5.0 WATER QUALITY DATA COLLECTION SUMMARY

Water quality measurements were collected during 8 Assabet River surveys performed under a variety of conditions. Water quality measurements were obtained in-situ and by grab sampling for laboratory analysis throughout the Assabet River and its tributaries. Water quality data collected during the Summer 1999, Summer 2000, dry-weather, and wet-weather surveys are summarized below.

5.1 Summer 1999 Survey

Water quality data was collected at 21 river locations, 5 river impoundment locations and in 5 tributaries on July 21-25, 1999. Reference hydrologic and point source discharge data, in-situ water quality, and water chemistry data are summarized below.

5.1.1 Reference Hydrologic and Point Source Discharge Data

Effluent measurements for the 4 major POTWs were collected concurrently with the July 1999 river survey and are compiled in Table 5-1. Samples were collected at Marlborough West, Hudson, and Maynard on July 20 and 21 and samples were collected at Westborough one week prior on July 14, 1999. Westborough effluent characteristics appear to be consistent from week to week, based on review of available data. Thus, comparison of Westborough effluent characteristics measured on July 14, 1999 to other measurements collected on the following week appears unlikely to result in significant inaccuracies. These data were obtained by the POTWs in support of the Assabet River assessment project. The cooperation of Assabet River POTW personnel is greatly appreciated.

The average total flow of the four major POTW effluents was approximately 13.3 cfs (8.6 MGD) during the week of July 19-23, 1999. For the four major POTWs combined, the estimated total phosphorus load was 66 lbs/day and the total nitrogen load was 1,150 lbs/day.

The majority of the riverflow during the July 1999 survey was from the POTWs, based on review of the stream gauge and the POTW flowrates. The USGS Maynard gauge is upstream of the Maynard POTW, so it is appropriate to remove the Maynard POTW from consideration in evaluating flow components at the Maynard gauge. The average USGS Maynard streamflow was approximately 15 cfs during the July 1999 survey (Figure 4-1) and the average total POTW effluent flow entering the Assabet River above the gauge was approximately 12 cfs. Thus, the POTW flow appears to have accounted for approximately 80% of the total flow in the Assabet River above rivermile 7.4 during the July 1999 survey.

5.1.2 In-situ Water Quality Measurements

In-situ water quality measurements were collected at 21 river locations, in 5 river impoundments, and in 5 tributaries during the July 1999 survey. Table 5-2 contains a summary of synoptic dissolved oxygen, temperature, and pH measurements collected during the July 1999 survey.

Diurnal variations in dissolved oxygen (DO) concentrations are an indicator of photosynthetic activity and extreme DO concentrations variations are indicative of eutrophic conditions. Dissolved oxygen may be expressed as concentration in mg/l or as "%" saturation. Dissolved oxygen concentration is a useful metric for comparison to the applicable water quality standards and for assessment of potential harmful effects of water quality conditions on fish and other aquatic organisms. The applicable water quality standard for DO concentration in the Assabet River is 5.0 mg/l.

At river sampling locations, in-situ measurements were collected throughout each day with focus on early morning and late afternoon sampling to capture diurnal variations. At Assabet River sampling locations, minimum DO concentration measurements were below 5.0 mg/l at 9 of 21 locations (Table 5-2). DO concentration measurements below 5.0 mg/l were not collected in only one particular reach, but were scattered throughout the length of the river. Also, diurnal DO concentration variations were large at numerous locations, as tabulated in the column entitled; "ΔDO". Daily DO concentration variations of more than 6.0 mg/l were measured at 8 of 21 river locations.

Figures 5-1(a) and (b) present minimum DO measurements vs. rivermile in the upper-half and lower-half of the Assabet River, respectively. The lowest DO minimums are generally observed in gently sloping reaches of the river. These reaches are also downstream of POTW effluent release point. For example, a DO minimum of 3.0 was measured at Chapin Rd (RM 19.5), in a gradually sloping reach of the river located downstream of the Marlborough West POTW. The highest minimum DO concentrations were observed immediately below dams due, in part, to aeration provided by water as it passes over a dam.

In the 5 river impoundments, in-situ water quality profile measurements were collected during the July 1999 survey. Table 5-3 contains a summary of synoptic dissolved oxygen, temperature, pH, and Secchi depth measurements collected in river impoundments. Impoundment measurements were generally collected in the center of the impoundment near the dam. Measurements were collected at different times, from early morning to mid-afternoon.

DO concentration measurements collected in the river impoundments ranged from 4.95 to 8.7 mg/l, except for one near-bottom measurement of 1.1 mg/l. Modest vertical gradients, featuring decreasing DO concentration, temperature, and pH values, were observed in 4 river impoundments. In the Ben Smith Impoundment, a strong vertical DO concentration gradient, decreasing from 8.7 mg/l near surface 1.1 mg/l near the bottom was observed. Low dissolved oxygen concentrations near the bottom of the water column are indicative of large sediment oxygen demand. DO concentration

measurements in 4 of the 5 river impoundments were indicative of small to moderate sediment oxygen demand. In the Ben Smith Impoundment, evidence of large sediment oxygen demand was observed.

5.1.3 Continuous In-situ Water Quality Measurements

Continuous-recording water quality meters were deployed at five locations to capture diurnal changes in DO concentrations. Meters were deployed at School St (RM28), Bigelow Rd. (RM 21.7), Cox St. (RM 15.9), USGS Gauge (RM 7.4), and Route 2 (RM 2.4). DO concentrations were measured and recorded every 10 minutes for approximately 24 hour period. DO concentration measurements collected at the five locations are presented in Figures 5-2 through 5-6 along with synoptic DO measurements collected concurrently at each location.

Figure 5-2 presents DO concentration measurements collected at School Street, Northborough (RM 28) from July 19 into July 21. DO concentration measurements varied from 4.0 mg/l to 7.6 mg/l on July 20. A diurnal trend was observed and continuous measurements were well-matched with synoptic measurements (represented by solid circles and triangles in Figure 5-2). Non-concurrent measurements noted in Figure 5-2 are defined at measurements collected at the same time, but on adjacent days, and are included to demonstrate consistency of daily diurnal DO concentration patterns. Differences between continuously-recorded and synoptic DO measurements are likely due to a combination of factors including local variations in DO concentration and DO sensor measurement errors. The water quality standard for DO concentration of 5.0 mg/l was not met for a period of 12 hours on July 20, 1999.

Figure 5-3 presents DO concentration measurements collected at Bigelow Road, Berlin (RM 21.7) from July 19 into July 21. DO concentration measurements varied from 4.4 mg/l to 11.4 mg/l on July 20. The diurnal range (ΔDO = 7.0 mg/l) was larger than that observed at School St., but the minimum DO concentration was higher.

Figure 5-4 presents DO concentration measurements collected at Cox Street, Hudson (RM 15.9) from July 21 into July 22. DO concentration measurements varied from 3.8 mg/l to 14.0 mg/l. The diurnal range (ΔDO = 10.2 mg/l) was very large and the minimum DO concentration was well-below the water quality standard. DO concentration measurements at Cox St. are strongly indicative of nutrient-rich waters. Continuous DO measurements were well-matched with synoptic measurements (represented by solid circles and triangles) and the water quality standard was not obtained for a period of 5 hours on July 22, 1999

Figure 5-5 presents DO concentration measurements collected at the USGS gauge in Maynard (RM 7.4) from July 21 into July 22. DO concentration measurements varied from 6.0 mg/l to 8.3 mg/l and the minimum DO concentration was well-above the water quality standard. The physical setting of the USGS gauge location provides significant aeration of waters passing through. Rivermile 7.4 is situated

in the steepest reach of the Assabet River and is below the Ben Smith Dam. Relatively small DO concentration variations and relatively high minimum DO values were observed at rivermile 7.4.

Figure 5-6 presents DO concentration measurements collected at the Route 2 Bridge, Concord (RM 2.4) from July 22 into July 23. DO concentration measurements varied from 5.4 mg/l to 13.4 mg/l. The diurnal range (ΔDO = 8.0 mg/l) was large and the minimum DO concentration was above the water quality standard. Again, continuous DO measurements were well-matched with synoptic measurements.

5.1.4 Chemical Analysis of Water Samples

Water samples were collected for laboratory analysis of a suite of nutrient-related parameters at 21 river locations, in 5 river impoundments, and in 5 tributaries during the Summer 1999 survey. Methods of collection and analysis are provided in Section 3.5. Table 5-4 contains a summary of laboratory analysis measurements performed on samples collected at river and impoundment locations on July 21 and 22, 1999. A second round of samples was collected at river locations on July 23, 1999. Analyses performed on the two rounds of samples were very similar both in terms of parameter concentration measurements and trends in measurements. As a result, the July 21, 1999 data set is presented herein and the July 23, 1999 data set is provided in Appendix C.

Phosphorus

Phosphorus is an essential nutrient for plant growth and is a common growth limiting factor for biota in freshwater systems. Total and ortho-phosphorus analyses were performed on Assabet River water samples. Dissolved phosphorus contains ortho-phosphorus that is representative of biologically available phosphorus. Ortho-phosphorus may be readily taken up by aquatic organisms. Total phosphorus represents both the dissolved form (including ortho-phosphorus) and the particulate form that must be converted by natural biological processes prior to aquatic plant uptake. Thus, ortho-phosphorus is readily available phosphorus and total phosphorus represents the total amount of phosphorus that may potentially be taken up by aquatic organisms.

Total phosphorus concentration measurements ranged from 0.03 to 0.71 mg/l with a typical value of 0.3 mg/l. Ortho-phosphorus concentration measurements ranged from 0.05 mg/l to 0.62 mg/l with a typical value of 0.25 mg/l. Total and ortho-phosphorus concentration measurements were generally higher in the Upper Assabet River and decreased with distance downstream. It appears likely that phosphorus is being taken up into biomass in the river impoundments, based on reductions observed and the extent of biomass generation underway in the system during July 1999 surveys (see Section 7).

Nitrogen

Nitrogen is also an essential nutrient for aquatic plant growth. Nitrogen is more abundant and less frequently limiting than phosphorus in freshwater systems. Nitrate, Ammonia-Nitrogen, and Total Kjeldal Nitrogen (TKN) analyses were performed on water samples from the Assabet River. Total nitrogen, defined as the sum of TKN and nitrate, represents the concentration of nitrogen in both dissolved and particulate forms in the water column. Ammonium and nitrate are the two forms of nitrogen that are most readily accessible for biological uptake. Available nitrogen, defined as the sum of nitrate and ammonia, represents the bioavailable component of nitrogen in the water column.

Nitrate concentration measurements ranged from 0.3 mg/l to 8.2 mg/l. Nitrate concentrations measurements collected below the Westborough POTW (RM 29.5) to the Ben Smith/Crow Island Impoundment were relatively high (2.3 mg/l to 8.2 mg/l), while nitrate concentrations below the Impoundment were much lower (below 1.0 mg/l). Considering the amount of biomass generation underway in the system (see Section 7), it appears likely that nitrate is being taken up into biomass in the river impoundments. Ammonia concentration measurements ranged from 0.03 mg/l to 0.14 mg/l. Total Kjeldahl nitrogen concentration measurements ranged from 0.29 mg/l to 1.4 mg/l.

Biochemical Oxygen Demand

Biochemical oxygen demand is standard metric for oxygen demand exerted directly by a wastewater effluent upon a receiving waterbody. BOD_5 concentration measurements ranged from 0.5 mg/l to 5.8 mg/l throughout the Assabet River. These BOD_5 concentration measurement are moderate and are not sufficiently large to directly account for the DO variations observed the Assabet River. Apparently, diurnal DO variations in the Assabet River are primarily due to biological activity related to nutrient enrichment, rather the direct impact of BOD_5 loadings.

Bacteria

Fecal coliform analyses measure the presence of a group of waterborne bacteria and are typically applied to assess the potential for the presence of harmful bacteria (e.g., *e. coli*). Fecal coliform levels ranged from 60 to 4,500 col/100 ml. The applicable water quality standard for fecal coliform in the Assabet River is a geometric mean of 200 col/100 ml with no more than 10% of samples above 400 col/100 ml.

Fecal coliform measurements are generally elevated during wet-weather events due to the presence of increased organic loads and other factors. A rainfall event occurred on July 19, 1999 (Figure 4-1) and fecal coliform measurements were collected on July 21 and July 23 (2 and 4 days after rainfall, respectively). The fecal coliform measurements collected on July 21, 1999 (Table 5-4) were considerably higher than the July 23, 1999 analysis results (see Appendix C). These findings are consistent with the expectation that elevated fecal coliform levels are associated with rainfall events.

Tributary Water Chemistry

Water samples were collected for laboratory analysis of a suite of nutrient-related parameters at 6 tributaries locations on July 21 and July 23, 1999. Table 5-5 contains a summary of laboratory analysis measurements performed on samples collected at tributary locations. Phosphorus concentration measurements ranged from 0.02 mg/l to 0.12 mg/l and were significantly lower than phosphorus measurements collected in the Assabet River. Tributary nitrogen (all species) and BOD measurements collected in the tributaries were generally similar to nitrogen and BOD measurements collected in the Assabet River.

5.2 Summer 2000 Survey

Water quality measurements were collected at 23 river locations, in 5 river impoundments, and in 10 tributaries on August 28 to September 1, 2000. Reference hydrologic and point source discharge data, in-situ water quality, and water chemistry data collected during the Summer 2000 survey are summarized below.

5.2.1 Reference Hydrologic and Point Source Discharge Data

Effluent measurements for the 4 major POTWs were collected concurrently with the Summer 2000 river survey and are compiled in Table 5-6. Samples were collected at Westborough, Marlborough West, Hudson, and Maynard between August 29 and September 6, 2000. The average total flow of the 4 major POTW effluents was approximately 14.2 cfs. For the four major POTWs combined, the estimated total phosphorus load was 64.3 lbs/day and the total nitrogen load was 1,090 lbs/day. The point source total phosphorus and total nitrogen loads associated the Summer 1999 and Summer 2000 surveys were very similar (see Table 5-1).

Streamflow measured at the USGS Maynard gauge concurrently with the Summer 2000 survey is presented in Figure 4-3. The average USGS Maynard gauge streamflow during the Summer 2000 survey was 39 cfs, corresponding to below average conditions for August (the mean streamflow for August is 60 cfs, see Figure 2-3). Using a simple water budget estimate, the total POTW effluent flowrate was estimated to consist of approximately one-third of the total Assabet River flow during the Summer 2000 survey with the remaining two-thirds coming from baseflow and tributary flow.

5.2.2 In-situ Water Quality Measurements

In-situ water quality measurements were collected at 23 river locations, in 5 river impoundments, and in 10 tributaries during the Summer 2000 survey. Table 5-7 contains a summary of synoptic dissolved oxygen, temperature, and pH measurements collected at the river and impoundment locations during

the Summer 2000 survey. Table 5-8 contains a summary of in-situ water quality measurements collected in tributaries.

At river sampling locations, in-situ measurements were collected throughout each day with focus on early morning and late afternoon sampling to capture diurnal variations. At Assabet River sampling locations, minimum DO concentration measurements were below 5.0 mg/l at 7 of 28 locations (Table 5-7). Also, diurnal DO concentration variations were large at numerous locations, as tabulated in the column entitled; "ΔDO". Daily DO concentration variations of more than 6.0 mg/l were measured at 10 of 28 river locations.

At 5 river impoundment locations, in-situ water quality profile measurements were collected during the Summer 2000 survey. Table 5-9 contains a summary of synoptic dissolved oxygen, temperature, pH, and Secchi depth measurements collected in river impoundments. Impoundment measurements were generally collected in the center of the impoundment near the dam. Measurements were collected in the morning when lowest DO concentrations typically occur.

River impoundment DO concentration measurements ranged from 10.4 to 4.8 mg/l. Modest vertical gradients, featuring decreasing DO concentration, temperature, and pH values with depth, were observed in all 5 river impoundments. DO concentration measurements in all 5 river impoundments were indicative of small to moderate sediment oxygen demand with no measurements below 4.8 mg/l observed.

At tributary sampling locations, in-situ measurements were collected throughout one day of the survey with a focus on early morning and late afternoon sampling (Table 5-8). At two tributary locations, Stirrup Brook and Elizabeth Brook, all dissolved oxygen concentrations were below the water quality standard of 5 mg/l. Large diurnal DO concentration variations were observed in 3 locations, however these variations were less than those observed in river locations.

In general, spatial and temporal trends in DO concentration values measured during the Summer 2000 survey were similar to those of the Summer 1999 survey. Summer 1999 survey DO concentration values were generally observed to experience greater diurnal variations, including higher maximum and lower minimum values, relative to the Summer 2000 survey. DO concentration measurements collected during both Summer surveys were strongly indicative of nutrient-rich, eutrophic systems.

5.2.3 Continuous In-situ Water Quality Measurements

Continuous-recording water quality meters were deployed at six locations to capture diurnal changes in DO concentrations. Meters were deployed at School St (RM28), Boundary Rd. (RM 23.9), Cox St. (RM 15.9), USGS Gauge (RM 7.4), Damonmill (RM 4.4), and Route 2 (RM 2.4). DO concentrations were measured and recorded every 10 minutes for an approximately 48-hour period. DO

concentration measurements collected at the six locations are presented in Figures 5-7 through 5-12 along with synoptic DO measurements collected concurrently at each location.

Figure 5-7 presents DO concentration measurements collected at School Street, Northborough (RM 28) from August 25 – August 28. DO concentration measurements varied from 4.5 mg/l to 7.3 mg/l on August 28th. A diurnal trend was observed and continuous measurements were well-matched with synoptic measurements (represented by solid circles and triangles in Figure 5-7). Differences between continuously-recorded and synoptic DO measurements are likely due to a combination of factors including local variations in DO concentration and DO sensor measurement error. The water quality standard for DO concentration of 5.0 mg/l was not met for a period of 8 hours on August 28, 2000.

Figure 5-8 presents DO concentration measurements collected at Boundary Street, Marlborough(RM 23.9) from August 28 - August 30. DO concentration measurements varied from 6.5 mg/l to 12.3 mg/l on August 29. The diurnal range was larger than that observed at School St., but the minimum DO concentration did not fall below the water quality standard for dissolved oxygen during this time period. Continuous DO measurements were well-matched with synoptic measurements (represented by solid circles and triangles).

Figure 5-9 presents DO concentration measurements collected at Cox Street, Hudson (RM 15.9) from August 25 into August 28. DO concentration measurements varied from 4.3 mg/l to greater than 14 mg/l. The diurnal range (ΔDO > 10 mg/l) was very large and the minimum DO concentration fell below the water quality standard. DO concentration measurements at Cox St. are strongly indicative of nutrient-rich waters.

Figure 5-10 presents DO concentration measurements collected at the USGS gauge in Maynard (RM 7.4) from August 28 into August 30. DO concentration measurements varied from 6.5 mg/l to 8.7 mg/l and the minimum DO concentration was above the water quality standard. As observed in the summer 1999 survey, the physical setting of the USGS gauge location provides significant aeration of waters passing through. Rivermile 7.4 is situated in the steepest reach of the Assabet River and is below the Ben Smith Dam. Relatively small DO concentration variations and relatively high minimum DO values were observed at rivermile 7.4.

Figure 5-11 presents DO concentration measurements collected at the Damonmill, Concord (RM 4.4) from August 30 into September 1. DO concentration measurements varied from 6.2 mg/l to 13.2 mg/l. The diurnal range (ΔDO = 7.0 mg/l) was large and the minimum DO concentration was above the water quality standard. Again, continuous DO measurements were well-matched with synoptic measurements. Figure 5-12 presents DO concentration measurements collected at Rt. 2 Bridge, Concord (RM 2.4) from August 30 into September 1. DO concentrations measurements varied from 4.6 mg/l to 12.8 mg/l.

In general, spatial and temporal trends in DO concentration values measured during the Summer 2000 survey were similar to those of the Summer 1999 survey. Summer 1999 survey DO concentration values were generally observed to experience greater diurnal variations, including higher maximum and lower minimum values, relative to the Summer 2000 survey. This trend is illustrated by comparison on Figures 5-2 and 5-7 presenting continuous DO concentration measurements at School Street, Northborough(RM 28.0) in the summers of 1999 and 2000, respectively. The shape of the DO concentration vs. time curve is similar for the two sets of measurements, but the Summer 1999 measurements (Figure 5-2) experience a larger variation and associated lower minimum DO concentration values.

5.2.4 Chemical Analysis of Water Samples

Water samples were collected for laboratory analysis of a suite of nutrient-related parameters at 23 river locations, in 5 river impoundments, and in 10 tributaries during the August 2000 survey. Methods of collection and analysis are provided in Section 3-6. Tables 5-10 and 5-11 contain summaries of laboratory analysis measurements performed on samples collected in the Assabet River and its tributaries, respectively, on August 29, 2000.

Phosphorus

Total phosphorus concentration measurements ranged from 0.04 to 0.93 mg/l with a typical value of 0.3 mg/l. Ortho-phosphorus concentration measurements ranged from 0.01 mg/l to 0.79 mg/l with a typical value of 0.2 mg/l. In general, phosphorus concentration measurements collected during the Summer 2000 survey were similar to Summer 1999 measurements in magnitude and in spatial distribution. In both summer surveys, total and ortho-phosphorus concentration measurements were generally higher in the Upper Assabet River and decreased with distance downstream indicating a process of biomass uptake in the system.

Nitrogen

Nitrate concentration measurements ranged from 0.69 mg/l to 6.2 mg/l. Ammonia concentration measurements ranged from 0.03 mg/l to 0.44 mg/l. Total Kjeldahl nitrogen concentration measurements ranged from 0.42 mg/l to 2.9 mg/l. In general, nitrogen concentration measurements collected during the Summer 2000 survey were similar to Summer 1999 measurements in magnitude and in spatial distribution. Peak ammonia and TKN concentrations measurements collected during the Summer 2000 survey were higher than those of the Summer 1999 survey, but typical concentrations were similar. In both summer survey data, the role of biomass uptake of the nitrogen forms, nitrate and ammonia is evident based on the spatial distribution of concentration measurements.

Biochemical Oxygen Demand

BOD_5 concentration measurements ranged from 0.5 mg/l to 2.3 mg/l throughout the Assabet River. BOD_{30} concentration measurements ranged from 3 mg/l to 5 mg/l throughout the Assabet River system during the Summer 2000 survey.

Bacteria

Fecal coliform analyses measure the presence of a group of waterborne bacteria and are typically applied to assess the potential for the presence of harmful bacteria (e.g., *e. coli*). Fecal coliform levels ranged from 20 to 1,700 col/100 ml. The applicable water quality standard for fecal coliform in the Assabet River is a geometric mean of 200 col/100 ml with no more than 10% of samples above 400 col/100 ml. No significant rainfall occurred in the days prior to the fecal coliform sampling event (Figure 4-3).

Tributary Water Chemistry

Water samples were collected for laboratory analysis of a suite of nutrient-related parameters at 10 tributaries locations on August 29, 2000. Table 5-10 contains a summary of laboratory analysis measurements performed on samples collected at tributary locations. TKN, ammonia, nitrate, and BOD measurements collected in the tributaries were generally similar to those collected in the Assabet River mainstem, while tributary phosphorus concentrations were dramatically lower.

