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FINAL REPORT

CHESAPEAKE BAY PROGRAM BLIND AUDIT

Fiscal Year 2014 Final Report

PREPARED FOR:

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TABLE OF CONTENTS

LIST OF TABLES

APPENDICES

LIST OF FIGURES

INTRODUCTION

The purpose of this Blind Audit Program is to provide samples of specific nutrient analytes at concentrations commonly found in estuarine systems for analysis by laboratories that analyze water samples collected from the Chesapeake Bay and its tributaries. The concentrations of these samples, which are unknown to the recipient analysts, are compared to their prepared concentrations.

In the early years of the Chesapeake Bay Program, U.S. EPA provided blind audit samples on an irregular basis to laboratories analyzing Chesapeake Bay water samples. However, these audit samples were designed for waste water/drinking water applications rather than for estuarine water applications. Consequently, the concentrations were much higher than normally occur in the Bay and did not provide a reasonable estimate of accuracy for low level nutrient concentrations. For example, a blind audit concentration of 1.0 mg NH4-N/L would be comparable to National Pollutant Discharge Elimination System (NPDES) water samples, but would be at least an order of magnitude greater than concentrations normally occurring in most parts of Chesapeake Bay.

The only continuous program providing an estimate of laboratory performance has been the Chesapeake Bay Coordinated Split Sample Program (CSSP). Data generated from this program provide the only long term QA/QC data base to compare nutrient measurements provided by laboratories analyzing water samples collected from Chesapeake Bay and its tributaries. Samples for CSSP are natural water samples collected from Chesapeake Bay or a tributary. Briefly, a common unfiltered water sample is distributed to the various field/laboratory personnel who, in turn, subsample into dissolved and particulate fractions. These are analyzed and the results compared to those of other participating laboratories. Resulting data analysis can show how field filtration techniques and/or laboratory practices affect data variability. CSSP samples are each subject to cumulative errors of analytical determinations from variation in both field and laboratory procedures. Also, these data sets cannot definitively determine the accuracy of laboratory analyses.

The current Blind Audit Program has been designed to complement the CSSP. Blind Audit particulate samples distributed to participants have few cumulative errors associated with field filtering and subsampling procedures. Prepared concentrates of dissolved substances, whose concentrations are unknown to the analysts, are provided so that laboratory accuracy can be assessed.

This is the sixteenth year of the Blind Audit Program and it is the continued intent of this program to provide unknown, low level dissolved and particulate nutrient samples to laboratories analyzing Chesapeake Bay Program nutrients, as well as to other laboratories interested in participating in the Blind Audit Program.

MATERIALS AND METHODS

Blind Audit samples were sent to participating laboratories on 25 September 2013 and 30 March 2014. Participating laboratories and contact personnel are found in Table 1.

Parameters measured were: total dissolved organic nitrogen, total dissolved organic phosphorus, nitrate+nitrite, ammonium, orthophosphate and dissolved organic carbon. High and low concentration samples were provided for each analyte. Particulate carbon, nitrogen and phosphorus, chlorophyll and total suspended solids, were also provided for those laboratories that routinely analyze these parameters. Chlorophyll *a* samples were natural population

samples collected from the mouth of the Patuxent River.

Dissolved Blind Audit concentrates were prepared by careful dilution of high quality standards using 18.3 megohm deionized water. The concentrates were sealed in 20 mL ampoules for shipment to participants. One ampoule contained a concentrate of an organic nitrogen compound and an organic phosphorus compound to be diluted for the analysis of low level total dissolved nitrogen and total dissolved phosphorus. A second ampoule contained a concentrate of an organic nitrogen compound and an organic phosphorus compound to be diluted for the analysis of higher level total dissolved nitrogen and total dissolved phosphorus. A third ampoule contained a concentrate to be diluted for the analysis of low level inorganic nutrients (ammonium, nitrate and phosphate). A fourth ampoule contained a concentrate to be diluted for the analysis of higher level inorganic nutrients. The fifth and sixth ampoules contained a low and high concentration of dissolved organic carbon, respectively. At each participating laboratory, an aliquot from each ampoule was diluted and analyzed according to accompanying instructions for preparation and dilution. These Blind Audit samples were then inserted randomly in a typical estuarine sample set. Final concentrations were reported for each diluted concentrate according to the dilution instructions provided.

Particulate analytes are measured by analyzing suspended material concentrated on filter pads. There are no commercially available suspensions of pure carbon, nitrogen or phosphorus compounds, so a natural sample was subsampled onto filter pads for analysis by participating laboratories. A batch water sample was collected from the CBL pier, and subsampled for particulate samples of carbon, nitrogen and phosphorus. Particulate C/N samples were filtered from the batch sample with care taken to shake the batch before each filtration to ensure homogeneity. Vacuum filtration was used to process the filters. Samples were dried completely (overnight at 47^{O}C) before shipment. Two samples on 25 mm GF/F pads were sent to each laboratory for analysis.

The same general procedure was followed for particulate phosphorus samples in which they were concentrated by vacuum filtration on 47 mm GF/F pads.

Filter pads were sent to each laboratory for the analysis of particulate C, N, and P. The volume of sample filtered was noted in the instructions so that each laboratory could report concentrations in mg/L. Samples for chlorophyll *a* analysis were filtered from natural population samples onto 47 mm GF/F filter pads. Replicate pads were provided to participating laboratories.

Total suspended solids blind audits were prepared as follows: A suspension of a known mass of infusorial earth in deionized water was stirred with a magnetic stirrer. While stirring continued, an aliquot was subsampled by pipette into a screw cap vial for each participating laboratory. Detailed instructions explaining how to prepare this concentrate for total suspended solids analysis were also provided.

Samples were sent in coolers via next day carrier to the participating laboratories. A cold temperature was required for chlorophyll samples, so frozen cold packs were packed in those participants' coolers.

RESULTS

Tables and figures summarizing results from the summer 2013 and winter 2014 audits are found at the end of the report. Shortly after the completion of the study, a brief data report, including the concentrations of the prepared samples, was sent to each participant for them to check their data. These data reviews served as a final check of data before preparing this final report.

Concentrations were assessed statistically by calculating the mean and standard deviation of each sample set, then calculating how many standard deviations separated each laboratory's reported concentration from that mean (Table 2). The percent recovery of each laboratory's reported concentration relative to the prepared concentration was also calculated for the dissolved analytes (Table 3 and Appendix 1).

DISSOLVED FRACTION

Total Dissolved Nitrogen: Results from the summer 2013 and winter 2014 were excellent. Low and high reported concentrations had mean values that closely reflected the prepared concentrations. For example, the reported low concentrations of total dissolved N for summer 2013 were extremely close to the prepared concentration (prepared low: 0.423 mg N/L with mean reported concentration of 0.429 mg N/L).

Total Dissolved Phosphorus: Most reported concentrations for both summer 2013 and winter 2014 samples were consistently close to other laboratories' reported concentrations. Coefficients of variation were 7-10% and close to the prepared (recalculated) concentrations; e.g., prepared (recalculated) high summer concentration of 0.0672 mg P/L with a mean reported concentration of 0.0673 mg P/L.

Ammonium: Analysis of low level samples for summer 2013 provided a mean concentration of 0.033 mg N/L compared to the prepared concentration of 0.035 mg N/L. Low level winter 2014 results were similar with 0.021 mg N/L mean reported concentration compared to the prepared concentration of 0.022 mg N/L. Variation around that mean for low level ammonium reported concentrations resulted in coefficients of variation of 22% for summer 2013; 20% for winter 2014.Results for both summer 2013 and winter 2014 high level concentrations were in close agreement with prepared concentrations and other reported values. Coefficients of variation of less than 5% were obtained.

