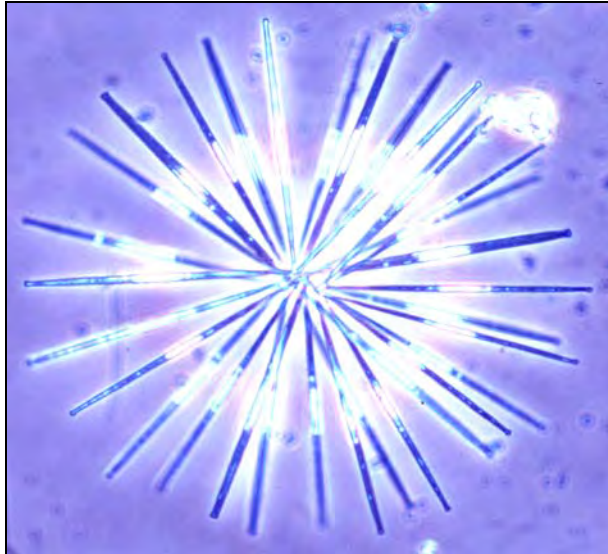


***Nutrient and Plankton Dynamics in Quabbin Reservoir:
Results of the MDC/DWM's 1998-99 Sampling Program***



**Metropolitan District Commission
Division of Watershed Management
Quabbin Section**

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Cover Photograph:

A colonial diatom of the genus *Synedra*, this organism was one of the diatom taxa that contributed to the spring maximum in phytoplankton densities. Each cell composing the colony is about 90 microns in length. Photographs of other phytoplankton organisms observed during the year of study are provided in Appendix D.

Acknowledgements:

This report was written by David Worden, MDC Limnologist. Field work was coordinated and conducted by David Worden and Robert Bishop, MDC Environmental Analyst, with assistance from the following MDC staff: David Chandler, Peter Deslauriers, Matt Hopkinson, and Patricia Austin. Laboratory analysis of water samples was performed at the MWRA Central Laboratory on Deer Island with guidance and support from Diane Rossi, MWRA Client Services Coordinator. Microscopic analysis of plankton samples and photography of specimens was performed by David Worden. Lisa Gustavsen, MDC Planner, assisted in formatting and final production of this report.

Citation:

Worden, David. 2000. Nutrient and Plankton Dynamics in Quabbin Reservoir: Results of the MDC/DWM's 1998-99 Sampling Program. Metropolitan District Commission, Division of Watershed Management.

Abstract:

This report details the scope, methods, and results of an intensive program of monthly sampling and analysis of nutrients and plankton in Quabbin Reservoir conducted from October 1998 through September 1999. Laboratory measurement of nutrient concentrations was performed by MWRA staff of the Deer Island Central Laboratory at a higher level of precision and sensitivity than any previous study. The spatial coverage of the program (six stations each sampled at various depths) and frequency of sampling, combined with the efficacy of laboratory measurements provides the most comprehensive database currently available on nutrient and plankton dynamics in Quabbin Reservoir. Major findings include marked seasonal and vertical variations in nutrient concentrations mediated by phytoplankton dynamics, a slight horizontal gradient in silica concentrations correlated to hydraulic residence time, and an annual cycle of phytoplankton succession and abundance characteristic of many temperate, oligotrophic systems.

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Nutrient and Plankton Dynamics in Quabbin Reservoir: Results of the MDC/DWM's 1998-99 Sampling Program

Beginning in October of 1998, MDC/DWM staff initiated a yearlong program of monthly sampling of Quabbin Reservoir. The goal of this program was to document current nutrient and plankton dynamics and to update the existing database on nutrient concentrations and plankton characteristics.

1.0 FIELD PROCEDURES AND LABORATORY METHODS

Samples for analysis of nutrients and plankton were collected concurrently during the sampling program. Field procedures and laboratory methods for nutrients and plankton are described separately in the sections that follow.

1.1 Nutrients

Sampling and analysis of water samples was undertaken in collaboration with MWRA staff at the Deer Island Central Laboratory who provided sample containers and where all grab samples were sent for analysis. Sampling protocol, chain-of-custody documentation, and sample delivery was performed in accordance with MWRA guidance. A list of the parameters measured and details of methodology, sample preservation, holding times, and detection limits are summarized in Table 1 below.

Table 1 - Quabbin Reservoir Nutrient Analyses: Laboratory Methods

Parameter and Method	Preservation	Holding Time	Detection Limit
Total Phosphorus EPA - 365.4	Sulfuric Acid	28 days	5 ug/L
Ammonia-Nitrogen EPA - 350	Filtered and Frozen	indefinite	5 ug/L
Nitrate-Nitrogen EPA - 353.2	Filtered and Frozen	indefinite	5 ug/L
Total Kjeldahl-Nitrogen EPA - 351.2	Sulfuric Acid	28 days	600 ug/L
Silica EPA - 200.7	Nitric Acid	28 days	10 ug/L
Alkalinity EPA - 310.1	Refrigeration	14 days	10 ug/L as CaCO ₃

In addition to collaborating with the MWRA on laboratory analyses, the field program of monthly sampling was coordinated with personnel from the University of Massachusetts

Department of Civil and Environmental Engineering (UMass-CEE). Current research by UMass-CEE staff and graduate students is focused on characterizing natural organic matter (NOM) in Quabbin Reservoir and quantifying NOM fate and transport within the basin.

Samples collected by UMass-CEE personnel were analyzed in their lab for numerous parameters including total and dissolved organic carbon (TOC and DOC), UV absorbance (254 nm), trihalomethane formation potential (THMFP), and chlorophyll-A. MDC and UMass-CEE worked together each month to collect samples simultaneously at all sampling stations from October, 1998 to September, 1999. The results of the UMass-CEE sampling and analyses will be available in the future.

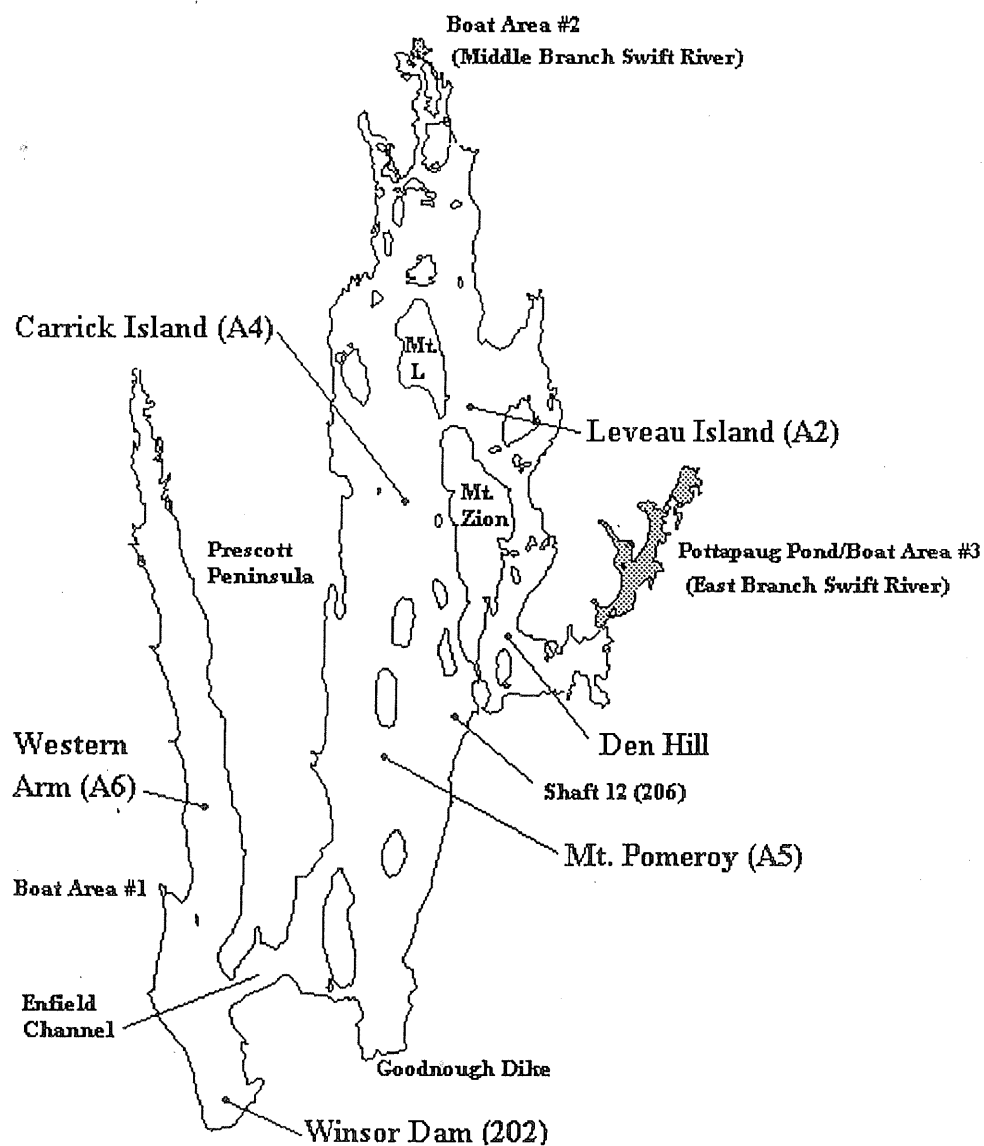
Grab samples were collected monthly at the six main stations (Winsor Dam/Station 202, West Arm/Station A6, Mt. Pomeroy/Station A5, Carrick Island/Station A4, Den Hill, and Leveau Island/Station A2; see Figure 1) weather and ice conditions permitting. Samples were collected in the epilimnion, metalimnion, and hypolimnion during the period of thermal stratification (generally May through early November; see Section 2.0 below) and near the top and bottom of the water column during periods of isothermy and mixing. Water column profiles of temperature, dissolved oxygen, and other parameters measured with a multiprobe were evaluated in the field to determine depths for metalimnetic samples.

A Van Dorn bottle was used to collect grab samples at depth, whereas surficial grabs were collected by hand. In order to reduce interference in the lab analysis for ammonia and nitrate, samples to be analyzed for these parameters were filtered in the field using a glass fiber Acrodisc (pore size = 1 micron; Gelman Sciences, Inc.) attached to a syringe. Samples were preserved with acid or filtered in the field as indicated in the above table and stored in a cooler until they were transferred to a refrigerator in the MDC laboratory. Samples to be analyzed for ammonia and nitrate were frozen. Samples were delivered on ice in a cooler to the Deer Island Central Laboratory generally within one week of collection.

1.2 Plankton

Taxonomic composition, density, and seasonal dynamics of the plankton community in Quabbin Reservoir were evaluated through a program of monthly sampling at the six main sampling stations within the basin (identified in Section 1.1 above). Transparent vinyl tubing (1 inch O.D. x 3/4 inch I.D.) was used to collect depth-integrated samples. The weighted end of the tube was lowered from the surface to a pre-selected depth, the surface end of the tube stoppered to prevent loss of water during tube retrieval, and the tube retrieved with an extracted “core” of the water column. The water in the tube was transferred into a polyethylene bottle (4 liter capacity measuring approximately 30 cm high and 15 cm in diameter) rendering a composite sample of plankton over that depth.

Figure 1 - Quabbin Reservoir Sampling Station Locus Map



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Integrated samples were generally collected to a depth of 15 meters, which was approximately the depth to the bottom of the metalimnion during most of the period of thermal stratification. Data from water column profiles of dissolved oxygen and hydrogen ion activity (pH) indicate that most photosynthetic activity occurs in the epilimnion and metalimnion. The epilimnion and metalimnion were represented in their entirety in the samples integrated to 15 meters, except for late stages of stratification when the thermocline and lower limit of the metalimnion were eroded deeper. The initial sampling effort of the program in October 1998 was the only exception to the procedure of depth-integrated plankton sampling described above. At that time, vinyl tubing had not been obtained for use in collecting integrated samples, so grab samples at various depths were used to create composite samples at each station.

Samples were preserved in the field with Lugol's Solution (3 ml per 1,000 ml of sample according to Standard Methods) and transported to the lab for processing. Prior to microscopic analysis, all samples were concentrated by a process of sedimentation. This entailed keeping the sample bottles undisturbed for a least one week to allow the organisms to settle to the bottom and then decanting the overlying supernatant in each bottle with a peristaltic pump. The one-week minimum sedimentation period surpasses the EPA (1973) guideline of 4 hours per 1 cm depth of sample bottle. Samples were concentrated generally between 5% and 15% of their original volume by this process. Final results reported for each sample incorporate the appropriate correction factor.

In addition to the quantitative samples of plankton collected with the integrated tube sampler, a net was used to collect qualitative samples of the larger forms of plankton. A plankton net of 35 micron mesh was manipulated vertically in the water column at Station A5 (Mount Pomeroy) in conjunction with monthly collection of integrated tube samples. The net filters and concentrates plankton from an unknown quantity of water and cannot provide estimates of density, but does enable the relative abundances of the larger forms to be determined.

Microscopic analysis of plankton samples was performed with a compound microscope capable of magnification from 40 to 1,000 times and using phase-contrast illumination. Plankton taxa in the integrated samples were enumerated using a Sedgewick-Rafter (S-R) Cell that enables plankton densities to be quantified. Each concentrated sample was inverted a few times to homogenize the sample and then 1 ml of the sample was withdrawn with a pipette and placed into the S-R Cell. Approximately 15 minutes were allowed for the plankton to settle to the bottom of the S-R Cell before enumeration. Plankton were enumerated in a total of 10 fields described by an ocular micrometer. At 200X magnification, the ocular field measures 0.3136 square millimeters in area (previously calibrated with a stage micrometer) and the fields were selected for viewing at approximately 0.5 cm intervals across the length of the S-R Cell.

Plankton densities were expressed as Areal Standard Units (ASUs; equivalent to 400 square microns). The area of each specimen viewed in each counting field was estimated using the ocular micrometer (the ocular field was divided into a 10 by 10 grid, each square in the grid having an area of 3,136 square microns or 7.84 ASUs at 200X

magnification). In the case of taxa that form gelatinous envelopes or sheaths, such as *Microcystis*, the area of the envelope was included in the estimate for that specimen. The areal extent of certain colonial taxa, such as the diatoms *Asterionella* and *Tabellaria*, was estimated by measuring the dimensions of one cell and multiplying by the number of cells in the colony. Cell fragments or structures lacking protoplasm, including lorica of *Dinobryon*, diatom frustules, and thecae of dinoflagellates, were not included in the count.

Phytoplankton and zooplankton were generally identified to genus. One exception was copepods which were identified only to suborder (Calanoida or Cyclopoida) at the present time. An effort was made to identify dominant forms of plankton to species. Taxonomic references used to identify plankton are listed in Section 8.0 at the end of this report.

2.0 THERMAL STRATIFICATION AND DISTRIBUTION OF NUTRIENTS

Typical of most deep lakes and reservoirs in the temperate region, Quabbin Reservoir becomes thermally stratified in summer. The thermal structure of the water column had a major influence on the vertical distribution of many nutrients measured during the summer and fall period of the sampling program. A brief overview of the process of thermal stratification and its influence on nutrient distribution is given below.

Solar radiation and atmospheric warming in spring and summer cause a progressive gain of heat in surficial waters and the formation of a thermal gradient in the water column. The thermally stratified water column of summer is characterized by a layer of warm, less dense water occupying the top of the water column ("epilimnion"), a stratum of cold, dense water at the bottom ("hypolimnion"), and a middle stratum exhibiting a pronounced transition in temperature ("metalimnion"). Thermal stratification of the Quabbin Reservoir water column generally begins in late April or early May.

Waters of the epilimnion circulate due to wind acting on the surface, whereas waters of the hypolimnion are isolated from atmospheric influences by the stratification structure and remain relatively undisturbed. Most photosynthetic activity by phytoplankton occurs in the epilimnion and metalimnion where light intensity is greatest and, especially in the epilimnion, where plankton is recirculated toward the surface by wind-driven turbulence (Section 4.0 below). Due to the predominance of photosynthetic production in the epilimnion and metalimnion they generally comprise what is termed the trophogenic zone (zone of net organic synthesis).

In contrast, the predominant process in the hypolimnion is decomposition of organic matter. Planktonic organisms and detritus sinking down from overlying strata into the hypolimnion are not recirculated. The constant "rain" of sedimenting organic matter reaching the dark, quiescent waters of the hypolimnion is broken down via microbial respiration. As a result of the ascendancy of this process, the hypolimnion generally composes what is termed the tropholytic zone (zone of net organic decomposition).

The boundary between the trophogenic and tropholytic zones is a function of light penetration with the term compensation level applied to the depth at which photosynthetic production is matched by decomposition. Water column profiles of dissolved oxygen and hydrogen ion activity (pH) measured with a multiprobe document the relative intensities of the processes occurring in these zones. In the epilimnion and metalimnion (approximately the trophogenic zone), dissolved oxygen remained near saturation concentrations due to releases of oxygen from photosynthetic organisms. Also, photosynthetic uptake of carbon dioxide tends to increase pH and values in the epilimnion and metalimnion remained near neutral, generally ranging between 6.2 and 7.0.

Conversely, in the hypolimnion (approximately the tropholytic zone), dissolved oxygen concentrations decreased due to demand by the oxidizing processes of decomposition and respiration. Minimum values generally ranging from 45 to 70 percent saturation were reached in the latter part of the stratification period (October - early November). The production of carbon dioxide by microbial respiration tends to decrease pH and, by the end of the stratification period, hypolimnetic pH reached minimum values generally ranging from 5.4 to 5.8.

The antagonistic processes occurring in the trophogenic and tropholytic zones determined patterns of nutrient distribution vertically in the water column (Section 3.0 below). These vertical patterns become pronounced in the latter part of the stratification period. However, in late fall after heat has been lost from the upper portion of the water column, the thermal gradient is weak and the stratification structure is eventually dispersed by wind-driven turbulence. This event is known as fall “turnover” and results in a water column that is isothermal and thoroughly mixed (generally occurring in mid to late November). Subsequent to fall turnover and during the November through April period of water column isothermy and mixing, all stations exhibited nutrient concentrations that were similar throughout the water column.

3.0 RESULTS OF NUTRIENT ANALYSES

Results from the nutrient sampling program confirm that Quabbin Reservoir is an oligotrophic system characterized by very low rates of nutrient input and biological productivity (Table 2, also see complete nutrient database in Appendix A). Concentrations of all nutrients and patterns of season fluctuation were similar across all six sampling stations except for Den Hill where concentrations of total phosphorus, silica, and alkalinity ranged relatively higher. This likely reflects the influence of the East Branch Swift River which drains approximately 30% of the entire Quabbin watershed and discharges into the reservoir at a distance of about 2,600 meters “upgradient” of the Den Hill sampling station. Additionally, a slight gradient was evident in silica concentrations between stations proximate to watershed loading sources (Den Hill and West Arm/A6) and stations in the central basin “downgradient” from those sources (Mt. Pomeroy/A5 and Carrick Island/A4; see Section 3.2 below).

Table 2 - Summary of Laboratory Results for Sampling Program Conducted from October 1998 through September 1999

Parameter	Range of Station Medians in Samples from Epilimnion/Surface	Range of Station Medians in Samples from Metalimnion	Range of Station Medians in Samples from Hypolimnion/Bottom
Total Phosphorus (ug/L)	<5	<5 - 6	<5 - 6
Ammonia-Nitrogen (ug/L)	<5	<5 - 5	<5 - 10
Nitrate-Nitrogen (ug/L)	<5 - 6	<5	7 - 18
Total Inorganic Nitrogen (ug/L)	<10 - 13	<10 - 11	13 - 28
Total Kjeldahl-Nitrogen (mg/L)	<0.6	<0.6	<0.6
Silica (mg/L)	1.21 - 1.34	1.12 - 1.31	1.27 - 1.56
Alkalinity (mg/L as CaCO ₃)	2.34 - 2.76	2.24 - 2.90	2.46 - 2.78
TROPIC STATE CRITERIA (epilimnetic values; from Wetzel, 1983)			
Trophic Category	Total Phosphorus	Total Inorganic Nitrogen	
ultra-oligotrophic	<5 ug/L	<200 ug/L	
oligo-mesotrophic	5 - 10 ug/L	200 - 400 ug/L	

Seasonal and vertical fluctuations in nutrient concentrations provided the most pronounced patterns in the distribution of nutrients over the year of study. Minimum concentrations of many nutrients occurred during the summer growing season of phytoplankton (Section 4.0 below). Specifically, phytoplankton demand was evident for ammonia, nitrate, and silica when the onset of seasonal low concentrations occurred

sequentially for these nutrients in April, May, and July respectively (Figures 2 through 4). Results for the nitrogen species (ammonia, nitrate, and total Kjeldahl-nitrogen), silica, total phosphorus, and alkalinity are discussed separately in the sections that follow.

