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Nitrogen, Phosphorus, and Suspended Solids Concentrations in Tributaries to the Great Bay Estuary Watershed in 2010

New Hampshire Department of Environmental Services

Matthew A. Wood
New Hampshire Department of Environmental Services

Philip Trowbridge
New Hampshire Department of Environmental Services

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A Final Report to

The Piscataqua Region Estuaries Partnership

Submitted by

Matthew A. Wood &
Philip Trowbridge
N.H. Department of Environmental Services
Watershed Management Bureau
Concord, NH

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Introduction

Nitrogen, phosphorus, and sediment loads to the Great Bay Estuary are a growing concern. The Piscataqua Region Estuaries Partnership (PREP) calculates the nitrogen load from tributaries to the Great Bay Estuary for its State of the Estuaries reports. Therefore, the purpose of this study was to collect representative data on nitrogen, phosphorus, and suspended sediment concentrations in tributaries to the Great Bay Estuary in 2010. The study design followed the tributary sampling design which was implemented by the New Hampshire Department of Environmental Services between 2001 and 2007 and by the University of New Hampshire in 2008 and 2009, so as to provide comparable data to the previous loading estimates.

Methods

Sampling and Analytical Methods

The field sampling and laboratory analysis methods have been documented in the approved Quality Assurance Project Plan (RFA #08113; NHEP, 2008).

Grab samples were collected from the head-of-tide stations on eight tributaries to the Great Bay Estuary (Figure 1) on a monthly frequency from March to December. In some cases, samples were not collected every month due to site accessibility. The samples were analyzed for total dissolved nitrogen (TDN), total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS), ammonia (NH_4), nitrate (NO_3), dissolved organic nitrogen (DON), non-purgeable organic carbon which is equivalent to dissolved organic carbon (DOC) and orthophosphate (PO_4). A total of ten field duplicate samples were collected for each parameter (one station per sampling date) for quality assurance.

The Water Quality Analysis Laboratory at the University of New Hampshire used USGS Method I-4650-03 (alkaline persulfate digestion) to determine TN and TP and high temperature catalytic oxidation (Merriam et al., 1996) to determine the TDN concentrations in samples. Suspended solids concentrations were calculated using APHA method 2540-D. Nitrate concentration was determined using EPA method 353.2 and NH_4 using EPA method 350.1. Dissolved organic carbon was determined using EPA method 415.1. Orthophosphate was measured using EPA method 365.1. Dissolved organic nitrogen was calculated by subtracting NH_4 and NO_3 from TDN.

Physico-chemical parameters (water temperature, specific conductance, dissolved oxygen, and pH) were measured in the field using a YSI 556 multi-parameter instrument.

Quality Assurance Audit

Several quality control tests were planned in the Quality Assurance Project Plan (NHEP, 2008). The results of quality control samples for TN, TP, TDN, TSS, NH_4, NO_3, DON, DOC and PO_4 have been summarized in Tables 1 through 9. All of the data quality objectives for the study were substantially met. There were no major deviations from the planned methods.

Four TDN samples had results where TDN was greater than TN (02-GWR on 9/22/10, 05-SFR on 11/24/10, 02-WNC on 9/22/10 and 07-CCH on 7/28/10). The difference between the TDN and TN samples ranged from 0.01 to 0.09 mg N/L, which was only a small fraction (1.7-27%) of

the TN in the sample. The results show that all of the available nitrogen was in its dissolved form; therefore, these TDN results were retained.

A number of the field quality control samples for TP had relative percent difference values greater than the data quality objectives (Table 3). Most of the samples that were outside of quality control limits had low concentrations (<10x the method detection limit) which artificially inflate the relative percent different calculations. The high variability in the field duplicates for TP is likely indicative of natural variability in the river. All of the TP results were retained.

Several of the results for ammonium (22), nitrate (4), orthophosphate (37), total phosphorus (9) and total suspended solids (2) were reported below the reporting detection levels (0.005, 0.005, 0.005, 0.007 and 1 mg/L, respectively). These results are being reported as < 0.005 mg/L and < 1 mg/L, not the values reported by the laboratory.

Results and Discussion

The quality assured results for TN, TP, TDN, TSS, NH_4, NO_3, DON, DOC and PO_4 concentrations for each station visit are shown in Table 10. Figures 2 through 10 show the monthly concentrations for each parameter at each station.

The purpose of this report is to publish the results from the PREP sampling program for tributaries to the Great Bay Estuary. A detailed accounting of total nitrogen loads to the estuary from all sources (e.g., wastewater treatment facilities, non-point sources, and atmospheric deposition) will be included in PREP's State of the Estuaries reports. In the meantime, the following are some general observations which can be made based on the data:

- The average concentrations of TN at each station ranged from 0.44-1.54 mg N/L. The maximum concentrations occurred in the Cocheco River (station 07-CCH) and were consistently higher than the other stations throughout the entire monitoring period. The rest of the stations had average TN concentrations between 0.44 and 0.65 mg N/L.

- The average concentrations of TP at each station ranged from 0.018 to 0.056 mg P/L. The maximum concentrations occurred in the Cocheco River (station 07-CCH). The rest of the stations had average TP concentrations between 0.018 and 0.040 mg P/L.

- The average concentrations of TDN at each station ranged from 0.30 to 1.41 mg/L. The maximum concentrations occurred in the Cocheco River (station 07-CCH) and were consistently higher than the other stations throughout the entire monitoring period. The rest of the stations had average TDN concentrations between 0.30 and 0.50 mg/L.

- The average TSS concentrations ranged from 2.3 to 18.5 mg/L. The highest average concentration was in the Winnicut River (02-WNC), which had a high peak level on 8/25/10 of 81.1 mg/L. The high levels of TSS can most likely be attributed to a 2.5 inch rain event that occurred on 8/25/10. The rest of the stations had average TSS concentrations between 2.3 and 4.8 mg/L.

- The average concentrations of NO_3 at each station ranged from 0.07 to 1.17 mg N/L. The maximum concentrations occurred in the Cocheco River (station 07-CCH) and were consistently higher than the other stations throughout the entire monitoring period. The remaining stations had average NO_3 concentrations between 0.07 and 0.19 mg N/L.

- The average NH_4 concentration ranged from 0.012 to 0.033 mg N/L. The Bellamy River had the highest average concentration (05-BLM), however, the maximum concentration varied among the stations during the various sampling dates.

- The average concentrations of DON at each station ranged from 0.19 to 0.28 mg N/L. The maximum concentrations occurred in the Winnicut and Exeter Rivers (stations 02-WNC and 09-EXT, respectively).

- The average concentrations of DOC at each station ranged from 4.99 to 7.21 mg C/L. The maximum concentrations occurred in the Winnicut River (station 02-WNC), however, the maximum concentration varied among the stations during the various sampling dates.

- The average concentrations of PO_4 at each station ranged from 0.005 to 0.027 mg P/L. The maximum concentrations occurred in the Cocheco River (station 07-CCH) and were consistently higher than the other stations throughout the entire monitoring period. The remaining stations had average PO_4 concentrations between 0.005 and 0.011 mg P/L.

The results for TDN, DON and DOC from station 07-CCH on 4/28/10 are omitted from Table 10 and Figures 4, 8 and 9. These results were reported as lost by the laboratory. Additionally, samples were not collected at station 02-WNC on 5/26/10 because the site could not be accessed due to a construction/dam removal project. These data are omitted from Table 10 and Figures 2 through 10.