Tributary total phosphorus and ortho-phosphorus concentration measurements ranged from 0.02 mg/l to 0.05 mg/l, roughly an order of magnitude lower than comparable river mainstem measurements (generally ranging from 0.1 mg/l to 0.7 mg/l) (Table 5-11). This observation suggests that tributary inflows did not represent the dominant source of phosphorus loadings during the Summer 2000 survey.

5.3 Dry-weather Surveys

Dry-weather surveys were performed in January 18-19, February 8-9, and March 27, 2000. Dry-weather surveys featured measurement of in-situ water quality and water chemistry at 10 river locations and 6 tributary locations. Reference hydrologic and point source data, in-situ water quality data, and water chemistry data collected during the three dry-weather surveys are summarized below.

5.3.1 Reference Hydrologic and Point Source Discharge Data

Effluent measurements for the 4 major POTWs were collected concurrently with the 3 dry-weather surveys and are compiled in Table 5-12. Samples were collected at the Westborough, Marlborough West, Hudson, and Maynard POTWs. The average total flow of the four major POTW effluents ranged

from 15.4 to 19.2 cfs during the 3 surveys. For the 4 major POTWs combined, the estimated total phosphorus loads were 357 lbs/day, 226 lbs/day, and 84 lbs/day, during January, February, and March 2000 surveys, respectively. Total nitrogen loads were 972, 1,970, and 1,110 lbs/day during January, February, and March surveys, respectively. POTW total phosphorus loads observed during the January and February surveys were 3 to 5 times greater than summertime POTW total phosphorus loads observed during the summers of 1999 and 2000 (of ~65 lbs/day; see Tables 5-1 and 5-6).

Streamflows in the Assabet River were significantly greater during the winter-time dry-weather surveys than during the summer-time surveys. USGS Maynard gauge streamflows in the Assabet River were 144 cfs, 129 cfs, and 250 cfs and during the January, February, and March surveys, respectively (Figure 4-2). Each of these streamflows is below average for the month, based on the period of record (monthly average streamflows are 220 cfs, 250 cfs, and 410 cfs for January, February, and March – see Figure 2-3). The relative flow contribution of the POTW discharges was much smaller during the winter surveys than during the summer surveys. The estimated percent contribution of POTWs to total flow in the Assabet River during the winter-time surveys was approximately 5 to 10% as contrasted with 80% and 34% during the Summer 1999 and Summer 2000 surveys, respectively.

5.3.2 In-situ Water Quality Measurements

Table 5-13 presents a summary of in-situ water quality data collected for the river stations for all three dry-weather surveys. Measurements were only collected once during the day, so diurnal variations in dissolved oxygen are not illustrated by this data set. Dissolved oxygen concentration values were typically above the 5 mg/L water quality standard for dissolved oxygen.

5.3.3 Chemical Analysis of Water Samples

Tables 5-14 and 5-15 contain a summary of water quality analysis results for grab water samples collected in the Assabet River and its tributaries during the January, February, and March dry-weather surveys. For the majority of parameters, the highest concentrations of nutrients were observed during the second survey performed in February.

Phosphorus

In the Assabet River, total phosphorus concentration measurements ranged from 0.1 mg/l to 0.6 mg/l, except at the headwaters where levels were very low (at Maynard Street, Westboro, RM 30.7). Total phosphorus concentration measurements were generally consistent throughout the river and throughout the three surveys with typical values of 0.4 mg/l. River total phosphorus concentrations were highest during the February survey and lowest during the March survey.

Ortho-phosphorus concentration measurements ranged from 0.1 mg/l to 0.5 mg/l with a typical value of 0.3 mg/l, except at the headwaters where levels were very low. River total phosphorus concentrations were highest during the February survey and lowest during the March survey. In March, lower concentrations of available phosphorus may have been the result of increased biological activity.

Nitrogen

In the Assabet River, nitrate concentration measurements ranged from 0.16 mg/l to 2.8 mg/l. Nitrate concentrations measurements were fairly consistent throughout the river system, with peak values observed below the Gleasondale Impoundment (RM 14.1). Ammonia concentration measurements ranged from 0.03 mg/l to 0.51 mg/l. Total Kjeldahl nitrogen concentration measurements ranged from 0.05 mg/l to 0.98 mg/l.

Biochemical Oxygen Demand

BOD_5 concentration measurements ranged from 0.25 mg/l to 7.9 mg/l throughout the Assabet River. BOD_{30} concentration measurements ranged from 0.25 mg/l to 13 mg/l throughout the Assabet River.

Bacteria

Fecal coliform levels ranged from 10 to 690 col/100 ml. The applicable water quality standard for fecal coliform in the Assabet River is a geometric mean of 200 col/100 ml with no more than 10% of samples above 400 col/100 ml. One fecal coliform measurement exceeded 400 col/100 ml and was observed during the February survey. No significant rainfall occurred in the days prior to the dry-weather fecal coliform sampling events (Figure 4-2).

Tributary Water Chemistry

Water samples were collected for laboratory analysis of a suite of nutrient-related parameters at 6 tributaries locations during the three dry-weather surveys. Table 5-15 contains a summary of laboratory analysis measurements performed on samples collected at tributary locations.

Tributary total phosphorus concentration measurements ranged from 0.02 mg/l to 0.36 mg/l and were typically 3 to 10 times lower those of the Assabet River mainstem. Ortho-phosphorus concentration measurements were below the laboratory method detection limit (0.005 mg/l) at all cases, indicating very low ortho-phosphorus concentration in the river tributaries. This observation suggests that during winter-time dry-weather survey conditions tributary inflows represent a negligible source of available phosphorus and a relatively small source of total phosphorus to the Assabet River system.

Nitrogen and BOD concentration measurements from Assabet River tributaries were generally similar to those collected in the Assabet River. Typical tributary TKN and ammonia concentration

measurements of 0.5 mg/l and 0.08 mg/l, respectively, were very similar to those collected in the Assabet River. Tributary nitrate concentrations measurements, however, were typically approximately one-third of Assabet River mainstem levels (0.5 mg/l in tributaries vs. 1.5 mg/l in the mainstem).

5.4 Wet-weather Survey Summary

Wet-weather surveys were performed on March 16, March 27, and September 12, 2000. Wet-weather surveys featured measurement of water chemistry at 10 tributary locations during a precipitation/runoff event. Reference hydrologic and point source data, in-situ water quality data, and water chemistry data collected during the three dry-weather surveys are summarized below.

5.4.1 Reference Hydrologic and Point Source Discharge Data

Effluent measurements for the 4 major POTWs were collected concurrently with the 3 wet-weather surveys and are compiled in Table 5-16. Samples were collected at the Westborough, Marlborough West, Hudson, and Maynard POTWs. The average total flow of the 4 major POTW effluents ranged from 13.3 to 21.7 cfs during the 3 surveys. For the 4 major POTWs combined, the estimated total phosphorus loads were 316 lbs/day, 84 lbs/day, and 60 lbs/day, during March 16, March 27, and September 12, 2000 surveys, respectively. Total nitrogen loads were 1,200 lbs/day, 1,110 lbs/day, and 1,250 lbs/day, during March 16, March 27, and September 12, 2000 surveys, respectively.

Wet-weather surveys were designed to capture nutrient loadings from tributaries during dynamic storm runoff events. As a result, wet-weather surveys were performed on the rising edge of the storm hydrograph, as illustrated in the USGS Maynard stream gauge record for 2000 (Figures 4-2 and 4-3). USGS Maynard gauge base streamflows in the Assabet River immediately prior to the wet-weather surveys were 375 cfs, 250 cfs, and 30 cfs.

5.4.2 In-situ Water Quality Measurements

Table 5-17 presents a summary of the in situ water quality data collected for the river stations for all three wet-weather surveys. Measurements were only collected once during the day, so diurnal variations in dissolved oxygen are not illustrated by this data set. Dissolved oxygen concentration values were typically above the 5 mg/L water quality standard for dissolved oxygen.

5.4.3 Chemical Analysis of Water Samples

Table 5-18 contains a summary of water quality analysis results of grab water samples collected at 10 tributary locations during the three wet-weather surveys. In general, wet-weather nutrient concentration measurements were more variable from survey to survey than those of dry-weather surveys.

Phosphorus

Total phosphorus concentration measurements ranged from 0.01 to 0.77 mg/l, with the highest concentrations (typically 0.4 mg/l) observed in the March 16, 2000 survey and the lowest concentrations observed during the March 27, 2000 survey (typically 0.08 mg/l). Ortho-phosphorus concentrations were not detected in any of the tributary locations during the two March 2000 surveys and were measured at concentrations ranging from 0.01 to 0.03 mg/l during the September 2000 survey. During the wet-weather surveys ortho-phosphorus measurements were typically at least one order of magnitude lower than those of the river mainstem (0.03 mg/l in tributaries vs. 0.3 mg/l in river). During 2 of the 3 wet-weather surveys, total phosphorus measurements were typically 5 times lower than those of the river mainstem (0.08 mg/l in tributaries vs. 0.4 mg/l in river). Wet-weather total phosphorus concentrations measured during the March 16, 2000 survey were higher and were similar to those typical of the river mainstem.

Nitrogen

Nitrate concentration measurements ranged from 0.01 mg/l to 0.90 mg/l. Ammonia was only detected in one tributary, Spencer Brook, at a concentration of 0.04 mg/l during the first survey. Concentration measurements ranged from 0.07 mg/l to 0.4 mg/l for the second and third surveys. Total Kjeldahl nitrogen concentration measurements ranged from 0.29 mg/l to 2.6 mg/l. For tributary nitrogen (all species), the highest concentrations were observed during the third wet-weather survey performed in September.

Biochemical Oxygen Demand

BOD_5 concentration measurements ranged from less than 1 mg/l to 16.9 mg/l. Again, the highest concentrations were observed during the September tributary survey.

Bacteria

Fecal coliform levels ranged from less than 10 to 2000 col/100 ml. The maximum coliform levels were measured during the third survey performed in September. The applicable water quality standard for fecal coliform in the Assabet River is a geometric mean of 200 col/100 ml with no more than 10% of samples above 400 col/100 ml. The two surveys performed in March had fecal coliform levels below the applicable water quality standard. Therefore, these tributaries are not contributing excessive fecal coliform loadings to the Assabet River during base flow conditions.

5.5 Water Quality Survey Summary

The following observations were made of water quality conditions in the Assabet River during the data collection program.

During Summer 1999 and Summer 2000 surveys:

- Water quality conditions in the Assabet River during the Summer 1999 and Summer 2000 surveys were similar.
- DO concentrations experienced large diurnal variations throughout the river, indicating intensive biological activity.
- Nutrient concentrations of both phosphorus and nitrogen species were at levels indicative of nutrient saturation (i.e., neither nutrient was limited) and were more than sufficient to support eutrophication.
- Typical ranges of nutrient concentrations in the Assabet River were:
  - Total phosphorus: 0.2 to 0.8 mg/l
  - Ortho-phosphorus: 0.1 to 0.6 mg/l
  - Nitrate: 0.5 to 8.0 mg/l
  - Ammonia: 0.04 to 0.2 mg/l
- Phosphorus concentration measurements collected in tributaries were generally dramatically lower than those collected in the Assabet River mainstem. In particular, the maximum ortho-phosphorus concentration measurement collected from a tributary was 0.06 mg/l, an order of magnitude lower than typical river ortho-phosphorus concentrations. This observation indicates that tributaries were not major sources of available phosphorus during the Summer 1999 and Summer 2000 surveys.
- Nitrogen concentration measurements collected in tributaries were generally similar to those collected in the Assabet River mainstem.

During Dry-weather surveys:

- Water quality measurements collected during January, February, and March 2000 dry-weather surveys were generally similar in terms of nutrient concentration measurements.
- Typical ranges of nutrient concentrations in the Assabet River were:

- Total phosphorus: 0.2 to 0.6 mg/l
- Ortho-phosphorus: 0.1 to 0.7 mg/l
- Nitrate: 0.6 to 2.8 mg/l
- Ammonia: 0.05 to 0.4 mg/l

- Phosphorus concentration measurements collected in tributaries were generally dramatically lower than those collected in the Assabet River mainstem.
- Nitrogen concentration measurements collected in tributaries were generally similar to those collected in the Assabet River mainstem.
- Assabet River nutrient concentration measurements collected during the dry-weather surveys were generally similar to those collected during the two summer surveys. Nitrate concentrations measurements were moderately lower during the dry-weather surveys relative to summer-time surveys.

During Wet-weather Surveys

- Water quality measurements collected during the three wet-weather surveys varied significantly from survey to survey in terms of nutrient concentration measurements.
- Ortho-phosphorus concentration measurements were low (max. value 0.01 mg/l) in all wet-weather surveys.
- Total phosphorus concentration measurements were elevated (and similar to river survey levels) during one survey (March 27, 2000) with typical values ranging from 0.3 to 0.8 mg/l, but were lower in the other two surveys with typical values ranging from 0.03 to 0.1 mg/l.
- Nitrogen concentration measurements collected during the wet-weather surveys were generally similar to those collected in the river during other surveys.

The water quality data collection program was successful in capturing nutrient and nutrient-related measurements throughout the Assabet River and its tributaries under a variety of conditions. Water quality measurements will be applied to support the TMDL project in numerous ways including supporting estimation of nutrient loadings, characterization of nutrient and biological dynamics, and mathematical modeling of the Assabet River system.

5.6 Nutrient Loadings Evaluation

A total nutrient budget for the Assabet River system was estimated based on hydrologic and water quality measurements collected during six (6) field surveys. The surveys were performed in July 1999 and from February through September 2000 during various seasonal, meteorological, and streamflow conditions and are summarized in Table 5-19. River streamflows at the USGS Maynard gauge during the surveys ranged from 15 cfs to 375 cfs, representing a broad range of hydrologic conditions. Of the 6 water quality surveys, 3 were performed under dry-weather conditions and 3 were performed under wet-weather conditions.

Nutrient loadings were estimated for point sources and non-point sources as the product of flow and nutrient concentration measurements. Each water quality survey provides a synopsis or "snapshot" of nutrient loadings to the Assabet River system at that point in time. Nutrient loadings from the 4 major POTW discharges and the 10 largest tributaries to the Assabet River are tabulated for each survey and presented in Tables 5-20 through 5-23. Ortho-phosphorus, total phosphorus, nitrate, and total nitrogen loadings are tabulated in the tables and are presented in a pie chart format in Figures 5-13 through 5-16.

5.6.1 Ortho-Phosphorus Loadings Estimates

Table 5-20 contains a summary of point and non-point source estimates of ortho-phosphorus loadings (lbs/day) based on field measurements collected during the 6 water quality surveys. Point source loading estimates were obtained using flow and nutrient concentrations provided by the POTWs and collected during the same time period as the ambient water quality surveys. Non-point source loading estimates were obtained from streamflow measurements and nutrient concentration measurements collected in tributaries during the surveys. In cases where the tributary was not sampled, field measurements were linearly scaled using watershed areas to account for all non-point source loadings (see table footnotes for details).

Table 5-20 provides loadings (lbs/day) and percent contribution to overall ortho-phosphorus loadings for each source during each survey. For example, during the July 1999 survey, the Hudson POTW contributed 15.2 lbs/day of ortho-phosphorus load representing 25% of the overall estimated ortho-phosphorus load to the Assabet River on that particular day. Also, during the July 1999 survey, all of the non-point sources combined were estimated to contribute 1.74 lbs/day representing 2.8% of the overall ortho-phosphorus load, as shown in the subtotal in the second to last row of Table 5-20.

Figure 5-13 presents percent contributions of ortho-phosphorus from point and non-point sources for all 6 surveys in a pie chart format. Point source loadings are indicated by darkly-shaded regions and non-point source loadings are indicated by lightly-shaded regions. For example, during the July 1999 survey (upper left), the Hudson POTW contribution of 25% and the total non-point source loading of 3% are illustrated.

The overall ortho-phosphorus load to the river varied from 52 lbs/day to 319 lbs/day in the six surveys. In 4 of the 6 surveys, including all summer surveys, the ortho-phosphorus load was relatively similar varying from 52 lbs/day to 65 lb/day. Ortho-phosphorus loadings were relatively higher, 200 lbs/day and 319 lbs/day, during two winter-time surveys, concurrent with relatively high streamflows (130 cfs and 375 cfs) and relatively large POTW loadings (Table 5-20). Even during wet-weather events, non-point source ortho-phosphorus loads were relatively small compared to point source loads.

The four POTWs were observed to be the primary source of ortho-phosphorus during all 6 water quality surveys. Point sources accounted for 88% to 98% of the overall estimated ortho-phosphorus load during the surveys (Table 5-20). The Westborough POTW was observed to account for the largest portion of the point source load (38% to 69% of the overall load). The Maynard POTW was observed to account for the smallest portion (4% to 9%) with Marlborough and Hudson POTW accounting for variable contributions ranging from 3% to 38% of the overall ortho-phosphorus load each. POTW ortho-phosphorus loadings were generally less during the summer-time than during the winter-time at all POTWs except for the Hudson POTW. Non-point sources of ortho-phosphorus were greatest during wet-weather events that occurred at relatively high river flowrates (e.g., the March 27, 2000 survey).

5.6.2 Total Phosphorus Loadings Estimates

Table 5-21 and Figure 5-14 contain summaries of total phosphorus loadings from point and non-point sources to the Assabet River during the 6 water quality surveys. Overall total phosphorus loadings to the Assabet River ranged from 66 lbs/day to 1,395 lbs/day with relatively large loadings observed during winter-time surveys. Notably, the total phosphorus loadings estimate for the March 16, 2000 wet-weather survey was 1,395 lbs/day, 5 times higher than that of any other survey (277 lbs/day).

Relative contributions of total phosphorus loadings from non-point and point sources were observed to vary from survey to survey. During dry-weather surveys, summer-time surveys and relatively low flow surveys (15 cfs to 130 cfs), point source total phosphorus loadings were dominant, accounting for 81% to 97% of the total phosphorus load in 4 of 6 surveys (Table 5-21). During two (2) relatively high flow, wet-weather surveys, non-point sources of total phosphorus accounted for the majority of loadings (52% and 77%). Thus, both non-point and point sources of total phosphorus were found to be major contributors of total phosphorus. The relative contributions of non-point and point sources to the total phosphorus load was observed to vary likely due to a combination of factors including seasonality, weather conditions, and streamflow.

5.6.3 Nitrate and Total Nitrogen Loadings Estimates

Nitrate and total nitrogen loadings are presented in Tables 5-22 and 5-23 and Figures 5-15 and 5-16 and were observed to be partitioned between point and non-point sources in a manner similar to total

phosphorus loadings. The overall nitrate load to the Assabet River varied from 983 lbs/day to 2,250 lbs/day while total nitrogen loads varied from 1,190 lbs/day to 3,850 lbs/day in the six surveys.

Point sources contributed the majority of nitrate during 5 of 6 surveys and contributed the majority of total nitrogen loadings to the Assabet River during 4 of the 6 surveys. Non-point sources contributed the majority of nitrate and total nitrogen loadings during 1 and 2 of the 6 surveys, respectively, corresponding to relatively high-streamflow and wet-weather conditions (i.e., March 16 and March 27, 2000 wet-weather surveys).

5.6.4 Summary

The following observations were made based on nutrient loadings estimates from the 6 water quality surveys.

- During all 6 surveys, the vast majority of ortho-phosphorus loadings came from the point sources (88% to 98%).
- During the worst-case summer-time conditions (July 1999, August 2000, and September 2000), the vast majority of all 4 nutrient loadings came from the point sources (83% to 98%).
- During relatively high-flow and wet-weather events (two March 2000 surveys), the majority of total phosphorus and total nitrogen loadings were observed to come from non-point sources.

Table 5-1 Summer 1999: Summary of POTW Flows, Nutrient Concentrations, and Nutrient Loadings

Parameter	Units	Westborough RM 30 7/14/99	Marlborough West RM 23.6 7/21/99	Hudson RM 15.7 7/21/99	Maynard RM 6.7 7/20/99	Total
Flow	cfs	6.1	3.2	2.6	1.3	13.3
Total P Load	lb/day	26.2	17.3	16.9	5.65	66.0
Ortho P Load	lb/day	23.6	17.3	15.2	3.45	59.5
Total N Load	lb/day	409	306	324	112	1,150
Nitrate Load	lb/day	335	277	324	107	1,040
BOD Load	lb/day	99.5	157	56.4	--	313
Total P	mg/l	0.79	1	1.2	0.79	
DP	mg/l	0.71 **	1	1.08 **	0.48	
Total N*	mg/l	12.3	17.7	23	15.6	
TKN	mg/l	2.24	1.7	ND	0.65	
NH3	mg/l	--	0.3	0.2	< 0.50	
NO2	mg/l	BDL	--	ND	--	
NO3	mg/l	10.1	16.0	23	--	
NO2+NO3	mg/l	--	--	--	14.9	
BOD	mg/l	3.0	9.1	4.0	--	
TSS	mg/l	4.0	--	14.0	2.0	

Notes:
*Total N was calculated based on: Total N = (TKN + NO2 + NO3)
**Calculated based on: dissolved-P = 0.90 * Total-P

Table 5-2 Summer 1999: Summary of Synoptic In-Situ DO Concentration, Temperature and pH Measurements

Station	RM	Description	Max DO	Min DO	Δ DO	Max %DO	Min %DO	Δ %DO	Max Temp (°F)	Min Temp (°F)	Max pH	Min pH
R28	30.7	Maynard St. Westborough	11.35	8.05	3.3	128.9	92.8	36.1	71.7	61.2	7.99	7.14
R27	29.8	Rt. 9 Westborough	8.88	3.66	5.22	84.2	41.1	43.1	74.4	69.1	6.76	6.51
R26	28.9	Rt. 135 Westborough	10.18	3.54	6.64	122.6	39.6	83	76.3	67.1	7.25	6.65
R25	28.0	School St. Northborough	7.28	4.73	2.55	85.5	51.6	33.9	73.8	67.3	6.95	6.76
R24	25.9	River St. Northborough	9.23	8.01	1.22	97.3	89.5	7.8	74.4	69.5	7.33	7.11
R23	25.1	Allen St. Impoundment										
R22	25.0	Below Allen St. Impoundment	8.73	7.65	1.08	99.6	87.4	12.2	76.1	70.9	7.49	7.08
R21	23.9	Boundary St. Marlborough	13.22	5.76	7.46	151.9	67	84.9	78.5	67.1	8.6	6.96
R20	23.5	Robin Hill Rd. Marlborough	10.43	5.15	5.28	125.1	58.4	66.7	76.1	69.4	7.71	7.04
R19	21.7	Bigelow Rd. Berlin	11.99	5.11	6.88	145.4	57	88.4	78.2	69.0	8.21	7.04
R18	19.2	Chapin Rd. Hudson	11	2.95	8.05	134.1	34.2	99.9	77.8	72.8	7.83	6.91
R17	17.9	Hudson Center Impoundment										
R16	17.6	South St. Hudson	8.49	6.79	1.7	101.3	80.8	20.5	78.1	75.3	7.68	6.98
R15	15.9	Cox St. Hudson	13.08	3.55	9.53	163	40.6	122.4	80.2	71.5	8.9	7.04
R13	14.1	Gleasondale Impoundment										
R12	13.9	Below Gleasondale Dam, Stow	8.82	7.1	1.72	109.7	83.8	25.9	78.7	74.6	7.51	7.31
R11	11.4	Boon Road, Stow	7.49	4.75	2.74	90.3	57.5	31.8	79.3	76.8	7.37	7.04
R10	9.2	White Pond Road, Maynard	10.29	5.7	4.59	129.1	68.4	60.7	79.3	76.7	8.71	7.45
R9	8.7	Ben Smith Impoundment										
R8	8.6	Rt. 117/62 Maynard	5.89	3.48	2.41	73.6	42	31.6	79.8	76.6	7.43	7.11
R7	7.4	USGS Gauge, Maynard	8.26	6.04	2.22	103.8	70.3	33.5	80.4	73.2	7.8	7.27
R6	6.2	Powder Mill Impoundment										
R5	6.1	Below Powder Mill Dam	6.93	5.45	1.48	82.9	65.5	17.4	77.5	75.9	7.54	7.13
R4	4.4	Damonmill, Concord	13.17	3.83	9.34	170	43.1	126.9	83.8	70.0	9.07	7.02
R3	3.1	Rt. 62, Concord	12.23	4.91	7.32	154	55.5	98.5	80.7	68.7	8.91	7.19
R2	2.4	Rt. 2 Bridge, Concord	12.4	5.12	7.28	155	65.6	89.4	80.0	69.3	8.82	7.1

