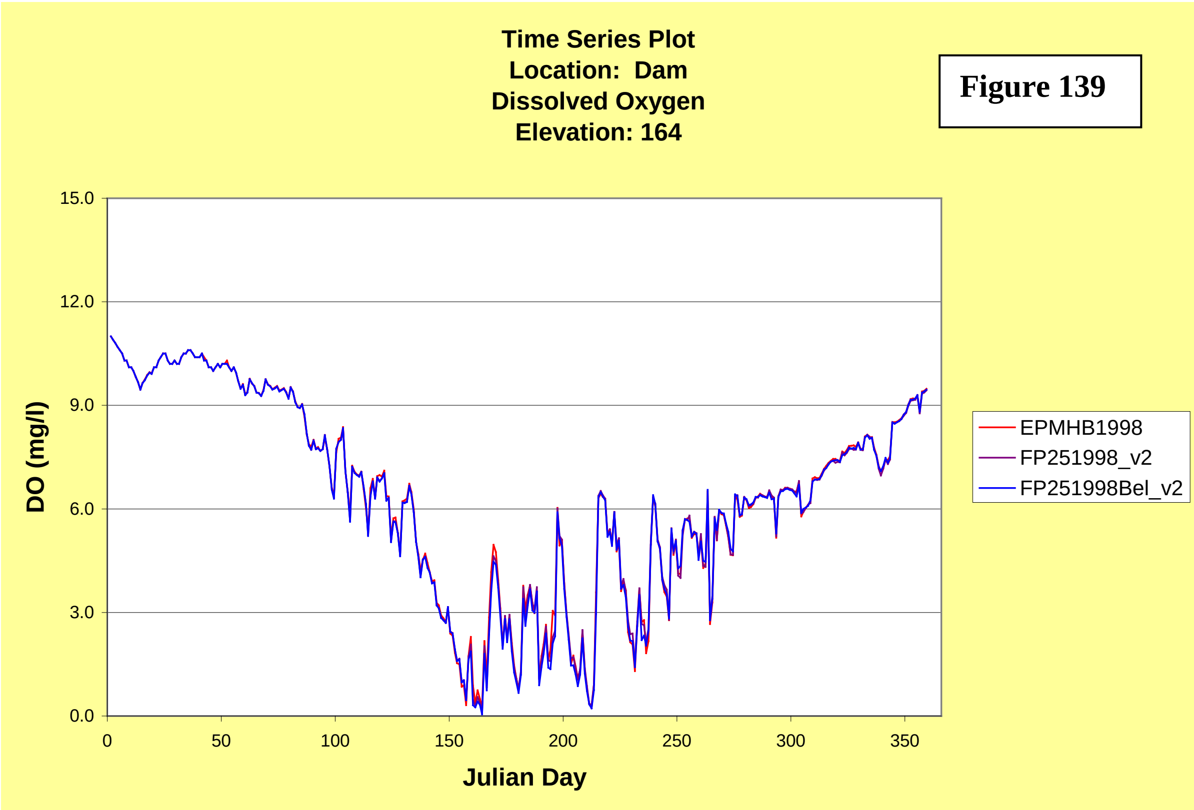
Figure 135




Time Series Plot
Location: DS WWTP
Dissolved Oxygen
Elevation: 166
Figure 136
15.0
12.0
9.0
6.0
3.0
0.0
DO (mg/l)
0
50
100
150
200
250
300
350
Julian Day
EPMHB1998
FP251998_v2
FP251998Bel_v2

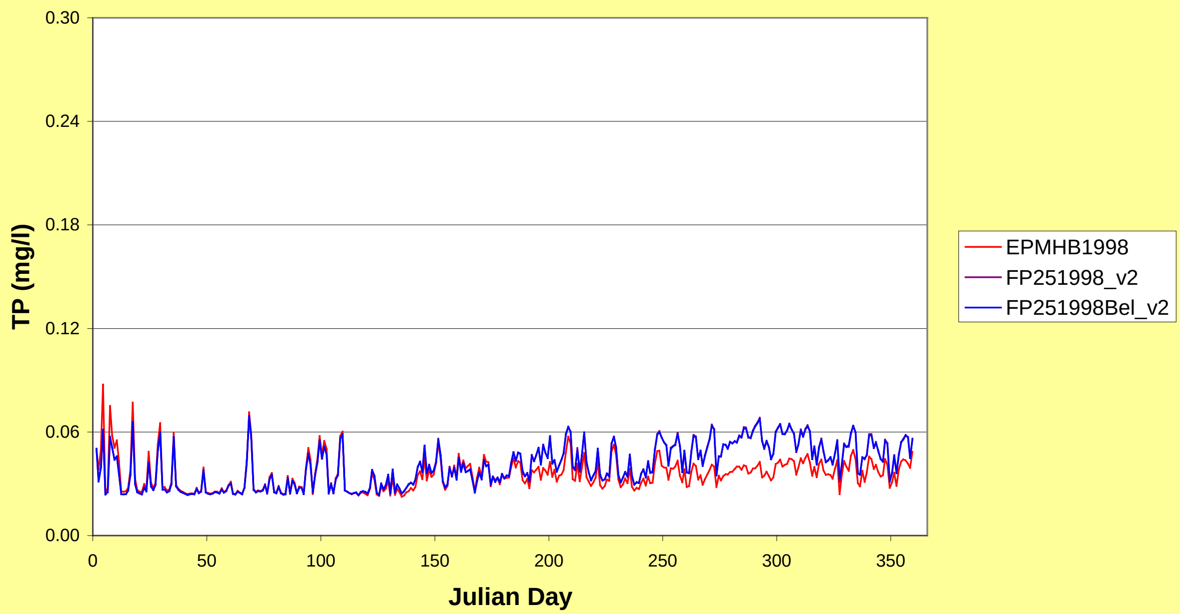

Time Series Plot
Location: 7
Dissolved Oxygen
Elevation: 166
Figure 137
15.0
12.0
9.0
6.0
3.0
0.0
DO (mg/l)
0
50
100
150
200
250
300
350
Julian Day
EPMHB1998
FP251998_v2
FP251998Bel_v2


Time Series Plot
Location: DS S. Fork
Dissolved Oxygen
Elevation: 164
Figure 138
15.0
12.0
9.0
6.0
3.0
0.0
DO (mg/l)
0
50
100
150
200
250
300
350
Julian Day
EPMHB1998
FP251998_v2
FP251998Bel_v2


Time Series Plot
Location: Dam
Dissolved Oxygen
Elevation: 164
Figure 139
15.0
12.0
9.0
6.0
3.0
0.0
DO (mg/l)
0
50
100
150
200
250
300
350
Julian Day
EPMHB1998
FP251998_v2
FP251998Bel_v2

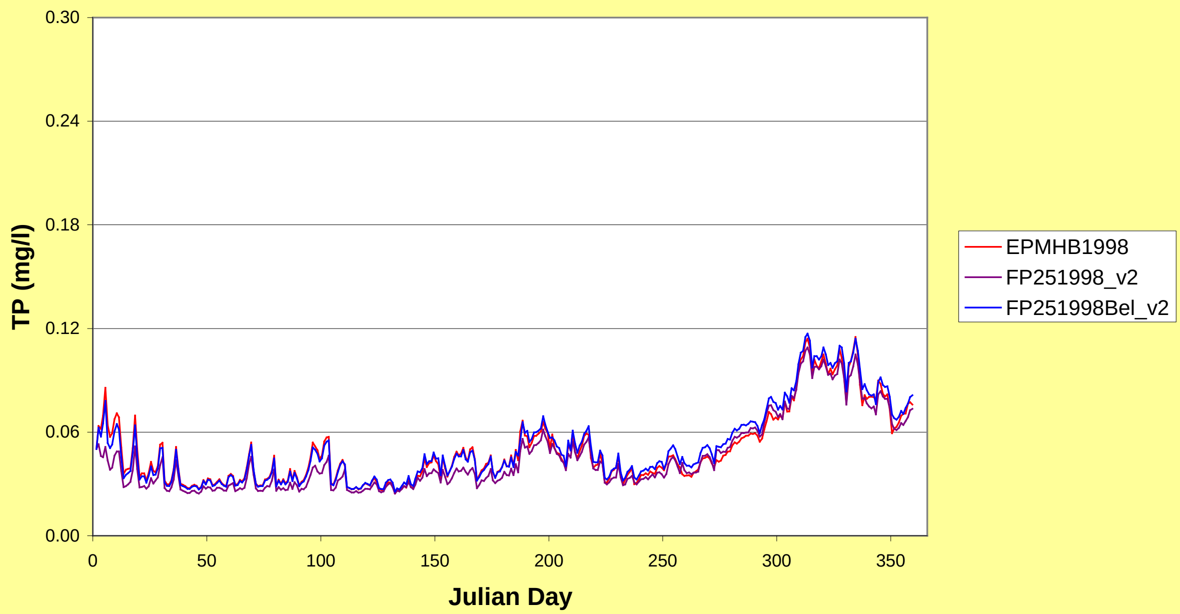
Time Series Plot
Location: DS WWTP
Total Phosphorus
Elevation: 170

Figure 140



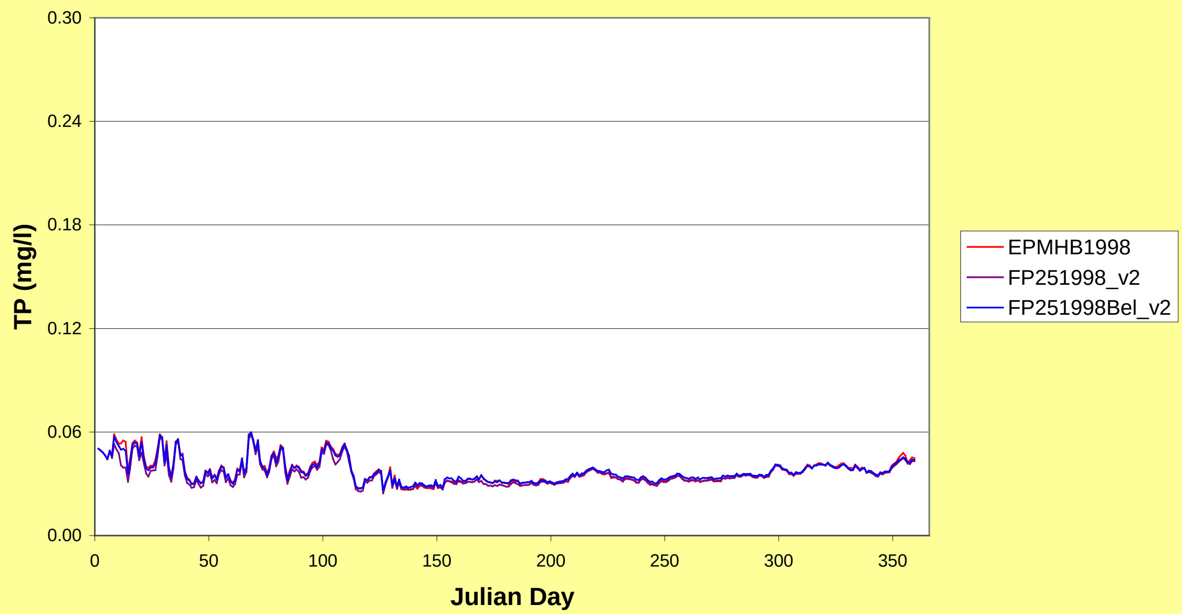
Time Series Plot
Location: 7
Total Phosphorus
Elevation: 170

Figure 141



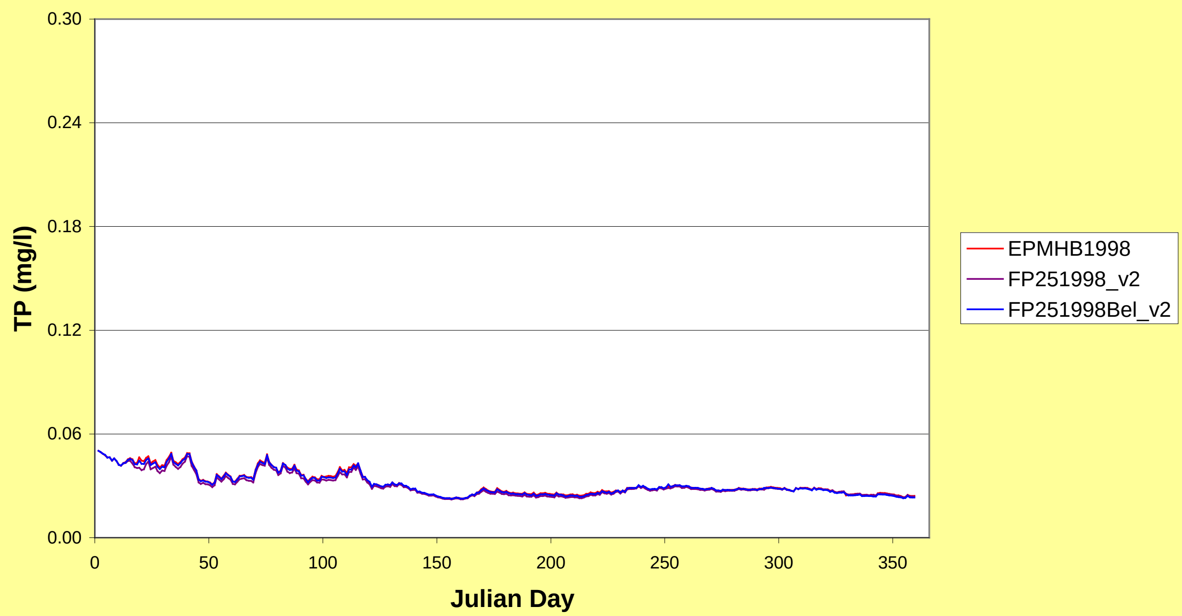
Time Series Plot
Location: DS S. Fork
Total Phosphorus
Elevation: 170

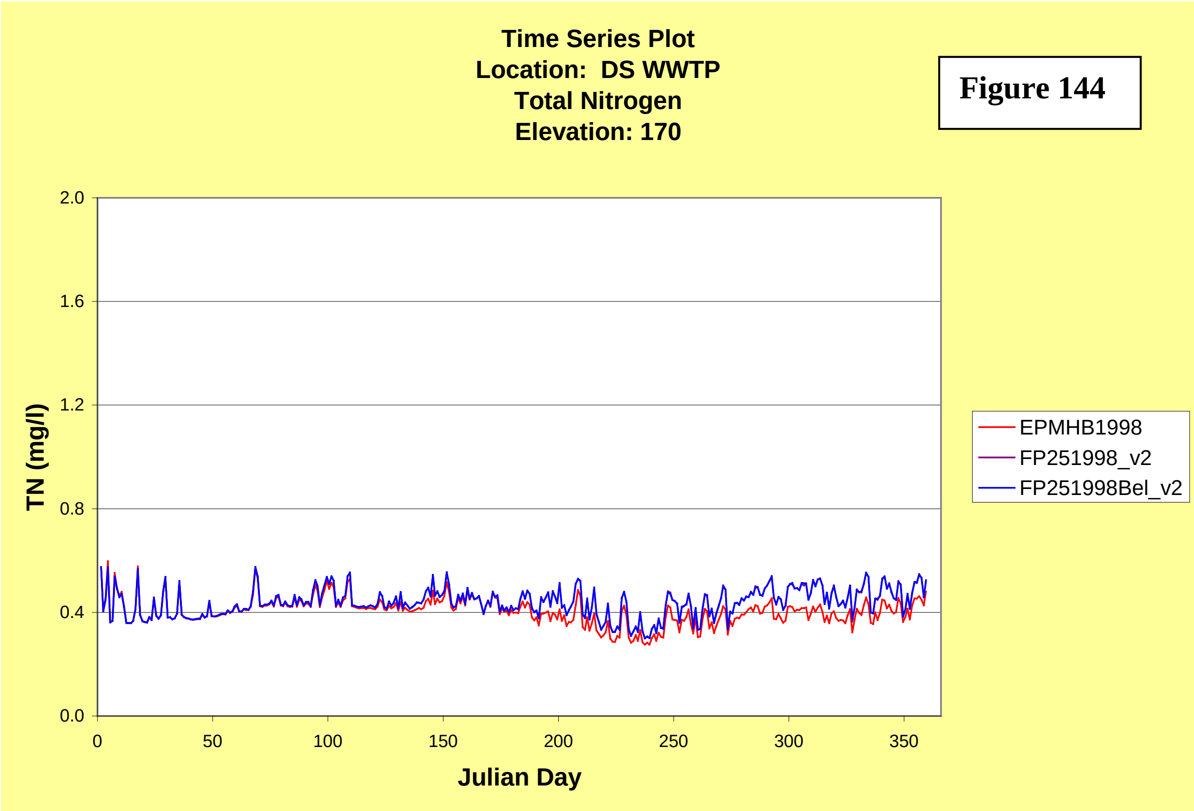
Figure 142

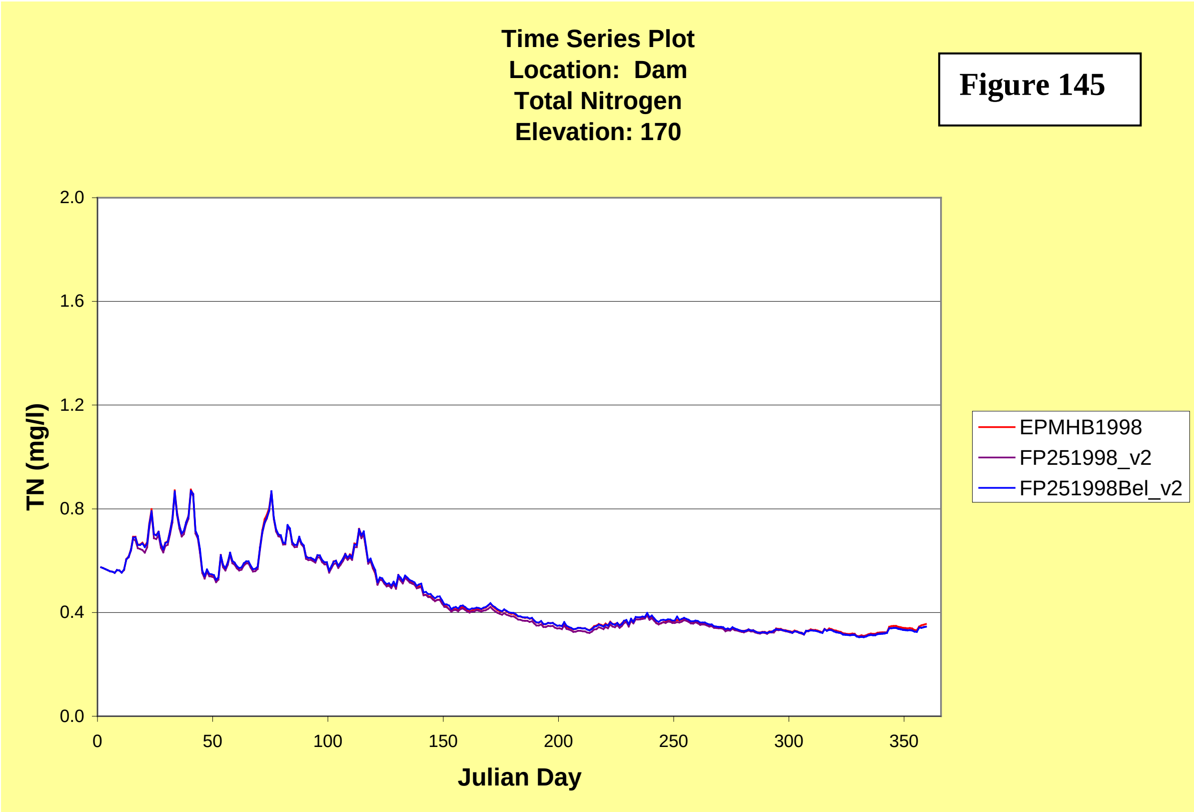


Time Series Plot
Location: Dam
Total Phosphorus
Elevation: 170

Figure 143

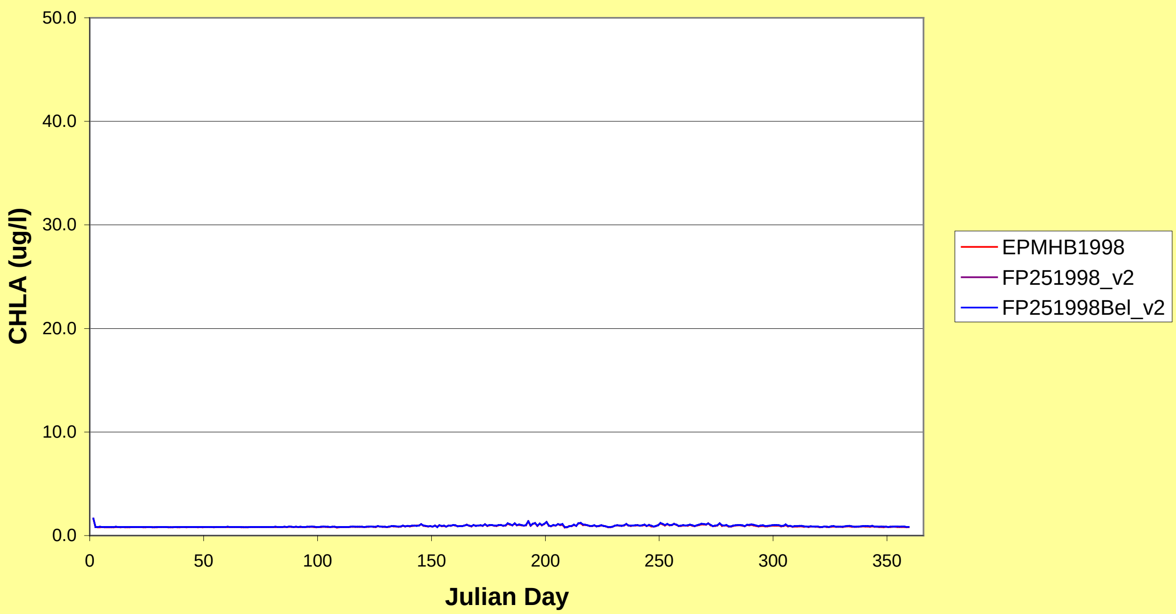



Time Series Plot
Location: DS WWTP
Total Nitrogen
Elevation: 170
Figure 144
TN (mg/l)
2.0
1.6
1.2
0.8
0.4
0.0
0
50
100
150
200
250
300
350
Julian Day
EPMHB1998
FP251998_v2
FP251998Bel_v2


Time Series Plot
Location: Dam
Total Nitrogen
Elevation: 170
Figure 145
TN (mg/l)
2.0
1.6
1.2
0.8
0.4
0.0
0
50
100
150
200
250
300
350
Julian Day
EPMHB1998
FP251998_v2
FP251998Bel_v2

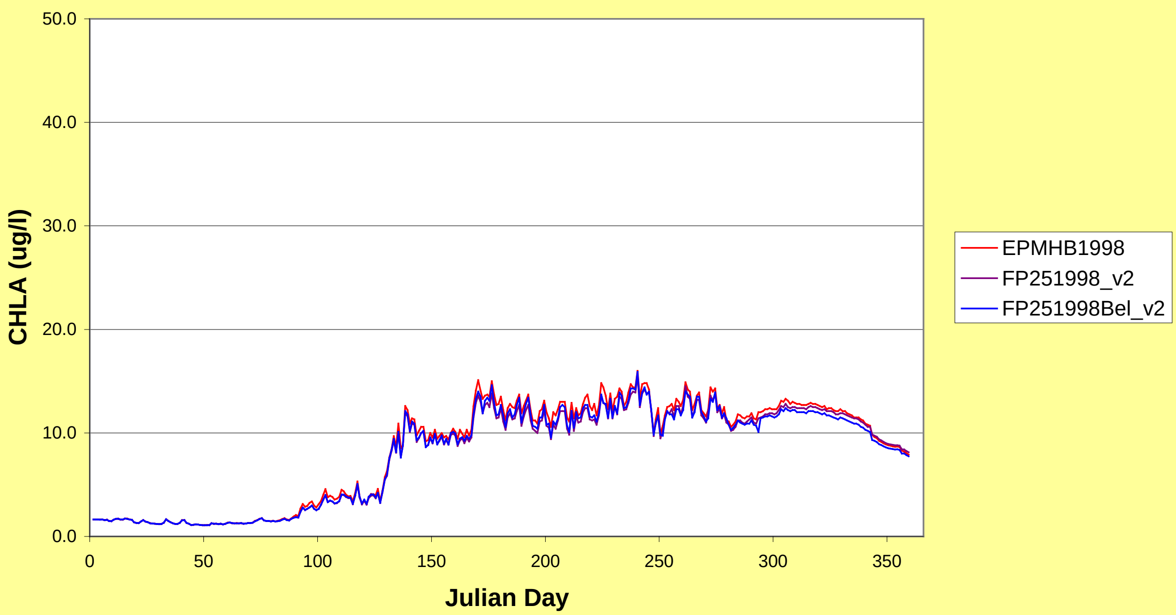
Time Series Plot
Location: DS WWTP
Chlorophyll a
Elevation: 170

Figure 146



Time Series Plot
Location: Dam
Chlorophyll a
Elevation: 170

Figure 147



Water Quality Modeling Report
Charlotte-Mecklenburg Utilities / City of Mount Holly
Regional Wastewater Treatment

Charlotte Mecklenburg Utilities
Charlotte, NC

City of Mount Holly

Prepared by:
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Charlotte, NC 28269
(704)-510-8461

March 2008

Table of Contents

1. Introduction

In 2006, CMU and the City of Mount Holly cooperated in a Feasibility and Preliminary Planning Study which evaluated the growing wastewater demands in both service areas and identified a number of alternatives that would meet future wastewater projections (Black & Veatch 2006). The proposed regional wastewater treatment plant was identified as the recommended alternative to meet the needs of a growing population in Mecklenburg County, the City of Charlotte and the Town of Mount Holly. Objectives for the Preliminary Planning Study included the following:

- Evaluate population projections
- Project wastewater flows that may be produced based on growth projections
- Identify and evaluate wastewater treatment alternatives – both separate and regional solutions
- Perform a detailed evaluation of environmental impacts associated with each alternative

Alternatives identified in the study included a new regional WWTP adjacent to the existing Long Creek Pump Station in western Mecklenburg County as well as combinations of expansion and new construction on the Gaston County side of the Catawba River. Each of the six action alternatives as well as the No Action and Land Application alternatives considered for this project were presented in detail in Chapter 4 of this Environmental Impact Statement (EIS). The alternatives included:

- Alternative 1: Operate separately with existing facilities
- Alternative 2: Operate separately with additional and upgraded facilities
- Alternative 3: Operate jointly at upgraded Mount Holly WWTP
- Alternative 4: Operate jointly at new Mount Holly WWTP
- Alternative 5: Operate jointly at new CMU WWTP
- Alternative 6: Combination of new and existing facilities
- No action

- Land application only

As part of the evaluation of environmental impacts, a water quality modeling study of Lake Wylie was conducted to evaluate the potential impacts that increased wastewater discharge would have on the lake. Current conditions and many future scenarios were modeled to determine the potential water quality impacts from the proposed regional WWTP. The existing condition, which is similar to Alternative 1, was modeled assuming that the Mount Holly plant discharged at the current permitted flow of 4 mgd and at their existing nutrient concentrations. Currently, Mount Holly does not have permit limits for nutrients but is required to monitor for them on a monthly basis. From a modeling perspective, Alternatives 2 through 6 were the same assuming similar treatment levels at the combined or separate facilities. Alternatives 7 and 8 do not contribute additional discharges into Lake Wylie and therefore were not explicitly modeled.

Nonpoint source inputs were included in the model as measured values from the monitored tributaries. Inputs from ungaged tributaries were estimated based on loads from nearby creeks and scaled by contributing watershed area. Anticipated changes in nonpoint sources loadings as a result of future population growth were also included in the model using an export coefficient approach.

2. Background

A detailed water quality model was developed to estimate the potential environmental impacts associated with the construction of a new WWTP that would discharge to Lake Wylie. Assessment of current water quality conditions was a critical component in this effort. Surface water quality sampling in the project area and surrounding water bodies is conducted routinely by several governmental agencies, including US Geological Survey (USGS), NC Department of Water Quality (DWQ) and the Land Use and Environmental Services Agency (LUESA) of Mecklenburg County.

As part of LUESA's monitoring program, five stations are sampled in Lake Wylie on a monthly basis. Determination of model requirements and preliminary discussions with DWQ staff members resulted in the addition of four mainstem sampling sites located adjacent to samples currently being collected in the coves. Figure 1 shows the nine sampling locations, with the added sites designated with an "A" (e.g. LW4A).

All sites were sampled on a monthly basis from May through December 2007; twice-monthly samples were collected July – September 2007. Samples were collected from the surface and near the lake bottom and analyzed for the following parameters:

- Water temperature
- Depth
- Dissolved oxygen
- Conductivity
- pH
- Total suspended solids, total solids, turbidity
- Chlorophyll-a
- Nutrients (total phosphorus, orthophosphate, total Keldahl nitrogen, nitrate-nitrogen, ammonia-nitrogen)
- Fecal coliform

Water quality modeling of Lake Wylie was performed to assist in the evaluation of water quality impacts from the proposed facility and to support the development of speculative NPDES limits by NC DWQ for the plant discharge into Lake Wylie. A CE-QUAL-W2 model of the lake (Lake Wylie Model) was previously developed by Duke Energy in support of the Federal Energy Regulatory Commission (FERC) relicensing process (Sawyer and Ruane, 2006). At that time, the Lake Wylie Model went through an extensive calibration process that included review and collaboration with several federal and state agencies. The calibration used flow and quality data from 1998 and 2002 which represented average and low flow years, respectively. Until 2007, 2002 represented the lowest flow year on record. Although additional data were collected during 2007, these data were not considered sufficient to warrant a recalibration of the model. Through discussions with the NC DWQ, it was agreed that the model would not be recalibrated as part of this project. The model would be run for the same two years used for calibration (1998 and 2002) and would incorporate changes that would occur with a new regional wastewater treatment plant.