References

NHEP. 2008. Ambient River Monitoring of Tributaries to the Great Bay Estuary in 2008 - 2012. New Hampshire Estuaries Project, University of New Hampshire, Durham, NH. Published Online, http://www.prep.unh.edu/resources/qapps/ambient_river_monitoring-nhep-08.pdf . Accessed March 26, 2009.

Merriam, J.L, W.H. McDowell, and W.S. Currie. 1996. A high-temperature catalytic oxidation technique for determining total dissolved nitrogen. *Soil Science Society of America Journal* 60: 1050-1055.

Table 1: Summary of Quality Control Samples for Total Nitrogen

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Duplicates / 0 Failed DQO.
Precision-Lab	RPD < 15%	Lab Duplicates	7 Lab Duplicates / 0 Failed DQO 4 Lab Replicates / 0 Failed DQO
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	10 CRM tests / 0 Failed DQO 13 LFM tests / 4 Failed DQO All of the failures were close to the DQO or were for samples with low concentrations (<10xMDL)
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of TN concentrations in 2010 (0.15-2.90 mg/L) matched the range from 2001-2009 (0.11-2.99 mg/L).
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 0.15 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	79 routine samples and 10 field duplicates were collected (99% of planned samples)

Table 2: Summary of Quality Control Samples for Total Dissolved Nitrogen

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Dupes / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	12 Lab Dupes / 1 Failed DQO The failure was for a sample with a low concentration (<10xMDL)
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	14 CRM tests / 0 Failed DQO 18 LFM tests / 1 Failed DQO The failure was for a sample with a low concentration (<10xMDL)
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of TDN concentrations in 2010 (0.14-2.39 mg/L) matched the range from 2008-2009 (0.17-2.57).
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 0.14 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	78 routine samples and 10 field duplicates were collected (98% of planned samples)

Table 3: Summary of Quality Control Samples for Total Phosphorus

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Dupes / 6 Failed DQO All of the failures were close to the DQO or were for samples with low concentrations (<10xMDL)
Precision-Lab	RPD < 15%	Lab Duplicates	6 Lab Dupes / 1 Failed DQO The failure was for a sample with a low concentration (<10xMDL) 3 Lab Reps / 0 Failed DQO
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	10 CRM tests / 0 Failed DQO 8 LFM tests / 1 Failed DQO The failure was for a sample with a low concentration (<10xMDL)
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of TP concentrations in 2010 (0.007-0.12 mg/L) matched the range from 2001-2009 (0.003-0.35 mg/L).
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 0.007 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	79 routine samples and 10 field duplicates were collected (99% of planned samples)

Table 4: Summary of Quality Control Samples for Suspended Solids

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Dupes / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	**NO DATA**
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	**NO DATA**
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of TSS concentrations in 2010 (1-81 mg/L) were similar to the range from 2001-2009 (0.9-57).
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 1 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	79 routine samples and 10 field duplicates were collected (99% of planned samples)

Table 5: Summary of Quality Control Samples for Nitrate

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Dupes / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	9 Lab Dupes / 0 Failed DQO
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	9 CRM tests / 0 Failed DQO 10 LFM tests / 1 Failed DQO The failure was for a sample with a low concentration (<10xMDL)
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of Nitrate concentrations in 2010 (0.005-2.00 mg/L) had a lower minimum than the range from 2009 (0.025-2.05 mg/L). The lower nitrate levels are credible because nitrate can be fully consumed in the water column for primary productivity. The average concentration in 2010 (0.24 mg/L) matched the average from 2009 (0.23 mg/L)
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 0.005 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	79 routine samples and 10 field duplicates were collected (99% of planned samples)

Table 6: Summary of Quality Control Samples for Ammonium

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Dupes / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	10 Lab Dupes / 3 Failed DQO All of the failures were close to the DQO or were for samples with low concentrations (<10xMDL)
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	13 CRM tests / 0 Failed DQO 40 LFM tests / 7 Failed DQO All of the failures were close to the DQO or were for samples with low concentrations (<10xMDL)
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of Ammonia concentrations in 2010 (0.005-0.100 mg/L) had a higher maximum than the range from 2009 (0.005-0.065 mg/L). The average concentration in 2010 (0.021 mg/L) matched the average from 2009 (0.020 mg/L)
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 0.005 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	79 routine samples and 10 field duplicates were collected (99% of planned samples)

Table 7: Summary of Quality Control Samples for Dissolved Organic Nitrogen

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Dupes / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	**NO DATA (This parameter is calculated from other laboratory measurements.)**
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	**NO DATA (This parameter is calculated from other laboratory measurements.)**
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of DON concentrations in 2010 (0.065-0.421 mg/L) matched the range from 2009 (0.029-0.344 mg/L).
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 0.065 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	78 routine samples and 10 field duplicates were collected (98% of planned samples)

Table 8: Summary of Quality Control Samples for Dissolved Organic Carbon

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Dupes / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	12 Lab Duplicates / 0 Failed DQO
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	14 CRM tests / 0 Failed DQO 18 LFM tests / 5 Failed DQO All of the failures were close to the DQO or were for samples with low concentrations (<10xMDL)
Comparability	Measurements should follow standard methods that are repeatable	NA	NA (Not sampled in previous years)
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 3.28 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	78 routine samples and 10 field duplicates were collected (98% of planned samples)

Table 9: Summary of Quality Control Samples for Orthophosphate

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	10 Field Dupes / 1 Failed DQO The failure was for a sample with a low concentration (<10xMDL)
Precision-Lab	RPD < 15%	Lab Duplicates	7 Field Dupes / 3 Failed DQO All of the failures were close to the DQO or were for samples with low concentrations (<MDL)
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	14 CRM tests / 0 Failed DQO 25 LFM tests / 5 Failed DQO All of the failures were close to the DQO or were for samples with low concentrations (<10xMDL)
Comparability	Measurements should follow standard methods that are repeatable	NA	NA (Not sampled in previous years)
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 0.005 mg/L.
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	79 routine samples and 10 field duplicates were collected (99% of planned samples)

