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Nitrogen, Phosphorus, and Suspended Solids Concentrations in Tributaries to the Great Bay Estuary Watershed in 2011

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A Final Report to

The Piscataqua Region Estuaries Partnership

Submitted by

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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 2011. 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 2010, 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, amended in 2010).

University of New Hampshire researchers collected grab samples 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), 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.

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

UNH provided the field and laboratory data to the New Hampshire Department of Environmental Services to be quality assured and then added to the Environmental Monitoring Database.

Field sampling proceeded as planned with the following exceptions:

- 89 of the 90 planned samples were collected for laboratory analysis (99%). This meets the data quality objective for completeness (80% of planned samples). Field parameters were not collected at all station visits due to equipment malfunctions or lost field data sheets. Field parameters are not required for this study so the absence of these data is acceptable.

- Bridge construction at station 05-SFR on the Salmon Falls River prevented sampling at this site in April and May 2011. The sampling station was moved upstream to 06-SFR for June through October 2011. Two samples were collected in June to make up for the missing samples from April and May. Stations 05-SFR and 06-SFR are only 0.75 miles apart. The only major source of nutrients between 06-SFR and 05-SFR is the Rollinsford WWTF. This WWTF loads 2.84 tons of nitrogen per year on average (2003-2008). For comparison, non-point source nitrogen loads from the Salmon Falls River watershed are 304 tons per year on average (2003-2008). Given the small contribution of the Rollinsford WWTF, substituting data from 06-SFR for 05-SFR for five months should not bias the load calculations significantly.
- Fish ladder construction at station 02-WNC on the Winnicut River required that the sampling location be moved slightly. Samples are normally collected from the bridge. The fish ladder is directly beneath the bridge so this method was not possible. Instead, samples were collected downstream of the construction zone at the point where culverts carrying the river water through the construction zone discharged back to the river. Samples were collected at this alternative location for June through September.
- The time of sample collection at 02-WNC on 6/23/11 was not recorded.

The results of quality control samples for TN, TP, TDN, TSS, NH_4, NO_3, DOC and PO_4 have been summarized in Tables 1 through 8. All of the data quality objectives for laboratory results for the study were substantially met. There were no major deviations from the planned laboratory methods.

<u>Field duplicate samples:</u>

- Total Nitrogen: Two of the 10 field duplicates had RPD values greater than the data quality objectives (<30%). The failing pairs had RPD values that were close to the data quality objective (32% and 41% vs. 30%). The high variability in the field duplicates for TN is likely indicative of natural variability in the river. All of the TN results were considered acceptable.
- Ammonia: Four of the 10 field duplicates had RPD values greater than the data quality objectives. However, all of the failing duplicate pairs were for low concentrations, near the detection limit, which inflate RPD calculations. The results were considered acceptable.
- Total Phosphorus: Five of the 10 field duplicates had RPD values greater than the data quality objectives. However, all of the failing duplicate pairs were for low concentrations, near the detection limit, which inflate RPD calculations. The results were considered acceptable.
- Orthophosphate: Five of the 10 field duplicates had RPD values greater than the data quality objectives. However, all of the failing duplicate pairs were for low concentrations, near the detection limit, which inflate RPD calculations. The results were considered acceptable.
- Suspended Sediments: Two of the 10 field duplicates had RPD values greater than the data quality objectives. However, all of the failing duplicate pairs were for low concentrations, near the detection limit, which inflate RPD calculations. The results were considered acceptable.

- All of the field duplicate samples for DOC, TDN, NO3, and the field parameters were within data quality objectives.

Laboratory quality control samples:
The results of laboratory QC tests are shown on Tables 1-8. All of the instances where QC results did not meet data quality objectives were for low concentrations (<10x MDL), which is acceptable.

Logical tests:
Laboratory results for nitrogen and phosphorus species were checked to verify that dissolved species were not greater than total species.

- TN vs. TDN: TN should be greater than or equal to TDN. Out of the 89 results for TN and TDN, two results had higher TDN values than TN. TDN was only slightly higher than TN (2-3% higher), which was considered acceptable.
- TDN vs. NO_3+NH_4: TDN should be greater than or equal to the sum of NO_3 and NH_4. Out of 89 samples, the sum of NO_3 and NH_4 was greater than TDN in two samples. The exceedences were very small and considered acceptable.
- TP vs. PO_4: TP should be greater than or equal to PO_4. Out of 89 samples, there were two samples with PO_4 greater than TP (02-GWR and 05-SFR on 3/23/11). The PO_4 results for these stations visits were invalidated because the concentrations were unusually high for the station and time of year.

Results below detection limits:
Several of the results for ammonium (11), orthophosphate (28), total phosphorus (5) and total suspended solids (2) were reported below the reporting detection levels (0.005, 0.005, 0.007 and 1 mg/L, respectively). These results are being reported as < RDL, not the values reported by the laboratory.

Consistency/Comparability:
The range of concentrations measured in 2011 were consistent with previous sampling efforts at these sites (Tables 1-8). Time series plots of the data at different stations were used to identify any unusual results. Similar to previous years, the nitrogen concentrations in the Cocheco River are much higher than in other rivers. The only other anomalous result was a spike in total phosphorus at 07-CCH on 4/27/11 (0.190 mg/L). TP spikes of this magnitude have been observed in previous sampling at these stations. Therefore, this data point will be assumed to be valid.

Summary of Invalidated Results:

Parameter	Station	Date	Sample Purpose	Result	Units
ORTHOPHOSPHATE	02-GWR	03/23/11	ROUTINE	0.013	MG/L
	05-SFR	03/23/11	ROUTINE	0.021	MG/L

Results and Discussion

The quality assured results for TN, TP, TDN, TSS, NH_4, NO_3, DOC and PO_4 concentrations for each station visit are shown in Table 9. Figures 3 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 0.230-1.995 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 0.378 and 0.611 mg N/L.

- The average concentrations of TP at each station ranged from 0.019 to 0.061 mg P/L. The maximum concentrations occurred in the Cocheco River (station 07-CCH). The rest of the stations had average TP concentrations between 0.019 and 0.043 mg P/L.

- The average concentrations of TDN at each station ranged from 0.219 to 0.927 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 0.219 and 0.436 mg/L.

- The average TSS concentrations ranged from 1.4 to 4.09 mg/L. The highest average concentration was in the Oyster River (station 05-OYS).

- The average concentrations of NO_3 at each station ranged from 0.080 to 0.715 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 0.080 and 0.148 mg N/L.

- The average NH_4 concentration ranged from 0.012 to 0.020 mg N/L. The Bellamy River had the highest average concentration (station 05-BLM).

- The average concentrations of DOC at each station ranged from 4.468 to 8.691 mg C/L. The maximum concentrations occurred in the Winnicut River (station 02-WNC).

- The average concentrations of PO_4 at each station ranged from 0.006 to 0.016 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 0.006 and 0.011 mg P/L.