3.1 Nitrogen

The onset of seasonal low concentrations of ammonia and nitrate began in April and May respectively as a result of demand by phytoplankton (Figures 2 and 3). Supplies of ammonia were depleted throughout the water column with concentrations generally remaining below the detection limit of 5 ug/L at all stations and depths through July. On the June sampling date, nitrate also was below this detection limit at all stations and depths.

The depletion of these nutrients at all depths, including the hypolimnion, is indicative of the extensive photic zone (zone receiving enough light to support net photosynthetic production by phytoplankton) that exists in the reservoir due to the great clarity of the water (Section 4.0 below). Phytoplankton growing in the photic zone extracted ammonia and nitrate and incorporated them into their organic constituents as amino nitrogen. Many phytoplankton growing in the epilimnion and metalimnion eventually sank down into the hypolimnion where they could not be recycled upward in the water column by wind-driven mixing. The processes of nutrient uptake and sedimentation by phytoplankton functioned to remove ammonia and nitrate from the water column more rapidly than they were replaced by inputs to the reservoir.

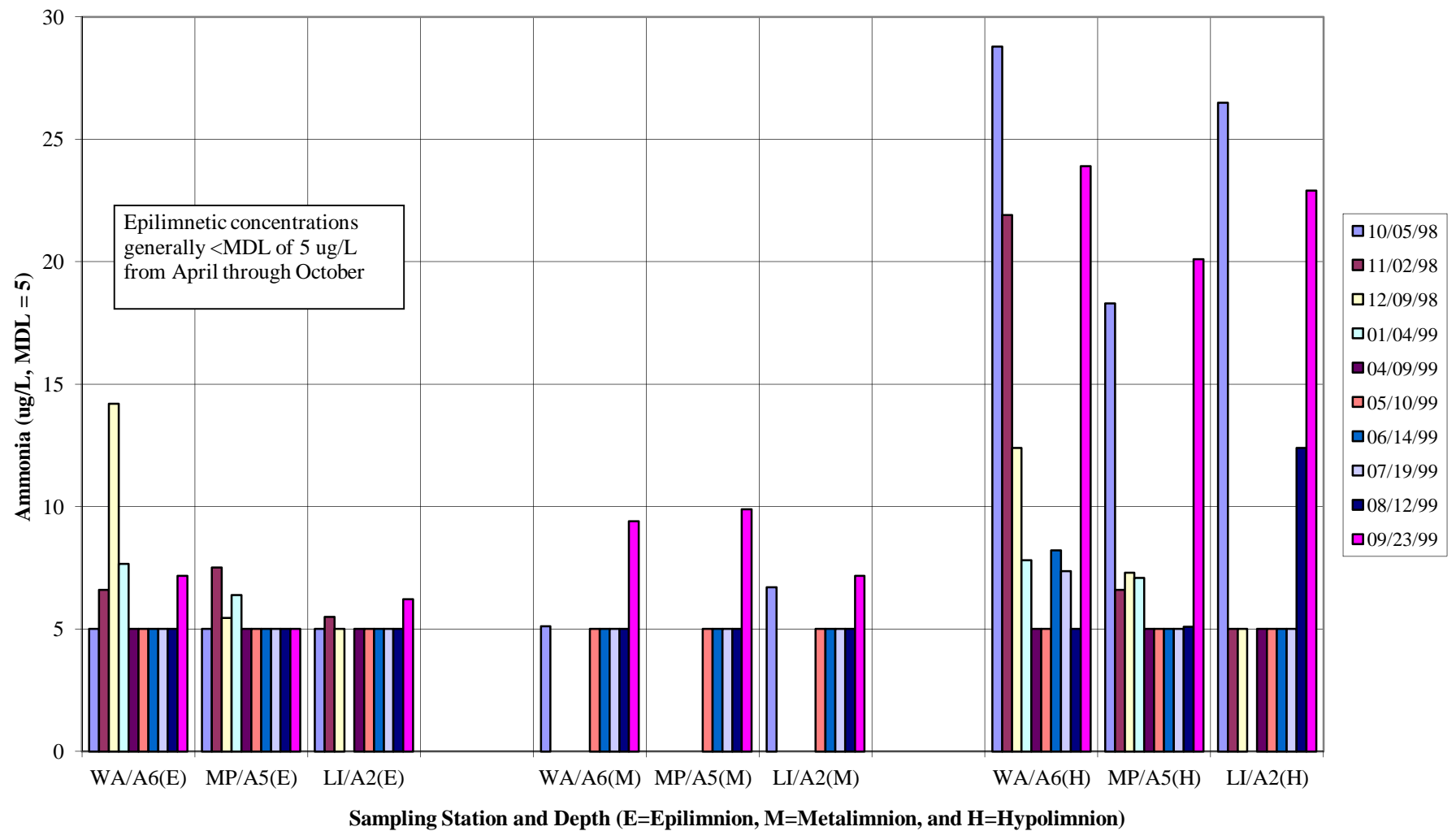
Hypolimnetic concentrations of ammonia and nitrate increased from August through October while epilimnetic concentrations of these nutrients remained depressed (Table 2 and Figures 2 and 3). This vertical gradient in nutrient concentrations was the result of decomposition of organic material (mostly phytoplankton) sedimenting out from overlying waters toward the bottom. Microbial decomposition of sedimenting organic material generated ammonia. Much of this ammonia was oxidized to nitrate in a process known as nitrification mediated by chemoautotrophic bacteria.

As a result the above processes exceeding the rate of photosynthetic assimilation, both ammonia and nitrate accumulated in the hypolimnion during the late summer and fall period of thermal stratification. These accumulated nutrients were mixed into the entire water column between the October and November sampling dates during fall turnover.

Concentrations in the November through April period of mixing were generally intermediate between the extremes of summer epilimnetic depletion and hypolimnetic accumulation. Some of the ammonia and nitrate measured in the water column during this time was recycled from the hypolimnion at fall turnover. Generally, these intermediate concentrations reflect loading rates from the watershed and atmosphere in the absence of intense seasonal demand by phytoplankton. At all stations and depths

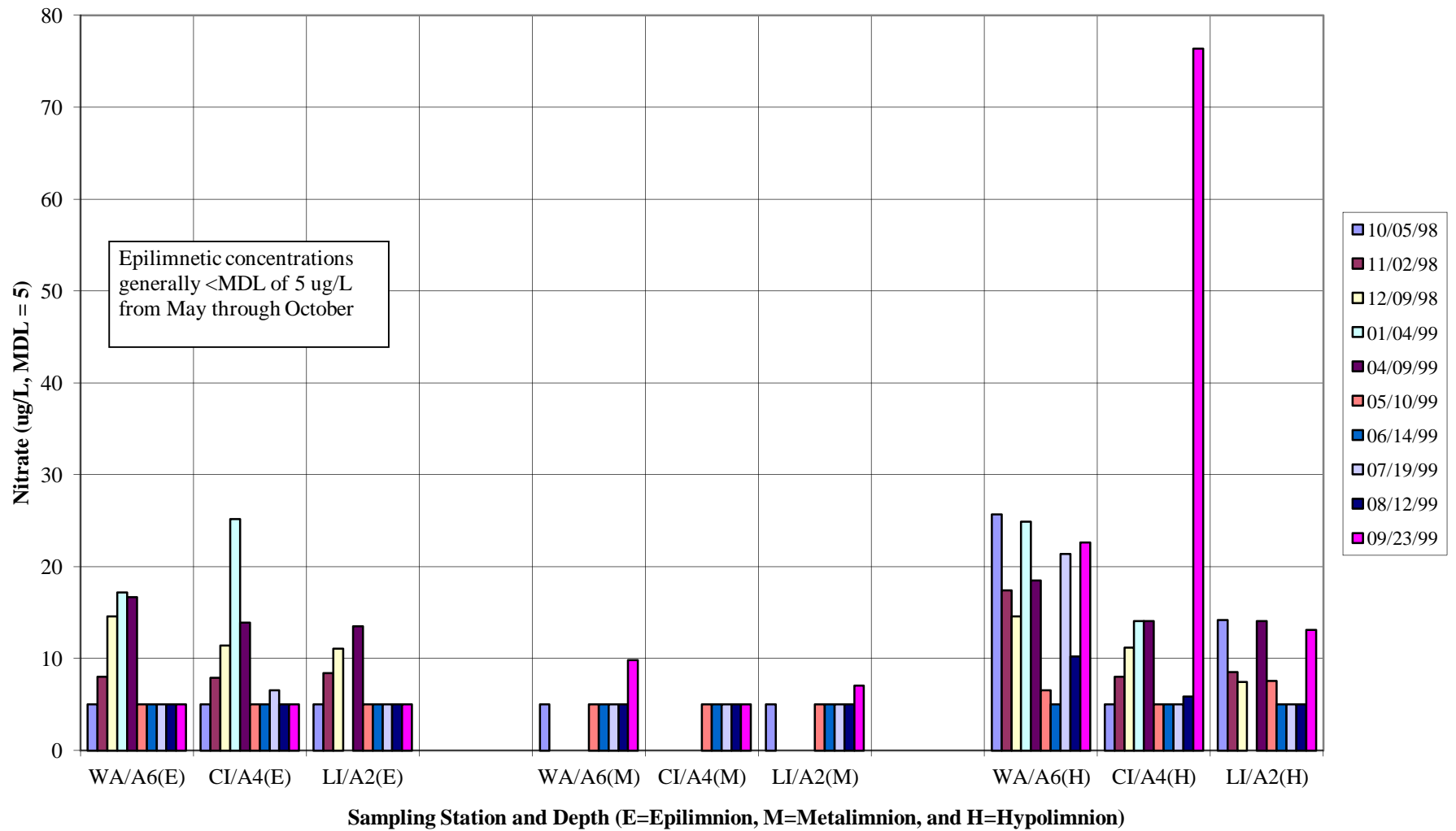
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Quabbin Reservoir Water Column: Seasonal Pattern of Ammonia Concentrations



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Figure 3
Quabbin Reservoir Water Column: Seasonal Pattern of Nitrate Concentrations



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throughout the year, the combined concentrations of ammonia and nitrate (total inorganic nitrogen or TIN) are well below the “ultra-oligotrophic” category threshold of 200 ug/L identified by Wetzel (1983).

Concentrations of total Kjeldahl-nitrogen (TKN; organic forms of nitrogen plus ammonia) were generally less than the detection limit of 0.60 mg/L at all stations and depths throughout the year (Table 2). Specifically, 83 percent of all samples had TKN concentrations less than the detection limit. Concentrations of TKN in all samples collected in December were elevated in comparison to results for all other months and appear to represent an isolated incident of sample bottle contamination or laboratory error.

3.2 Silica

Silica is a unique nutrient because, among major groups of phytoplankton, it is essential only to diatoms. All diatom species build an enclosing wall or frustule using silica extracted from the surrounding water. The vertical profile of silica concentrations observed in the reservoir during the phytoplankton growing season had minimum concentrations in the metalimnion (a “negative heterograde distribution”) typical of many temperate lakes and reservoirs (Wetzel, 1983). Diatoms growing in the metalimnion (Section 4.0 below) assimilated silica and many eventually sank down into the hypolimnion as described above in Section 3.1. The processes of diatom growth and sedimentation functioned to remove silica from the epilimnion and especially, the metalimnion more rapidly than it was replaced by inputs to the reservoir. This was documented in July and August when metalimnetic concentrations of silica reached seasonal minima at all stations (Figure 4).

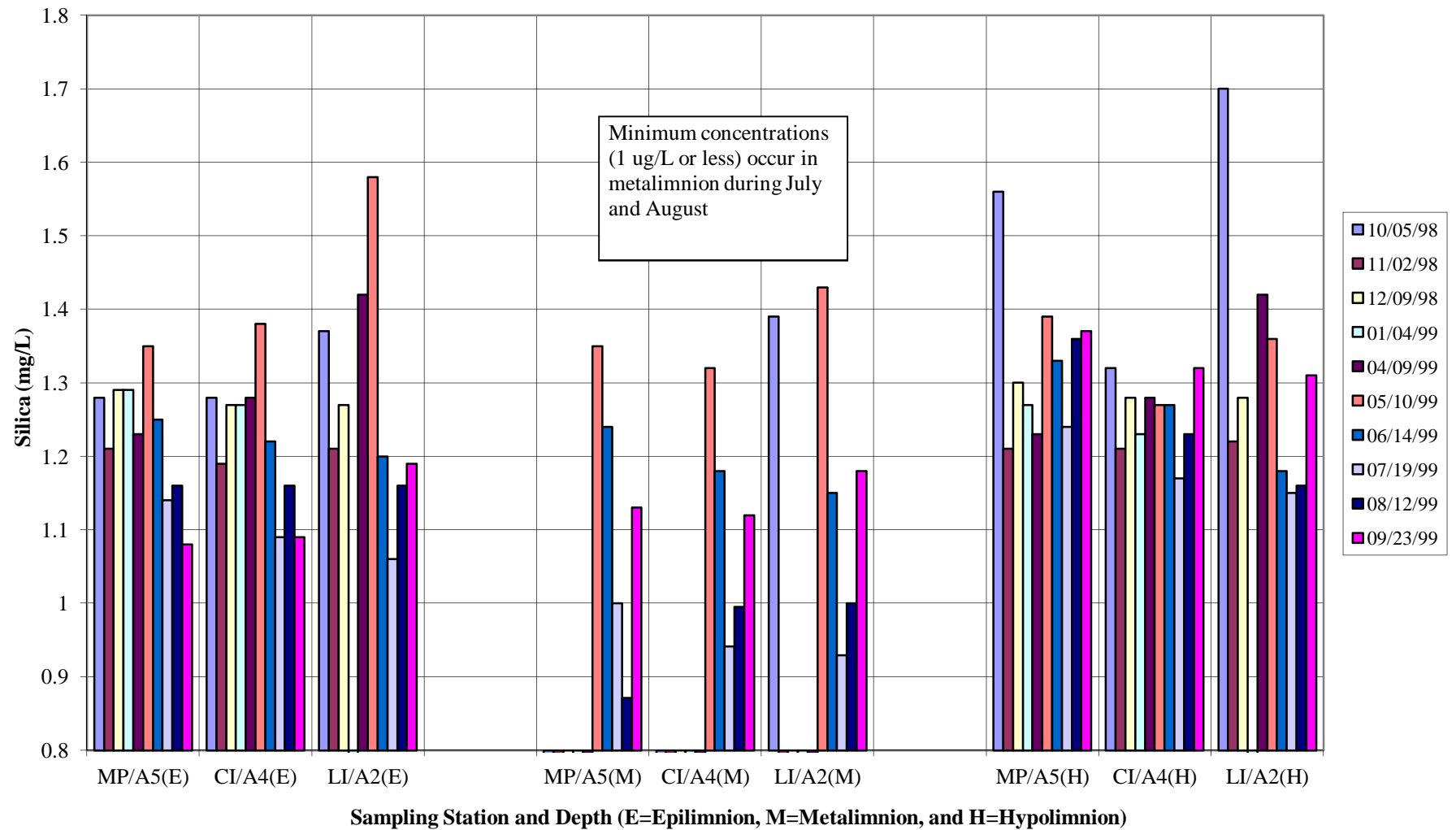
In contrast to the metalimnetic lows, maximum concentrations of silica were measured in the hypolimnion in September and October (Figure 4). These higher concentrations resulted from the presence of sedimenting diatom frustules in the hypolimnion during the late summer and fall period of thermal stratification. Many of these sedimenting frustules were in the process of dissolution, but not all frustules redissolved completely and a significant portion of them become incorporated into bottom sediments. Deep sediments function as a “sink” for the silica of deposited frustules, much of which is not recycled into the water column. This contributes to a slight gradient in silica concentrations across the basin (see below).

The homogenizing effect of fall turnover is evident in the silica concentrations measured in November, which were similar from top to bottom. As with ammonia and nitrate (Section 3.1 above), silica concentrations in the November through April mixing period were intermediate between the extremes of summer metalimnetic depletion and hypolimnetic accumulation.

Despite the seasonal lows in metalimnetic silica, concentrations were consistently above 0.5 mg/L that is a threshold below which diatoms generally decline in the plankton

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Figure 4
Quabbin Reservoir Water Column: Season Pattern of Silica Concentrations



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community (Wetzel, 1983). In Laurel Lake, a eutrophic hardwater lake located in the Berkshires of Western Massachusetts, a large population of diatoms was observed to bloom in May and reduce silica concentrations to less than 0.1 mg/L before collapsing (Soukup, 1974). The rate of silica loading to the reservoir is mainly determined by natural weathering of aluminosilicate minerals in the watershed (Wetzel, 1983) and is not subject to management or manipulation.

Occasional spikes of relatively elevated silica concentrations documented at the Den Hill sampling station likely reflect episodic increases in loading from East Branch Swift River (Section 3.0 above). Additionally, a slight gradient was evident in silica concentrations between stations proximate to watershed loading sources (Den Hill and West Arm/A6) and stations in the central basin “downgradient” from those sources (Mt. Pomeroy/A5 and Carrick Island/A4; see Table 3).

The gradient of decreasing silica concentrations between stations located adjacent to watershed loading sources and stations in the central basin is a result of the following factors: (1) the shape of the reservoir basin and the hydraulic residence time of water moving along the flowpath through it, (2) the net loss of silica from the water column mediated by diatom growth and subsequent sedimentation, and (3) the fact that silica is delivered to the reservoir almost exclusively in surface runoff and groundwater. Silica is not a significant constituent of atmospheric precipitation (Soukup, 1974).

Table 3 - Range of Station Median and Maximum Silica Concentrations

Stations and Depth (values reported in mg/L)		Den Hill and West Arm	Station 202 and Leveau Island	Mt. Pomeroy and Carrick Island
		>>>>> increasing residence time >>>>>		
Epilimnion/Surface	Median	1.33 - 1.34	1.21 - 1.34	1.24 - 1.25
	Max.	1.50 - 2.29	1.52 - 1.58	1.35 - 1.38
Metalimnion	Median	1.24 - 1.31	1.16 - 1.17	1.12 - 1.13
	Max.	1.50 - 1.92	1.43 - 1.55	1.32 - 1.35
Hypolimnion/Bottom	Median	1.49 - 1.56	1.28 - 1.35	1.27 - 1.32
	Max.	2.09 - 2.33	1.70 - 1.99	1.32 - 1.56

The design of Quabbin Reservoir takes advantage of natural and constructed features to maximize the residence time of water flowing through the basin toward the central basin and Shaft 12 (Quabbin Aqueduct). Runoff entering the reservoir from major tributaries along the western shoreline must flow around Prescott Peninsula and through Enfield Channel before entering the central basin. Similarly, runoff entering the basin from major tributaries along the northeastern shoreline must flow through The Pass or other passages north of Mount L before entering the central basin. Finally, the influential discharge from East Branch Swift River must flow around the barrier formed by Mount Zion and the baffle dam before entering the central basin through The Pass.

As water travels along this flowpath, the processes of diatom growth and sedimentation function to remove silica from the water column, much of which is deposited in the sediment as diatom frustules and not recycled. Therefore, the lower concentrations measured in the central basin represent residual silica that remains after partial depletion by diatom populations located upgradient in the flowpath and closer to loading sources. Although silica concentrations observed at all stations and depths during the year of study registered within the narrow range of 0.88 to 2.33 mg/L, the great precision of silica measurements performed by the laboratory (Section 5.0 below) enabled this gradient to be elucidated.

3.3 Total Phosphorus

In contrast to the seasonal fluctuations of ammonia, nitrate, and silica described above, concentrations of total phosphorus were low generally throughout the year at all stations and depths with levels remaining below or near the detection limit of 5 ug/L (Table 2). This concentration of total phosphorus is the threshold of the “ultra-oligotrophic” category of Wetzel (1983).

The consistently low concentrations reflect the constant demand for this nutrient by phytoplankton and indicate that phosphorus is the nutrient limiting phytoplankton growth (Section 4.0 below). Limitation of phytoplankton productivity by a short supply of phosphorus relative to other nutrients is typical of most temperate lakes and reservoirs.