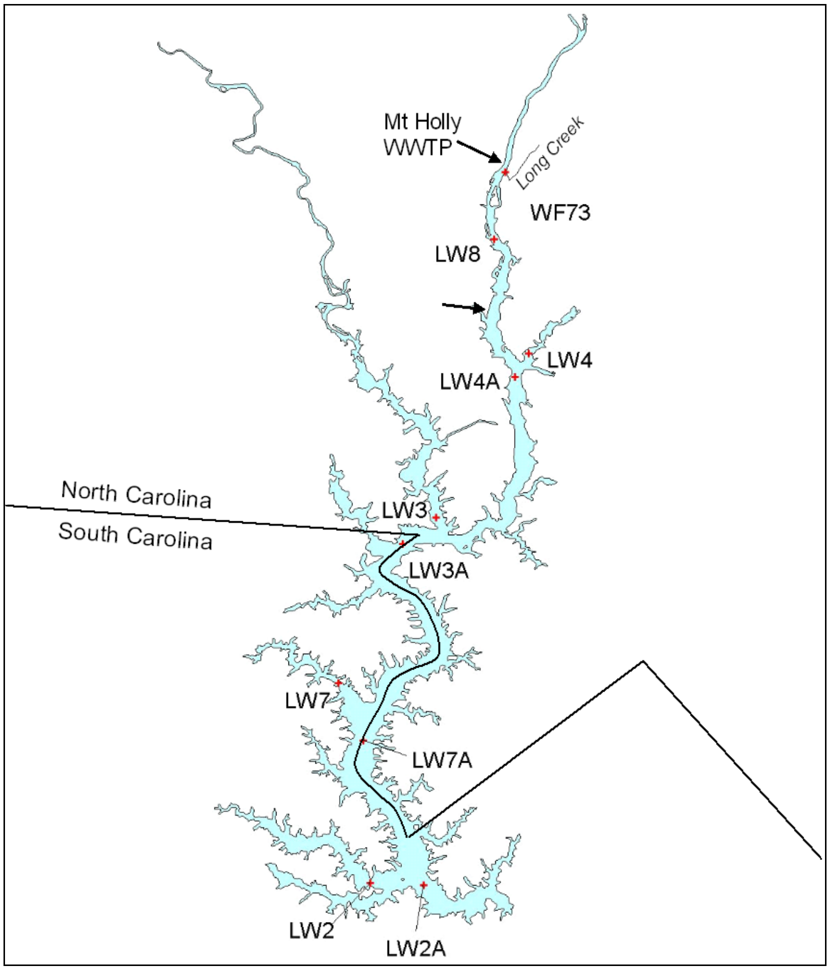


Figure 1 LUESA monitoring stations on Lake Wylie. Additional mainstem stations added for this project are designated with an "A" (e.g. "LW4A").

3. Lake Wylie CE-QUAL-W2 Model

CE-QUAL-W2 is a two-dimensional, hydrodynamic and water quality model for reservoirs and rivers. It is assumed that lateral variations across a lake or reservoir can be ignored.

Because of this assumption, the model is best suited to reservoirs that are relatively long and narrow like Lake Wylie. The hydrodynamic module predicts water surface elevations and velocities in the horizontal and vertical directions. The hydrodynamic module is directly linked to a water quality module that predicts time-varying concentration of water quality parameters.

CE-QUAL-W2 model processes are described in detail in the User's manual for the model (Cole and Wells, 2002). The model uses a finite difference method to solve the laterally averaged equation of motion. The reservoir is represented by a grid consisting of a series of vertical segments and horizontal layers. The hydrodynamic calculations consider the effects of variable water density caused by differences in temperature and TDS. The model simulates the interactions of many biological and chemical factors that affect water quality. Specific processes simulated in the model include:

- Temperature and salinity
- The DO-carbon balance
- The nitrogen cycle
- The phosphorus cycle
- The silicon cycle
- Phytoplankton
- Bacteria
- First order decay

Required inputs include the bathymetry of the reservoir, initial conditions, inflow rates and concentration of water quality constituents, outflow rates, water surface elevations and kinetic rate coefficients.

The base CE-QUAL-W2 model was developed by the US Corps of Engineers (Cole and Wells, 2002) and the Lake Wylie application was developed by Resource Environmental Management Inc. at the request of Duke Energy. Information on the model application to Lake Wylie and the detailed calibration were provided by Ruane and Hauser (2006) and Sawyer and Ruane (2006). The bathymetry for the model was developed by dividing the reservoir into branches and then segmenting the branches longitudinally and vertically. The model configuration is shown on Figure 2.

The CE-QUAL-W2 model represents Lake Wylie as a single water body containing nine branches and ten tributaries. Branch 1 is the mainstem of the lake while the other branches are simulated arms of the lake. The ten tributaries enter the lake as point sources and include natural streams and discharges from WWTPs and power plants. The tributary inflows enter the lake at a specific location or segment within the model. A list of the branch and tributary inflows are shown in Table 3.1. As seen on the figure, segment lengths vary through the lake. Vertically, each layer is 1 meter thick.

Table 3.1 Lake Wylie Model Inflows

Branch	**Segments**	**Input Segment**	**Name**
1	2-39	2	Mountain Island Dam Releases
2	42-47	12	South Fork Catawba River
3	50-53	14	Catawba Creek
4	56-58	15	Mill Creek
5	61-64	22	Crowder's Creek
6	67-70	27	Torrence Branch
7	73-80	29	Allison Creek
8	81-84	27	Unnamed
9	87-90	78	Little Allison Creek
Tributary	**Segments**	**Input Segment**	**Name**
1	n/a	2	Dutchman's Ck, Long Ck, and local inflow
2	n/a	7	Paw Creek
3-7	n/a	44	Allen Steam Plant
8	n/a	76	Catawba Nuclear Plant
9	n/a	2	Mount Holly WWTP
10	n/a	6	Belmont WWTP

As described by Sawyer and Ruane (2006), the model was calibrated using data from 1998 and 2002. The primary calibration year was 2002 and was the driest year on record. During 2002, Duke Power conducted an intensive study of water quality and flows on the lake. In 1998, tributary inflows were relatively high during the first part of the year and low for the remainder of the year making it an average flow year overall. In addition, 1998 had a good database of measured flow and water quality constituents to use in the calibration process. The model was originally calibrated for 2002 conditions then model settings were then applied to 1998 conditions and the model performed well.

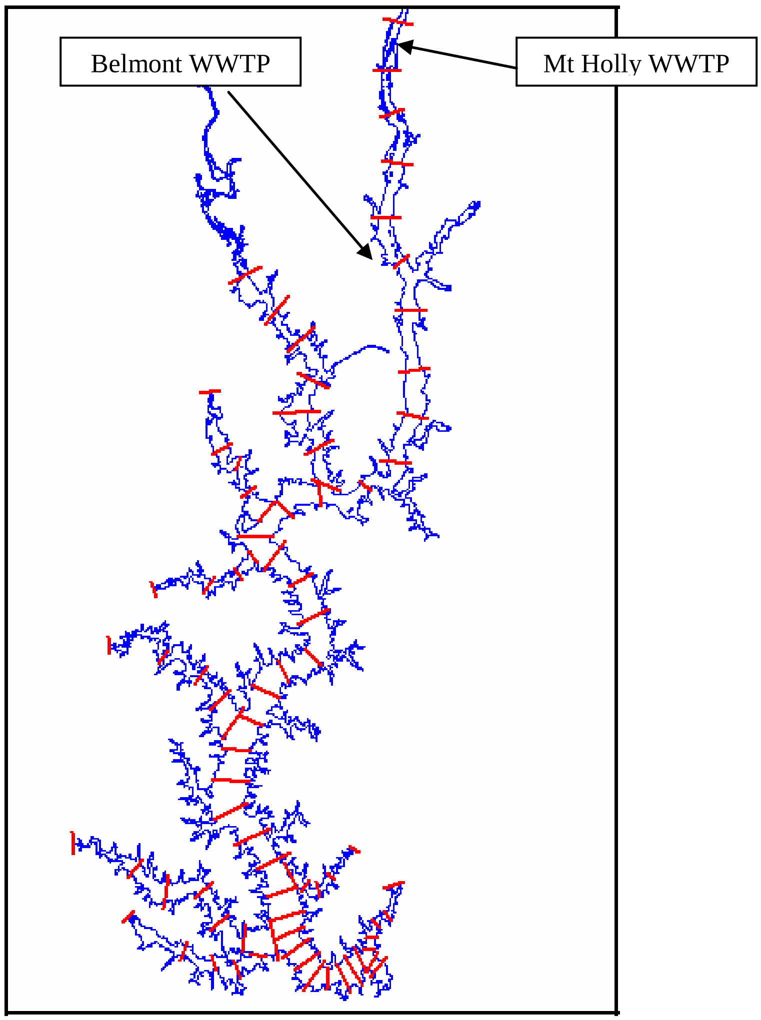


Figure 2. Model configuration for Lake Wylie

4. Case Descriptions

The calibrated Lake Wylie model developed by Duke Energy was used to evaluate the effects of increased wastewater discharges to the upper section of Lake Wylie. Many scenarios were simulated to evaluate existing and potential future conditions. For both existing and future conditions both normal operating conditions and permit conditions were simulated. Increases in future nonpoint source (NPS) loads were also simulated. The specific cases modeled and presented in this report are summarized in Table 4-1.

Normal plant operations for the existing condition were simulated using measured data as reported by the Mount Holly and Belmont WWTPs. Under this condition, flow and effluent quality varied daily or monthly. Permit limits for the existing condition were simulated by assuming that these plants discharged at their maximum permitted flow every day. Because these plants do not have permit limits for nutrients, their actual measured values were used. Phosphorus concentrations for the Belmont WWTP were modified for the permit limit case by assuming that additional flow above the normal operating flow would come from residential uses and be typical of domestic wastewater. Concentrations measured at Mount Holly's WWTP were used to represent this domestic wastewater component.

Normal plant operations for the future condition were simulated by assuming that the new regional plant would experience similar variations in flow and effluent quality that is currently measured at the McDowell WWTP. The procedures detailed in the "*Technical Support Document for Water Quality-based Toxics Control*" (EPA, 1991) were used to determine the maximum loads that could be discharged without exceeding permit limits. It was assumed that permit limits for the future flow rate of 25 mgd would be 1 mg/L total phosphorus (TP), 6 mg/L total nitrogen (TN) and 6 mg/L BOD. It was also assumed that the permit limits for nutrients would be given as loads and not concentrations and that interim flow rates would have the same load limits and therefore somewhat higher concentrations.

The Technical Support Document presents equations that relate permit limits to long-term averages (LTA) of effluent quality using a coefficient of variation (CV). These equations are then used to calculate what the long-term average should be to meet permit limits. This procedure was used to develop input files for effluent flow and quality for the proposed regional plant. An iterative procedure was used to calculate the input values using the following specific steps:

1. Obtain the McDowell WWTP for 2007 and calculate the LTA and CV. The McDowell data set contained mostly daily values for flow, BOD, and nutrients.

2. Using the CVs calculated in step 1, calculate what the LTAs would be to achieve the assumed permit limits.

3. Increase the McDowell WWTP daily flows by a uniform factor until the LTA matches the one calculated in step 2.

4. Increase the McDowell WWTP BOD concentrations by a uniform factor until the LTA matches the one calculated in step 2.

5. Using the new flows, calculate the McDowell WWTP nutrient loads. Then increase the loads until the LTAs match the ones calculated in step 2.

By following this procedure a simulated set of effluent data was produced that represented the largest loads that could be discharged while still meeting permit limits. Permit limits were expressed as weekly or monthly averages so, while the LTAs were less than the permit limits there were many days when the flow or loads exceeded the limits. For the future scenario of a 25 mgd permitted plant, the LTA for flow was 21.7 mgd but the flow ranged from 15.4 to 50.2 mgd throughout the year. The LTA for BOD was 4.0 mg/L and ranged from 3.3 to 15.2 mg/L; TP concentrations ranged from 0.4 to 7.4 mg/L with an average of 0.8 mg/L; TN concentrations ranged from 2.1 to 10.8 mg/L with an average of 5.8 mg/L.

For scenarios using the permit limits, it was assumed that the WWTP discharged at the permit limits every day throughout the entire year.

Table 4.1 Lake Wylie Model – Case Descriptions

Case ID	Case Description	Discharge Inputs						Lake Inputs	
		Mt Holly		Belmont		Long Creek			
		Flow	Quality	Flow	Quality	Flow	Quality	Flow	Quality
EM2002	Existing Conditions, 2002 flow	2006 measured	2006 measured	2006 measured	2006 measured			2002 flow	2002 quality
EM1998	Existing Conditions, 1998 flow	2006 measured	2006 measured	2006 measured	2006 measured			1998 flow	1998 quality
EPMHB2002	Permit Limits, 2002 flow	4 MGD	2006 measured	5 MGD	2006 adjusted			2002 flow	2002 quality
EPMHB1998	Existing Plants, 1998 flow	4 MGD	2006 measured	5 MGD	2006 adjusted			1998 flow	1998 quality
FN172002	Future Normal Operations (17 MGD), Existing NPS Load, 2002 flow			2006 measured	2006 measured	varies, typical for 17 MGD limit	Based on other WWTP, consistent with limits of TN = 8.82, TP = 1.47, BOD = 8.8	2002 flow	2002 quality
FN252002	Future Normal Operations (25 MGD), Existing NPS Load, 2002 flow			2006 measured	2006 measured	varies, typical for 25 MGD limit	Based on other WWTP, consistent with limits of TN = 6.0, TP = 1.0, BOD = 6	2002 flow	2002 quality
FN251998	Future Normal Operations (25 MGD), Existing NPS Load, 1998 flow			2006 measured	2006 measured	varies, typical for 25 MGD limit	Based on other WWTP, consistent with limits of TN = 6.0, TP = 1.0, BOD = 6	1998 flow	1998 quality
FN252002 NPS	Future Normal Operations (25 MGD) Future NPS Load, 2002 flow			2006 measured	2006 measured	varies, typical for 25 MGD limit	Based on other WWTP, consistent with limits of TN = 6.0, TP = 1.0, BOD = 6	2002 flow	2002 quality, adjusted for future NPS loads
FN251998 NPS	Future Normal Operations (25 MGD), Future NPS Load, 1998 flow			2006 measured	2006 measured	varies, typical for 25 MGD limit	Based on other WWTP, consistent with limits of TN = 6.0, TP = 1.0, BOD = 6	1998 flow	1998 quality, adjusted for future NPS loads

Case ID	Case Description	Discharge Inputs						Lake Inputs	
		Mt Holly		Belmont		Long Creek			
		Flow	Quality	Flow	Quality	Flow	Quality	Flow	Quality
FP172002	Future at Permit Limits (17 MGD), Belmont at Existing Loads, 2002 flow			2006 measured	2006 measured	17 MGD	TN = 8.82, TP = 1.47, BOD = 8.8	2002 flow	2002 quality
FP252002	Future at Permit Limits (25 MGD), Belmont at Existing Loads, 2002 flow			2006 measured	2006 measured	25 MGD	TN = 6.0, TP = 1.0, BOD = 6	2002 flow	2002 quality
FP251998	Future at Permit Limits (25 MGD), Belmont at Existing Loads, 1998 flow			2006 measured	2006 measured	25 MGD	TN = 6.0, TP = 1.0, BOD = 6	1998 flow	1998 quality
FP252002 Bel	Future at Permit Limits (25 MGD), Belmont at Permit Limits, 2002 flow			5 MGD	2006 adjusted	25 MGD	TN = 6.0, TP = 1.0, BOD = 6	2002 flow	2002 quality
FP251998 Bel	Future at Permit Limits (25 MGD), Belmont at Permit Limits, 1998 flow			5 MGD	2006 adjusted	25 MGD	TN = 6.0, TP = 1.0, BOD = 6	1998 flow	1998 quality

5. Model Inputs

In an effort to determine the effects from the proposed Long Creek Regional WWTP, the CE-QUAL-W2 model developed by Duke Energy was modified to incorporate this new point source loading into Lake Wylie. Numerous existing, future, and permit limit scenarios were modeled using low and average river flows to help determine these effects (Table 4.1). The average flow year was represented using 1998 data while a low flow year was represented using 2002 flows. The model was modified to replace the Mount Holly WWTP discharge with a new point source representing the effluent from the proposed regional WWTP. All other model input parameters were not modified, with exception of the natural water quality inflow data associated with future non-point source (NPS) loading scenarios. Brief descriptions of the modified inputs are provided in the following sections.

5.1 River and Tributary inputs

5.1.1 Inflow Volumes

The majority of the inflow to Lake Wylie comes from flow releases through the Mountain Island Dam with the remaining inflow primarily stemming from the South Fork Catawba River watershed (Sawyer and Ruane, 2006). These two inflows account for approximately 85 percent of the lake inflow.

As stated previously the CE-QUAL-W2 model represents Lake Wylie as a single water body containing nine branches, two natural tributaries, and eight other tributaries that represent discharges from WWTPs or power plants. The model inflows are represented as branch, tributary, or distributed branch inflow. The tributary inflows enter the lake at a specific location or segment within the model. The distributed branch inflows enter the model along a branch and represent overland flow that enters the lake directly and is not included in the branch or tributary inflows. These distributed flows enter the lake at the surface. A list of the branch and tributary inflows was shown in Table 3.1. The majority of the natural inflows to Lake Wylie do not have associated flow monitoring stations. Flows for ungaged streams were estimated using data from a nearby gaging station and adjusted based on drainage area.

5.1.2 Existing Condition Nonpoint Source Loadings

Existing nonpoint source (NPS) loads entering Lake Wylie were included in the model by using measured flow and water quality of the tributaries to the lake. All inflows have associated temperature and water quality data. However, the majority of the natural inflows to Lake Wylie do not have water quality monitoring stations. To estimate inputs from these unmonitored inflows, data from nearby monitoring stations were used.

5.1.3 Future Nonpoint Source Loadings

Nonpoint source loadings from the Lake Wylie watershed were estimated using an export coefficient approach based on current and anticipated future land uses. Export coefficients represent the average total load of a pollutant that enters into a water body and are expressed as the mass per unit area per year (e.g. kg ha^{-1} y^{-1}). This approach is generally used for calculating runoff pollutant loads from rural areas, although it has been successfully applied to more urban areas as well (reference). Since collecting site specific data for calculating these values is often cost-prohibitive, literature values from similar regions are often used. Due to specific climatological and physiographic characteristics of individual watersheds, land use export coefficients can exhibit a wide range of variability in nutrient export. By selecting values that were measured in watersheds with similar climate, topography and land use, these differences can be minimized (Beaulac and Reckhow 1982). Table 5.1 shows the export coefficients used for this project (Reckhow et al 1980, DWQ 1997, Black & Veatch, 1990).

To estimate the relative increase in future NPS loads, current loads were first determined using existing land use data for the Lake Wylie watershed (USGS, 1996 LULC dataset). Loads were calculated by multiplying the total area for each land use type by the corresponding export coefficients listed in Table 5.1.

Table 5.1 Export Coefficients for TN and TP

Land Use	TN ($kg\ ha^{-1}\ y^{-1}$)	TP ($kg\ ha^{-1}\ y^{-1}$)
Cultivated	16	4.5
Forest	2.2	0.2
High Intensity	10	1.9
Impervious surface	10	1.9
Low Intensity	7.4	1
Managed Herbaceous Cover	2.9	0.5
Shrubland	2.2	0.2
Unconsolidated Sediment	2.2	0.2
Unmanaged Herbaceous Cover-Upland	2.2	0.2
Water	0	0
Wetland	2.2	0.2

Future land use was determined by using population growth rates for each county. It was assumed that agricultural and forested land would be converted to low and high intensity development (residential and commercial land use types) to accommodate the increased population. Future NPS loads were calculated by multiplying the area in each future land use by the corresponding export coefficient. The difference between existing and future NPS loadings to the lake was calculated as a percentage for similar subbasins/counties within the Lake Wylie watershed.

Increases in NPS loads were modeled within CE-QUAL-W2 by increasing the existing inflows (including branch, tributary, and distributed loads) water quality inflow concentrations into the lake. This was accomplished by increasing the existing TN and TP loadings for all inflows (branch, tributary, and distributed) draining to Lake Wylie by the percent differences between existing and future NPS loads. The percentage of increase was based on drainage area location. All TN and TP loadings were increased by an average of 22.2 percent in Mecklenburg County, 2.53 percent for drainage areas west of the lake, and 8.5 percent for Tributary 1 and its distributed inflow.

5.2 WWTP Point Source Loadings

Wastewater treatment plant point sources to Lake Wylie included the Mount Holly WWTP and the Belmont WWTP. In the model, the Mount Holly WWTP and Belmont effluent data inputs were included in tributaries 9 and 10 which enter the model in segments 2 and 6 respectively. In the future scenarios, the Mount Holly WWTP data was replaced with the effluent data from the proposed regional facility. The effluent data consist of inflow volumes, temperature, and water quality constituents. These parameters are described in the following sections and are listed in Tables 5-2 and 5-3.

5.2.1 WWTP Inflow Volumes

Inflows from the Mount Holly and Belmont WWTPs consist of 2006 measured data, to represent effluent flow volumes under the existing condition scenarios. The 2006 measured data consisted of average daily outflows from the Mount Holly facility and monthly average outflows from the Belmont facility. The permit limit flows assumed that the permit limit flow was constant for the entire modeling period.

Two types of flow conditions were modeled for the future scenarios: normal operating conditions and constant permit limit conditions. Normal operating conditions simulated variations in flow and effluent quality that would be expected at a WWTP and were based on discharge data from the McDowell WWTP. The normal operating conditions used in the model represented the highest flows and loads that could be discharged while still meeting permit limits (see Chapter 4 for a detailed description of the calculation method). The permit limit conditions assumed that the permit limit flow was constant for the entire modeling period.

5.2.2 WWTP Inflow Temperature

Daily average temperatures measured at the Mount Holly WWTP and monthly average temperatures at the Belmont WWTP in 2006 were used for the temperature of model inflow for each respective plant. Daily average temperatures measured at the McDowell WWTP in 2007 were used for the temperature of model inflow from the proposed regional facility.

5.2.3 WWTP Inflow Water Quality

The water quality parameters that were simulated in the model include phosphorus, ammonia, nitrate, biochemical oxygen demand 5-day (BOD5), and dissolved oxygen (DO). For the existing condition, water quality concentrations in the discharge from the Mount Holly and Belmont WWTPs were based on measured data recorded in 2006 for each respective plant. For the permit limit operations at the Belmont WWTP, the phosphorus concentration was adjusted to more accurately represent this scenario. The measured flows from the Belmont WWTP include industrial loadings, therefore under the permit limit condition any additional flow was assumed to be domestic waste. Mount Holly nutrient concentrations were used to represent domestic wastewater for this additional flow. A mass balance approach was used to determine the adjusted phosphorus values, which ranged from 1.52 to 9.97 mg/L.

Water quality concentrations for the proposed regional WWTP under normal operating conditions were derived using data measured at the McDowell WWTP in 2007 as described in Chapter 4. These concentrations represented the highest loads that could be discharged without exceeding any permit limits. Water quality concentrations for the proposed regional WWTP under permit limit conditions were calculated based on assumed permit limits for TN, TP, and BOD5 based on plant capacity. All calculated water quality constituents were assumed constant for the modeling period.

Within the CE-QUAL-W2 model, BOD5 is represented using organic matter. Therefore, it was necessary to convert BOD5 to total organic matter. This was accomplished by calculating the maximum oxygen demand, assuming a ratio of ultimate BOD to BOD5 of 1.85, and calculating the total organic matter using typical cellular metabolism stoichiometry. The total organic matter was then distributed between labile dissolved organic matter (LDOM), refractory dissolved organic matter (RDOM), labile particulate organic matter (LPOM), and refractory particulate organic matter (RPOM) and input into the CE-QUAL-W2 model.

Table 5.2 Inputs Values Used for Existing WWTP Discharges

Constituent	Mount Holly Effluent		Belmont Effluent	
	2006 Value	Basis of Value	2006 Value	Basis of Value
Flow	1.30 - 5.32 mgd	Average daily 2006 measured data	1.10 - 1.46 mgd	Average monthly 2006 measured data
Temperature	9.0 - 32.0 °C	Average daily 2006 measured data	8.8 - 24.6 °C	Average monthly 2006 measured data
Phosphorus*	0.98 - 5.80 mg/L	Average monthly 2006 measured data	1.85 - 30.00 mg/L	Average monthly 2006 measured data
Ammonia	0.50 - 4.42 mg/L	Average monthly 2006 measured data	0.16 - 0.72 mg/L	Average monthly 2006 measured data
Nitrate**	1.57 - 17.68* mg/L	Calculated based on 2006 measured total nitrogen and ammonia data	12.34 - 25.19 mg/L	Calculated based on 2006 measured total nitrogen and ammonia data
LDOM	0.97 - 3.70 mg/L	Calculated based on 2006 measured BOD5 data	0.58 - 2.89 mg/L	Calculated based on 2006 measured BOD5 data
RDOM	0.24 - 0.92 mg/L	Calculated based on 2006 measured BOD5 data	0.14 - 0.72 mg/L	Calculated based on 2006 measured BOD5 data
LPOM	3.39 - 12.93 mg/L	Calculated based on 2006 measured BOD5 data	2.02 - 10.13 mg/L	Calculated based on 2006 measured BOD5 data
RPOM	0.24 - 0.92 mg/L	Calculated based on 2006 measured BOD5 data	0.14 - 0.72 mg/L	Calculated based on 2006 measured BOD5 data
DO	4.59 - 7.75 mg/L	Monthly averages from 2002 daily DMR data	3.60 - 10.25 mg/L	Average monthly 2006 measured data

* Assumes TP is equal to PO4 (no org P)
** Assumes no organic nitrogen in TN value

Table 5.3 Inputs Values Used for Proposed Regional WWTP Effluent (Future Conditions)

	Normal Operating Conditions			Permit Limits		
Constituent	**FN17**	**FN25**	**Basis of Value**	**FP17**	**FP25**	**Basis of Value**
Flow	10.5 - 34.19 mgd	15.40 - 50.13 mgd	Calculated based on 2007 McDowell data - consistent with permit limits	17 mgd	25 mgd	Plant capacity
Temperature	15.2 - 27.6 °C	15.2 - 27.6 °C	McDowell WWTP average daily 2007 measured data	15.2 - 27.6 °C	15.2 - 27.6 °C	McDowell WWTP average daily 2007 measured data
Phosphorus	0.54 - 10.8 mg/L	0.37 - 7.40 mg/L	Calculated based on 2007 McDowell data - consistent with permit limits	1.47 mg/L	1.0 mg/L	Total phosphorous permit limit
Ammonia	0.18 - 4.14 mg/L	0.18 - 4.14 mg/L	Calculated based on 2007 McDowell data - consistent with permit limits	0.30 mg/L	0.20 mg/L	3.3% of the TN permit limit (Based on McDowell WWTP 2007 effluent data)
Nitrate	1.28 - 15.36 mg/L	0.88 - 10.56 mg/L	Calculated based on 2007 McDowell data - consistent with permit limits	7.31 mg/L	4.97 mg/L	82.8% of the TN permit limit (Based on McDowell WWTP 2007 effluent data)
LDOM	1.28 - 5.87 mg/L	0.89 - 3.96 mg/L	Calculated based on 2007 McDowell data - consistent with permit limits	2.29 mg/L	1.56 mg/L	Calculated based on BOD5 permit limit
RDOM	0.32 - 1.47 mg/L	0.22 - 0.99 mg/L	Calculated based on 2007 McDowell data - consistent with permit limits	0.57 mg/L	0.39 mg/L	Calculated based on BOD5 permit limit

	Normal Operating Conditions			Permit Limits		
Constituent	**FN17**	**FN25**	**Basis of Value**	**FP17**	**FP25**	**Basis of Value**
LPOM	4.47 - 20.56 mg/L	3.01 - 13.84 mg/L	Calculated based on 2007 McDowell data - consistent with permit limits	8.03 mg/L	5.47 mg/L	Calculated based on BOD5 permit limit
RPOM	0.32 - 1.47 mg/L	0.22 - 0.99 mg/L	Calculated based on 2007 McDowell data - consistent with permit limits	0.57 mg/L	0.39 mg/L	Calculated based on BOD5 permit limit
DO	7.2 - 10.1 mg/L	7.2 - 10.1 mg/L	McDowell WWTP average daily 2007 measured data	7.2 - 10.1 mg/L	7.2 - 10.1 mg/L	McDowell WWTP average daily 2007 measured data

6. Model Outputs

For each scenario simulated, the model outputs include estimated concentrations of each parameter at one meter depth intervals in each segment and for each day of the year. To summarize the model results and provide a method to compare scenarios, three types of plots were produced to graphically present the results of the modeling. These included vertical profiles, time series plots and contour plots of DO, TP, TN, and chlorophyll *a*. Vertical profiles illustrate how these parameters change with depth in the water column. The vertical profiles are shown at selected locations and for three days during the year to highlight seasonal and spatial differences. Time series plots were produced to show how concentrations at one location changed throughout the year. Time series plots were produced at two or three elevations and for several segments. Contour plots show a longitudinal and vertical slice through the lake. These were produced for three days for each scenario and for the four parameters. The graphical outputs included in this report are listed in Table 6-1. Selected graphs are included in Section 7. However, all of the outputs were presented in electronic format to DWQ staff in the Modeling and TMDL Unit.

Table 6.1 Lake Wylie Model Graphical Outputs

Vertical Profiles

Segment	Locations	Parameters	Dates (Julian day)
3	DS WWTP	DO, TP, TN, Chla	141, 228, 269
4		DO, TP, TN, Chla	141, 228, 269
5		DO, TP, TN, Chla	141, 228, 269
6	Belmont	DO, TP, TN, Chla	141, 228, 269
7		DO, TP, TN, Chla	141, 228, 269
8		DO, TP, TN, Chla	141, 228, 269
9		DO, TP, TN, Chla	141, 228, 269
10		DO, TP, TN, Chla	141, 228, 269
11	US S. Fork	DO, TP, TN, Chla	141, 228, 269
13	DS S. Fork	DO, TP, TN, Chla	141, 228, 269
30	Dam	DO, TP, TN, Chla	141, 228, 269

Time Series

Segment	Locations	Parameters	Depths	Elevation
3	DS WWTP	DO, TP, TN, Chla	2, 6	170, 166
4		DO, TP, TN, Chla	2, 6	170, 166
5		DO, TP, TN, Chla	2, 6	170, 166
6	Belmont	DO, TP, TN, Chla	2, 6	170, 166
7		DO, TP, TN, Chla	2, 6	170, 166
8		DO, TP, TN, Chla	2, 6	170, 166
9		DO, TP, TN, Chla	2, 6	170, 166
10		DO, TP, TN, Chla	2,7	170, 165
11	US S. Fork	DO, TP, TN, Chla	2, 8	170, 164
13	DS S. Fork	DO, TP, TN, Chla	2, 8	170, 164
30	Dam	DO, TP, TN, Chla	2, 8, 14	170, 164, 158

Contour Plots

Parameters	Dates
DO, TP, TN, Chla	141, 228, 269

Groups - for vertical and time series plots

Normal Operating Conditions

EM2002, FN172002, FN252002, FN252002NPS
EM1998, FN251998, N251998NPS

Permit Conditions

EPMHB2002, FP172002, FP252002, FP252002Bel
EPMHB1998, FP251998, FP251998Bel

Segment 3 includes the discharge for the Mt Holly/Long Creek WWTP
Segment 6 is where Belmont WWTF is located
Segment 11 is upstream of the South Fork Branch
Segment 13 is downstream of the South Fork Branch
Segment 30 is in the downstream portion of Lake Wylie

7. Water Quality Impacts

The fourteen scenarios simulated represent variations in effluent flow and quality as well as river conditions. These fourteen scenarios were arranged into four groups for comparison, including normal operating conditions at low and average river flows and permit limit conditions at low and average river flows. Results of the CE-QUAL-W2 model were extracted from the output files and plotted using Excel. Over one thousand plots were generated as listed in Section 6. Selected plots (Figures 3 through 50) are included at the end of this report for discussion. The discussion below focuses on the permit limits condition because that is considered by NC DWQ to be the critical condition.