Notes:

1. Bold horizontal line indicates approximate impoundment dam locations.

Table 5-3 Summer 1999: Summary of River Impoundment Synoptic In-Situ Water Quality Measurements

Station	RM	Description	Time	Depth (ft)	DO (mg/L)	Temp (°C)	pH	Secci Depth (ft)	Total Depth (ft)
R23	25.1	Allen St. Impoundment	6:20 AM					NA	4
		Surface		1	7.07	21.8	7.01		
		Bottom		3	6.15	21.9	6.96		
R17	17.9	Hudson Center Impoundment	3:25 PM					vegetation too thick	7
		Surface		1	8.32	25.78	7.22		
		Middle		3	7.80	25.50	7.12		
		Bottom		6	5.20	24.24	6.93		
R13	14.1	Gleasondale Impoundment	2:40 PM					7.5	7.5
		Surface		1	8.45	25.00	7.37		
		Middle		4	7.90	24.47	7.22		
		Bottom		7	4.50	23.84	6.90		
R9	8.7	Ben Smith Impoundment	5:48 AM					3.7	8.5
		Surface		1	8.74	25.5	8.35		
		Middle		3	8.56	25.4	8.33		
		Middle		5	1.4	24.3	7.18		
		Bottom		7	1.14	23.4	6.88		
R6	6.2	Powder Mill Impoundment	4:50 PM					4.5	8
		Surface		1	7.04	26.31	7.42		
		Middle		3	6.42	25.76	7.30		
		Bottom		5	4.95	24.56	7.11		

Table 5-4 Summer 1999: Summary of Assabet River Water Quality Laboratory Analysis Measurements

Sample Location			Phosphorus		Nitrogen			Oxygen Demand		Solids		Bacteria
			Total-P	Ortho-P	Nitrates	Ammonia	TKN	BOD-5	BOD-30	TSS	Set. Solids	Fecal Col.
Station	RM	Description	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	per 100ml
R28	30.7	Maynard St. Westborough	0.03	0.05	0.79	0.04	0.69	0.5 *	13.9	0.5 *	0.05 *	2100
R27	29.8	Rt. 9 Westborough	0.71	0.6	7.7	0.14	0.61	2.7	17.5	4	0.05 *	480
R26	28.9	Rt. 135 Westborough	0.71	0.62	8.2	0.12	0.69	3	15.2	5	0.05 *	1100
R25	28.0	School St. Northborough	0.68	0.59	7.7	0.12	0.56	4.7	25.1	9	0.05 *	1600
R24	25.9	River St. Northborough	0.6	0.54	5.5	0.05	0.52	1.9	23.5	3	0.05 *	900
R23	25.1	Allen St. Impoundment**	0.55	0.5	5.1	0.09	0.45	0.5 *	16.7	9	0.05 *	340
R22	25.0	Below Allen St. Impoundment	0.62	0.49	5.6	0.04	0.65	1.2	16.7	8	0.1	920
R21	23.9	Boundary St. Marlborough	0.5	0.42	5.3	0.04	0.81	1.7	15.5	1	0.05 *	220
R20	23.5	Robin Hill Rd. Marlborough	0.46	0.29	6.5	0.05	1.4	0.5 *	19.5	13	0.1	300
R19	21.7	Bigelow Rd. Berlin	0.36	0.24	5.5	0.04	1.1	2.8	19	2	0.05 *	400
R18	19.2	Chapin Rd. Hudson	0.22	0.17	6.4	0.09	0.29	1.6	23.1	9	0.05 *	180
R17	17.9	Hudson Center Impoundment	0.28	0.16	3	0.1	0.62	0.5 *	17.1	1	0.05 *	60
R16	17.6	South St. Hudson	0.22	0.14	2.5	0.13	0.68	0.5 *	17	3	0.05 *	680
R15	15.9	Cox St. Hudson**	0.345	0.12	2.35	0.04	0.995	0.5	18.15	0.5	0.05	600
R13	14.1	Gleasondale Impoundment	0.3	0.27	3.6	0.07	0.51	0.5 *	19.4	2	0.05 *	120
R12	13.9	Below Gleasondale Dam, Stow	0.34	0.26	4	0.07	0.35	1.7	17.5	2	0.1	260
R11	11.4	Boon Road, Stow	0.37	0.31	3	0.06	0.34	2.5	23.7	7	0.05 *	120
R10	9.2	White Pond Road, Maynard	0.47	0.22	0.47	0.05	0.36	2.8	23	15	0.2	10 *
R9	8.7	Ben Smith Impoundment	0.37	0.21	0.34	0.11	1	0.5 *	22	21	0.4	20
R8	8.6	Rt. 117/62 Maynard	0.42	0.22	0.3	0.2	0.62	2.4	25.1	23	0.2	20
R7	7.4	USGS Gauge, Maynard	0.2	0.16	0.32	0.05	0.35	0.5 *	18.6	24	0.05 *	460
R6	6.2	Powder Mill Impoundment	0.62	0.2	0.32	0.18	0.93	5.8	20.7	65	1.5	680
R5	6.1	Below Powder Mill Dam	0.27	0.2	0.55	0.14	0.93	1.5	21.5	16	0.05 *	4500
R4	4.4	Damonmill, Concord	0.19	0.16	0.65	0.015 *	0.69	0.5 *	15.5	11	0.05 *	200
R3	3.1	Rt. 62, Concord	0.17	0.15	0.78	0.04	0.66	1.6	16.4	6	0.05 *	520
R2	2.4	Rt. 2 Bridge, Concord**	0.22	0.18	0.975	0.03	0.665	3	18.9	5.5	0.05 *	2750

Notes:

1. * Indicates non-detect. Value is one-half the detection limit.

2. ** Indicates duplicate sample. Value is average of sample and duplicate.

3. Bold horizontal line indicates approximate impoundment dam locations.

Table 5-5 Summer 1999: Summary of Tributary Water Quality Laboratory Analysis

July 21, 1999:

Sample Location			Dissolved Oxygen (In situ) (mg/L)	Phosphorus		Nitrogen			Oxygen Demand		Solids		Bacteria
				Total-P	Ortho-P	Nitrates	Ammonia	TKN	BOD-5	BOD-30	TSS	Set. Solids	Fecal Col.
Station	RM	Description		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	per 100ml
T11	29.4	Hop Brook	4.52	0.06	0.06	0.22	0.05	0.52	2.6	23.3	15	0.05 *	120
T7	18.1	Hog Brook	8.05	0.06	0.03	0.37	0.06	0.84	1.6	17.6	2	0.05 *	240
T6	17.8	Mill Brook	7.62	0.04	0.04	0.33	0.21	1.2	0.5 *	20.7	5	0.1	800
T3	4.3	Second Division	5.5	0.10	0.04	0.24	0.10	1.2	2.4	22.9	17	0.3	620
T2	3.0	Nashoba Brook**	4.85	0.06	0.04	0.23	0.05	0.82	2	16.95	23.5	0.05 *	400

July 23, 1999:

Sample Location			Dissolved Oxygen (In situ) (mg/L)	Phosphorus		Nitrogen			Oxygen Demand		Solids		Bacteria
				Total-P	Ortho-P	Nitrates	Ammonia	TKN	BOD-5	BOD-30	TSS	Set. Solids	Fecal Col.
Station	RM	Description		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	per 100ml
T11	29.4	Hop Brook Trib.	8.46	0.06	0.03	0.75	0.06	0.46	3.1	21.3	6	0.05 *	50
T7	18.1	Hog Brook	11.19	0.05	0.03	0.45	0.06	0.86	1.9	17.7	4	0.05 *	100
T6	17.8	Mill Brook	7.61	0.05	0.03	0.57	0.17	1.55	2.05	17.4	7	0.1	825
T3	4.3	Second Division**	4.64	0.125	0.04	0.245	0.07	0.87	2.7	17	66	0.45	275
T2	3.0	Nashoba Brook	6.17	0.07	0.02	0.17	0.06	0.87	2.8	17.5	9	0.05 *	150

Notes:

1. *** Indicates non-detect. Value is one-half the detection limit.**
2. **** Indicates duplicate sample. Value is average of sample and duplicate.**
3. **Bold horizontal line indicates approximate impoundment locations.**

Table 5-6 Summer 2000: Summary of POTW Flows, Nutrient Concentrations, and Nutrient Loadings

Parameter	Units	Westboro RM 30 8/29/2000	Marlborough West RM 23.6 8/29/2000	Hudson RM 15.7 9/4/2000	Maynard RM 6.7 9/4/2000	Total
Flow	cfs	6.9	3.2	2.7	1.4	14.2
Total P Load	lb/day	32.4	3.5	23.0	5.34	64.3
Ortho P Load	lb/day	32.8	3.5	18.7	4.04	59.0
Total N Load	lb/day	330	374	288	104	1,100
Nitrate Load**	lb/day	287	352 **	288	89.5 **	1,020
BOD Load	lb/day	74.4	55.9	28.8	26.5	186
Total P	mg/l	0.87	0.2	1.6	0.70	
DP	mg/l	0.88	0.2	1.3	0.53	
Total N*	mg/l	8.87	21.4	20	13.70	
TKN	mg/l	1.12	1.3	0.01	1.87	
NH3	mg/l	--	0.1	0.01	0.8	
NO2	mg/l	0.05	--	0.01	--	
NO3	mg/l	7.7	--	20	--	
NO2+NO3	mg/l	--	20.1	--	11.8	
BOD	mg/l	2	3.2	2	3.5	
TSS	mg/l	3	3	6	2	

Notes:
*Total N was calculated based on: Total N = (TKN + NO2 + NO3)
**Calculated based on: dissolved-P = 0.90 * Total-P

Table 5-7 Summer 2000: Summary of River Synoptic In-Situ DO concentration, Temperature and pH Measurements

Station	Rivermile	Description	Max DO	Min DO	Δ DO	Max %DO	Min %DO	Δ %DO	Max Temp (°C)	Min Temp (°C)	Max pH	Min pH
R28	30.7	Maynard St. Westboro	9.54	8.50	1.04	103.7	89.1	14.6	71.9	60.9	7.69	7.30
R27	29.8	Rt. 9 Westboro	7.72	4.56	3.16	89.9	50.8	39.1	73.2	67.7	6.90	6.59
R26	28.9	Rt. 135 Westboro	7.88	4.22	3.66	94.4	45.9	48.5	75.9	65.8	7.06	6.73
R25	28.0	School St. Northboro	7.28	4.47	2.81	84.8	49.7	35.1	73.3	65.8	6.97	6.74
R24	25.9	River St. Northboro	9.14	7.94	1.20	105.4	86.5	18.9	72.4	65.8	7.23	7.09
R23	25.1	Allen St. Impoundment	13.11	5.22	7.89	148.4	56.6	91.8	72.9	65.7	7.92	6.93
R22	25.0	Below Allen St. Impoundment	8.93	8.08	0.85	101.7	90.0	11.7	71.1	67.3	7.99	7.09
R21	23.9	Boundary St. Marlboro	12.28	6.51	5.77	146.4	70.5	75.9	75.4	65.2	8.22	6.91
R20	23.5	Robin Hill Rd. Marlboro	10.22	5.46	4.76	117.2	59.0	58.2	71.5	66.1	7.40	6.93
R19	21.7	Bigelow Rd. Berlin	11.98	5.15	6.83	140.8	57.0	83.8	74.0	66.0	8.23	6.90
R18	19.2	Chapin Rd. Hudson	11.74	5.91	5.83	135.4	64.8	70.6	74.4	67.7	7.96	6.94
R17	17.9	Hudson Center Impoundment	13.99	5.56	8.43	168.5	62.0	106.5	76.1	69.1	8.57	6.87
R16	17.6	South St., Hudson	9.32	7.76	1.56	109.0	86.9	22.1	75.4	69.5	7.90	7.16
R15	15.9	Cox St. Hudson	13.23	4.33	8.90	155.9	48.7	107.2	76.0	68.1	8.66	7.00
R14	15.8	Below Cox St. Hudson	11.37	4.75	6.62	129.7	52.0	77.7	67.3	71.2	6.97	7.89
R13	14.1	Gleasondale Impoundment	9.87	7.85	2.02	112.5	91.5	21.0	74.5	69.5	7.32	7.02
R12	13.9	Below Gleasondale Dam, Stow	9.78	8.02	1.76	110.8	93.4	17.4	75.0	70.1	7.58	7.23
R11	11.4	Boon Road, Stow	9.87	8.10	1.77	116.1	36.6	79.5	75.9	71.5	7.90	7.24
R10	9.2	White Pond Road, Maynard	12.51	9.40	3.11	154.3	108.1	46.2	78.9	72.2	9.16	7.32
R9	8.7	Ben Smith Impoundment	18.20	2.56	15.64	222.2	28.5	193.7	78.3	68.1	9.82	6.72
R8	8.6	Rt. 117/62 Maynard	9.49	7.79	1.70	112.7	90.7	22.0	78.7	69.9	8.73	7.22
R7	7.4	USGS Gauge, Maynard	8.66	6.48	2.18	103.7	74.7	29.0	77.5	69.9	7.84	7.22
R6	6.2	Powder Mill Impoundment	8.80	4.14	4.66	104.3	48.0	56.3	75.4	69.9	7.90	6.96
R5	6.1	Below Powder Mill Dam	9.98	7.64	2.34	118.9	88.3	30.6	76.2	72.3	7.57	7.40
R4	4.4	Damonmill, Concord	13.23	6.16	7.07	162.1	70.2	91.9	80.0	69.0	9.21	7.04
R3	3.1	Rt. 62, Concord	14.41	6.07	8.34	163.0	68.7	94.3	78.6	67.3	8.88	7.13
R2	2.4	Rt. 2 Bridge, Concord	12.80	6.24	6.56	151.3	70.7	80.6	78.2	67.2	8.78	6.97
R1	1.6	Park Street, Concord	12.49	6.34	6.15	152.2	71.6	80.6	77.4	67.2	8.65	7.01

Note: Bold horizontal line indicates approximate impoundment locations.

Table 5-8 Summer 2000: Summary of Tributary Synoptic In-Situ DO concentration, Temperature and pH Measurements

Station	Rivermile	Description	Max DO	Min DO	Δ DO	Max %DO	Min %DO	Δ %DO	Max Temp (°C)	Min Temp (°C)	Max pH	Min pH
T11	29.4	Hop Brook, Westboro	7.89	7.23	0.66	92.2	79.5	12.7	73.6	67.9	7.20	6.87
T10	26.0	Cold Harbor Brook, Northboro	7.62	4.53	3.09	71.2	46.4	24.8	65.9	61.0	6.92	6.60
T9	24.3	Stirrup Brook, Marlborough	4.47	3.64		47.0	36.0	11.0	64.3	58.9	6.75	6.56
T8	22.4	North Brook, Berlin	7.83	7.56	0.27	85.1	82.5	2.6	70.1	47.5	7.11	6.96
T7	18.1	Hog Brook, Hudson	13.00	8.34	4.66	155.6	88.2	67.4	75.3	64.5	9.26	7.21
T6	17.8	Mill Brook, Hudson	7.66	6.85	0.81	86.6	79.3	7.3	72.7	69.0	7.13	7.03
T5	12.9	Ft. Meadow Brook, Hudson	10.06	8.87	1.19	103.5	94.9	8.6	65.3	62.1	7.50	7.29
T4	9.4	Elizabeth Brook, Maynard	3.68	3.01	0.67	41.6	32.5	9.1	70.4	65.8	6.56	6.41
T3	4.3	Second Division Brook, Concord	6.40	6.10	0.30	69.9	69.2	0.7	69.8	66.6	7.10	6.92
T2	3.0	Nashoba Brook, Concord	11.34	6.40	4.94	125.0	73.1	51.9	71.5	69.0	6.95	6.88
T1	1.3	Spencer Brook, Concord	8.89	6.72	2.17	95.8	76.0	19.8	70.6	66.1	6.97	6.69

Table 5-9 Summer 2000: Summary of River Impoundment Synoptic In-Situ Water Quality Measurements

Station	RM	Description	Time	Dept (ft)	DO (mg/L)	Temp (^{0}C)	pH	Secci Depth (ft)	Total Depth (ft)
R23	25.1	Allen St. Impoundment	5:50					4.5	4.5
		Surface		1	8.5	19.82	7.15		
		Middle		2.5	8.2	19.76	7.11		
		Bottom		4	7.3	19.77	7.11		
R17	17.9	Hudson Center Impoundment	6:40					9	9
		Surface		1	9.4	20.85	7.28		
		Middle		4	9.5	20.88	7.19		
		Bottom		6	8.4	20.85	7		
R13	14.1	Gleasondale Impoundment	7:55					9	9
		Surface		1	8.8	20.82	7.13		
		Middle		4	8.8	20.83	7.08		
		Bottom		8	8.8	20.82	7.07		
R9	8.7	Ben Smith Impoundment	10:35					4.5	9
		Surface		1	10.4	22.5	7.96		
		Middle		3	9.2	22.11	7.52		
		Bottom		6	7.5	20.2	6.94		
R6	6.2	Powder Mill Impoundment	9:25					8	8.5
		Surface		1	8.3	22.41	7.67		
		Middle		3	7.6	22.21	7.58		
		Bottom		6	4.9	21.59	7.15		

Table 5-10 Summer 2000: Summary of Assabet River Water Quality Laboratory Analysis Measurements

Sample Location			Phosphorus		Nitrogen			Oxygen Demand		Solids		Bacteria
Station	Rivermile	Description	Total-P mg/L	Ortho-P mg/L	Nitrates mg/L	Ammonia mg/L	TKN mg/L	BOD-5 mg/L	BOD-30 mg/L	TSS mg/L	Set. Solids mg/L	Fecal Col. per 100ml
R28	30.7	Maynard St. Westboro	0.04	0.01	1.2	0.05	0.53	0.25 *	9.9	11	0.1 *	200
R27	29.8	Rt. 9 Westboro	0.93	0.79	4.2	0.44	2.9	1.9	15	9	0.2	200
R26	28.9	Rt. 135 Westboro	0.79	0.71	4.6	0.08	0.96	2	14.4	6	0.1 *	360
R25	28.0	School St. Northboro	0.73	0.67	4	0.14	1.7	2.3	14.2	6	0.1 *	100
R24	25.9	River St. Northboro	0.455	0.425	2.9	0.07	1.25	0.25 *	12.05	11.5	0.1 *	360
R23	25.1	Allen St. Impoundment	0.49	0.44	3.1	0.09	0.82	0.25 *	12.2	14	0.1 *	240
R22	25.0	Below Allen St. Impoundment	0.47	0.42	3.9	0.06	0.82	1.3	12.1	12	0.1 *	220
R21	23.9	Boundary St. Marlboro	0.37	0.35	3.7	0.04	0.57	0.25 *	11.1	5	0.1 *	180
R20	23.5	Robin Hill Rd. Marlboro	0.26	0.2	6.2	0.06	0.8	0.25 *	11.7	6	0.1 *	120
R19	21.7	Bigelow Rd. Berlin	0.18	0.14	5.2	0.05	0.71	0.25 *	14.7	9	0.1 *	40
R18	19.2	Chapin Rd. Hudson	0.14	0.11	4.1	0.07	1.1	0.25 *	12.9	8	0.1 *	100
R17	17.9	Hudson Center Impoundment**	0.115	0.055	3.35	0.11	1.35	0.25 *	8.85	6.5	0.1 *	50
R16	17.6	South St., Hudson	0.12	0.08	2.8	0.08	1.3	0.25 *	11.3	12	0.1 *	280
R15	15.9	Cox St. Hudson	0.11	0.06	2.1	0.09	1.5	0.25 *	11.5	9	0.1 *	1700
R14	15.8	Below Cox St. Hudson	0.61	0.45	4.4	0.07	0.81	0.25 *	9.8	10	0.1 *	560
R13	14.1	Gleasondale Impoundment	0.45	0.3	3.7	0.09	0.84	0.25 *	11.3	9	0.1 *	80
R12	13.9	Below Gleasondale Dam, Stow	0.43	0.36	3.4	0.08	0.67	0.25 *	8.4	10	0.1 *	260
R11	11.4	Boon Road, Stow	0.16	0.12	2.1	0.05	0.7	0.25 *	11.3	9	0.1 *	80
R10	9.2	White Pond Road, Maynard	0.11	0.06	1.1	0.04	0.53	0.25 *	11	28	1.2	20
R9	8.7	Ben Smith Impoundment	0.12	0.04	0.76	0.04	0.61	0.8	13.3	6	0.1 *	10 *
R8	8.6	Rt. 117/62 Maynard	0.13	0.05	0.74	0.05	0.59	1.4	10.9	6	0.8	40
R7	7.4	USGS Gauge, Maynard	0.08	0.05	0.69	0.06	0.77	0.8	11.6	7	0.1 *	60
R6	6.2	Powder Mill Impoundment**	0.09	0.045	0.92	0.105	1.25	0.25 *	10.1	10.5	0.1 *	160
R5	6.1	Below Powder Mill Dam	0.11	0.075	0.825	0.055	0.58	0.25 *	12.1	17	0.2	190
R4	4.4	Damonmill, Concord	0.08	0.06	0.86	0.04	0.52	0.25 *	3	8	0.1 *	120
R3	3.1	Rt. 62, Concord	0.07	0.05	1	0.04	0.48	0.25 *	8.5	9	0.1 *	120
R2	2.4	Rt. 2 Bridge, Concord	0.07	0.05	0.84	0.05	0.51	0.25 *	9	3	0.1 *	120
R1	1.6	Park Street, Concord	0.06	0.04	0.87	0.03	0.42	0.25 *	13	5	0.1 *	80

Notes: Bold horizontal line indicates approximate impoundment locations.
* Indicates non-detect. Value is one-half the detection limit.
** Indicates duplicate sample. Value is average of sample and duplicate.