As noted in Section 3.0 above, total phosphorus concentrations ranged slightly higher at the Den Hill sampling station where only 33 percent of samples had concentrations less than the detection limit as compared to all other stations with 71 percent of samples having concentrations less than the detection limit.

3.4 Alkalinity

Although not a nutrient, alkalinity is a measure of the capacity of water to buffer changes in hydrogen ion activity (pH) and also provides an indication of the availability of dissolved inorganic carbon (free carbon dioxide, bicarbonate, and carbonate). Dissolved inorganic carbon is essential for photosynthesis and, under conditions of short supply, has been shown to favor growth by cyanophytes (blue-green algae) over other phytoplankton. However, nuisance growth by cyanophytes is generally limited to nutrient-rich systems at the opposite end of the trophic spectrum from Quabbin Reservoir.

The concentrations of alkalinity measured in the reservoir represent a low buffering capacity typical of softwater systems. However, fluctuations in pH were not extreme and corresponded to seasonal processes occurring in the stratified water column (Section 2.0 above). Measured concentrations of alkalinity were quite stable throughout the year of study, showing minimal seasonal or vertical variability. Median concentrations at all stations and depths ranged from 2.24 to 2.90 mg/L as CaCO₃ (Table 2). As noted in Section 3.0 above, alkalinity concentrations ranged slightly higher at the Den Hill sampling station (range of medians at all depths = 2.76 - 2.90 mg/L) compared to all

other stations (range of medians at all depths = 2.24 - 2.73 mg/L) due to the influence of East Branch Swift River.

3.5 Comparison to Historical Nutrient Data

Historical measurements of nutrients in Quabbin Reservoir are documented in the reports from two sampling programs conducted in the late 1980s. The consulting firm of Tighe & Bond, under contract with the MDC, conducted sampling and analysis of Quabbin Reservoir (and other MDC resource waters) from May 1986 through May 1988 (Tighe & Bond, 1988). Following closely on the Tighe & Bond study, a program of sampling and analysis conducted jointly by the Massachusetts Department of Environmental Protection (Division of Water Pollution Control) and the MDC was initiated in April 1989 and continued until November 1989 (DEP/MDC, 1990). Both studies entailed field measurements and water sampling at a variety of locations across the basin including some of the main sampling stations used in the present study such as Winsor Dam/Station 202, Station 206 (offshore from Shaft 12 and close to Mt. Pomeroy/A5), and Den Hill. Many of the stations currently used for contemporary monitoring efforts are those originally established in these historical studies. Data from these historical reports are summarized in Appendix C.

In comparison to recently generated nutrient data, both these historical studies suffer from the shortcomings of laboratory techniques then available, which did not have the sensitivity or reliability of analyses performed at the MWRA Deer Island Central Laboratory. In particular, minimum detection limits for ammonia and nitrate were much higher than the 5 ug/L detection limit of recent analyses (Table 4). Furthermore, the historical analyses quantify ammonia and nitrate in relatively broad increments of 10 ug/L as opposed to 1 ug/L increments documented in recent analyses.

Table 4 - Comparison of Minimum Detection Limits in Historical Studies

Parameter*	Tighe & Bond (1988)	DEP/MDC (1990)
Total Phosphorus	<ul style="list-style-type: none"> stated as 2 ug/L, but lowest reported value was 5 ug/L 	<ul style="list-style-type: none"> 5 ug/L
Ammonia-Nitrogen	<ul style="list-style-type: none"> 10 ug/L reported in 10 ug/L increments 	<ul style="list-style-type: none"> 20 ug/L reported in 10 ug/L increments
Nitrate-Nitrogen	<ul style="list-style-type: none"> stated as 50 ug/L, but reported as 40 ug/L reported in 10 ug/L increments 	<ul style="list-style-type: none"> 20 ug/L reported in 10 ug/L increments
* detection limit in recent measurements for parameters listed above was 5 ug/L and results were reported in increments of 1 ug/L		

Tighe & Bond (1988) report results for total phosphorus and ammonia that appear erroneous, being much higher than reported by DEP/MDC (1990) or the recent data. In addition to less sensitive laboratory analyses, neither historical study included silica as an analyte to be measured and sampling for the Tighe & Bond study (1988) entailed surface

grabs only. These limitations prevented the seasonal and vertical variations in the concentrations of certain nutrients, major features of the recently generated database, from being detected.

Despite the shortcomings listed above, both historical studies reinforce certain findings documented by the recent data. Both historical studies document the influence of East Branch Swift River on water quality in the Den Hill area of the basin. In both studies, measurements of turbidity and color at Den Hill have the highest average and maximum values among all sampling locations. Additionally, the DEP/MDC study (1990) confirms the recent finding of relatively higher concentrations of total phosphorus and alkalinity at Den Hill compared to other locations. Both historical studies report generally low, but temporally stable concentrations of alkalinity consistent with recent data.

The DEP/MDC study (1990) documents total phosphorus concentrations below or near the detection limit of 5 ug/L throughout the summer, thus reinforcing the finding of phosphorus as the limiting nutrient based on recent data. It is not surprising that this study also documents ammonia and nitrate concentrations generally below the detection limit of 20 ug/L when recent data show maximum concentrations of these parameters generally below the 20 ug/L threshold at all sampling locations throughout the year. Historical data on phytoplankton and Secchi transparency also reinforce findings documented by recent data (Section 4.3 below).

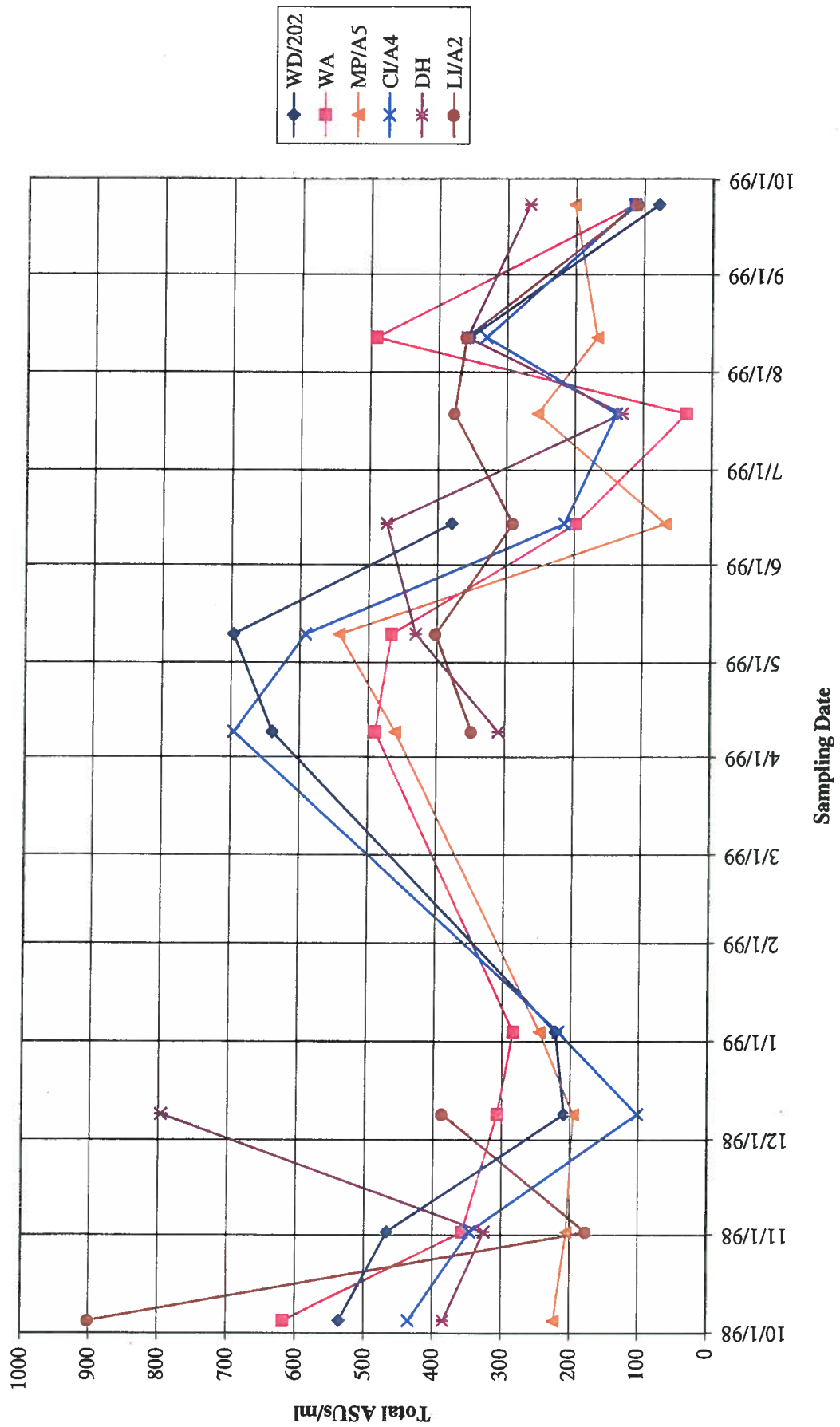
4.0 RESULTS OF PLANKTON ANALYSES

A total of approximately 40 phytoplankton taxa were observed in the quantitative samples collected during the year of study (see Appendix B for complete phytoplankton database). Total densities ranged from 36 to 900 ASUs/ml with seasonal variations in density and community composition generally consistent across all sampling stations. Additionally, a total of 12 zooplankton taxa were observed in the qualitative samples collected with a plankton net. Results for phytoplankton and zooplankton are discussed separately in the sections that follow.

4.1 Phytoplankton

The sampling program was initiated near the end of one growing season (October 1998), continued through the winter period of minimal activity, and encompassed most of the next growing season (Figure 5). However, the results of the sampling program are presented chronologically starting with the winter lull in phytoplankton activity through the beginning of a single growing season to its end. This presentation approach is useful for describing phytoplankton dynamics and appropriate due to their regularity from year to year (see below).

Figure 5
Summary of 1998-99 Quabbin Reservoir Phytoplankton Analyses



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The seasonal succession of phytoplankton in Quabbin Reservoir followed a pattern characteristic of many temperate, oligotrophic systems (Figure 5). During the winter period of low temperatures and light intensities growth by phytoplankton was sufficient only to maintain low population densities. Total densities in January 1999 ranged from 217 to 284 ASUs/ml (no samples were collected in February or March due to ice cover).

Phytoplankton growth was triggered in the spring as light conditions improved and water temperatures increased. Populations expanded rapidly during the period of spring turnover (late March and April) and reached a spring maximum dominated by diatoms in May at the onset of thermal stratification. Phytoplankton densities ranged from 309 to 696 ASUs/ml in the samples collected in April and May with diatoms composing an average of 47 percent of total densities across all sampling stations. The most abundant diatom of the spring maximum was *Asterionella* followed by *Cyclotella*, *Tabellaria*, *Rhizosolenia*, and *Synedra*. The chrysophyte *Dinobryon* and the cyanophyte *Microcystis* also contributed significantly to the spring maximum.

The spring maximum of phytoplankton populations depleted the supply of major nutrients in the trophogenic zone (Section 3.0 above) resulting in subsequent population declines as growth was offset by losses due to sedimentation. Phytoplankton densities in June ranged from 66 to 379 ASUs/ml except at Den Hill where populations of diatoms continued to increase slightly between the May and June sampling dates (430 to 475 total ASUs/ml respectively). The persistence of diatoms at Den Hill in June when populations had declined at all other stations is likely due to the comparatively greater rate of nutrient supply delivered to this sampling station from East Branch Swift River (Section 3.0 above).

Diatoms were observed only infrequently through the summer and early fall, being replaced mainly by low densities of cyanophytes (mostly *Microcystis*), chrysophytes (mostly *Dinobryon*), and chlorophytes. Phytoplankton densities ranged from 36 to 376 ASUs/ml in the samples collected in July, August, and September except at Western Arm (Station A6) where the chlorophyte *Gloeocystis* contributed 176 ASUs/ml to a total of 492 ASUs/ml in August.

The persistence of *Dinobryon* in the community generally throughout the year is indicative of the very low concentrations of phosphorus maintained in the water column by the processes of phytoplankton uptake and sedimentation. This organism has been shown to be inhibited by concentrations of phosphorus greater than 5 ug/L (Rodhe, 1948) and also to have a competitive advantage over other taxa due to its ability to extract this nutrient from water containing extremely low concentrations (Lehman, 1976).

Results of nutrient analyses (Section 3.0 above) document seasonal low concentrations of silica in the metalimnion during July and August indicating sustained growth of diatoms in this stratum. This observation contradicts the sparse densities of diatoms observed in the depth-integrated tube samples collected during this period. A likely explanation is that the tube sampling technique affords only poor representation of diatoms that may be proliferating within a relatively narrow stratum of the water column. Future sampling

efforts will include pumping water directly from the metalimnion in order to document populations focused in this stratum.

In October (near the end of the 1998 growing season), densities were elevated at certain stations due to an abundance of cyanophyte taxa. Phytoplankton densities ranged from 222 to a high of 900 ASUs/ml at Leveau Island (Station A2) in the samples collected in October. Densities at all stations declined between the October and November sampling dates and, except for Den Hill and Leveau Island (Station A2), continued to decline through December. Populations of diatoms at Leveau Island and especially, Den Hill are mainly responsible for secondary peaks of growth in December (387 and 796 total ASUs/ml respectively). Densities at all other stations in December ranged from 101 to 307 ASUs/ml. The general pattern of a fall maximum in phytoplankton densities, such as observed in October 1998, followed by population declines coinciding with the onset of low winter light intensities and water temperatures is characteristic of temperate, oligotrophic systems.

Measurements of Secchi transparency in 1998-99 are consistent with the pattern of phytoplankton dynamics described above (Figure 6). Greatest transparencies were observed in June, July, and August with a maximum value of 14 meters (46 feet) recorded at Mt. Pomeroy (Station A5) on July 19, 1999. The great clarity of the water in the summer months coincides with the low phytoplankton densities that followed the spring maximum in April and May.

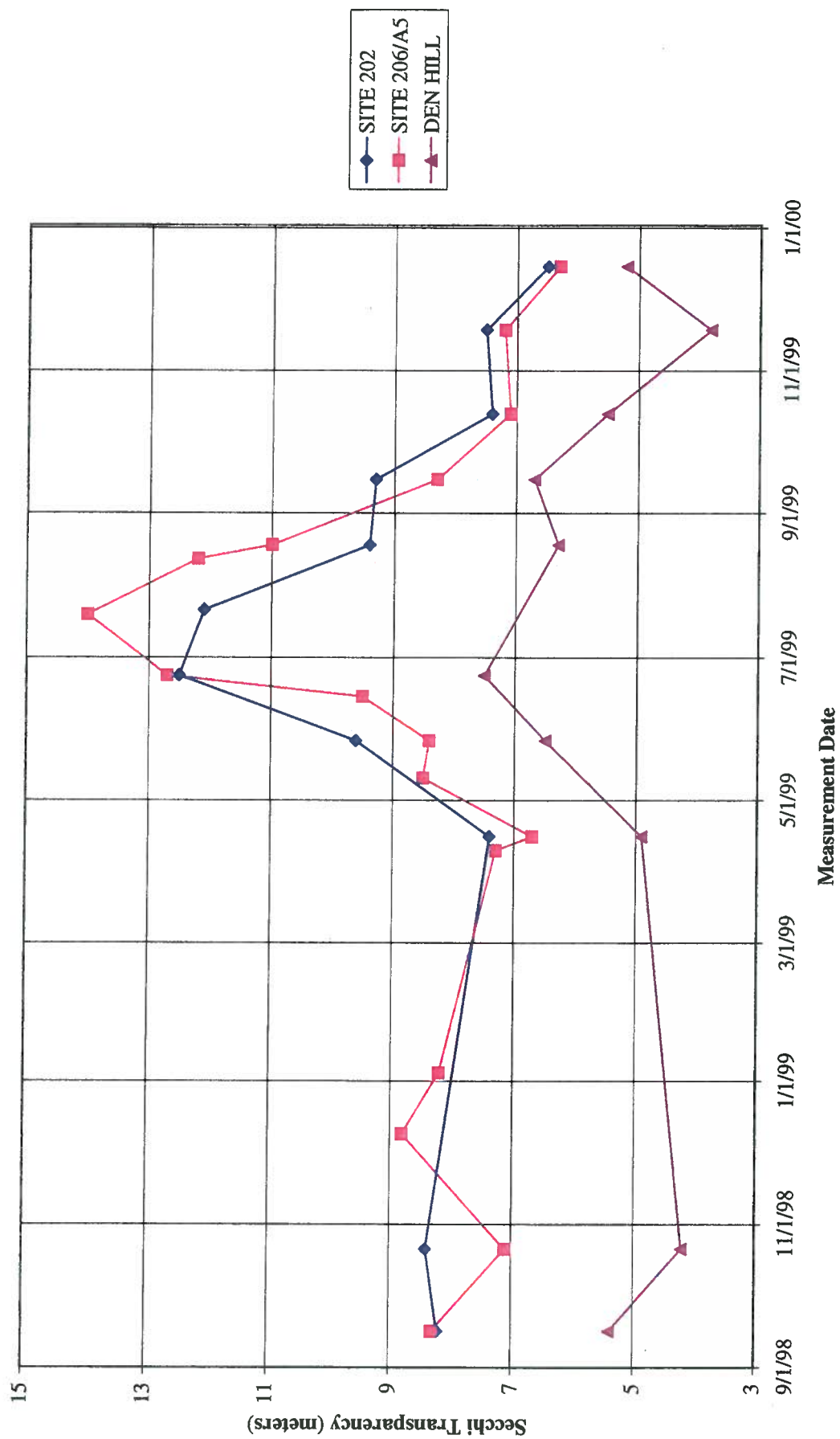
In a system protected from watershed alterations and increases in nutrient loading such as Quabbin Reservoir, the seasonal periodicity of phytoplankton populations is usually similar from one year to the next. Historical records of Secchi transparency measurements dating back to 1990 provide evidence of regularity in the annual pattern of phytoplankton dynamics (Figure 7). Low transparencies are evident each spring and fall on either side of regular peaks in transparency occurring each summer. As in 1998-99, the historical peaks in transparency correspond to low summer phytoplankton densities. These peaks are inserted between spring and fall periods of reduced transparency corresponding to spring and fall maximums in phytoplankton density.

The consistently lower transparency values recorded historically at Den Hill are accountable to the influence of East Branch Swift River. This tributary drains a large watershed containing extensive wetlands, which are a source of dissolved organic compounds that add color to the water and reduce transparency (Section 3.5 above).