Vertical profiles of DO, TP, TN and chlorophyll *a* are presented at 2 to 4 important locations and for two days (August 16, 2002 and August 16, 1998). Time series plots are also presented at these same 2 to 4 important locations at one elevation. Time series for DO are presented at an elevation of 166 or 164 because this elevation is close to the thermocline and represents the location where low DO concentrations are typically experienced. Time series plots for TP, TN and chlorophyll *a* are presented at an elevation of 170 which is close to the surface. No contour plots are presented in this report but are included in the electronic files transmitted with the report.

7.1 Dissolved Oxygen

Dissolved oxygen concentrations are affected by many chemical and biological processes in a reservoir. When evaluating wastewater discharges, the input of BOD is the primary factor affecting the DO concentration. As seen from the plots during a low flow year, DO concentrations under the future scenario of a new WWTP would not vary greatly from existing conditions (Figures 3 through 6 and 15 through 18). In the segment downstream of the Belmont discharge, DO concentrations would be slightly higher in the upper portion of the water column (Figure 4). In the area downstream of the junction with the South Fork Branch, the different scenarios exhibit virtually no differences in DO concentrations throughout the water column (Figure 5). In the lower portion of the lake, concentrations would be slightly reduced in the upper portions of the water column in the future scenarios (Figure 6).

The DO patterns for an average flow year are somewhat different. Downstream of the Belmont discharge, low DO concentrations would likely occur about 0.5 - 1 meter higher in the water column (Figure 28). Minor differences in DO concentrations are predicted to occur in the area downstream of the South Fork Branch (Figure 29 and 41) while virtually no differences are expected in the lower section of the lake (Figure 30 and 42).

7.2 Total Phosphorus

Model results show that the predicted TP concentrations would be higher in the upper reaches of the lake under the future condition with a new WWTP discharge (Figures 7, 31, 19, and 43). The greatest differences between existing and future conditions would be observed in the segment downstream of the regional Long Creek WWTP during a low flow year (Figure 7). There were virtually no differences between existing and future conditions in the lower portion of the lake (Figures 8 and 22). Differences were further reduced during the average flow year (Figure 32). Total phosphorus concentrations in the South Carolina portion of the lake would be below the instream water quality criteria of 0.06 mg/L during the average flow year (Figures 45 and 46). During a low flow year, the model predicts that the criteria would be exceeded for a few days early in the year (Figure 21). Values exceeding the criteria would occur under all modeled scenarios for 2002 flows including the existing permit limits for the existing WWTPs.

7.3 Total Nitrogen

Patterns of TN concentrations are similar to those predicted for phosphorus. Predicted TN concentrations would be higher in the upper reaches of the lake under the future conditions scenario (Figure 9, 23, 33, and 47). The difference between existing and future conditions would be greatest in the segment downstream of the regional Long Creek WWTP during a low flow year (Figure 9). There were virtually no differences in TN concentrations between existing and future conditions in the lower portion of the lake (Figure 10 and 24).

Differences were further reduced during the average flow year (Figure 34 and 48). Total nitrogen concentrations in the South Carolina portion of the lake would be below the instream water quality criteria of 1.5 mg/L for all conditions modeled.

7.4 Chlorophyll *a*

Chlorophyll *a* concentrations were very low in the upper portion of the reservoir and generally increase in a downstream direction under both existing and future conditions scenarios (Figures 11 through 14). The differences between the existing and future conditions are greatest during a low flow year and in the segments at and immediately downstream of the Belmont WWTP. As shown in Figure 12, in Segment 7 (downstream of the Belmont WWTP) chlorophyll *a* concentrations would be about 3 µg/L higher due to the increased load from the Regional Long Creek plant and about 2.5 µg/L higher due to the increased load from the Belmont WWTP. Only minor differences between the scenarios were apparent downstream of the junction with the South Fork Branch (Figure 13 and 14). Virtually no differences in chlorophyll *a* concentrations were seen between scenarios run using average flow conditions (Figures 35 through 38). In all cases the predicted chlorophyll *a* concentrations were well below the water quality criteria of 40 µg/L.

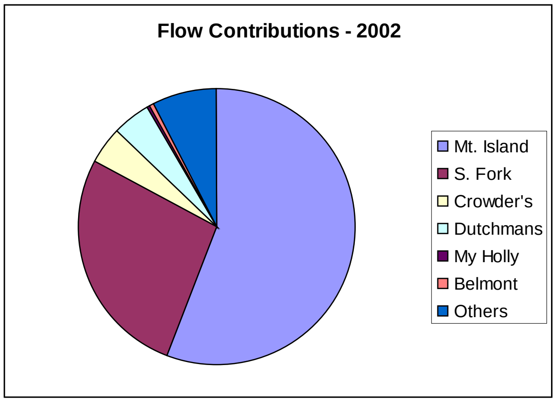
7.5 Flow and Nutrient Contributions

The contributions of flow and nutrient loads were calculated for the existing and future scenarios for flow conditions represented by 1998 and 2002. The major contributors included:

- Mountain Island Lake
- South Fork Branch,
- Crowder's Creek,
- Dutchman's Creek and Long Creek (which are combined in a single input in the model),
- Mount Holly WWTP (existing) or Regional Long Creek WWTP (future),
- Belmont WWTP
- Combination of all other inflows, including distributed flows.

For purposes of this analysis inflows from the power plants were not included in the load calculations. The specific scenarios compared were the existing conditions assuming that WWTPs were operating at their permit limits (EPMHB2002 and EPMHB1998) and the future scenario assuming a new Regional Long Creek WWTP with a discharge of 25 mgd (FP252002Bel and FP251998BEL). It was assumed that permit limits for TP and TN for the new regional facility were 1 mg/L and 6 mg/L, respectively. In the future scenario, the Belmont plant was assumed to be operating at the current permit limits.

The contributions of flow from the major inputs to Lake Wylie are shown in Figure 51. Even in a dry year, the combined flows from Mountain Island Lake and the South Fork Branch were estimated to contribute over 80 percent of the flows to the lake. Contributions of TP and TN are shown in Figures 52 and 53, respectively. Even though Mountain Island Lake was estimated to contribute more than half of the flow it was estimated that this source would contribute less than 15 percent of the TP and about 20 percent of the TN. The largest source of nutrients for both the existing and future cases was estimated to be the South Fork Branch. The Belmont WWTP was estimated to contribute about 26 percent of the TP loads under existing permit conditions; about double the load contributed by the Mount Holly WWTP. Under the future scenario, the new Regional Long Creek WWTP could contribute a slightly higher load than the Belmont WWTP although the flow would be five times greater. Similar patterns were shown in the comparison of TN load contributions.



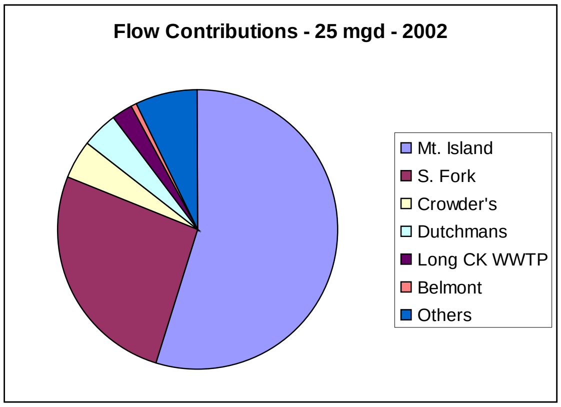


Figure 51 Comparison of Flow Contributions for Existing and Future Scenarios

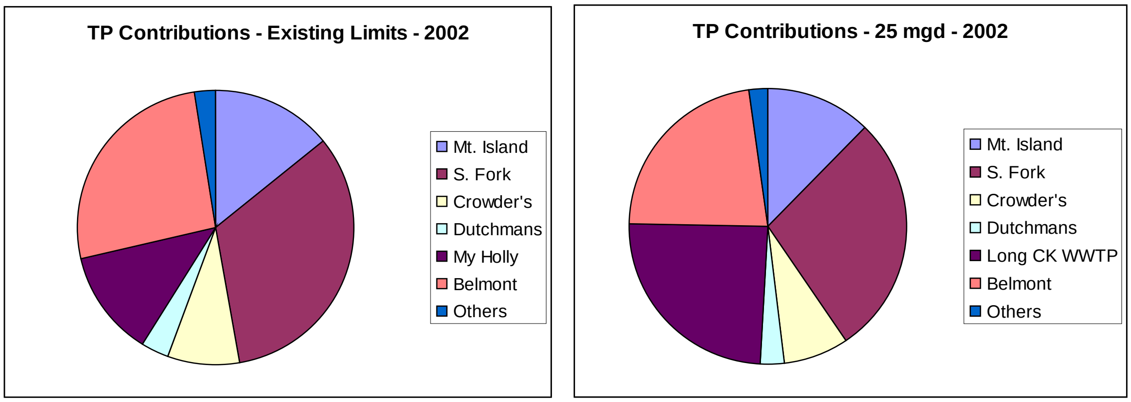


Figure 52 Comparison of TP Contributions for Existing and Future Scenarios

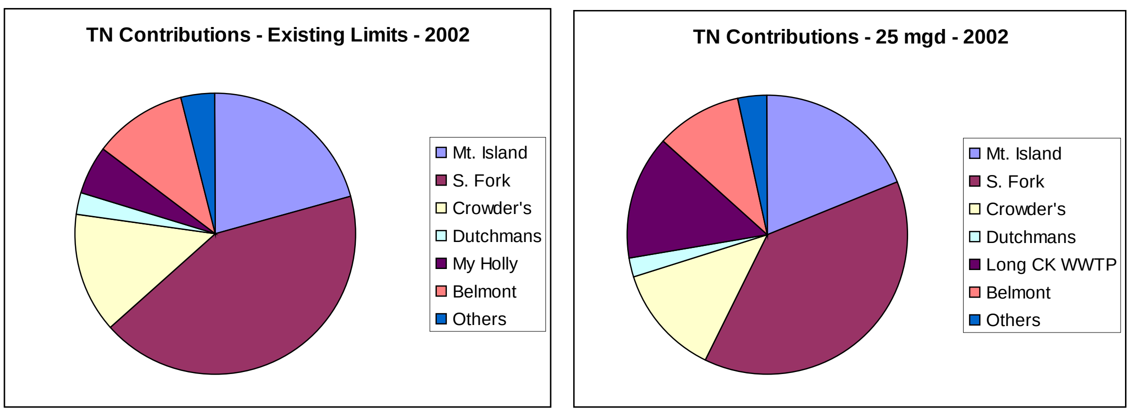


Figure 53 Comparison of TN Contributions for Existing and Future Scenarios

8. Findings and Conclusions

Water quality modeling of Lake Wylie was performed to assist in the evaluation of water quality impacts from the proposed facility and to support the development of speculative NPDES limits by NC DWQ for the plant discharge into Lake Wylie. The previously calibrated Lake Wylie model was used to evaluate the effects of increased wastewater discharges to the upper section of Lake Wylie. Many scenarios were simulated to evaluate existing and potential future conditions. For both existing and future conditions both normal operating conditions and permit conditions were simulated. Increases in future nonpoint source (NPS) loads were also simulated. Wastewater treatment plant point sources to Lake Wylie included the Mount Holly WWTP and the Belmont WWTP.

The water quality parameters that were simulated in the model included phosphorus, ammonia, nitrate, BOD, and DO. For normal operating conditions, the concentrations used represented the highest loads that could be discharged without exceeding any permit limits. Water quality concentrations for the proposed regional WWTP under permit limit conditions were calculated based on assumed permit limits for TN, TP, and BOD5 based on plant capacity. The fourteen scenarios simulated represent variations in effluent flow and quality as well as river conditions.

Model results indicated the following conditions would occur:

- Dissolved oxygen concentrations under the future scenario of a new WWTP would not vary greatly from existing conditions. In the area downstream of the junction with the South Fork Branch, the different scenarios exhibited virtually no differences in DO concentrations throughout the water column. In the lower section of the lake, concentrations would be slightly reduced in the upper portions of the water column in the future scenarios.

- During an average flow year, low DO concentrations would likely occur about 0.5 - 1 meter higher in the water column downstream of the Belmont WWTP. Only minor differences in DO concentrations were predicted to occur in the area downstream of the South Fork Branch while virtually no differences were expected in the lower section of the lake.

- Predicted TP concentrations would be higher in the upper reaches of the lake under the future condition with a new WWTP discharge.

- There were virtually no differences in TP concentrations between existing and future conditions in the lower section of the lake. Differences were further reduced during the average flow year.

- Predicted TP concentrations in the South Carolina portion of the lake would be below the instream water quality criteria of 0.06 mg/L throughout the average flow year. However, during a dry flow year, under all existing and future conditions, it was estimated that the TP criteria would be exceeded for a few days early in the year.

- Predicted TN concentrations would be higher in the upper reaches of the lake under the future conditions scenario. There were virtually no differences in TN concentrations between existing and future conditions in the lower section of the lake. Differences were further reduced during the average flow year.

- Total nitrogen concentrations in the South Carolina portion of the lake would be below the instream water quality criteria of 1.5 mg/L for all conditions modeled.

- Chlorophyll *a* concentrations were very low in the upper section of the reservoir and generally increase in a downstream direction under both existing and future conditions scenarios.

- Only minor differences between the scenarios were apparent downstream of the junction with the South Fork Branch. Virtually no differences in chlorophyll *a* concentrations were seen between scenarios run using average flow conditions.

- In all cases the predicted chlorophyll *a* concentrations were well below the water quality criteria of 40 μg/L.

- The largest source of nutrients for both the existing and future cases was estimated to be the South Fork Branch.

- Under the future scenario, the new Regional Long Creek WWTP could contribute a slightly higher load than the Belmont WWTP although the flow would be five times greater. Similar patterns were shown in the comparison of TN load contributions.

Overall, the modeling shows that the effects of the new regional Long Creek WWTP would have minor impacts on water quality in Lake Wylie. Effects would be mostly confined to the upper reaches of the lake. Water quality criteria for TN and chlorophyll *a* would be met under all conditions. Criteria for TP could be exceeded for a few days during a low flow year under both existing and future conditions.

9. References

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Selected Figures for Permit Conditions, 2002 Flow

Scenarios:

EPMHB2002 – permit limits, existing plants

FP172002 – future permit limits at 17 mgd

FP252002 – future permit limits at 25 mgd, with Belmont at existing loads

FP252002Bel – future permit limits at 25 mgd with Belmont at increased loads

Vertical Plots – August 16, 2002

DO and Chlorophyll *a* at Segments 3, 7, 13 and 30

TP and TN at Segments 3 and 30

Time Series Plots

DO at Elevation 166 or 164 (near thermocline) at Segments 3, 7, 13 and 30

TP at Elevation 170 (near surface) at Segments 3, 7, 13, and 30

TN at Elevation 170 (near surface) at Segments 3 and 30

Chlorophyll a at Elevation 170 (near surface) at Segments 3 and 30

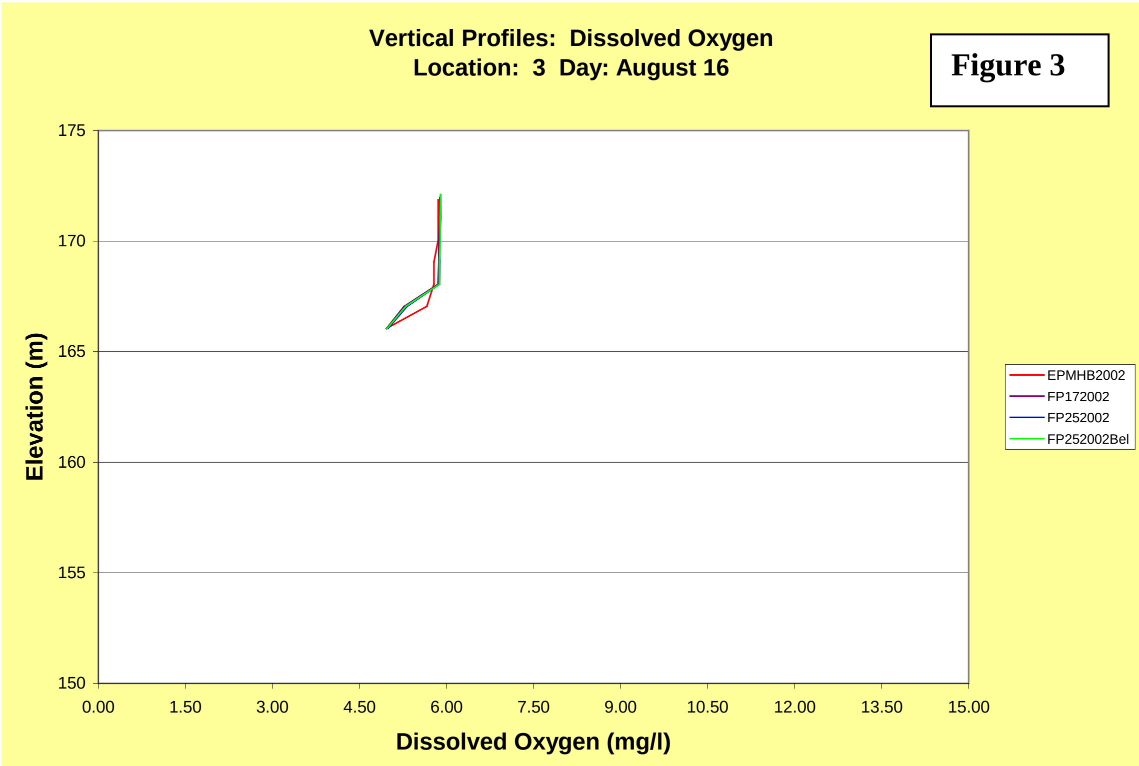
Segments

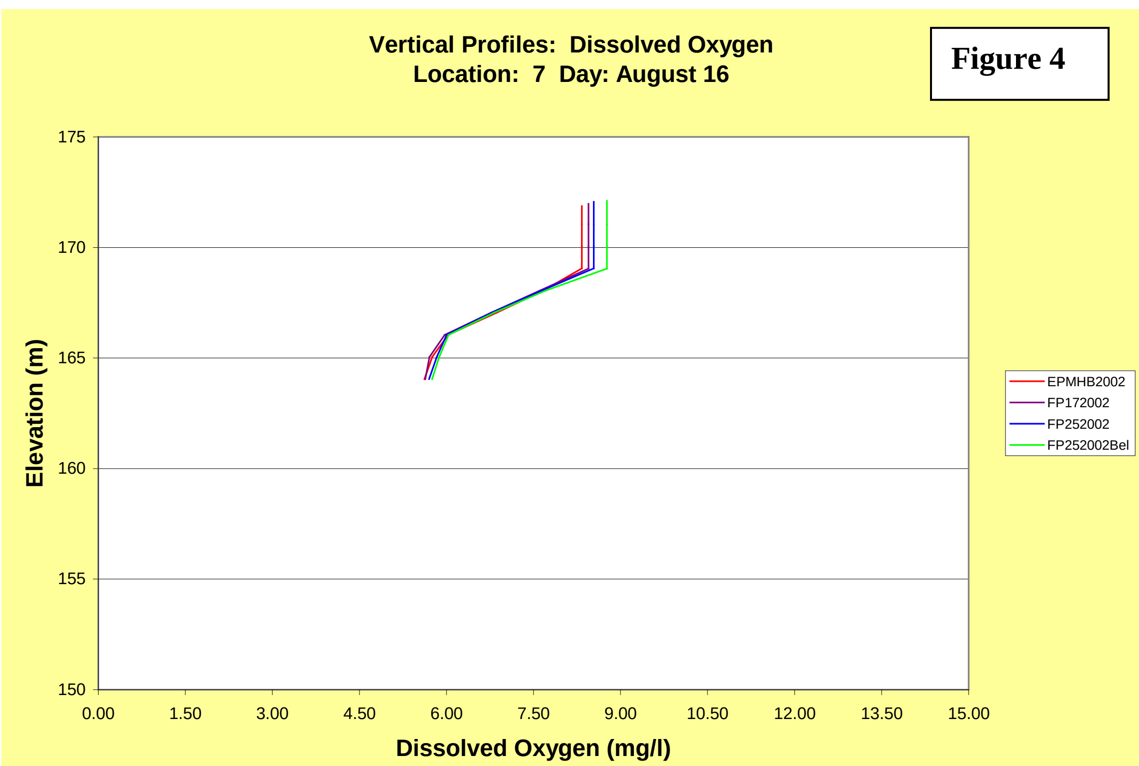
3 – downstream of Mount Holly/Long Creek Regional WWTP

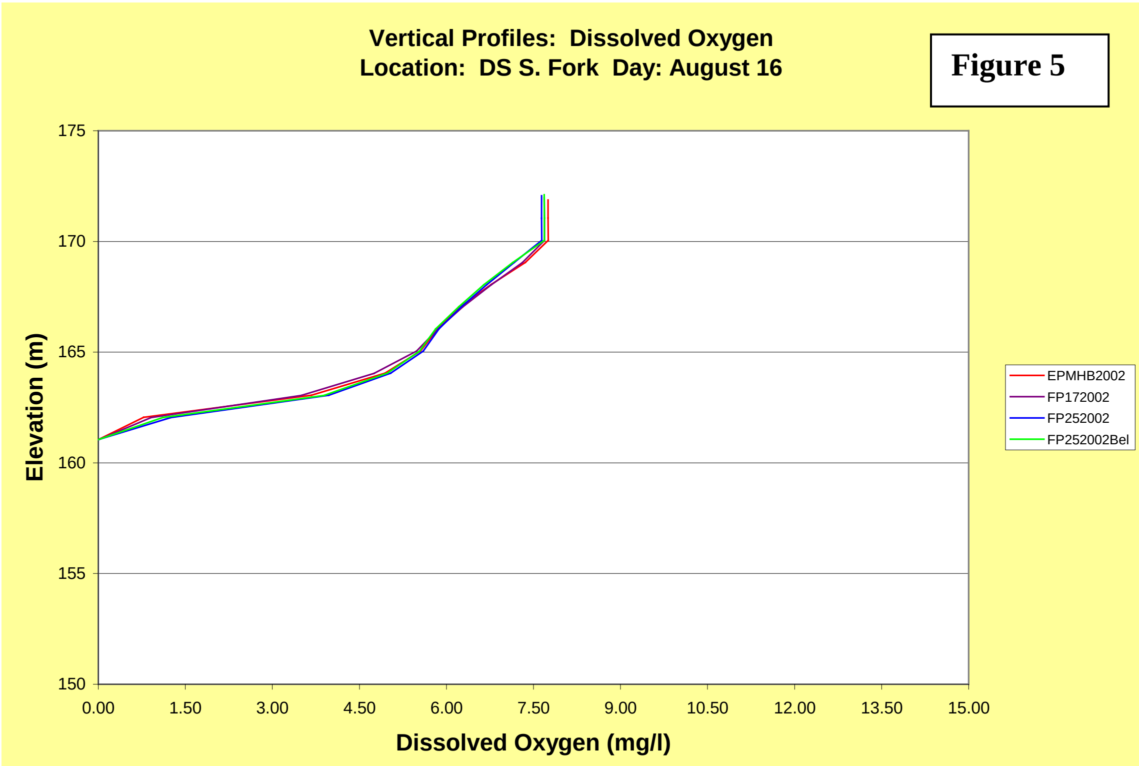
7 – segment downstream of Belmont WWTP

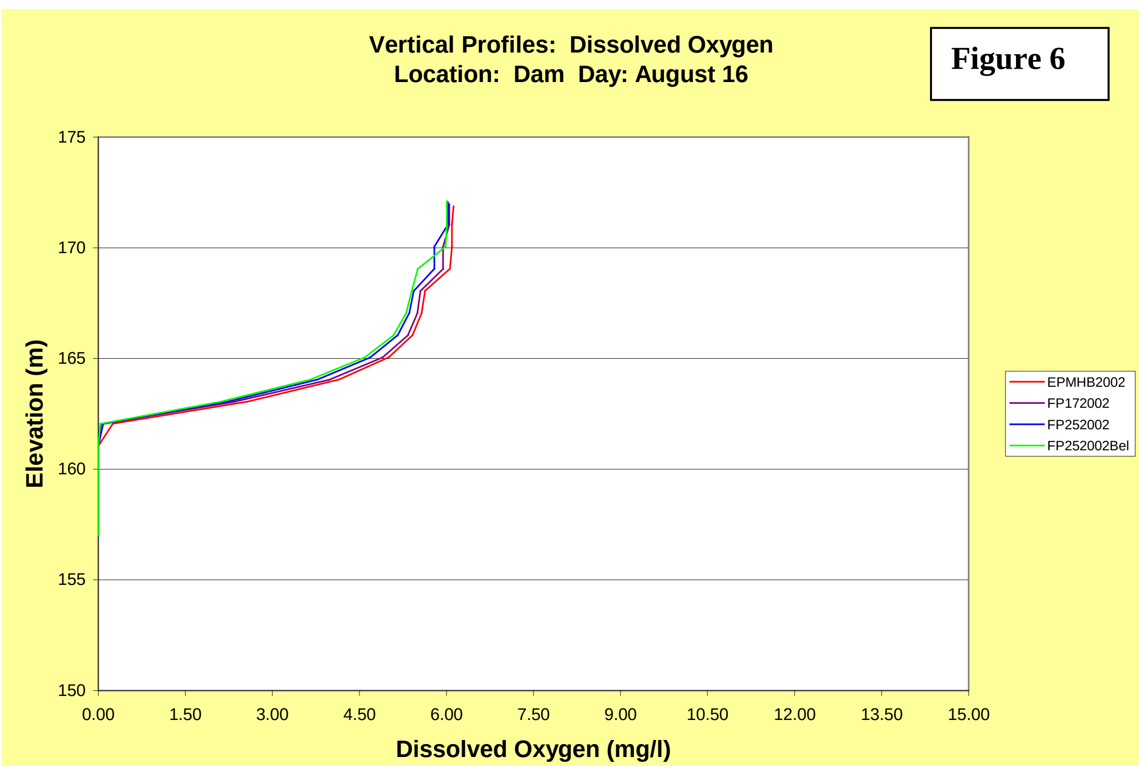
13 – segment downstream of junction with South Fork Branch

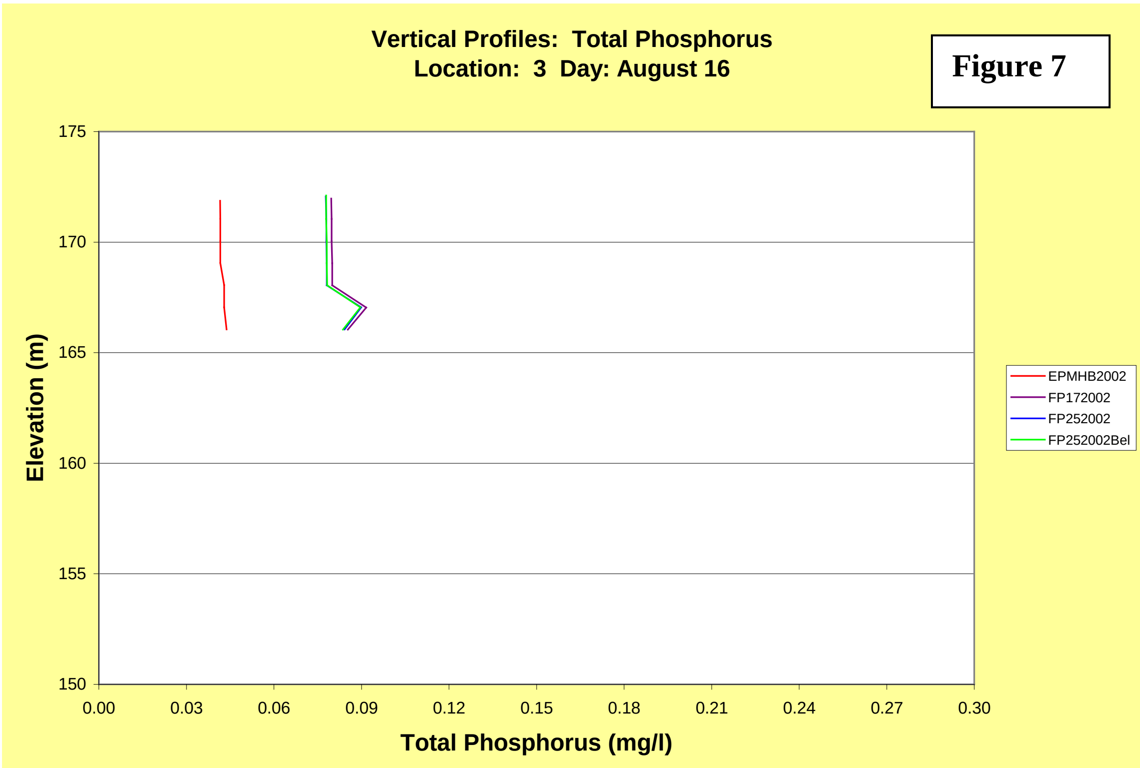
30 – segment in lower portion of the lake near the dam

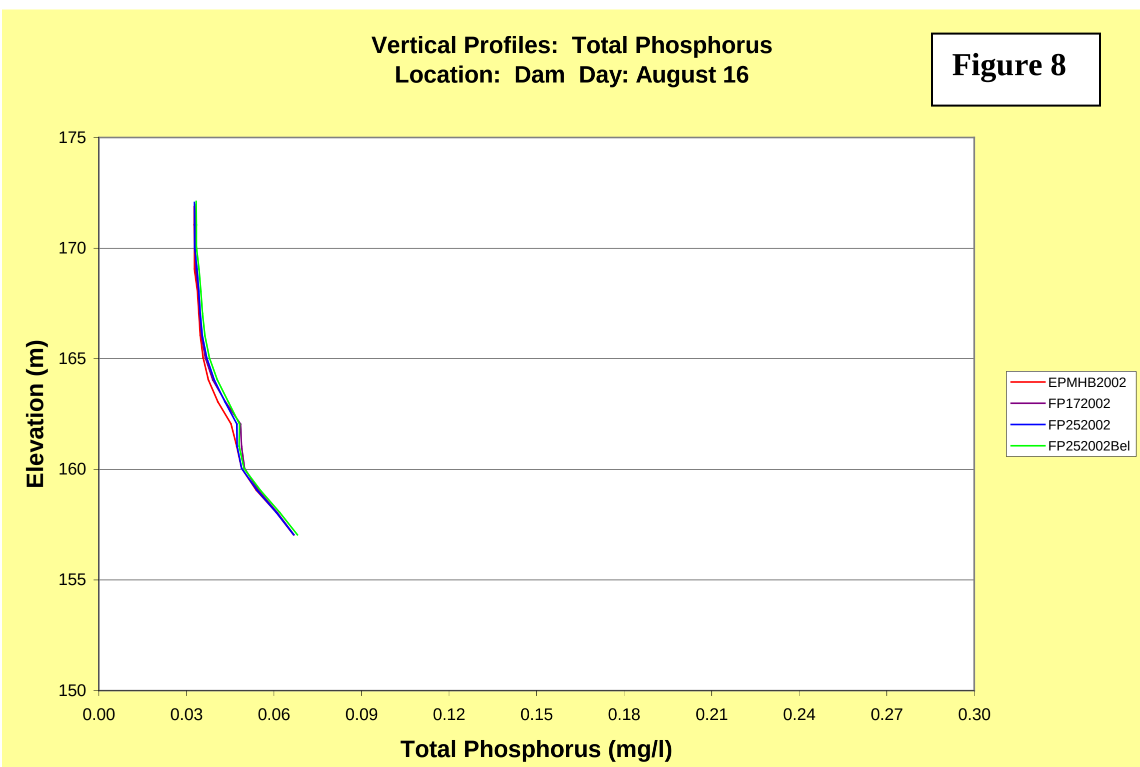

Vertical Profiles: Dissolved Oxygen
Location: 3 Day: August 16
Figure 3
Elevation (m)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Dissolved Oxygen (mg/l)
EPMHB2002
FP172002
FP252002
FP252002Bel