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 / 2 Failed DQO The failures were close to the DQO (32% and 41% RPD).
Precision-Lab	RPD < 15%	Lab Duplicates	8 Lab Duplicates / 1 Failed DQO 10 Lab Replicates / 1 Failed DQO All of the failures were for samples with low concentrations (<10xMDL)
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	11 CRM tests / 0 Failed DQO 7 LFM tests / 2 Failed DQO All of the failures were for samples with low concentrations (<10xMDL)
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of TN concentrations in 2011 (0.23-2.00 mg/L) matched the range from 2001-2010 (0.11-2.99 mg/L).
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 0.23 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	6 Lab Dupes / 3 Failed DQO The failures were all for a samples with a low concentration (<10xMDL)
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	8 CRM tests / 0 Failed DQO 3 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 2011 (0.18-1.96 mg/L) matched the range from 2008-2010 (0.17-2.57).
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 0.18 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 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 / 5 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	8 Lab Reps / 5 Failed DQO 10 Lab Dupes / 3 Failed DQO The failures were for samples with low concentrations (<10xMDL)
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	9 CRM tests / 0 Failed DQO 11 LFM tests / 3 Failed DQO The failures were for samples with a low concentration (<10xMDL)
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of TP concentrations in 2011 (0.007-0.19 mg/L) matched the range from 2001-2010 (0.003-0.35 mg/L).
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 0.009 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 / 2 Failed DQO The failures were for samples with a low concentration (<10xMDL)
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 2011 (1-10.9 mg/L) were similar to the range from 2001-2010 (0.9-57).
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 1.2 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	6 Lab Dupes / 0 Failed DQO
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	6 CRM tests / 0 Failed DQO 6 LFM tests / 0 Failed DQO
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of nitrate concentrations in 2011 (0.006-1.50 mg/L) was similar to the range from 2009-2010 (0.005-2.05 mg/L).
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 0.006 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 / 4 Failed DQO All of the failures were samples with low concentrations (<10xMDL)
Precision-Lab	RPD < 15%	Lab Duplicates	5 Lab Dupes / 0 Failed DQO
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	5 CRM tests / 0 Failed DQO 11 LFM tests / 0 Failed DQO
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of ammonia concentrations in 2011 (0.005-0.062 mg/L) was similar to the range for 2009-2010 (0.005-0.100 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 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	7 Lab Duplicates / 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 3 LFM tests / 1 Failed DQO All of the failures were samples with low concentrations (<10xMDL)
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of dissolved organic carbon in 2011 (3.24-12.5 mg/L) was similar to the range for 2010 (3.28-10.09 mg/L).
Sensitivity	Not expected to be an issue for this project (see discussion below)	NA	Lowest detected concentration was 3.24 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 8: 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 / 5 Failed DQO All of the failures were close to the DQO or were for samples with low concentrations (<MDL)
Precision-Lab	RPD < 15%	Lab Duplicates	10 Lab Dupes / 2 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	10 CRM tests / 0 Failed DQO 9 LFM tests / 2 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 orthophosphate concentrations (0.005-0.34 mg/L) was similar to 2010 (0.005-0.052 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 9: Validated Laboratory Results at Tributary Stations

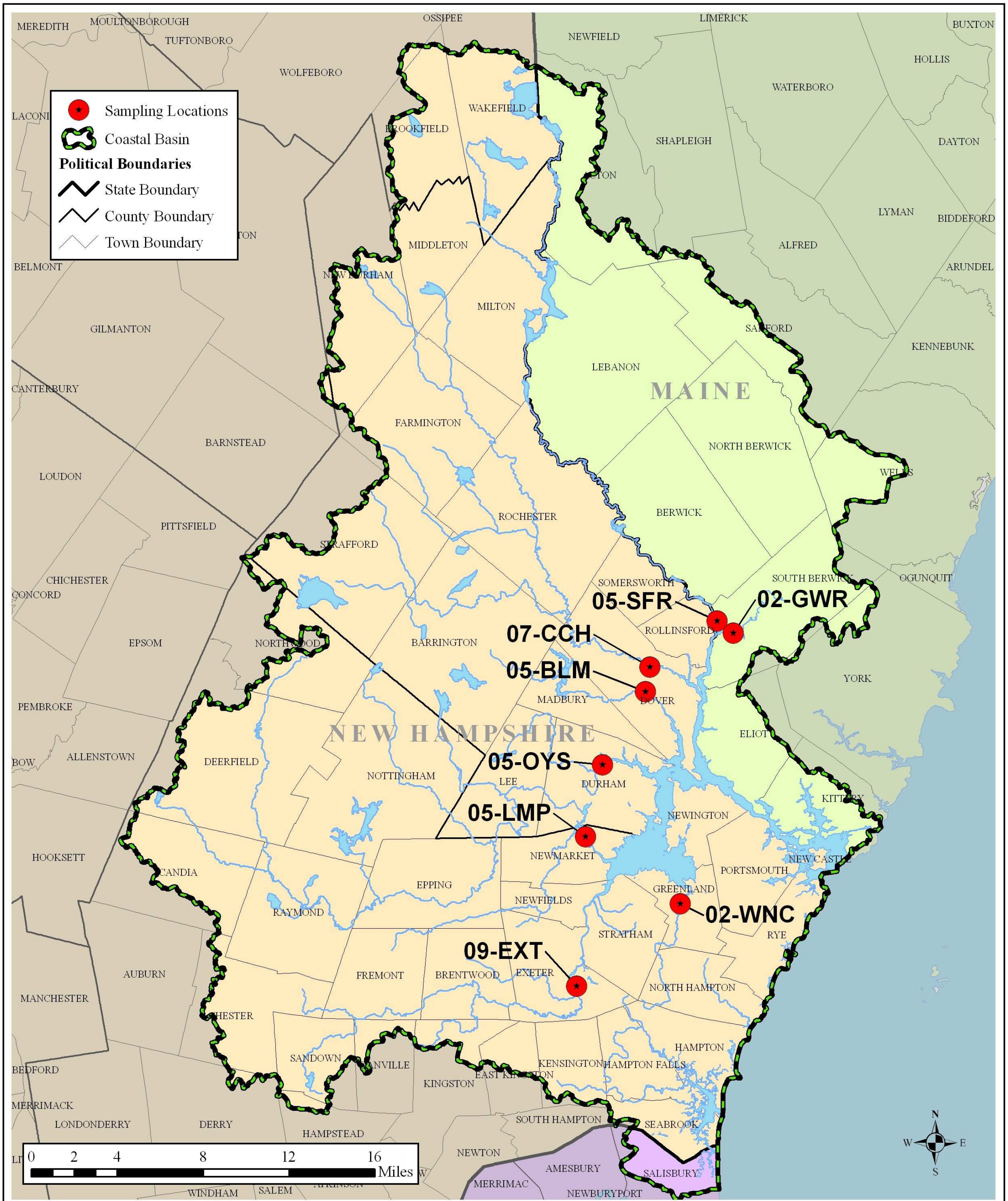
Station ID	Collection Date	DOC (mg C/L)	TN (mg N/L)	NH4 (mg N/L)	TDN (mg N/L)	NO3 (mg N/L)	TP (mg P/L)	PO4 (mg P/L)	TSS (mg/L)
02-GWR	3/23/2011	4.874	0.275	0.062	0.255	0.108	<0.007	n/a	2.259
02-GWR	4/27/2011	5.479	0.326	0.020	0.217	0.077	0.011	<0.005	2.197
02-GWR	5/25/2011	7.492	0.345	<0.005	0.239	0.070	0.028	<0.005	2.649
02-GWR	6/22/2011	6.558	0.395	0.025	0.304	0.114	0.021	0.005	2.252
02-GWR	7/27/2011	5.196	0.419	0.015	0.212	0.026	0.023	<0.005	3.167
02-GWR	8/24/2011	8.063	0.430	0.009	0.327	0.071	0.034	0.005	4.143
02-GWR	9/28/2011	8.377	0.378	0.011	0.299	0.065	0.032	0.012	2.750
02-GWR	9/28/2011*	8.656	0.402	0.011	0.284	0.070	0.046	0.006	2.263
02-GWR	10/26/2011	11.711	0.447	0.007	0.339	0.075	0.071	0.031	5.304
02-GWR	11/21/2011	6.107	0.408	0.013	0.319	0.102	0.015	0.014	2.535
02-GWR	12/21/2011	5.568	0.357	0.016	0.234	0.133	0.013	<0.005	<1
02-WNC	3/23/2011	5.557	0.450	0.005	0.345	0.171	0.013	0.008	2.346
02-WNC	4/27/2011	7.032	0.394	0.022	0.365	0.121	0.032	<0.005	1.988
02-WNC	4/27/2011*	6.874	0.356	0.020	0.352	0.131	<0.007	0.005	2.167
02-WNC	5/25/2011	8.818	0.690	0.013	0.371	0.080	0.013	0.012	3.093
02-WNC	6/23/2011	9.317	0.689	0.045	0.516	0.152	0.046	0.015	7.100
02-WNC	7/27/2011	7.091	0.424	0.006	0.270	0.019	0.023	<0.005	2.500
02-WNC	8/24/2011	12.211	0.857	0.027	0.500	0.101	0.062	0.027	3.189
02-WNC	9/28/2011	11.112	0.530	0.023	0.483	0.077	0.028	0.008	3.203
02-WNC	10/26/2011	12.536	0.620	0.016	0.460	0.101	0.015	0.014	7.500
02-WNC	11/21/2011	7.764	0.569	0.011	0.486	0.235	0.020	0.009	3.506
02-WNC	12/21/2011	5.475	0.669	0.016	0.564	0.421	0.009	0.006	2.488
05-BLM	3/23/2011	5.877	0.450	0.031	0.230	0.087	0.032	<0.005	2.139
05-BLM	4/27/2011	5.837	0.271	0.017	0.190	0.055	0.023	<0.005	2.327
05-BLM	5/25/2011	6.916	0.422	0.006	0.212	0.035	0.085	<0.005	4.033
05-BLM	6/22/2011	6.639	0.507	0.052	0.384	0.134	0.038	0.010	3.500
05-BLM	6/22/2011*	7.319	0.564	0.050	0.399	0.137	0.036	0.005	2.198
05-BLM	7/27/2011	5.970	0.396	0.009	0.280	0.051	0.032	0.008	3.520
05-BLM	8/24/2011	4.535	0.304	<0.005	0.219	0.058	0.018	<0.005	2.645
05-BLM	9/28/2011	6.751	0.453	0.015	0.311	0.077	0.038	0.008	2.568
05-BLM	10/26/2011	8.702	0.544	0.011	0.308	0.056	0.040	0.008	6.187
05-BLM	11/21/2011	7.875	0.554	0.014	0.300	0.084	0.015	0.007	2.607
05-BLM	12/21/2011	6.481	0.412	0.040	0.340	0.161	0.031	<0.005	2.930
05-LMP	3/23/2011	4.616	0.431	0.013	0.222	0.146	<0.007	<0.005	1.968
05-LMP	4/27/2011	4.914	0.220	0.009	0.178	0.070	<0.007	<0.005	1.235