4.2 Zooplankton

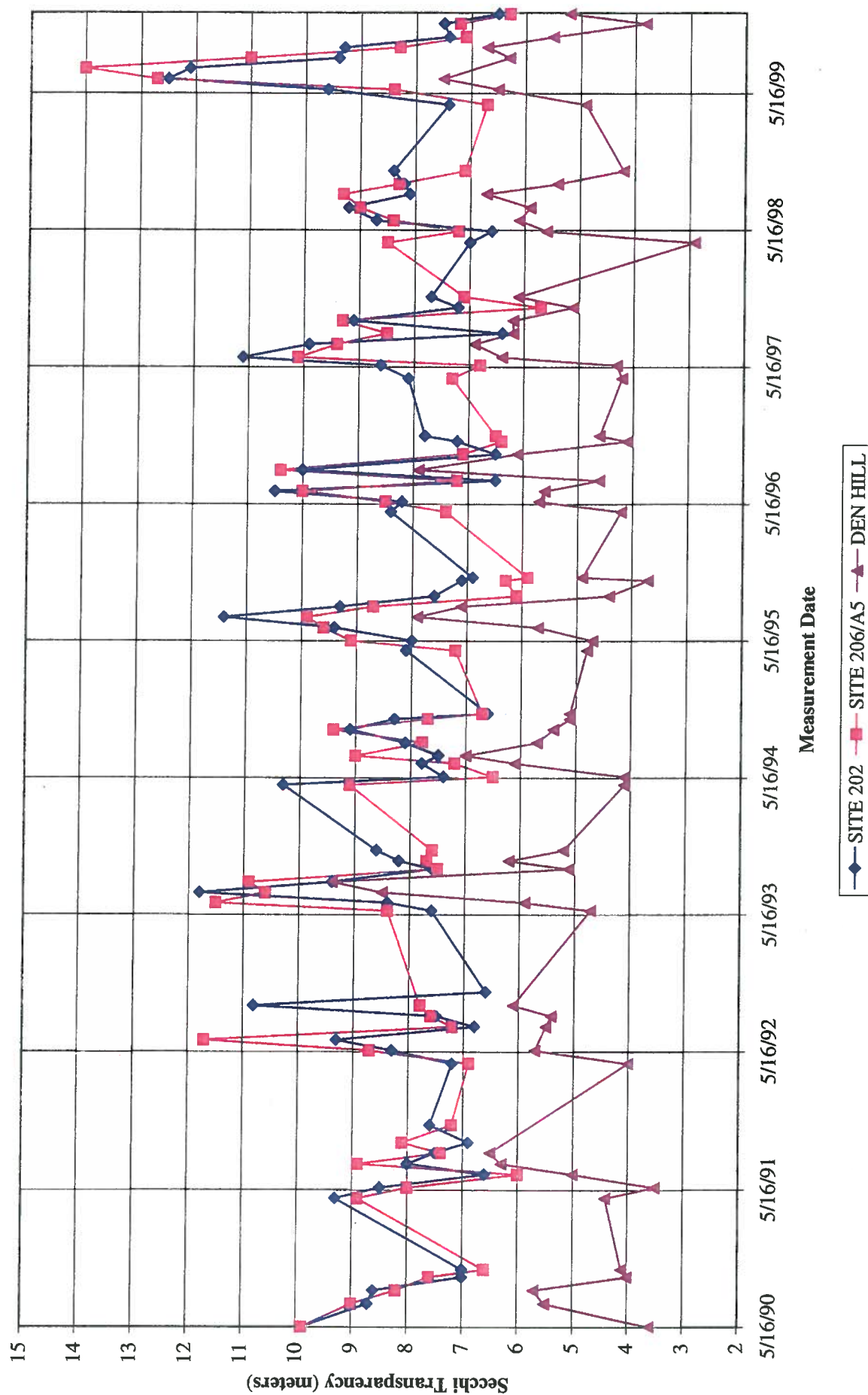
The zooplankton community of Quabbin Reservoir observed during the year of study was composed of the typical freshwater fauna of rotifers (Rotatoria) and two groups of microcrustacea; Cladocera (cladocerans or water fleas) and Copepoda (copepods). Populations of rotifers were numerically dominant generally throughout the year and

Figure 6
Secchi Transparency in Quabbin Reservoir: 1998-99 Year of Study



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Figure 7
Historical Measurements of Secchi Transparency in Quabbin Reservoir: 1990 - 1999



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were represented by the following six genera: *Asplanchna*, *Conochilus*, *Keratella*, *Kellicottia*, *Polyarthra*, and *Trichocera*. Four species of cladocera were observed consisting of *Bosmina longirostris*, *Daphnia catawba*, *Daphnia dubia*, and *Holopedium gibberum*. Copepod populations consisted of representatives of the two planktonic suborders Calanoida and Cyclopoida.

Populations of rotifers appeared to reach a summer maximum in relative abundance among the zooplankton community with *Polyarthra*, *Keratella*, and *Kellicottia*, especially prevalent. Conversely, cladocerans and copepods appeared to reach greatest proportional representation in spring and fall, including immature copepods (nauplii). These results from the 1998-99 year of study represent a preliminary investigation into the zooplankton community of Quabbin Reservoir and more detailed work is planned for the future.

4.3 Comparison to Historical Plankton Data

The two sampling programs conducted in the late 1980s, discussed in regard to historical nutrient data (Section 3.5 above), also provide historical data on plankton and Secchi transparency in Quabbin Reservoir. In the Tighe & Bond study (1988), plankton were collected with an 80 micron mesh net hauled vertically through the water column to a depth of 10 feet. A total of 51 net samples were collected over the course of this study with phytoplankton densities reported as ASUs/ml and zooplankton densities reported as number/L. In the DEP/MDC study (1990), a total of 42 samples were collected, these being a combination of composite and grab samples collected at various depths. Analysis of these samples was performed by Larry Pistrang, MDC Aquatic Biologist, and phytoplankton densities were reported as ASUs/ml. Data from these historical reports are summarized in Appendix C.

Although not directly comparable to recent data due to the disparities in sampling technique, the phytoplankton data from both historical studies document patterns remarkably similar to recent findings. The main features of community composition, abundance, and seasonal dynamics are consistent among all three data sets. Spring maximums dominated by diatoms were documented in both historical studies as were the subsequent crash of populations leading to very low densities in summer.

Measurements of Secchi transparency were inversely correlated to phytoplankton densities in both historical studies precisely like recent measurements. Thus, the recurring pattern of peaks in transparency each summer corresponding to seasonal periodicity of phytoplankton populations can be traced back as far as 1986 (Tighe & Bond, 1988). Both historical studies also confirm consistently lower transparency values at Den Hill compared to other locations due to the influence of East Branch Swift River (Section 4.1 above).

In addition to diatoms, the Tighe & Bond study (1988) identifies *Dinobryon* as a consistent component of the phytoplankton community and often contributing to peaks in densities. Among the zooplankton, the rotifers *Kellicottia* and *Conochilus* were identified

as the dominant organisms which is consistent with the recent finding of dominance by these and other rotifers. This study also reports occasional observations of the cladocerans *Leptodora* and *Polyphemus* in the net samples. These two organisms were not observed during the 1998-99 year of study and it is likely that the Tighe & Bond analyst misidentified one or the other and/or confused one with *Holopedium gibberum*. In particular, *Polyphemus* is an unlikely inhabitant of the reservoir limnetic zone being generally restricted to pools, marshes, and littoral zone habitats.

The DEP/MDC study (1990) includes data from grabs collected at various depths at a single location and documents vertical gradients in the densities of certain organisms. Most notable was the occurrence in June of *Uroglenopsis* at relatively high densities at a depth of four meters (308 - 321 ASUs/ml) compared to grabs above and below that depth (0 - 14 ASUs/ml). Additionally, in August, *Dinobryon* was absent at the surface, at 4 meters, and at 9 meters, but was detected at a density of 187 ASUs/ml at a depth of 13 meters. Both these organisms are flagellated and can exercise some control over their position in the water column, especially at depths removed from vigorous mixing induced by wind acting on the surface. As stated above, future sampling efforts will include pumping water directly from the metalimnion or other strata of interest in order to document vertical gradients in phytoplankton densities.

One of the earliest studies of Quabbin Reservoir phytoplankton was conducted during the summers (June, July, and August) of 1966 through 1968 (Erickson and Reynolds, 1969). The results of this study stand in sharp contrast to the historical data generated in the late 1980s and the data generated during the 1998-99 year of study. Erickson and Reynolds (1969) divided the reservoir into four distinct areas based on the frequencies of occurrence of threshold densities of desmids, dinoflagellates, and a broad category of plankton taxa identified as “chlorococcoids”. However, the results reported in 1969 are not representative because the study was conducted during a period of drought when the average volume of reservoir storage was 225 billion gallons or only 55 percent of capacity. Additionally, Pottapaug Pond was included as part of an area identified as having a distinct phytoplankton fauna that also included the eastern arm of the main reservoir basin. Inclusion of samples from Pottapaug Pond, a shallow system dominated by influences from an extensive littoral zone and epiphytic algae, confounded the analysis of reservoir phytoplankton. Many of the taxa listed in the 1969 publication were also observed during the 1998-99 year of study, but not in the regional patterns or relative abundances reported in 1969.

5.0 RESULTS OF FIELD DUPLICATE ANALYSES

As part of the nutrient sampling program, the reliability of laboratory results were checked by submitting duplicate samples of Quabbin Reservoir water as well as duplicates of samples collected from Quabbin tributaries and Wachusett Reservoir. Different locations were selected each month for collection of duplicate pairs of samples. Duplicates were collected simultaneously in the field using identical methods, containers, and preservation. One set of bottles of the duplicate pair was labeled only as field duplicate and, therefore, was a “blind” duplicate sent to the laboratory with no reference

to location. All samples were stored together and delivered to the laboratory at the same time. A total of 33 duplicate samples were submitted to the laboratory over the year of study (generally three duplicate samples each month).

Results of laboratory analysis of the field duplicates were evaluated using the coefficient of variation as a measure of laboratory precision (Table 5). Coefficient of variation (CV) is the standard deviation expressed as a percentage of the mean and was calculated for each analyte in each of the duplicate pairs of samples. Values around 20 percent indicate reasonable precision with lower values indicating good to excellent precision. Conversely, values greater than 20 percent indicate poor precision.

Results for silica exhibit the greatest precision with a median CV value of 0.9 percent, an average CV value of 1.7 percent, and no duplicate pairs having a CV greater than 20 percent. Measurements of silica were remarkable in their precision with concentrations in samples ranging from 1,120 to 13,900 ug/L and discrepancies between duplicate pairs generally 20 ug/L or less. Nitrate was the second most precise laboratory measurement with a median CV value of 1.4 percent and only 9.1 percent of duplicate pairs having a CV greater than 20 percent.

Table 5 - Summary of Coefficients of Variation (CV) Calculated for Duplicate Samples

Parameter	Median CV	Average CV	Maximum CV	Percent of CV Values >20%
Total Phosphorus	10.7%	22.3%	110.4%	30.3%
Ammonia-Nitrogen	6.4%	12.1%	36.0%	12.1%
Nitrate-Nitrogen	1.4%	8.6%	117.7%	9.1%
Total Kjeldahl-Nitrogen	15.3%	17.7%	33.1%	15.2%
Silica	0.9%	1.7%	15.2%	none
Alkalinity	4.2%	10.2%	110.4%	12.1%

Measurements of total phosphorus and total Kjeldahl-nitrogen were the least precise with median CV values of 10.7 and 15.3 percent respectively. These parameters also had the highest proportion of duplicate pairs with a CV greater than 20 percent (total phosphorus with 30.3 percent and total Kjeldahl-nitrogen with 15.2 percent). However, the concentrations of these parameters in the samples were often below or near the laboratory detection limit and this factor contributed to the difficulty of making precise measurements.

6.0 SUMMARY AND CONCLUSIONS

- Results confirm “ultra-oligotrophic” status (Wetzel, 1983) of Quabbin Reservoir based on very low concentrations of total phosphorus and total inorganic nitrogen.
- Spatial variation in nutrient concentrations at stations across the basin was minor except for relatively higher concentrations of total phosphorus, silica, and alkalinity at Den Hill and a slight gradient in silica concentrations (see below).
- Concentrations of ammonia, nitrate, and silica exhibited marked seasonal and vertical variations due to demand by phytoplankton in the trophogenic zone (epilimnion and metalimnion) and decomposition of sedimenting phytoplankton in the tropholytic zone (hypolimnion).
- Ammonia and nitrate were depleted in the trophogenic zone in spring and remained below or near the detection limit of 5 ug/L until fall turnover, whereas concentrations increased in the tropholytic zone from August through fall turnover.
- Minimum concentrations of silica were measured in the metalimnion in July and August, whereas hypolimnetic concentrations increased from September through fall turnover; a slight gradient of decreasing concentrations, correlated to hydraulic residence time, is evident between stations proximate to watershed loading sources (Den Hill and West Arm) and stations in the central basin “downgradient” from those sources (Mt. Pomeroy and Carrick Island).
- Concentrations of total phosphorus were low throughout the year at all stations and depths with levels generally remaining below or near the detection limit of 5 ug/L; this indicates that phosphorus is the limiting nutrient for Quabbin Reservoir phytoplankton.
- During the November through April period of water column isothermy and mixing, the water column was homogenized (no vertical gradients) with concentrations of most nutrients intermediate between summer extremes measured in the trophogenic and tropholytic zones.
- Quabbin Reservoir exhibits an annual cycle of phytoplankton succession characteristic of many temperate, oligotrophic systems consisting of the following: minimal activity in winter due to low temperatures and light intensities, a spring maximum dominated by diatoms, a summer minimum following the spring depletion of nutrients, another maximum in the fall, and then a return to low winter densities.
- Current and historical measurements of Secchi transparency are consistent with the seasonal periodicity of phytoplankton described above with greatest clarity documented during summer periods of low densities and periods of reduced transparency corresponding to spring and fall maximums.

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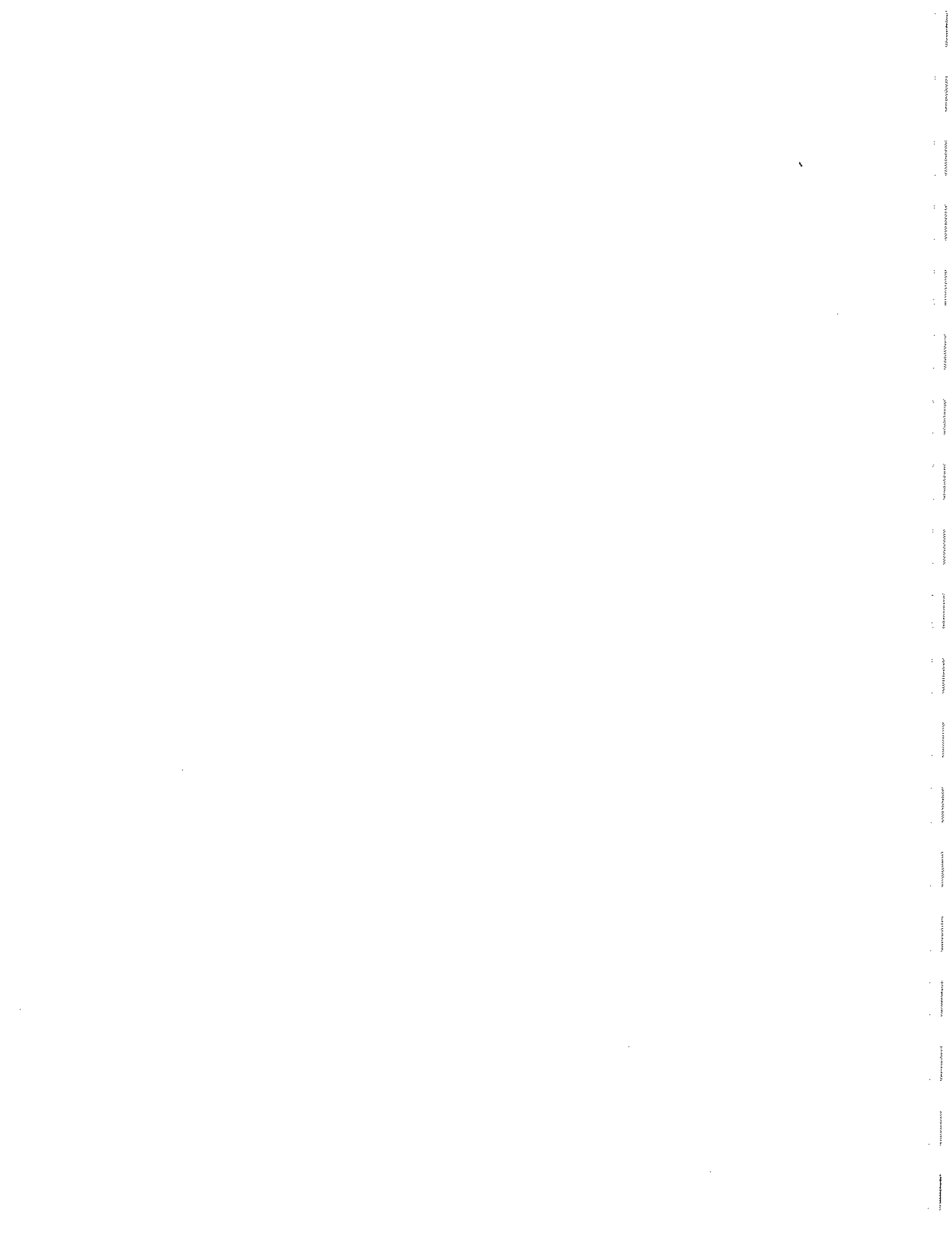
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APPENDIX A

Nutrient Database for 1998-99 Year of Study



Ammonia (mg/L)

Lab #	Sampling Location	Sampling Date										Median	Average	Max.
		10/05/98	11/02/98	12/09/98	01/04/99	04/09/99	05/10/99	06/14/99	07/19/99	08/12/99	09/23/99			
MD28	Winsor Dam/202 (E)	0.005	0.0059	0.0104	0.00795	0.005	0.005	0.005	na	0.005	0.005	0.005	0.006	0.010
MD29	Winsor Dam/202 (M)	0.005	na	na	na	na	0.005	0.005	na	0.005	0.005	0.005	0.005	0.005
MD30	Winsor Dam/202 (H)	0.0242	0.008	0.0107	0.00809	0.005	0.005	0.005	na	0.00538	0.005	0.005	0.008	0.024
MD43	Western Arm/A6 (E)	0.005	0.0066	0.0142	0.00766	0.005	0.005	0.005	0.005	0.005	0.00717	0.005	0.007	0.014
MD44	Western Arm/A6 (M)	0.0051	na	na	na	na	0.005	0.005	0.005	0.005	0.0094	0.005	0.006	0.009
MD45	Western Arm/A6 (H)	0.0288	0.0219	0.0124	0.00781	0.005	0.005	0.00821	0.00736	0.005	0.0239	0.008	0.013	0.029
MD37	Mt. Pomeroy/A5 (E)	0.005	0.0075	0.00545	0.00638	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.008
MD38	Mt. Pomeroy/A5 (M)	na	na	na	na	na	0.005	0.005	0.005	0.005	0.00988	0.005	0.006	0.010
MD39	Mt. Pomeroy/A5 (H)	0.0183	0.0066	0.0073	0.00709	0.005	0.005	0.005	0.005	0.00508	0.0201	0.006	0.008	0.020
MD34	Carrick Island/A4 (E)	0.005	0.0057	0.005	0.00595	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.006
MD35	Carrick Island/A4 (M)	na	na	na	na	na	0.005	0.005	0.005	0.005	0.0112	0.005	0.006	0.011
MD36	Carrick Island/A4 (H)	0.005	0.0066	0.0077	0.00624	0.005	0.005	0.005	0.005	0.00582	0.0237	0.005	0.008	0.024
MD40	Den Hill (E)	0.0064	0.012	0.0124	na	0.005	0.005	0.005	0.005	0.005	0.00781	0.005	0.007	0.012
MD41	Den Hill (M)	0.0121	na	na	na	na	0.0056	0.005	0.005	0.005	0.00956	0.005	0.007	0.012
MD42	Den Hill (H)	0.0113	0.0112	0.0109	na	0.005	0.00893	0.005	0.005	0.0207	a*	0.010	0.010	0.021
MD31	Leveau Island/A2 (E)	0.005	0.0055	0.005	na	0.005	0.005	0.005	0.005	0.005	0.00622	0.005	0.005	0.006
MD32	Leveau Island/A2 (M)	0.0067	na	na	na	na	0.005	0.005	0.005	0.005	0.00717	0.005	0.006	0.007
MD33	Leveau Island/A2 (H)	0.0265	0.005	0.005	na	0.005	0.005	0.005	0.005	0.0124	0.0229	0.005	0.010	0.027

Notes: (1) values in *italic* indicate <MDL

(2) letter in **bold** represents the following anomalous (elevated) value: a* = 0.122

(3) Notation for position of sample collection in stratified water column is as follows: E=Epilimnion, M=Metalimnion, and H=Hypolimnion

Nitrate (mg/L)