Nitrate + Nitrite: Particularly good agreement was found among most of the laboratories for low concentrations for both audits, except one laboratory reported a value about three times higher than that reported by other laboratories for the low level sample of summer 2013. Two other laboratories reported concentrations about two times higher than that reported by other laboratories for the low level sample of winter 2014. Results for both summer 2013 and winter 2014 high level concentrations were in close agreement with other reported values. Mean concentrations closely approximated prepared concentrations and low standard deviations provided percent coefficients of variation of 3-4 %.

Orthophosphate: Low level concentrations for summer 2013 and winter 2014 were extremely variable, with coefficients of variation of 22% and 21%. Analysis of low level samples for summer 2013 provided a mean concentration of 0.0098 mg P/L compared to the prepared concentration of 0.0090 mg P/L. Low level winter 2014 results were similar with 0.0081 mg P/L mean reported concentration compared to the prepared concentration of 0.0074 mg P/L. Reported results of the high level concentrations were closer to the prepared concentration, with coefficients of variation of 4% and 5% (prepared high for winter 2014: 0.0372 mg P/L with mean reported concentration of 0.0375 mg P/L).

Dissolved Organic Carbon: Particularly good agreement was found among most laboratories for low and high concentrations for both audits. Coefficients of variation were 3-15% for both concentration ranges for both audits, with most laboratories reporting concentrations within 10% of the prepared concentration.

PARTICULATE FRACTION

Again, it should be noted that particulate carbon, nitrogen and phosphorus samples were filtered from a common estuarine water sample and, consequently, are not true blind audit samples produced from pure constituents. Particulate results are graphically presented in Figures 1 and 4.

Particulate Carbon: Among laboratory agreement was not close for the summer 2013 audit with a coefficient of variation of 11%, due largely to one laboratory's low reported concentration (Table 2). The among-laboratory winter results were closer. A coefficient of variation of 6% was determined,

Particulate Nitrogen: Results for particulate nitrogen followed the same pattern as particulate C. The coefficient of variation for the summer was 14% due largely to one laboratory's low reported concentration. The coefficient of variation for the winter 2014 audit was 20%, due largely to another laboratory's high reported concentration.

Particulate Phosphorus: Particulate phosphorus concentrations showed some variability between the participating laboratories (coefficient of variation of 22%) for the summer 2013 audit. The winter 2014 results were less variable with a coefficient of variation of 8%.

Chlorophyll: Most of the chlorophyll *a* results for the summer 2013 and winter 2014 audits displayed the usual close agreement that was remarkable for multi-laboratory comparison of low concentrations of an environmentally transitory compound. Results from one laboratory were about half those of the "consensus" concentrations for both audits. The coefficients of variation were 15% for the summer 2013 samples and 25% for the winter 2014 samples.

Total Suspended Solids: The concentrate of infusorial earth suspended in deionized water was suspended further in deionized water by each laboratory, then concentrated on a filter pad and weighed. For the summer 2013 sample, 42.0 mg/L was prepared with a coefficient of variation of only 5%. For the winter 2014 sample, 33.9 mg/L was prepared with a coefficient of variation only 2%.

DISCUSSION

Several important issues should be considered when assessing whether individual Blind Audit results are within acceptable limits.

Variation Associated With An Analytical Method: As we have noted in previous Blind Audit Reports, analytical variability is associated with any quantitative determination. The method detection limit (three times the standard deviation of seven low level replicate natural samples) is often used to express that level of variation. Total dissolved nitrogen data provide a good example. The detection limit at CBL has been determined to be 0.02 mg N/L. Any total dissolved nitrogen measurement has a potential 0.02 mg N/L variability associated with it. This variability, when expressed as a percent of the TRUE concentration, can be extremely large for low level concentrations and fairly low for higher concentrations. For example, a 0.20 mg N/L concentration has an analytical variability of 10% associated with it; whereas, a 1.20 mg N/L concentration has an analytical variability of 2%.

Acceptance Limits of Provided Dissolved Samples: Companies that prepare large quantities of performance evaluation samples assign acceptable confidence limits around the TRUE value. In one case (SPEX, CertiPrep), the mean recovery and standard deviation are later reported along with the true concentration and the 95% confidence interval (CI). The 95% CI is the mean recovery +/- two standard deviations and is developed from regression equations from Water Pollution Performance Evaluation Studies. A recently purchased set of these standards gave a true total P value of 3.00 mg P/L with a 95% CI of 2.47-3.42 mg P/L. The lower end of the 95% CI recovery allows 82% recovery of the true concentration. This type of statistical analysis was not performed on the Blind Audit Program samples prepared for this study prior to their distribution to the participants.

Parameters assessed in the Blind Audit do not have predetermined acceptance limits, so we are following the statistical procedure of ERA (Environmental Resource Associates), an approved source of wastewater and drinking water proficiency samples, and the State of Wisconsin Proficiency Testing program. They average the results for each parameter and at each concentration, then calculate the standard deviation from the mean. Results that are within two standard deviations PASS and those greater than three standard deviations FAIL. Results between two and three standard deviations receive the WARN flag.

Most of the data comparisons based on standard deviations showed similar characteristics (Table 2); that is, the reported concentrations were similar, and one or two concentrations fell slightly beyond one standard deviation from the mean of all data for that portion of the study. Apparently, it is a statistical "reality" in small sample sets with little variability between individual values, that at least one value will lie just beyond one standard deviation from the mean. Thus, for most of the data sets compared by means and standard deviations, all the reported concentrations "passed." It should also be noted that approximately the same number were in the "warning" category as in most of the previous studies, and that only four values in the entire study "failed."

Data sets with relatively small standard deviations yielded more potentially extraneous "warning" points. For example, in the winter 2014 blind audit of high level ammonium concentration, the prepared concentration was 0.222 mg N/L and the mean reported concentration was 0.225 mg N/L (!) and reported concentrations ranged from 0.204-0.247 mg N/L. The coefficient of variation was ONLY 4.2%! Thirteen laboratories reported results for this high level sample that were within two standard deviations (S.D. 0.012 mg N/L) of the mean. Since the standard deviation was so small, two laboratories' reported results for this sample were between two and three standard deviations of the mean, so were labeled WARN. Thus, by that measure of accuracy, most of the data "passed" and two were "warned." This ammonium data comparison points toward a form of circular reasoning in these statistical assessments. The data being evaluated are also the data that were used to calculate the mean and standard deviation to which the data are being compared. All of the reported data were within 11% of the prepared concentration!

Data were also assessed by comparing reported concentrations to those that had been prepared (Table 3). Groupings of data in PASS, WARN, and FAIL categories were arbitrarily set. Reported data that were within 10% of the prepared concentration were considered as PASS. Reported data that were 80-90% or 110 -120% of the prepared concentration were tabulated as WARN. Reported data that were <80% or >120% of the prepared concentration were tabulated as FAIL.