Table 10: Validated Laboratory Results at Tributary Stations

Station ID	Collection Date	DOC (mg C/L)	TN (mg N/L)	NH4 (mg N/L)	TDN (mg N/L)	NO3 (mg N/L)	DON (mg N/L)	TP (mg P/L)	PO4 (mg P/L)	TSS (mg/L)
02-GWR	03/24/2010*	6.055	0.336	0.040	0.215	0.041	0.134	0.011	<0.005	5.67
	03/24/2010	5.991	0.291	0.039	0.250	0.040	0.170	0.022	0.021	6.90
	04/28/2010	4.133	0.461	<0.005	0.199	0.046	0.149	0.011	<0.005	1.98
	05/26/2010	6.029	0.451	0.013	0.298	0.102	0.183	0.005	0.005	4.04
	06/23/2010	6.031	0.766	0.010	0.363	0.138	0.215	0.048	<0.005	2.78
	07/28/2010	10.087	0.656	0.024	0.431	0.102	0.305	0.032	<0.005	2.65
	08/25/2010	4.720	0.371	0.008	0.226	0.041	0.177	0.029	0.005	3.10
	09/22/2010	4.560	0.154	<0.005	0.211	0.025	0.186	0.022	<0.005	2.14
	10/27/2010	7.747	0.435	<0.005	0.337	0.073	0.262	0.064	0.038	2.45
	11/24/2010*	7.425	0.439	0.006	0.286	0.092	0.188	0.013	<0.005	2.64
	11/24/2010	7.961	0.405	0.007	0.302	0.095	0.200	0.016	<0.005	2.57
	12/22/2010	5.666	0.420	0.034	0.367	0.166	0.167	0.029	0.014	1.68
02-WNC	03/24/2010	6.723	0.551	0.025	0.363	0.107	0.231	0.022	<0.005	9.62
	04/28/2010	5.353	0.761	0.021	0.545	0.308	0.217	0.019	0.013	3.23
	05/26/2010									
	06/23/2010	6.267	0.701	0.045	0.535	0.210	0.281	0.062	0.005	6.77
	07/28/2010	9.445	0.771	0.011	0.525	0.093	0.421	0.047	0.006	3.53
	08/25/2010*	6.265	0.970	0.042	0.452	0.149	0.261	0.062	0.009	70.24
	08/25/2010	6.407	0.824	0.048	0.479	0.170	0.261	0.054	0.012	81.11
	09/22/2010	7.880	0.472	0.028	0.481	0.111	0.342	0.047	0.011	4.68
	10/27/2010	7.431	0.626	0.012	0.471	0.179	0.280	0.039	<0.005	42.60
	11/24/2010	8.004	0.558	0.020	0.467	0.190	0.257	0.019	0.007	12.30
	12/22/2010	7.375	0.626	0.016	0.611	0.350	0.245	0.056	0.012	2.80
05-BLM	03/24/2010	3.277	0.311	0.027	0.139	0.028	0.085	0.002	0.005	3.61
	04/28/2010	5.300	0.636	0.022	0.282	0.068	0.192	0.037	<0.005	3.15
	05/26/2010	5.063	0.551	0.006	0.277	0.092	0.180	0.008	<0.005	3.02
	06/23/2010	5.211	0.601	0.013	0.362	0.123	0.226	0.040	<0.005	3.76
	07/28/2010	6.021	0.481	0.082	0.329	<0.005	0.245	0.033	0.006	3.44
	08/25/2010	4.919	0.596	0.063	0.302	0.043	0.195	0.028	<0.005	8.01
	09/22/2010	4.051	0.469	0.070	0.417	0.127	0.220	0.010	0.005	9.86
	10/27/2010	4.994	0.607	0.016	0.302	0.124	0.162	0.068	0.005	4.70
	11/24/2010	5.623	0.353	0.014	0.339	0.102	0.222	0.003	<0.005	5.43
	12/22/2010*	6.149	0.813	0.014	0.380	0.149	0.217	0.048	<0.005	3.17
	12/22/2010	7.136	0.689	0.017	0.376	0.163	0.196	0.033	<0.005	3.07
05-LMP	03/24/2010	5.110	0.516	0.035	0.281	0.097	0.148	0.053	<0.005	4.49

Station ID	Collection Date	DOC (mg C/L)	TN (mg N/L)	NH4 (mg N/L)	TDN (mg N/L)	NO3 (mg N/L)	DON (mg N/L)	TP (mg P/L)	PO4 (mg P/L)	TSS (mg/L)
	04/28/2010	4.267	0.486	0.033	0.263	0.092	0.137	0.012	<0.005	1.55
	05/26/2010	5.453	0.516	<0.005	0.285	0.069	0.213	0.027	0.006	3.68
	06/23/2010*	5.246	0.456	<0.005	0.376	0.159	0.217	0.011	<0.005	1.90
	06/23/2010	5.090	0.406	<0.005	0.362	0.162	0.197	0.004	<0.005	1.76
	07/28/2010	6.834	0.616	0.011	0.353	0.051	0.290	0.016	0.006	1.72
	08/25/2010	5.215	0.521	0.009	0.281	0.015	0.257	0.021	<0.005	4.10
	09/22/2010	6.461	0.706	<0.005	0.298	0.065	0.228	0.009	<0.005	2.80
	10/27/2010	4.822	0.502	0.006	0.235	0.040	0.189	0.003	<0.005	1.81
	11/24/2010	5.678	0.472	0.008	0.267	0.074	0.185	0.006	<0.005	1.66
	12/22/2010	5.322	0.406	0.020	0.349	0.154	0.175	0.018	0.014	<1
05-OYS	03/24/2010	5.863	0.506	0.035	0.302	0.095	0.172	0.043	0.008	9.12
	04/28/2010	4.438	0.341	0.016	0.338	0.154	0.167	0.014	<0.005	3.76
	05/26/2010	5.904	0.511	<0.005	0.358	0.127	0.227	0.042	0.006	3.02
	06/23/2010	5.566	0.845	<0.005	0.436	0.208	0.227	0.018	<0.005	4.50
	07/28/2010	6.377	0.496	<0.005	0.307	<0.005	0.301	0.020	0.006	3.30
	08/25/2010	4.403	0.361	<0.005	0.270	0.062	0.207	0.045	<0.005	4.56
	09/22/2010*	5.063	0.353	<0.005	0.257	0.005	0.248	0.036	0.006	4.19
	09/22/2010	5.027	0.319	<0.005	0.243	0.010	0.233	0.031	<0.005	3.36
	10/27/2010	7.484	0.596	<0.005	0.377	0.111	0.265	0.122	0.014	3.77
	11/24/2010	6.687	0.502	0.019	0.428	0.199	0.210	0.016	0.012	3.18
	12/22/2010	6.817	0.738	0.020	0.486	0.262	0.205	0.044	0.009	6.25
05-SFR	03/24/2010	5.180	0.481	0.033	0.226	0.068	0.124	0.024	0.005	4.91
	04/28/2010*	4.296	0.486	0.047	0.341	0.124	0.170	0.004	<0.005	1.77
	04/28/2010	4.289	0.556	0.052	0.324	0.128	0.144	0.011	<0.005	2.09
	05/26/2010	5.856	0.786	<0.005	0.314	0.126	0.188	0.049	<0.005	2.84
	06/23/2010	5.426	0.746	<0.005	0.405	0.205	0.198	0.024	<0.005	3.80
	07/28/2010	5.376	0.506	0.039	0.448	0.214	0.195	0.033	0.014	2.04
	08/25/2010	4.061	0.666	0.015	0.285	0.056	0.213	0.027	0.008	5.45
	09/22/2010	5.100	0.903	<0.005	0.385	0.098	0.287	0.060	0.008	4.20
	10/27/2010*	5.126	0.558	0.024	0.339	0.121	0.194	0.027	0.006	1.11
	10/27/2010	5.158	0.589	0.023	0.397	0.112	0.262	0.008	<0.005	1.17
	11/24/2010	6.434	0.326	0.082	0.343	0.085	0.176	0.030	0.005	2.47
	12/22/2010	6.533	0.345	0.056	0.322	0.115	0.151	0.017	0.010	1.36
07-CCH	03/24/2010	4.863	0.541	0.046	0.331	0.166	0.120	0.025	0.007	10.54
	04/28/2010		1.750	0.047		0.964		0.029	0.021	3.71
	05/26/2010*	4.683	1.218	0.026	1.169	0.958	0.186	0.031	0.029	2.53