Station ID	Collection Date	DOC (mg C/L)	TN (mg N/L)	NH4 (mg N/L)	TDN (mg N/L)	NO3 (mg N/L)	TP (mg P/L)	PO4 (mg P/L)	TSS (mg/L)
05-LMP	5/25/2011	5.837	0.478	0.007	0.239	0.048	0.019	<0.005	2.842
05-LMP	6/22/2011	6.086	0.534	0.051	0.368	0.148	0.014	0.005	1.250
05-LMP	7/27/2011	6.293	0.512	0.007	0.318	0.066	0.039	0.007	2.313
05-LMP	7/27/2011*	6.492	0.453	0.011	0.348	0.072	0.026	0.006	3.786
05-LMP	8/24/2011	6.389	0.352	<0.005	0.225	0.035	0.018	<0.005	1.622
05-LMP	9/28/2011	7.485	0.540	0.015	0.400	0.120	0.015	0.015	1.221
05-LMP	10/26/2011	8.976	0.428	<0.005	0.287	0.056	0.016	<0.005	1.550
05-LMP	11/21/2011	6.148	0.448	<0.005	0.227	0.084	0.034	0.007	1.524
05-LMP	11/21/2011*	6.597	0.325	<0.005	0.295	0.096	0.016	<0.005	1.524
05-LMP	12/21/2011	4.629	0.270	<0.005	0.252	0.165	0.021	<0.005	1.629
05-OYS	3/23/2011	3.917	0.443	0.018	0.258	0.241	0.023	<0.005	2.688
05-OYS	4/27/2011	5.295	0.381	0.010	0.259	0.122	0.028	0.005	3.120
05-OYS	5/25/2011	7.036	0.567	0.005	0.268	0.091	0.016	<0.005	10.900
05-OYS	5/25/2011*	6.994	0.748	0.008	0.268	0.093	0.025	<0.005	10.687
05-OYS	6/22/2011	6.651	0.638	0.038	0.439	0.187	0.049	0.016	3.868
05-OYS	7/27/2011	5.455	0.375	<0.005	0.209	0.006	0.023	<0.005	2.242
05-OYS	8/24/2011	5.615	0.752	<0.005	0.246	0.025	0.066	<0.005	7.250
05-OYS	9/28/2011	6.678	0.601	0.018	0.407	0.129	0.045	0.014	2.489
05-OYS	10/26/2011	9.371	0.545	0.018	0.417	0.154	0.037	0.010	4.118
05-OYS	11/21/2011	7.100	0.618	0.013	0.368	0.164	0.043	0.016	2.321
05-OYS	12/21/2011	4.829	0.426	0.019	0.389	0.254	0.041	0.009	1.903
05-SFR	3/23/2011	3.238	0.244	0.022	0.202	0.140	<0.007	n/a	1.602
05-SFR	11/21/2011	5.927	0.459	0.016	0.255	0.100	0.017	0.010	1.602
05-SFR	12/21/2011	4.238	0.483	0.009	0.201	0.132	0.037	<0.005	<1
06-SFR	6/1/2011	5.492	0.476	0.046	0.284	0.151	0.013	<0.005	2.918
06-SFR	6/22/2011	5.393	0.709	0.021	0.358	0.150	0.034	0.010	2.682
06-SFR	7/27/2011	5.202	0.505	0.011	0.365	0.153	0.024	0.008	2.182
06-SFR	8/24/2011	5.405	0.437	0.011	0.370	0.203	0.024	0.011	1.916
06-SFR	9/28/2011	8.170	0.494	0.012	0.313	0.083	0.022	0.011	2.050
06-SFR	10/26/2011	7.183	0.435	0.012	0.253	0.075	0.031	0.009	1.944
06-SFR	10/26/2011*	6.842	0.338	0.011	0.226	0.077	0.030	0.014	2.111
07-CCH	3/23/2011	3.909	0.530	0.027	0.416	0.391	0.022	0.005	2.800
07-CCH	4/27/2011	4.399	0.628	<0.005	0.516	0.359	0.190	<0.005	1.986
07-CCH	5/25/2011	4.888	0.613	0.011	0.365	0.239	0.022	0.010	4.414
07-CCH	6/22/2011	5.428	1.335	0.026	1.380	1.040	0.090	0.026	1.971
07-CCH	7/27/2011	5.384	1.995	0.010	1.958	1.499	0.081	0.010	2.294