When comparing reported concentrations to those prepared, the lower concentration ranges had more data that fell in WARN and FAIL categories than the higher level concentrations, i.e., there was less accuracy at the lower concentration ranges (Table 3). The acceptance criteria for low concentration samples are quite narrow. For example, for winter 2014 blind audit of 0.022 mg N/L prepared for ammonium has a PASS category (+/-10%) of only 0.018 - 0.024 mg N/L. For the winter 2014 blind audit, four out of thirteen participating laboratories reported results that fell in the FAIL category, indicating that their reported concentrations were greater than +/-20% of the prepared concentration in this low range. These results could be interpreted as an inability for all participants to accurately measure low level ammonium from concentrates provided to them. It would be important to know if there is also difficulty in measuring natural low level samples. An alternative interpretation would be that it may be appropriate to broaden the acceptance boundaries for very low concentrations of prepared samples. There was also a broad range in percentage recovery of low level ammonium reported values in past audits; however, when comparing with other participants, the coefficient of variation remains remarkably small. For example, winter 2014 reported data based on comparisons with other participants was mean 0.021 mg N/L, S.D. 0.004, C.V. 20%.

There was less divergence between participants for the summer 2012 through winter 2014 low level ammonium samples than in audits of summer 2011 and winter 2012. The proportions of the standard deviations to the means for the low level ammonium samples were smaller than they have been for the last few years. For the winter 2014 audit, the coefficient of variation for 0.022 mg NH4-N/L was 20%. The coefficient of variation was 16% for 0.042 mg NH4-N/L (Summer 2006) and 39% for 0.036 mg NH4-N/L (Winter 2007). This indicates that inter-laboratory comparisons of any ammonium data prepared by laboratories from concentrates below 0.042 mg N/L could probably be somewhat improving!

There were nineteen instances where concentrations reported for dissolved constituents or total suspended solids fell in the WARN or FAIL category based on the standard deviation of all participants' reported concentrations and also in the WARN or FAIL category based on percent recovery. These are listed for the individual laboratories in Appendix 1.

Acceptance Limits of Provided Particulate Samples: For each study, particulate carbon, nitrogen, phosphorus and chlorophyll *a* samples were filtered from a common estuarine water sample and, consequently, are not true blind audit samples made from pure constituents. There is no "true" or prepared concentration with which to compare. The standard deviation was less than 10% of the mean reported concentrations for particulate carbon and phosphorus for the winter 2014 audit. The standard deviation was 10-23% of the mean reported concentration for particulate carbon and nitrogen for the summer 2013 audit, due largely to one or two laboratory's disparate reported concentrations. For particulate phosphorus, one laboratory's reported concentration was about half that of the mean of the other participants' data for the summer 2013 audit. For the winter 2014 audit, there was much closer agreement between reported concentrations of particulate phosphorus, with a coefficient of variation of less than 8%, but one laboratory's particulate nitrogen reported concentration was about half that of the other participants.

Over the years, the concentration of particulate constituents provided to the participants has varied randomly over approximately a five-fold range. For example, particulate carbon in winter 1998 was approximately 0.45 mg C/L, and in winter 2013 was approximately 2.35 mg C/L.

Reporting Data Accurately: Most data originally reported by all participants for both these blind audits appeared, on casual inspection, to be reported accurately. Subtle entry or calculation errors may have gone undetected.

The summer 2007 and winter 2008 audits were the first pair of audits in which no participant noted any discrepancies when all were contacted to review their data. No results were miscalculated (and later corrected), or had "slipped a decimal" or exhibited some other obvious entry error that could have been easily avoided. After years of reporting "difficulties," participants had improved their reporting practices! Sadly, this improvement in reporting did not extend to the summer 2008 through summer 2010 audits. At last, for the winter 2011 audit, no participant noted any discrepancies when all were contacted to review their data. We had returned to that great condition where no results were miscalculated (and later corrected), or had "slipped a decimal" or exhibited some other obvious entry error that could have been easily avoided. Sadly, for the summer 2011 blind audit, results were AGAIN (!) reported and then later corrected. Results that had been entered on the wrong parts of the results form were noted as FAIL, but the corrected data were used for statistical comparisons. Happily, for the next five audits (winter 2012, summer 2012, winter 2013, summer 2013 and winter 2014), no participant noted any discrepancies when all were contacted to review their data.

The number of significant figures reported in analytical results can significantly affect data comparability in a blind audit study. If a laboratory reports only two significant figures (for whatever reasons) and an audit sample has a prepared concentration expressed in three significant figures, then substantial under or over estimates of the comparative concentration can be reported. For example, if a 0.032 mg P/L sample has been prepared and a laboratory only reports two significant figures, i.e., 0.03 mg P/L, then the results expressed are 86% of the prepared value. During the 2000 study, all participants reported three significant digits for most parameters. It is noteworthy that the 2000 study's coefficients of variation were, generally, smaller than in the previous two years, probably a result of comparisons of data containing the appropriate number of significant digits. Unfortunately, some 2001 through winter 2014 participants reported only two significant digits for some analytes, thus potentially giving substantial under or over estimates for the comparisons.

CONCLUSION

Now that thirty-three rounds of the Blind Audit Program have been completed, some consistent patterns have been observed that warrant action or further investigation:

1. Results for particulate carbon and nitrogen were generally consistent between laboratories. Reported concentrations of particulate analytes have usually been similar between laboratories participating in the Blind Audit Program, but there were fewer similarities in these audits. For the summer 2013 audit, particulate carbon, particulate nitrogen, and particulate phosphorus reported concentrations from a few laboratories displayed some wide divergence from the range of the other reported concentrations. For the winter 2014 audit, one laboratory reported concentrations of particulate nitrogen that were different from the range of the other reported concentrations. For particulate carbon and nitrogen, that laboratory's reported concentrations were about 60% of the mean of the other participants' data for the winter 2013 audit. The proportion of the standard deviation to the mean was in its usual range for all participants for the

summer 2012 blind audit. Still, this indicates that most participating laboratories usually execute and report these measurements with accuracy and precision, reporting the appropriate number of significant digits.

2. For all participating laboratories in each audit, there was remarkable consistency between participating laboratories in the measurement of total suspended solids from suspensions of infusorial earth.

3. Most of the chlorophyll *a* results for the summer 2013 and winter 2014 audits displayed the usual close agreement that was remarkable for multi-laboratory comparison of low concentrations of an environmentally transitory compound. Results from one laboratory were about half those of the "consensus" concentrations for both audits.

4. Reported concentrations of dissolved analytes were usually similar between laboratories participating in the Blind Audit Program. No laboratory reported concentrations for individual analytes that were widely different from the range of the other reported concentrations for <u>both</u> blind audits. This indicates that most participating laboratories usually execute and report these measurements with accuracy and precision, reporting the appropriate number of significant digits.

5. When comparing reported concentrations to those prepared, the lower concentration ranges had more data that fell beyond +/- 10% of the prepared sample than the higher level concentration ranges, i.e., there was less accuracy at the lower concentration ranges. This was particularly apparent for ammonium and orthophosphate. The categories for PASS, WARN, and FAIL for low concentration samples are quite narrow. Therefore, for very low concentrations of prepared samples, it may be appropriate to broaden the acceptance boundaries.

6. There was less variation in reported concentrations of low level ammonium for both these blind audits, in comparison to several previous audits. This probably indicates that inter-laboratory comparisons of any ammonium data prepared from concentrates with resultant concentrations below 0.042 mg N/L could be improving.

7. Care should continue to be taken when completing report forms. For the summer 2013 and winter 2014 blind audits, some results were AGAIN (!) reported with insufficient significant digits. For the past FIVE!! blind audits, no results were reported and subsequently corrected!! Over the course of the years, a few laboratories repeatedly had made calculation or entry errors that were later corrected. It is hoped that corrections of these lapses have served as reminders of the importance to continuously check many aspects of data management to ensure overall data quality.

Table 1. Participants in the Summer 2013 and Winter 2014 Blind Audit Program.