Table 5-11 Summer 2000: Summary of Tributary Water Quality Laboratory Analysis Measurements

Sample Location			Phosphorus		Nitrogen			Oxygen Demand		Solids		Bacteria
Station	Rivermile	Description	Total-P mg/L	Ortho-P mg/L	Nitrates mg/L	Ammonia mg/L	TKN mg/L	BOD-5 mg/L	BOD-30 mg/L	TSS mg/L	Set. Solids mg/L	Fecal Col. per 100ml
T11	29.4	Hop Brook, Westboro	0.04	0.02	0.06	0.16	2.1	0.9	11.2	11	0.1 *	20
T10	26.0	Cold Harbor Brook, Northboro	0.02	0.01	0.24	0.06	0.69	0.25 *	13.2	3	0.1 *	380
T9	24.3	Stirrup Brook, Marlborough	0.05	0.02	0.76	0.06	0.72	2.8	14.9	7	0.1 *	100
T8	22.4	North Brook, Berlin	0.02	0.005 *	0.13	0.06	0.82	0.25 *	15.5	7	0.8	20
T7	18.1	Hog Brook, Hudson	0.02	0.005 *	0.08	0.05	0.61	0.25 *	12.6	6	0.1 *	20
T6	17.8	Mill Brook, Hudson	0.04	0.02	0.15	0.12	1.6	0.8	12	31	1.6	100
T5	12.9	Ft. Meadow Brook, Hudson	0.02	0.005 *	0.26	0.04	0.61	0.25 *	9.8	7	0.1 *	180
T4	9.4	Elizabeth Brook, Maynard	0.02	0.01	0.06	0.015 *	0.04	1.2	13	16	0.2	20
T3	4.3	Second Division Brook, Acton	0.02	0.005 *	0.04	0.06	0.66	0.25 *	9	10	0.4	20
T2	3.0	Nashoba Brook, Concord	0.03	0.01	0.16	0.05	0.54	0.25 *	2	5	0.1 *	10 *
T1	1.3	Spencer Brook, Concord	0.04	0.02	0.04	0.04	0.5	0.25 *	15	6	0.1 *	60

Notes:
* Indicates non-detect. Value is one-half the detection limit.
** Indicates duplicate sample. Value is average of sample and duplicate.

Table 5–12 Dry-weather Surveys: Summary of POTW Flows, Nutrient Concentrations, and Nutrient Loadings

Dry-weather Survey – January 18-19, 2000						
		WESTBORO	MARLBOROUGH	HUDSON	MAYNARD	
PARAMETER	UNITS	RM 30	RM 23.6	RM 15.7	RM 6.7	TOTAL
		1/18/2000	2/2/2000	1/19/2000	1/19/2000	
Flow	cfs	8.0	2.7	3.2	1.5	15.5
Total P Load	lb/day	223	84.4	29.3	20.6	357
Ortho P Load	lb/day	221	108	26.4	14.9	370
Total N Load	lb/day	309	161	337	165	972
Nitrate Load	lb/day	255	108	327	114	805
BOD Load	lb/day	43.3	130	68.9	81.2	324
Total P	mg/l	5.14	5.7	1.7	2.54	
DP	mg/l	5.09	7.3	1.53 **	1.83	
Total N*	mg/l	7.12	10.9	19.5	20.3	
TKN	mg/l	1.12	3.6	0.53	6.3	
NH3	mg/l	-----	8.3	0.09	6.7	
NO2	mg/l	0.11	-----	-----	-----	
NO3	mg/l	5.89	-----	19.0	-----	
NO2+NO3	mg/l	-----	7.3	-----	14	
BOD	mg/l	1.0	8.8	4.0	10	
TSS	mg/l	9.2	5.6	15	4.0	
Dry-weather Survey – February 8-9, 2000						
		WESTBORO	MARLBOROUGH	HUDSON	MAYNARD	
PARAMETER	UNITS	RM 30	RM 23.6	RM 15.7	RM 6.7	TOTAL
		2/16/2000	2/16/2000	2/16/2000	2/16/2000	
Flow	cfs	7.0	3.5	3.2	1.6	15.4
Total P Load	lb/day	95.3	96.4	9.05	25.4	226
Ortho P Load	lb/day	95.3	75.6	8.15	18.3	197
Total N Load	lb/day	270	1,186	314	204.	1,970
Nitrate Load	lb/day	224	1,033	313	88.4	1,660
BOD Load	lb/day	76.0	193	34.8	113	416
Total P	mg/l	2.51	5.1	0.52	2.93	
DP	mg/l	2.51	4	0.47 **	2.11	
Total N*	mg/l	7.12	62.7	18.02	23.5	
TKN	mg/l	1.12	8.1	0.01	13.3	
NH3	mg/l	-----	7.2	0.01	10.3	
NO2	mg/l	0.11	-----	0.01	-----	
NO3	mg/l	5.89	-----	18	-----	
NO2+NO3	mg/l	-----	54.6	-----	10.2	
BOD	mg/l	2	10.2	2	13	
TSS	mg/l	3.8	7.4	11	18	

Table 5-12 Dry-weather Surveys: Summary of POTW Flows, Nutrient Concentrations, and Nutrient Loadings (continued)

Dry-weather Survey - March 27, 2000						
		WESTBORO	MARLBOROUGH	HUDSON	MAYNARD	
PARAMETER	UNITS	RM 30	RM 23.6	RM 15.7	RM 6.7	TOTAL
		4/5/2000	4/5/2000	4/5/2000	4/5/2000	
Flow	cfs	9.0	4.3	4.0	1.9	19.2
Total P Load	lb/day	39.7	16.1	14.2	13.6	83.7
Ortho P Load	lb/day	35.4	4.60	12.8	3.89	56.6
Total N Load	lb/day	431	216	267	200	1,110
Nitrate Load	lb/day	348	46.0	262	131	787
BOD Load	lb/day	48.4	324	87.4	114	575
Total P	mg/l	0.82	0.7	0.65	1.31	
DP	mg/l	0.73	0.2	0.59 **	0.37	
Total N*	mg/l	8.89	9.4	12.2	19.3	
TKN	mg/l	1.6	7.4	0.23	6.66	
NH3	mg/l	----	5.3	0.08	4.92	
NO2	mg/l	0.11	----	----	----	
NO3	mg/l	7.18	----	----	----	
NO2+NO3	mg/l	----	2	12	12.6	
BOD	mg/l	1	14.1	4	11	
TSS	mg/l	4	8	20	7	

Notes:
*Total N was calculated based on: Total N = (TKN + NO2 + NO3)
**Calculated based on: dissolved-P = 0.90 * Total-P

Table 5-13 Dry-weather Surveys: Summary of In-Situ DO concentration, Temperature and pH Measurements

			January Survey				February Survey				March Survey			
Station	Rivermile	Description	Temp.	pH	DO (mg/L)	Sp. Cond	Temp.	pH	DO (mg/L)	Sp. Cond	Temp.	pH	DO (mg/L)	Sp. Cond
R28	30.7	Maynard St. Westboro	32.9	5.99	14.2	139.00	34.3	6.05	18.6	216.00	48.1	6.20	12.56	117.00
R24	25.9	River St. Northboro	32.2	6.53	15.14	210.00	32.7	6.39	15.98	484.00	46.5	6.64	12.47	271.00
R23	25.1	Allen St. Impoundment												
R21	23.9	Boundary St. Marlboro	32.1	6.79	15.02	103.00	33.8	6.93	16.13	579.00	47.8	6.88	12.23	283.00
R19	21.7	Bigelow Rd. Berlin	32.3	6.90	16.15	310.00	35.4	6.91	16.3	507.00	47.9	6.86	11.72	250.00
R17	17.9	Hudson Center Impoundment												
R16	17.6	South St., Hudson	32.8	7.38	15.24	319.00	32.8	6.87	16.13	516.00	50.8	7.06	12.04	250.00
R15	15.9	Cox St. Hudson	32.1	6.31	13.63	363.00	32.4	6.79	16.14	482.00	52.3	7.01	12.51	238.00
R13	14.1	Gleasondale Impoundment												
R12	13.9	Below Gleasondale Dam, Stow	32.8	7.26	15.48	309.00	32.3	6.53	15.35	498.00	52.1	7.07	12.2	249.00
R9	8.7	Ben Smith Impoundment												
R7	7.4	USGS Gauge, Maynard	32.7	6.78	14.22	329.00	32.9	6.75	15.94	432.00	53.2	7.32	12.62	219.00
R6	6.2	Powder Mill Impoundment												
R5	6.1	Below Powder Mill Dam	32.7	6.94	13.89	326.00	32.8	6.76	16.57	437.00	53.6	7.08	12.15	221.00
R3	3.1	Rt. 62, Concord	32.1	7.12	14.12	303.00	32.2	6.76	16.58	430.00	54.4	7.11	12.44	218.00

Table 5-14 Dry-weather Surveys: Summary of Assabet River Water Quality Laboratory Analysis Measurements

January Survey: January 18-19, 2000

Sample Location			Phosphorus		Nitrogen			Oxygen Demand		Solids		Bacteria
			Total-P	Ortho-P	Nitrates	Ammonia	TKN	BOD-5	BOD-30	TSS	Set. Solids	Fecal Col.
Station	Rivermile	Description	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	per 100ml
R28	30.7	Maynard St. Westboro	0.06	0.005 *	0.16	0.04	0.41	0.8	1.7	2	0.05 *	13
R24	25.9	River St. Northboro	0.46	0.31	1.7	0.06	0.58	0.25 *	2.9	2	0.05 *	30
R23	25.1	Allen St. Impoundment										
R21	23.9	Boundary St. Marlboro	0.585	0.515	2.2	0.06	0.465	0.25 *	0.25 *	0.5 *	0.05 *	46
R19	21.7	Bigelow Rd. Berlin	0.52	0.37	1.9	0.12	0.53	1.1	1.5	2	0.05 *	21
R17	17.9	Hudson Center Impoundment										
R16	17.6	South St., Hudson	0.4	0.32	2.1	0.05	0.49	0.25 *	0.25 *	3	0.05 *	12
R15	15.9	Cox St. Hudson	0.38	0.29	2.1	0.015 *	0.24	0.25 *	3.9	1	0.05 *	20
R13	14.1	Gleasondale Impoundment										
R12	13.9	Below Gleasondale Dam, Stow	0.49	0.31	2.4	0.05	0.62	0.25 *	1.4	1	0.05 *	22
R9	8.7	Ben Smith Impoundment										
R7	7.4	USGS Gauge, Maynard	0.24	0.21	1.6	0.03	0.26	7.9	9.2	2	0.05 *	20
R6	6.2	Powder Mill Impoundment										
R5	6.1	Below Powder Mill Dam	0.44	0.215	1.6	0.06	0.42	0.25 *	9.4	1.25	0.05 *	33
R3	3.1	Rt. 62, Concord	0.31	0.2	1.6	0.09	0.45	0.25 *	8.8	2	0.05 *	50

February Survey: February 8-9, 2000

Sample Location			Phosphorus		Nitrogen			Oxygen Demand		Solids		Bacteria
			Total-P	Ortho-P	Nitrates	Ammonia	TKN	BOD-5	BOD-30	TSS	Set. Solids	Fecal Col.
Station	Rivermile	Description	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	per 100ml
R28	30.7	Maynard St. Westboro	0.02	0.005 *	0.19	0.065	0.355	0.25 *	11.65	6.5	0.5 *	43
R24	25.9	River St. Northboro	0.39	0.34	1.6	0.09	0.35	0.25 *	13	9	0.5 *	62
R23	25.1	Allen St. Impoundment										
R21	23.9	Boundary St. Marlboro	0.76	0.73	2.7	0.13	0.48	0.25 *	11	8	0.1	68
R19	21.7	Bigelow Rd. Berlin	0.89	0.76	2.8	0.51	0.74	0.25 *	12	10	0.2	22
R17	17.9	Hudson Center Impoundment										
R16	17.6	South St., Hudson	0.73	0.64	2.4	0.34	0.53	0.25 *	11	7	0.5 *	380
R15	15.9	Cox St. Hudson	0.56	0.52	2.1	0.3	0.46	0.25 *	9.4	7	0.5 *	120
R13	14.1	Gleasondale Impoundment										
R12	13.9	Below Gleasondale Dam, Stow	0.64	0.56	2.8	0.39	0.78	1.1	9	6	0.5 *	220
R9	8.7	Ben Smith Impoundment										
R7	7.4	USGS Gauge, Maynard	0.36	0.32	2.05	0.14	0.515	0.25 *	5.8	5.5	0.5 *	690
R6	6.2	Powder Mill Impoundment										
R5	6.1	Below Powder Mill Dam	0.4	0.37	2	0.41	0.98	0.25 *	7.3	9	0.5 *	95
R3	3.1	Rt. 62, Concord	0.4	0.3	1.9	0.39	0.86	0.25 *	7.4	10	0.5 *	75

Table 5-14 Dry-weather Surveys: Summary of Assabet River Water Quality Laboratory Analysis Measurements (continued)

March Survey: March 27, 2000

Sample Location			Phosphorus		Nitrogen			Oxygen Demand		Solids		Bacteria
Station	Rivermile	Description	Total-P mg/L	Ortho-P mg/L	Nitrates mg/L	Ammonia mg/L	TKN mg/L	BOD-5 mg/L	BOD-30 mg/L	TSS mg/L	Set. Solids mg/L	Fecal Col. per 100ml
R28	30.7	Maynard St. Westboro	0.05	0.005 *	0.25	0.04	0.44	1.1	NA	7.0	0.1 *	6 *
R24	25.9	River St. Northboro	0.205	0.185	0.845	0.045	0.46	0.25 *	NA	3	0.1 *	20
R23	25.1	Allen St. Impoundment										
R21	23.9	Boundary St. Marlboro	0.38	0.26	0.91	0.04	0.44	0.5	NA	5	0.6	90
R19	21.7	Bigelow Rd. Berlin	0.23	0.16	0.93	0.05	0.46	0.25 *	NA	9	1.4	10
R17	17.9	Hudson Center Impoundment										
R16	17.6	South St., Hudson	0.23	0.1	0.79	0.06	0.51	0.25 *	NA	7	1.0	5 *
R15	15.9	Cox St. Hudson	0.14	0.09	0.75	0.04	0.42	0.25 *	NA	3	0.1 *	40
R13	14.1	Gleasondale Impoundment										
R12	13.9	Below Gleasondale Dam, Stow	0.24	0.13	1	0.015 *	0.025 *	0.25 *	NA	3	1.0	90
R9	8.7	Ben Smith Impoundment						0.05				
R7	7.4	USGS Gauge, Maynard	0.18	0.09	0.62	0.05	0.42	0.25 *	NA	4	0.1 *	20
R6	6.2	Powder Mill Impoundment										
R5	6.1	Below Powder Mill Dam	0.25	0.13	0.73	0.14	0.69	0.25 *	NA	8.0	0.1 *	55
R3	3.1	Rt. 62, Concord	0.20	0.10	0.68	0.08	0.46	0.25 *	NA	2.0	0.6	20

Notes:

1. * Indicates non-detect. Value is one-half the detection limit.
2. ** Indicates duplicate sample. Value is average of sample and duplicate.
3. Bold horizontal line indicates approximate impoundment locations.

Table 5-15 Dry-weather Surveys: Summary of Tributary Water Quality Laboratory Analysis Measurements

January Survey

Sample Location			Phosphorus		Nitrogen			Oxygen Demand		Solids		Bacteria
Station	Rivermile	Description	Total-P mg/L	Ortho-P mg/L	Nitrates mg/L	Ammonia mg/L	TKN mg/L	BOD-5 mg/L	BOD-30 mg/L	TSS mg/L	Set. Solids mg/L	Fecal Col. per 100ml
T11	29.4	Hop Brook, Westboro	0.08	0.005 *	0.8	0.04	0.32	0.25 *	1.3	1	0.05 *	8
T10	26.0	Cold Harbor Brook, Northboro	0.15	0.005 *	0.64	0.05	0.43	1.2	1.7	1	0.05 *	26
T8	22.4	North Brook, Berlin	0.14	0.005 *	0.47	0.07	0.45	0.25 *	0.25 *	2	0.05 *	4
T5	12.9	Ft. Meadow Brook, Hudson	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
T4	9.4	Elizabeth Brook, Maynard	0.14	0.005 *	0.31	0.015 *	0.19	0.25 *	6.2	0.5 *	0.05 *	3
T2	3.0	Nashoba Brook, Concord	0.18	0.005 *	0.87	0.11	0.67	0.25 *	6	5	0.05 *	11

February Survey

Sample Location			Phosphorus		Nitrogen			Oxygen Demand		Solids		Bacteria
Station	Rivermile	Description	Total-P mg/L	Ortho-P mg/L	Nitrates mg/L	Ammonia mg/L	TKN mg/L	BOD-5 mg/L	BOD-30 mg/L	TSS mg/L	Set. Solids mg/L	Fecal Col. per 100ml
T11	29.4	Hop Brook, Westboro	0.02	0.005 *	0.9	0.14	0.31	0.25 *	9.4	4	0.05 *	34
T10	26.0	Cold Harbor Brook, Northboro	0.05	0.005 *	0.71	0.08	0.27	1.2	10	7	0.2 *	1 *
T8	22.4	North Brook, Berlin	0.01	0.005 *	0.61	0.08	0.34	0.25 *	14.8	12	0.05 *	4
T5	12.9	Ft. Meadow Brook, Hudson	0.02	0.005 *	0.33	0.14	0.41	0.25 *	5	11	0.05 *	16
T4	9.4	Elizabeth Brook, Maynard	0.02	0.005 *	0.4	0.13	0.44	1	5	7	0.05 *	3
T2	3.0	Nashoba Brook, Concord	0.14	0.005 *	0.95	0.31	0.85	0.25 *	6.2	2	0.05 *	8

March Survey

Sample Location			Phosphorus		Nitrogen			Oxygen Demand		Solids		Bacteria
Station	Rivermile	Description	Total-P mg/L	Ortho-P mg/L	Nitrates mg/L	Ammonia mg/L	TKN mg/L	BOD-5 mg/L	BOD-30 mg/L	TSS mg/L	Set. Solids mg/L	Fecal Col. per 100ml
T11	29.4	Hop Brook, Westboro	0.36	0.005 *	0.56	0.04	0.39	0.25 *	NT	1	0.1 *	5 *
T10	26.0	Cold Harbor Brook, Northboro	0.23	0.005 *	0.31	0.03	0.32	0.25 *	NT	4	1 *	20
T8	22.4	North Brook, Berlin	0.03	0.005 *	0.38	0.04	0.38	0.25 *	NT	6.0	0.2	5 *
T5	12.9	Ft. Meadow Brook, Hudson	0.02	0.005 *	0.37	0.05	0.39	0.25 *	NT	6	0.8	5 *
T4	9.4	Elizabeth Brook, Maynard	0.05 *	0.005 *	0.11	0.05	0.44	0.5	NT	3	0.1 *	5 *
T2	3.0	Nashoba Brook, Concord	0.07	0.005 *	0.45	0.04	0.3	0.25 *	NT	2	0.1 *	40

Notes:
1. * Indicates non-detect. Value is one-half the detection limit.
2. ** Indicates duplicate sample. Value is average of sample and duplicate.
3. NA – Sample not taken at location due to frozen conditions.

Table 5-16 Wet-weather Surveys: Summary of POTW Loads, Nutrient Concentrations and Nutrient Loadings

Wet-weather Survey - March 16, 2000						
		WESTBORO	MARLBOROUGH	HUDSON	MAYNARD	
PARAMETER	UNITS	RM 30	RM 23.6	RM 15.7	RM 6.7	TOTAL
		3/9/2000	3/15/2000	3/15/2000	3/16/2000	
Flow	cfs	10.2	4.7	4.7	2.2	21.7
Total P Load	lb/day	214	50	28	24	316
Ortho P Load	lb/day	208	50	25	22	305
Total N Load	lb/day	489	181	332	193	1,200
Nitrate Load	lb/day	395	71	327	84	877
BOD Load	lb/day	55	136	50	123	364
Total P	mg/l	3.89	2	1.1	2.04	
DP	mg/l	3.77	2	0.99 **	1.88	
Total N*	mg/l	8.89	7.2	13.18	16.67	
TKN	mg/l	1.6	4.4	0.17	9.47	
NH3	mg/l	----	5.1	----	8.9	
NO2	mg/l	0.11	----	0.01	----	
NO3	mg/l	7.18	----	13	----	
NO2+NO3	mg/l	----	2.8	----	7.2	
BOD	mg/l	1	5.4	2	10.6	
TSS	mg/l	4.8	1.9	14	14	
Wet-weather Survey - March 27, 2000						
		WESTBORO	MARLBOROUGH	HUDSON	MAYNARD	
PARAMETER	UNITS	RM 30	RM 23.6	RM 15.7	RM 6.7	TOTAL
		4/5/2000	4/5/2000	4/5/2000	4/5/2000	
Flow	cfs	9.0	4.3	4.0	1.9	19.2
Total P Load	lb/day	39.7	16.1	14.2	13.6	83.7
Ortho P Load	lb/day	35.4	4.60	12.8	3.89	56.6
Total N Load	lb/day	431	216	267	200	1,110
Nitrate Load	lb/day	348	46.0	262	131	787
BOD Load	lb/day	48.4	324	87.4	114	575
Total P	mg/l	0.82	0.7	0.65	1.31	
DP	mg/l	0.73	0.2	0.59 **	0.374	
TotalN*	mg/l	8.89	9.4	12.23	19.26	
TKN	mg/l	1.6	7.4	0.23	6.66	
NH3	mg/l	----	5.3	0.08	4.92	
NO2	mg/l	0.11	----	----	----	
NO3	mg/l	7.18	----	----	----	
NO2+NO3	mg/l	----	2	12	12.6	
BOD	mg/l	1	14.1	4	11	
TSS	mg/l	5	8	20	7	

Table 5-16 Wet-weather Surveys: Summary of POTW Loads, Nutrient Concentrations and Nutrient Loadings (continued)

Wet-weather Survey - September 12, 2000						
		WESTBORO	MARLBOROUGH	HUDSON	MAYNARD	
PARAMETER	UNITS	RM 30	RM 23.6	RM 15.7	RM 6.7	TOTAL
		9/6/2000	9/6/2000	9/6/2000	9/6/2000	
Flow	cfs	6.5	3.0	2.5	1.3	13.3
Total P Load	lb/day	38.8	3.20	14.7	3.40	60.2
Ortho P Load	lb/day	35.0	1.60	11.2	2.25	50.1
Total N Load	lb/day	363	566	214	109	1,250
Nitrate Load	lb/day	344	539	214	93.4	1,190
BOD Load	lb/day	106	25.6	26.8	25.2	183
		WESTBORO	MARLBOROUGH	HUDSON	MAYNARD	
PARAMETER	UNITS	RM 30	RM 23.6	RM 15.7	RM 6.7	TOTAL
		9/6/2000	9/6/2000	9/6/2000	9/6/2000	
Total P	mg/l	1.1	0.2	1.1	0.47	
DP	mg/l	0.99 **	0.1	0.84	0.31	
Total N*	mg/l	10.29	35.4	16.02	15.23	
TKN	mg/l	0.5	1.7	0.01	2.23	
NH3	mg/l	----	0.1	0.01	1.32	
NO2	mg/l	0.05	----	0.01	----	
NO3	mg/l	9.74	----	16	----	
NO2+NO3	mg/l	----	33.7	----	13	
BOD	mg/l	3	1.6	2	3.5	
TSS	mg/l	4.1	3.6	6	4	

Notes:
*Total N was calculated based on: Total N = (TKN + NO2 + NO3)
**Calculated based on: dissolved-P = 0.90 * Total-P

Table 5-17 Wet-weather Surveys: Summary of In-Situ DO concentration, Temperature and pH Measurements