Lab #	Sampling Location	Sampling Date										Median	Average	Max.	
		10/05/98	11/02/98	12/09/98	01/04/99	04/09/99	05/10/99	06/14/99	07/19/99	08/12/99	09/23/99				
MD28	Winsor Dam/202 (E)	0.005	0.0065	0.0144	0.0172	0.0175	0.005	0.005	na	0.005	0.005	0.005	0.005	0.009	0.018
MD29	Winsor Dam/202 (M)	0.005	na	na	na	na	0.005	0.005	na	0.005	0.005	0.005	0.005	0.005	0.005
MD30	Winsor Dam/202 (H)	0.023	0.0065	0.0144	0.0247	0.0182	0.005	0.005	na	0.00992	0.005	0.005	0.010	0.012	0.025
MD43	Western Arm/A6 (E)	0.005	0.008	0.0146	0.0172	0.0167	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.009	0.017
MD44	Western Arm/A6 (M)	0.005	na	na	na	na	0.005	0.005	0.005	0.005	0.00982	0.005	0.005	0.006	0.010
MD45	Western Arm/A6 (H)	0.0257	0.0174	0.0146	0.0249	0.0185	0.00654	0.005	0.0214	0.0102	0.0226	0.005	0.018	0.017	0.026
MD37	Mt. Pomeroy/A5 (E)	0.005	0.0085	0.00621	0.0204	0.0142	0.005	0.005	0.0196	0.005	0.005	0.005	0.006	0.009	0.020
MD38	Mt. Pomeroy/A5 (M)	na	na	na	na	na	0.0439	0.005	0.005	0.005	0.005	0.005	0.005	0.013	0.044
MD39	Mt. Pomeroy/A5 (H)	0.0082	0.0082	0.0121	0.0149	0.0152	0.0102	0.005	0.005	0.00525	0.0152	0.005	0.009	0.010	0.015
MD34	Carrick Island/A4 (E)	0.005	0.0079	0.0114	0.0252	0.0139	0.005	0.005	0.00652	0.005	0.005	0.005	0.006	0.009	0.025
MD35	Carrick Island/A4 (M)	na	na	na	na	na	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
MD36	Carrick Island/A4 (H)	0.005	0.008	0.0112	0.0141	0.0141	0.005	0.005	0.005	0.00587	0.0764	0.005	0.007	0.015	0.076
MD40	Den Hill (E)	0.005	0.0132	0.0181	na	0.0266	0.005	0.005	0.0118	0.00507	0.005	0.005	0.005	0.011	0.027
MD41	Den Hill (M)	0.005	na	na	na	na	0.0072	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.007
MD42	Den Hill (H)	0.0076	0.013	0.0179	na	0.0285	0.0403	0.005	0.005	0.005	0.0171	0.005	0.013	0.015	0.040
MD31	Leveau Island/A2 (E)	0.005	0.0084	0.0111	na	0.0135	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.007	0.014
MD32	Leveau Island/A2 (M)	0.005	na	na	na	na	0.005	0.005	0.005	0.005	0.00704	0.005	0.005	0.005	0.007
MD33	Leveau Island/A2 (H)	0.0142	0.0085	0.00743	na	0.0141	0.00754	0.005	0.005	0.005	0.0131	0.005	0.008	0.009	0.014

Notes: (1) values in *italics* indicate <MDL

(2) Notation for position of sample collection in stratified water column is as follows: E=Epilimnion, M=Metalimnion, and H=Hypolimnion

Total Inorganic Nitrogen (mg/L)

Lab #	Sampling Location	Sampling Date													
		10/05/98	11/02/98	12/09/98	01/04/99	04/09/99	05/10/99	06/14/99	07/19/99	08/12/99	09/23/99				
MD28	Winsor Dam/202 (E)	0.010	0.012	0.025	0.025	0.023	0.010	0.010	na	0.010	0.010	Median	Average	Max	
MD29	Winsor Dam/202 (M)	0.010	na	na	na	na	0.010	0.010	na	0.010	0.010	0.010	0.015	0.025	
MD30	Winsor Dam/202 (H)	0.047	0.015	0.025	0.033	0.023	0.010	0.010	na	0.015	0.010	0.010	0.010	0.010	
MD43	Western Arm/A6 (E)	0.010	0.015	0.029	0.025	0.022	0.010	0.010	0.010	0.010	0.012	0.011	0.015	0.029	
MD44	Western Arm/A6 (M)	0.010	na	na	na	na	0.010	0.010	0.010	0.010	0.019	0.010	0.012	0.019	
MD45	Western Arm/A6 (H)	0.055	0.039	0.027	0.033	0.024	0.012	0.013	0.029	0.015	0.047	0.028	0.029	0.055	
MD37	Mt. Pomeroy/A5 (E)	0.010	0.016	0.012	0.027	0.019	0.010	0.010	0.025	0.010	0.010	0.011	0.015	0.027	
MD38	Mt. Pomeroy/A5 (M)	na	na	na	na	na	0.049	0.010	0.010	0.010	0.015	0.010	0.019	0.049	
MD39	Mt. Pomeroy/A5 (H)	0.027	0.015	0.019	0.022	0.020	0.015	0.010	0.010	0.010	0.035	0.017	0.018	0.035	
MD34	Carrick Island/A4 (E)	0.010	0.014	0.016	0.031	0.019	0.010	0.010	0.012	0.010	0.010	0.011	0.014	0.031	
MD35	Carrick Island/A4 (M)	na	na	na	na	na	0.010	0.010	0.010	0.010	0.016	0.010	0.011	0.016	
MD36	Carrick Island/A4 (H)	0.010	0.015	0.019	0.020	0.019	0.010	0.010	0.010	0.012	0.100	0.013	0.022	0.100	
MD40	Den Hill (E)	0.011	0.025	0.031	na	0.032	0.010	0.010	0.017	0.010	0.013	0.013	0.018	0.032	
MD41	Den Hill (M)	0.017	na	na	na	na	0.013	0.010	0.010	0.010	0.015	0.011	0.012	0.017	
MD42	Den Hill (H)	0.019	0.024	0.029	na	0.034	0.049	0.010	0.010	0.026	na	0.025	0.025	0.049	
MD31	Leveau Island/A2 (E)	0.010	0.014	0.016	na	0.019	0.010	0.010	0.010	0.010	0.011	0.010	0.012	0.019	
MD32	Leveau Island/A2 (M)	0.012	na	na	na	na	0.010	0.010	0.010	0.010	0.014	0.010	0.011	0.014	
MD33	Leveau Island/A2 (H)	0.041	0.014	0.012	na	0.019	0.013	0.010	0.010	0.017	0.036	0.014	0.019	0.041	

Notes:

(1) values in *italic* indicate <MDL

(2) Notation for position of sample collection in stratified water column is as follows: E=Epilimnion, M=Metalimnion, and H=Hypolimnion

Total Kjeldahl-Nitrogen (mg/L)

Lab #	Sampling Location	Sampling Date											
		10/05/98	11/02/98	12/09/98	01/04/99	04/09/99	05/10/99	06/14/99	07/19/99	08/12/99	09/23/99		
MD28	Winsor Dam/202 (E)	0.955	0.6	1.08	0.6	0.666	0.6	0.6	na	0.6	0.627		
MD29	Winsor Dam/202 (M)	0.987	na	na	na	na	0.6	0.6	na	0.6	0.6		
MD30	Winsor Dam/202 (H)	0.987	0.6	0.959	0.6	0.6	0.6	0.6	na	0.6	0.638		
MD43	Western Arm/A6 (E)	0.6	0.6	0.665	0.6	0.6	0.6	0.6	0.6	0.6	0.6		
MD44	Western Arm/A6 (M)	0.6	na	na	na	na	0.6	0.6	0.6	0.6	0.6		
MD45	Western Arm/A6 (H)	1.12	0.6	0.707	0.6	0.6	0.6	0.6	0.6	0.6	0.6		
MD37	Mt. Pomeroy/A5 (E)	0.6	0.6	0.6	0.6	0.655	0.6	0.6	0.6	0.6	0.6		
MD38	Mt. Pomeroy/A5 (M)	na	na	na	na	na	0.6	0.6	0.6	0.6	0.6		
MD39	Mt. Pomeroy/A5 (H)	0.798	0.6	0.808	0.6	0.6	0.6	0.6	0.6	0.6	0.6		
MD34	Carrick Island/A4 (E)	0.6	0.6	1.43	0.6	0.6	0.6	0.6	0.6	0.6	0.6		
MD35	Carrick Island/A4 (M)	na	na	na	na	na	0.6	0.7	0.6	0.6	0.697		
MD36	Carrick Island/A4 (H)	0.6	0.6	1.06	0.6	0.6	0.6	0.6	0.6	0.6	0.6		
MD40	Den Hill (E)	0.6	0.6	0.6	na	0.6	0.6	0.6	0.6	0.6	0.6		
MD41	Den Hill (M)	0.6	na	na	na	na	0.6	0.6	0.6	0.6	0.6		
MD42	Den Hill (H)	0.6	0.6	0.774	na	0.6	0.6	0.6	0.6	0.6	0.652		
MD31	Leveau Island/A2 (E)	0.651	0.6	0.998	na	0.6	0.6	0.6	0.6	0.6	0.6		
MD32	Leveau Island/A2 (M)	0.889	na	na	na	na	0.6	0.6	0.6	0.6	0.6		
MD33	Leveau Island/A2 (H)	0.6	0.6	0.961	na	0.6	0.6	0.65	0.6	0.6	0.6		

Notes: (1) values in *italic* indicate <MDL

(2) Notation for position of sample collection in stratified water column is as follows: E=Epilimnion, M=Metalimnion, and H=Hypolimnion

Silica (mg/L; converted from reported units of ug/L)

Lab #	Sampling Location	Sampling Date											
		10/05/98	11/02/98	12/09/98	01/04/99	04/09/99	05/10/99	06/14/99	07/19/99	08/12/99	09/23/99		
MD28	Winsor Dam/202 (E)	1.25	1.19	1.34	1.34	1.36	1.52	1.34	na	1.25	1.14		
MD29	Winsor Dam/202 (M)	1.16	na	na	na	na	1.55	1.36	na	1.12	1.08		
MD30	Winsor Dam/202 (H)	1.99	1.18	1.35	1.35	1.35	1.55	1.41	na	1.39	1.27		
MD43	Western Arm/A6 (E)	1.30	1.23	1.39	1.40	1.50	1.46	1.37	1.26	1.20	1.16		
MD44	Western Arm/A6 (M)	1.25	na	na	na	na	1.5	1.36	1.16	1.04	1.40		
MD45	Western Arm/A6 (H)	2.09	1.51	1.43	1.40	1.46	1.56	1.42	1.45	1.51	1.66		
MD37	Mt. Pomeroy/A5 (E)	1.28	1.21	1.29	1.29	1.23	1.35	1.25	1.14	1.16	1.08		
MD38	Mt. Pomeroy/A5 (M)	na	na	na	na	na	1.35	1.24	1.00	0.87	1.13		
MD39	Mt. Pomeroy/A5 (H)	1.56	1.21	1.3	1.27	1.23	1.39	1.33	1.24	1.36	1.37		
MD34	Carrick Island/A4 (E)	1.28	1.19	1.27	1.27	1.28	1.38	1.22	1.09	1.16	1.09		
MD35	Carrick Island/A4 (M)	na	na	na	na	na	1.32	1.18	0.94	1.00	1.12		
MD36	Carrick Island/A4 (H)	1.32	1.21	1.28	1.23	1.28	1.27	1.27	1.17	1.23	1.32		
MD40	Den Hill (E)	1.40	1.37	1.33	na	2.29	1.94	1.14	0.98	1.09	1.16		
MD41	Den Hill (M)	1.45	na	na	na	na	1.92	1.29	0.88	1.00	1.18		
MD42	Den Hill (H)	1.56	1.37	1.34	na	2.23	1.72	1.62	1.18	1.33	2.33		
MD31	Leveau Island/A2 (E)	1.37	1.21	1.27	na	1.42	1.58	1.20	1.06	1.16	1.19		
MD32	Leveau Island/A2 (M)	1.39	na	na	na	na	1.43	1.15	0.93	1.00	1.18		
MD33	Leveau Island/A2 (H)	1.70	1.22	1.28	na	1.42	1.36	1.18	1.15	1.16	1.31		

Note: (1) Notation for position of sample collection in stratified water column is as follows: E=Epilimnion, M=Metalimnion, and H=Hypolimnion

Total Phosphorus (mg/L)

Lab #	Sampling Location	Sampling Date										09/23/99
		10/05/98	11/02/98	12/09/98	01/04/99	04/09/99	05/10/99	06/14/99	07/19/99	08/12/99		
MD28	Winsor Dam/202 (E)	0.005	0.005	0.005	0.00536	0.005	0.00804	0.005	na	0.005	0.005	
MD29	Winsor Dam/202 (M)	0.0066	na	na	na	na	0.00743	0.005	na	c*	0.005	
MD30	Winsor Dam/202 (H)	0.0438	0.005	0.005	0.00735	0.00666	0.00531	0.005	na	0.005	0.005	
MD43	Western Arm/A6 (E)	a*	0.005	0.005	0.00718	0.005	0.00637	0.005	0.005	0.005	0.005	
MD44	Western Arm/A6 (M)	0.0309	na	na	na	na	0.00576	0.005	0.005	0.005	0.00863	
MD45	Western Arm/A6 (H)	0.0078	0.005	0.005	0.00867	0.005	0.005	0.005	0.005	0.005	0.0101	
MD37	Mt. Pomeroy/A5 (E)	0.005	0.005	0.005	0.0115	0.005	0.005	0.005	0.005	0.005	0.005	
MD38	Mt. Pomeroy/A5 (M)	na	na	na	na	na	0.005	0.005	0.005	0.005	0.005	
MD39	Mt. Pomeroy/A5 (H)	0.0052	0.005	0.005	0.0085	0.005	0.005	0.0057	0.005	0.005	0.00922	
MD34	Carrick Island/A4 (E)	0.0058	0.005	0.005	0.00619	0.005	0.00607	0.005	0.005	0.005	0.005	
MD35	Carrick Island/A4 (M)	na	na	na	na	na	0.00698	0.005	0.005	0.005	0.005	
MD36	Carrick Island/A4 (H)	0.005	0.005	0.005	0.0141	0.005	0.00516	0.0074	0.005	0.005	0.00632	
MD40	Den Hill (E)	0.0061	0.0081	0.005	na	0.0074	0.00804	0.005	0.005	0.005	0.00733	
MD41	Den Hill (M)	0.0078	na	na	na	na	0.00804	0.0064	0.005	0.005	0.00559	
MD42	Den Hill (H)	0.0063	0.006	0.005	na	0.00875	0.00728	0.0074	0.0058	0.005	0.0124	
MD31	Leveau Island/A2 (E)	0.0079	0.005	0.005	na	0.00517	0.005	0.005	0.005	0.005	0.005	
MD32	Leveau Island/A2 (M)	b*	na	na	na	na	0.00501	0.005	0.005	0.005	0.005	
MD33	Leveau Island/A2 (H)	0.0102	0.005	0.005	na	0.00561	0.005	0.0072	0.005	0.005	0.005	

Notes: (1) values in *italic* indicate <MDL

(2) letters in **bold** represent the following anomalous (elevated) values: a* = 0.468, b* = 0.589, and e* = 0.273

(3) Notation for position of sample collection in stratified water column is as follows: E=Epilimnion, M=Metalimnion, and H=Hypolimnion

Alkalinity (mg/L as CaCO₃)

Lab #	Sampling Location	Sampling Date									
		10/05/98	11/02/98	12/09/98	01/04/99	04/09/99	05/10/99	06/14/99	07/19/99	08/12/99	09/23/99
MD28	Winsor Dam/202 (E)	2.24	2.5	2.34	2.26	2.3	1.63	2.42	na	2.64	2.68
MD29	Winsor Dam/202 (M)	1.96	na	na	na	na	2.09	2.73	na	2.72	2.24
MD30	Winsor Dam/202 (H)	1.62	a*	3.07	1.75	2.46	1.77	2.45	na	2.70	2.48
MD43	Western Arm/A6 (E)	2.25	2.63	3.07	2.26	2.17	2.76	2.58	2.73	2.82	2.52
MD44	Western Arm/A6 (M)	2.34	na	na	na	na	2.68	2.41	2.87	2.54	2.24
MD45	Western Arm/A6 (H)	2.51	2.77	2.75	2.87	2.55	2.61	2.28	2.64	2.32	2.5
MD37	Mt. Pomeroy/A5 (E)	1.92	2.4	2.71	2.79	2.54	2.54	b*	2.67	2.58	2.68
MD38	Mt. Pomeroy/A5 (M)	na	na	na	na	na	2.6	2.76	2.73	3.26	2.46
MD39	Mt. Pomeroy/A5 (H)	2.71	2.94	2.76	1.65	2.59	2.62	2.56	2.6	2.86	2.52
MD34	Carrick Island/A4 (E)	1.84	2.9	2.51	2.65	2.66	2.31	2.59	2.89	3.18	2.38
MD35	Carrick Island/A4 (M)	na	na	na	na	na	2.48	2.62	2.73	2.92	2.38
MD36	Carrick Island/A4 (H)	2.46	2.41	2.62	1.5	2.11	2.46	2.45	2.82	2.42	2.46
MD40	Den Hill (E)	1.89	3.02	2.62	na	2.44	2.34	2.79	2.93	3.00	2.76
MD41	Den Hill (M)	2.93	na	na	na	na	2.52	2.73	2.86	3.02	3.08
MD42	Den Hill (H)	2.69	2.98	2.66	na	1.92	2.34	2.78	3.04	3.28	5.04
MD31	Leveau Island/A2 (E)	1.41	3.71	2.61	na	2.42	2.34	2.58	2.57	2.72	2.76
MD32	Leveau Island/A2 (M)	2.67	na	na	na	na	2.83	2.64	2.63	2.50	2.62
MD33	Leveau Island/A2 (H)	2.11	2.97	2.6	na	2.59	2.78	2.65	3.54	3.26	2.72

Notes: (1) a* holding time exceeded

(2) b* missed sample in field

(3) Notation for position of sample collection in stratified water column is as follows: E=Epilimnion, M=Metalimnion, and H=Hypolimnion

APPENDIX B

Phytoplankton Database for 1998-99 Year of Study

SEDGEWICK-RAFTER CELL PHYTOPLANKTON COUNTS: QUABBIN RESERVOIR

Sampling Date:
5-Oct-98

Conc./Enum. Factors =

Phytoplankton Taxa

	Sample Location (composites grab @ 1 and 3 m, except MP/AS @ 3, 5, 7, and 9 m)											
	Western Arm/AS6			Mt. Penrose/AS5			Campick Is./AS4			Den Hill		
	14.96 / 167.12	Raw Count / ASU/ml	16.21 / 154.24	Raw Count / ASU/ml	29.24 / 85.51	Raw Count / ASU/ml	19.57 / 127.76	Raw Count / ASU/ml	64.46 / 38.79	Raw Count / ASU/ml	31.11 / 80.37	Raw Count / ASU/ml
Bacillariophyceae (diatoms)												
<i>Asterionella</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Cyclotella</i>	/	0.3	/	46	/	/	0.1	13	0.1	4	0.3	24
<i>Fragilaria</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Melosira</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Navicula</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Rhizosolenia</i>	/	/	/	/	/	/	/	/	/	/	0.2	16
<i>Synedra</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Tabellaria</i>	/	/	/	/	/	/	/	/	0.2	8	/	/
Chlorophyta (green algae)												
<i>Actinastrum</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Arthrodesmus</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Chlosterium</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Coelastrum</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Crucigenia</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Desmidiium</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Elakatothrix</i>	/	/	/	/	/	/	/	/	0.1	4	0.1	8
<i>Eudorina</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Gloeoxytis</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Mougeotia</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Pediastrum</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Scenedesmus</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Sinistrostrum</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Sphaerocystis</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Spirogyra</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Spondylium</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Zygnema</i>	/	/	/	/	/	/	/	/	/	/	/	/
Chrysophyta (yellow-green algae, including diatoms)												
<i>Chrysopharella</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Dinobryon</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Malmonus</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Synura</i>	/	/	/	/	/	/	/	/	/	/	/	/
Cyanophyta (blue-green algae)												
<i>Anabaena</i>	/	0.6	/	93	/	/	/	/	/	/	/	/
<i>Aphanocapsa</i>	1.0	167	0.1	15	0.6	51	1.0	128	3.3	128	/	/
<i>Chroococcus</i>	0.9	150	1.0	154	0.9	77	0.6	77	0.5	19	1.3	104
<i>Coelosphaerium</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Merismopedia</i>	0.4	67	0.8	123	0.3	26	0.3	38	0.9	35	1.7	137
<i>Microcystis</i>	0.7	117	0.9	139	0.3	26	1.1	341	3.3	128	7.4	595
<i>Oscillatoria</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Plankoderna</i>	0.2	33	0.3	46	0.5	43	0.3	33	1.5	58	0.2	36
Pyrrhophyta (dinoflagellates)												
<i>Ceratium</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>Peridinium</i>	/	/	/	/	/	/	/	/	/	/	/	/
Unidentified												
<i>flagellates</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>testate rhizopods</i>	/	/	/	/	/	/	/	/	/	/	/	/
<i>unicellular resting spores</i>	/	/	/	/	/	/	/	/	/	/	/	/
Totals =	3.2	535	4.0	617	2.6	222	3.4	434	9.9	384	11.2	900