Participant Institution	**Point of Contact**	**Phone**	**Dissolved**	**Particulate**	**Chlorophyll a**	**DOC**	**TSS**
Old Dominion University, Water Quality Laboratory (**ODU**)	Suzanne Doughton	757-451-3044	✓	✓	✓	✓	✓
University of Maryland, Horn Point Laboratory (**HPL**)	Erica Kiss	410-221-8317	✓	✓	✓	✓	✓
Virginia Institute of Marine Science, Analytical Service Center (**VIMS**)	Carol Pollard	804-684-7213	✓	PP ONLY S13	✓	x	✓
Virginia Division of Consolidated Laboratory Services (**DCLS**)	Jay Armstrong	804-648-4480 x328	✓	✓	✓	✓	✓
Maryland Department of Health and Mental Hygiene (**DHMH**)	Shala Ameli	410-767-6190	✓	✓	✓	✓	✓
University of Maryland Chesapeake Biological Laboratory (**CBL**)	Jerry Frank	410-326-7252	✓	✓	✓	✓	✓
Delaware Department of Natural Resources (**DNREC**)	Ben Pressly	302-739-9942	✓	✓	✓	✓	✓
Academy of Natural Science of Philadelphia (**ACNAT**)	Paul Kiry	215-299-1076	✓	✓	✓	✓ NO DOC S13	✓
Pennsylvania DEP, Bureau of Laboratories (**PADEP**)	Pam Higgins	717-346-8233	HIGH SAMPLES	x	x	✓	✓
Massachusetts Water Resources Authority, Central Laboratory (**MWRA**)	Cara Seaman	617-660-7808	✓	✓	✓	x	✓
Hampton Roads Sanitation District, Central Environmental Laboratory (**HRSD**)	Stacie Metzler	757-460-4217	HIGH SAMPLES	x	✓	✓	✓
Occoquan Watershed Monitoring Lab (**OCC**)	Dongmei Wang	703-361-5606	✓	PCPN	✓	✓	✓
University of Connecticut Center for Environmental Science & Engineering (**UCONN)**	Chris Perkins	860-486-2668	✓	✓	✓	✓ NO DOC W14	✓
US Geological Survey Indianapolis, IN (**IWSC**)	Aubrey Bunch	317-600-2783	x	x	✓	x	x
New Jersey Department of Health (**NJDH**)	Doug Haltmeier	609-530-2801	TDP	x	x	x	✓

Table 2. Summary of Mean Concentration and Standard Deviation for Each Group of Analytes in the Summer 2013 and the Winter 2014 Blind Audit, Including Distribution of Reported Concentrations from the Mean.

Parameter	Concentration in mg/L		Number of Laboratories			
			Standard Deviations from Mean			
			<1	1-2	2-3	>3
	Mean	S.D.	**PASS**	**PASS**	**WARN**	**FAIL**
Summer 2013						
Total Dissolved Nitrogen	0.429	0.034	8	4		
Total Dissolved Nitrogen	0.981	0.067	8	5	1	
Total Dissolved Phosphorus	0.0385	0.0040	10	2	1	
Total Dissolved Phosphorus	0.0673	0.0048	11	3	1	
Ammonium	0.033	0.007	9	4		
Ammonium	0.264	0.012	12	2	1	
Nitrate + Nitrite	0.033	0.017	12			1
Nitrate + Nitrite	0.858	0.029	10	5		
Orthophosphate	0.0098	0.0021	10	2	1	
Orthophosphate	0.0388	0.0017	11	3	1	
Dissolved Organic Carbon	2.13	0.18	9	2		
Dissolved Organic Carbon	6.15	0.21	8	2	1	
Particulate Carbon	1.67	0.181	9		1	
Particulate Nitrogen	0.296	0.0402	8	1	1	
Particulate Phosphorus	0.0437	0.0098	9		2	
Total Suspended Solids	41.7	2.02	11	2	1	
Winter 2014						
Total Dissolved Nitrogen	0.277	0.0254	8	4		
Total Dissolved Nitrogen	0.724	0.0726	12	1	1	
Total Dissolved Phosphorus	0.0254	0.0026	10	2	1	
Total Dissolved Phosphorus	0.0539	0.0037	9	5	1	
Ammonium	0.021	0.004	10	2	1	
Ammonium	0.225	0.009	12	1	2	
Nitrate + Nitrite	0.0149	0.0033	10	2	1	
Nitrate + Nitrite	0.700	0.0266	12	2	1	
Orthophosphate	0.0081	0.0017	10	2	1	
Orthophosphate	0.0375	0.0019	11	3	1	
Dissolved Organic Carbon	2.22	0.33	9	1	1	
Dissolved Organic Carbon	5.23	0.37	10		1	
Particulate Carbon	0.797	0.0477	6	4		
Particulate Nitrogen	0.135	0.0275	9		1	
Particulate Phosphorus	0.00914	0.00071	7	4		
Total Suspended Solids	32.3	0.54	10	4		

Table 3. Summary of Prepared and Reported Concentrations for Each Analyte and Percent Recovery of the Prepared Concentration by Participating Laboratories

			Number of Laboratories		
Parameter	Prepared Concentration mg/L	Reported Concentration Range mg/L	Within 90% - 110% of Prepared Concentration	Within 80 -90%, or 110-120% of Prepared Concentration	<80%, or >120% of Prepared Concentration
			PASS	**WARN**	**FAIL**
Summer 2013					
Total Dissolved Nitrogen	0.423	0.364-0.491	8	4	
Total Dissolved Nitrogen	0.987	0.860-1.08	13	1	
Total Dissolved Phosphorus	0.0406	0.0283-0.0436	10	2	1
Total Dissolved Phosphorus	0.0672	0.0600-0.0786	13	2	
Ammonium	0.035*	0.021-0.046	4	5	4
Ammonium	0.262	0.247-0.296	14	1	
Nitrate + Nitrite	0.029	0.025-0.092	10	1	2
Nitrate + Nitrite	0.856	0.819-0.909	15		
Orthophosphate	0.009	0.0074-0.0160	7	4	2
Orthophosphate	0.039	0.0346-0.0413	14	1	
Dissolved Organic Carbon	1.994	1.95-2.50	9		2
Dissolved Organic Carbon	5.98	5.87-6.68	10	1	
Total Suspended Solids	42.0	36.0-44.0	13	1	
Winter 2014					
Total Dissolved Nitrogen	0.283	0.229-0.314	8	4	
Total Dissolved Nitrogen	0.707	0.592-0.930	12	1	1
Total Dissolved Phosphorus	0.0266	0.0200-0.0302	9	3	1
Total Dissolved Phosphorus	0.0532	0.0490-0.0632	13	2	
Ammonium	0.022*	0.015-0.030	3	6	4
Ammonium	0.222	0.204-0.247	14	1	
Nitrate + Nitrite	0.0141	0.0115-0.0240	9	3	2
Nitrate + Nitrite	0.7045	0.622-0.728	14	1	
Orthophosphate	0.0074	0.0061-0.0130	9	1	3
Orthophosphate	0.0372	0.0342-0.0417	14	1	
Dissolved Organic Carbon	2.00	1.86-3.13	6	2	2
Dissolved Organic Carbon	5.00	4.87-6.27	9		1
Total Suspended Solids	33.9	31.5-33.4	13		

*The prepared sample concentration was quite low, so the acceptance boundaries are narrow.