			March 27, 2000				September 12, 2000			
Station	Rivermile	Description	Temp.	pH	DO (mg/L)	Sp. Cond	Temp.	pH	DO (mg/L)	Sp. Cond
T11	29.4	Hop Brook, Westboro	50.9	6.51	11.39	293	68.6	7.92	9.98	542
T10	26.0	Cold Harbor Brook, Northboro	50.3	6.42	10.47	232	64.3	6.86	4.2	425
T9	24.3	Stirrup Brook, Marlborough	51.5	6.33	9.2	150	59.2	6.83	3.82	251
T8	22.4	North Brook, Berlin	50.3	6.55	11.33	88	66.5	6.99	7.54	156
T7	18.1	Hog Brook, Hudson	50.3	6.54	10.28	245	65.6	7.18	8.45	296
T6	17.8	Mill Brook, Hudson	50.6	6.63	11.46	125	69.5	7.07	7.38	183
T5	12.9	Ft. Meadow Brook, Hudson	50.6	6.59	11.12	197	65.5	7.14	7.28	329
T4	9.4	Elizabeth Brook, Maynard	53.0	6.51	11	163	67.6	6.48	2.73	256
T2	3.0	Nashoba Brook, Concord	51.7	6.63	11.16	199	70.0	6.98	2.17	282
T1	1.3	Spencer Brook, Concord	51.5	6.53	10.98	81	68.3	7.03	0.87	135

Table 5-18 Wet-weather Surveys: Summary of Tributary Water Quality Laboratory Analysis Measurements

March 16, 2000

Sample Location			Phosphorous		Nitrogen			Oxygen Demand		Solids		Bacteria
Station	Rivermile	Description	Total-P (mg/L)	Ortho-P (mg/L)	Nitrate (mg/L)	Ammonia (mg/L)	TKN (mg/L)	BOD-5 (mg/L)	BOD-30 (mg/L)	TSS (mg/L)	Set. Solids (ml/L)	Fecal Col. (per 100 ml)
T11	29.4	Hop Brook, Westboro	0.34	0.005 *	0.58	0.015 *	0.44	0.5 *	4.2	29	0.1 *	10
T10	26.0	Cold Harbor Brook, Northboro	0.19	0.005 *	0.6	0.015 *	0.52	0.5 *	4.3	47	0.1 *	5 *
T9	24.3	Stirrup Brook, Marlborough	0.77	0.005 *	0.19	0.015 *	0.32	1.8	4	56	0.2	5 *
T8	22.4	North Brook, Berlin	0.5	0.005 *	0.55	0.015 *	0.29	0.5 *	6	4	0.8	60
T7	18.1	Hog Brook, Hudson	0.61	0.005 *	0.48	0.015 *	0.34	0.5 *	3.9	39	0.2	50
T6	17.8	Mill Brook, Hudson	0.62	0.005 *	0.4	0.015 *	0.3	0.5 *	3.9	165	0.8	60
T5	12.9	Ft. Meadow Brook, Hudson	0.22	0.005 *	0.47	0.015 *	0.32	0.5 *	6.3	455	1.6	70
T4	9.4	Elizabeth Brook, Maynard	0.44	0.005 *	0.34	0.015 *	0.58	0.5 *	4.2	3	0.1 *	10
T2	3.0	Nashoba Brook, Concord	0.32	0.005 *	0.51	0.015 *	0.52	0.5 *	4.2	4	0.4	60
T1	1.3	Spencer Brook, Concord	0.3	0.005 *	0.16	0.04	0.96	0.5 *	3.6	7	0.4	5 *

March 27, 2000

Sample Location			Phosphorous		Nitrogen			Oxygen Demand		Solids		Bacteria
Station	Rivermile	Description	Total-P (mg/L)	Ortho-P (mg/L)	Nitrate (mg/L)	Ammonia (mg/L)	TKN (mg/L)	BOD-5 (mg/L)	BOD-30 (mg/L)	TSS (mg/L)	Set. Solids (ml/L)	Fecal Col. (per 100 ml)
T11	29.4	Hop Brook, Westboro	0.06	0.005 *	0.41	0.07	0.65	1.3	NT	57	0.2	30
T10	26.0	Cold Harbor Brook, Northboro	0.005 *	0.005 *	0.26	0.12	0.55	1.7	NT	73	1.4	80
T9	24.3	Stirrup Brook, Marlborough	0.02	0.005 *	0.03	0.12	0.41	2.9	NT	423	6	50
T8	22.4	North Brook, Berlin	0.06	0.005 *	0.4	0.12	0.46	0.7	NT	274	1.4	400
T7	18.1	Hog Brook, Hudson	0.07	0.005 *	0.2	0.13	0.43	0.25 *	NT	822	1.4	170
T6	17.8	Mill Brook, Hudson	0.1	0.005 *	0.23	0.15	0.63	0.9	NT	2010	10	300
T5	12.9	Ft. Meadow Brook, Hudson	0.11	0.005 *	0.32	0.18	0.7	1.9	NT	808	8	260
T4	9.4	Elizabeth Brook, Maynard	0.02	0.005 *	0.12	0.15	0.72	0.9	NT	21	0.01 *	500
T2	3.0	Nashoba Brook, Concord	0.05	0.005 *	0.55	0.27	0.88	0.6	NT	17	0.1 *	230
T1	1.3	Spencer Brook, Concord	0.2	0.005 *	0.09	0.08	0.79	0.7	NT	784	8	20

Table 5-18 Wet-weather Surveys: Summary of Tributary Water Quality Laboratory Analysis Measurements (continued)

September 12, 2000												
Sample Location			Phosphorus		Nitrogen			Oxygen Demand		Solids		Bacteria
Station	Rivermile	Description	Total-P mg/L	Ortho-P mg/L	Nitrates mg/L	Ammonia mg/L	TKN mg/L	BOD-5 (mg/L)	BOD-30 (mg/L)	TSS (mg/L)	Set. Solids (ml/L)	Fecal Col. (per 100 ml)
T11	29.4	Hop Brook, Westboro										
T10	26.0	Cold Harbor Brook, Northboro	0.03	0.01	0.04	0.1	1.2	4.1	12	9	0.4	2000
T9	24.3	Stirrup Brook, Marlborough	0.05	0.01	0.53	0.12	1.3	3.4	19	9	2.8	200
T8	22.4	North Brook, Berlin										
T7	18.1	Hog Brook, Hudson	0.27	0.01	0.17	0.17	1.75	4.6	20	308	1.5	165
T6	17.8	Mill Brook, Hudson	0.18	0.03	0.9	0.4	2.6	16.9	19	36	1.2	30
T5	12.9	Ft. Meadow Brook, Hudson	0.04	0.005 *	0.35	0.09	1.1	3.7	19	21	1.6	1000
T4	9.4	Elizabeth Brook, Maynard	0.005 *	0.01	0.005 *	0.18	1.2	3.3	11	16	0.1 *	100
T2	3.0	Nashoba Brook, Concord										
T1	1.3	Spencer Brook, Concord	0.41	0.01	0.005 *	0.23	1.8	8.2	15	167	2	60

Notes:
1. *Indicates non-detect. Value is one-half the detection limit.
2. **Indicates duplicate sample. Value is average of sample and duplicate.

Table 5-19 Assabet River Field Surveys: Water Quality Survey Reference Information Summary

Survey	Date(s)	Season	Met. Cond.	USGS, Maynard Streamflow (cfs)
Summer 1999 Intensive	July 19-21, 1999	Summer	Dry	15
Dry-weather #2	February 8, 2000	Winter	Dry	130
Wet-weather #1	March 16, 2000	Winter	Wet	375
Wet-weather #2	March 27, 2000	Winter	Wet	250
Summer 2000 Intensive	August 28-31, 2000	Summer	Dry	40
Sept. 12, 2000 Wet #3	September 12, 2000	Summer	Wet	30

Table 5-20 Ortho-Phosphorus Loadings to the Assabet River: A Compilation of Point Source and Non-Point Source and Non-Point Source Loadings During Six (6) Field Surveys

Sample Location		Watershed Area ($miles^2$)	Intensive Summer July 1999 Survey		Dry-weather Survey 2 - Feb. 8-9, 2000		Wet-weather Survey 1 - March 16, 2000		Wet-weather Survey 2 - March 27, 2000		Wet-weather Survey 3 - Sept. 12, 2000		Intensive Summer August 2000 Survey	
			Ortho-Phosphorus		Ortho-Phosphorus		Ortho-Phosphorus		Ortho-Phosphorus		Ortho-Phosphorus		Ortho-Phosphorus	
Rivermile	Description		Load lbs/day	% of Total	Load lbs/day	% of Total	Load lbs/day	% of Total	Load lbs/day	% of Total	Load lbs/day	% of Total	Load lbs/day	% of Total
Point Sources														
30	Westborough POTW		23.6	38	95.3	48	208	65	35.4	55	35.0	68	32.8	54
23.6	Marlborough POTW		17.3	28	75.6	38	50.4	16	4.60	7	1.6	3	3.5	6
15.7	Hudson POTW		15.2	25	8.15	4	24.9	8	12.8	20	11.2	22	18.7	31
6.7	Maynard POTW		3.45	6	18.3	9	21.8	7	3.89	6	2.25	4	4.04	7
Non-Point Sources														
29.7	Hop Brook	9.3	0.17	0.3	0.14 b	0.1	0.59 b	0.2	0.43 b	0.7	0.07 a	0.1	0.08	0.1
24.5	Cold Harbor Brook	11.5	0.11 a	0.2	0.20 a	0.1	0.62 b	0.2	0.45 b	0.7	0.08 a	0.2	0.02	0.0
23.1	Stirrup Brook	4.9	0.05 a	0.1	0.09 a	0.0	0.23 b	0.1	0.19 b	0.3	0.00	0.0	0.09	0.2
22.5	North Brook, Berlin	18	0.18 a	0.3	0.29 b	0.1	1.34 b	0.4	0.93 b	1.4	0.13 a	0.2	0.04 b	0.1
17.5	Hog Brook, Hudson	6.3	0.06 a	0.1	0.11 a	0.1	0.26 b	0.1	0.23 b	0.4	0.03	0.1	0.02 b	0.0
17.3	Mill Brook, Hudson	6.6	0.06 a	0.1	0.12 a	0.1	0.63 b	0.2	0.28 b	0.4	0.09	0.2	0.10	0.2
13.0	Ft. Meadow Brook	13.4	0.09 a	0.1	0.16 a	0.1	0.35 b	0.1	0.21 b	0.3	0.01 b	0.0	0.03 b	0.0
9.5	Elizabeth Brook, Maynard	20	0.20 a	0.3	0.38 b	0.2	2.08 b	0.7	1.19 b	1.8	0.24	0.5	0.21	0.3
4.3	Second Division Brook	2.13	0.02 a	0.0	0.04 a	0.0	0.17 a	0.1	0.10 a	0.1	0.01 a	0.0	0.02 a	0.0
3.0	Nashoba Brook	47.6	0.40	0.6	0.88 b	0.4	4.39 b	1.4	2.05 b	3.1	0.33 a	0.7	0.48	0.8
1.3	Spencer Brook, Concord	7.7	0.08 a	0.1	0.14 a	0.1	0.55 b	0.2	0.42 b	0.6	0.01	0.0	0.08	0.1
Other Non-point Sources		34.3	0.33	0.5	0.61	0.3	2.69	0.8	1.55	2.4	0.24	0.5	0.33	0.5
Source Totals														
Point Source Sub-Total			**59.5**	**97.2**	**197.**	**98.4**	**305.**	**95.6**	**56.6**	**87.6**	**50.1**	**97.6**	**59.0**	**97.5**
Non-Point Source Sub-Total			**1.74**	**2.8**	**3.14**	**1.6**	**13.9**	**4.4**	**8.04**	**12.4**	**1.24**	**2.4**	**1.5**	**2.5**
TOTAL			**61.3**	**100**	**200.**	**100**	**319.**	**100**	**65.0**	**100**	**52.1**	**100**	**60.8**	**100**

Notes:

a - Estimated values based on percentage of total watershed area. Total Load calculated using linear scaling of measured loads. Total Load = [sum of measured values * (177 / sum of watershed areas)]. Based on total Assabet River watershed area of 177 square miles

b - Ortho-phosphorous was non-detect in lab data, based on one-half detection limit of 0.01 mg/L.

Table 5-21 Total Phosphorus Loadings to the Assabet River: A Compilation of Point Source and Non-Point Source Loadings During Six (6) Field Surveys

			Intensive Summer July 1999 Survey		Dry-weather Survey 2 - Feb. 8-9, 2000		Wet-weather Survey 1 - March 16, 2000		Wet-weather Survey 2 - March 27, 2000		Wet-weather Survey 3 - Sept. 12, 2000		Intensive Summer August 2000 Survey	
Sample Location		Watershed	Total Phosphorus		Total Phosphorus		Total Phosphorus		Total Phosphorus		Total Phosphorus		Total Phosphorus	
Rivermile	Description	Area (miles^2)	Load lbs/day	% of Total	Load lbs/day	% of Total	Load lbs/day	% of Total	Load lbs/day	% of Total	Load lbs/day	% of Total	Load lbs/day	% of Total
Point Sources														
30	Westborough POTW		26.2	38	95.2	34	213.9	15	39.7	23	38.8	59	32.4	48
23.6	Marlborough POTW		17.3	25	96.4	35	50.3	4	16.1	9	3.20	5	3.50	5
15.7	Hudson POTW		16.9	25	9.0	3	27.7	2	14.2	8	14.7	22	23.0	34
6.7	Maynard POTW		5.6	8	25.4	9	23.6	2	13.6	8	3.40	5	5.34	8
Non-Point Sources														
29.7	Hop Brook	9.3	0.17	0.2	0.54	0.2	40.2	2.9	5.20	3.0	0.32 a	0.5	0.16	0.2
24.5	Cold Harbor Brook	11.5	0.15 a	0.2	3.30 a	1.2	23.7	1.7	0.45 b	0.3	0.40 a	0.6	0.05	0.1
23.1	Stirrup Brook	4.9	0.07 a	0.1	1.41 a	0.5	35.7	2.6	0.77	0.4	0.01	0.0	0.23	0.3
22.5	North Brook, Berlin	18	0.24 a	0.4	0.58	0.2	134	9.6	11.2	6.4	0.62 a	0.9	0.16	0.2
17.5	Hog Brook, Hudson	6.3	0.08 a	0.1	1.81 a	0.7	31.9	2.3	3.24	1.8	0.90	1.4	0.10	0.1
17.3	Mill Brook, Hudson	6.6	0.09 a	0.1	1.89 a	0.7	78.6	5.6	5.57	3.2	0.52	0.8	0.20	0.3
13.0	Ft. Meadow Brook	13.4	0.12 a	0.2	2.55 a	0.9	15.4	1.1	4.69	2.7	0.09	0.1	0.11	0.2
9.5	Elizabeth Brook, Maynard	20	0.27 a	0.4	1.50	0.5	183	13.2	4.78	2.7	0.12 b	0.2	0.42	0.6
4.3	Second Division Brook	2.13	0.03 a	0.0	0.61 a	0.2	12.9 a	0.9	1.10 a	0.6	0.07 a	0.1	0.05 a	0.1
3.0	Nashoba Brook	47.6	0.59	0.9	24.7	8.9	281	20.1	20.5	11.7	1.64 a	2.5	1.45	2.1
1.3	Spencer Brook, Concord	7.7	0.10 a	0.1	2.21 a	0.8	33.2	2.4	16.7	9.5	0.21	0.3	0.16	0.2
Other Non-point Sources		34.3	0.45	0.7	9.92	3.6	209	15.0	17.8	10.1	1.19	1.8	0.70	1.0
Source Totals														
Point Source Sub-Total			**66.0**	**96.5**	**226.**	**81.6**	**316.**	**22.6**	**83.7**	**47.6**	**60.1**	**90.8**	**64.3**	**94.5**
Non-Point Source Sub-Total			**2.36**	**3.5**	**51.0**	**18.4**	**1,080.**	**77.4**	**92.0**	**52.4**	**6.10**	**9.2**	**3.7**	**5.5**
TOTAL			**68.0**	**100**	**277.**	**100**	**1,390.**	**100**	**176.**	**100**	**66.2**	**100**	**68.0**	**100**

Notes:

a - Estimated values based on percentage of total watershed area. Total Load calculated using linear scaling of measured loads. Total Load = [sum of measured values * (177 / sum of watershed areas)]. Based on total Assabet River watershed area of 177 square miles

b – Total phosphorous was non-detect in lab data, based on one-half detection limit of 0.01 mg/L.

Table 5-22 Nitrate Loadings to the Assabet River: A Compilation of Point Source and Non-Point Source Loadings During Six (6) Field Surveys

Sample Location		Watershed Area ($miles^2$)	Intensive Summer July 1999 Survey		Dry-weather Survey 2 - Feb. 8-9, 2000		Wet-weather Survey 1 - March 16, 2000		Wet-weather Survey 2 - March 27, 2000		Wet-weather Survey 3 - Sept. 12, 2000		Intensive Summer August 2000 Survey	
			Nitrate		Nitrate		Nitrate		Nitrate		Nitrate		Nitrate	
Rivermile	Description		Load lbs/day	% of Total	Load lbs/day	% of Total	Load lbs/day	% of Total	Load lbs/day	% of Total	Load lbs/day	% of Total	Load lbs/day	% of Total
Point Sources														
30	Westborough POTW		335	32	224	10	395	18	348	26	344	29	287	28
23.6	Marlborough POTW		277	26	1033	48	70.5	3	46.0	3	538	45	352	34
15.7	Hudson POTW		324	31	313	15	327	15	262	20	214	18	288	28
6.7	Maynard POTW		107	10	88.4	5	83.5	4	131	10	93.4	8	89.5	9
Non-Point Sources														
29.7	Hop Brook	9.3	0.6	0.1	24.4	1.1	68.6	3.2	35.5	2.7	0.73 a	0.1	0.2	0.0
24.5	Cold Harbor Brook	11.5	0.6 a	0.1	31.1 a	1.5	75.0	3.5	23.5	1.8	0.90 a	0.1	0.6	0.1
23.1	Stirrup Brook	4.9	0.2 a	0.0	13.3 a	0.6	8.8	0.4	1.15	0.1	0.15	0.0	3.5	0.3
22.5	North Brook, Berlin	18	0.9 a	0.1	35.3	1.7	148	6.8	74.7	5.6	1.41 a	0.1	1.0	0.1
17.5	Hog Brook, Hudson	6.3	0.3 a	0.0	17.0 a	0.8	25.1	1.2	9.25	0.7	0.57	0.0	0.4	0.0
17.3	Mill Brook, Hudson	6.6	0.3 a	0.0	17.8 a	0.8	50.7	2.4	12.8	1.0	2.62	0.2	0.7	0.1
13.0	Ft. Meadow Brook	13.4	0.4 a	0.0	24.0 a	1.1	32.8	1.5	13.6	1.0	0.78	0.1	1.4	0.1
9.5	Elizabeth Brook, Maynard	20	1.0 a	0.1	30.1	1.4	142	6.6	28.7	2.2	0.11 b	0.0	1.3	0.1
4.3	Second Division Brook	2.13	0.1 a	0.0	5.8 a	0.3	15.4 a	0.7	6.5 a	0.5	0.17 a	0.0	0.3 a	0.0
3.0	Nashoba Brook	47.6	2.3	0.2	167	7.8	447	20.8	225	16.9	3.73 a	0.3	7.7	0.7
1.3	Spencer Brook, Concord	7.7	0.4 a	0.0	20.8 a	1.0	17.7	0.8	7.53	0.6	0.0 b	0.0	0.2	0.0
Other Non-point Sources		34.3	1.73	0.2	93.3	4.4	248	11.5	105	7.9	2.68	0.2	4.14	0.4
Source Totals														
Point Source Sub-Total			**1,040.**	**99.1**	**1,660.**	**77.5**	**877.**	**40.7**	**787.**	**59.1**	**1,190.**	**98.9**	**1,020.**	**97.9**
Non-Point Source Sub-Total			**8.98**	**0.9**	**480.**	**22.5**	**1,280.**	**59.3**	**544.**	**40.9**	**13.8**	**1.1**	**21.4**	**2.1**
TOTAL			**1,050.**	**100**	**2140.**	**100**	**2,160.**	**100**	**1,330.**	**100**	**1,200.**	**100**	**1,040.**	**100**

Notes:

a - Estimated values based on percentage of total watershed area. Total Load calculated using linear scaling of measured loads. Total Load = [sum of measured values * (177 / sum of watershed areas)]. Based on total Assabet River watershed area of 177 square miles

b - Nitrate was non-detect in lab data, based on one-half detection limit of 0.01 mg/L.