Station ID	Collection Date	DOC (mg C/L)	TN (mg N/L)	NH4 (mg N/L)	TDN (mg N/L)	NO3 (mg N/L)	DON (mg N/L)	TP (mg P/L)	PO4 (mg P/L)	TSS (mg/L)
	05/26/2010	4.662	1.180	0.025	1.163	0.967	0.170	0.066	0.031	2.85
	06/23/2010	4.649	1.929	<0.005	1.828	1.598	0.229	0.096	0.036	2.91
	07/28/2010	4.915	1.855	0.016	1.940	1.653	0.270	0.066	0.052	2.95
	08/25/2010	4.608	2.904	0.100	2.362	2.197	0.065	0.056	0.030	2.94
	09/22/2010	4.944	2.438	0.011	2.385	2.033	0.341	0.051	0.028	5.42
	10/27/2010	4.287	0.648	<0.005	0.608	0.426	0.182	0.094	0.019	2.56
	11/24/2010	6.408	1.131	0.009	1.106	0.976	0.121	0.050	0.027	2.42
	12/22/2010	5.581	1.052	0.024	0.965	0.760	0.182	0.026	0.021	1.18
09-EXT	03/24/2010	6.034	0.401	0.032	0.297	0.079	0.186	0.005	0.007	3.27
	04/28/2010	5.267	0.501	0.026	0.328	0.090	0.211	0.009	<0.005	2.07
	05/26/2010	7.074	0.766	0.005	0.411	0.083	0.324	0.027	<0.005	3.20
	06/23/2010	6.054	0.511	0.005	0.328	0.063	0.261	0.002	0.005	2.49
	07/28/2010*	6.726	0.426	<0.005	0.321	<0.005	0.318	0.060	0.006	1.73
	07/28/2010	6.935	0.401	<0.005	0.345	<0.005	0.342	0.037	0.006	1.42
	08/25/2010	6.534	0.646	0.019	0.425	0.111	0.296	0.017	0.005	3.24
	09/22/2010	7.352	0.575	<0.005	0.411	0.040	0.369	0.021	<0.005	2.55
	10/27/2010	7.971	0.637	0.006	0.350	0.052	0.292	0.029	0.005	<1
	11/24/2010	9.049	0.487	0.007	0.318	0.050	0.262	0.044	<0.005	2.61
	12/22/2010	7.985	0.524	0.010	0.366	0.122	0.234	0.031	0.008	1.49