Appendix 1 Summer 2013 and Winter 2014 Reported Concentrations, Prepared Concentrations and Recoveries

University of Connecticut Center for Environmental Science and Engineering (UCONN)

	Summer 2013 Reported Concentration		Summer 2013 Prepared Concentration	Summer 2013 Percent Recovered		Winter 2014 Reported Concentration		Winter 2014 Prepared Concentration	Winter 2014 Percent Recovered
TDN (mg N/L)	0.364		0.423	86.1		0.267		0.283	94.3
TDN (mg N/L)	0.894		0.987	90.6		0.697		0.707	98.6
TDP (mg P/L)	0.038		0.0406	93.6		0.0240		0.0266	90.2
TDP (mg P/L)	0.06		0.0672	89.3		0.0490		0.0532	92.1
NH4 (mg N/L)	0.032		0.035	91.4		0.020		0.022	90.9
NH4 (mg N/L)	0.257		0.262	98.1		0.215		0.222	96.8
NO23 (mg N/L)	0.028		0.029	96.6		0.0140		0.0141	99.3
NO23 (mg N/L)	0.82		0.856	95.8		0.682		0.7045	96.8
PO4 (mg P/L)	0.01		0.009	111.1		0.0070		0.0074	94.6
PO4 (mg P/L)	0.036		0.039	92.3		0.0360		0.0372	96.8
PC (mg C/L)	1.7865		NA	NA		0.8745		NA	NA
PN (mg N/L)	0.297		NA	NA		0.1245		NA	NA
PP (mg P/L)	0.023	W	NA	NA		0.0090		NA	NA
CHL (ug/L)	16.545		NA	NA		8.15		NA	NA
DOC (mg C/L)	2.194		1.994	110.0		*		2	*
DOC (mg C/L)	6.342		5.98	106.1		*		5	*
TSS (mg/L)	41.2		42	98.1		33.1		33.9	97.6

* No sample sent to participant - sample not requested, parameter or concentration range not routine
"W" Warn and "F" Fail based on standard deviation of all participants' reported concentrations

Academy of Natural Science of Philadelphia (ACNAT)

	Summer 2013 Reported Concentration		Summer 2013 Prepared Concentration	Summer 2013 Percent Recovered		Winter 2014 Reported Concentration		Winter 2014 Prepared Concentration	Winter 2014 Percent Recovered
TDN (mg N/L)	0.370		0.423	87.5		0.232		0.283	82.0
TDN (mg N/L)	0.891		0.987	90.3		0.652		0.707	92.2
TDP (mg P/L)	0.0359		0.0406	88.4		0.0272		0.0266	102.3
TDP (mg P/L)	0.0631		0.0672	93.9		0.0508		0.0532	95.5
NH4 (mg N/L)	0.021		0.035	61.1		0.020		0.022	88.6
NH4 (mg N/L)	0.247		0.262	94.3		0.230		0.222	103.6
NO23 (mg N/L)	0.027		0.029	91.7		0.0115		0.0141	81.6
NO23 (mg N/L)	0.874		0.856	102.1		0.673		0.7045	95.5
PO4 (mg P/L)	0.0074		0.009	82.7		0.0077		0.0074	104.3
PO4 (mg P/L)	0.0388		0.039	99.5		0.0342		0.0372	91.9
PC (mg C/L)	1.1500	W	NA	NA		0.8475		NA	NA
PN (mg N/L)	0.1980	W	NA	NA		0.1105		NA	NA
PP (mg P/L)	0.0649	W	NA	NA		0.0101		NA	NA
CHL (ug/L)	8.70	W	NA	NA		3.45	W	NA	NA
DOC (mg C/L)	*		1.994	*		2.24		2	112.0
DOC (mg C/L)	*		5.98	*		5.21		5	104.2
TSS (mg/L)	38.7		42	92.1		31.6		33.9	93.2

* No sample sent to participant - sample not requested, parameter or concentration range not routine
"W" Warn and "F" Fail based on standard deviation of all participants' reported concentrations

Appendix 1 Cont'. Summer 2013 and Winter 2014 Reported Concentrations, Prepared Concentrations and Recoveries

Virginia Institute of Marine Science, Analytical Servie Center (VIMS)

	Summer 2013 Reported Concentration		Summer 2013 Prepared Concentration	Summer 2013 Percent Recovered		Winter 2014 Reported Concentration		Winter 2014 Prepared Concentration	Winter 2014 Percent Recovered
TDN (mg N/L)	0.437		0.423	103.4		0.282		0.283	99.5
TDN (mg N/L)	0.995		0.987	100.8		0.754		0.707	106.7
TDP (mg P/L)	0.0430		0.0406	105.9		0.0265		0.0266	99.6
TDP (mg P/L)	0.0689		0.0672	102.5		0.0536		0.0532	100.8
NH4 (mg N/L)	0.021		0.035	60.0		0.018		0.022	80.9
NH4 (mg N/L)	0.275		0.262	104.9		0.204	W	0.222	91.7
NO23 (mg N/L)	0.028		0.029	94.8		0.0141		0.0141	100.0
NO23 (mg N/L)	0.840		0.856	98.1		0.704		0.7045	99.9
PO4 (mg P/L)	0.0086		0.009	95.6		0.0061		0.0074	82.4
PO4 (mg P/L)	0.0405		0.039	103.8		0.0349		0.0372	93.8
PC (mg C/L)	*		NA	NA		*		NA	NA
PN (mg N/L)	*		NA	NA		*		NA	NA
PP (mg P/L)	0.0495		NA	NA		0.0090		NA	NA
CHL (ug/L)	15.95		NA	NA		7.77		NA	NA
DOC (mg C/L)	*		1.994	*		*		2	*
DOC (mg C/L)	*		5.98	*		*		5	*
TSS (mg/L)	41.2		42	98.1		33.4		33.9	98.5

* No sample sent to participant - sample not requested, parameter or concentration range not routine
"W" Warn and "F" Fail based on standard deviation of all participants' reported concentrations

Hampton Roads Sanitation District, Central Environmetal Laboratory (HRSD)

	Summer 2013 Reported Concentration		Summer 2013 Prepared Concentration	Summer 2013 Percent Recovered		Winter 2014 Reported Concentration		Winter 2014 Prepared Concentration	Winter 2014 Percent Recovered
TDN (mg N/L)	*		0.423	*		*		0.283	*
TDN (mg N/L)	0.860		0.987	87.1		0.930	W	0.707	131.5
TDP (mg P/L)	*		0.0406	*		*		0.0266	*
TDP (mg P/L)	0.0700		0.0672	104.2		0.0500		0.0532	94.0
NH4 (mg N/L)	*		0.035	*		*		0.022	*
NH4 (mg N/L)	0.260		0.262	99.2		0.220		0.222	99.1
NO23 (mg N/L)	*		0.029	*		*		0.0141	*
NO23 (mg N/L)	0.840	W	0.856	98.1		0.690		0.7045	97.9
PO4 (mg P/L)	*		0.009	*		*		0.0074	*
PO4 (mg P/L)	0.0390		0.039	100.0		0.0370		0.0372	99.5
PC (mg C/L)	*		NA	NA		*		NA	NA
PN (mg N/L)	*		NA	NA		*		NA	NA
PP (mg P/L)	*		NA	NA		*		NA	NA
CHL (ug/L)	12.40		NA	NA		7.40		NA	NA
DOC (mg C/L)	2.07		1.994	103.8		2.10		2	105.0
DOC (mg C/L)	6.10		5.98	102.0		5.40		5	108.0
TSS (mg/L)	42.4		42	101.0		31.5		33.9	92.9