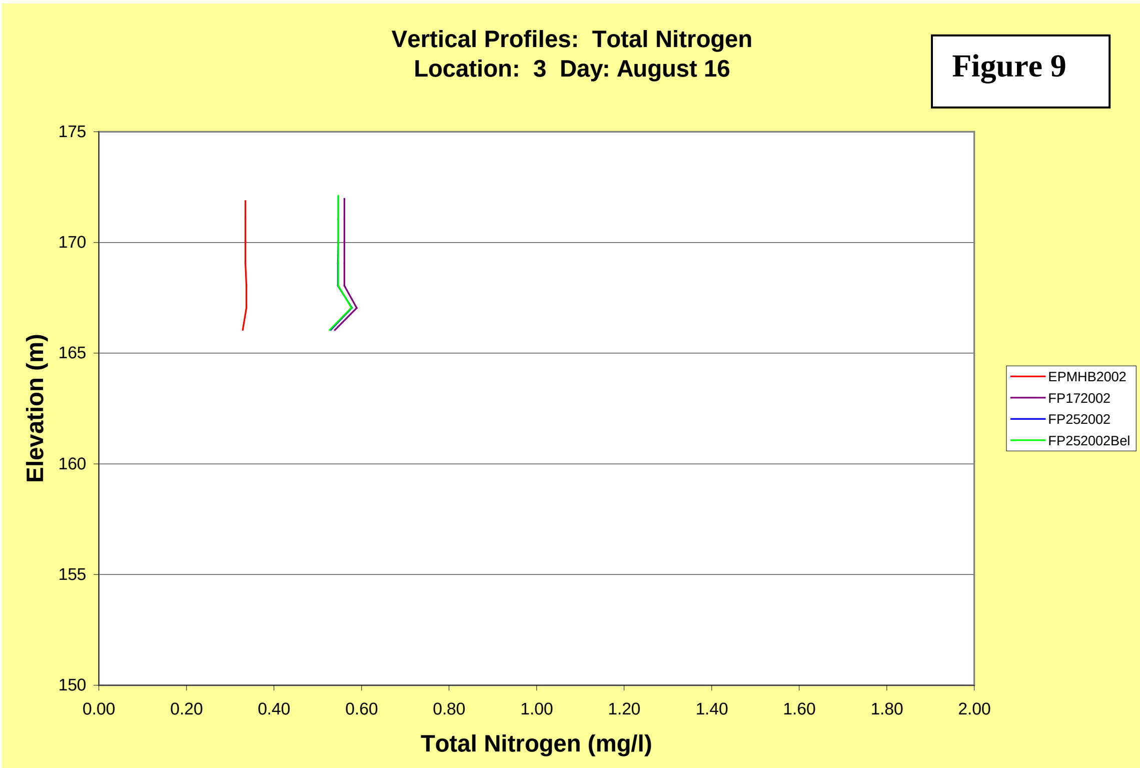

Vertical Profiles: Dissolved Oxygen
Location: 7 Day: August 16
Figure 4
Elevation (m)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Dissolved Oxygen (mg/l)
EPMHB2002
FP172002
FP252002
FP252002Bel

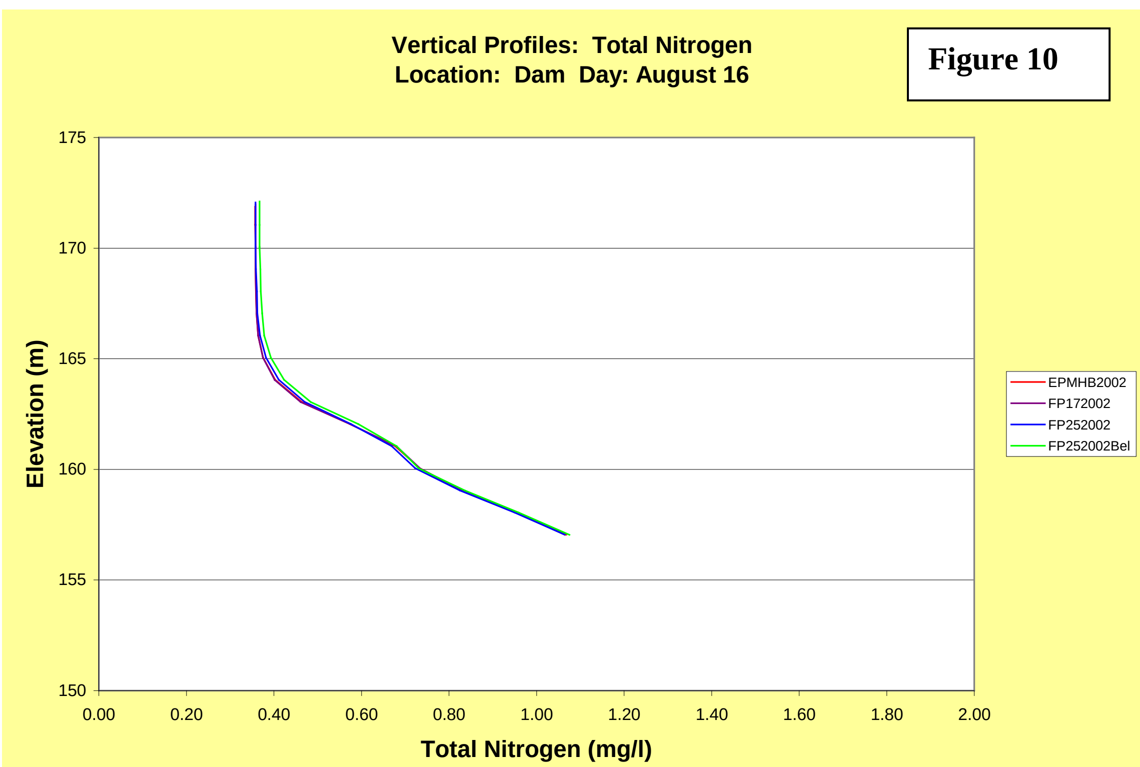

Vertical Profiles: Dissolved Oxygen
Location: DS S. Fork Day: August 16
Figure 5
Elevation (m)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Dissolved Oxygen (mg/l)
EPMHB2002
FP172002
FP252002
FP252002Bel

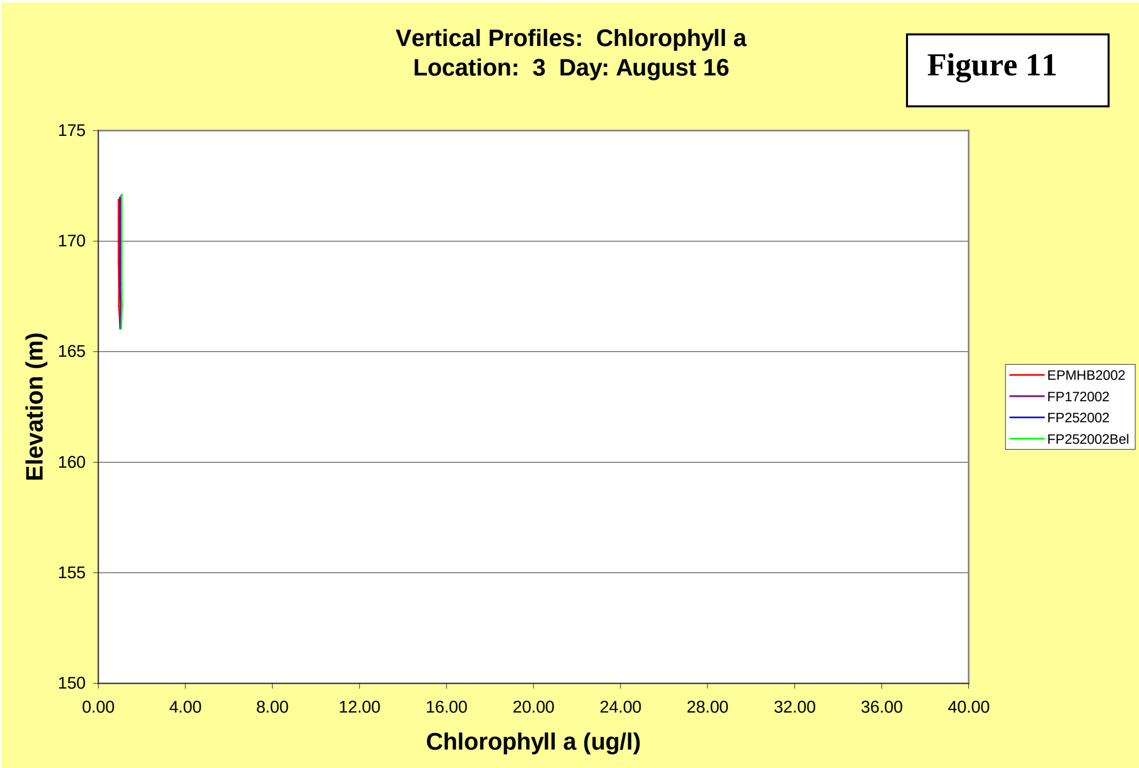

Vertical Profiles: Dissolved Oxygen
Location: Dam Day: August 16
Figure 6
Elevation (m)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Dissolved Oxygen (mg/l)
EPMHB2002
FP172002
FP252002
FP252002Bel

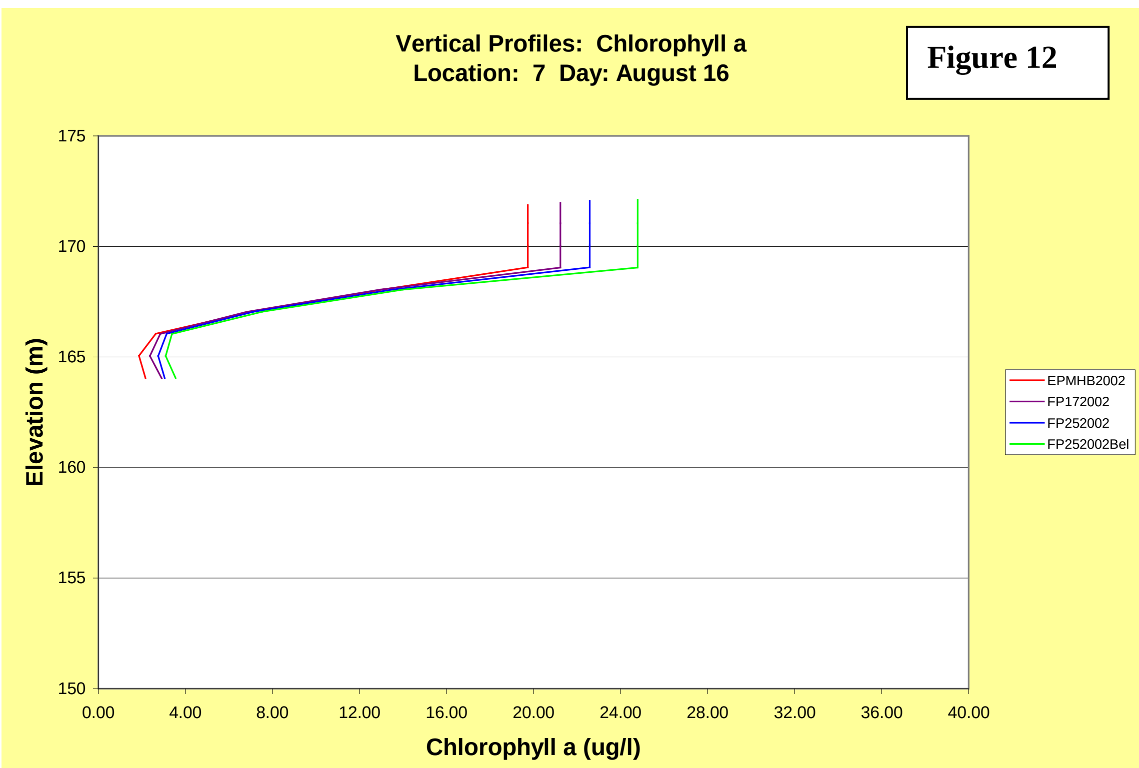

Vertical Profiles: Total Phosphorus
Location: 3 Day: August 16
Figure 7
175
170
165
160
155
150
0.00
0.03
0.06
0.09
0.12
0.15
0.18
0.21
0.24
0.27
0.30
Elevation (m)
Total Phosphorus (mg/l)
EPMHB2002
FP172002
FP252002
FP252002Bel

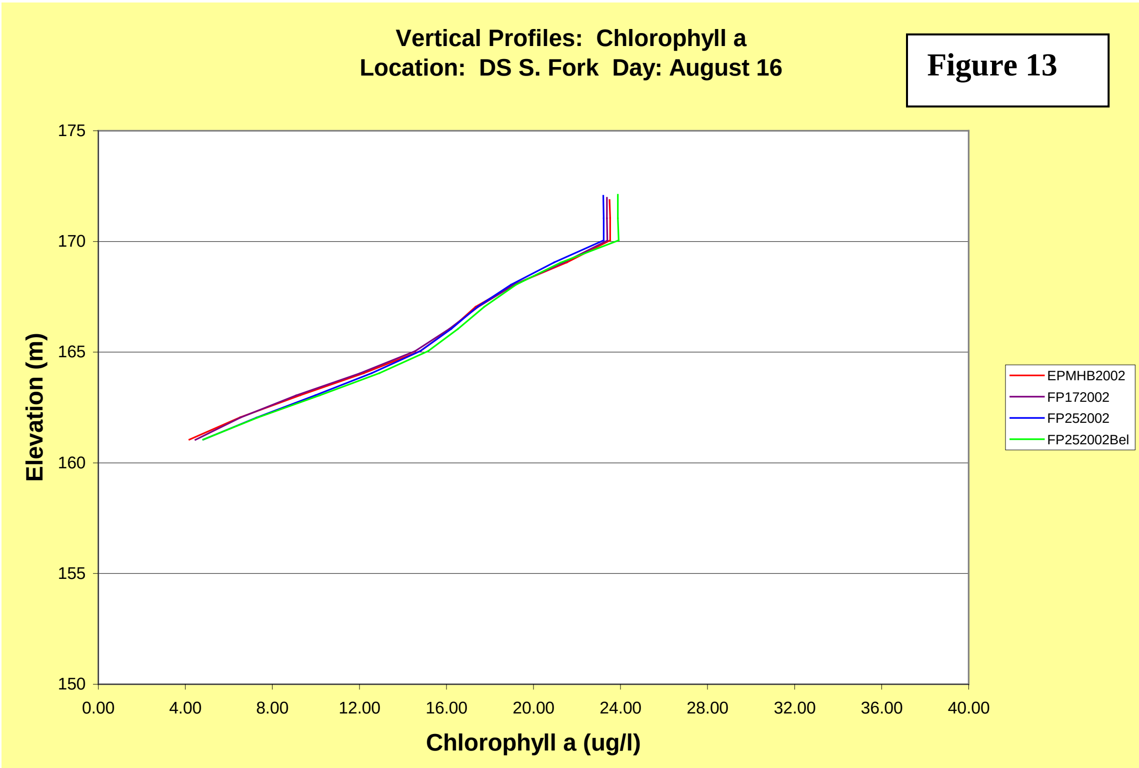

Vertical Profiles: Total Phosphorus
Location: Dam Day: August 16
Figure 8
175
170
165
160
155
150
0.00
0.03
0.06
0.09
0.12
0.15
0.18
0.21
0.24
0.27
0.30
Elevation (m)
Total Phosphorus (mg/l)
EPMHB2002
FP172002
FP252002
FP252002Bel

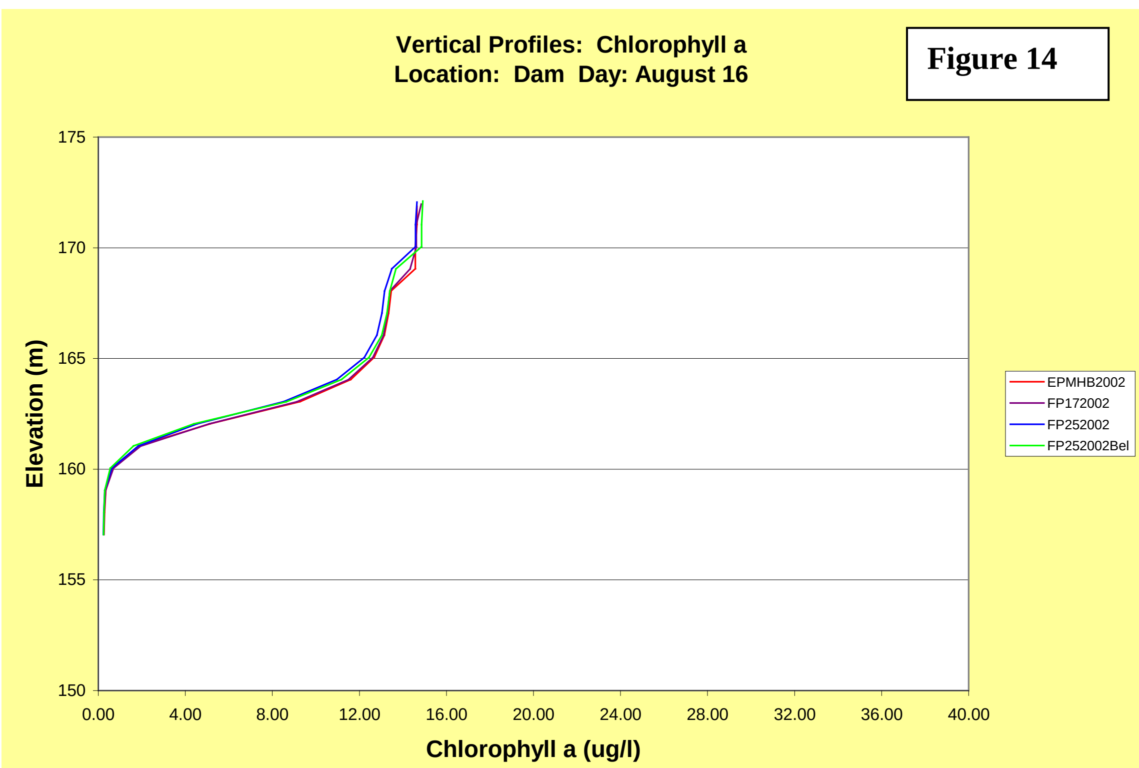

Vertical Profiles: Total Nitrogen
Location: 3 Day: August 16
Figure 9
Elevation (m)
175
170
165
160
155
150
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
Total Nitrogen (mg/l)
EPMHB2002
FP172002
FP252002
FP252002Bel

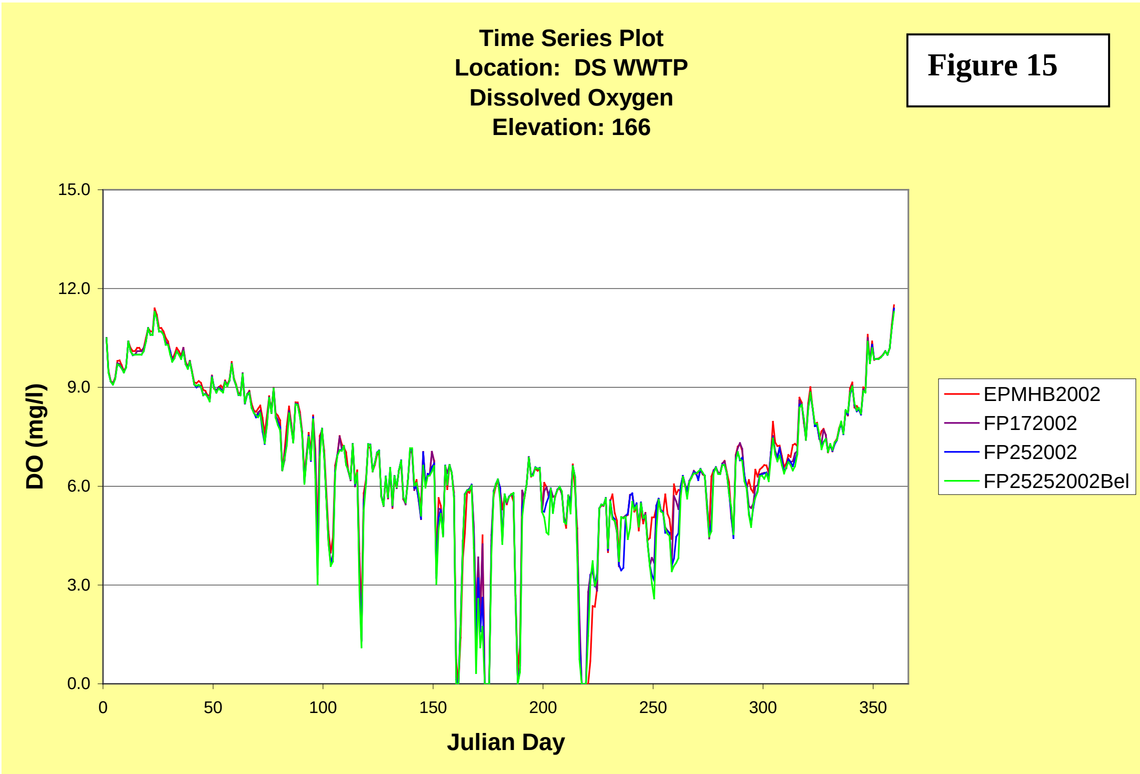

Vertical Profiles: Total Nitrogen
Location: Dam Day: August 16
Figure 10
Elevation (m)
175
170
165
160
155
150
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
Total Nitrogen (mg/l)
EPMHB2002
FP172002
FP252002
FP252002Bel

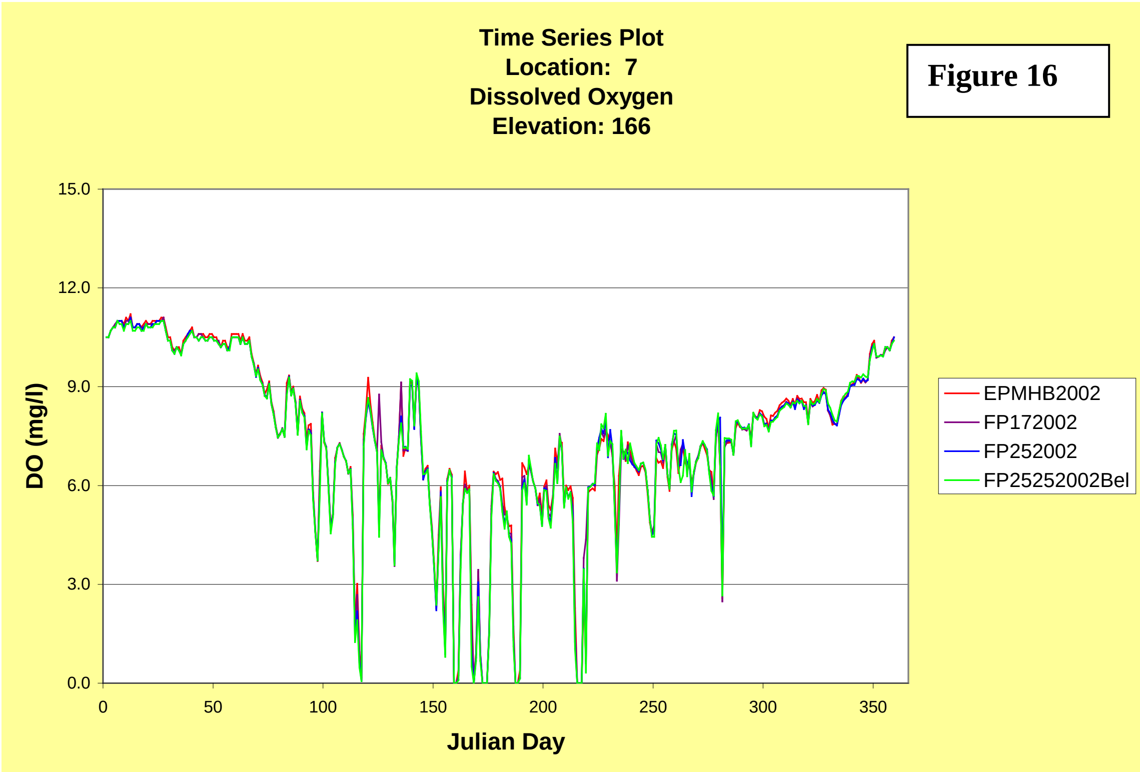

Vertical Profiles: Chlorophyll a
Location: 3 Day: August 16
Figure 11
Elevation (m)
175
170
165
160
155
150
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
36.00
40.00
Chlorophyll a (ug/l)
EPMHB2002
FP172002
FP252002
FP252002Bel

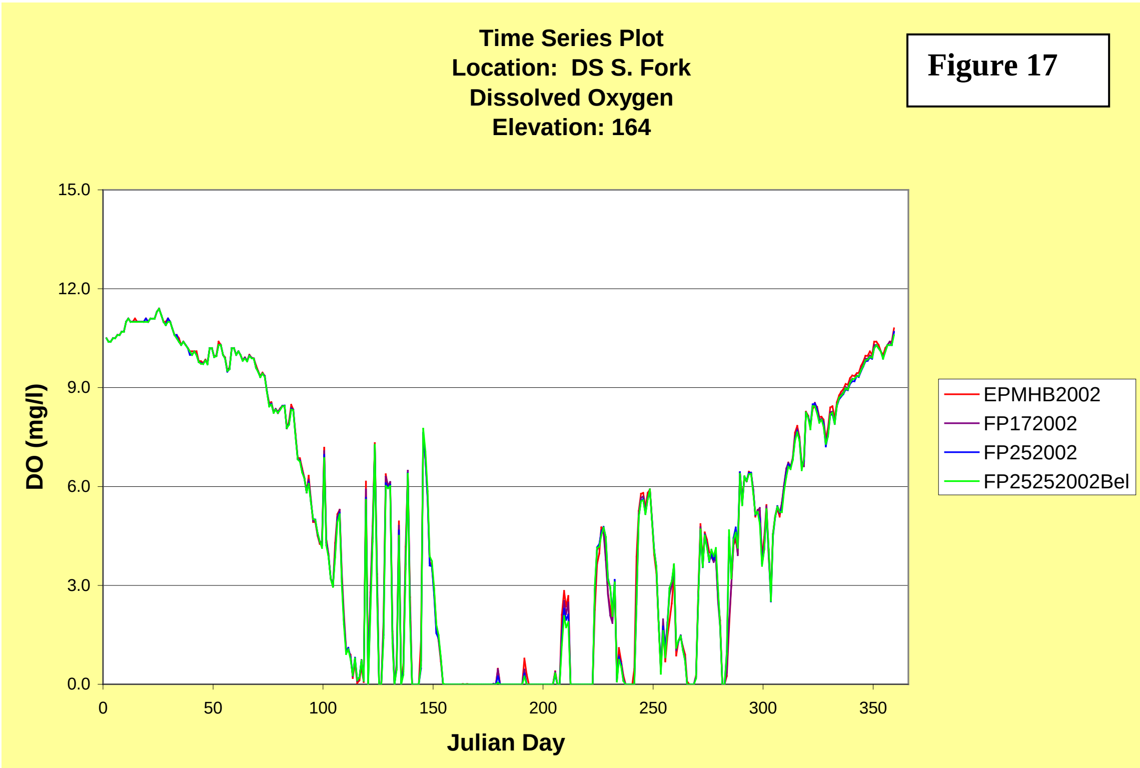

Vertical Profiles: Chlorophyll a
Location: 7 Day: August 16
Figure 12
Elevation (m)
175
170
165
160
155
150
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
36.00
40.00
Chlorophyll a (ug/l)
EPMHB2002
FP172002
FP252002
FP252002Bel

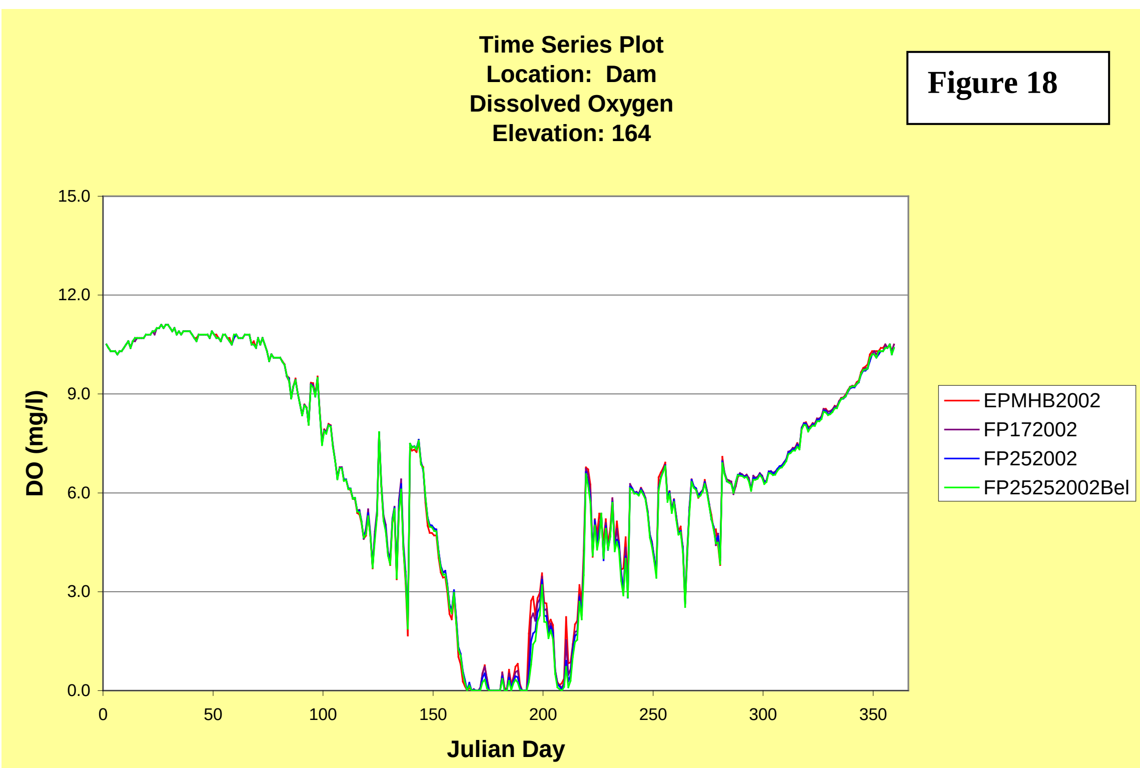

Vertical Profiles: Chlorophyll a
Location: DS S. Fork Day: August 16
Figure 13
175
170
165
160
155
150
Elevation (m)
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
36.00
40.00
Chlorophyll a (ug/l)
EPMHB2002
FP172002
FP252002
FP252002Bel