* Field duplicate sample

Figure 1: Sampling locations in the Great Bay Estuary, Coastal Basin

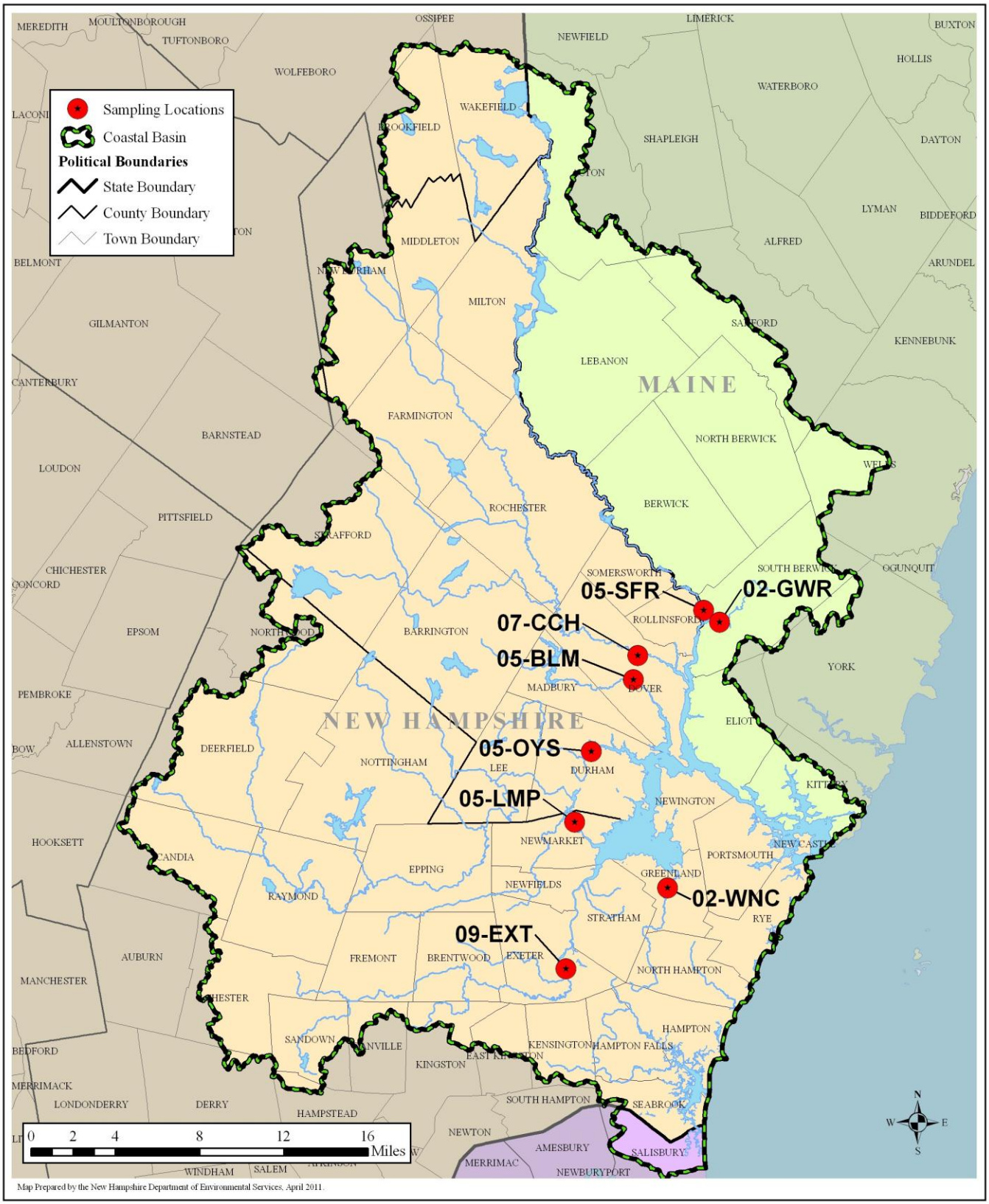

Figure 2: Total Nitrogen Concentrations (in mg N/L) at Tributary Stations

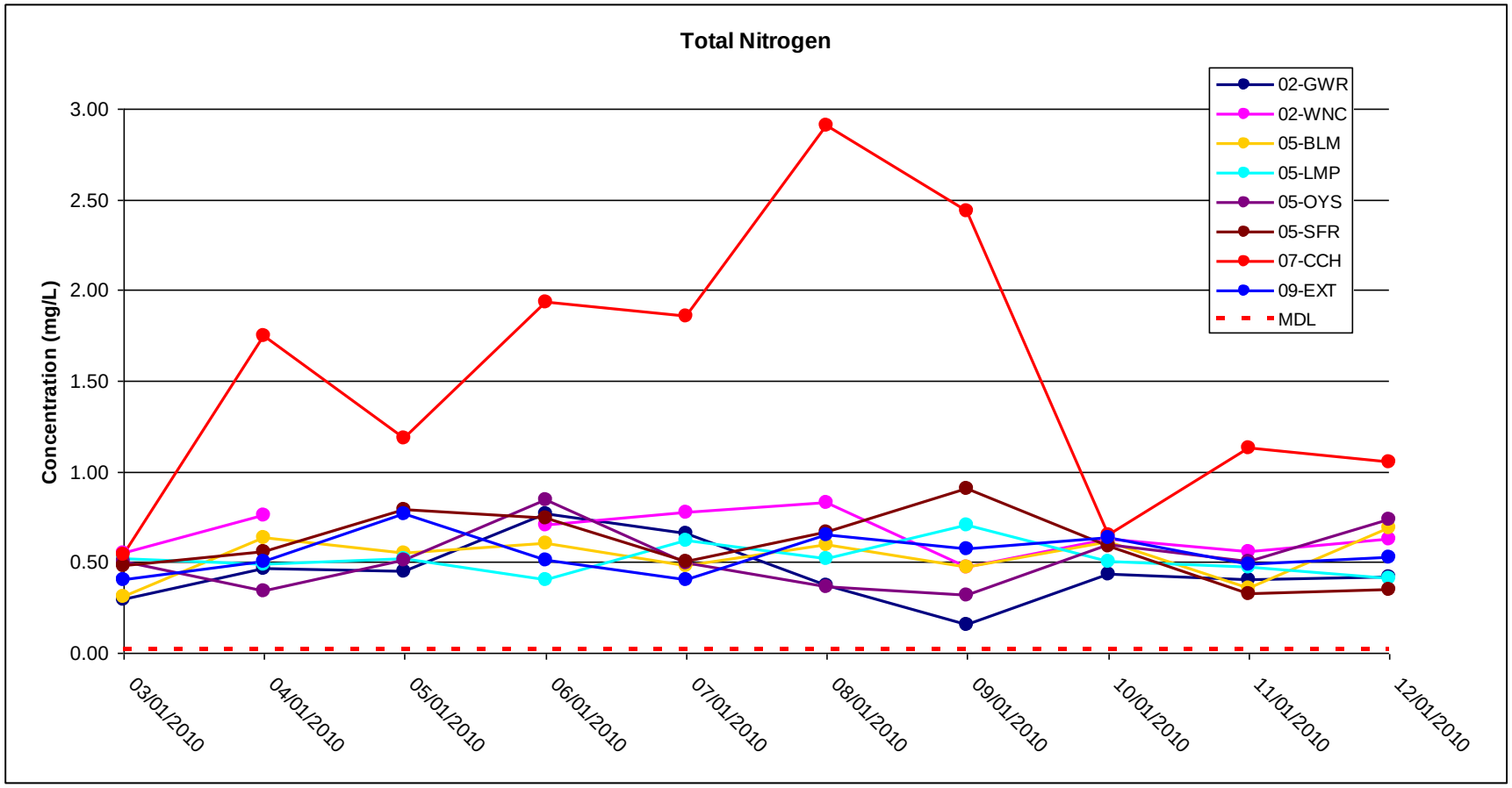

Figure 3: Total Phosphorus in Concentrations (mg P/L) at Tributary Stations

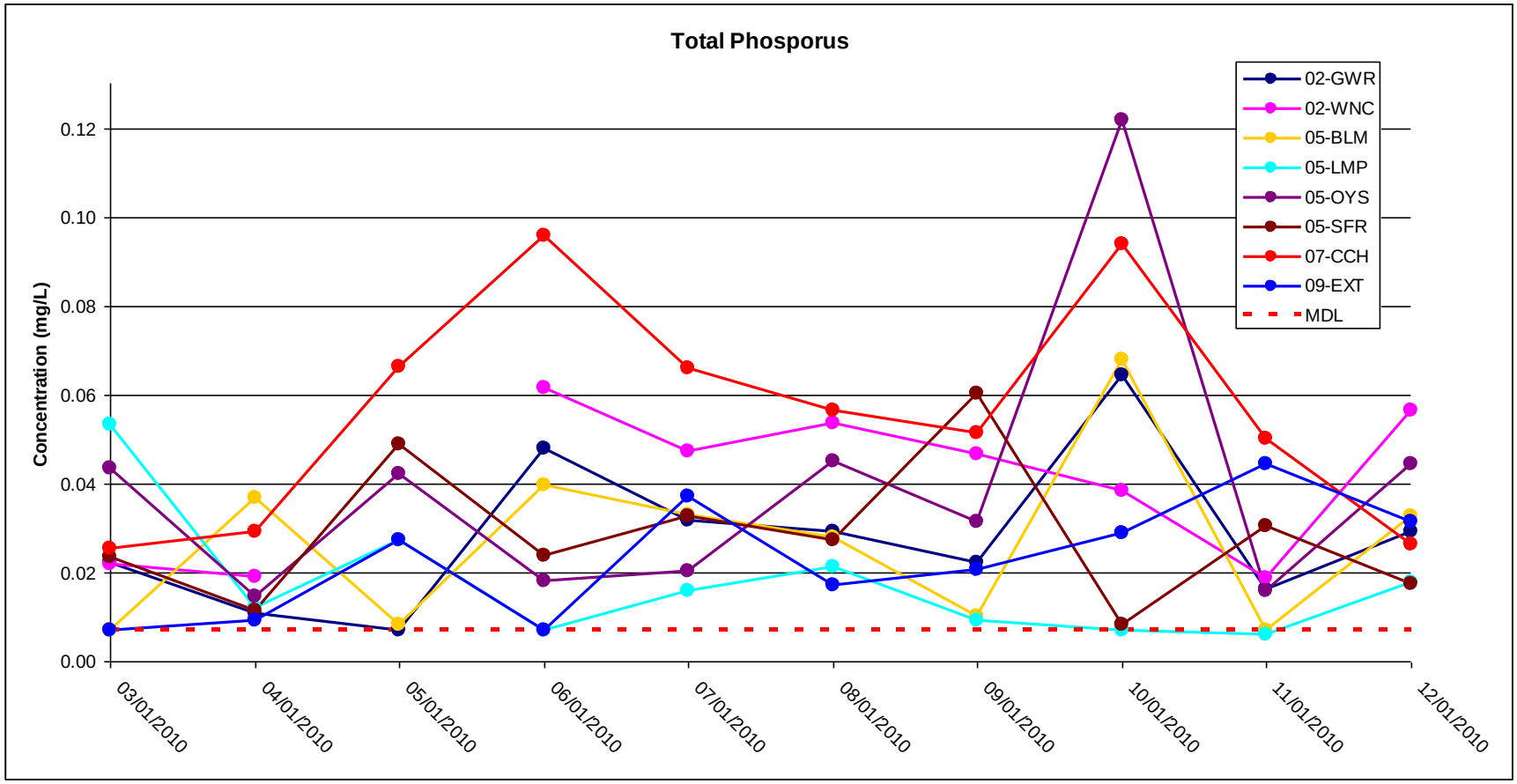

Figure 4: Total Dissolved Nitrogen Concentrations (in mg N/L) at Tributary Stations