* No sample sent to participant - sample not requested, parameter or concentration range not routine
"W" Warn and "F" Fail based on standard deviation of all participants' reported concentrations

University of Maryland, Horn Point Laboratory (HPL)

	Summer 2013 Reported Concentration		Summer 2013 Prepared Concentration	Summer 2013 Percent Recovered		Winter 2014 Reported Concentration		Winter 2014 Prepared Concentration	Winter 2014 Percent Recovered
TDN (mg N/L)	0.437		0.423	103.3		0.279		0.283	98.6
TDN (mg N/L)	1.030		0.987	104.4		0.721		0.707	102.0
TDP (mg P/L)	0.0415		0.0406	102.2		0.0264		0.0266	99.2
TDP (mg P/L)	0.0719		0.0672	107.0		0.0537		0.0532	100.9
NH4 (mg N/L)	0.030		0.035	86.3		0.017		0.022	75.9
NH4 (mg N/L)	0.254		0.262	96.9		0.228		0.222	102.7
NO23 (mg N/L)	0.028		0.029	96.6		0.0141		0.0141	100.0
NO23 (mg N/L)	0.857		0.856	100.1		0.722		0.7045	102.5
PO4 (mg P/L)	0.0087		0.009	96.7		0.0071		0.0074	95.9
PO4 (mg P/L)	0.0383		0.039	98.2		0.0389		0.0372	104.6
PC (mg C/L)	1.6989		NA	NA		0.8315		NA	NA
PN (mg N/L)	0.3031		NA	NA		0.1300		NA	NA
PP (mg P/L)	0.0521		NA	NA		0.0096		NA	NA
CHL (ug/L)	14.50		NA	NA		9.60		NA	NA
DOC (mg C/L)	2.08		1.994	104.3		2.03		2	101.5
DOC (mg C/L)	6.01		5.98	100.5		4.90		5	98.0
TSS (mg/L)	43		42	102.4		31.7		33.9	93.5

* No sample sent to participant - sample not requested, parameter or concentration range not routine
"W" Warn and "F" Fail based on standard deviation of all participants' reported concentrations

Delaware Department of Natural Resources (DNREC)

	Summer 2013 Reported Concentration		Summer 2013 Prepared Concentration	Summer 2013 Percent Recovered		Winter 2014 Reported Concentration		Winter 2014 Prepared Concentration	Winter 2014 Percent Recovered
TDN (mg N/L)	0.491		0.423	116.1		0.229		0.283	80.9
TDN (mg N/L)	1.075		0.987	108.9		0.592		0.707	83.7
TDP (mg P/L)	0.0423		0.0406	104.2		0.0240		0.0266	90.2
TDP (mg P/L)	0.0786	W	0.0672	117.0		0.0520		0.0532	97.7
NH4 (mg N/L)	0.042		0.035	119.1		0.023		0.022	102.3
NH4 (mg N/L)	0.254		0.262	97.0		0.220		0.222	99.2
NO23 (mg N/L)	0.036		0.029	124.1		0.0240	W	0.0141	170.2
NO23 (mg N/L)	0.819		0.856	95.7		0.622	W	0.7045	88.3
PO4 (mg P/L)	0.0160	W	0.009	177.8		0.0090		0.0074	121.6
PO4 (mg P/L)	0.0390		0.039	100.0		0.0370		0.0372	99.5
PC (mg C/L)	1.7080		NA	NA		0.7615		NA	NA
PN (mg N/L)	0.2972		NA	NA		0.1200		NA	NA
PP (mg P/L)	0.0369		NA	NA		0.0079		NA	NA
CHL (ug/L)	12.45		NA	NA		7.70		NA	NA
DOC (mg C/L)	2.49		1.994	124.9		2.23		2	111.5
DOC (mg C/L)	6.68	W	5.98	111.6		5.2		5.0	104.4
TSS (mg/L)	41.85		42	99.6		32.5		33.9	96.0

* No sample sent to participant - sample not requested, parameter or concentration range not routine
"W" Warn and "F" Fail based on standard deviation of all participants' reported concentrations

Division of Consolidated Laboratory Services (DCLS)

	Summer 2013 Reported Concentration		Summer 2013 Prepared Concentration	Summer 2013 Percent Recovered		Winter 2014 Reported Concentration		Winter 2014 Prepared Concentration	Winter 2014 Percent Recovered
TDN (mg N/L)	0.439		0.423	103.8		0.276		0.283	97.5
TDN (mg N/L)	0.967		0.987	98.0		0.706		0.707	99.9
TDP (mg P/L)	0.0380		0.0406	93.6		0.0280		0.0266	105.3
TDP (mg P/L)	0.0624		0.0672	92.9		0.0540		0.0532	101.5
NH4 (mg N/L)	0.046		0.035	131.7		0.019		0.022	86.4
NH4 (mg N/L)	0.262		0.262	100.0		0.232		0.222	104.5
NO23 (mg N/L)	0.028		0.029	96.6		0.0130		0.0141	92.2
NO23 (mg N/L)	0.885		0.856	103.4		0.710		0.7045	100.8
PO4 (mg P/L)	0.0103		0.009	114.4		0.0070		0.0074	94.6
PO4 (mg P/L)	0.0392		0.039	100.5		0.0370		0.0372	99.5
PC (mg C/L)	1.7050		NA	NA		0.8140		NA	NA
PN (mg N/L)	0.3125		NA	NA		0.1270		NA	NA
PP (mg P/L)	0.0416		NA	NA		0.0086		NA	NA
CHL (ug/L)	15.10		NA	NA		6.60		NA	NA
DOC (mg C/L)	1.99		1.994	99.8		1.97		2	98.5
DOC (mg C/L)	6.01		5.98	100.5		4.95		5	99.0
TSS (mg/L)	41		42	97.6		32.0		33.9	94.4

* No sample sent to participant - sample not requested, parameter or concentration range not routine
"W" Warn and "F" Fail based on standard deviation of all participants' reported concentrations

Unversity of Maryland, Chesapeake Biological Laboratory (CBL)

	Summer 2013 Reported Concentration		Summer 2013 Prepared Concentration	Summer 2013 Percent Recovered		Winter 2014 Reported Concentration		Winter 2014 Prepared Concentration	Winter 2014 Percent Recovered
TDN (mg N/L)	0.419		0.423	99.1		0.267		0.283	94.3
TDN (mg N/L)	0.978		0.987	99.1		0.676		0.707	95.6
TDP (mg P/L)	0.0350		0.0406	86.2		0.0260		0.0266	97.7
TDP (mg P/L)	0.0614		0.0672	91.4		0.0544		0.0532	102.3
NH4 (mg N/L)	0.037		0.035	105.7		0.025		0.022	113.6
NH4 (mg N/L)	0.296	W	0.262	113.0		0.231		0.222	104.1
NO23 (mg N/L)	0.025		0.029	84.5		0.0139		0.0141	98.6
NO23 (mg N/L)	0.839		0.856	98.0		0.688		0.7045	97.7
PO4 (mg P/L)	0.0085		0.009	94.4		0.0077		0.0074	104.1
PO4 (mg P/L)	0.0385		0.039	98.7		0.0388		0.0372	104.3
PC (mg C/L)	1.7900		NA	NA		0.7420		NA	NA
PN (mg N/L)	0.3120		NA	NA		0.1250		NA	NA
PP (mg P/L)	0.0431		NA	NA		0.0090		NA	NA
CHL (ug/L)	16.02		NA	NA		7.16		NA	NA
DOC (mg C/L)	2.09		1.994	104.8		2.00		2	100.0
DOC (mg C/L)	6.09		5.98	101.8		4.99		5	99.8
TSS (mg/L)	42.9		42	102.1		32.7		33.9	96.5