Sampling Date:
9-Dec-98

Conclusions

Phytoplankton Taxa

[illegible]

SEDGEWICK-RAFTER CELL PHYTOPLANKTON COUNTS: QUABBIN RESERVOIR

Sampling Date: 4-Jan-99
(N/A = 12-Jan-99)
Conc./Enum. Factor =

Phytoplankton Taxa

	Sample Location (tube samples integrated to 7 m except WD202 integrated to 15 m)										CVA (mp) on 12-Jan	
	Winter Dam 202	Western Arm A6	Mt. Porter/AS	Carrick B./A4	Raw Count	ASU/ml	Raw Count	ASU/ml	Raw Count	ASU/ml	Raw Count	ASU/ml
12-Jan	201.30	14.96	17.34	11.50	11.50	11.50	11.50	11.50	11.50	11.50	17.68	141.41
Raw Count	ASU/ml	ASU/ml	ASU/ml	ASU/ml	ASU/ml	ASU/ml	ASU/ml	ASU/ml	ASU/ml	ASU/ml	ASU/ml	ASU/ml
Bacillariophyceae (diatoms)												
<i>Asterionella</i>	0.1	20	0.5	84	0.1	14	0.2	43	0.3	42		
<i>Cyclotella</i>												
<i>Fragilaria</i>												
<i>Melosira</i>												
<i>Navicula</i>												
<i>Rhizosolenia</i>	0.1	20										
<i>Synedra</i>												
<i>Tabellaria</i>					1.1	159						
Chlorophyta (green algae)												
<i>Actinastrum</i>												
<i>Arthrodesmus</i>												
<i>Chlosterium</i>												
<i>Coelastrum</i>												
<i>Crucigenia</i>												
<i>Dermidium</i>												
<i>Elakatothrix</i>	0.2	40	0.1	17								
<i>Eudorina</i>												
<i>Gloeoactis</i>												
<i>Mougeotia</i>												
<i>Pediastrum</i>	0.1	20										
<i>Scenedesmus</i>												
<i>Schroederia</i>												
<i>Sinistrostrum</i>												
<i>Sphaerocystis</i>												
<i>Spirogyra</i>												
<i>Sponchiastrium</i>												
<i>Zygnema</i>												
Chrysophyta (yellow-green algae, excluding diatoms)												
<i>Chrysophyceae</i>												
<i>Dinobryon</i>												
<i>Malomonas</i>												
<i>Synura</i>												
Cryptophyta (blue-green algae)												
<i>Anabaena</i>												
<i>Aphanocapsa</i>												
<i>Chroococcus</i>												
<i>Coelastrum</i>												
<i>Merismopodia</i>												
<i>Microcystis</i>	0.5	121	0.5	150	0.4	58	0.2	43	0.3	42		
<i>Oscillatoria</i>												
<i>Rhododermis</i>												
Peridiniaceae (Euglenidiales)												
<i>Ceratium</i>												
<i>Peridinium</i>												
Unidentified												
<i>Fluorescent</i>												
<i>testate rhizopods</i>												
<i>unicellular/retic. stages</i>												
Totals =	1.1	221	1.7	284	1.7	245	1.0	217	0.7	99		

SEDGEWICK-RAPTOR CELL PHYTOPLANKTON COUNTS: QUABBIN RESERVOIR

Sampling Date:
9-Apr-99

Cover/Enum. Factors =
Phytoplankton Taxa

	Sample Location (tube samples integrated to 8 m except WD202 integrated to 15 m)											
	Western Arm/A6			Mt. Pomroy/A5			Carrick Is./A4			Den Hill		
	Winsor Dam 202	12.27	203.76	19.56	127.82	14.75	22.62	110.53	13.62	183.57	11.16	CVA (tap)
	Raw Count / ASU/ml	Raw Count / ASU/ml	Raw Count / ASU/ml	Raw Count / ASU/ml	Raw Count / ASU/ml	Raw Count / ASU/ml	Raw Count / ASU/ml	Raw Count / ASU/ml	Raw Count / ASU/ml	Raw Count / ASU/ml	Raw Count / ASU/ml	
Bacillariophyceae (diatoms)												
<i>Achnanthes</i>	1.5	213	0.4	82	1.4	179	2.2	373	0.3	147	0.5	112
<i>Cyclotella</i>	0.3	40	0	0	0.3	38	0.1	17	0.1	11	0.1	22
<i>Fragilaria</i>												
<i>Mastogira</i>												
<i>Nitzschia</i>												
<i>Pseudo-nitzschia</i>												
<i>Synedra</i>												
<i>Tabellaria</i>												
Chlorophyta (green algae)												
<i>Actinostrum</i>												
<i>Artisanella</i>												
<i>Chlorococcum</i>												
<i>Coelastrum</i>												
<i>Cratogeomachia</i>												
<i>Denticula</i>												
<i>Elakotricha</i>												
<i>Eudorina</i>												
<i>Gloeothece</i>												
<i>Microcystis</i>												
<i>Pediastrum</i>												
<i>Scenedesmus</i>												
<i>Schroederia</i>												
<i>Synedra</i>												
<i>Sphaerocystis</i>												
<i>Spirogyra</i>												
<i>Spondylium</i>												
<i>Ulothrix</i>												
Cryptophyta (yellow-green algae, excluding diatoms)												
<i>Chrysochloris</i>												
<i>Dinobryon</i>	1.6	213	1.0	204	0.4	51	0.7	119	1.1	122	0.9	202
<i>Malomonas</i>	0.1	13										
<i>Synura</i>												
Cyanophyta (blue-green algae)												
<i>Anabaena</i>												
<i>Aphanizomenon</i>												
<i>Chroococcus</i>												
<i>Coelosphaerium</i>												
<i>Merismopedia</i>												
<i>Microcystis</i>	1.0	133	0.4	82	0.3	54	0.2	34	0.4	44	0.2	37
<i>Oscillatoria</i>												
<i>Rhododermis</i>												
Pyrrhophyta (dinoflagellates)												
<i>Ceratium</i>												
<i>Peridinium</i>	0.2	27										
Unidentified												
<i>Flagellata</i>												
<i>Isotria rhipidops</i>												
<i>Unidentified rhipidops</i>												
Total	4.8	639	2.4	489	3.6	460	4.1	695	2.8	309	2.3	515

Sampling Date: 10-Nov-99

Conc./Enum. Factors =
Phytoplankton Taxa

[illegible]

SEDEWICK-RAFTER CELL PHYTOPLANKTON COUNTS: QUABBIN RESERVOIR

Sampling Date:

14-Jun-99

CVA # 14-A-99

Cncc./Faun. Factor =

Phytoplankton Taxa

14-Jun-99

(SVA 14-99)

Cont./Faun. Factors =

Phytoplankton Taxa

	Sample Location (tube samples integrated to 15 m)										CVA (bp) on 16-June		
	Water Date 202	Western Arm/A6	Mt. Pond/A5	Carrick Is./A4	Dem Hill	Raw Count	ASU/ml	Raw Count	ASU/ml	Raw Count	ASU/ml	Raw Count	ASU/ml
	6.59 / 379.39	6.35 / 391.73	7.56 / 330.71	7.02 / 356.15	8.43 / 296.58							6.13 / 407.86	
	Raw Count / ASU/ml	Raw Count / ASU/ml	Raw Count / ASU/ml	Raw Count / ASU/ml	Raw Count / ASU/ml							Raw Count / ASU/ml	
Bacillariophyceae (diatoms)													
<i>Asterionella</i>	/ 0	/ 0	/ 0	/ 0	/ 0							/ 0	
<i>Cyclotella</i>	0.2 / 76	/ 0	/ 0	0.2 / 71	0.5 / 148					0.1 / 36		/ 0	
<i>Fragilaria</i>	/ 0	/ 0	/ 0	/ 0	/ 0					0.2 / 73		/ 0	
<i>Melosira</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Navicula</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Rhizosolenia</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Synedra</i>	/ 0	/ 0	/ 0	/ 0	0.1 / 30					0.2 / 73		0.1 / 41	
<i>Tubellaria</i>	0.6 / 228	/ 0	/ 0	/ 0	0.6 / 178					/ 0		/ 0	
Chlorophyta (green algae)													
<i>Actinocyclus</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Actinodiscus</i>	0.2 / 76	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Chloridium</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Coelastrum</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Coscinodiscus</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Denticula</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Ellakiastris</i>	/ 0	0.1 / 39	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Eudorina</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Gloeothece</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Mougeotia</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Pediastrum</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Scenedesmus</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Schroederia</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Staurastrum</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Sphaerocystis</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Spirogyra</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Spondylium</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Zyema</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
Cryptophyta (yellow-green algae, excluding Rhodospirillum rubrum)													
<i>Chlorococcoides</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Chlorococcus</i>	/ 0	0.1 / 39	/ 0	0.2 / 71	/ 0					/ 0		/ 0	
<i>Malmonetes</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Synechococcus</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
Cyanophyta (blue-green algae)													
<i>Anabaena</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Apicomplexa</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Chroococcus</i>	/ 0	/ 0	0.2 / 66	/ 0	/ 0					/ 0		0.2 / 82	
<i>Coelastrum</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Merismopedia</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Microcystis</i>	/ 0	0.3 / 118	/ 0	0.2 / 71	0.4 / 119					0.3 / 109		/ 0	
<i>Oscillatoria</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Rhododermis</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
Pyrenophyta (dinoflagellates)													
<i>Ceratium</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Peridinium</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
Unidentified													
<i>Flagellata</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Isotriche rhabdoids</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
<i>Unidentified/retaining stages</i>	/ 0	/ 0	/ 0	/ 0	/ 0					/ 0		/ 0	
Total =	1.0 / 379	0.5 / 197	0.2 / 66	0.6 / 214	1.6 / 475					0.8 / 290		0.3 / 122	

19-Jul-99

Concrete Facts

Concrete Facts

Phytoplankton Taxa

[illegible]

SEDGEWICK-RAPIER CELL PHYTOPLANKTON COUNTS: QUABBIN RESERVOIR

Sampling Date: 11-Aug-99

Conc. From Factors =
Phytoplankton Taxa

	Sample Location (tube samples integrated to 15 m)				Den Hill				Lewau Is./A2			
	Winsor Dam/202	Western Arm/A5	MT. Pomeroy/A5	Carrick Is./A4	Raw Count	ASU/ml	Raw Count	ASU/ml	Raw Count	ASU/ml	Raw Count	ASU/ml
	7.75 / 322.60	7.12 / 351.15	5.99 / 417.39	9.09 / 275.05	6.98 / 358.19	7.65 / 326.82						
	Raw Count / ASU/ml	Raw Count / ASU/ml	Raw Count / ASU/ml	Raw Count / ASU/ml	Raw Count / ASU/ml	Raw Count / ASU/ml						
Bacillariophyceae (diatoms)												
<i>Asterionella</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Cyclotella</i>	1 0	0.1 / 35	1 0	1 0	1 0	1 0						
<i>Fragilaria</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Melosira</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Navicula</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Rhizosolenia</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Synedra</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Tabellaria</i>	0.2 / 65	1 0	1 0	1 0	1 0	1 0						
Chlorophyta (green algae)												
<i>Actinastrum</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Arthroderma</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Closterium</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Coelastrum</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Crucigenia</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Damodiscum</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Elaktonothrix</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Eudorina</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Gleocoryia</i>	1 0	0.5 / 176	1 0	1 0	0.2 / 72	0.1 / 33						
<i>Mougeotia</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Pediastrum</i>	1 0	1 0	1 0	0.1 / 28	1 0	1 0						
<i>Scenedesmus</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Sphaerodictyon</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Staurastrum</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Sphaerocystis</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Spirogyra</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Spondylium</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Zygnema</i>	1 0	1 0	1 0	1 0	1 0	1 0						
Charophyta (yellow-green algae, excluding charitum)												
<i>Chrysopharrella</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Diacydon</i>	0.1 / 32	0.2 / 70	1 0	0.1 / 28	1 0	0.1 / 33						
<i>Melomonas</i>	1 0	0.1 / 35	1 0	1 0	1 0	1 0						
<i>Synura</i>	1 0	1 0	1 0	1 0	1 0	1 0						
Cyanophyta (blue-green algae)												
<i>Microcystis</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Aphanocapsa</i>	1 0	1 0	1 0	0.6 / 165	1 0	1 0						
<i>Chroococcus</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Coelastrum</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Merionisma</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Microcystis</i>	0.8 / 258	0.5 / 176	0.4 / 167	0.4 / 110	0.5 / 179	0.7 / 229						
<i>Ocellularia</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Rhabdoderma</i>	1 0	1 0	1 0	1 0	1 0	1 0						
Prasinophyta (dinoflagellates)												
<i>Ceratium</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>Peridinium</i>	1 0	1 0	1 0	1 0	1 0	1 0						
Unidentified												
<i>flagellates</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>testate rhizopods</i>	1 0	1 0	1 0	1 0	1 0	1 0						
<i>unicellular resting stages</i>	1 0	1 0	1 0	1 0	1 0	1 0						
Totals =	1.1 / 355	1.4 / 492	0.4 / 167	1.2 / 330	1.0 / 358	1.1 / 360						

SEDGWICK-RAFTER CELL PHYTOPLANKTON COUNTS: QUABEN RESERVOIR

Sampling Date:

21-Sep-99

Conc. Foun. Factors =

Phytoplankton Taxa

21 Sep 99

Conc. (num. Facies =

Phytoplankton Taxa

Phytoplankton Taxa	Sample Location (tube samples integrated to 15 m)											
	Wasser Dam/202		Western Arm/A6		Mt. Pomeroy/A5		Carrick Is./A4		Den Hill		Levee 1B/A2	
	Raw Count	ASU/ml	Raw Count	ASU/ml	Raw Count	ASU/ml	Raw Count	ASU/ml	Raw Count	ASU/ml	Raw Count	ASU/ml
Bacillariophyceae (diatoms)												
<i>Asterionella</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cyclotella</i>	0.1	39	0	0	0	0	0	0	0.1	38	0.1	36
<i>Fragilaria</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Melosira</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Nitzschia</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Rhizosolenia</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Synedra</i>	0	0	0	0	0.1	40	0	0	0	0	0	0
<i>Tubellaria</i>	0	0	0	0	0	0	0	0	0	0	0	0
Chlorophyta (green algae)												
<i>Actinastrum</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Arthroderma</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Chlorella</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Coelastrum</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cryptomonas</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Dunaliella</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Elakotobrix</i>	0	0	0	0	0	0	0	0	0.1	38	0	0
<i>Eudorina</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gloeothece</i>	0	0	0	0	0.2	81	0	0	0.1	38	0	0
<i>Mongosia</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Pediastrum</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Scolecococcus</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Schmidia</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Spirulina</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Sphaerocystis</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Sporocystis</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Staurastrum</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Synedra</i>	0	0	0	0	0	0	0	0	0	0	0	0
Cryptophyta (yellow-green algae, excluding diatoms)												
<i>Chrysophyta</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Dinobryon</i>	0	0	0.1	37	0.1	40	0	0	0	0	0.1	36
<i>Malmonas</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Synedra</i>	0	0	0	0	0	0	0	0	0	0	0	0
Cyanophyta (blue-green algae)												
<i>Anabaena</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Aphanizomenon</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Chroococcus</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Coelastrum</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Merismopedia</i>	0	0	0	0	0	0	0.1	38	0	0	0	0
<i>Microcystis</i>	0.1	39	0.2	75	0.1	40	0.1	38	0.4	152	0.1	36
<i>Oscillatoria</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Phaeodactylum</i>	0	0	0	0	0	0	0	0	0	0	0	0
Pyrenophyta (dinoflagellates)												
<i>Ceratium</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Peridinium</i>	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified												
<i>Daphnia</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Infusoria</i>	0	0	0	0	0	0	0.1	38	0	0	0	0
<i>Unidentified/retina stages</i>	0	0	0	0	0	0	0	0	0	0	0	0
Totals =	0.2	78	0.3	112	0.5	201	0.3	114	0.7	267	0.3	109

APPENDIX C

Summary of Data from Historical Studies (Tighe & Bond, 1988 and DEP/MDC, 1990)

Tighe & Bond Report, Volumes 1 and 2 (1988)
Ammonia

(surface grabs; results reported in mg/L)

Sampling Location	Sampling Date (Volume 1)							Sampling Date (Volume 2)							Med.	Ave.	Max.
	5/29/86	6/17/86	7/15/86	8/13/86	9/23/86	10/8/86	4/29/87	5/14/87	6/24/87	7/16/87	8/17/87	9/16/87	10/29/87	5/2/88			
Station 3403 (~Den Hill)	0.04	0.04	0.01	0.05	0.03	0.05	0.09	0.04	0.07	0.05	0.07	0.04	0.05	0.03	0.05	0.05	0.09
Station 3404 (~A5)	0.03	0.04	0.02	0.04	0.09	0.09	0.09	0.07	0.07	0.05	0.07	0.04	0.03	0.02	0.05	0.05	0.07
Station 3405 (Sheet 12/206)	0.04	0.03	0.01	0.02	0.08	0.03	0.08	0.05	0.08	0.07	0.05	0.03	0.05	0.01	0.05	0.05	0.08
Station 3406 (~WA/A6)	0.04	0.03	0.03	0.16	0.08	0.03	0.07	0.03	0.05	0.06	0.06	0.03	0.04	0.04	0.04	0.05	0.16
Station 3407 (~MP/A5)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.04	NA	NA	NA

Tighe & Bond Report, Volumes 1 and 2 (1988)
Nitrate plus Nitrite
(surface grabs; results reported in mg/L)

Sampling Location	Sampling Date (Volume 1)										Sampling Date (Volume 2)										Med.	Ave.	Max.
	5/29/86	6/17/86	7/15/86	8/13/86	9/23/86	10/8/86	4/29/87	5/14/87	6/24/87	7/16/87	8/17/87	9/16/87	10/29/87	5/2/88									
Station 3403 (~Den Hill)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.04	0.04	0.04	0.05	0.04	0.05	0.04	0.05	0.04	0.04	0.06				
Station 3404 (~A3)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.04	0.04	0.04	0.05	0.04	0.05	0.04	0.05	0.04	0.04	0.06				
Station 3405 (Shaft 12/206)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.07	0.04	0.04	0.04	0.05	0.04	0.05	0.04	0.05	0.04	0.04	0.07				
Station 3406 (~WA/A6)	0.04	0.04	0.04	0.14	0.04	0.04	0.04	0.07	0.04	0.04	0.04	0.05	0.04	0.05	0.04	0.05	0.04	0.05	0.14				
Station 3407 (~MP/A5)	DA	DA	DA	DA	DA	DA	DA	DA	DA	DA	DA	DA	DA	DA	DA	DA	DA	DA	DA				

Note: (1) Values in *italic* indicate <MDL

Tighe & Bond Report, Volumes 1 and 2 (1988)
 Total Phosphorus
 (surface grabs; results reported in mg/L)

Sampling Location	Sampling Date (Volume 1)							Sampling Date (Volume 2)							Med	Ave	Max
	5/29/86	6/17/86	7/15/86	8/13/86	9/23/86	10/23/86	4/29/87	5/14/87	6/24/87	7/16/87	8/17/87	9/16/87	10/29/87	5/2/88			
Station 3403 (~Den Hill)	0.006	0.010	0.008	0.009	0.017	0.018	0.012	0.012	0.019	0.011	0.013	0.012	0.020	0.024	0.012	0.014	0.024
Station 3404 (~A3)	0.006	0.011	0.009	0.015	0.008	0.017	0.010	0.008	0.013	0.023	0.012	0.018	0.023	0.023	0.013	0.014	0.023
Station 3405 (Shad12/206)	0.007	0.010	0.012	0.006	0.013	0.016	0.006	0.009	0.009	0.018	0.010	0.012	0.021	0.023	0.011	0.012	0.023
Station 3406 (~W/A/A6)	0.006	0.012	0.011	0.006	0.009	0.019	0.010	0.007	0.015	0.019	0.011	0.015	0.020	0.024	0.012	0.013	0.024
Station 3407 (~MP/A5)	na	na	na	na	na	na	na	na	na	na	na	na	na	0.025	na	na	na
Station 3416 (WD/202)	na	na	na	0.005	0.014	0.012	0.005	0.007	0.008	0.013	0.010	0.016	0.023	0.018	0.012	0.012	0.023