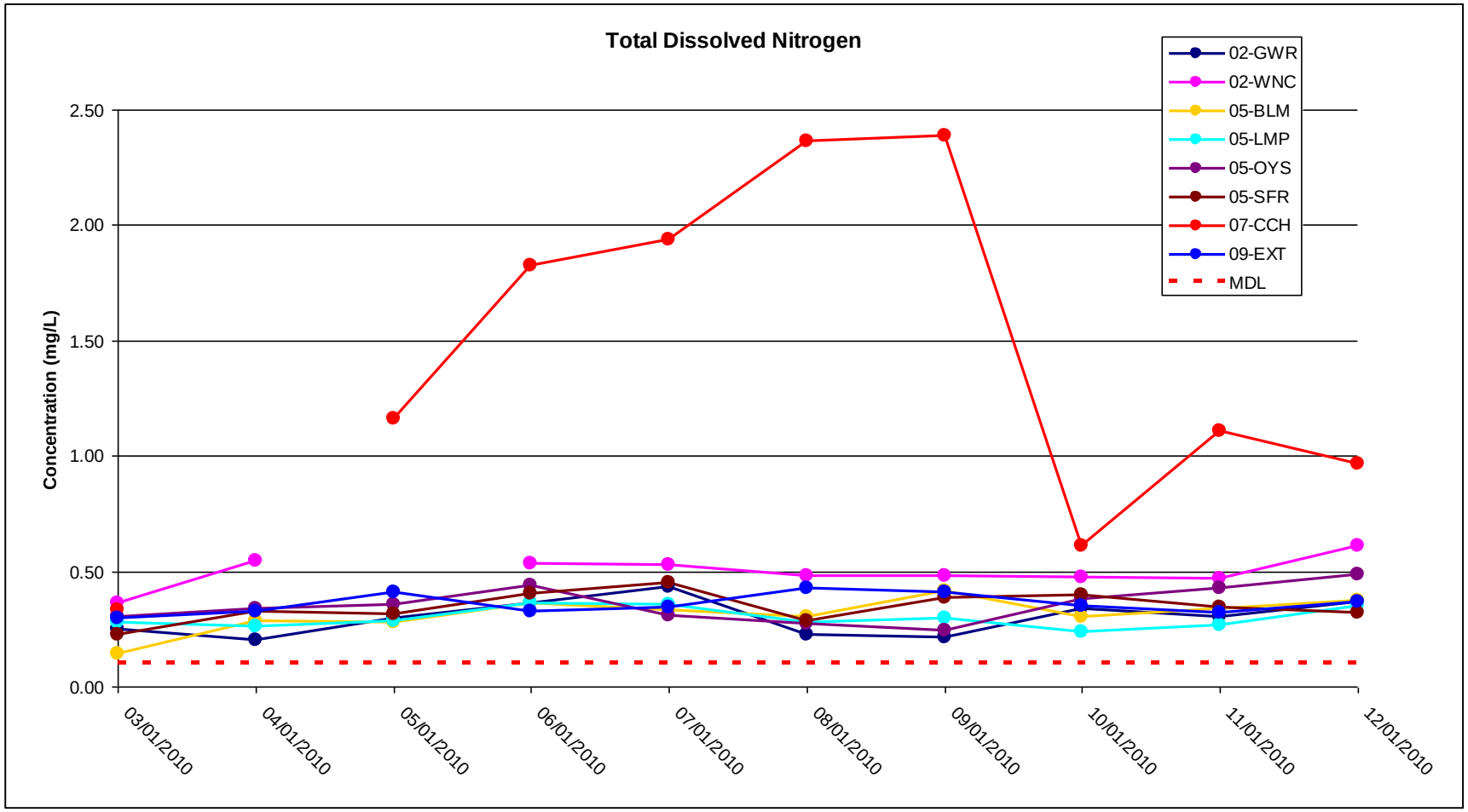

Figure 5: Total Suspended Solids Concentrations (in mg/L) at Tributary Stations

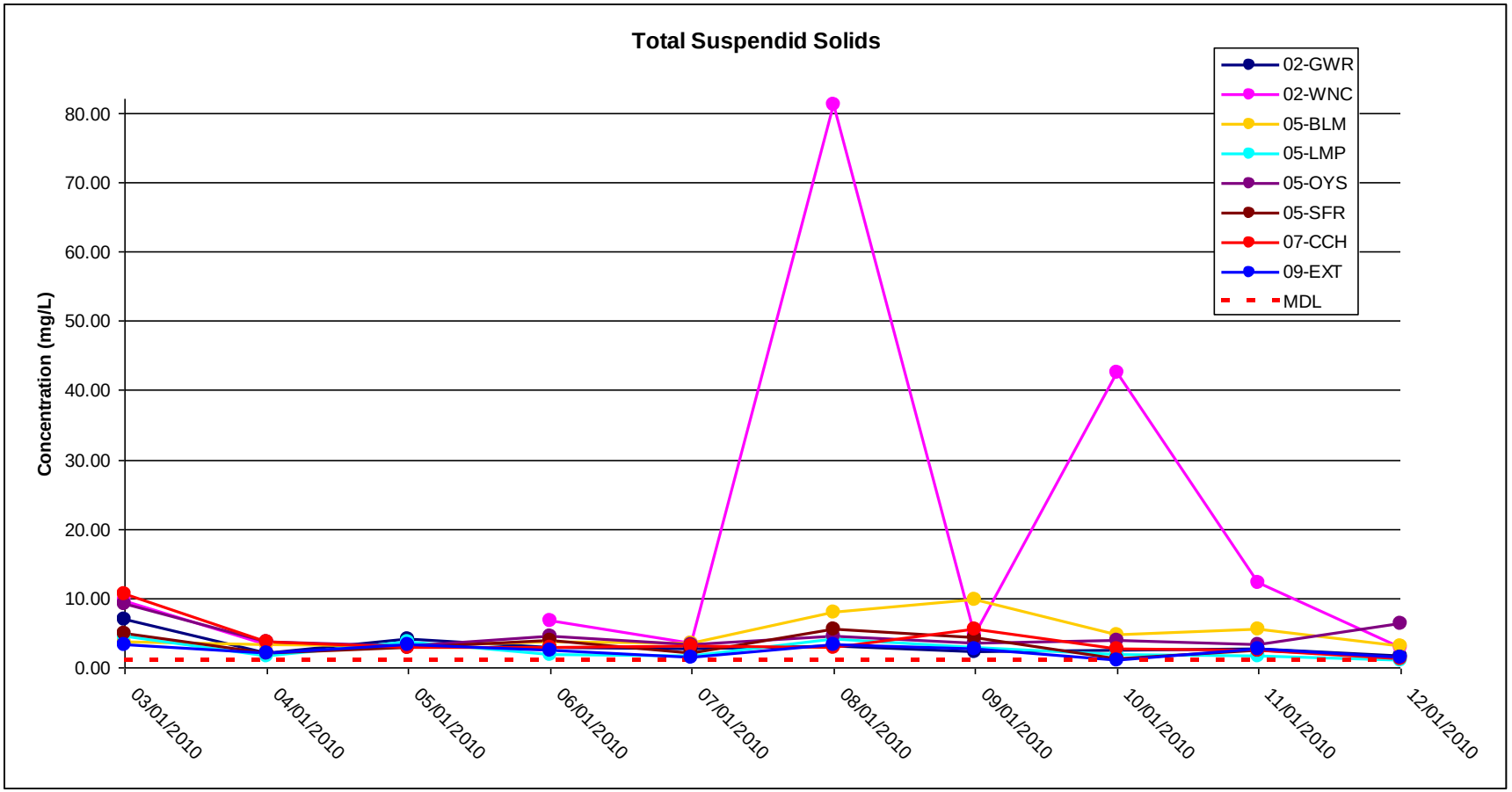

Figure 6: Nitrate Concentrations (in mg N/L) at Tributary Stations