* No sample sent to participant - sample not requested, parameter or concentration range not routine
"W" Warn and "F" Fail based on standard deviation of all participants' reported concentrations

Virginia Polytechnic Institute, Occoquan Watershed Monitoring Laboratory (OCC)

	Summer 2013 Reported Concentration		Summer 2013 Prepared Concentration	Summer 2013 Percent Recovered		Winter 2014 Reported Concentration		Winter 2014 Prepared Concentration	Winter 2014 Percent Recovered
TDN (mg N/L)	0.470		0.423	111.1		0.280		0.283	98.9
TDN (mg N/L)	1.080		0.987	109.4		0.730		0.707	103.3
TDP (mg P/L)	0.0400		0.0406	98.5		0.0200	W	0.0266	75.2
TDP (mg P/L)	0.0700		0.0672	104.2		0.0600		0.0532	112.8
NH4 (mg N/L)	0.040		0.035	114.3		0.030	W	0.022	136.4
NH4 (mg N/L)	0.270		0.262	103.1		0.230		0.222	103.6
NO23 (mg N/L)	0.030		0.029	103.4		0.0200		0.0141	141.8
NO23 (mg N/L)	0.900		0.856	105.1		0.720		0.7045	102.2
PO4 (mg P/L)	0.0100		0.009	111.1		0.0100		0.0074	135.1
PO4 (mg P/L)	0.0400		0.039	102.6		0.0400		0.0372	107.5
PC (mg C/L)	1.6400		NA	NA		0.7200		NA	NA
PN (mg N/L)	0.3660		NA	NA		0.2120	W	NA	NA
PP (mg P/L)	*		NA	NA		*		NA	NA
CHL (ug/L)	14.30		NA	NA		5.30		NA	NA
DOC (mg C/L)	2.50		1.994	125.4		2.50		2	125.0
DOC (mg C/L)	6.20		5.98	103.7		5.40		5	108.0
TSS (mg/L)	43.3		42	103.1		32.2		33.9	95.0

* No sample sent to participant - sample not requested, parameter or concentration range not routine
"W" Warn and "F" Fail based on standard deviation of all participants' reported concentrations

Maryland Department of Health and Mental Hygiene (DHMH)

	Summer 2013 Reported Concentration		Summer 2013 Prepared Concentration	Summer 2013 Percent Recovered		Winter 2014 Reported Concentration		Winter 2014 Prepared Concentration	Winter 2014 Percent Recovered
TDN (mg N/L)	0.420		0.423	99.3		0.284		0.283	100.4
TDN (mg N/L)	0.982		0.987	99.5		0.739		0.707	104.5
TDP (mg P/L)	0.0283	W	0.0406	69.7		0.0227		0.0266	85.3
TDP (mg P/L)	0.0612		0.0672	91.1		0.0561		0.0532	105.5
NH4 (mg N/L)	0.029		0.035	82.6		0.021		0.022	93.6
NH4 (mg N/L)	0.260		0.262	99.2		0.226		0.222	101.8
NO23 (mg N/L)	0.032		0.029	109.7		0.0123		0.0141	87.2
NO23 (mg N/L)	0.876		0.856	102.3		0.727		0.7045	103.2
PO4 (mg P/L)	0.0092		0.009	102.2		0.0080		0.0074	108.4
PO4 (mg P/L)	0.0346	W	0.039	88.7		0.0360		0.0372	96.8
PC (mg C/L)	1.7600		NA	NA		0.7840		NA	NA
PN (mg N/L)	0.3130		NA	NA		0.1230		NA	NA
PP (mg P/L)	0.0401		NA	NA		0.0095		NA	NA
CHL (ug/L)	15.25		NA	NA		6.28		NA	NA
DOC (mg C/L)	2.14		1.994	107.3		2.14		2	107.0
DOC (mg C/L)	6.23		5.98	104.2		5.08		5	101.6
TSS (mg/L)	42.2		42	100.5		32.7		33.9	96.5

* No sample sent to participant - sample not requested, parameter or concentration range not routine
"W" Warn and "F" Fail based on standard deviation of all participants' reported concentrations

Massachusetts Water Resource Authority, Central Laboratory (MWRA)

	Summer 2013 Reported Concentration		Summer 2013 Prepared Concentration	Summer 2013 Percent Recovered		Winter 2014 Reported Concentration		Winter 2014 Prepared Concentration	Winter 2014 Percent Recovered
TDN (mg N/L)	0.432		0.423	102.1		0.314		0.283	111.0
TDN (mg N/L)	0.993		0.987	100.6		0.777		0.707	109.9
TDP (mg P/L)	0.0386		0.0406	95.1		0.0302		0.0266	113.5
TDP (mg P/L)	0.0669		0.0672	99.6		0.0632	W	0.0532	118.8
NH4 (mg N/L)	0.028		0.035	80.3		0.020		0.022	89.5
NH4 (mg N/L)	0.260		0.262	99.2		0.216		0.222	97.3
NO23 (mg N/L)	0.027		0.029	94.1		0.0138		0.0141	97.9
NO23 (mg N/L)	0.825		0.856	96.4		0.728		0.7045	103.3
PO4 (mg P/L)	0.0090		0.009	99.6		0.0130	W	0.0074	175.7
PO4 (mg P/L)	0.0409		0.039	104.9		0.0417	W	0.0372	112.1
PC (mg C/L)	1.6400		NA	NA		0.7650		NA	NA
PN (mg N/L)	0.2680		NA	NA		0.1250		NA	NA
PP (mg P/L)	0.0455		NA	NA		0.0102		NA	NA
CHL (ug/L)	15.05		NA	NA		10.70		NA	NA
DOC (mg C/L)	*		1.994	*		*		2	*
DOC (mg C/L)	*		5.98	*		*		5	*
TSS (mg/L)	42		42	100.0		32.0		33.9	94.4

* No sample sent to participant - sample not requested, parameter or concentration range not routine
"W" Warn and "F" Fail based on standard deviation of all participants' reported concentrations

Old Dominion University, Water Quality Laboratory (ODU)

	Summer 2013 Reported Concentration		Summer 2013 Prepared Concentration	Summer 2013 Percent Recovered		Winter 2014 Reported Concentration		Winter 2014 Prepared Concentration	Winter 2014 Percent Recovered
TDN (mg N/L)	0.422		0.423	99.8		0.313		0.283	110.6
TDN (mg N/L)	1.005		0.987	101.8		0.750		0.707	106.1
TDP (mg P/L)	0.0436		0.0406	107.4		0.0275		0.0266	103.4
TDP (mg P/L)	0.0694		0.0672	103.3		0.0547		0.0532	102.8
NH4 (mg N/L)	0.027		0.035	77.7		0.018		0.022	82.7
NH4 (mg N/L)	0.258		0.262	98.4		0.229		0.222	103.2
NO23 (mg N/L)	0.027		0.029	92.4		0.0139		0.0141	98.6
NO23 (mg N/L)	0.829		0.856	96.9		0.713		0.7045	101.2
PO4 (mg P/L)	0.0085		0.009	94.4		0.0071		0.0074	95.9
PO4 (mg P/L)	0.0398		0.039	102.1		0.0378		0.0372	101.6
PC (mg C/L)	1.7895		NA	NA		0.8335		NA	NA
PN (mg N/L)	0.2980		NA	NA		0.1505		NA	NA
PP (mg P/L)	0.0429		NA	NA		0.0081		NA	NA
CHL (ug/L)	13.35		NA	NA		7.48		NA	NA
DOC (mg C/L)	1.98		1.994	99.2		1.86		2	92.8
DOC (mg C/L)	5.87		5.98	98.1		4.87		5	97.4
TSS (mg/L)	43.44		42	103.4		32.0		33.9	94.3