Station ID	Collection Date	DOC (mg C/L)	TN (mg N/L)	NH4 (mg N/L)	TDN (mg N/L)	NO3 (mg N/L)	TP (mg P/L)	PO4 (mg P/L)	TSS (mg/L)
07-CCH	8/24/2011	5.122	1.522	0.017	1.518	1.300	0.079	0.015	1.716
07-CCH	8/24/2011*	4.689	1.698	0.012	1.512	1.236	0.078	0.011	2.000
07-CCH	9/28/2011	5.593	1.128	0.015	0.965	0.702	0.053	0.034	1.626
07-CCH	10/26/2011	6.357	0.753	0.009	0.643	0.451	0.026	0.017	3.071
07-CCH	11/21/2011	5.295	0.722	0.022	0.734	0.504	0.027	0.018	1.557
07-CCH	12/21/2011	3.713	1.057	0.023	0.776	0.663	0.022	0.015	1.238
07-CCH	12/21/2011*	3.647	0.874	0.024	0.770	0.656	0.026	0.016	1.315
09-EXT	3/23/2011	5.344	0.230	0.007	0.230	0.136	0.109	0.005	2.130
09-EXT	3/23/2011*	5.077	0.350	0.018	0.231	0.107	0.124	<0.005	2.088
09-EXT	4/27/2011	6.529	0.253	0.016	0.244	0.055	0.018	<0.005	2.452
09-EXT	5/25/2011	7.558	0.651	0.009	0.272	0.061	0.045	0.005	3.466
09-EXT	6/22/2011	8.444	0.644	0.039	0.395	0.089	0.052	0.009	2.308
09-EXT	7/27/2011	9.297	0.492	0.025	0.390	0.053	0.034	0.013	1.938
09-EXT	8/24/2011	10.286	0.608	0.022	0.457	0.073	0.046	0.021	2.308
09-EXT	9/28/2011	9.140	0.708	0.022	0.460	0.121	0.032	0.013	3.023
09-EXT	10/26/2011	10.992	0.460	<0.005	0.336	0.055	0.050	0.010	2.200
09-EXT	11/21/2011	7.572	0.346	0.008	0.293	0.088	0.032	0.008	2.120
09-EXT	12/21/2011	5.597	0.443	0.008	0.312	0.172	0.015	0.010	1.682

* Field duplicate sample

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



Map Prepared by the New Hampshire Department of Environmental Services, April 2011.