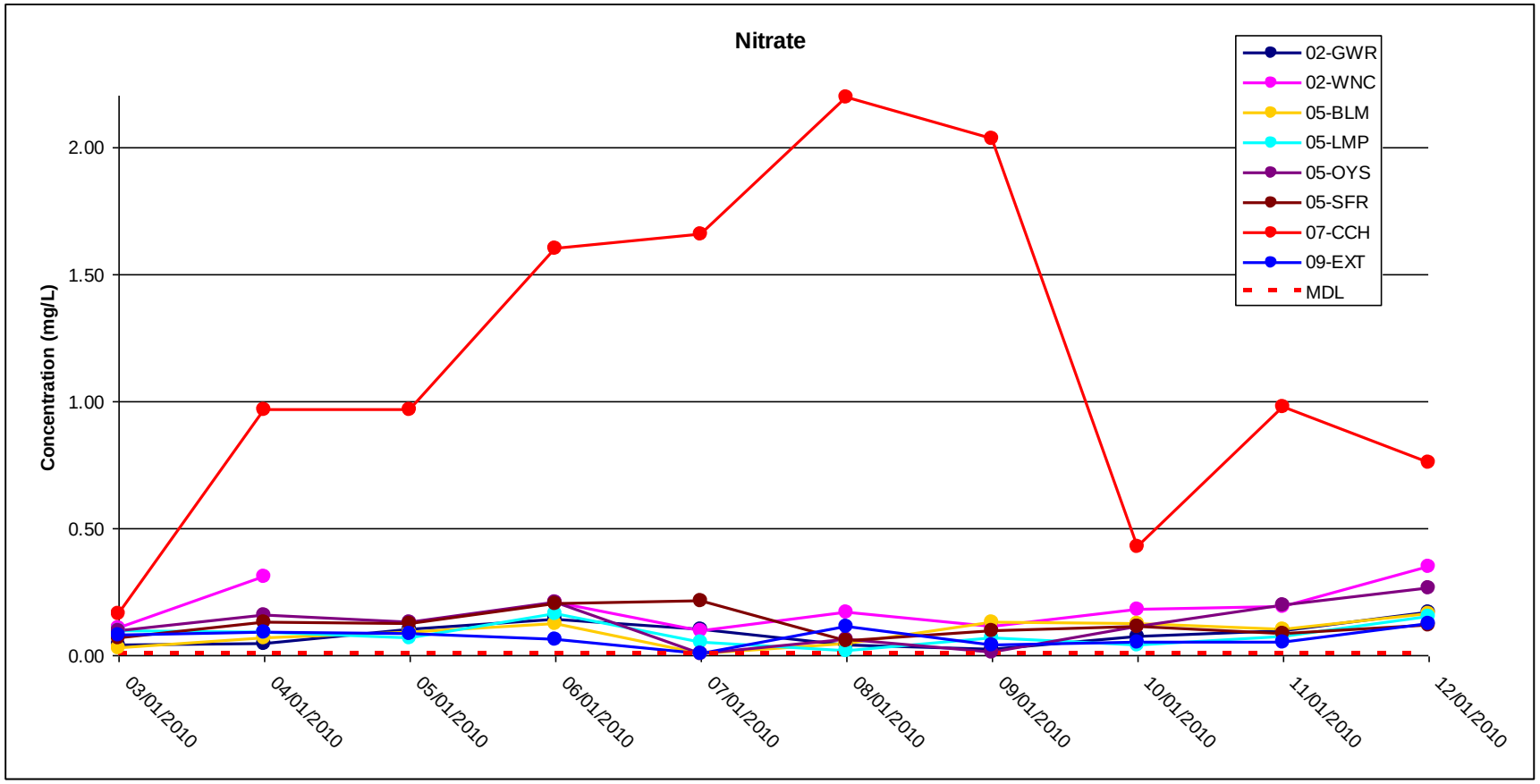

Figure 7: Ammonia Concentrations (in mg N/L) at Tributary Stations

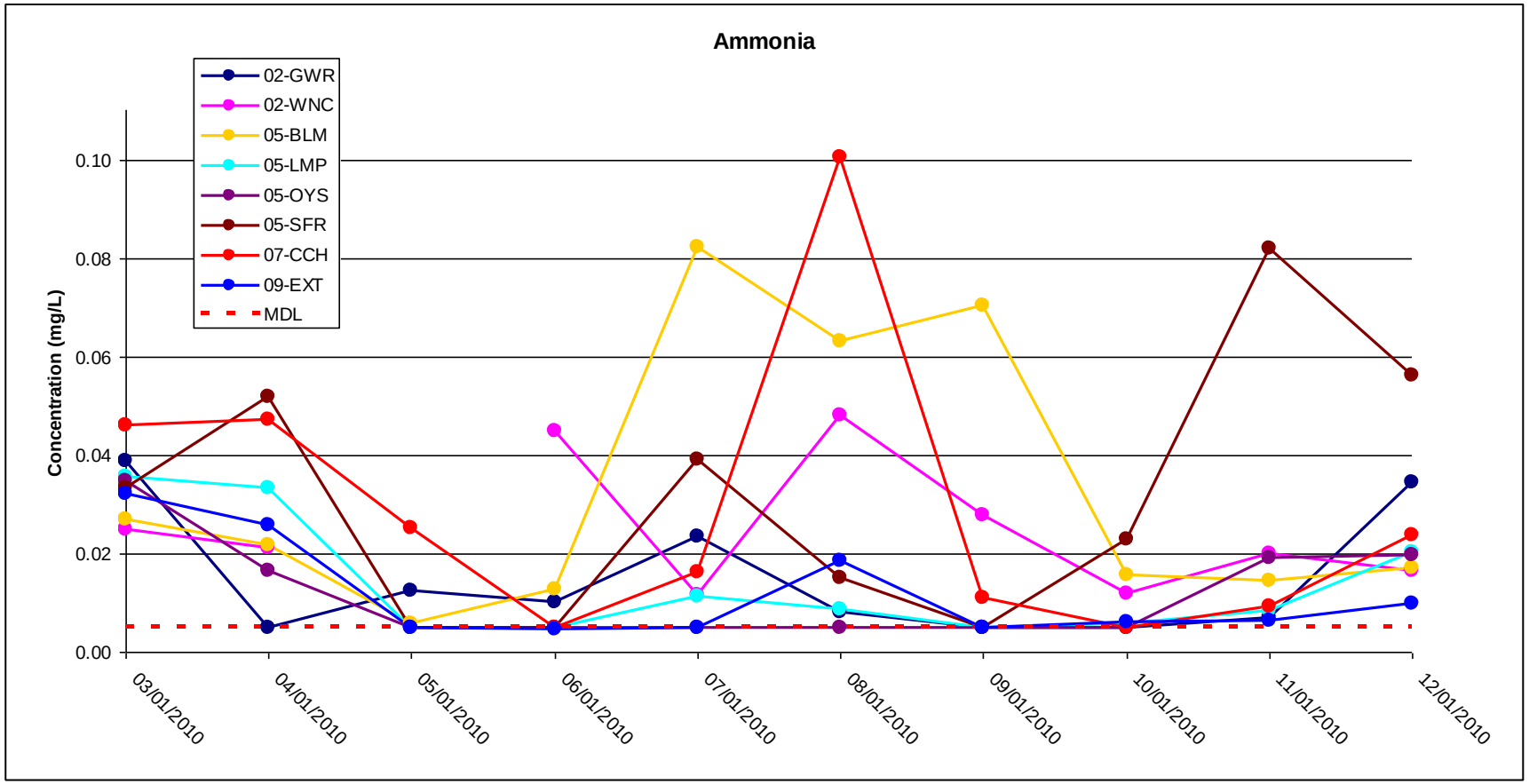

Figure 8: Dissolved Organic Nitrogen Concentrations (in mg N/L) at Tributary Stations