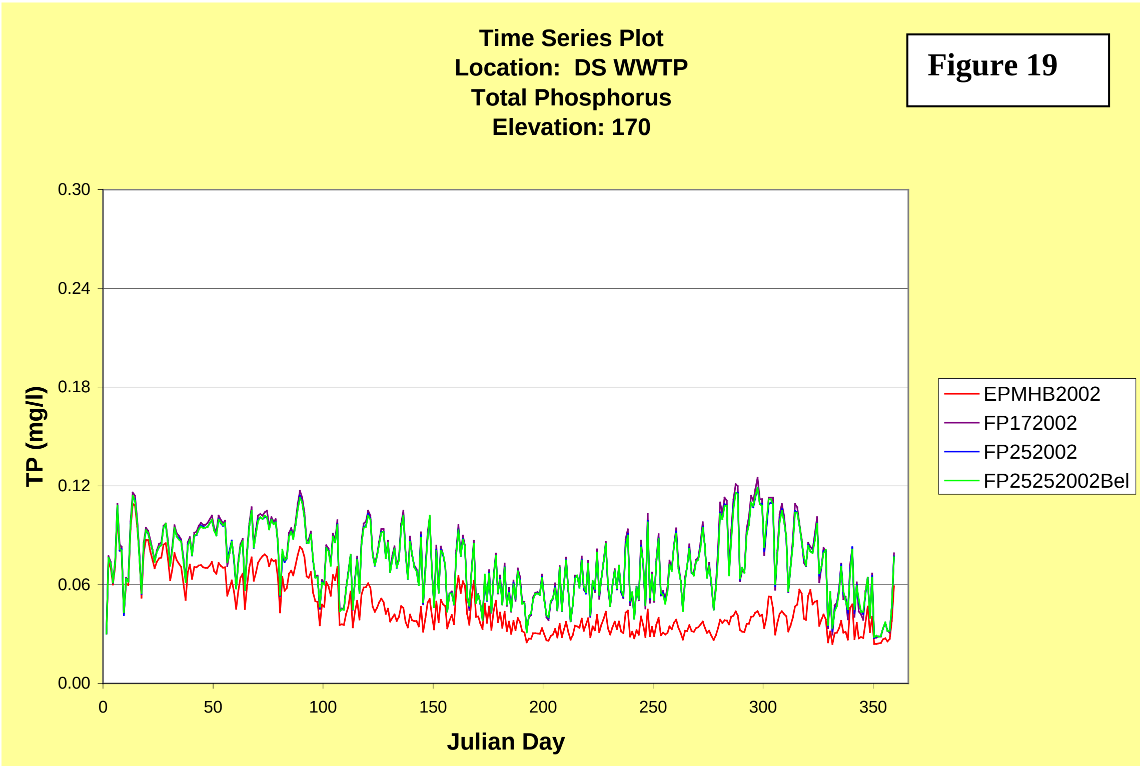

Vertical Profiles: Chlorophyll a
Location: Dam Day: August 16
Figure 14
175
170
165
160
155
150
Elevation (m)
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
36.00
40.00
Chlorophyll a (ug/l)
EPMHB2002
FP172002
FP252002
FP252002Bel

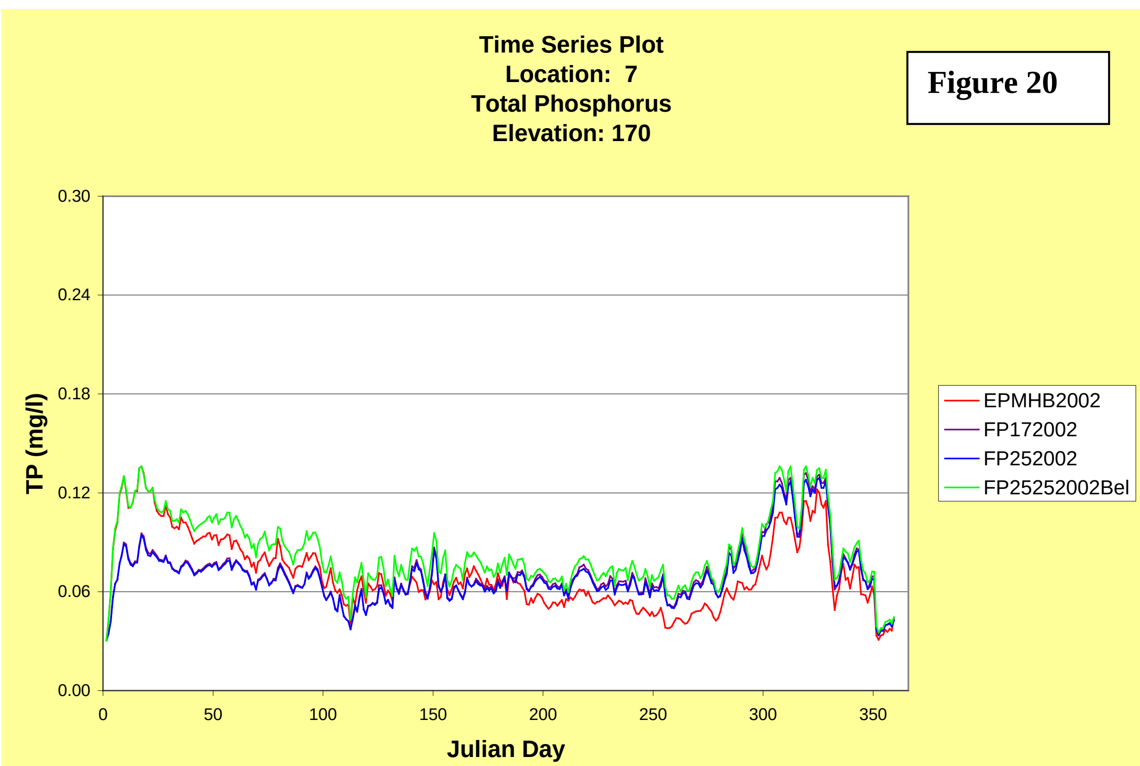

Time Series Plot
Location: DS WWTP
Dissolved Oxygen
Elevation: 166
Figure 15
DO (mg/l)
15.0
12.0
9.0
6.0
3.0
0.0
0
50
100
150
200
250
300
350
Julian Day
EPMHB2002
FP172002
FP252002
FP25252002Bel

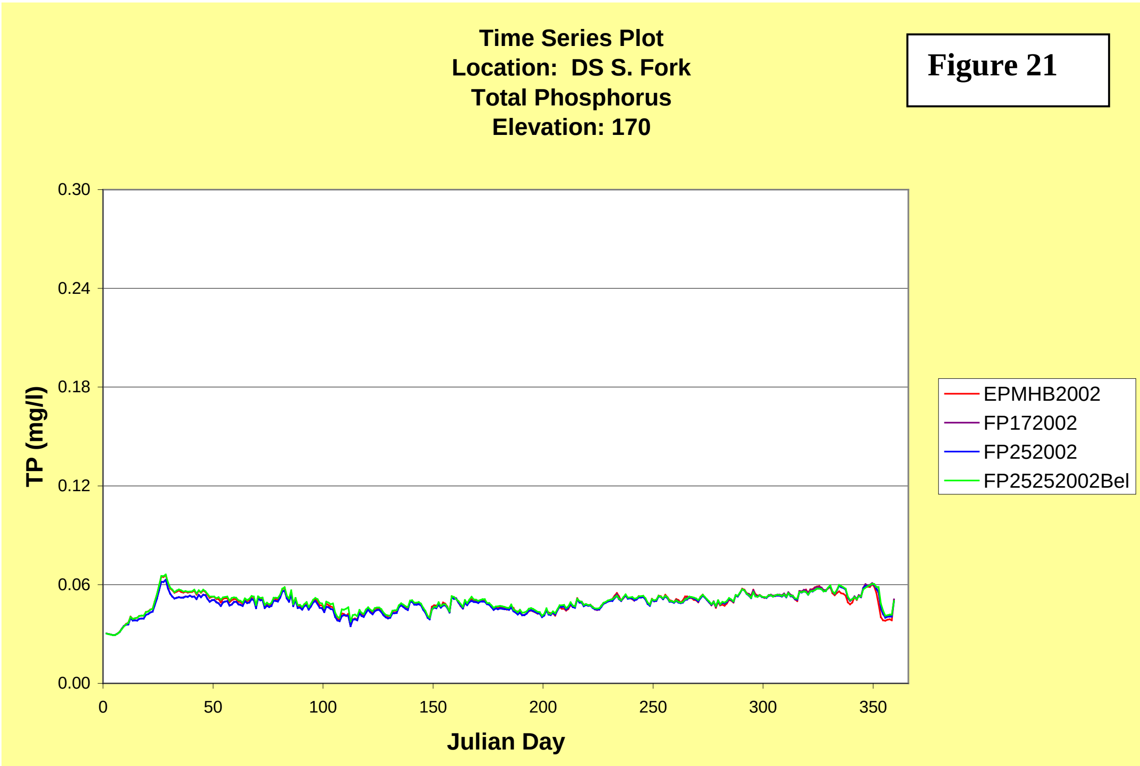

Time Series Plot
Location: 7
Dissolved Oxygen
Elevation: 166
Figure 16
DO (mg/l)
15.0
12.0
9.0
6.0
3.0
0.0
0
50
100
150
200
250
300
350
Julian Day
EPMHB2002
FP172002
FP252002
FP25252002Bel


Time Series Plot
Location: DS S. Fork
Dissolved Oxygen
Elevation: 164
Figure 17
DO (mg/l)
15.0
12.0
9.0
6.0
3.0
0.0
0
50
100
150
200
250
300
350
Julian Day
EPMHB2002
FP172002
FP252002
FP25252002Bel


Time Series Plot
Location: Dam
Dissolved Oxygen
Elevation: 164
Figure 18
DO (mg/l)
15.0
12.0
9.0
6.0
3.0
0.0
0
50
100
150
200
250
300
350
Julian Day
EPMHB2002
FP172002
FP252002
FP25252002Bel


Time Series Plot
Location: DS WWTP
Total Phosphorus
Elevation: 170
Figure 19
TP (mg/l)
0.30
0.24
0.18
0.12
0.06
0.00
0
50
100
150
200
250
300
350
Julian Day
EPMHB2002
FP172002
FP252002
FP25252002Bel


Time Series Plot
Location: 7
Total Phosphorus
Elevation: 170
Figure 20
TP (mg/l)
0.30
0.24
0.18
0.12
0.06
0.00
0
50
100
150
200
250
300
350
Julian Day
EPMHB2002
FP172002
FP252002
FP25252002Bel


Time Series Plot
Location: DS S. Fork
Total Phosphorus
Elevation: 170
Figure 21
TP (mg/l)
0.30
0.24
0.18
0.12
0.06
0.00
0
50
100
150
200
250
300
350
Julian Day
EPMHB2002
FP172002
FP252002
FP25252002Bel

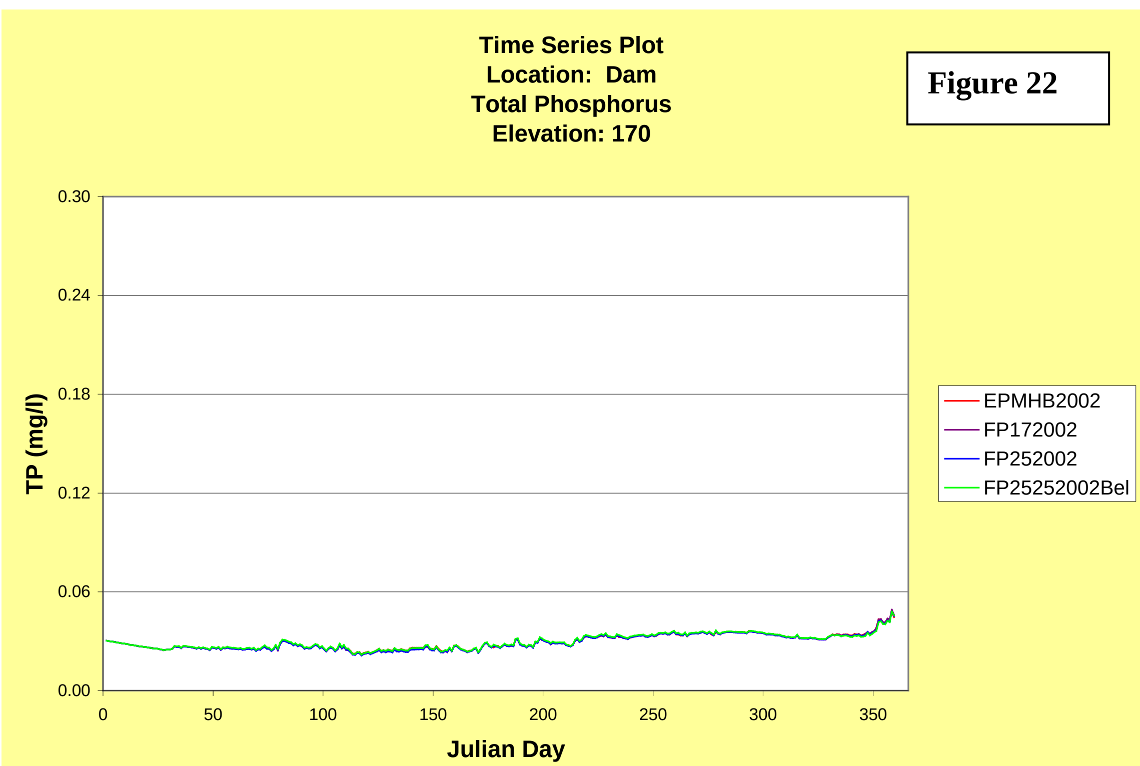

Time Series Plot
Location: Dam
Total Phosphorus
Elevation: 170
Figure 22
TP (mg/l)
0.30
0.24
0.18
0.12
0.06
0.00
0
50
100
150
200
250
300
350
Julian Day
EPMHB2002
FP172002
FP252002
FP25252002Bel

Figure 23

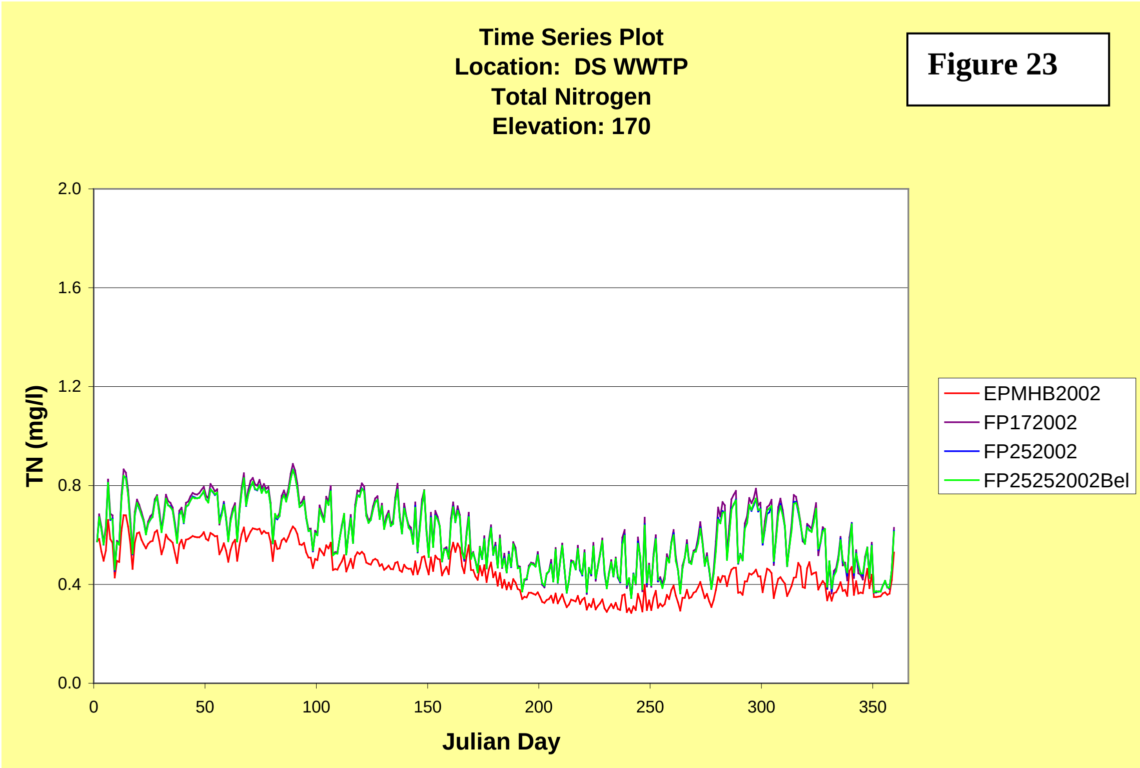
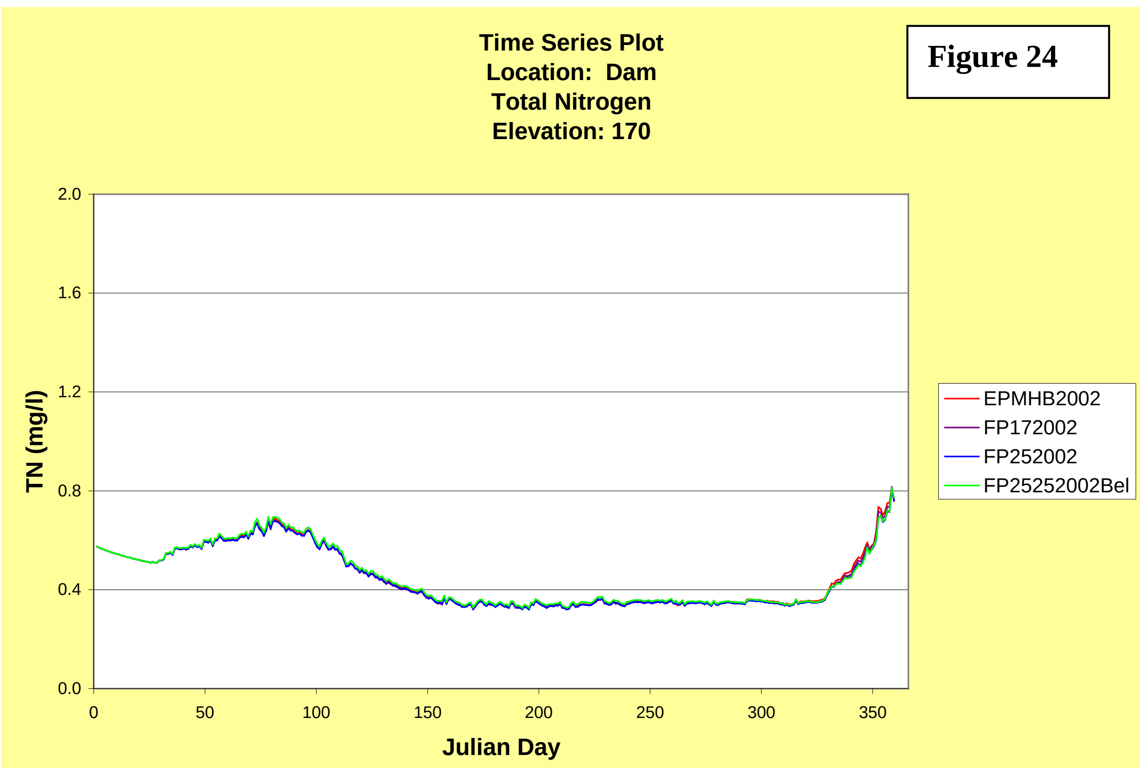
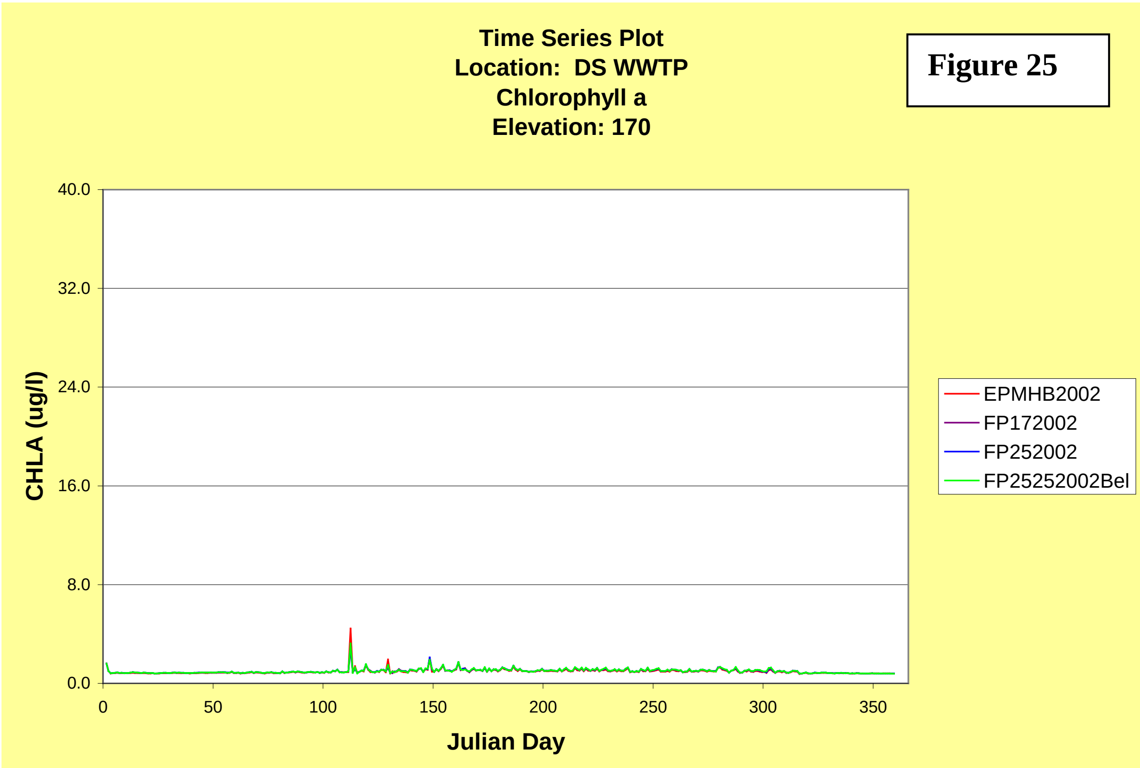
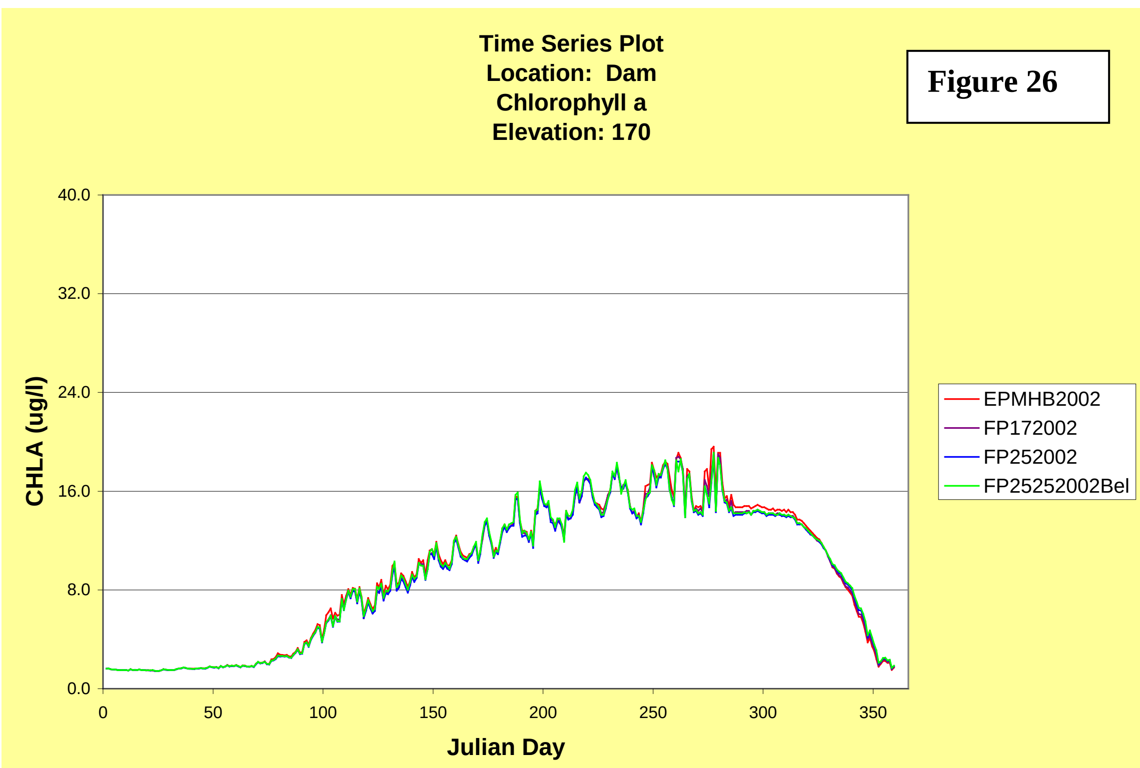


Figure 24




Time Series Plot
Location: DS WWTP
Chlorophyll a
Elevation: 170
Figure 25
CHLA (ug/l)
40.0
32.0
24.0
16.0
8.0
0.0
0
50
100
150
200
250
300
350
Julian Day
EPMHB2002
FP172002
FP252002
FP25252002Bel


Time Series Plot
Location: Dam
Chlorophyll a
Elevation: 170
Figure 26
CHLA (ug/l)
40.0
32.0
24.0
16.0
8.0
0.0
0
50
100
150
200
250
300
350
Julian Day
EPMHB2002
FP172002
FP252002
FP25252002Bel

Selected Figures for Permit Limits Conditions, 1998 Flow

Scenarios:

EPMHB1998 – permit limits, existing plants

FP251998 – future permit limits at 25 mgd, with Belmont at existing loads

FP251998 – future permit limits at 25 mgd, with Belmont at increased loads

Vertical Plots – August 16, 1998

DO and Chlorophyll *a* at Segments 3, 7, 13 and 30

TP and TN at Segments 3 and 30

Time Series Plots

DO at Elevation 166 or 164 (near thermocline) at Segments 3, 7, 13 and 30

TP at Elevation 170 (near surface) at Segments 3, 7, 13, and 30

TP at Elevation 170 (near surface) at Segments 3 and 30

Chlorophyll a at Elevation 170 (near surface) at Segments 3 and 30

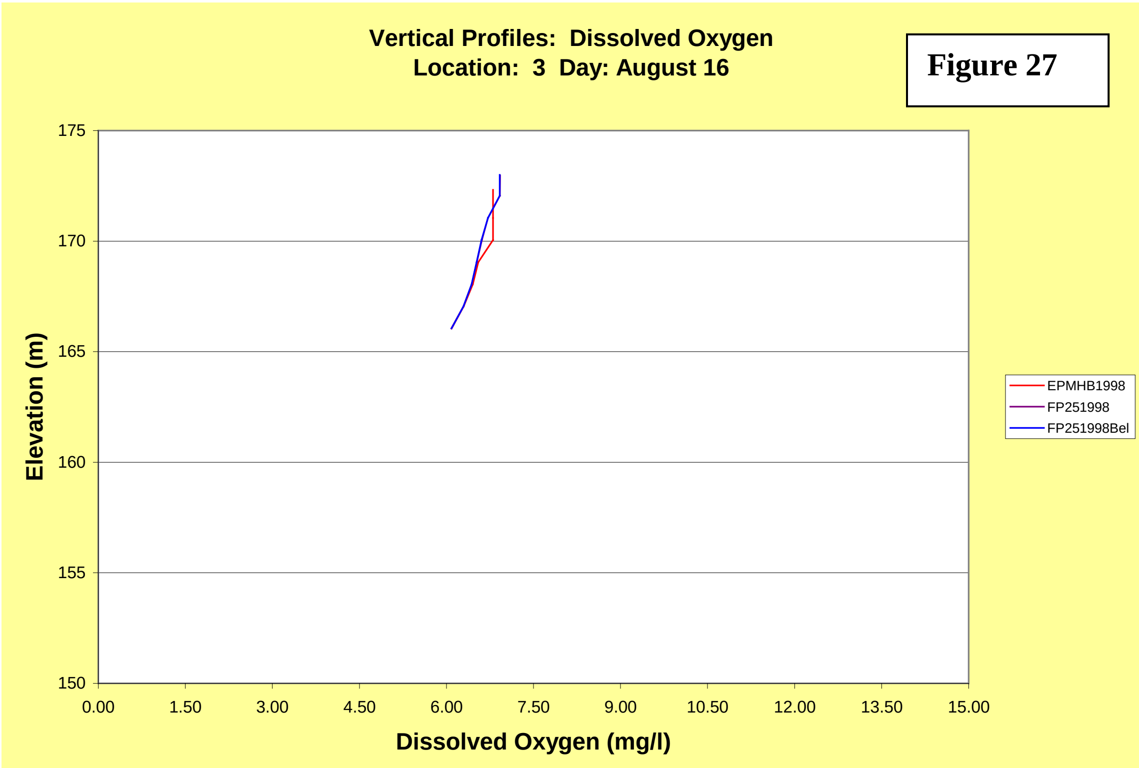
Segments

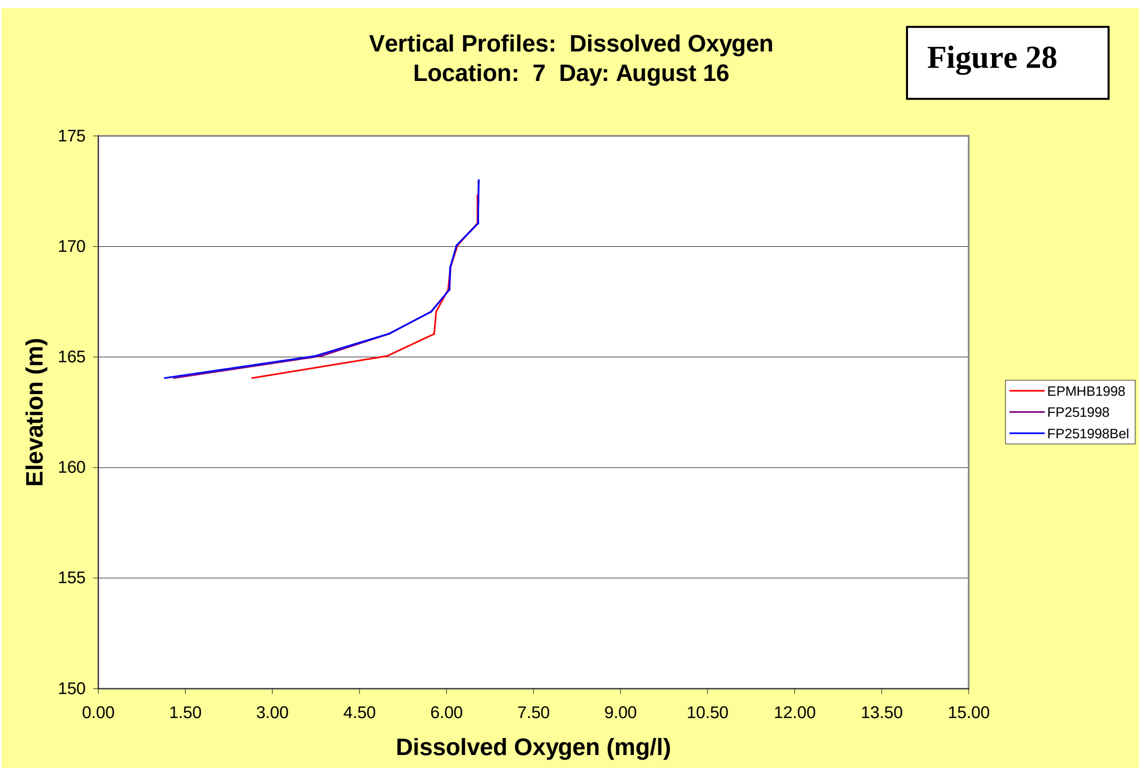
3 – downstream of Mount Holly/Long Creek Regional WWTP