Figure 2: Salmon Falls River Sampling Stations in 2011

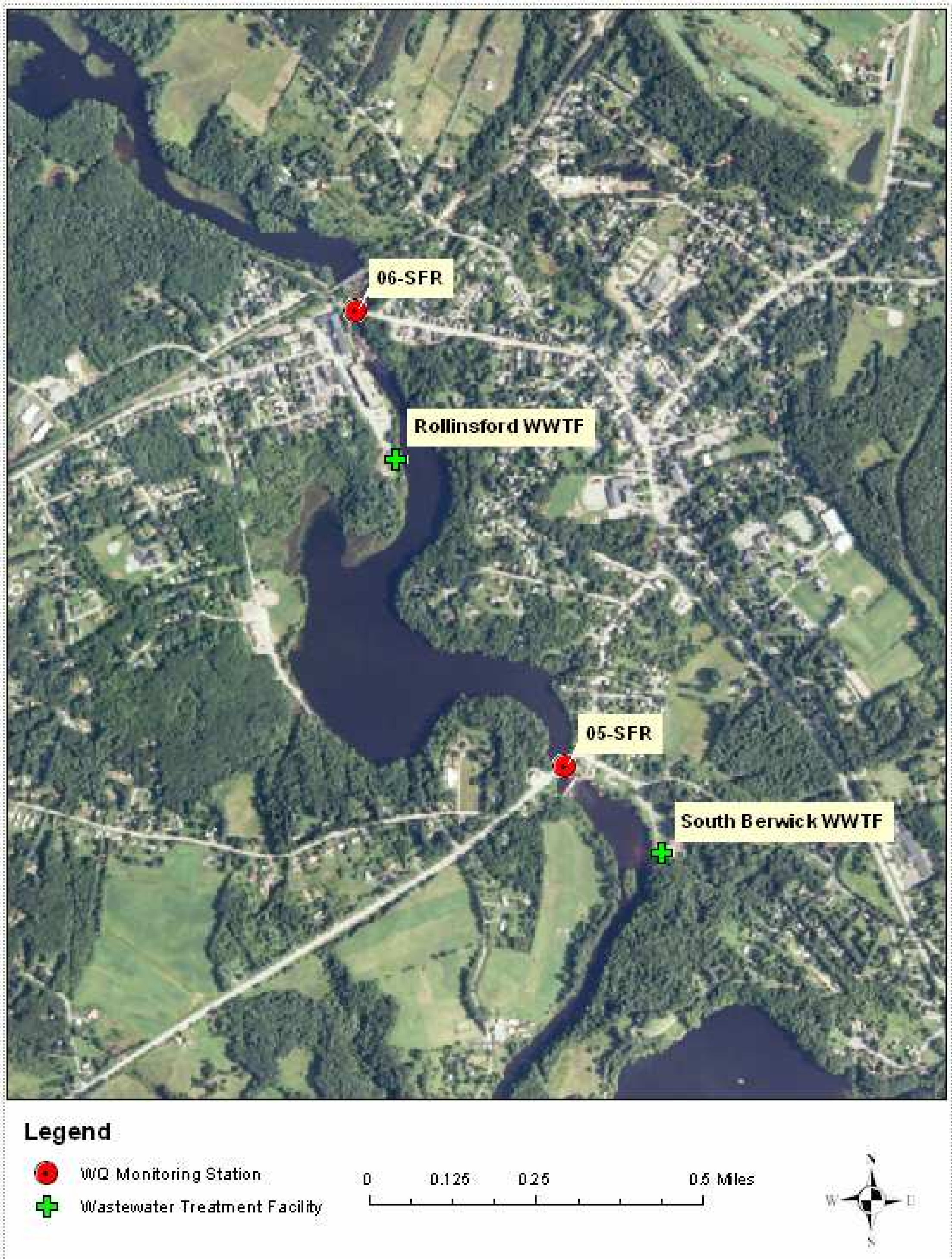


Figure 3: Total Nitrogen Concentrations (in mg N/L) at Tributary Stations

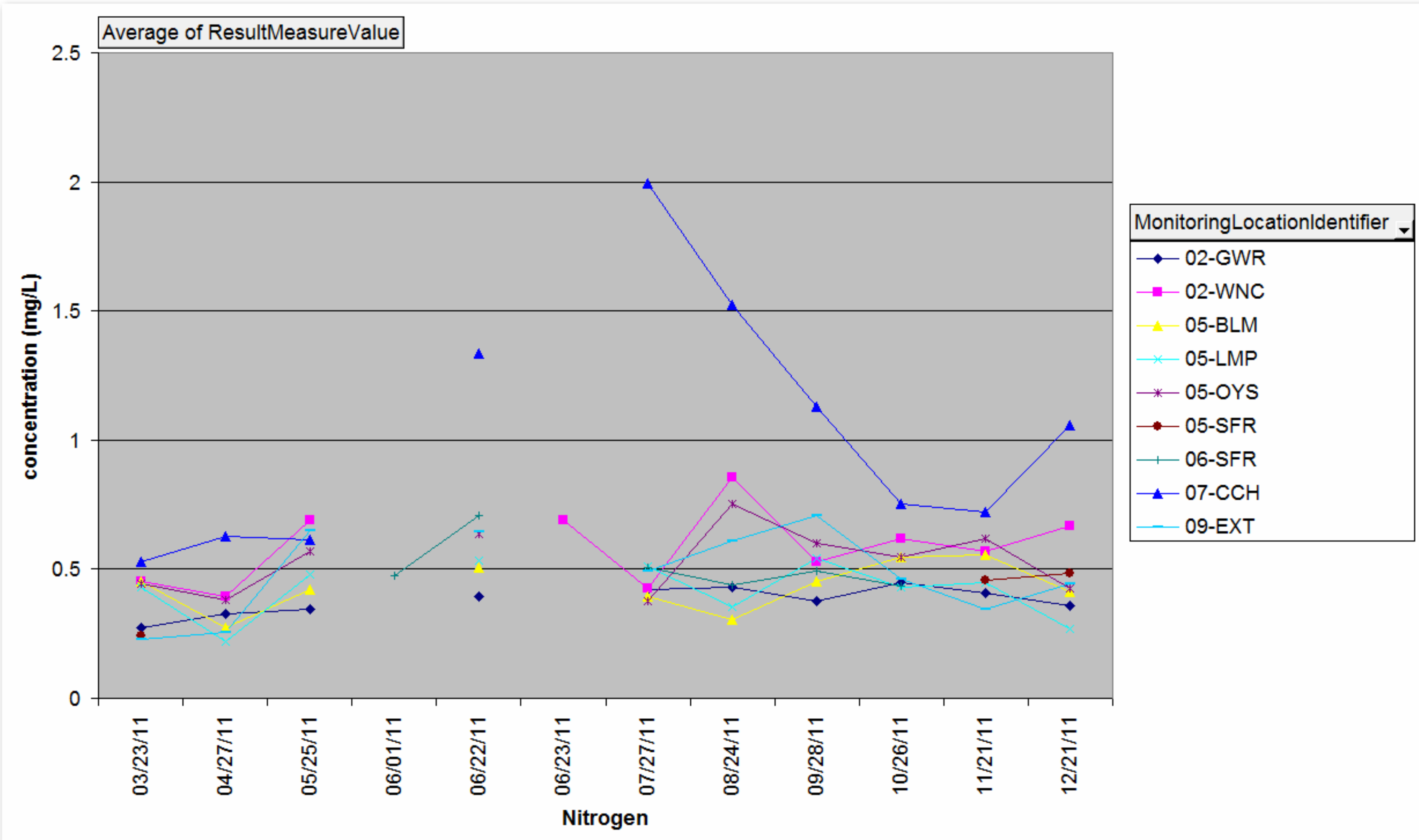


Figure 4: Total Phosphorus in Concentrations (mg P/L) at Tributary Stations

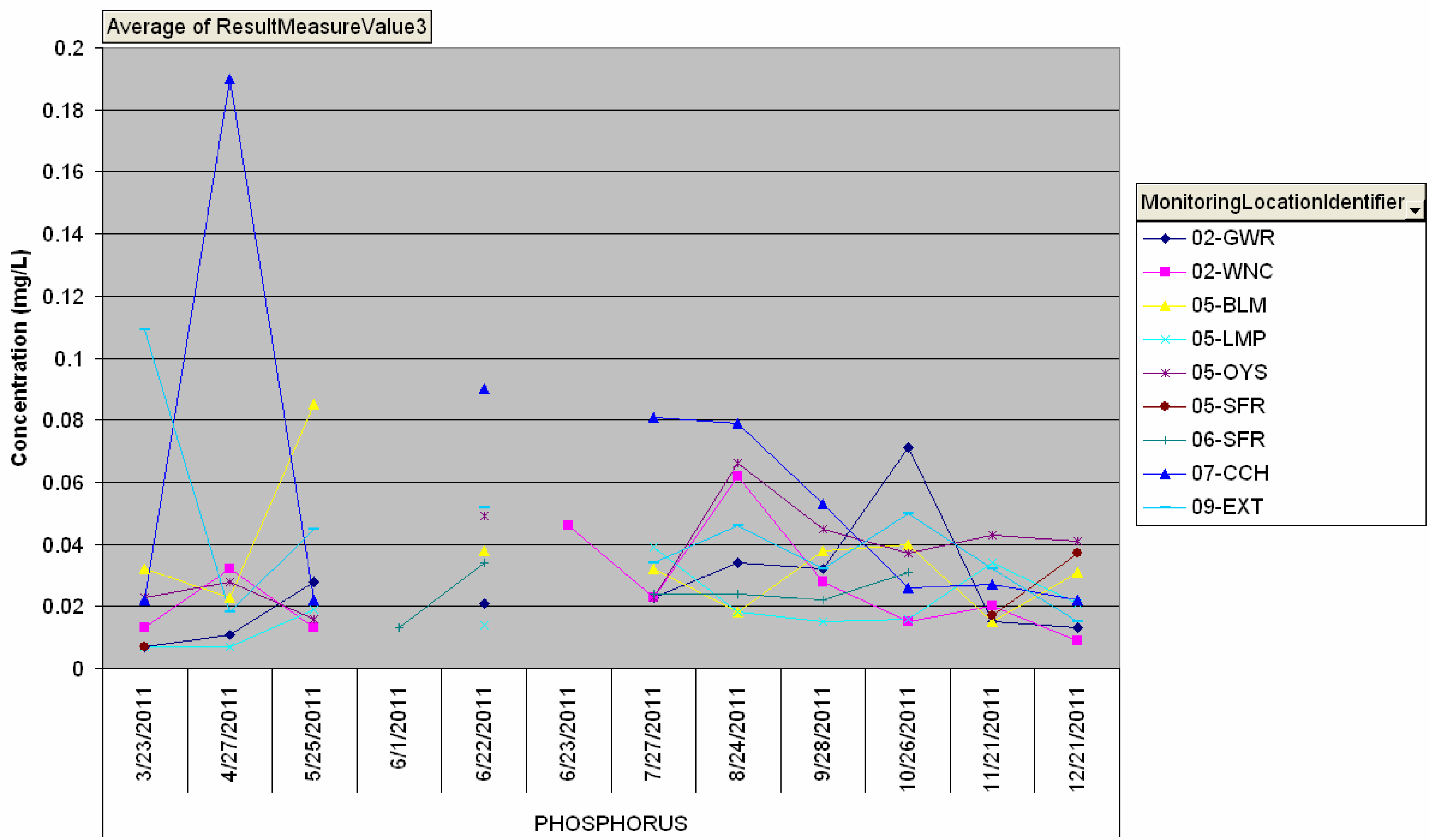


Figure 5: Total Dissolved Nitrogen Concentrations (in mg N/L) at Tributary Stations