Table 5-23 Total Nitrogen Loadings to the Assabet River: A Compilation of Point Source and Non-Point Source Loadings During Six (6) Field Surveys

Sample Location		Watershed Area (miles^2)	Intensive Summer July 1999 Survey		Dry-weather Survey 2 - Feb. 8-9, 2000		Wet-weather Survey 1 - March 16, 2000		Wet-weather Survey 2 - March 27, 2000		Wet-weather Survey 3 - Sept. 12, 2000		Intensive Summer August 2000 Survey	
			Total Nitrogen		Total Nitrogen		Total Nitrogen		Total Nitrogen		Total Nitrogen		Total Nitrogen	
Rivermile	Description		Load lbs/day	% of Total	Load lbs/day	% of Total	Load lbs/day	% of Total	Load lbs/day	% of Total	Load lbs/day	% of Total	Load lbs/day	% of Total
Point Sources														
30	Westborough POTW		409	34	270	10	489	13	431	15	363	26	330	28
23.6	Marlborough POTW		306	26	1,186	42	181	5	216	8	566	40	374	31
15.7	Hudson POTW		324	27	314	11	331	9	267	10	214	15	288	24
6.7	Maynard POTW		112	9	204	7	193	5	200	7	109	8	104	9
Non-Point Sources														
29.7	Hop Brook	9.3	2.09	0.2	32.8	1.2	121	3.1	91.7	3.3	8.59 a	0.6	8.65	0.7
24.5	Cold Harbor Brook	11.5	2.51 a	0.2	56.6 a	2.0	134	3.6	73.2	2.6	10.6 a	0.7	2.27	0.2
23.1	Stirrup Brook	4.9	1.07 a	0.1	24.1 a	0.8	23.7	0.6	16.9	0.6	0.53	0.0	6.77	0.6
22.5	North Brook, Berlin	18	3.93 a	0.3	54.9	1.9	225	5.9	161	5.8	16.6 a	1.2	7.50	0.6
17.5	Hog Brook, Hudson	6.3	1.37 a	0.1	31 a	1.1	42.9	1.1	29.1	1.0	6.38	0.5	3.36	0.3
17.3	Mill Brook, Hudson	6.6	1.44 a	0.1	32.4 a	1.1	88.7	2.3	47.9	1.7	10.2	0.7	8.62	0.7
13.0	Ft. Meadow Brook	13.4	1.94 a	0.2	43.7 a	1.5	55.1	1.4	43.5	1.6	3.22	0.2	4.70	0.4
9.5	Elizabeth Brook, Maynard	20	4.37 a	0.4	63.2	2.2	384	10.0	201	7.2	28.9	2.0	2.09	0.2
4.3	Second Division Brook	2.13	0.47 a	0.0	10.5 a	0.4	31.9 a	0.8	20.0 a	0.7	1.97 a	0.1	1.21 a	0.1
3.0	Nashoba Brook	47.6	10.4	0.9	317	11.1	904	23.5	586	21.1	44.0 a	3.1	33.8	2.8
1.3	Spencer Brook, Concord	7.7	1.68 a	0.1	37.9 a	1.3	124	3.2	73.6	2.6	0.94	0.1	2.19	0.2
	Other Non-point Sources	34.3	7.50	0.6	169	5.9	514	13.3	323	11.6	31.7	2.2	19.5	1.6
Source Totals														
Point Source Sub-Total			**1,150.**	**96.7**	**1,970.**	**69.3**	**1,200.**	**31.1**	**1,110.**	**40.1**	**1,250.**	**88.5**	**1,100.**	**91.6**
Non-Point Source Sub-Total			**39.0**	**3.3**	**873.**	**30.7**	**2,653.**	**68.9**	**1,670.**	**59.9**	**164.**	**11.5**	**101.**	**8.4**
TOTAL			**1,190.**	**100**	**2,850.**	**100**	**3,850.**	**100**	**2,780.**	**100**	**1,420.**	**100**	**1,200.**	**100**

Notes:

a - Estimated values based on percentage of total watershed area. Total Load calculated using linear scaling of measured loads. Total Load = [sum of measured values * (177 / sum of watershed areas)]. Based on total Assabet River watershed area of 177 square miles

Figure 5-1(a) Summer 1999: Minimum Dissolved Oxygen Concentrations Measurements with Schematic Physical Representation of the Assabet River (RM 18-31)

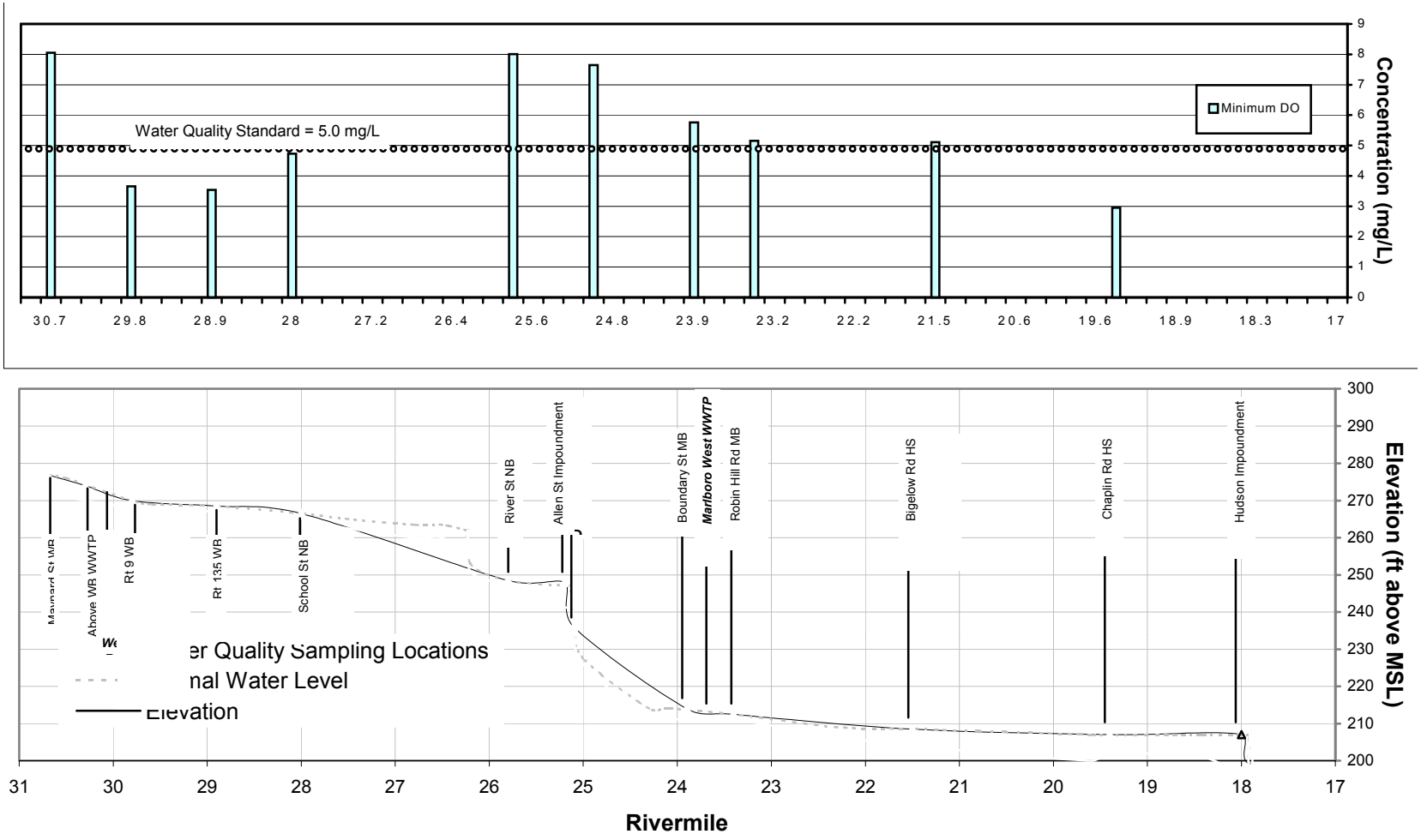


Figure 5-1(b) Summer 1999: Minimum Dissolved Oxygen Concentrations Measurements with Schematic Physical Representation of the Assabet River (RM 2-18)

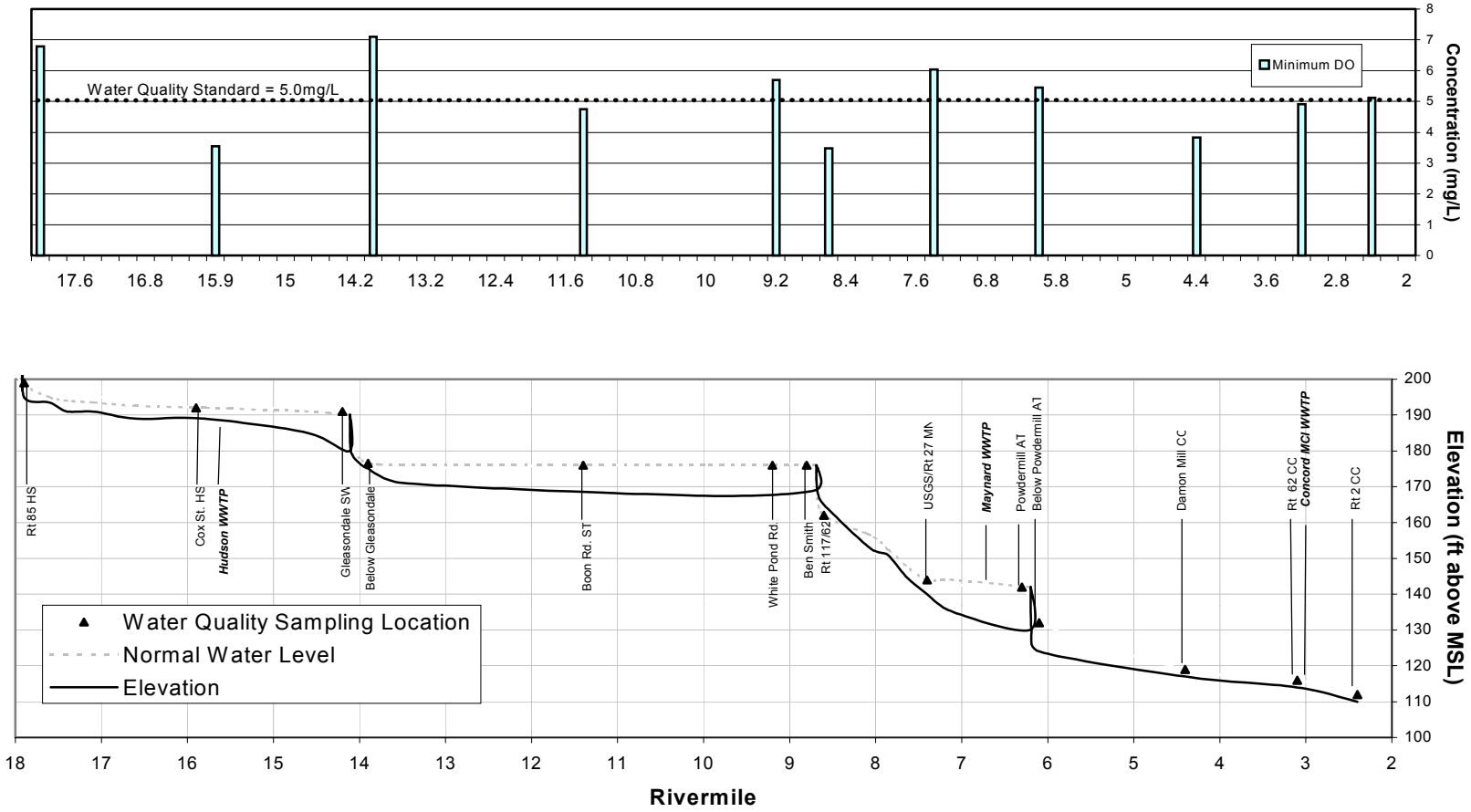


Figure 5-2 Summer 1999: Continuous Dissolved Oxygen Concentration Measurements Collected at Rivermile 28, School St., Northborough

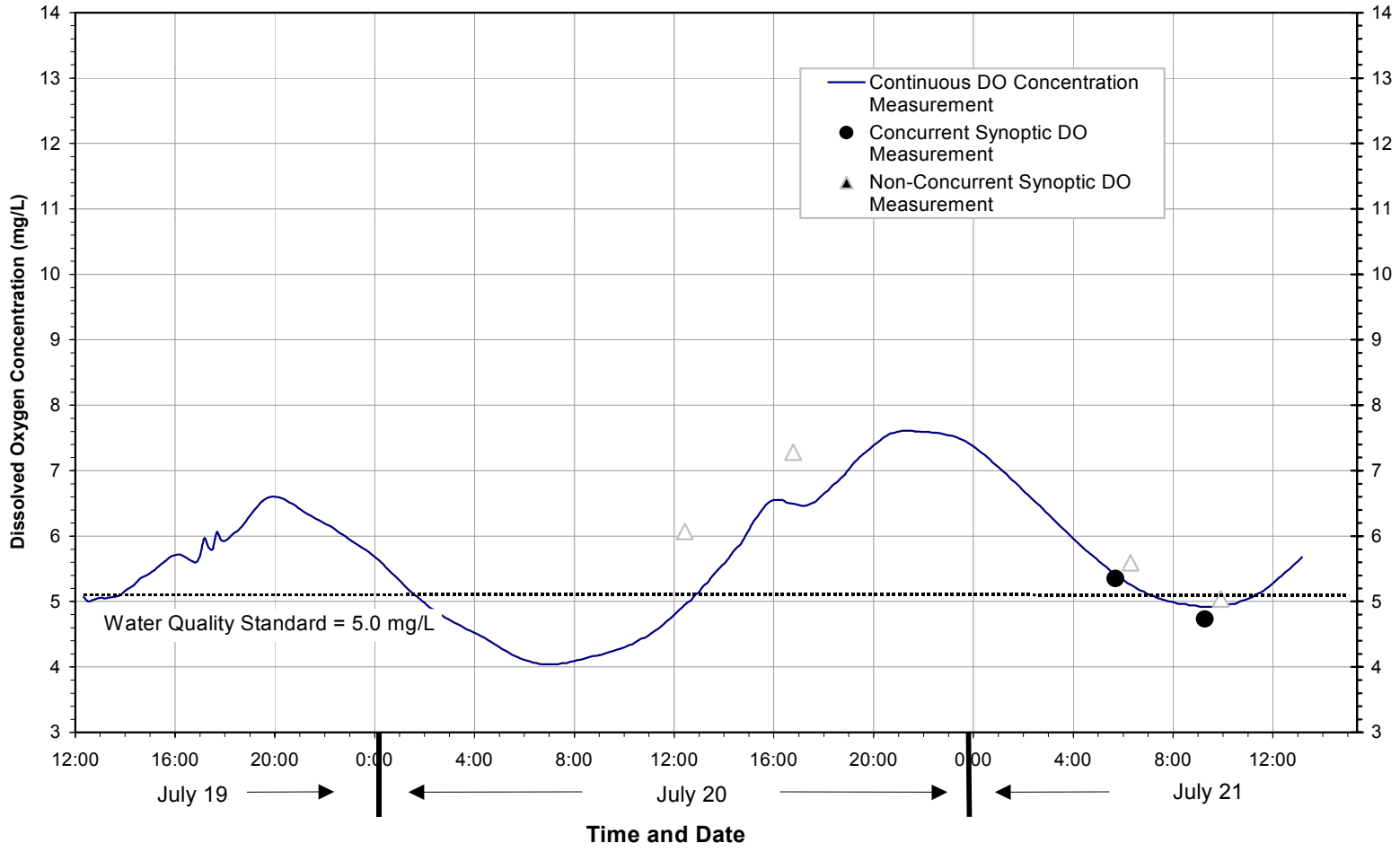


Figure 5-3 Summer 1999: Continuous Dissolved Oxygen Concentration Measurements Collected at Rivermile 21.5, Bigelow Road, Berlin

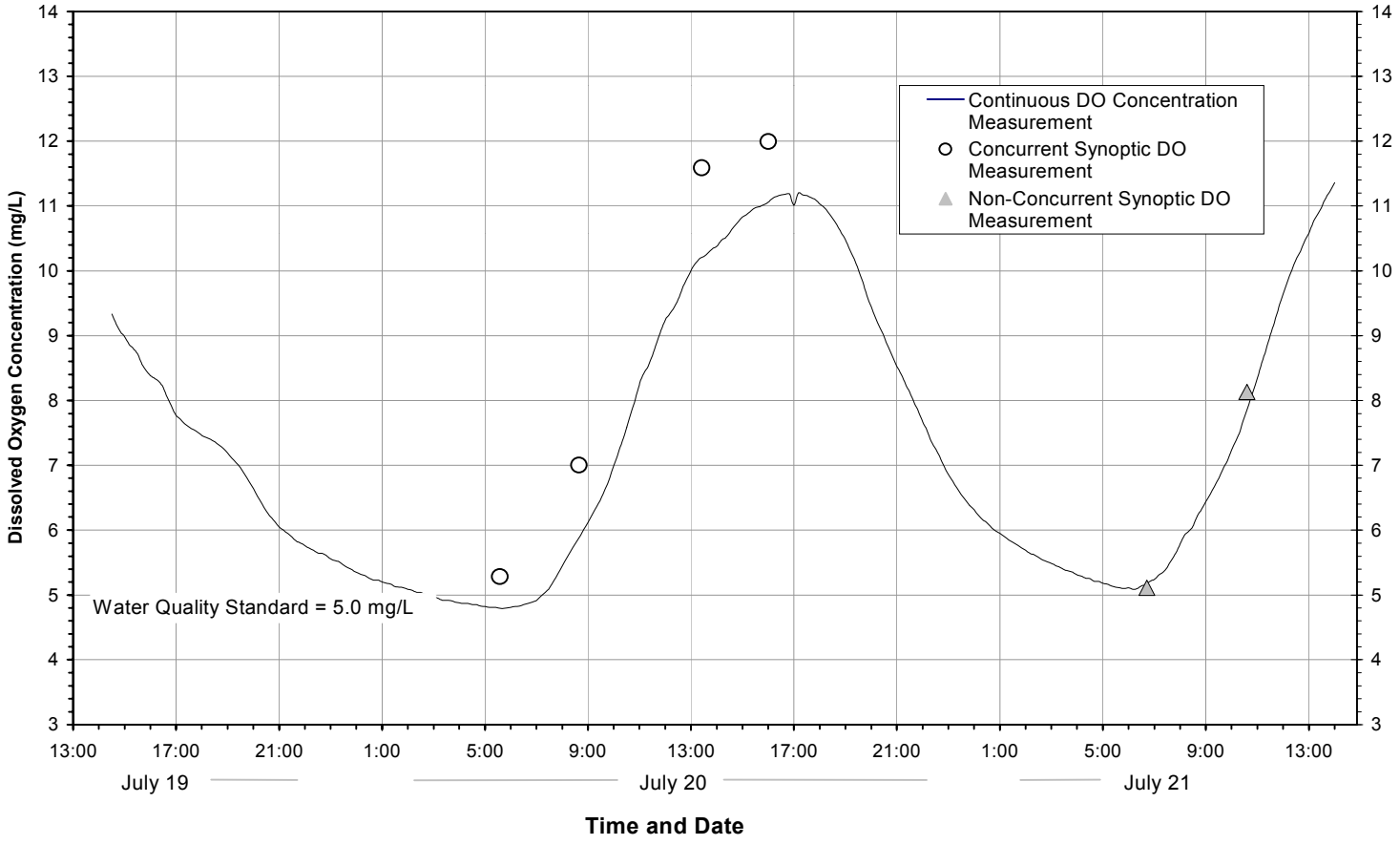


Figure 5-4 Summer 1999: Continuous Dissolved Oxygen Concentration Measurements Collected at Rivermile 15.9, Cox St., Hudson

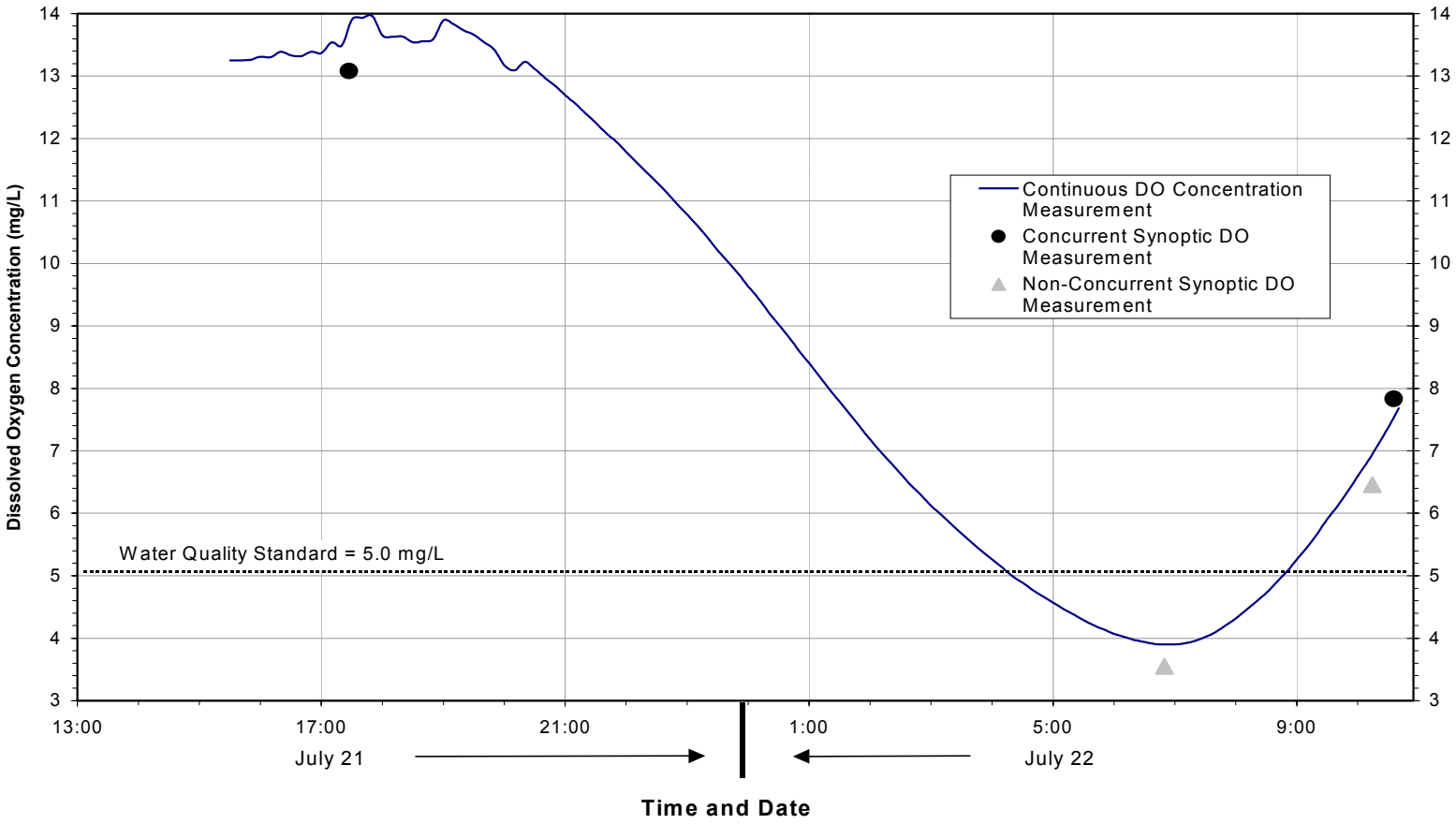


Figure 5-5 Summer 1999: Continuous Dissolved Oxygen Concentration Measurements Collected at Rivermile 7.4, USGS Gauge, Maynard

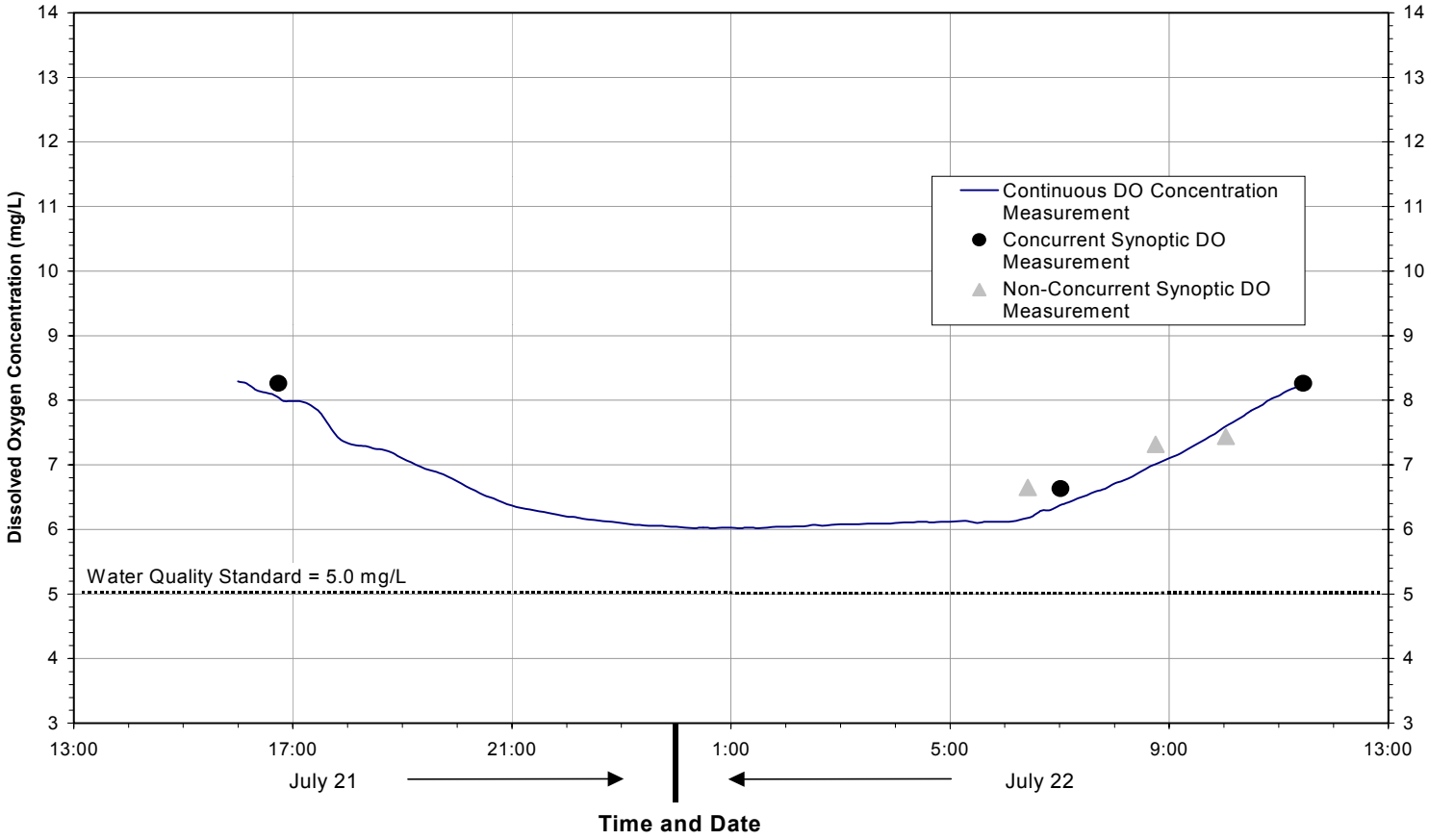


Figure 5-6 Summer 1999: Continuous Dissolved Oxygen Concentration Measurements Collected at Rivermile 2.4, Rt. 2 Bridge, Concord