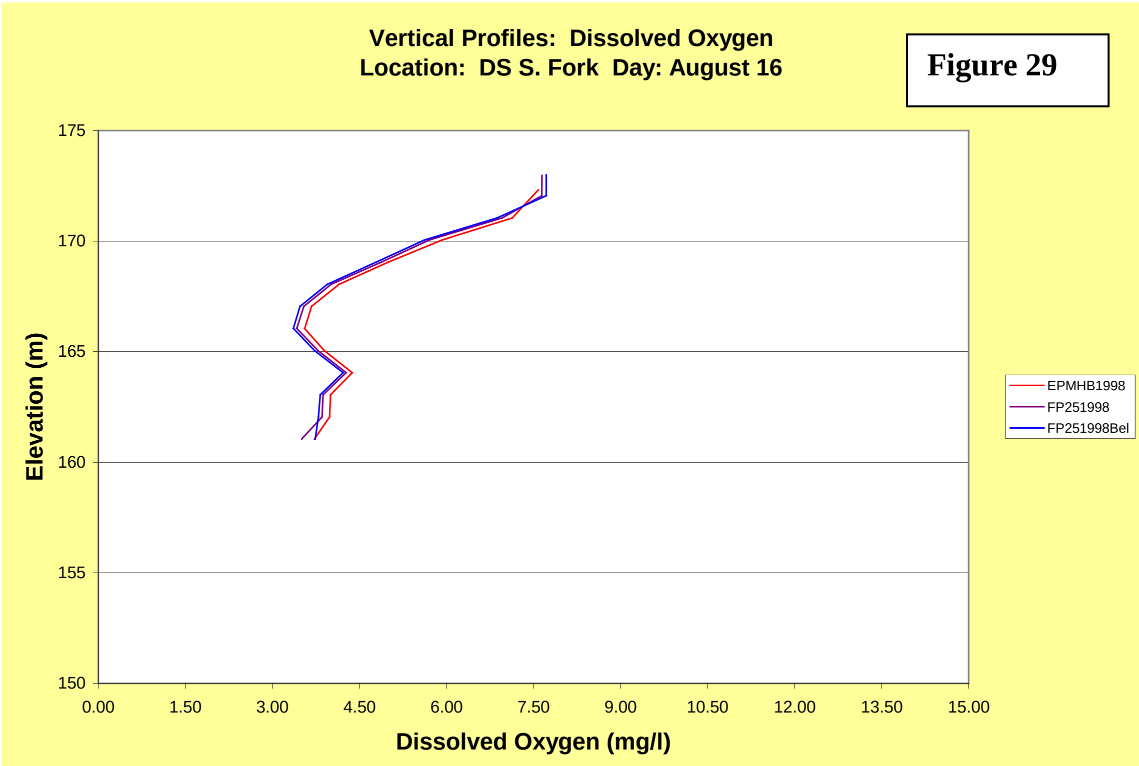
7 – segment downstream of Belmont WWTP

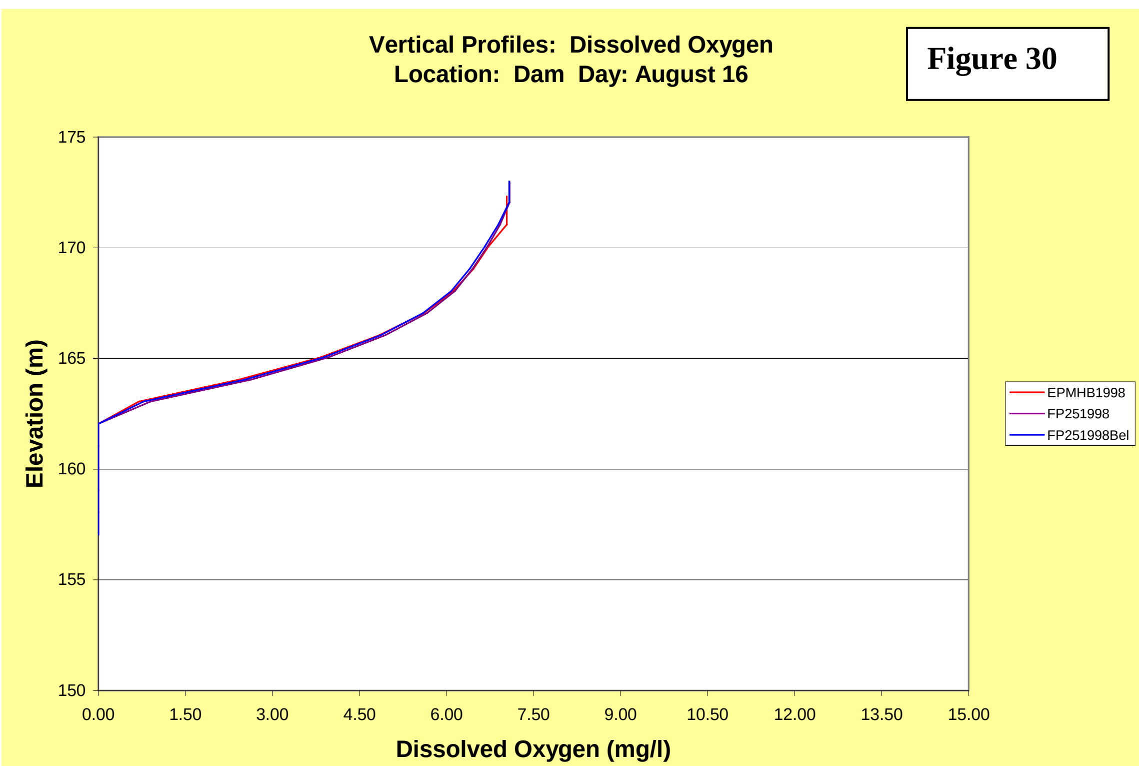
13 – segment downstream of junction with South Fork Branch

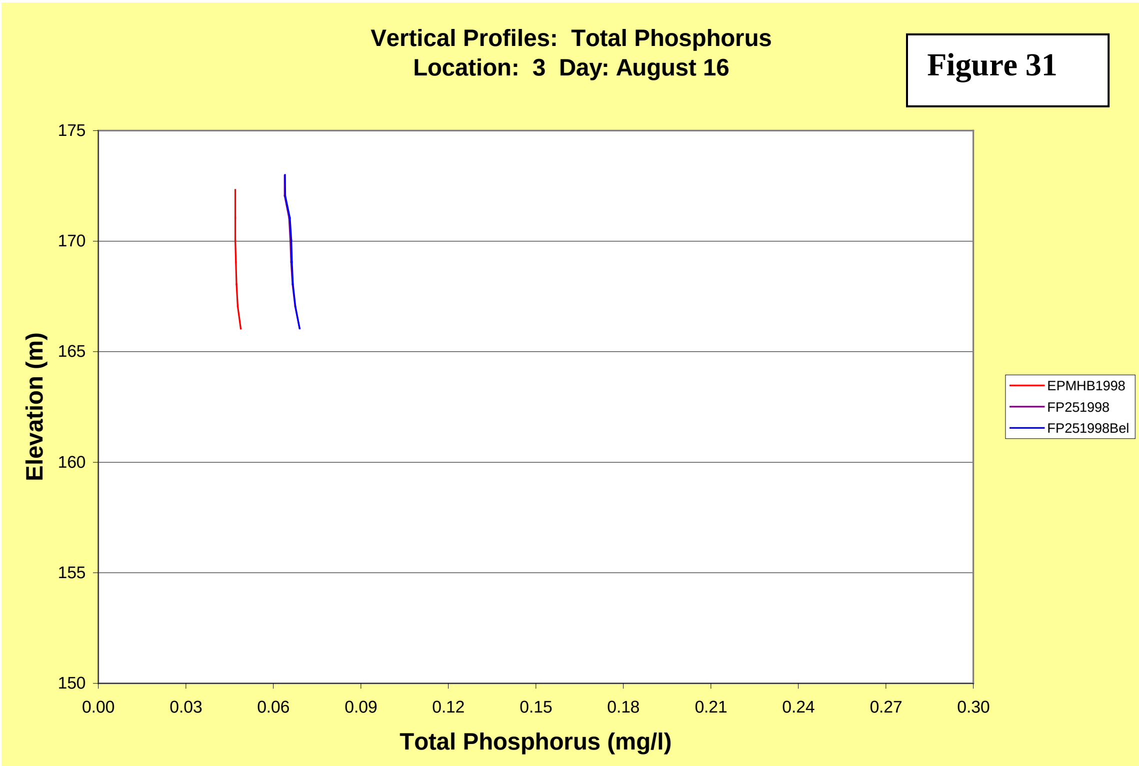
30 – segment in lower portion of the lake near the dam

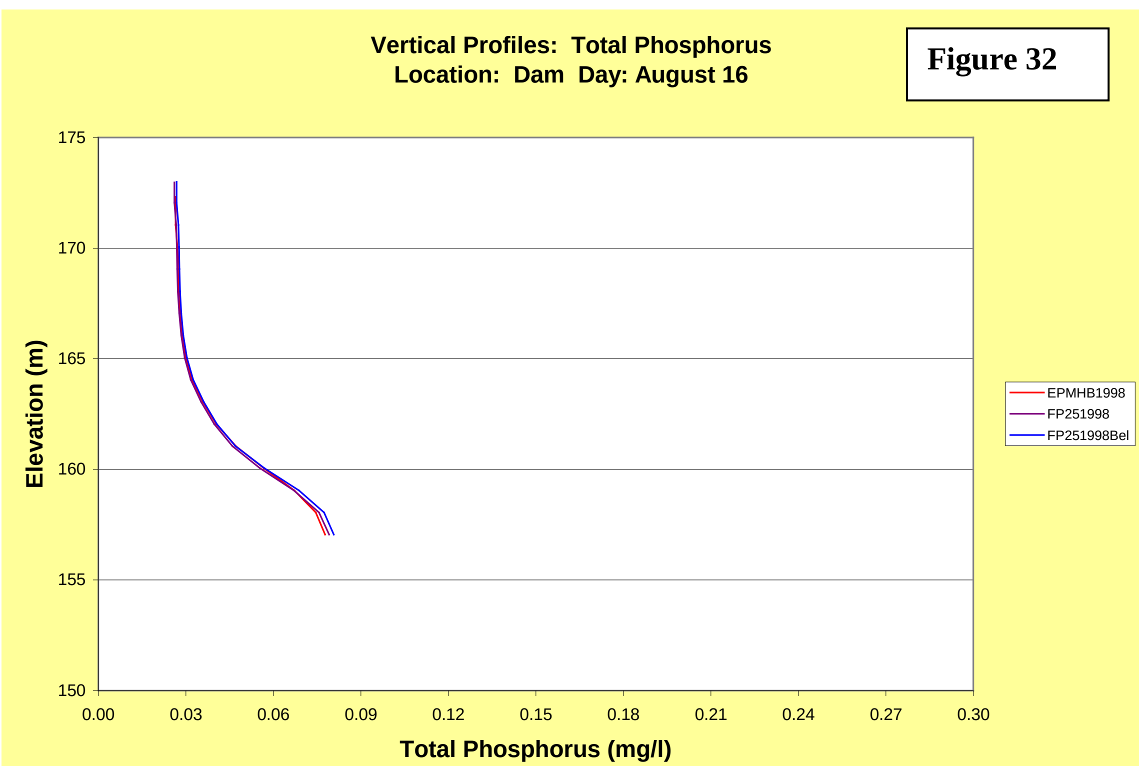

Vertical Profiles: Dissolved Oxygen
Location: 3 Day: August 16
Figure 27
Elevation (m)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Dissolved Oxygen (mg/l)
EPMHB1998
FP251998
FP251998Bel

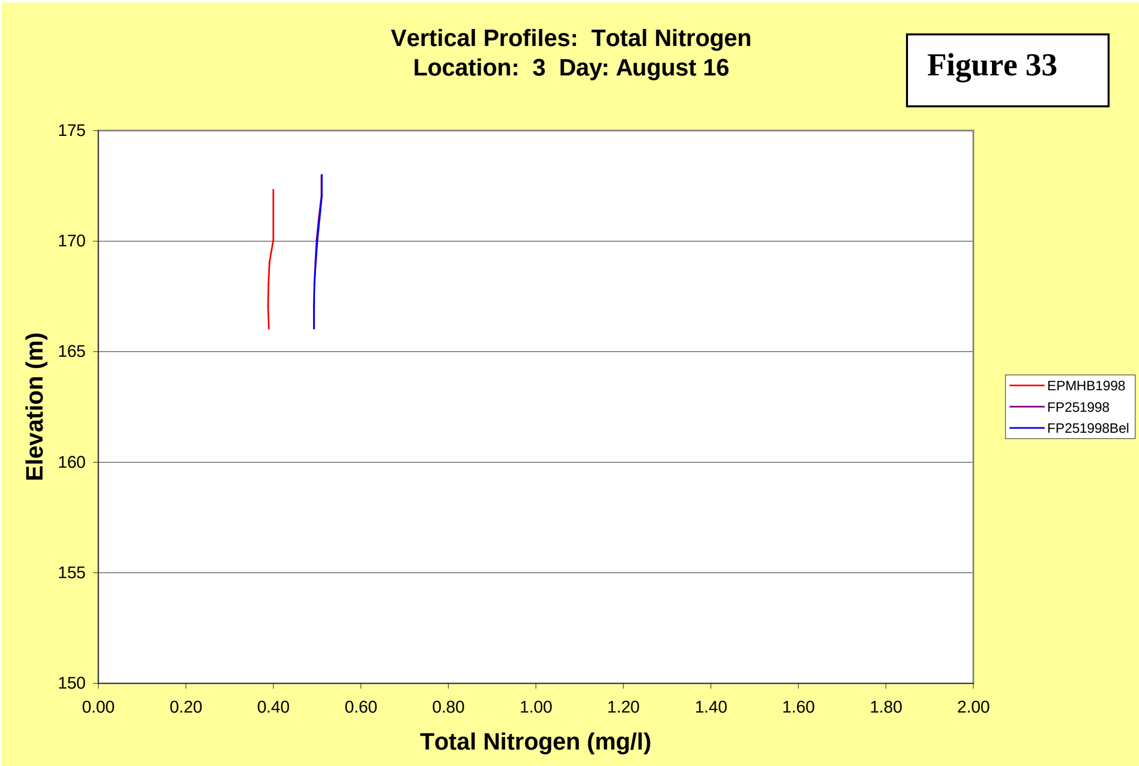

Vertical Profiles: Dissolved Oxygen
Location: 7 Day: August 16
Figure 28
Elevation (m)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Dissolved Oxygen (mg/l)
EPMHB1998
FP251998
FP251998Bel

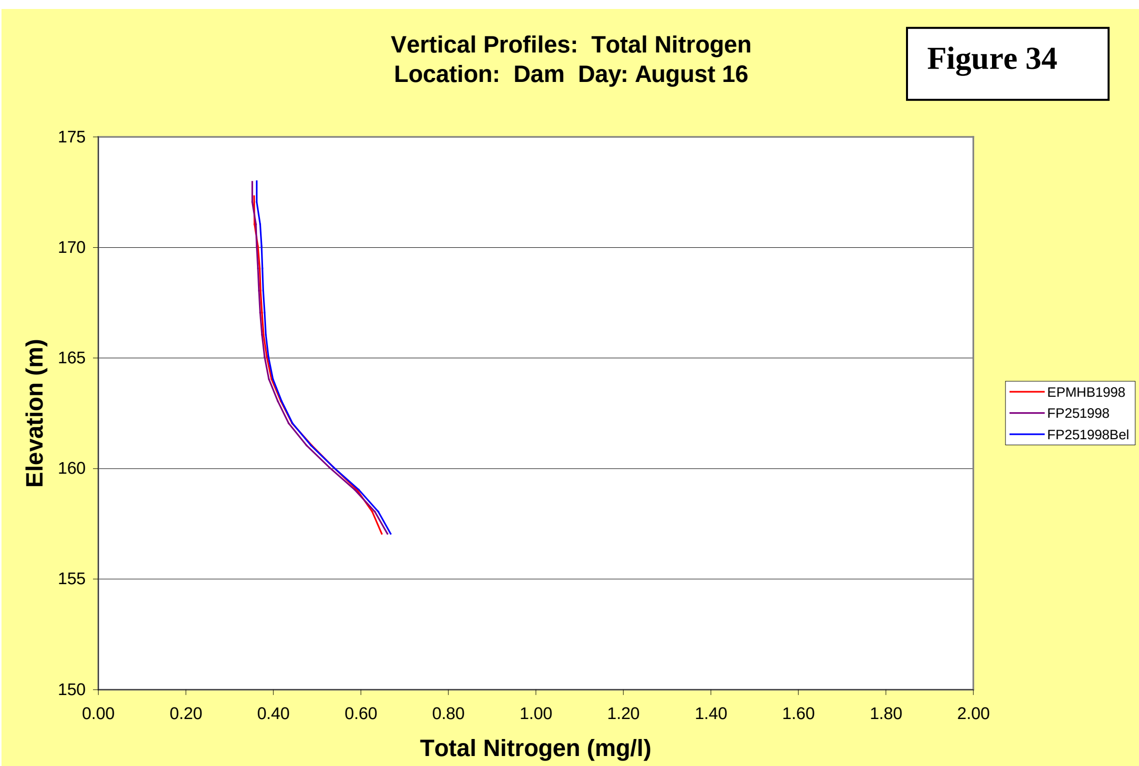

Vertical Profiles: Dissolved Oxygen
Location: DS S. Fork Day: August 16
Figure 29
Elevation (m)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Dissolved Oxygen (mg/l)
EPMHB1998
FP251998
FP251998Bel

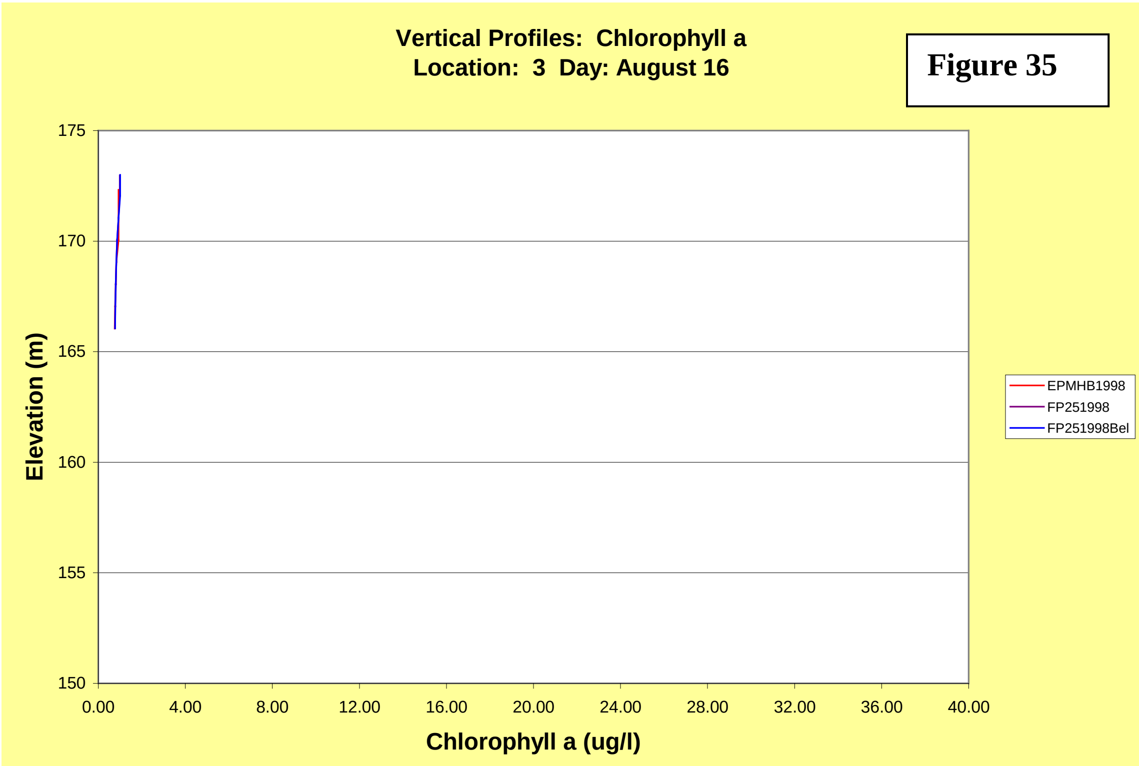

Vertical Profiles: Dissolved Oxygen
Location: Dam Day: August 16
Figure 30
Elevation (m)
175
170
165
160
155
150
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
13.50
15.00
Dissolved Oxygen (mg/l)
EPMHB1998
FP251998
FP251998Bel

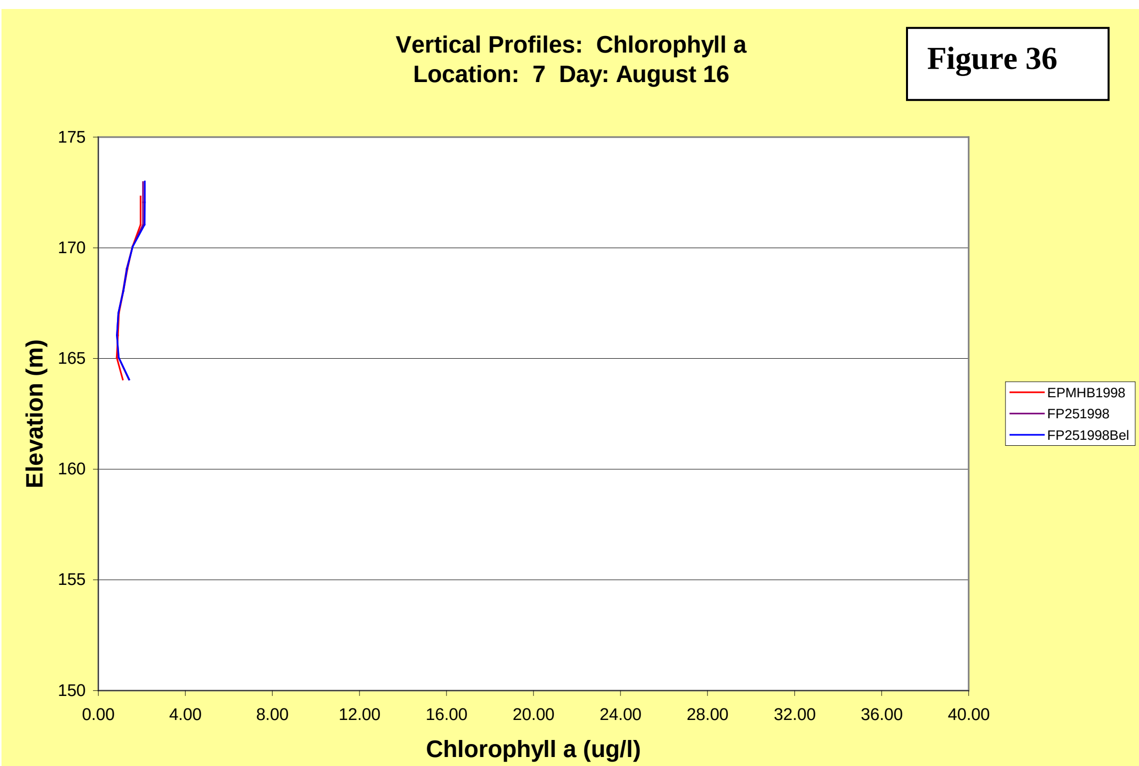

Vertical Profiles: Total Phosphorus
Location: 3 Day: August 16
Figure 31
Elevation (m)
175
170
165
160
155
150
0.00
0.03
0.06
0.09
0.12
0.15
0.18
0.21
0.24
0.27
0.30
Total Phosphorus (mg/l)
EPMHB1998
FP251998
FP251998Bel

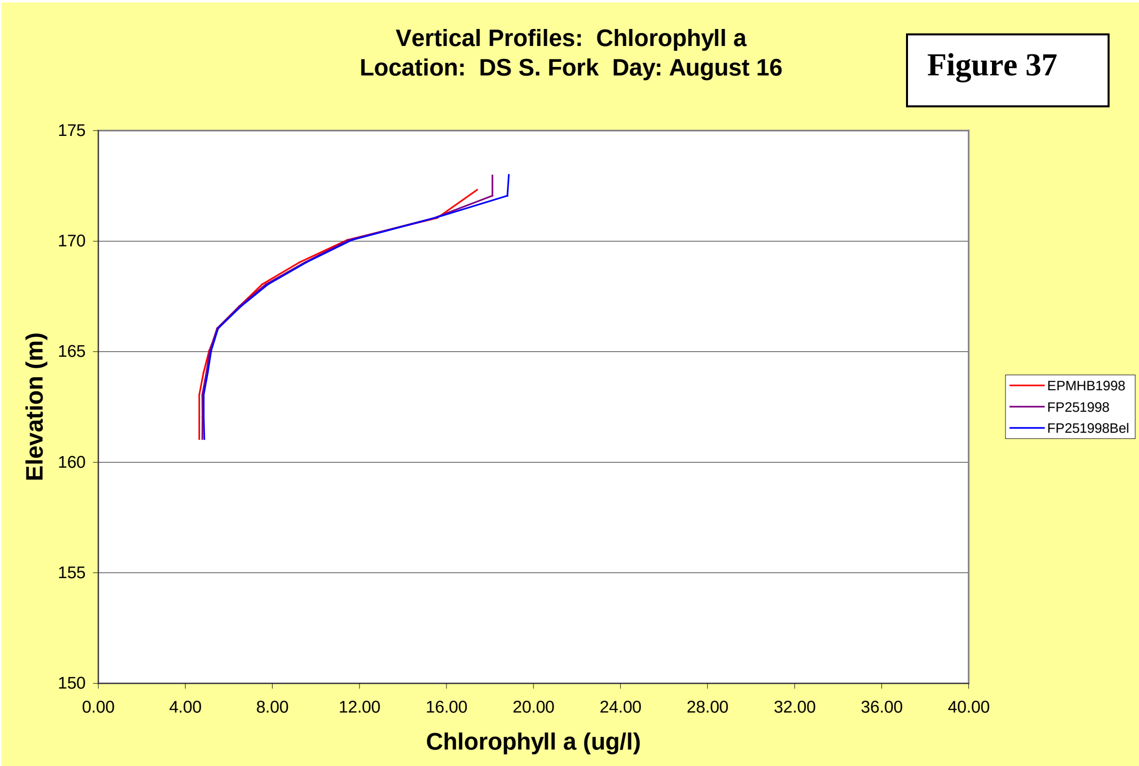

Vertical Profiles: Total Phosphorus
Location: Dam Day: August 16
Figure 32
Elevation (m)
175
170
165
160
155
150
0.00
0.03
0.06
0.09
0.12
0.15
0.18
0.21
0.24
0.27
0.30
Total Phosphorus (mg/l)
EPMHB1998
FP251998
FP251998Bel

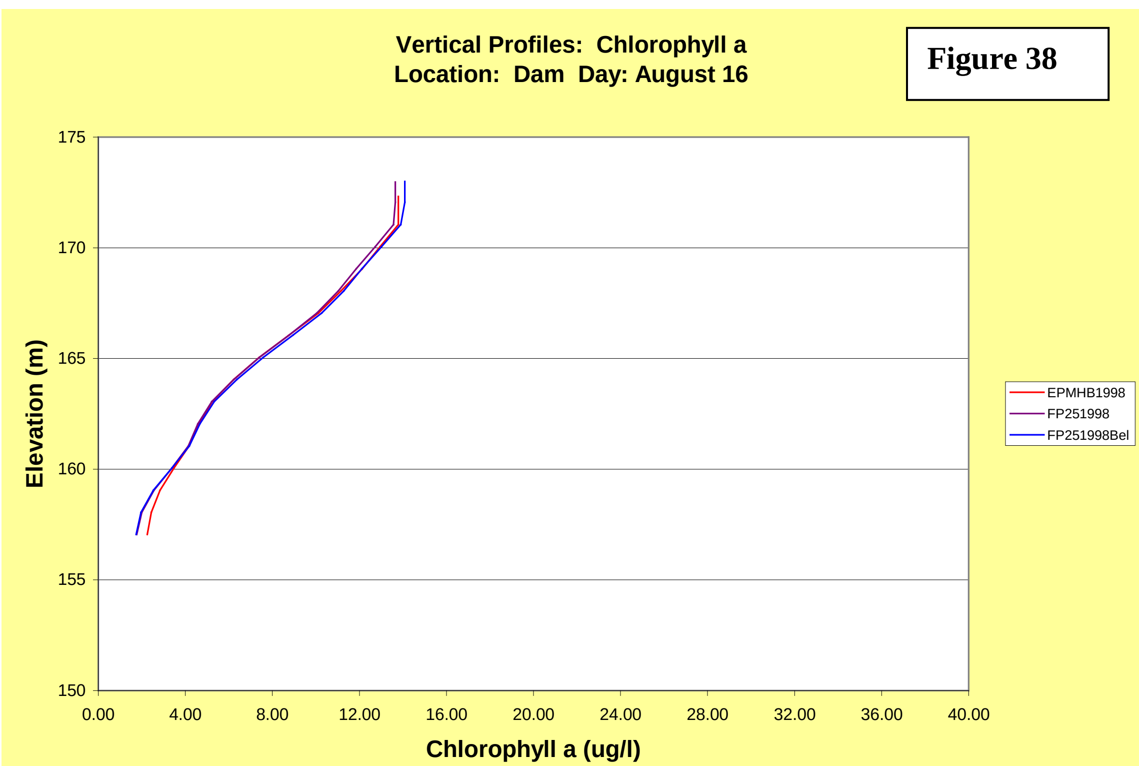

Vertical Profiles: Total Nitrogen
Location: 3 Day: August 16
Figure 33
175
170
165
160
155
150
Elevation (m)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
Total Nitrogen (mg/l)
EPMHB1998
FP251998
FP251998Bel