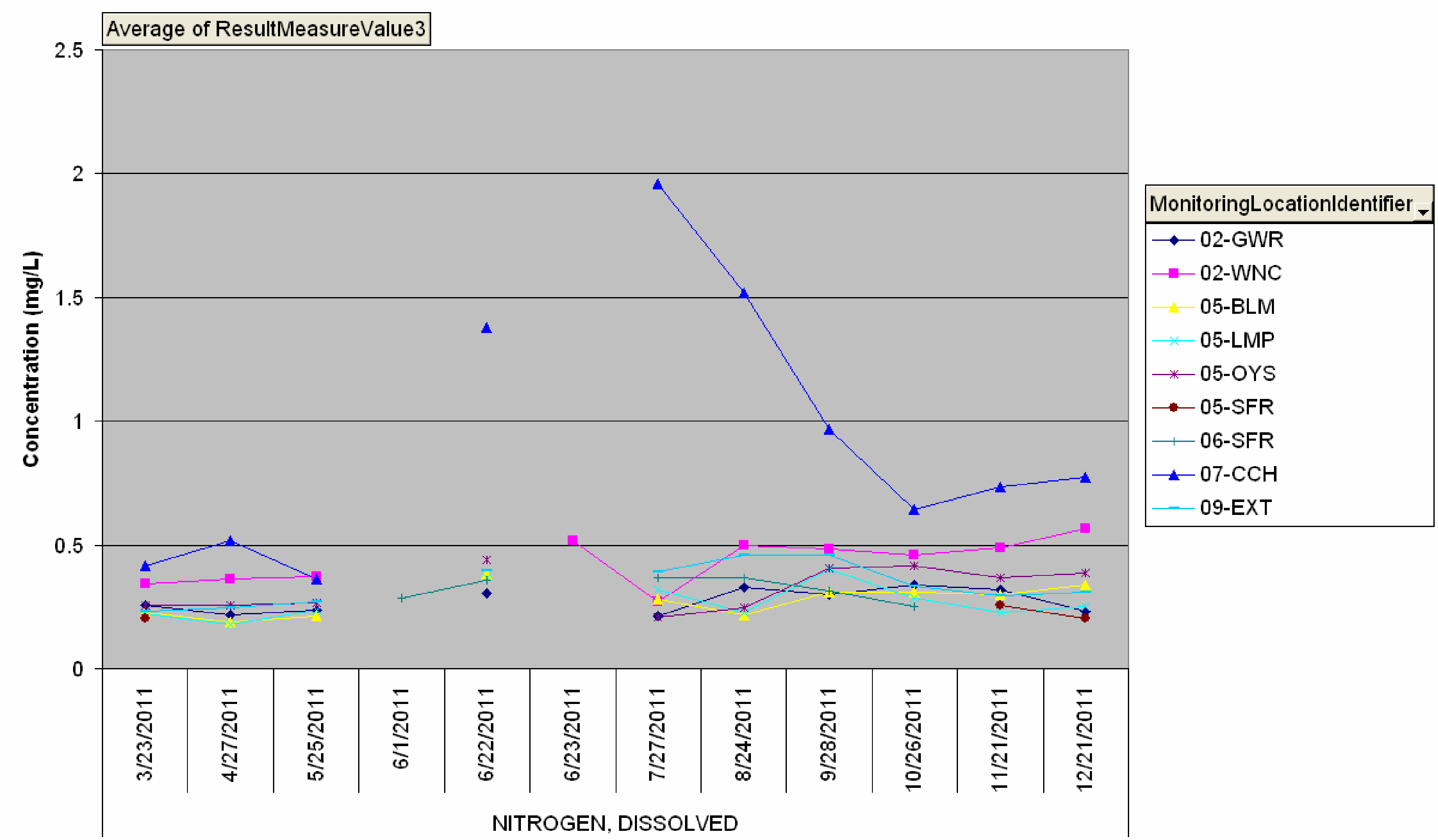


Figure 6: Total Suspended Solids Concentrations (in mg/L) at Tributary Stations

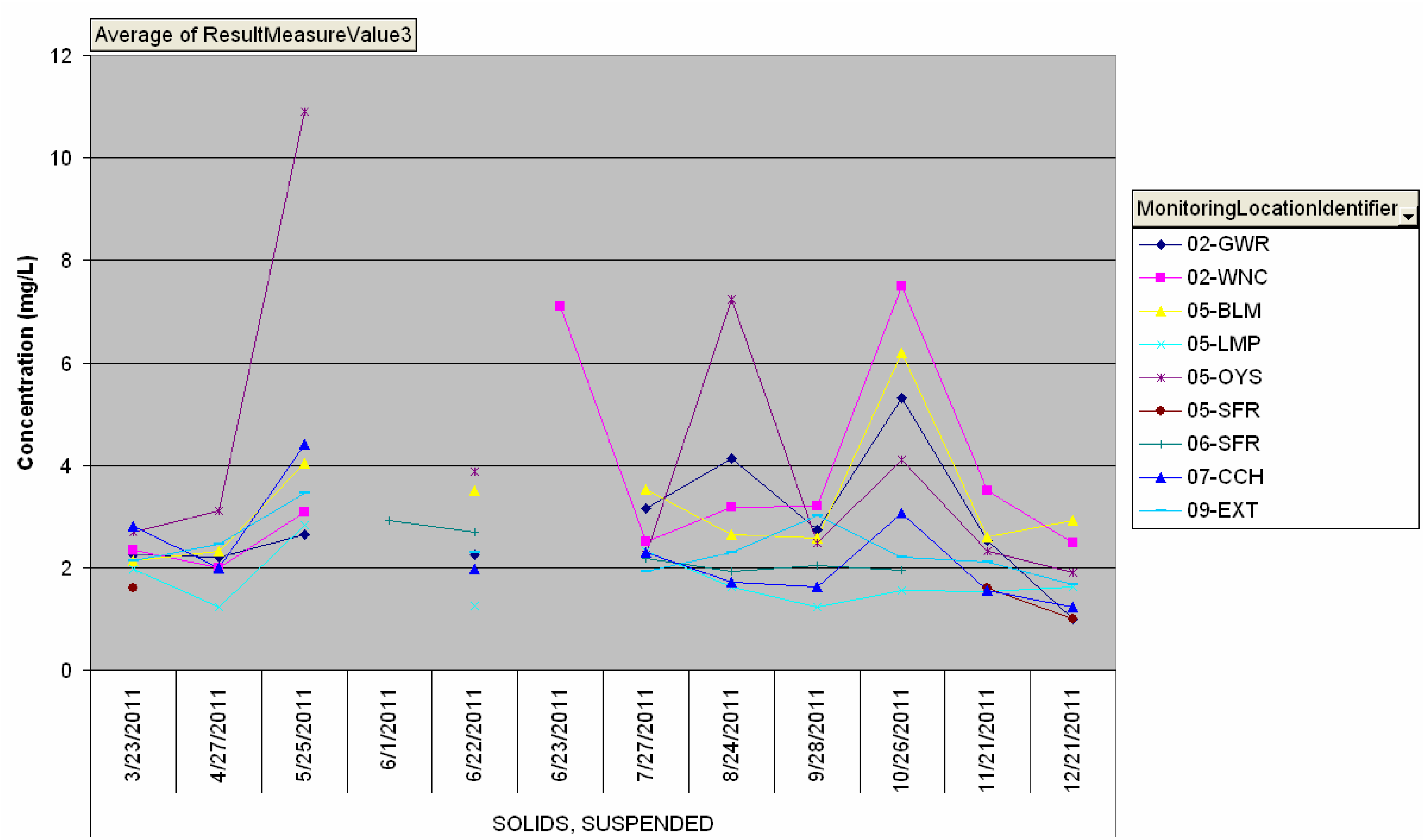


Figure 7: Nitrate Concentrations (in mg N/L) at Tributary Stations

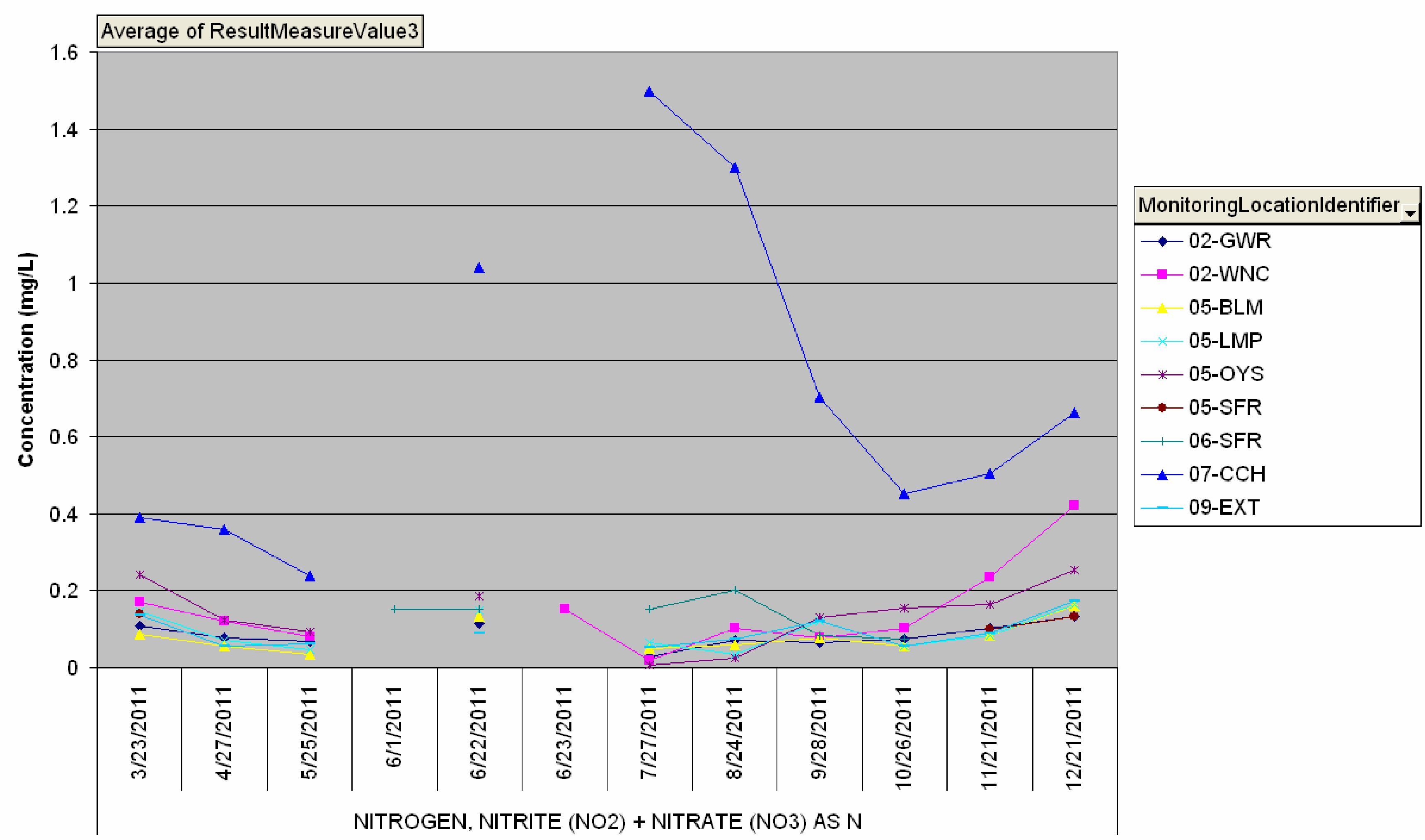


Figure 8: Ammonia Concentrations (in mg N/L) at Tributary Stations

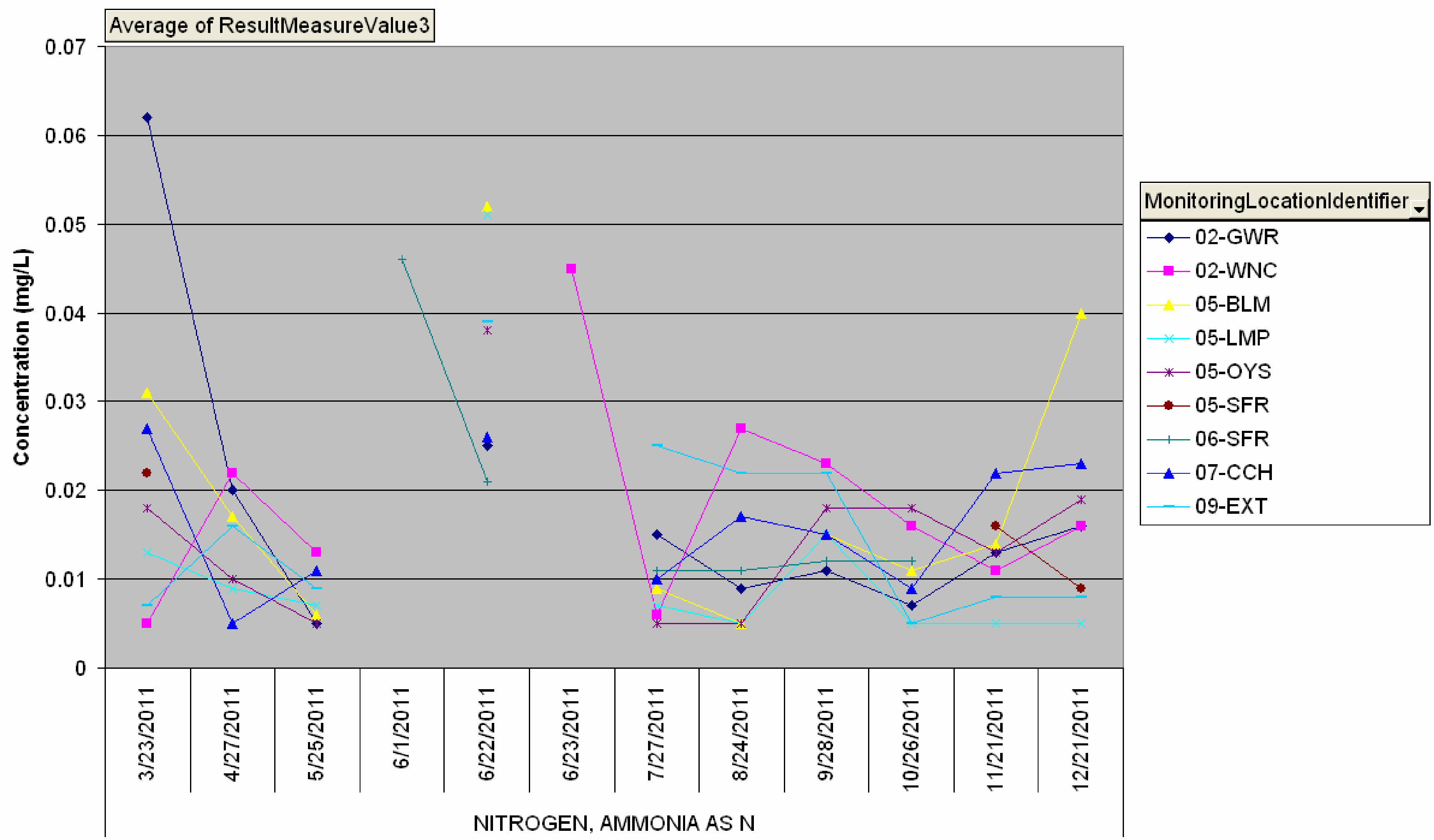