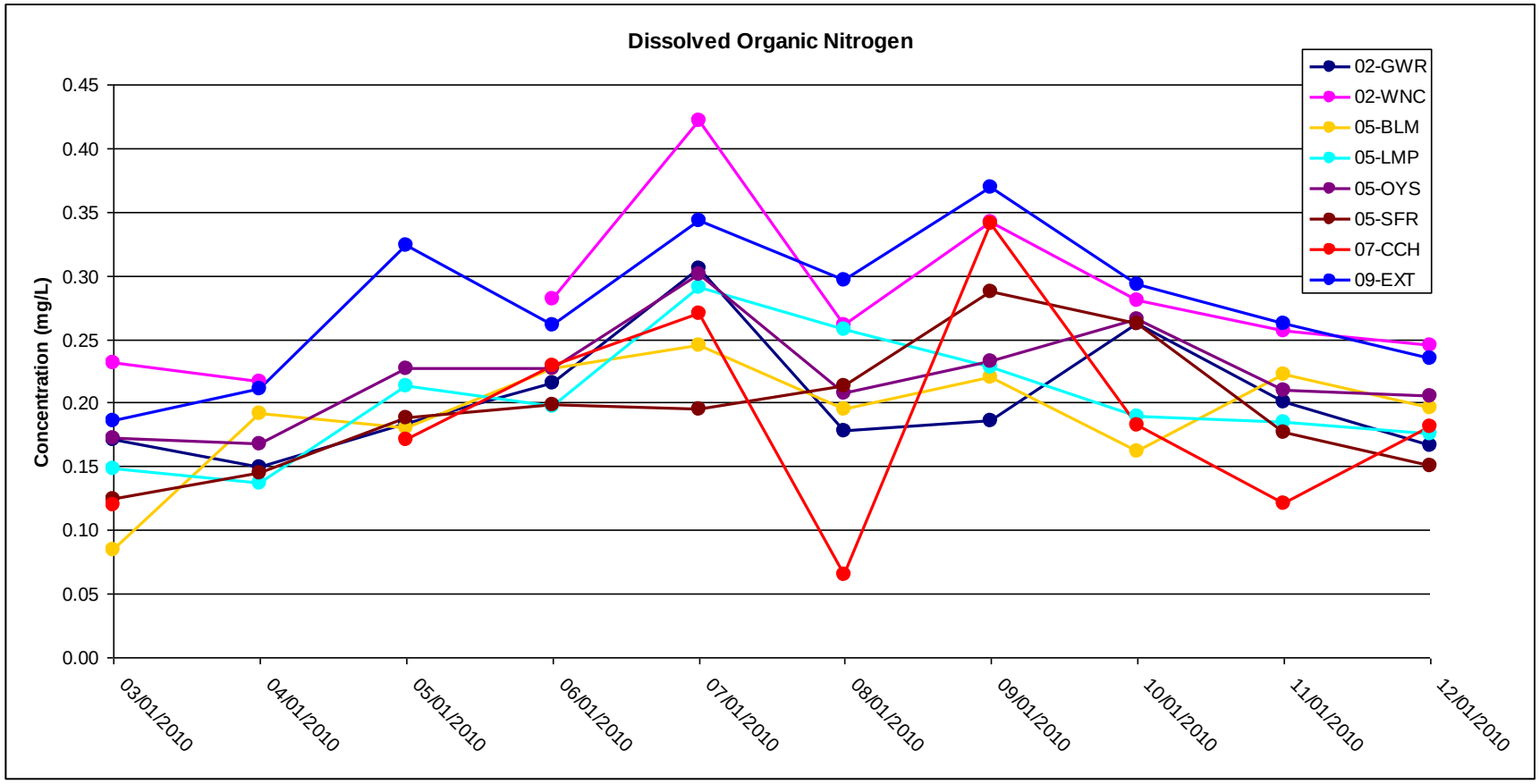

Figure 9: Dissolved Organic Carbon Concentrations (in mg C/L) at Tributary Stations

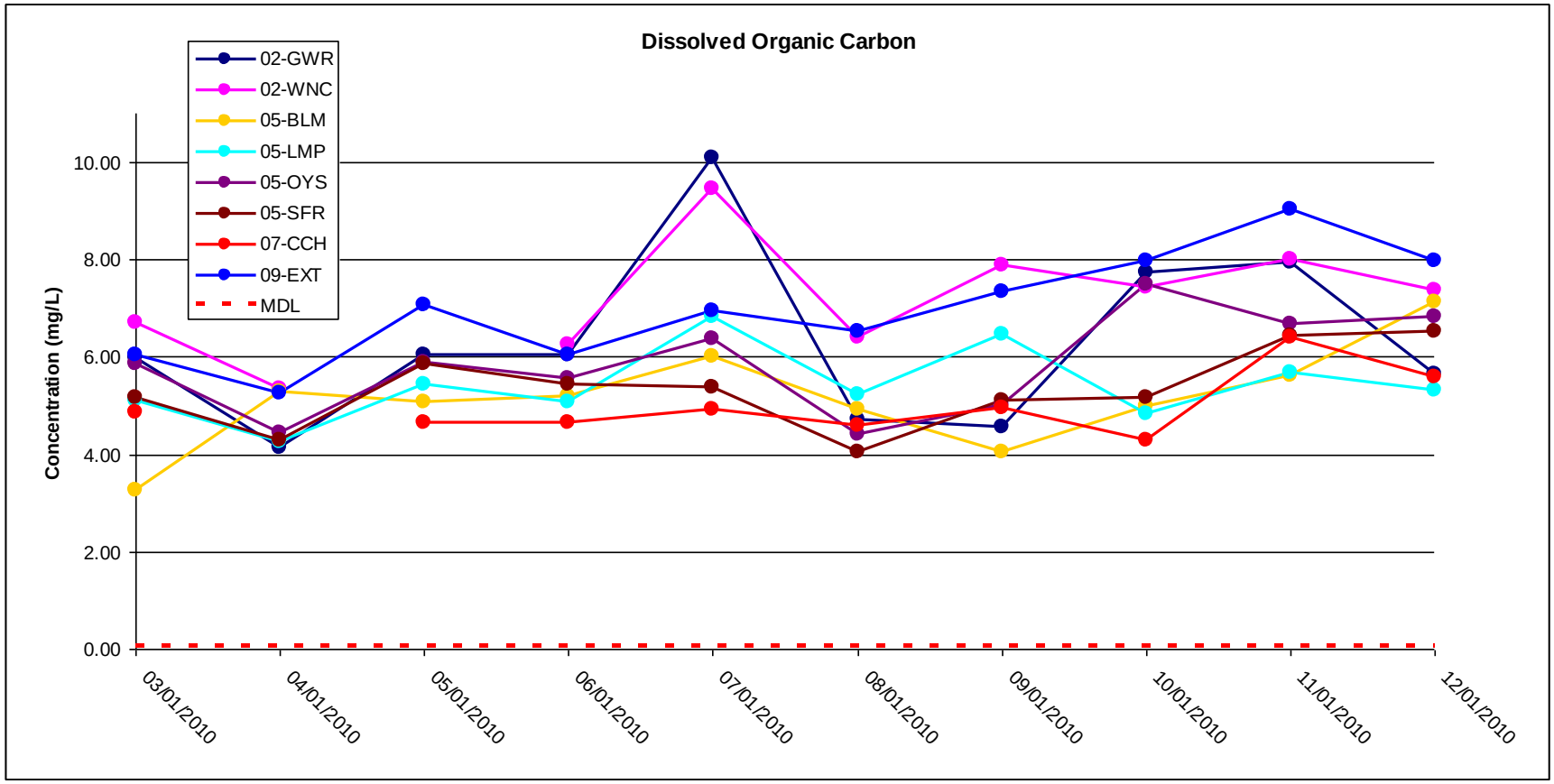

Figure 10: Orthophosphate Concentrations (in mg P/L) at Tributary Stations