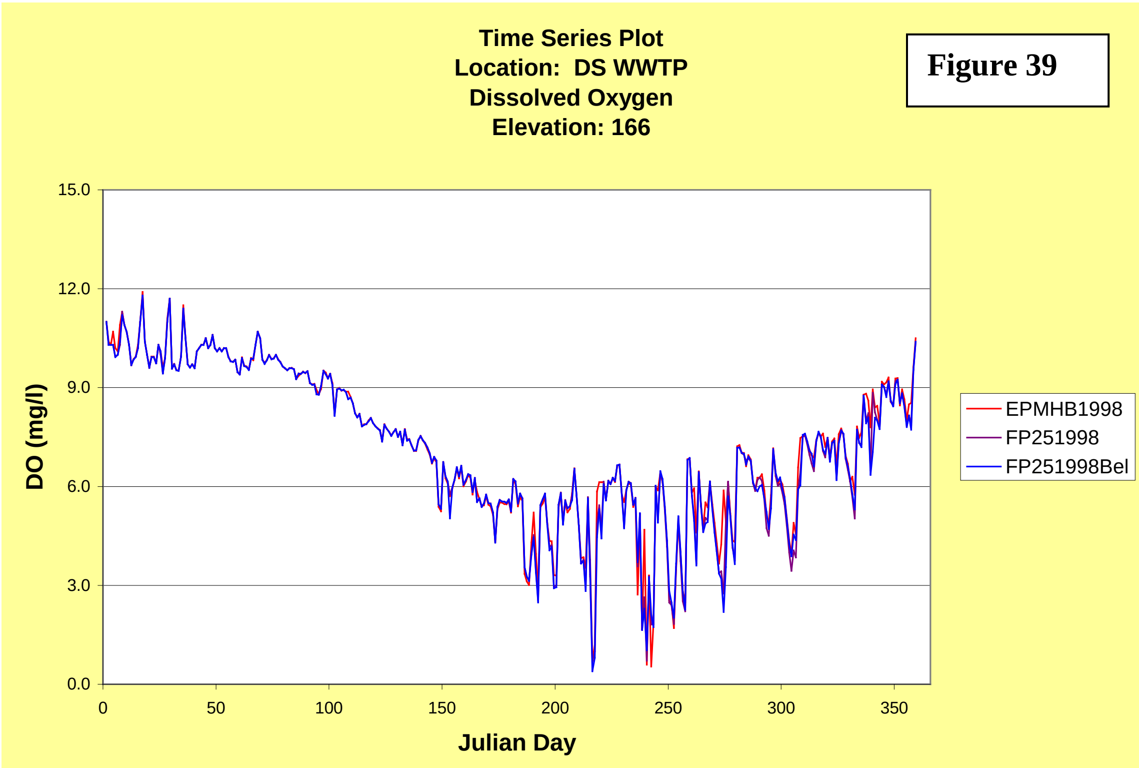

Vertical Profiles: Total Nitrogen
Location: Dam Day: August 16
Figure 34
175
170
165
160
155
150
Elevation (m)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
Total Nitrogen (mg/l)
EPMHB1998
FP251998
FP251998Bel

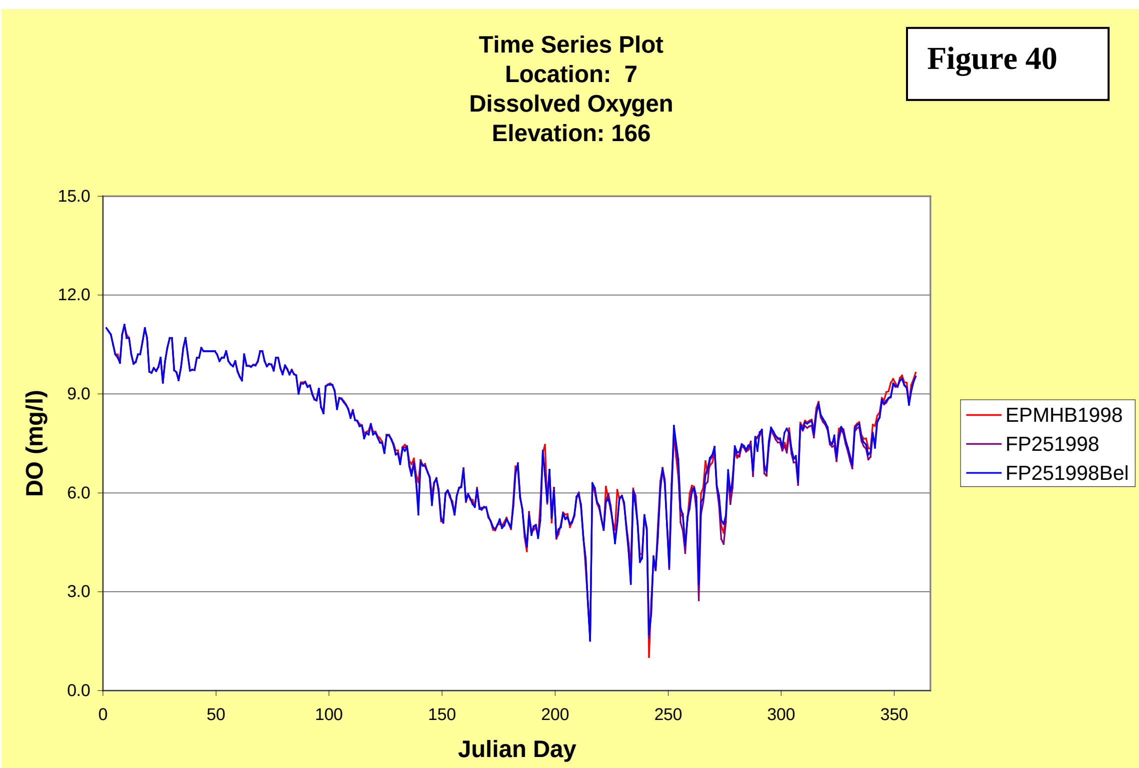

Vertical Profiles: Chlorophyll a
Location: 3 Day: August 16
Figure 35
175
170
165
160
155
150
Elevation (m)
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
36.00
40.00
Chlorophyll a (ug/l)
EPMHB1998
FP251998
FP251998Bel

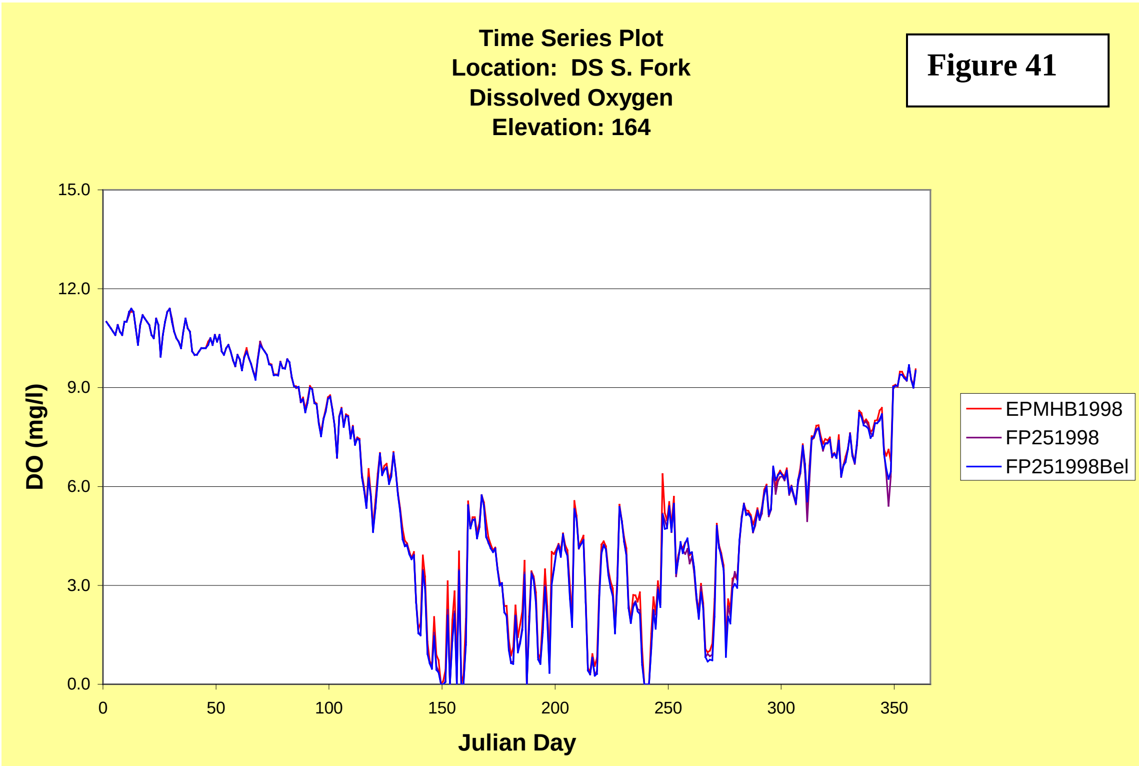

Vertical Profiles: Chlorophyll a
Location: 7 Day: August 16
Figure 36
175
170
165
160
155
150
Elevation (m)
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
36.00
40.00
Chlorophyll a (ug/l)
EPMHB1998
FP251998
FP251998Bel

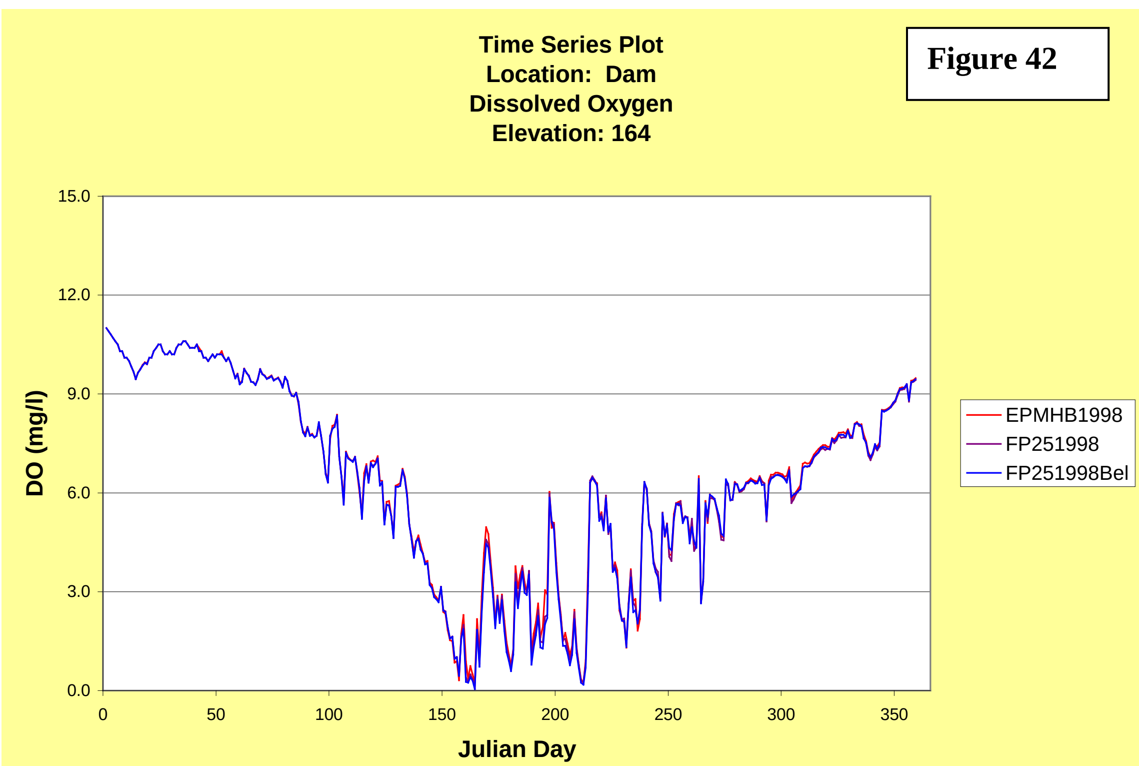

Vertical Profiles: Chlorophyll a
Location: DS S. Fork Day: August 16
Figure 37
Elevation (m)
175
170
165
160
155
150
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
36.00
40.00
Chlorophyll a (ug/l)
EPMHB1998
FP251998
FP251998Bel

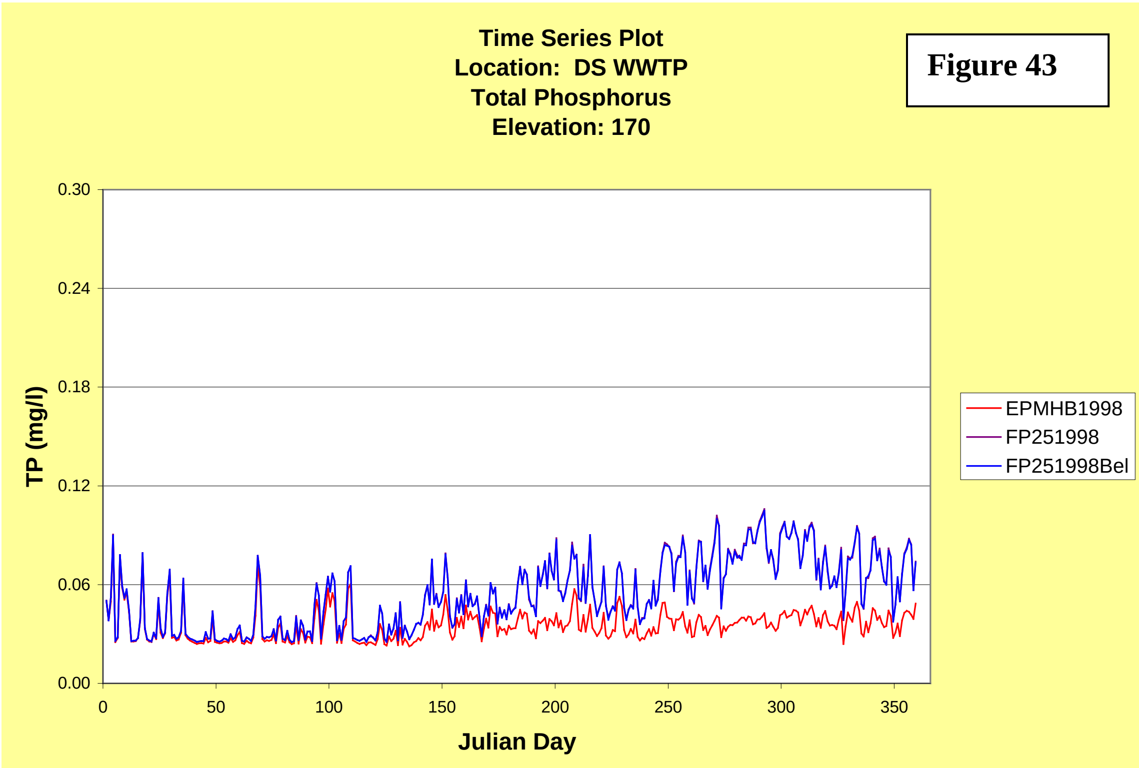

Vertical Profiles: Chlorophyll a
Location: Dam Day: August 16
Figure 38
Elevation (m)
175
170
165
160
155
150
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
36.00
40.00
Chlorophyll a (ug/l)
EPMHB1998
FP251998
FP251998Bel

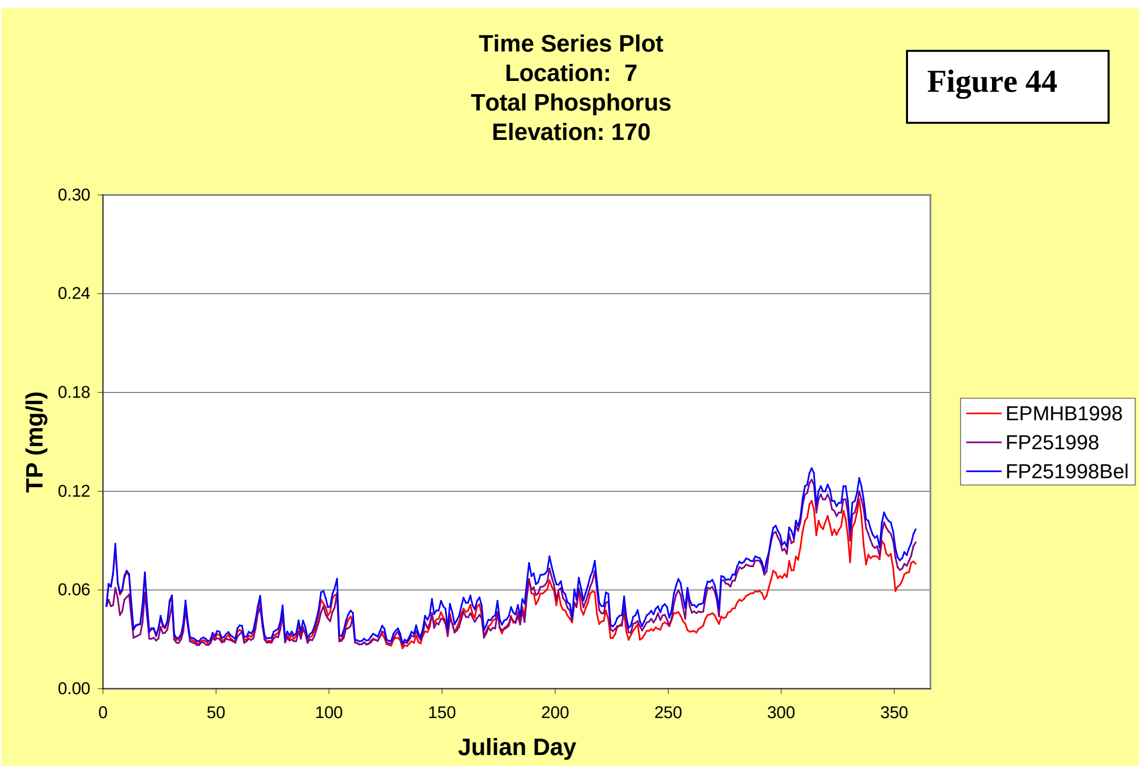

Time Series Plot
Location: DS WWTP
Dissolved Oxygen
Elevation: 166
Figure 39
DO (mg/l)
15.0
12.0
9.0
6.0
3.0
0.0
0
50
100
150
200
250
300
350
Julian Day
EPMHB1998
FP251998
FP251998Bel

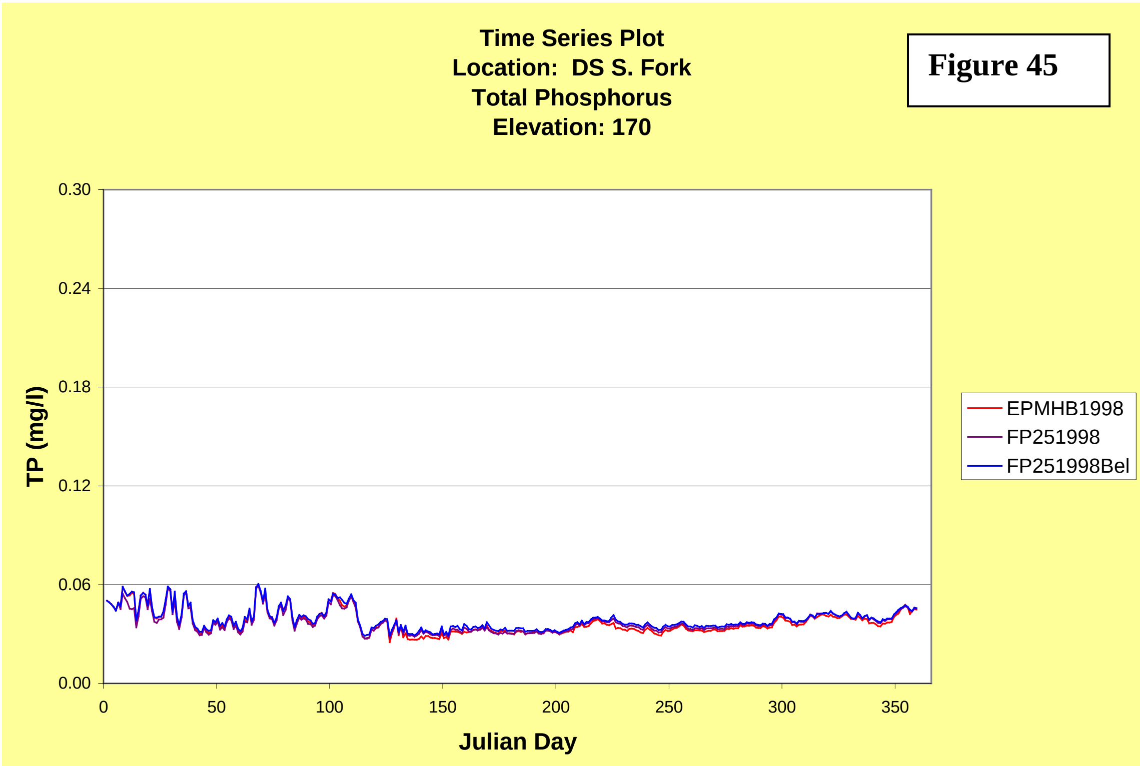

Time Series Plot
Location: 7
Dissolved Oxygen
Elevation: 166
Figure 40
DO (mg/l)
15.0
12.0
9.0
6.0
3.0
0.0
0
50
100
150
200
250
300
350
Julian Day
EPMHB1998
FP251998
FP251998Bel

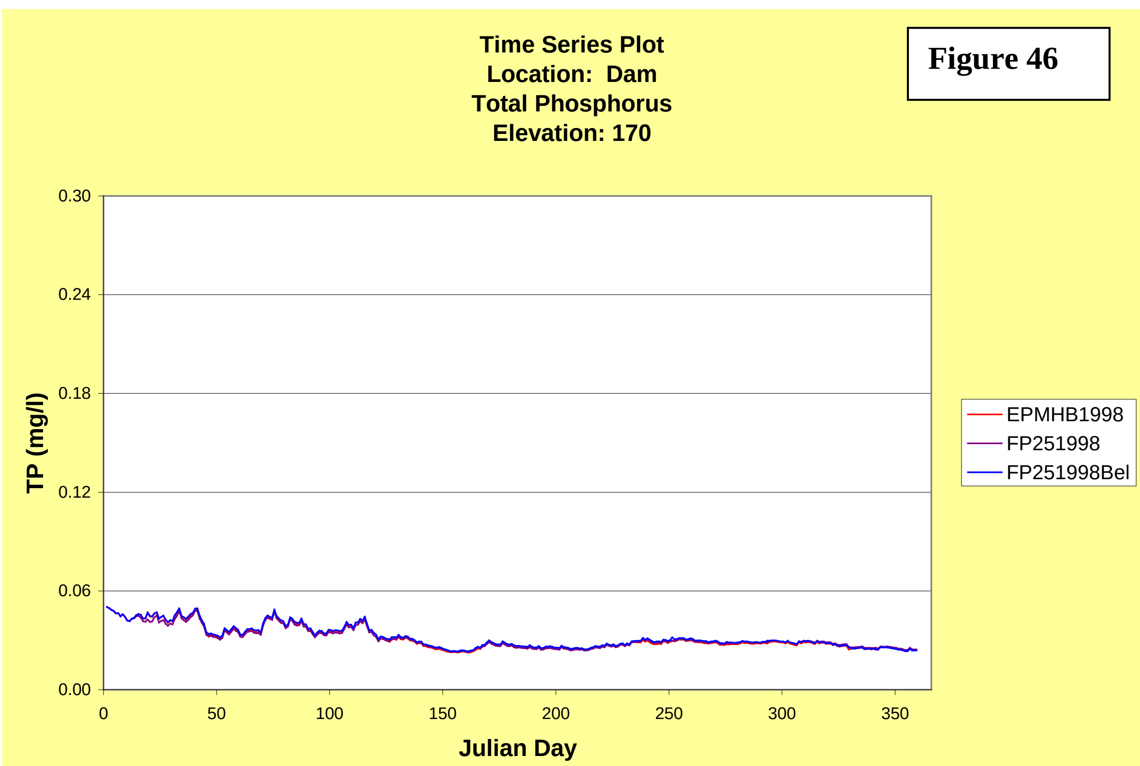

Time Series Plot
Location: DS S. Fork
Dissolved Oxygen
Elevation: 164
Figure 41
15.0
12.0
9.0
6.0
3.0
0.0
DO (mg/l)
0
50
100
150
200
250
300
350
Julian Day
EPMHB1998
FP251998
FP251998Bel

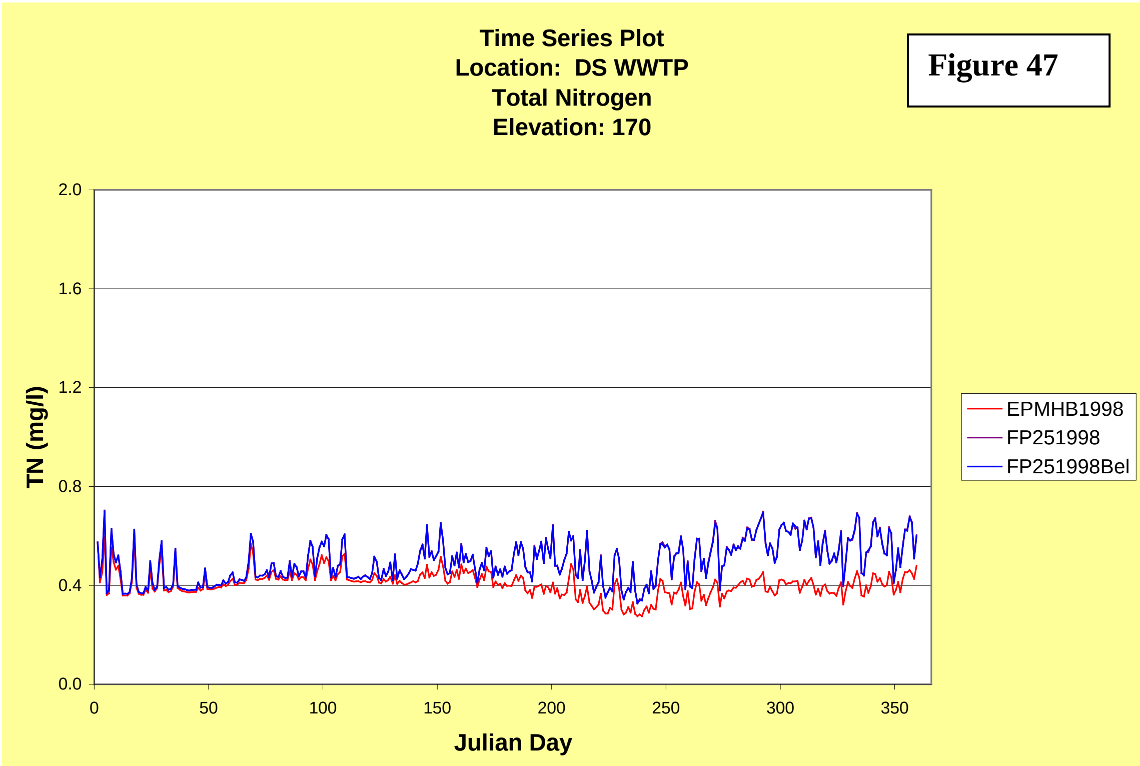

Time Series Plot
Location: Dam
Dissolved Oxygen
Elevation: 164
Figure 42
15.0
12.0
9.0
6.0
3.0
0.0
DO (mg/l)
0
50
100
150
200
250
300
350
Julian Day
EPMHB1998
FP251998
FP251998Bel

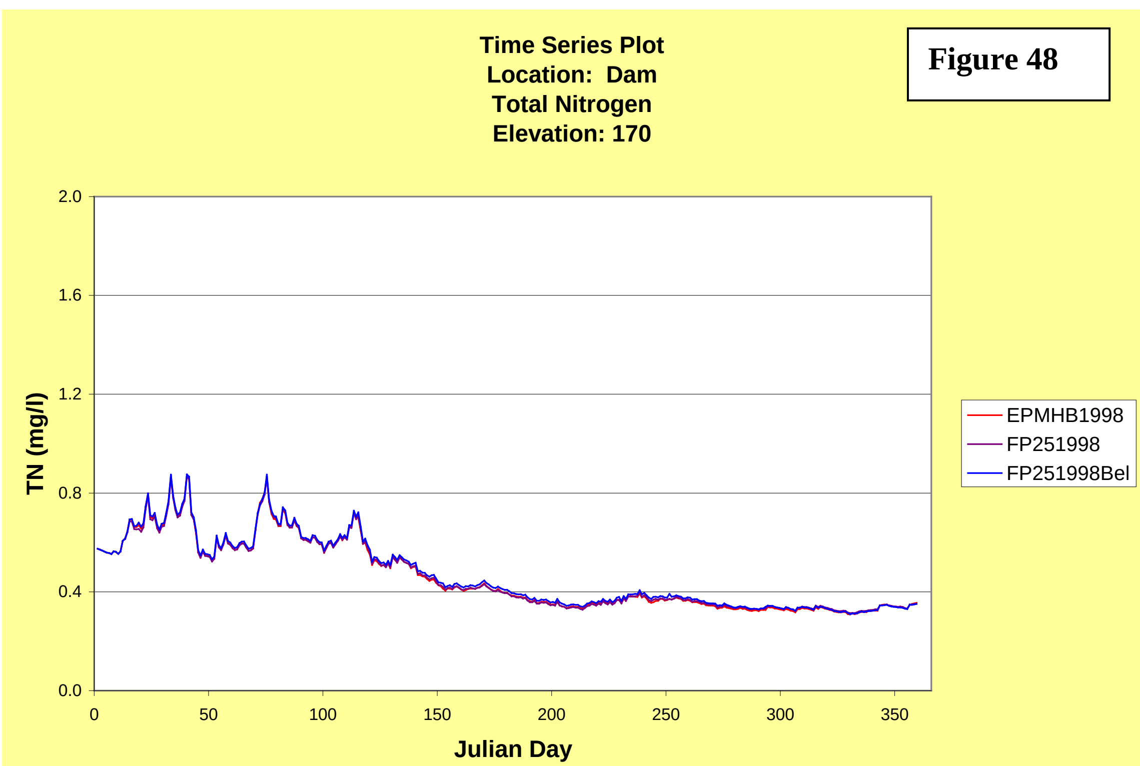

Time Series Plot
Location: DS WWTP
Total Phosphorus
Elevation: 170
Figure 43
TP (mg/l)
0.00
0.06
0.12
0.18
0.24
0.30
0
50
100
150
200
250
300
350
Julian Day
EPMHB1998
FP251998
FP251998Bel