(surface grabs; results reported in mg/L as CaCO_3)

Sampling Location	Sampling Date (Volume 1)						Sampling Date (Volume 2)						Med.	Ave.	Max.
	5/29/86	6/17/86	7/15/86	8/13/86	9/23/86	10/8/86	4/29/87	5/14/87	6/24/87	7/16/87	8/17/87	9/16/87			
Station 3403 (~Den Hill)	4	4	3.5	3	4	3	1	2	3	2	2	3	6	3	
Station 3404 (~A3)	5	3	3.5	3.5	4	4	2	2	3	2	4	2	6	4	
Station 3405 (Shaf12/206)	4	4	3	3	3.5	3	2	2	3	2	2	3	6	3	
Station 3406 (~WA/A6)	5	3.5	3	4	3.5	3.5	4	2	3	2	1	4	4	4	

Tighe & Bond Report, Volumes 1 and 2 (1988)

Total Phytoplankton

(from 10-foot vertical haul with 80 micron net; measurements reported in ASUs/ml)

Sampling Location	Sampling Date (Volume 1)												Sampling Date (Volume 2)				Med.	Ave.	Max.
	5/29/86	6/17/86	7/15/86	8/13/86	9/23/86	10/8/86	4/29/87	5/14/87	6/24/87	7/16/87	8/17/87	9/16/87	10/29/87						
Station 3403 (~Dea Hill)	6.8	118.3	39.9	4.9	2.7	20.0	36.3	115.2	302.9	111.3	5.0	0.6	6.5	20.0	59.3	302.9			
Station 3404 (~A3)	39.1	96.4	2.9	3.3	2.6	14.1	21.8	60.4	374.5	na	1.4	34.1	6.2	18.0	54.7	374.5			
Station 3405 (Shaft 12/206)	21.0	103.2	10.9	0.8	11.7	28.7	22.6	90.5	78.1	27.7	1.2	5.5	108.5	22.6	39.3	108.5			
Station 3406 (~WA/A6)	4.0	54.5	2.9	1.0	32.7	127.6	24.6	8.2	<0.1	0.8	7.5	1.5	120.4	7.9	32.1	127.6			

Tight & Bond Report, Volumes 1 and 2 (1988)
 Secchi Transparency
 (measurements reported in feet)

Sampling Location	Sampling Date (Volume 1)								Sampling Date (Volume 2)								Med.	Ave.	Max
	5/29/86	6/17/86	7/15/86	8/13/86	9/23/86	10/8/86	4/29/87	5/14/87	6/24/87	7/16/87	8/17/87	9/16/87	10/29/87	5/2/88					
Station 3403 (~Den Hill)	21.0	16.7	21.9	22.3	20.8	15.2	11.2	10.2	16.9	21.3	21.4	21.4	17.6	12.6			19.2	17.9	22.3
Station 3404 (~A3)	27.0	22.2	22.0	38.7	23.4	18.6	19.5	17.2	21.7	24.7	25.3	26.3	22.6	16.0			22.4	23.2	38.7
Station 3405 (Shaft 12/206)	33.0	26.4	30.3	38.7	34.2	28.4	24.2	23.7	29.6	31.8	32.8	28.4	19.2	20.7			29.0	28.7	38.7
Station 3406 (~WA/A6)	32.0	21.4	23.4	42.0	34.8	25.8	22.5	24.2	29.3	32.5	31.6	31.2	24.8	18.2			27.6	28.1	42.0

DEP/MDC Report (1990)

Ammonia

(results reported in mg/L; values in italix are <MDL of 0.02 mg/L)

Sampling Location		Sampling Date								Med.	Ave.	Max.
		4/19/89	5/18/89	6/14/89	7/19/89	8/16/89	9/21/89	10/25/89	11/15/89			
Station 01 (=WD/202)	surface	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	6-10m			0.02	0.02	0.02	0.02			0.02	0.02	0.02
	12-17m			0.02	0.02	0.02	0.02			0.02	0.02	0.02
	bottom	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.02	0.02	0.03
Station 02 (=WA/A6)	surface	0.02	0.02	0.02	0.02	0.02	0.02	0.02		0.02	0.02	0.02
	7-10m			0.02	0.02	0.02	0.02			0.02	0.02	0.02
	12-18m			0.02	0.02	0.02	0.02			0.02	0.02	0.02
	bottom	0.02	0.02	0.02	0.02	0.02	0.04	0.03		0.02	0.02	0.04
Station 03 (=Atherton)	surface	0.02	0.02	0.04	0.02	0.02	0.02	0.02		0.02	0.02	0.04
	7-10m			0.02	0.02	0.02	0.02			0.02	0.02	0.02
	13-17m				0.02	0.02	0.02			0.02	0.02	0.02
	bottom	0.02	0.02	0.02	0.02	0.02	0.02	0.02		0.02	0.02	0.02
Station 04 (Enfield Ch.)	surface	0.02	0.02	0.02	0.02	0.02	0.02	0.02		0.02	0.02	0.02
	6-10m			0.02	0.02	0.02	0.02			0.02	0.02	0.02
	13-17m			0.03	0.02	0.02	0.02			0.02	0.02	0.03
	bottom	0.02	0.02	0.02	0.03	0.02	0.02	0.03		0.02	0.02	0.03
Station 05	surface	0.02								na	na	na
	bottom	0.02								na	na	na
Station 06 (=MP/A5)	surface	0.02	0.02	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.04
	7-11m			0.02	0.02	0.02	0.02			0.02	0.02	0.02
	11-18m			0.02	0.02	0.02	0.02			0.02	0.02	0.02
	bottom	0.02	0.02	0.07	0.02	0.02	0.04	0.02	0.02	0.02	0.03	0.07
Station 07 (=CI/A4)	surface		0.02	0.02	0.02	0.02	0.02	0.02		0.02	0.02	0.02
	7-11m			0.02	0.02	0.02	0.02			0.02	0.02	0.02
	11-16m			0.03	0.02	0.02	0.02			0.02	0.02	0.03
	bottom		0.02	0.02	0.02	0.02	0.03	0.02		0.02	0.02	0.03
Station 08	surface	0.02								na	na	na
	bottom	0.02								na	na	na
Station 09 (=LI/A2)	surface		0.02	0.02	0.02	0.02	0.02	0.02		0.02	0.02	0.02
	7-10m			0.02	0.02	0.02	0.02			0.02	0.02	0.02
	11m			0.03						na	na	na
	bottom		0.02	0.04	0.02	0.03	0.02	0.02		0.02	0.03	0.04
Station 10 (=Den Hill)	surface	0.02	0.02	0.02	0.02	0.02	0.02	0.02		0.02	0.02	0.02
	6-9m			0.05	0.02	0.02	0.02			0.02	0.03	0.05
	11-13m			0.03	0.05	0.06		0.02		0.04	0.04	0.06
	bottom	0.02	0.02	0.04	0.02	0.02	0.02	0.02		0.02	0.02	0.04

DEP/MDC Report (1990)

Nitrate

(results reported in mg/L; values in italix are <MDL of 0.02 mg/L)

Sampling Location		Sampling Date								Med.	Ave.	Max.
		4/19/89	5/18/89	6/14/89	7/19/89	8/16/89	9/21/89	10/25/89	11/15/89			
Station 01 (=WD/202)	surface	0.02	0.02	0.02	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03
	6-10m			0.02	0.02	0.02	0.02			0.02	0.02	0.02
	12-17m			0.03	0.02	0.02	0.02			0.02	0.02	0.03
	bottom	0.02	0.03	0.02	0.04	0.02	0.04	0.04	0.07	0.04	0.04	0.07
Station 02 (=WA/A6)	surface	0.02	0.02	0.02	0.03	0.02	0.02	0.03		0.02	0.02	0.03
	7-10m			0.02	0.03	0.02	0.02			0.02	0.02	0.03
	12-18m			0.02	0.02	0.02	0.02			0.02	0.02	0.02
	bottom	0.02	0.02	0.03	0.03	0.02	0.03	0.03		0.03	0.03	0.03
Station 03 (=Atherton)	surface	0.02	0.02	0.05	0.02	0.02	0.02	0.02		0.02	0.02	0.05
	7-10m			0.02	0.02	0.02	0.02			0.02	0.02	0.02
	13-17m				0.03	0.03	0.02			0.03	0.03	0.03
	bottom	0.02	0.02	0.03	0.03	0.02	0.02	0.02		0.02	0.02	0.03
Station 04 (Enfield Ch.)	surface	0.02	0.02	0.02	0.02	0.02	0.02	0.03		0.02	0.02	0.03
	6-10m			0.02	0.02	0.02	0.02			0.02	0.02	0.02
	13-17m			0.07	0.02	0.03	0.02			0.03	0.04	0.07
	bottom	0.03	0.02	0.02	na	0.02	0.02	0.05		0.02	0.03	0.05
Station 05	surface	0.03								na	na	na
	bottom	0.03								na	na	na
Station 06 (=MP/A5)	surface	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.05	0.02	0.03	0.05
	7-11m			0.02	0.02	0.02	0.02			0.02	0.02	0.02
	11-18m			0.02	0.02	0.02	0.02			0.02	0.02	0.02
	bottom	0.02	0.02	0.05	0.02	0.02	0.03	0.03	0.04	0.03	0.03	0.05
Station 07 (=CI/A4)	surface		0.02	0.02	0.02	0.02	0.08	0.03		0.02	0.03	0.08
	7-11m			0.02	0.02	0.02	0.02			0.02	0.02	0.02
	11-16m			0.03	0.02	0.02	0.03			0.03	0.03	0.03
	bottom		0.02	0.02	0.02	0.03	0.03	0.02		0.02	0.02	0.03
Station 08	surface	0.03								na	na	na
	bottom	0.02								na	na	na
Station 09 (=LI/A2)	surface		0.02	0.02	0.02	0.02	0.02	0.07		0.02	0.03	0.07
	7-10m			0.02	0.02	0.02	0.02			0.02	0.02	0.02
	11m			0.04						na	na	na
	bottom		0.02	0.05	0.02	0.06	0.03	0.03		0.03	0.04	0.06
Station 10 (=Den Hill)	surface	0.07	0.03	0.02	0.02	0.28	0.02	0.05		0.03	0.07	0.28
	6-9m			0.02	0.04	0.02	0.02			0.02	0.03	0.04
	11-13m			0.04	0.06	0.05		0.03		0.05	0.05	0.06
	bottom	0.06	0.07	0.06	0.02	0.11	0.09	0.02		0.06	0.06	0.11

DEP/MDC Report (1990)

Total Kjeldahl-Nitrogen

(results reported in mg/L; values in italix are <MDL of 0.03 mg/L)

Sampling Location		Sampling Date								Med.	Ave.	Max.
		4/19/89	5/18/89	6/14/89	7/19/89	8/16/89	9/21/89	10/25/89	11/15/89			
Station 01 (=WD/202)	surface	0.08	0.21	0.48	0.21	0.26	0.43	0.22	0.48	0.24	0.30	0.48
	6-10m			0.39	0.21	0.32	0.23			0.28	0.29	0.39
	12-17m			0.42	0.28	0.19	0.34			0.31	0.31	0.42
	bottom	0.08	0.28	0.41	0.22	0.06	0.30	0.29	0.49	0.29	0.27	0.49
Station 02 (=WA/A6)	surface	0.03	0.28	0.39	0.20	0.47	0.36	0.18		0.28	0.27	0.47
	7-10m			0.45	0.21	0.15	0.38			0.30	0.30	0.45
	12-18m			0.31	0.27	0.22	0.19			0.25	0.25	0.31
	bottom	0.06	0.25	0.27	0.21	0.18	0.25	0.07		0.21	0.18	0.27
Station 03 (=Atherton)	surface	0.03	0.23	0.42	0.21	0.20	0.26	0.08		0.21	0.20	0.42
	7-10m			0.36	0.22	0.16	0.29			0.26	0.26	0.36
	13-17m				0.20	0.25	0.23			0.23	0.23	0.25
	bottom	0.40	0.20	0.49	0.23	0.45	0.25	0.09		0.25	0.30	0.49
Station 04 (Enfield Ch.)	surface	0.09	0.46	0.31	0.20	0.33	0.22	0.08		0.22	0.24	0.46
	6-10m			0.65	0.21	0.45	0.34			0.40	0.41	0.65
	13-17m			0.44	0.23	0.54	0.25			0.35	0.37	0.54
	bottom	0.11	0.27	0.48	0.23	0.29	0.23	0.10		0.23	0.24	0.48
Station 05	surface	0.07								na	na	na
	bottom	0.15								na	na	na
Station 06 (=MP/A5)	surface	0.03	0.26	0.51	0.27	0.99	0.27	0.09	0.21	0.27	0.33	0.99
	7-11m			0.43	0.23	0.40	0.20			0.32	0.32	0.43
	11-18m			0.39	0.29	0.59	0.20			0.34	0.37	0.59
	bottom	0.03	0.45	0.35	0.41	0.37	0.26	0.11	0.35	0.35	0.29	0.45
Station 07 (=CI/A4)	surface		0.13	0.47	0.26	0.60	0.23	0.06		0.25	0.29	0.60
	7-11m			0.40	0.40	0.37	0.31			0.39	0.37	0.40
	11-16m			0.43	0.37	0.44	0.30			0.40	0.39	0.44
	bottom		0.18	0.45	0.26	0.57	0.23	0.12		0.25	0.30	0.57
Station 08	surface	0.04								na	na	na
	bottom	0.03								na	na	na
Station 09 (=LI/A2)	surface		0.31	1.10	0.35	0.29	0.25	0.08		0.30	0.40	1.10
	7-10m			0.53	0.50	0.26	0.30			0.40	0.40	0.53
	11m			0.42						na	na	na
	bottom		0.43	0.41	0.56	0.50	0.22	0.12		0.42	0.37	0.56
Station 10 (=Den Hill)	surface	0.16	1.80	1.10	0.25	0.51	0.30	0.10		0.30	0.60	1.80
	6-9m			0.58	0.50	0.58	0.32			0.54	0.50	0.58
	11-13m			0.72	0.30	0.40		0.13		0.35	0.39	0.72
	bottom	0.03	0.41	0.67	0.60	0.27	0.15	0.16		0.27	0.33	0.67

DEP/MDC Report (1990)

Total Phosphorus

(results reported in mg/L; values in italix are <MDL of 0.005 mg/L)

Sampling Location		Sampling Date								Med.	Ave.	Max.
		4/19/89	5/18/89	6/14/89	7/19/89	8/16/89	9/21/89	10/25/89	11/15/89			
Station 01 (=WD/202)	surface	0.005	0.005	0.005	0.005	0.005	0.017	0.005	0.005	0.005	0.007	0.017
	6-10m			0.005	0.005	0.005	0.010			0.005	0.006	0.010
	12-17m			0.006	0.005	0.005	0.012			0.006	0.007	0.012
	bottom	0.004	0.005	0.005	0.005	0.005	0.012	0.005	0.005	0.005	0.006	0.012
Station 02 (~WA/A6)	surface	0.002	0.005	0.005	0.005	0.005	0.007	0.005		0.005	0.005	0.007
	7-10m			0.007	0.005	0.005	0.006			0.006	0.006	0.007
	12-18m			0.007	0.005	0.005	0.006			0.006	0.006	0.007
	bottom	0.003	0.005	0.006	0.005	0.005	0.010	0.005		0.005	0.006	0.010
Station 03 (~Atherton)	surface	0.002	0.005	0.005	0.005	0.005	0.006	0.005		0.005	0.005	0.006
	7-10m			0.005	0.010	0.005	0.008			0.007	0.007	0.010
	13-17m				0.006	0.005	0.024			0.006	0.012	0.024
	bottom	0.005	0.009	0.005	0.005	0.005	0.018	0.005		0.005	0.007	0.018
Station 04 (Enfield Ch.)	surface	0.004	0.005	0.005	0.005	0.005	0.007	0.006		0.005	0.005	0.007
	6-10m			0.006	0.005	0.009	0.010			0.008	0.008	0.010
	13-17m			0.005	0.006	0.005	0.008			0.006	0.006	0.008
	bottom	0.004	0.006	0.005	0.005	0.009	0.010	0.006		0.006	0.006	0.010
Station 05	surface	0.005								na	na	na
	bottom	0.005								na	na	na
Station 06 (~MP/A5)	surface	0.002	0.005	0.006	0.005	0.005	0.011	0.007	0.005	0.005	0.006	0.011
	7-11m			0.005	0.005	0.005	0.007			0.005	0.006	0.007
	11-18m			0.005	0.009	0.009	0.011			0.009	0.009	0.011
	bottom	0.003	0.007	0.005	0.007	0.005	0.008	0.007	0.005	0.006	0.006	0.008
Station 07 (=CVA4)	surface		0.010	0.005	0.005	0.005	0.008	0.007		0.006	0.007	0.010
	7-11m			0.005	0.008	0.005	0.008			0.007	0.007	0.008
	11-16m			0.005	0.009	0.021	0.010			0.010	0.011	0.021
	bottom		0.007	0.005	0.005	0.005	0.011	0.006		0.006	0.007	0.011
Station 08	surface	0.004								na	na	na
	bottom	0.004								na	na	na
Station 09 (~LV/A2)	surface		0.005	0.010	0.006	0.005	0.011	0.007		0.007	0.007	0.011
	7-10m			0.010	0.005	0.005	0.014			0.008	0.009	0.014
	11m			0.007						na	na	na
	bottom		0.007	0.007	0.005	0.005	0.016	0.008		0.007	0.008	0.016
Station 10 (=Den Hill)	surface	0.010	0.011	0.011	0.009	0.005	0.012	0.010		0.010	0.010	0.012
	6-9m			0.015	0.019	0.008	0.016			0.016	0.015	0.019
	11-13m			0.011	0.006	0.005		0.018		0.009	0.010	0.018
	bottom	0.007	0.014	0.010	0.007	0.005	0.032	0.015		0.010	0.013	0.032

DEP/MDC Report (1990)

Alkalinity

(results reported in mg/L as CaCO₃)

Sampling Location		Sampling Date								Med.	Ave.	Max.
		4/19/89	5/18/89	6/14/89	7/19/89	8/16/89	9/21/89	10/25/89	11/15/89			
Station 01 (=WD/202)	surface	3.7	3.2	3.4	3.5	3.3	3.5	3.6	3.9	3.5	3.5	3.9
	6-10m			3.5	3.6	3.0	3.5			3.5	3.4	3.6
	12-17m			3.6	3.6	2.7	3.5			3.6	3.4	3.6
	bottom	3.6	3.3	3.6	3.7	2.8	3.7	3.8	4.1	3.7	3.6	4.1
Station 02 (~WA/A6)	surface	9.0	3.1	3.5	3.5	3.0	3.5	3.4		3.5	4.1	9.0
	7-10m			3.4	3.5	3.2	3.5			3.5	3.4	3.5
	12-18m			3.5	3.6	3.4	3.6			3.6	3.5	3.6
	bottom	8.0	3.3	3.6	3.6	3.5	4.0	3.7		3.6	4.2	8.0
Station 03 (~Atherton)	surface	3.0	2.8	3.5	3.6	3.4	3.5	3.4		3.4	3.3	3.6
	7-10m			3.4	3.6	3.4	3.6			3.5	3.5	3.6
	13-17m				3.7	3.5	4.0			3.7	3.7	4.0
	bottom	3.1	3.1	3.6	3.6	3.7	3.9	3.6		3.6	3.5	3.9
Station 04 (Enfield Ch.)	surface	3.6	3.3	3.5	3.6	3.3	3.6	3.6		3.6	3.5	3.6
	6-10m			3.6	3.6	3.4	3.6			3.6	3.6	3.6
	13-17m			3.7	3.7	3.6	3.7			3.7	3.7	3.7
	bottom	3.6	3.4	3.7	3.7	3.8	3.8	3.5		3.7	3.6	3.8
Station 05	surface	3.7								na	na	na
	bottom	3.8								na	na	na
Station 06 (~MP/A5)	surface	3.8	3.2	3.5	3.1	3.5	3.2	3.6	3.4	3.5	3.4	3.8
	7-11m			3.5	3.5	3.6	3.3			3.5	3.5	3.6
	11-18m			3.7	3.6	3.9	3.8			3.8	3.8	3.9
	bottom	3.8	3.3	3.8	3.9	4.0	4.2	4.0	3.9	3.9	3.9	4.2
Station 07 (=CVA4)	surface		3.4	3.6	3.8	3.6	3.7	4.0		3.7	3.7	4.0
	7-11m			3.7	3.7	3.7	3.8			3.7	3.7	3.8
	11-16m			3.8	3.7	4.1	4.3			4.0	4.0	4.3
	bottom		3.4	3.8	3.9	4.0	4.3	4.0		4.0	3.9	4.3
Station 08	surface	4.0								na	na	na
	bottom	3.9								na	na	na
Station 09 (~LJA2)	surface		3.3	3.7	3.8	3.9	3.8	4.4		3.8	3.8	4.4
	7-10m			3.7	3.7	3.6	3.8			3.7	3.7	3.8
	11m			3.7						na	na	na
	bottom		3.4	3.8	3.9	4.2	3.9	4.4		3.9	3.9	4.4
Station 10 (=Den Hill)	surface	3.7	3.0	3.8	3.9	4.1	4.2	4.6		3.9	3.9	4.6
	6-9m			3.8	3.8	5.4	4.2			4.0	4.3	5.4
	11-13m			3.7	4.0	4.7		4.3		4.2	4.2	4.7
	bottom	3.7	3.3	3.8	3.9	4.2	4.4	3.6		3.8	3.8	4.4