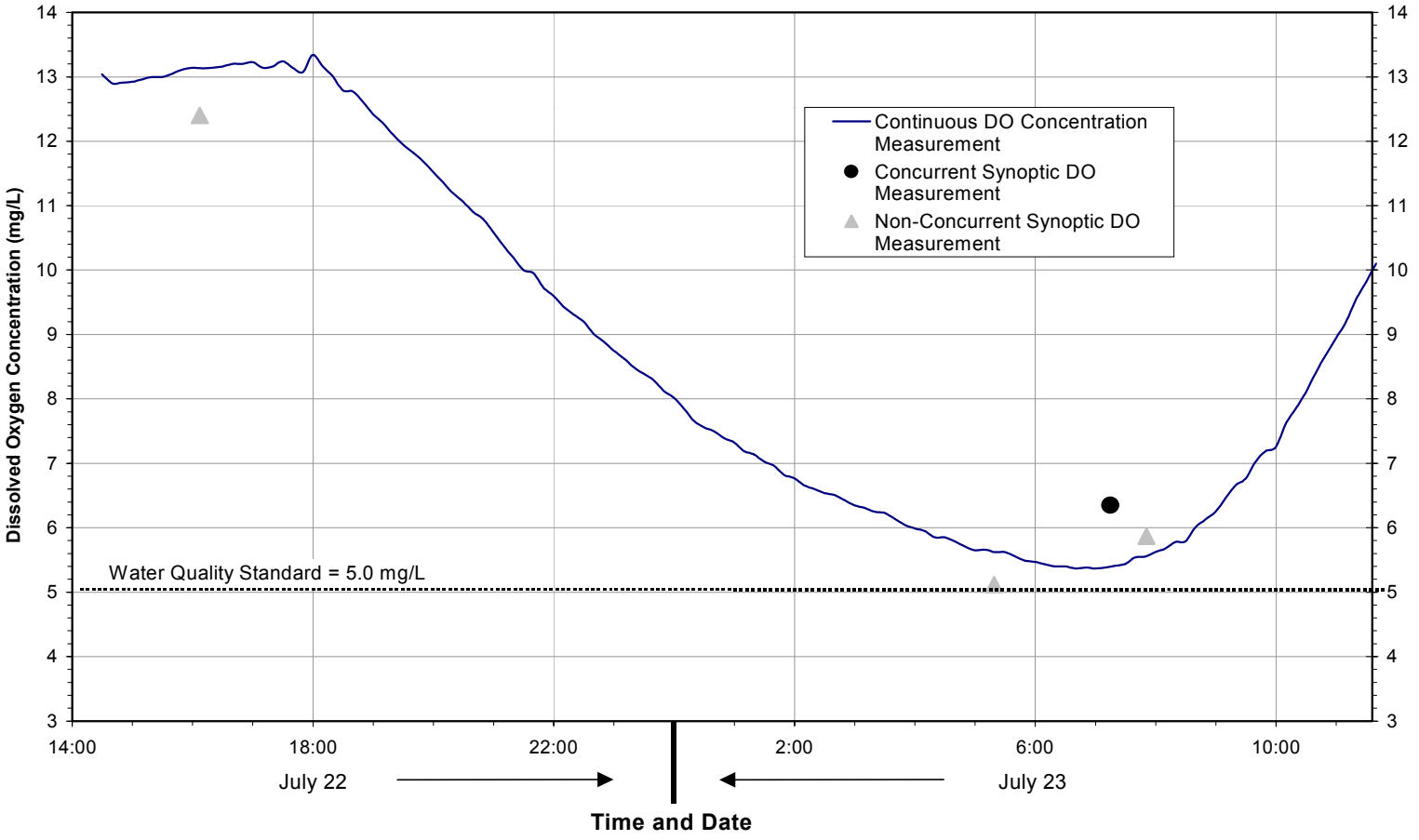


Figure 5-7 Summer 2000: Continuous Dissolved Oxygen Concentration Measurements Collected at Rivermile 28.0, School Street, Northborough

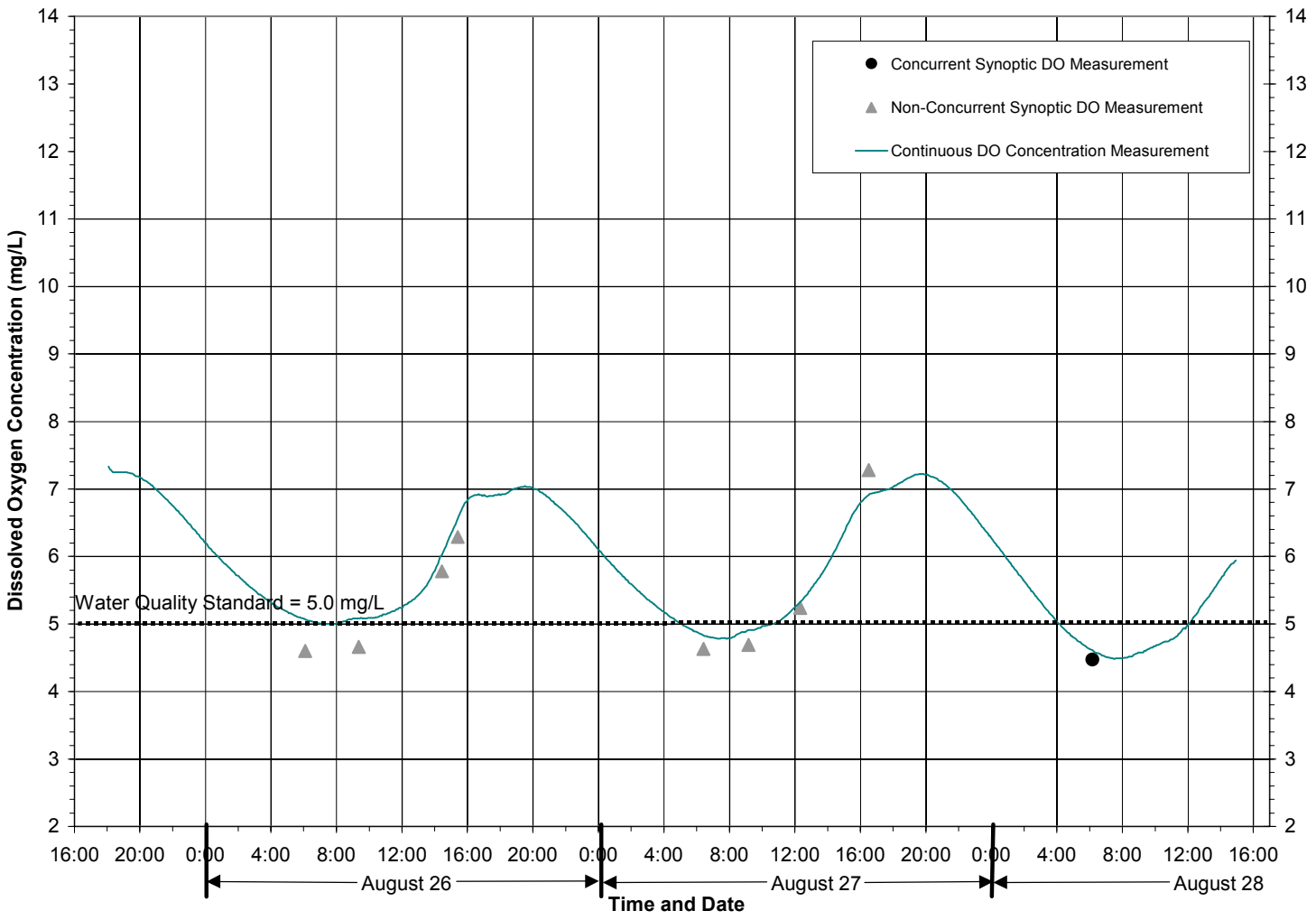


Figure 5-8 Summer 2000: Continuous Dissolved Oxygen Concentration Measurements Collected at Rivermile 23.9, Boundary Street, Marlborough

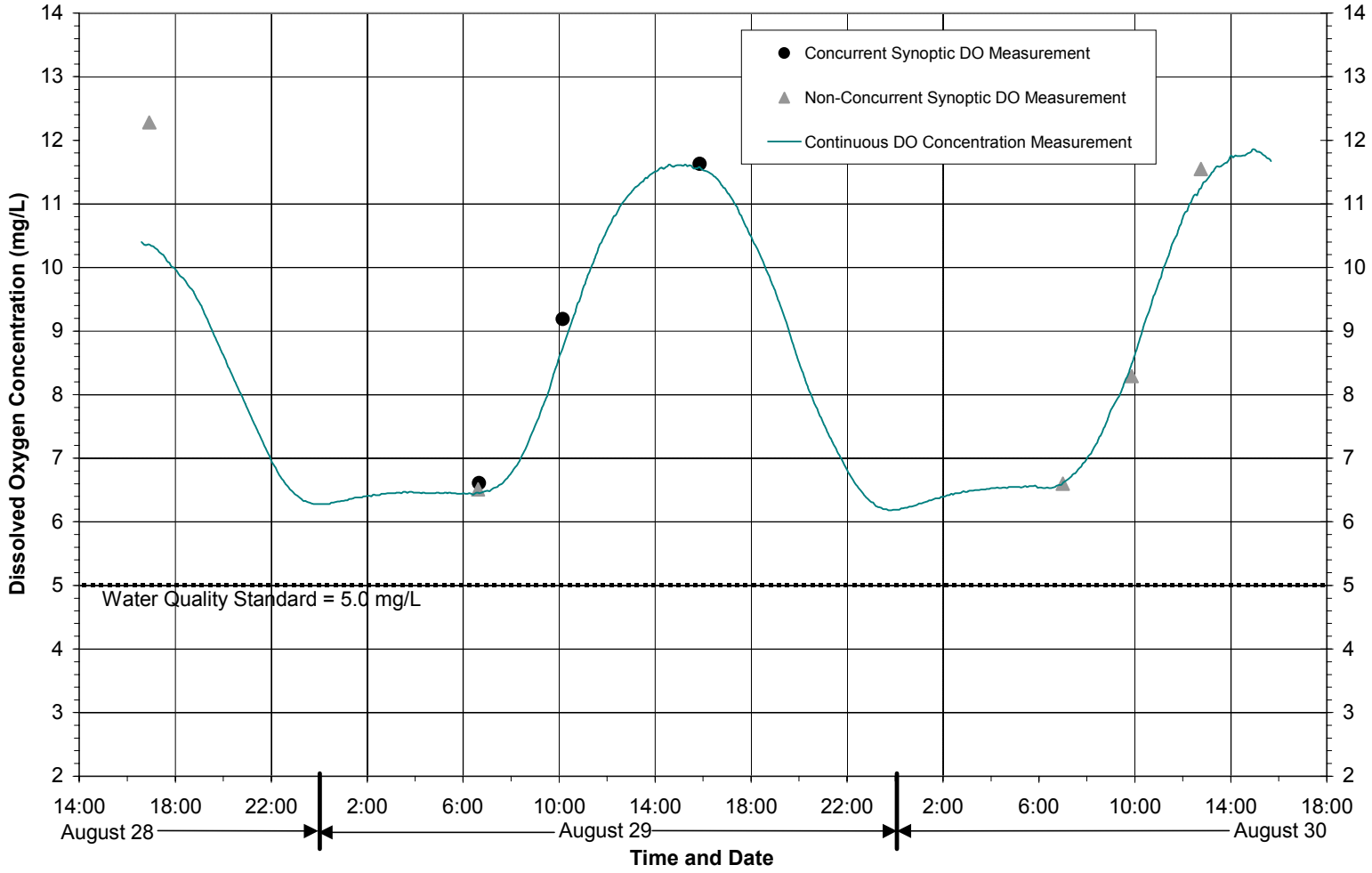


Figure 5-9 Summer 2000: Continuous Dissolved Oxygen Concentration Measurements Collected at Rivermile 15.9, Cox Street, Hudson

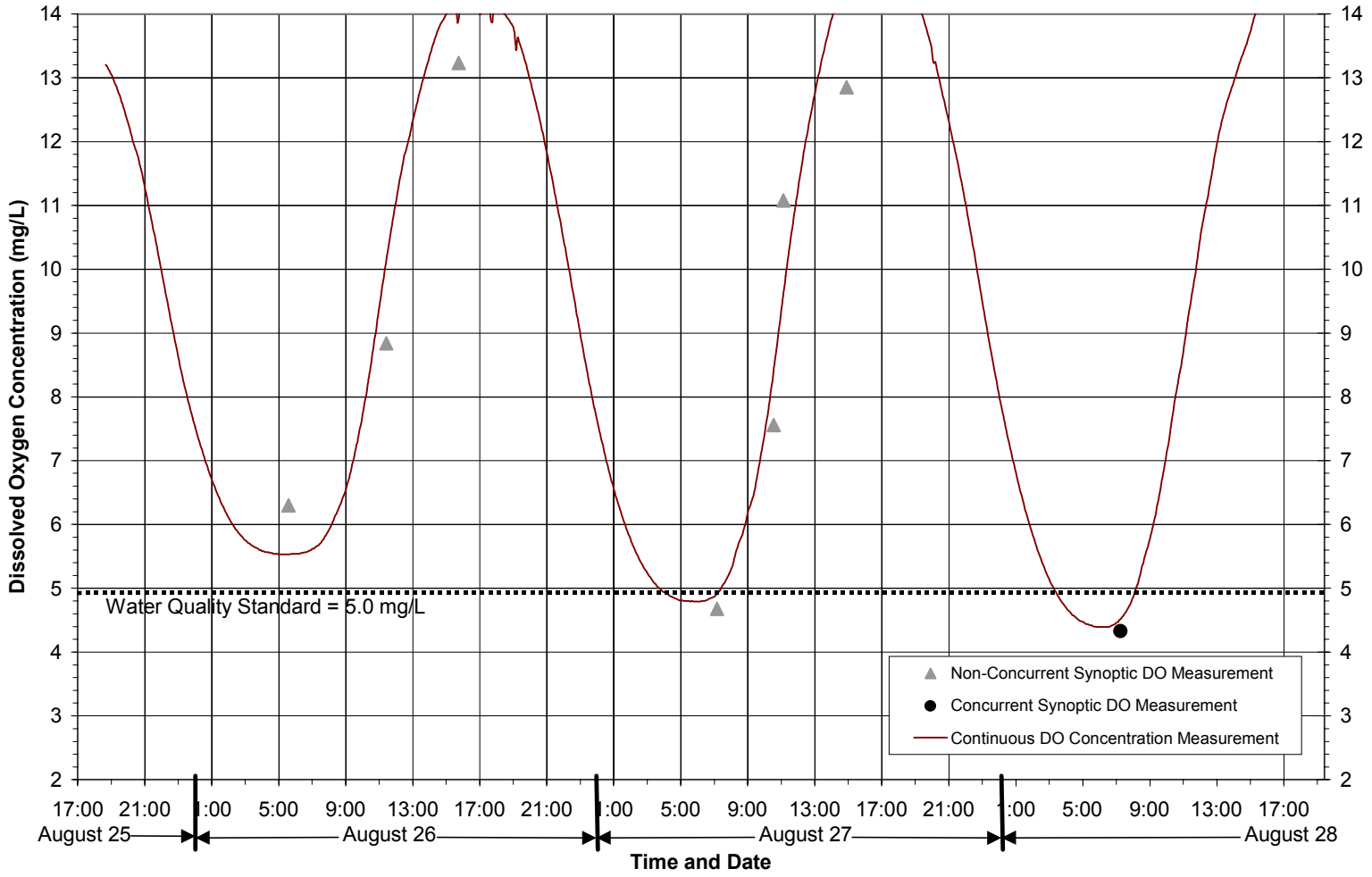


Figure 5-10 Summer 2000: Continuous Dissolved Oxygen Concentration Measurements Collected at Rivermile 7.4, USGS Gauge, Maynard

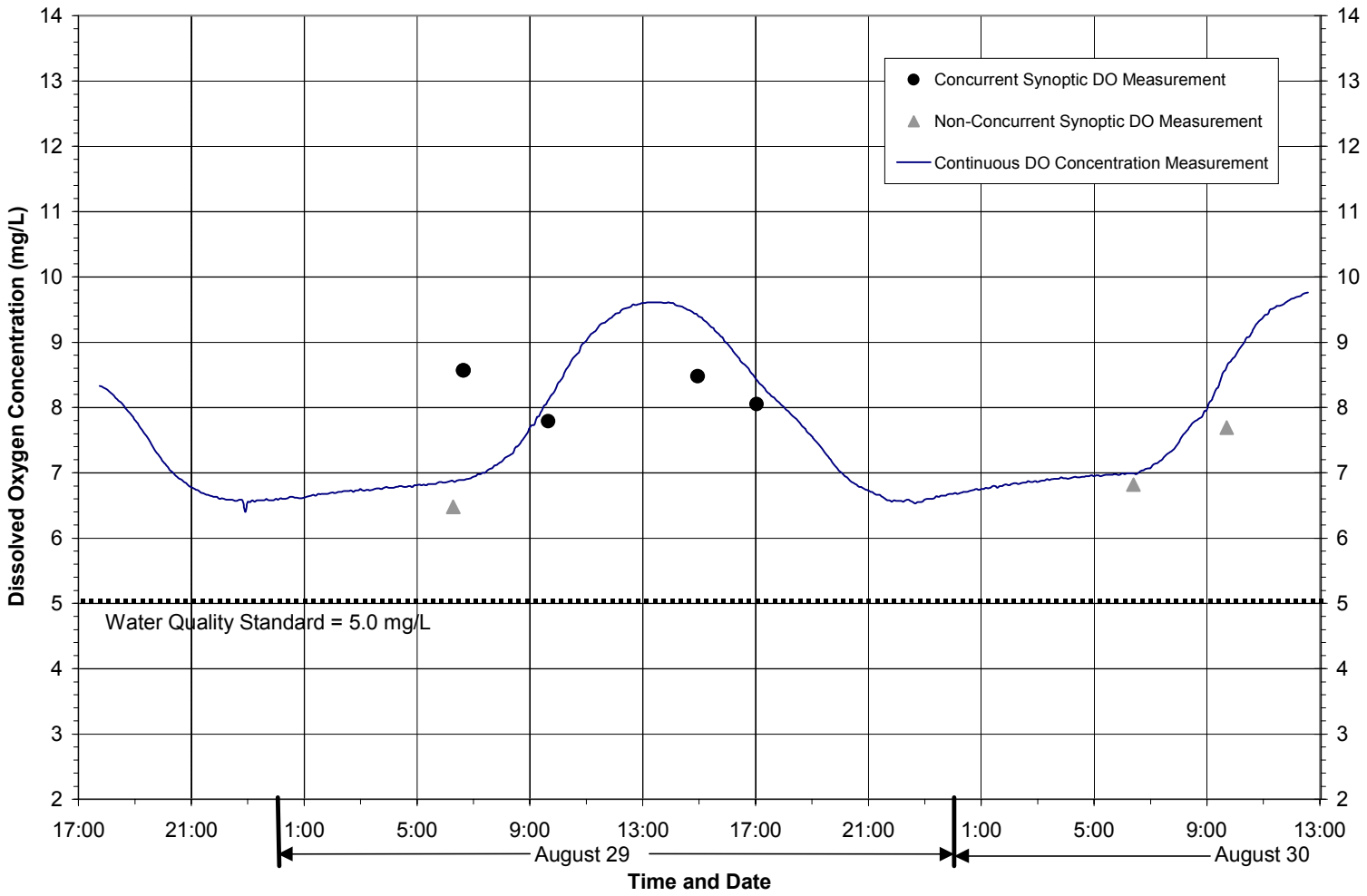


Figure 5-11 Summer 2000: Continuous Dissolved Oxygen Concentration Measurements Collected at Rivermile 4.4, Damonmill, Concord

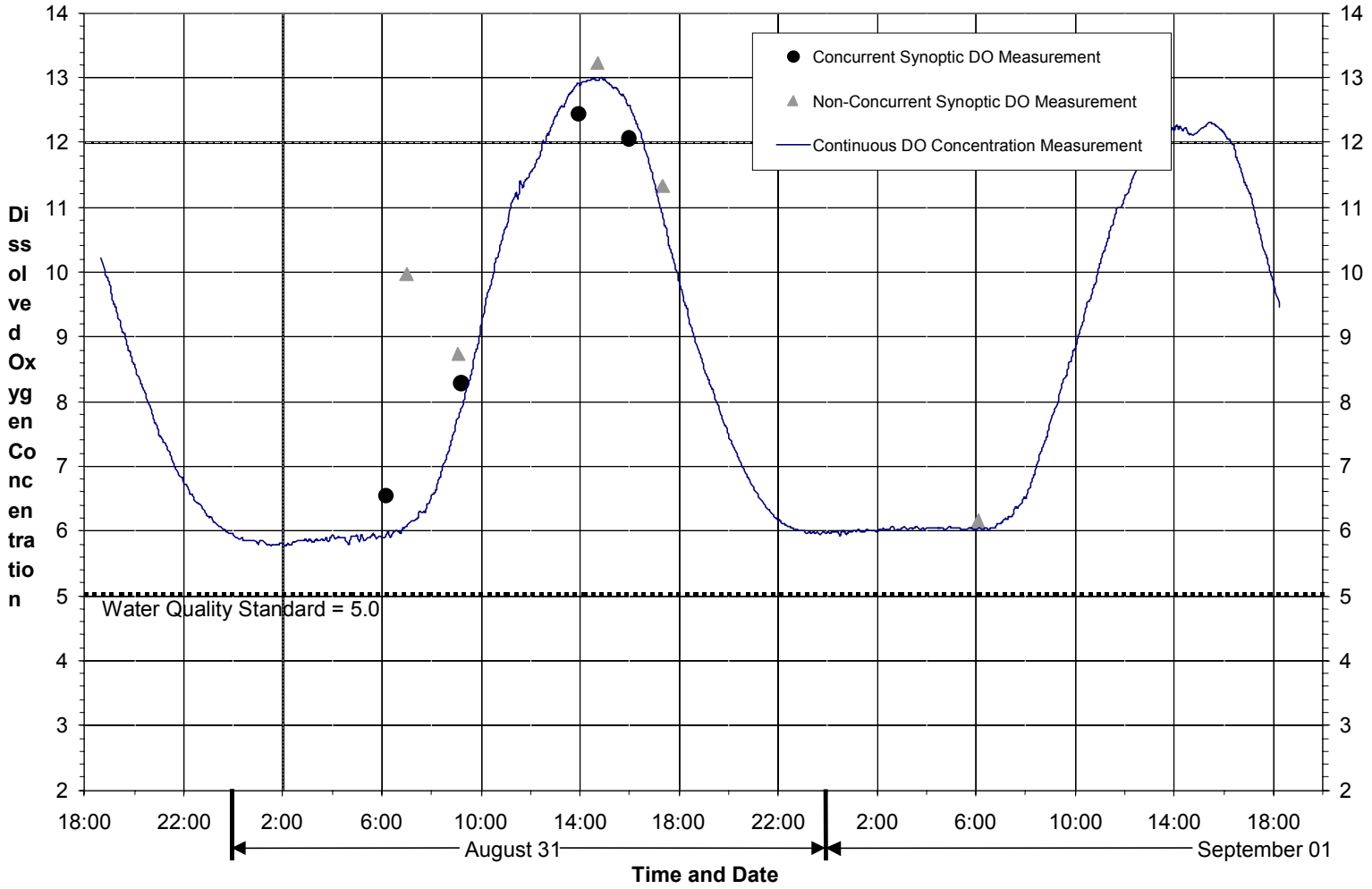


Figure 5-12 Summer 2000: Continuous Dissolved Oxygen Concentration Measurements Collected at Rivermile 2.4, Rt. 2 Bridge, Concord