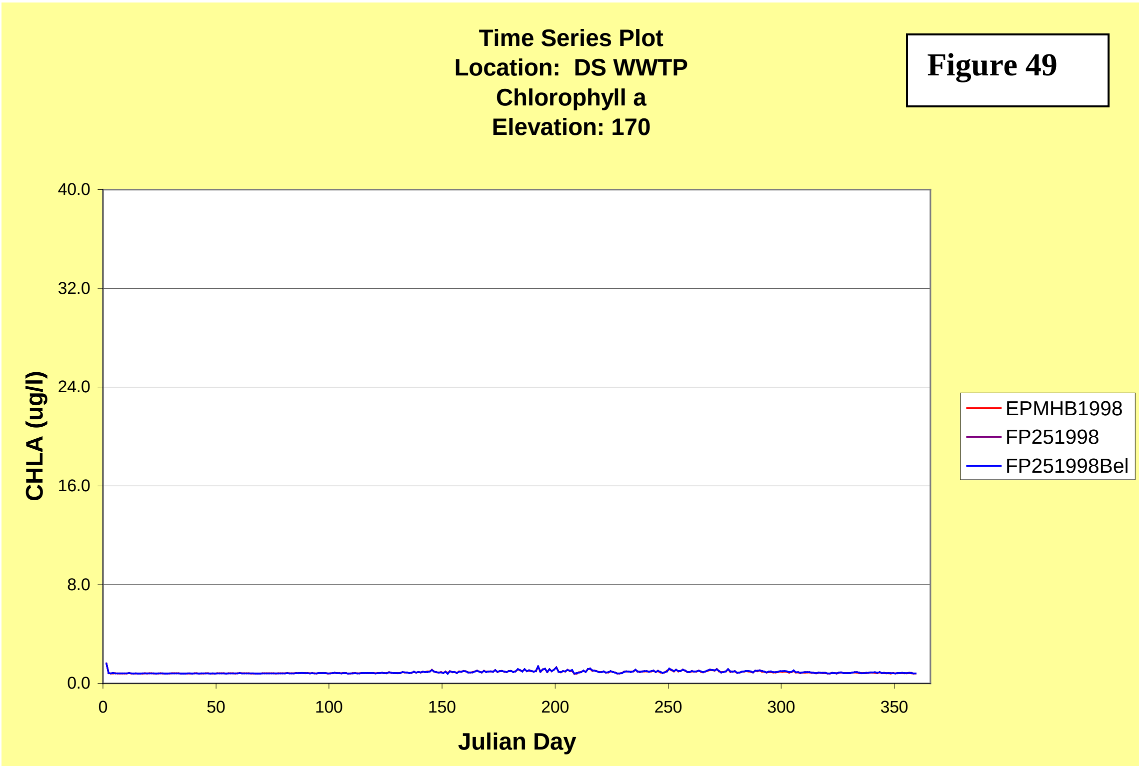

Time Series Plot
Location: 7
Total Phosphorus
Elevation: 170
Figure 44
TP (mg/l)
0.00
0.06
0.12
0.18
0.24
0.30
0
50
100
150
200
250
300
350
Julian Day
EPMHB1998
FP251998
FP251998Bel


Time Series Plot
Location: DS S. Fork
Total Phosphorus
Elevation: 170
Figure 45
TP (mg/l)
0.30
0.24
0.18
0.12
0.06
0.00
0
50
100
150
200
250
300
350
Julian Day
EPMHB1998
FP251998
FP251998Bel


Time Series Plot
Location: Dam
Total Phosphorus
Elevation: 170
Figure 46
TP (mg/l)
0.30
0.24
0.18
0.12
0.06
0.00
0
50
100
150
200
250
300
350
Julian Day
EPMHB1998
FP251998
FP251998Bel


Time Series Plot
Location: DS WWTP
Total Nitrogen
Elevation: 170
Figure 47
TN (mg/l)
2.0
1.6
1.2
0.8
0.4
0.0
0
50
100
150
200
250
300
350
Julian Day
EPMHB1998
FP251998
FP251998Bel


Time Series Plot
Location: Dam
Total Nitrogen
Elevation: 170
Figure 48
TN (mg/l)
2.0
1.6
1.2
0.8
0.4
0.0
0
50
100
150
200
250
300
350
Julian Day
EPMHB1998
FP251998
FP251998Bel


Time Series Plot
Location: DS WWTP
Chlorophyll a
Elevation: 170
Figure 49
CHLA (ug/l)
40.0
32.0
24.0
16.0
8.0
0.0
0
50
100
150
200
250
300
350
Julian Day
EPMHB1998
FP251998
FP251998Bel

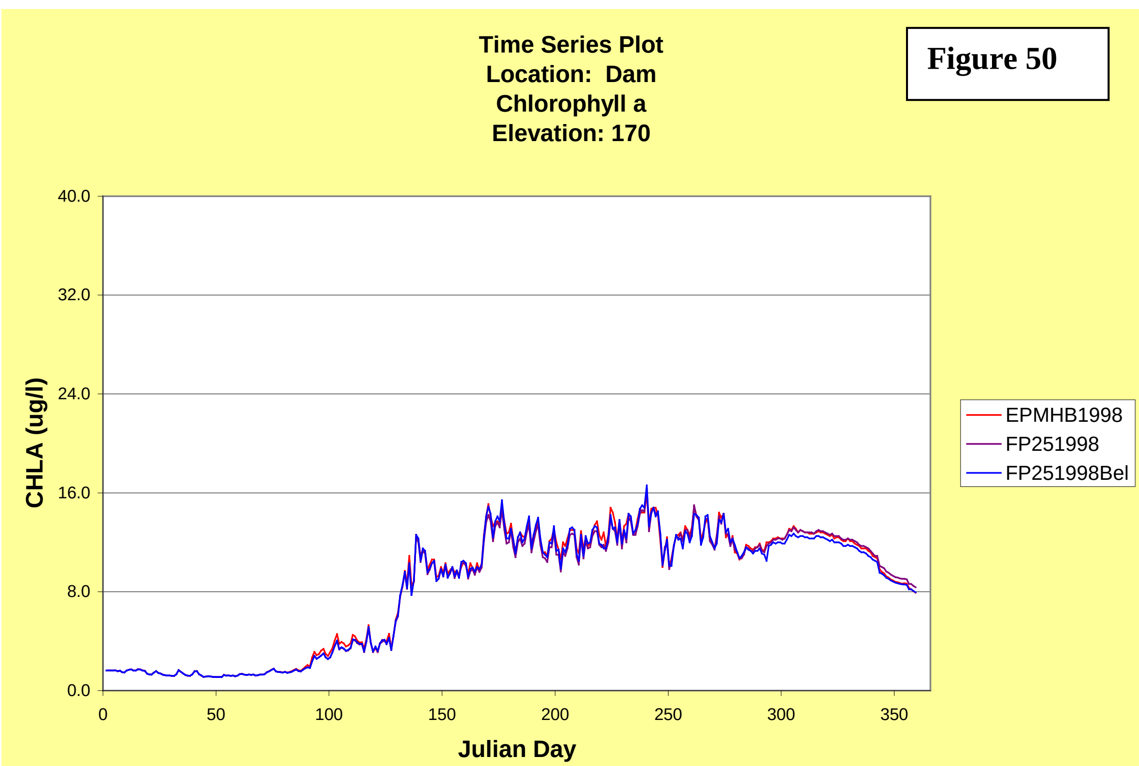

Time Series Plot
Location: Dam
Chlorophyll a
Elevation: 170
Figure 50
CHLA (ug/l)
40.0
32.0
24.0
16.0
8.0
0.0
0
50
100
150
200
250
300
350
Julian Day
EPMHB1998
FP251998
FP251998Bel

Table of Contents

Appendix D. Service Area and Project Area Soils Supplemental Existing Environment Information

Correlates with the following Sections:

Section 5.1.3.1 – Service Area Soils

Table 5.1d: Service area soils

Map Unit Symbol	Map Unit Name	Percent of Service Area
ApB	Appling sandy loam, 2 to 8% slopes	4.1%
ApD	Appling sandy loam, 8 to 15% slopes	2.0%
CeB2	Cecil sandy clay loam, 2 to 8% slopes, eroded	11.8%
CeD2	Cecil sandy clay loam, 8 to 15% slopes, eroded	18.6%
CfB	Cecil-Urban land complex 2 to 8% slopes (Gaston)	0.8%
CfD	Cecil-Urban land complex, 8 to 15% slopes (Gaston)	0.3%
CH	Chewalca loam, frequently flooded	0.6%
Co	Congaree loam, frequently flooded	0.5%
CuB	Cecil-Urban land complex, 2 to 8% slopes	0.6%
CuD	Cecil-Urban land complex, 8 to 15% slopes	0.1%
DaB	Davidson sandy clay loam, 2 to 8% slopes	0.1%
DaD	Davidson sandy clay loam, 8 to 15% slopes	0.1%
DaE	Davidson sandy clay loam, 15 to 25% slopes	0.0%
DAM	Dam	0.2%
EnB	Enon sandy loam, 2 to 8% slopes	4.6%
EnD	Enon sandy loam, 8 to 15% slopes	5.7%
GaB2	Gaston sandy clay loam, 2 to 8% slopes, eroded	1.3%
GaD2	Gaston sandy clay loam, 8 to 15% slopes, eroded	1.4%
GaE	Gaston sandy clay loam, 15 to 25% slopes	0.2%
HeB	Helena sandy loam, 2 to 8% slopes	5.4%
HuB	Helena-Urban land complex, 2 to 8% slopes	0.6%
IrA	Iredell fine sandy loam, 0 to 1% slopes	0.2%
IrB	Iredell fine sandy loam, 1 to 8% slopes	3.3%
MaB2	Madison sandy clay loam, 2 to 8% slopes, eroded	0.1%
MaD2	Madison sandy clay loam, 8 to 15% slopes, eroded	0.5%
MaE	Madison sandy clay loam, 15 to 25% slopes	0.0%
MeB	Mecklenburg fine sandy loam, 2 to 8% slopes	2.8%
MeD	Mecklenburg fine sandy loam, 8 to 15% slopes	1.3%
MkB	Mecklenburg-Urban land complex, 2 to 8% slopes	0.1%
MO	Monacan loam	2.5%
PaD2	Pacolet sandy clay loam, 8 to 15% slopes, eroded	0.5%
PaE	Pacolet sandy loam, 15 to 25% slopes	8.4%

Map Unit Symbol	Map Unit Name	Percent of Service Area
PaF	Pacolet sandy loam, 25 to 45% slopes	1.2%
Pt	Pits	0.1%
Ud	Udorthents, loamy (Gaston)	0.2%
UL	Udorthents, loamy	0.2%
Ur	Urban land	0.8%
VaB	Vance sandy loam, 2 to 8% slopes	2.1%
VaD	Vance sandy loam, 8 to 15% slopes	0.5%
W	Water	3.6%
WeB	Wedowee sandy loam, 8 to 15% slopes	0.4%
WkB	Wilkes loam, 4 to 8% slopes	2.5%
WkD	Wilkes loam, 8 to 15% slopes	3.6%
WkE	Wilkes loam, 15 to 25% slopes	3.1%
WkF	Wilkes loam, 25 to 45% slopes	1.9%
WnB	Winnsboro loam, 2 to 8% slopes	0.3%
WnD	Winnsboro loam, 8 to 15% slopes	0.1%
WoA	Worsham loam, 0 to 2% slopes	0.1%
WuD	Wilkes-Urban land complex, 8 to 15% slopes	0.2%

Service Area Soil Descriptions

CeB2, Cecil sandy clay loam, 2 to 8 percent slopes, eroded, is a well drained soil on broad, smooth ridges on the uplands. Mapped areas are oval and range from six to more than 1,000 acres. Typically the surface layer is yellowish red sandy clay loam about six inches thick. The subsoil is 47 inches thick. The upper part is red clay, and the lower part is red clay loam. The underlying material to a depth of 65 inches is red and yellow loam. This soil has a moderate potential for corn, soybeans, small grain, pasture, hay, and horticultural crops. The potential is also moderate for broadleaf and needleleaf trees. The soil has a high potential for most urban uses.

CeD2, Cecil sandy clay loam, 8 to 15 percent slopes, eroded, differs from the above description of CeB2 only in that its potential for most urban uses is only moderate because of the slope, a limitation that can be reduced or modified by special planning, design or maintenance.

This well drained soil is on side slopes adjacent to drainage ways. Mapped areas are commonly oblong and range from six to 100 acres. Typically, the surface layer is very dark grayish brown sandy loam about three inches thick. The subsoil is 28 inches thick. The upper part is red clay, and the lower part is red clay loam. The underlying material to a depth of 65 inches is mottled red, yellowish red, yellow, and reddish sandy loam. Most of the acreage with this soil type is woodland. A few areas are used for pasture. The potential for pasture is moderate. The soil has a moderately high potential for broadleaf and needleleaf trees. The potential is low for most urban and recreational uses because of the slope.

Section 5.1.3.2 - Project Area Soils

WkE, Wilkes Loam, 15 to 25 percent slopes, is a well drained soil on side slopes adjacent to drainage ways. Mapped areas are oblong and range from six to 200 acres. Typically the surface layer is dark grayish brown loam about four inches thick. The subsurface layer is brown loam three inches thick. The subsoil is eight inches thick. The upper part is strong brown clay, and the lower part is brown clay loam. The underlying material to a depth of 48 inches is olive brown, green, and black sandy loam. Below this is dark colored hard rock. Most of the acreage with this soil type is woodland. Some areas are used for pasture. This soil has low potential for crops and moderate potential for pasture, broadleaf, and needleleaf trees. The potential is low for most urban and recreational uses because of the slope and depth to bedrock.

WkF, Wilkes Loam 25 to 45 percent slopes, is described similarly to WkE except that it has steeper slopes. This soil is not suited to crops because of the slope. It has moderate potential for pasture and needleleaf trees. This soil has low potential for most urban and recreational uses because of the slope and depth to bedrock.

HeB2, Helena sandy loam, 2 to 8 percent slopes, is a moderately well drained soil on broad ridges and in slightly concave areas around the heads of intermittent streams. Mapped areas are five to 100 acres. Typically the surface layer is light olive brown sandy loam about eight inches thick. The subsoil is 32 inches thick. The upper part is brownish yellow sandy clay loam, the middle part is brownish yellow and yellowish brown clay, and the lower part is mottled yellowish brown, light gray, and reddish brown clay loam. The underlying material to a depth of 50 inches is light gray sandy clay. Below this is light gray sandy clay loam. This soil has moderately high potential for most crop, broadleaf, and needleleaf trees. The potential is low for urban uses because of slow permeability and high shrink-swell potential. Slow permeability significantly limits the absorption of effluent in septic tank absorption fields.

MeB, Mecklenburg fine sandy loam, 2 to 8 percent slopes, is a well drained soil on broad ridges on the uplands. Mapped areas are commonly oblong and range from five to more than 500 acres. Typically the surface layer is dark reddish brown fine sandy loam about seven inches thick. The subsoil is yellowish red clay 27 inches thick. The underlying material to a depth of 45 inches is mottled strong brown and yellowish red clay loam. Below this to a depth of 65 inches it is very dark grayish brown and light olive brown loam. Most of the acreage is used as cropland and pasture, with the remaining area forested. This soil has a moderately high potential for corn, soybeans, small grain, pasture, hay, and horticultural crops. The potential is moderate for broadleaf and needleleaf trees. The soil has a low potential for most urban uses because of slow permeability, moderate shrink-swell potential, low strength, and depth to bedrock.

Table of Contents

Appendix E. Terrestrial Communities Supplemental Existing Environment Information

Correlates with the following Sections:

Section 5.7.1.1 - Terrestrial Communities within the Proposed Service Area

Dry Mesic Oak-Hickory Forest

Dry mesic oak-hickory forests occur on mid-slopes, upland flats, and low ridges on acidic soils. Soil series include Cecil, Pacolet, and Wedowee. The forest is dominated by a mixture of oaks and hickories and was once the predominant community type in the Piedmont.

The canopy is composed of white oak (*Quercus alba*), tulip poplar (*Liriodendron tulipifera),* sycamore (*Platanus occidentalis*), shagbark hickory (*Carya ovata*), beech (*Fagus grandifolia*), loblolly pine (*Pinus taeda*), sweetgum (*Liquidambar styraciflua*), sugar maple (*Acer saccharum*), and red maple (*Acer rubrum*). Understory species include red maple, flowering dogwood (*Cornus florida*), American holly (*Ilex opaca*), and blackgum (*Nyssa sylvatica*). Shrubs include downy arrowwood (*Viburnum rafinesquianum),* deerberry (*Vaccinium stamineum*), and Blue Ridge blueberry (*Vaccinium pallidum*). Muscadine (*Vitis rotundifolia*) and poison ivy (*Toxicodendron radicans*) often are present. Herbs are fairly sparse, with heartleaf (*Hexastylis spp*.), rattlesnake plantain (*Goodyera pubescens*), striped prince's pine (*Chimaphila maculate*), nakedflower ticktrefoil (*Desmodium nudiflorum*), and rattlesnake weed (*Hieracium venosum*) common.

Mesic Mixed Hardwood Forest (Piedmont subtype)

Mesic mixed hardwood forests are transitional forests between alluvial or bottomland forests and upland communities such as dry-mesic oak-hickory forests. Typically the soils are well drained acidic consisting of soil series Cecil, Pacolet, and Wedowee (Typic Hapludults).

These forests are quite common. Under natural conditions these forests are uneven-aged, with old trees present. The Canopy is dominated by mesophytic trees such as American beech, red oak (*Quercus rubra*), tulip poplar, red maple, sugar maple, and in the western Piedmont, Cannadian hemlock (*Tsuga canadensis*). Typical understory trees include flowering dogwood (*Cornus florida*), hophornbeam (*Ostrya virginiana*), red maple, and American holly (*Ilex opaca*). Shrub species may include deerberry, downy arrowwood (*Viburnum rafinesquianum*), and mountain laurel (Kalmia latifolia). The herb layer is often moderately dense and diverse, though it may be sparse under heavy shade. Herb species may include Christmas fern (*Polystichum acrostichoides*), violet (Viola spp.), licorice bedstraw (*Galium circaezans*), little brownjug (*Hexastylis arifolia*), little heartleaf (H. minor), nakedflower ticktrefoil, dimpled troutlilly (*Erythronium umbilicatum ssp. Umbilicatum*), roundlobe hepatica (Hepatica Americana), fairywand (*Chamaelirium luteum*), beechdrops (*Epifagus virginiana*), heartleaf foamflower (*Tiarella cordifolia var. collina*), American alumroot (*Heuchera americana*), Tennessee starwort (*Stellaria pubera*), mayapple (*Podophyllum peltatum*), rattlesnake fern (*Botrychium virginianum*), and cankerweed (*Prenanthes serpentaria*).

Basic Mesic Forest (Piedmont subtype)

Basic mesic forests occupy lower slopes, north facing slopes, ravines, and occasionally well drained stream bottoms with basic soils. Soils are typically circumneutral or higher pH with series that include Wilkes (*Typic Hapludalf*).

The Canopy vegetation is dominated by mesophytic trees, primarily tulip poplar, American beech, southern sugar maple (*Acer floridanum*), and red oak. Trees typical of better drained bottomland sites, such as Shumard's oak (*Quercus shumardii*), black walnut (*Juglans nigra*), and sugarberry (*Celtis laevigata*), may be present. The understory may include eastern redbud (*Cercis canadensis*), flowering dogwood, hophornbeam, American hornbeam (*Carpinus caroliniana*), pawpaw (*Asimina triloba*), and slippery elm (*Ulmus rubra*). Shrubs may include Viburnium (*Viburnum spp*.), northern spicebush (*Lindera benzoin*), bigleaf snowbell (*Styrax grandifolius*), wild hydrangea (*Hydrangea arborescens*), American bladdernut (*Staphylea trifolia*), eastern sweetshrub (*Calycanthus floridus*), and painted buckeye (*Aesculus sylvatica*). The herb layer is generally dense and very diverse, with species such as Christmas fern, Canadian wildginger (*Asarum canadense*), white baneberry (*Actaea pachypoda*), common moonseed (*Menispermum canadense*), roundlobe hepatica, bloodroot (*Sanguinaria canadensis)*, bugbane (*Cimicifuga racemosa*), greater yellow lady's slipper (*Cypripedium pubescens var. calceolus*), American ginseng (*Panax quinquefolius*), northern maidenhair (*Adiantum pedatum*), mayapple, heartleaf foamflower (*Tiarella cordifolia var. cordifolia*), violet, eastern greenviolet (*Hybanthus concolor*), Dutchmans breeches (*Dicentra cucullaria*), eastern false rue anemone (*Enemion biternatum*), dwarf larkspur (*Delphinium tricorne*), little sweet betsy (*Trillium cuneatum*), veiny pea (*Lathyrus venosus*), and yellow flumewort (*Corydalis flavula*).

Basic Oak-Hickory Forest

Basic oak-hickory forests typically occupy slopes, ridges, upland flats, and other dry to dry-mesic sites with basic or circumneutral soils. Soil series include Iredell (*Typic Hapludalf*), and Mecklenburg (*Ultic Hapludalf).*

The canopy is dominated by mixtures of oaks and hickories, including white oak, post oak (*Quercus stellata*), black oak (*Q. velutina*), chinkapin oak (*Q. muehlenbergii*), southern shagbark hickory (*Carya carolinae-septentrionalis*), pignut hickory (*C. glabra*), mockernut hickory (*C. alba*), and red hickory (*C. ovalis*). Other canopy trees include white ash (*Fraxinus americana*), tulip poplar, black walnut, and pine (*Pinus spp*.) The understory includes species such as flowering dogwood, eastern redbud, white fringetree (*Chionanthus virginicus*), chalk maple (*Acer leucoderme*), and hophornbeam. Shrubs may include eastern sweetshrub (*Calycanthus floridus*), painted buckeye, fragrant sumac (*Rhus aromatica*), coral berry (*Symphoricarpos orbiculatus*), mapleleaf viburnum (*Viburnum acerifolium*), blackhaw (*Viburnum prunifolium*), and downy arrowwood. The herb layer is usually moderately diverse, with species such as whitetinge sedge (*Carex artitecta*), black edge sedge (*C. nigromarginata*), Solomon's seal (*Polygonatum biflorum*), licorice bedstraw (*Galium circaezans*), perfoliate bellwort (*Uvularia perfoliata*), littlehead nutrush (*Scleria oligantha*), Virginia snakeroot (*Aristolochia serpentaria*), flowering spurge (*Euphorbia corollata*), and in the mesic part of the range of this type, as on lower slopes, many of the herbs of the Basic Mesic Forest.

Dry Oak-Hickory Forest

Dry oak-hickory forests typically occupy ridgetops, upper slopes, steep south facing slopes, and other upland areas with acidic soils. Soil series include Cecil and Pacolet.

This forest is dominated by dry site oaks, primarily white oak, southern red oak (*Quercus falcate*), post oak, chestnut oak (*Quercus prinus*), blackjack oak (*Q. marilandica*), scarlet oak (*Q. coccinea*), black oak, mockernut hickory, red hickory, and pignut hickory. Pine species are often an important component, and may occasionally even be dominant. Typical understory species include sourwood (*Oxydendrum arboretum*), red maple, blackgum, flowering dogwood, and farkleberry (*Vaccinium arboreum*). Shrubs include deerberry, Blue Ridge blueberry, and other ericaceous shrubs. Muscadine and poison ivy are often present. Typical herbs include striped prince's pine, little brownjug, poverty oatgrass (*Danthonia spicata*), Virginia tephrosia (*Tephrosia virginiana*), greater tickseed (*Coreopsis major*), and rattlesnakeweed.

Piedmont/Low Mountain Alluvial Forest

The canopy of the Piedmont/Low Mountain Alluvial Forest is composed of the following trees: river birch (*Betula nigra*), American elm (*Ulmus americana*), winged elm (*Ulmus alata*), red elm (*Ulmus rubra*), sweet gum (*Liquidambar styraciflua*), hickory (*Carya aquatica*), boxelder, tulip poplar, sycamore, Carolina willow (*Salix caroliniana*), black gum (*Nyssa sylvatica*), and laurel oak (*Quercus laurifolia*). The shrub stratum consists of swamp doghobble (*Leucothoe racemosa*), spicebush (*Lindera benzoin*), buttonbush (*Cephalanthus occidentalis*), Chinese privet (*Ligustrum sinense*), highbush blueberry (*Vaccinium corymbosum*), swamp doghobble (*Leucothoe racemosa*), and silky dogwood (*Cornus amomum*). The herbaceous layer has lizard's tail (*Saururus cernuus)*, green dragon (*Arisaema dracontium*), smartweed (*Polygonum hydropiperoides*), cardinal flower (*Lobelia cardinalis*), greenbrier (*Smilax sp*.), arrowhead (*Sagittaria lancifolia*), maidencane (*Panicum hemitomon*), netted chain fern (*Woodwardia areolata*), false nettle (*Boehmeria cylindrica*), swamp mallow (*Hibiscus moscheutos*), trumpet creeper (*Campsis radicans*), and poison ivy.

Successional Areas

This community is not identified in Schafale and Weakley. Successional areas are those recovering from a disturbance such as soil removal, clear cutting, mowing, or agriculture. These areas often contain shrub sized individuals of the following tree species: sweetgum, loblolly pine, and sycamore. The herbaceous layer contains dog fennel (*Eupatorium capillifolium*), goldenrod (*Solidago canadensis*), tall fescue (*Lolium arundinaceum*), pokeweed (*Phytolacca americana*), Queen Anne's lace (*Daucus carota*), and Lespedeza (*Lespedeza stipulacea*).

Piedmont Prairies

Historical records have indicated that Piedmont prairie systems were abundant throughout the North Carolina Piedmont region prior to the removal of large native herbivores and the implementation of fire suppression (Barden, 1997). These successional areas have survived as relic systems in many areas where the vegetation is maintained or regularly disturbed such as along power line easements, agricultural pastures, and road rights of way. There are a number of current efforts in North Carolina to restore these relic ecosystems. The Piedmont Prairie habitat supports several endangered and threatened early successional plant species including: Schweinitz's sunflower (*elianthus schweinitzii*), Smooth coneflower (*Echinacea laevigata*), Georgia aster (*Symphyotrichum georgianum*), Carolina bird's-foot trefoil (*Lotus helleri)*, Tall larkspur (*Delphinium exaltatum*), and Butner

Barbara's buttons (*Marshallia sp*). Several Piedmont prairie restorations have been implemented within the service area in Mecklenburg County Nature Preserves as well as on Conservation Trust lands, and these are described further in Section 5.9.

Section 5.7.1.2 - Terrestrial Communities and Species Observed at the Proposed Alternative Sites

Dry Mesic Oak-Hickory Forest

This forest type is found on both the Mecklenburg and Gaston sides of the proposed alternatives sites. The canopy is composed of white oak (*Quercus alba*), tulip poplar (*Liriodendron tulipifera*), sycamore (*Platanus occidentalis*), shagbark hickory (*Carya ovata)*, beech (*Fagus grandifolia*), loblolly pine (*Pinus taeda*), sweetgum (*Liquidambar styraciflua*), sugar maple (*Acer saccharum*), and red maple (*Acer rubrum*). The shrub layer is composed of box elder (*Acer negundo*), red cedar (*Juniperus virginiana*), dogwood (*Cornus florida*), American holly (*Ilex opaca*), and white mulberry (*Morus alba*). The understory was sparse due to the closed canopy. The under story includes honeysuckle (*Lonicera japonica*), grape (*Vitus sp*.), and poison ivy (*Toxicodendron radicans*).

Mesic Mixed Hardwood Forest (Piedmont subtype)

This forest type is found on both the Mecklenburg and Gaston sides of the proposed alternatives sites. On the Mecklenburg side of the river the forest contains a higher percentage of loblolly pine than is usually found in this forest type. The canopy contains loblolly pine, white oak, sweetgum, red cedar, black cherry (*Prunus serotina*), and pignut hickory (*Carya glabra*). The shrub layer contains the tree species with the exception of the Loblolly pine. The herb layer was absent.

Piedmont/Low Mountain Alluvial Forest

Piedmont/Low Mountain alluvial forest is present on the Mecklenburg site along Lake Wylie and Long Creek and on the Gaston site along the Catawba River and tributaries that flow into the river. Several wetland areas were observed within this forest type. These wetland areas are discussed in Section 5.3. The canopy is composed of the following trees: river birch (*Betula nigra)*, American elm (*Ulmus americana*), winged elm (*Ulmus alata*), red elm (*Ulmus rubra*), sweet gum (*Liquidambar styraciflua*), hickory (*Carya aquatica*), box elder, tulip poplar, sycamore, Carolina willow (*Salix caroliniana*), black gum (*Nyssa sylvatica*), and laurel oak (*Quercus laurifolia*). The shrub stratum consists of swamp doghobble (*Leucothoe racemosa*), spicebush (*Lindera benzoin*), buttonbush (*Cephalanthus occidentalis*), Chinese privet (*Ligustrum sinense*), highbush blueberry (*Vaccinium corymbosum*), swamp doghobble (*Leucothoe racemosa*), and silky dogwood (*Cornus amomum)*. The herbaceous layer has lizard's tail (*Saururus cernuus*), green dragon (*Arisaema dracontium*), smartweed (*Polygonum hydropiperoides)*, cardinal flower (*Lobelia cardinalis*), greenbrier (*Smilax sp*.), arrowhead (*Sagittaria lancifolia*), maidencane (*Panicum hemitomon*), netted chain fern (*Woodwardia areolata*), false nettle (*Boehmeria cylindrica*), swamp mallow (*Hibiscus moscheutos*), trumpet creeper (*Campsis radicans*), and poison ivy.

Successional Areas

This community is not identified in Schafale and Weakley. Successional areas are found on the soil borrow area on the east side of Lake Wylie and within the power line right-of-ways at both locations. These successional areas are visible on Figure 5.7a. These areas contain shrub sized individuals of the following tree species: sweetgum, loblolly pine, and sycamore. The herbaceous layer contains dog fennel (*Eupatorium capillifolium*), goldenrod (*Solidago canadensis*), tall fescue (*Lolium arundinaceum*), pokeweed (*Phytolacca americana*), Queen Anne's lace (*Daucus carota*), and Lespedeza (*Lespedeza stipulacea*). One small patch of the federally endangered Schweinitz's sunflower (*Helianthus schweinitzii*) was located in a power line right-of-way near the Mount Holly WWTP (Figure 5.7a).