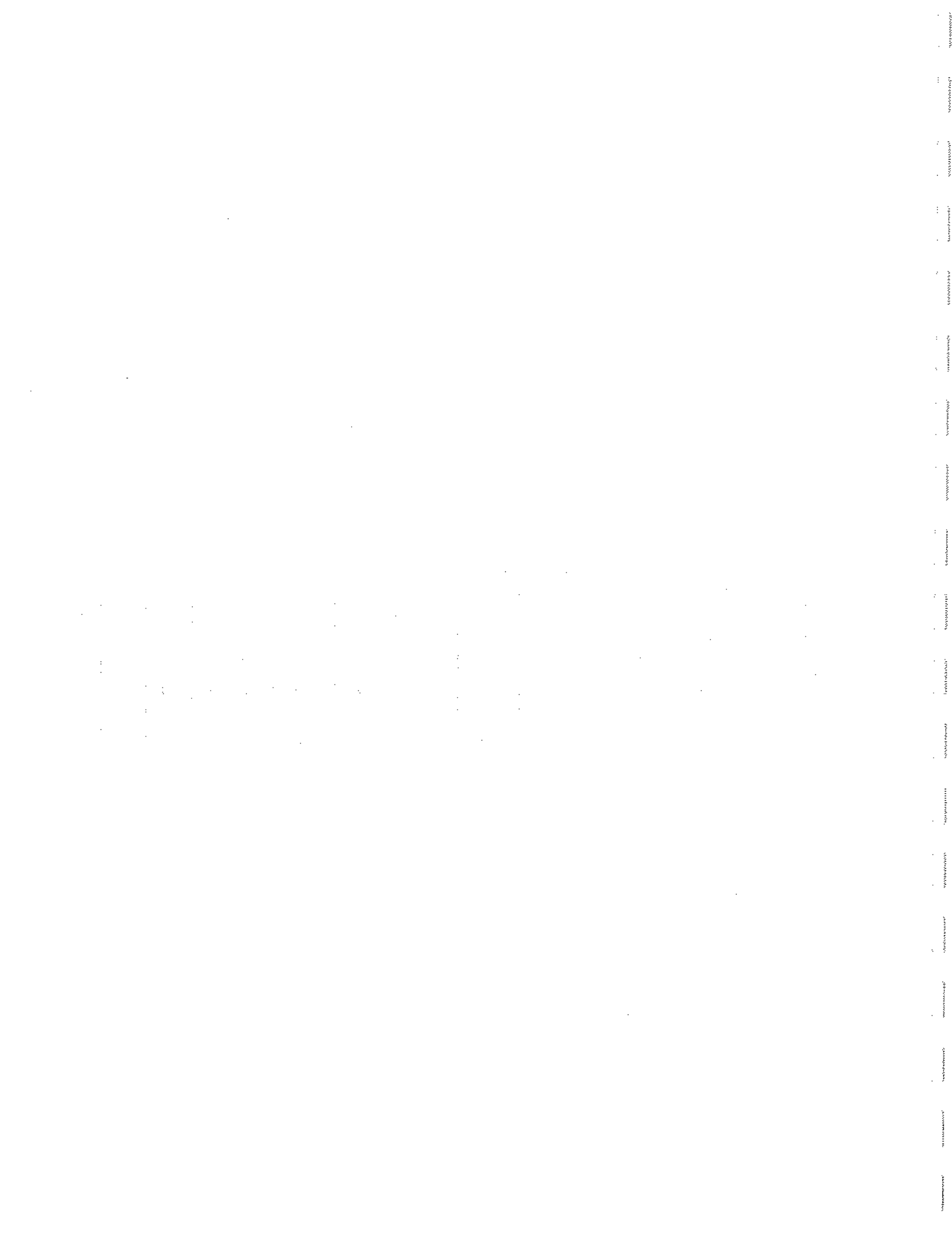
DEP/MDC Report (1990)
Total Phytoplankton
(results reported in ASUs/ml)

Sampling Location	Sampling Date							
	4/19/89	5/18/89	6/14/89	7/19/89	8/16/89	9/21/89	10/25/89	11/15/89
Station 01 (=WD/202)	146.8	157.3	97.9*	na	21.6 (g @ 8)	na	na	91.7
Station 02 (~WA/A6)	213.7	150.7	na	na	na	103 (g @ 12.5)	na	na
Station 03 (~Atherton)	210.7	129.2	na	na	na	na	na	na
Station 04 (Enfield Ch.)	194.1	116.3	na	na	na	na	na	na
Station 05	188.4	na	na	na	na	na	na	na
Station 06 (~MP/A5)	209.8	175.2	300.2*	na	91.7*	103.1*	114.3*	194.2*
Station 07 (=CI/A4)	na	260.1	386.9*	na	na	na	na	na
Station 08	183.2	na	na	na	na	na	na	na
Station 09 (~LU/A2)	na	110.6	na	na	na	na	na	na
Station 10 (=Den Hill)	92.1	66.4	302.6 (g @ 0.5)	na	na	na	na	na

- Notes:
- (1) all samples are composites (composed of grabs at various depths) unless otherwise indicated
 - (2) values marked with an asterisk are an average of totals from multiple discrete grab samples at various depths
 - (3) values marked (g) are discrete grab samples collected at the depth noted (in meters)

DEP/MDC Report (1990)
Secchi Transparency
 (results reported in meters)

Sampling Location	Sampling Date								Med.	Ave.	Max.
	4/19/89	5/18/89	6/14/89	7/19/89	8/16/89	9/21/89	10/25/89	11/15/89			
Station 01 (=WD/202)	8.3	8.0	8.3	8.6	9.8	10.1	9.0	8.5	8.6	8.8	10.1
Station 02 (~WA/A6)	9.5	9.0	8.0	9.6	9.7	9.3	10.0	na	9.5	9.3	10.0
Station 03 (~Atherton)	5.5	9.0	6.4	9.1	10.2	9.0	8.8	na	9.0	8.3	10.2
Station 04 (Enfield Ch.)	6.4	8.0	7.6	9.8	9.7	9.0	8.3	na	8.3	8.4	9.8
Station 05	6.4	na	na	na	na	na	na	na	na	na	na
Station 06 (~MP/A5)	9.5	10.4	8.9	9.8	10.0	9.1	7.0	8.0	9.3	9.1	10.4
Station 07 (=CI/A4)	na	7.3	5.8	9.4	8.5	8.2	8.0	na	8.1	7.9	9.4
Station 08	6.0	na	na	na	na	na	na	na	na	na	na
Station 09 (~LI/A2)	na	4.9	3.8	8.0	6.0	7.1	5.1	na	5.6	5.8	8.0
Station 10 (=Den Hill)	4.5	2.7	2.6	4.7	4.5	4.6	4.0	na	4.5	3.9	4.7



APPENDIX D

Photographs of Quabbin Phytoplankton

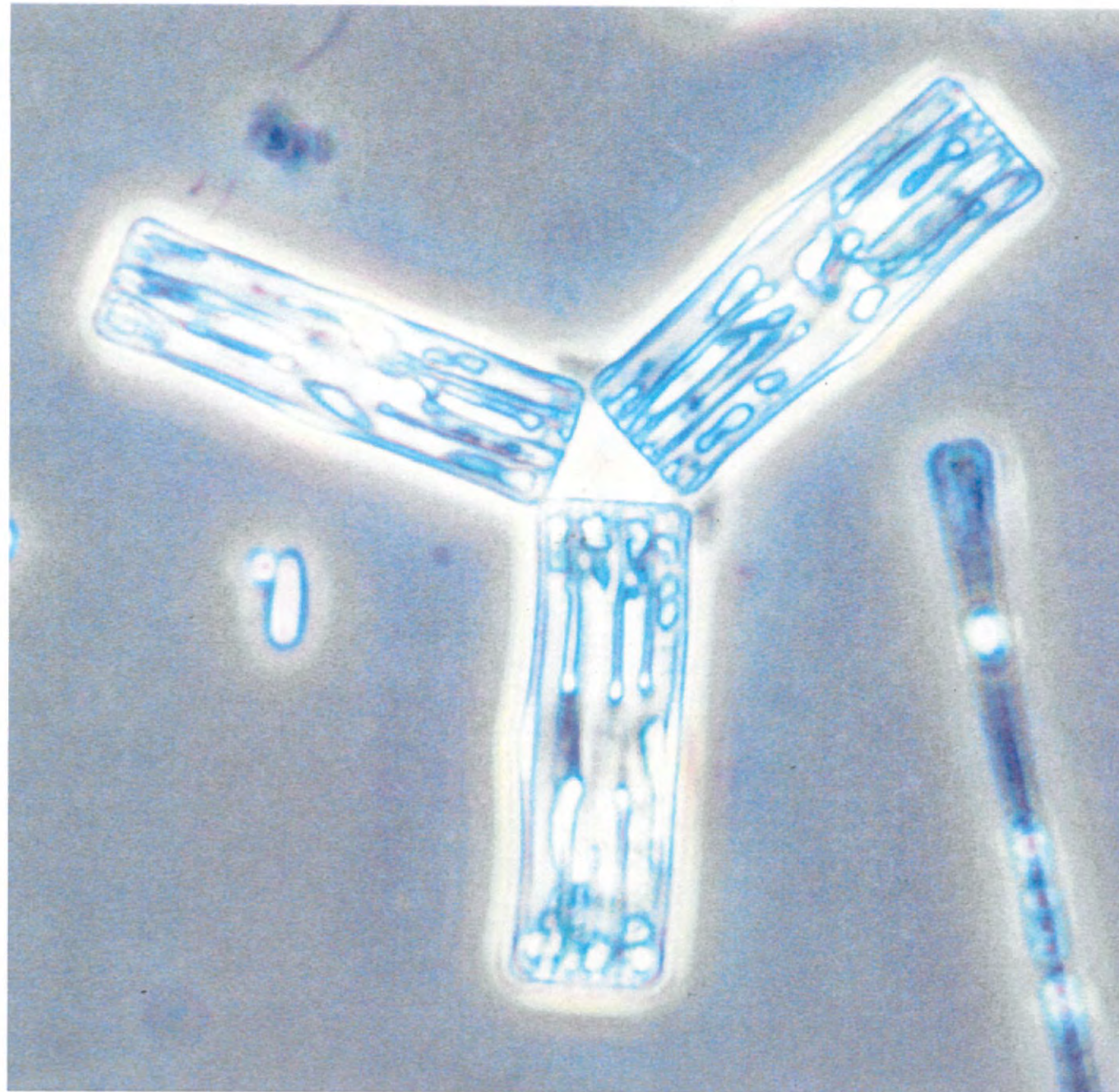


Dinobryon bavaricum
(colonial chrysophyte)

Total Length of vase-shaped
shell (lorica) =
112 microns

Quabbin Reservoir

Mt. Pomeroy
(Station A5)
August 12, 1999

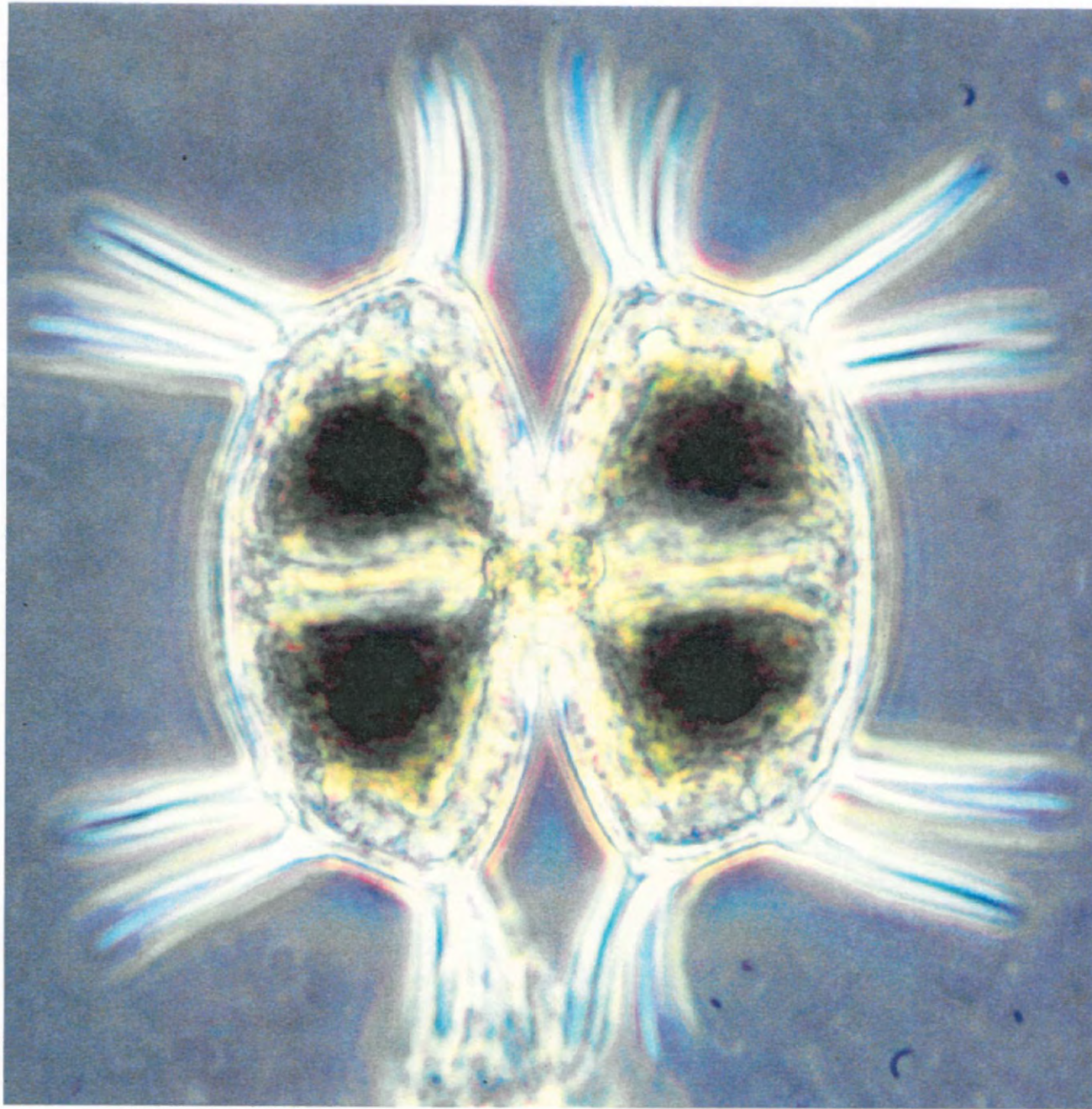


*Tabellaria
flocculosa*
(chain-forming
diatom)

Total Length
of each cell =
34 microns

Quabbin
Reservoir

Mt. Pomeroy
(Station A5)
May 10, 1999



Xanthidium
(desmid)

Total Length =
100 microns

Quabbin
Reservoir

Mt. Pomeroy
(Station A5)
Sept. 23, 1999

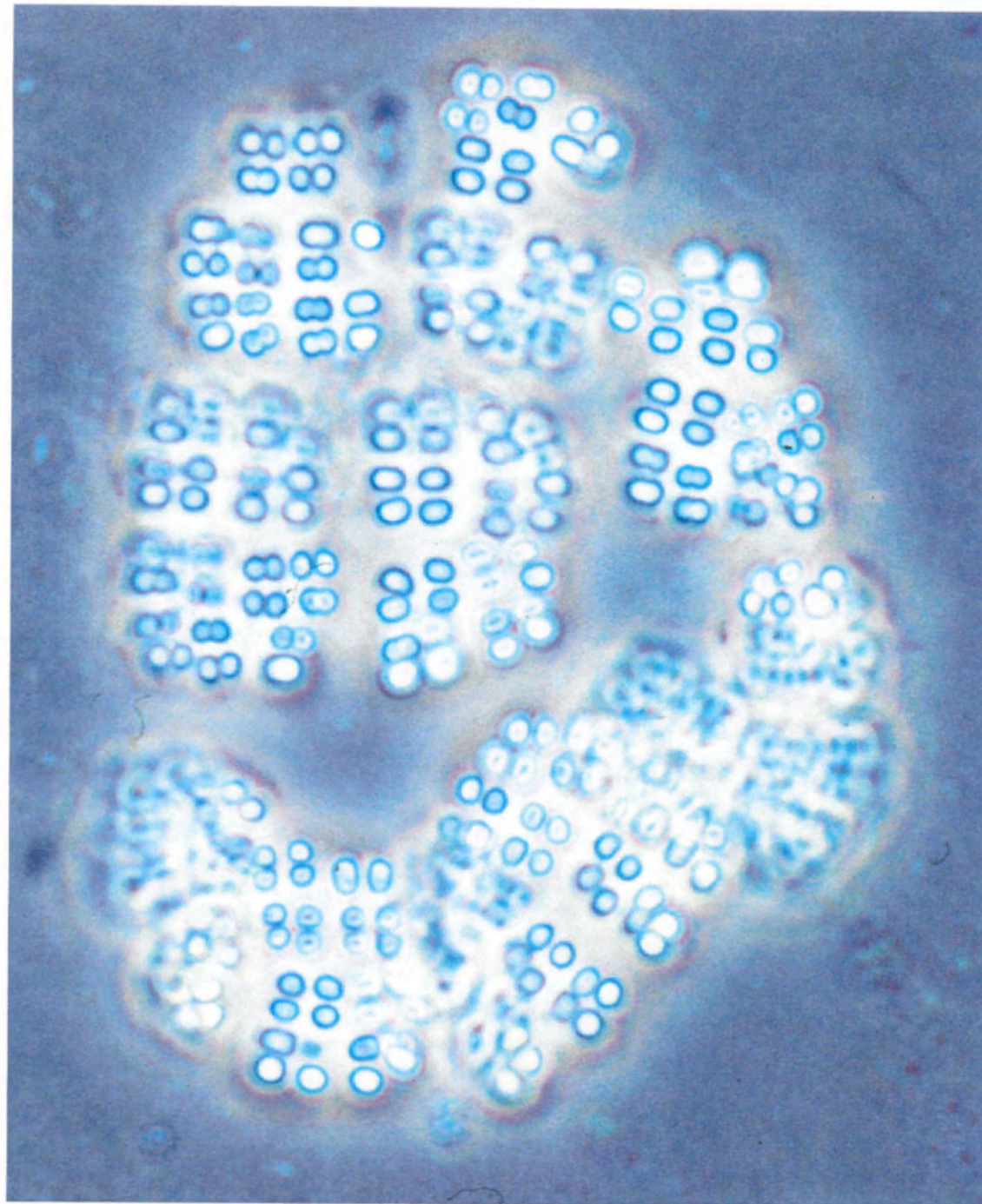


Mallomonas
(chrysophyte)

Total Length =
48 microns

Quabbin Reservoir

Mt. Pomeroy
(Station A5)
Dec. 15, 1999



Merismopedia
(colonial cyanophyte)

Diameter of each cell =
3 microns

Quabbin Reservoir

Mt. Pomeroy
(Station A5)
September 23, 1999