Figure 9: Dissolved Organic Carbon Concentrations (in mg C/L) at Tributary Stations

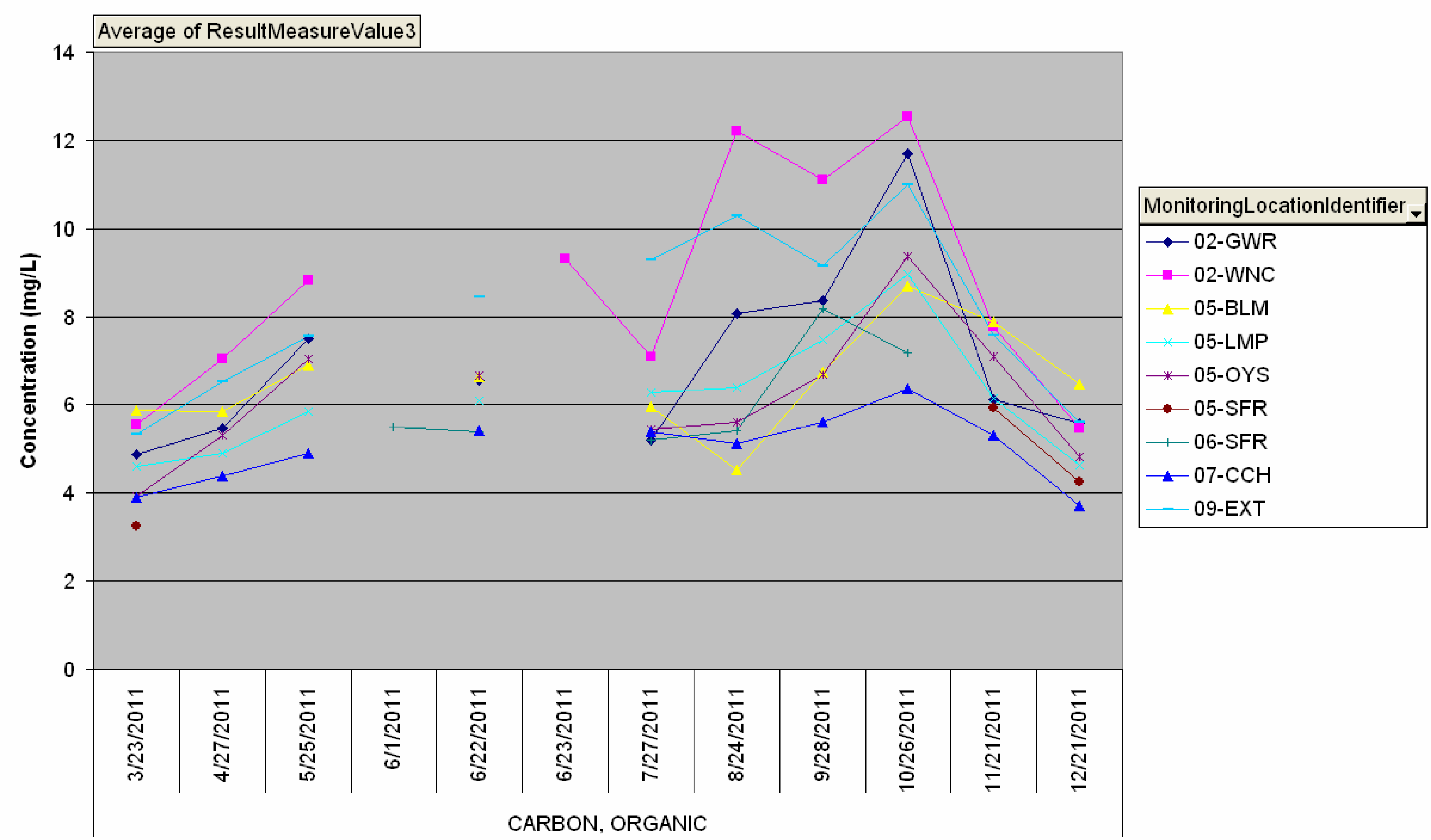


Figure 10: Orthophosphate Concentrations (in mg P/L) at Tributary Stations