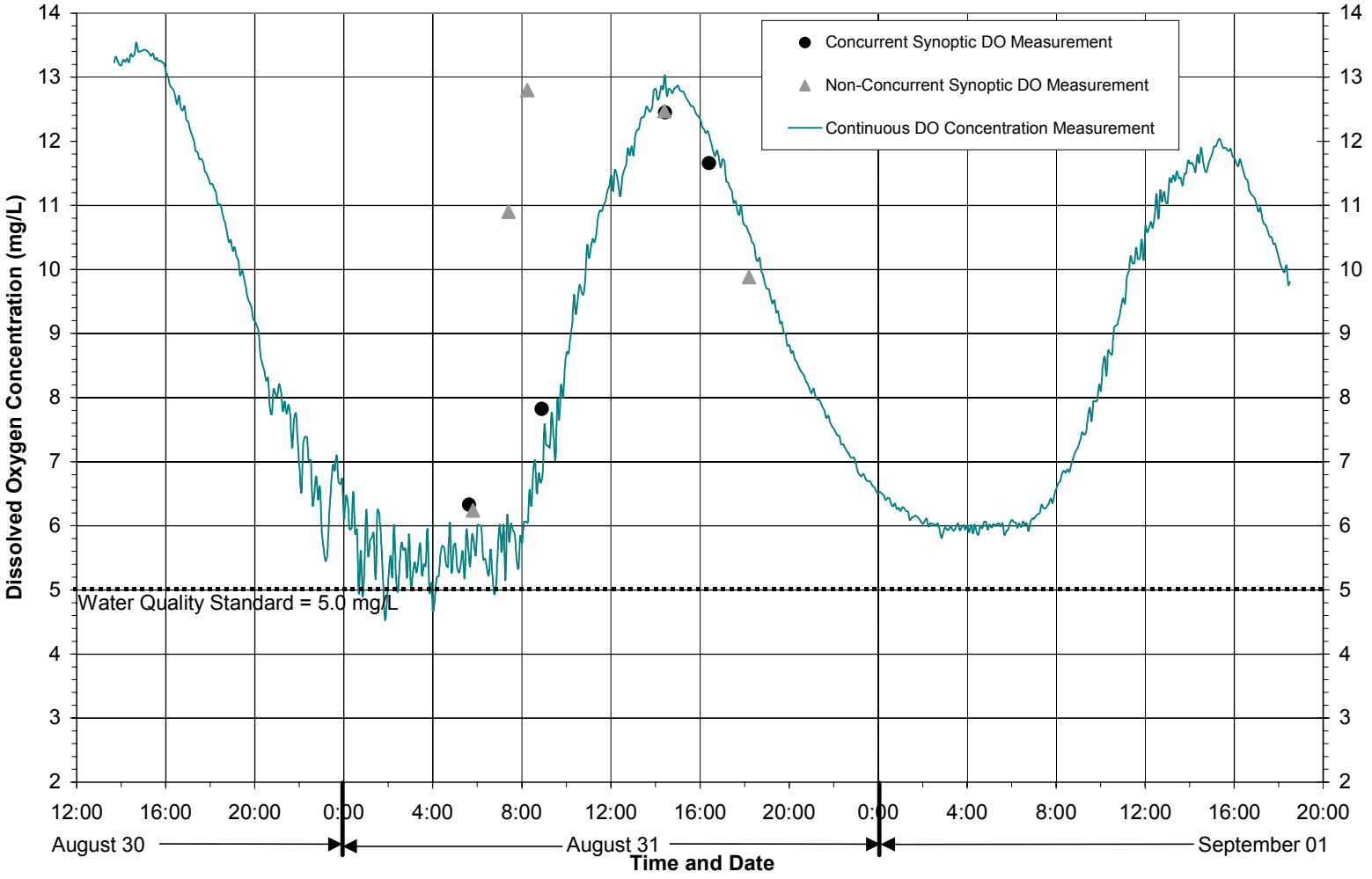
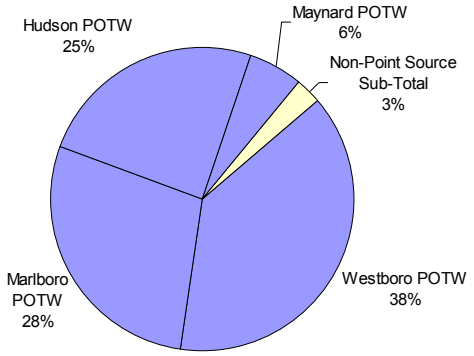
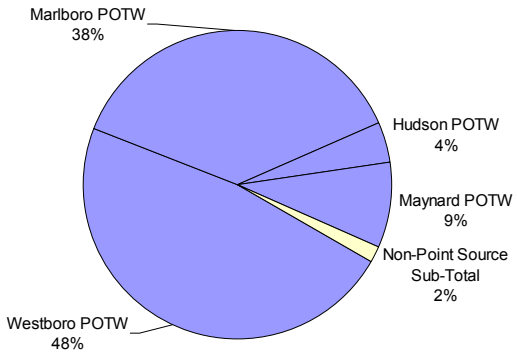


Figure 5-13 Ortho-Phosphorous Loadings to the Assabet River - Distributions of Point Source vs. Non-Point Source Loadings During Six (6) Field Surveys

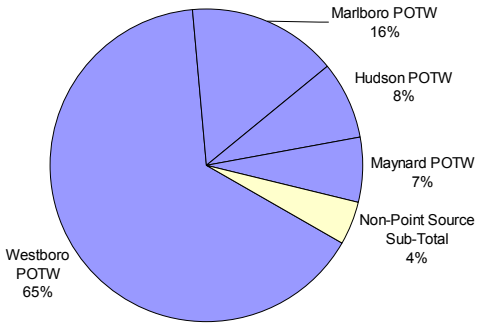
Intensive Summer - July 1999 Survey - Ortho-P Loadings



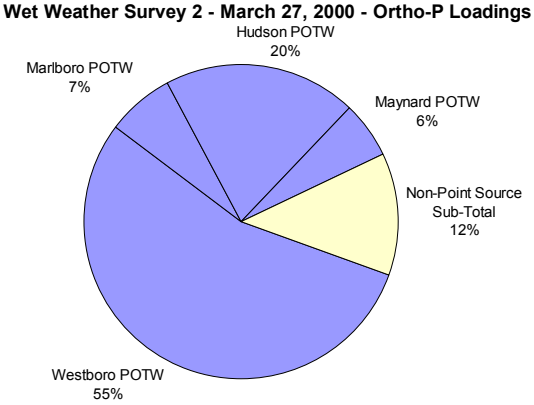
Dry-Weather Survey 2 - Feb. 8-9, 2000 - Ortho-P Loadings



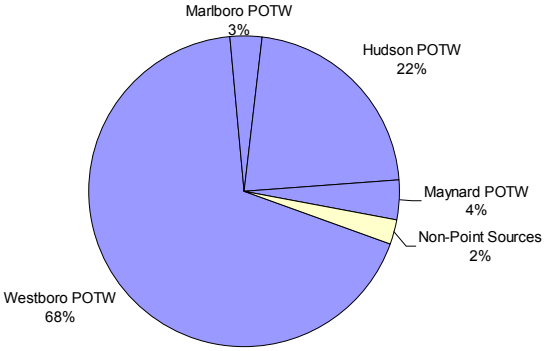
Wet Weather Survey 1 - March 16, 2000 - Ortho-P Loadings



Wet Weather Survey 2 - March 27, 2000 - Ortho-P Loadings



Wet Weather Survey 3 - Sept. 12, 2000 - Ortho-P Loadings



Intensive Summer - August 2000 - Ortho-P Loadings

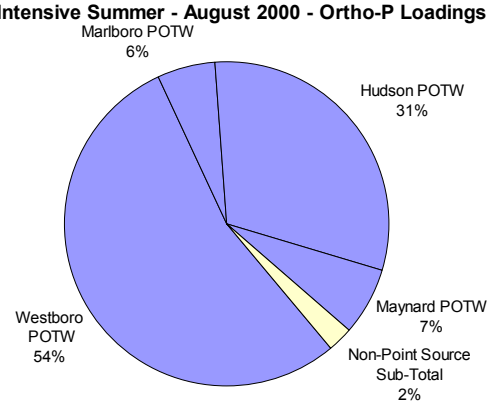
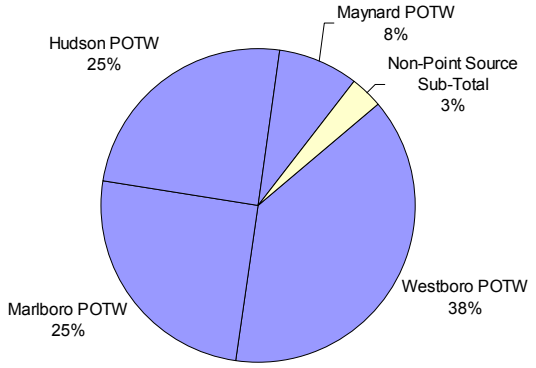
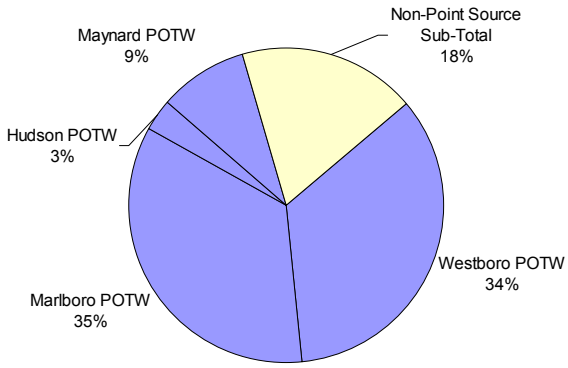


Figure 5-14 Total Phosphorous Loadings to the Assabet River - Distributions of Point Source vs. Non-Point Source Loadings During Six (6) Field Surveys

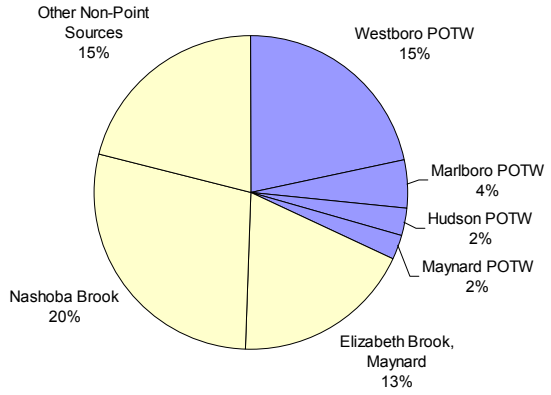
Intensive Summer - July 1999 Survey - Total-P Loadings



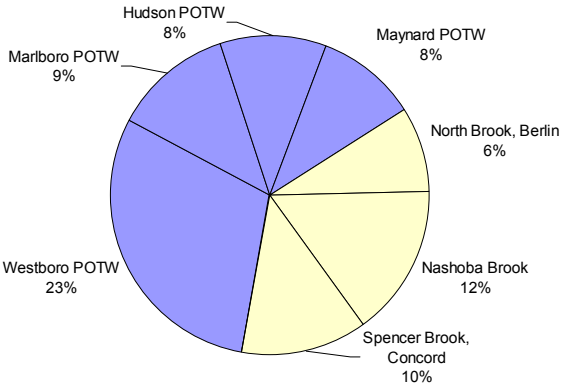
Dry-Weather Survey 2 - Feb. 8-9, 2000 - Total-P Loadings



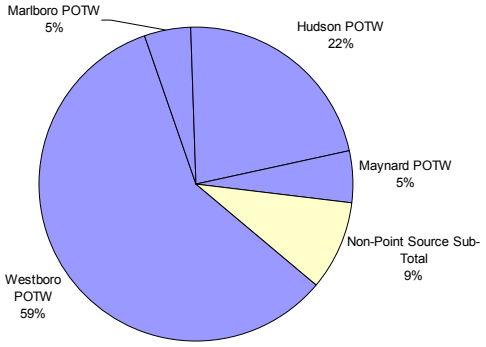
Wet Weather Survey 1 - March 16, 2000 - Total-P Loadings



Wet Weather Survey 2 - March 27, 2000 - Total-P Loadings



Wet Weather Survey 3 - Sept. 12, 2000 - Total-P Loadings



Intensive Summer - August 2000 - Total-P Loadings

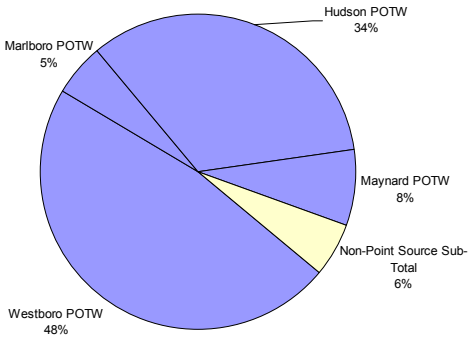
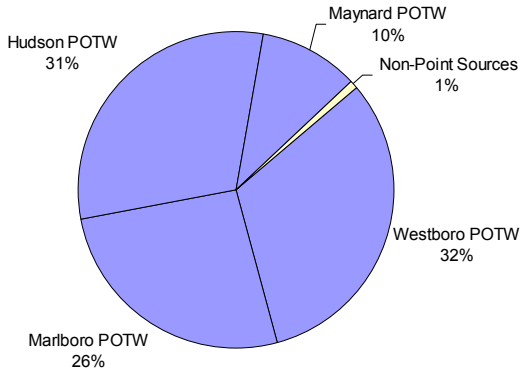
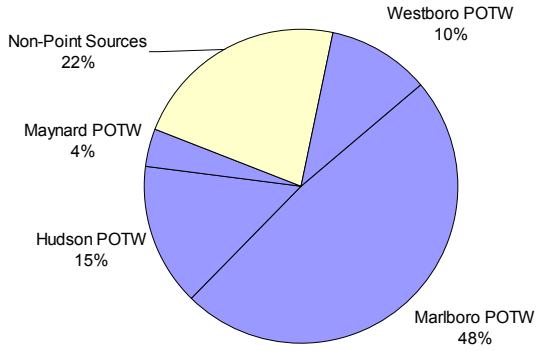


Figure 5-15 Nitrate Loadings to the Assabet River – Distribution of Point Source vs. Non-Point Source Loadings During Six (6) Field Surveys

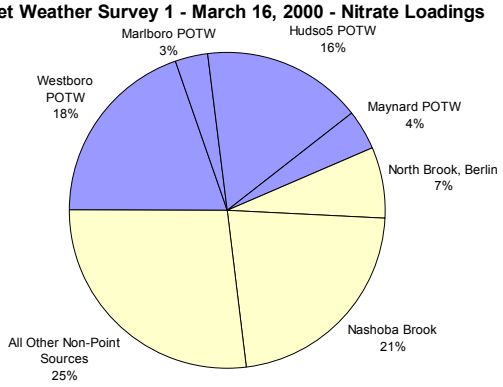
Intensive Summer - July 1999 Survey - Nitrate Loadings



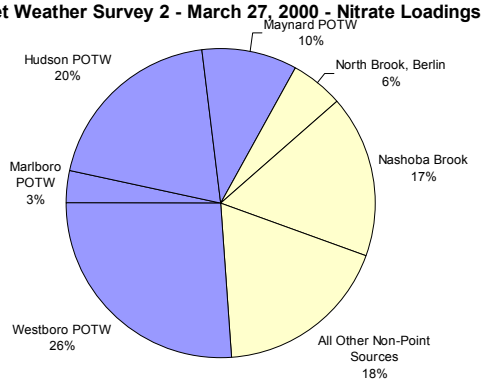
Dry-Weather Survey 2 - Feb. 8-9, 2000 - Nitrate Loadings



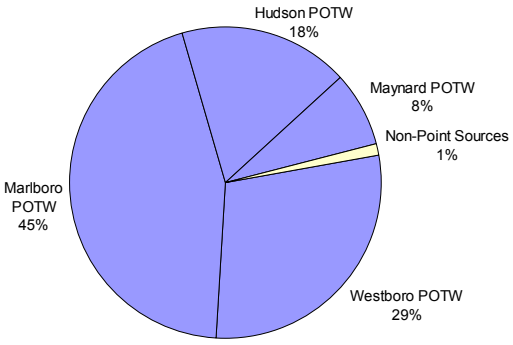
Wet Weather Survey 1 - March 16, 2000 - Nitrate Loadings



Wet Weather Survey 2 - March 27, 2000 - Nitrate Loadings



Wet Weather Survey 3 - Sept. 12, 2000 - Nitrate Loadings



Intensive Summer - August 2000 Survey - Nitrate Loadings

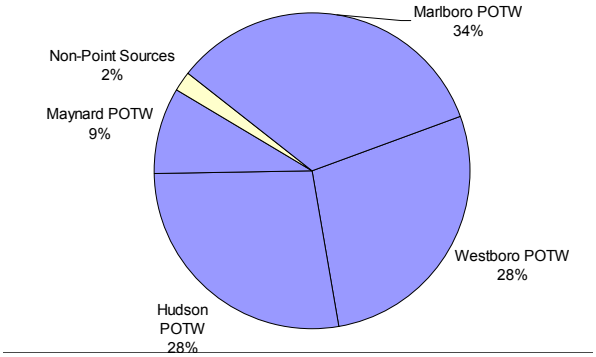
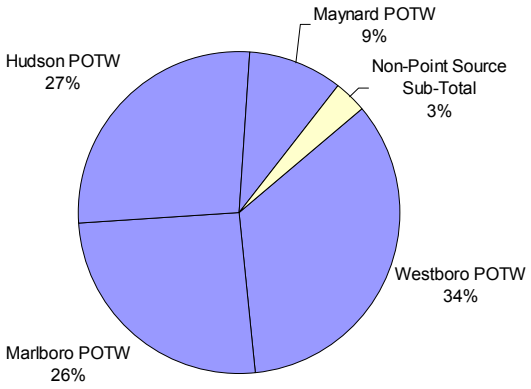
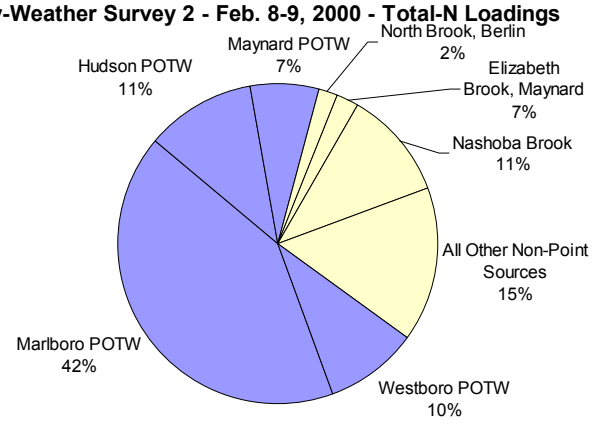


Figure 5-16 Total Nitrogen Loadings to the Assabet River – Distribution of Point Source vs. Non-Point Source Loadings During Six (6) Field Surveys

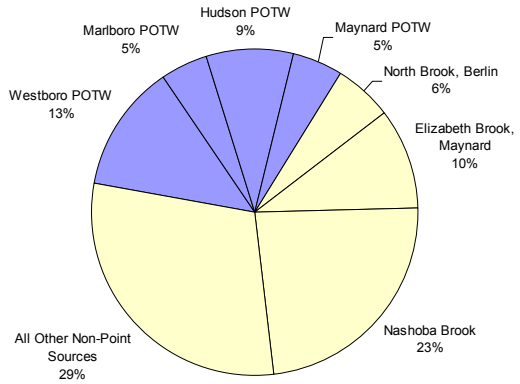
Intensive Summer - July 1999 Survey - Total-N Loadings



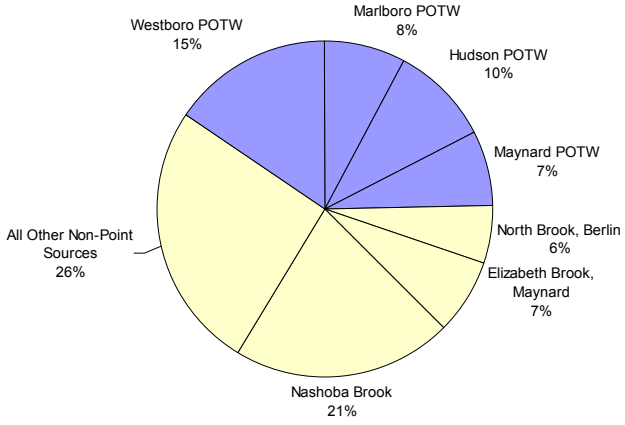
Dry-Weather Survey 2 - Feb. 8-9, 2000 - Total-N Loadings



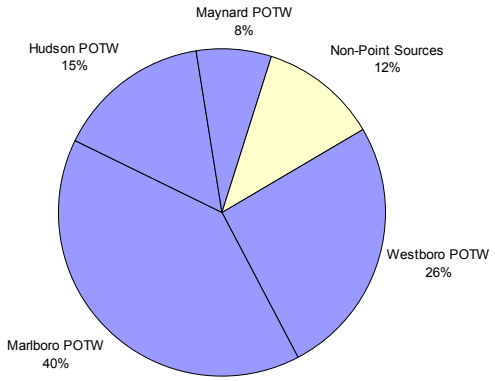
Wet Weather Survey 1 - March 16, 2000 - Total-N Loadings



Wet Weather Survey 2 - March 27, 2000 - Total-N Loadings



Wet Weather Survey 3 - Sept. 12, 2000 - Total-N Loadings



Intensive Summer - August 2000 - Total-N Loadings