* No sample sent to participant - sample not requested, parameter or concentration range not routine
"W" Warn and "F" Fail based on standard deviation of all participants' reported concentrations

Old Dominion University, Water Quality Laboratory (ODU) - Alternate Instrumentation (L) Latchet

	Summer 2013 Reported Concentration		Summer 2013 Prepared Concentration	Summer 2013 Percent Recovered		Winter 2014 Reported Concentration		Winter 2014 Prepared Concentration	Winter 2014 Percent Recovered
TDN (mg N/L)	0.450		0.423	106.4		0.298		0.283	105.3
TDN (mg N/L)	1.057		0.987	107.1		0.717		0.707	101.4
TDP (mg P/L)	0.0364		0.0406	89.7		0.0231		0.0266	86.8
TDP (mg P/L)	0.0679		0.0672	101.0		0.0496		0.0532	93.2
NH4 (mg N/L)	0.039		0.035	110.3		0.015		0.022	67.7
NH4 (mg N/L)	0.263		0.262	100.5		0.225		0.222	101.4
NO23 (mg N/L)	0.028		0.029	95.2		0.0136		0.0141	96.5
NO23 (mg N/L)	0.884		0.856	103.2		0.698		0.7045	99.1
PO4 (mg P/L)	0.0087		0.009	96.7		0.0075		0.0074	101.4
PO4 (mg P/L)	0.0384		0.039	98.5		0.0374		0.0372	100.5
PC (mg C/L)	*		NA	NA		*		NA	NA
PN (mg N/L)	*		NA	NA		*		NA	NA
PP (mg P/L)	0.0406		NA	NA		0.0095		NA	NA
CHL (ug/L)	*		NA	NA		*		NA	NA
DOC (mg C/L)	*		1.994	*		*		2	*
DOC (mg C/L)	*		5.98	*		*		5	*
TSS (mg/L)	*		42	*		*		33.9	*

* No sample sent to participant - sample not requested, parameter or concentration range not routine
"W" Warn and "F" Fail based on standard deviation of all participants' reported concentrations

Pennsylvania Department of Environmental Protection, Bureau of Laboratories (PADEP)

	Summer 2013 Reported Concentration		Summer 2013 Prepared Concentration	Summer 2013 Percent Recovered		Winter 2014 Reported Concentration		Winter 2014 Prepared Concentration	Winter 2014 Percent Recovered
TDN (mg N/L)	*		0.423	*		*		0.283	*
TDN (mg N/L)	0.920		0.987	93.2		0.700		0.707	99.0
TDP (mg P/L)	*		0.0406	*		*		0.0266	*
TDP (mg P/L)	0.0680		0.0672	101.2		0.0550		0.0532	103.4
NH4 (mg N/L)	*		0.035	*		*		0.022	*
NH4 (mg N/L)	0.284		0.262	108.4		0.247	W	0.222	111.3
NO23 (mg N/L)	*		0.029	*		*		0.0141	*
NO23 (mg N/L)	0.870		0.856	101.6		0.710		0.7045	100.8
PO4 (mg P/L)	*		0.009	*		*		0.0074	*
PO4 (mg P/L)	0.0370		0.039	94.9		0.0370		0.0372	99.5
PC (mg C/L)	*		NA	NA		*		NA	NA
PN (mg N/L)	*		NA	NA		*		NA	NA
PP (mg P/L)	*		NA	NA		*		NA	NA
CHL (ug/L)	*		NA	NA		*		NA	NA
DOC (mg C/L)	1.95		1.994	97.8		2.18		2	109.0
DOC (mg C/L)	5.91		5.98	98.8		5.20		5	104.0
TSS (mg/L)	36	W	42	85.7		32.0		33.9	94.4

* No sample sent to participant - sample not requested, parameter or concentration range not routine
"W" Warn and "F" Fail based on standard deviation of all participants' reported concentrations

Appendix 1 Cont'. Summer 2013 and Winter 2014 Reported Concentrations, Prepared Concentrations and Recoveries

New Jersey Department of Heathlth (NJDH)

	Summer 2013 Reported Concentration		Summer 2013 Prepared Concentration	Summer 2013 Percent Recovered		Winter 2014 Reported Concentration		Winter 2014 Prepared Concentration	Winter 2014 Percent Recovered
TDN (mg N/L)	*		0.423	*		*		0.283	*
TDN (mg N/L)	*		0.987	*		*		0.707	*
TDP (mg P/L)	0.0403		0.0406	99.3		0.0242		0.0266	91.0
TDP (mg P/L)	0.0695		0.0672	103.4		0.0524		0.0532	98.5
NH4 (mg N/L)	0.035		0.035	99.1		0.028		0.022	127.7
NH4 (mg N/L)	0.254		0.262	96.9		0.227		0.222	102.3
NO23 (mg N/L)	0.092	F	0.029	316.9		0.0159		0.0141	112.8
NO23 (mg N/L)	0.909		0.856	106.2		0.721		0.7045	102.3
PO4 (mg P/L)	0.0124		0.009	137.8		0.0076		0.0074	103.2
PO4 (mg P/L)	0.0413		0.039	105.9		0.0390		0.0372	104.8
PC (mg C/L)	*		NA	NA		*		NA	NA
PN (mg N/L)	*		NA	NA		*		NA	NA
PP (mg P/L)	*		NA	NA		*		NA	NA
CHL (ug/L)	*		NA	NA		*		NA	NA
DOC (mg C/L)	1.98		1.994	99.3		3.13	W	2	156.3
DOC (mg C/L)	6.18		5.98	103.3		6.27	W	5	125.3
TSS (mg/L)	44		42	104.8		32.5		33.9	95.9

* No sample sent to participant - sample not requested, parameter or concentration range not routine
"W" Warn and "F" Fail based on standard deviation of all participants' reported concentrations

USGS - Indiana

	Summer 2013 Reported Concentration		Summer 2013 Prepared Concentration	Summer 2013 Percent Recovered		Winter 2014 Reported Concentration		Winter 2014 Prepared Concentration	Winter 2014 Percent Recovered
TDN (mg N/L)	*		0.423	*		*		0.283	*
TDN (mg N/L)	*		0.987	*		*		0.707	*
TDP (mg P/L)	*		0.0406	*		*		0.0266	*
TDP (mg P/L)	*		0.0672	*		*		0.0532	*
NH4 (mg N/L)	*		0.035	*		*		0.022	*
NH4 (mg N/L)	*		0.262	*		*		0.222	*
NO23 (mg N/L)	*		0.029	*		*		0.0141	*
NO23 (mg N/L)	*		0.856	*		*		0.7045	*
PO4 (mg P/L)	*		0.009	*		*		0.0074	*
PO4 (mg P/L)	*		0.039	*		*		0.0372	*
PC (mg C/L)	*		NA	NA		*		NA	NA
PN (mg N/L)	*		NA	NA		*		NA	NA
PP (mg P/L)	*		NA	NA		*		NA	NA
CHL (ug/L)	15.78		NA	NA		*		NA	NA
DOC (mg C/L)	*		1.994	*		*		2	*
DOC (mg C/L)	*		5.98	*		*		5	*
TSS (mg/L)	*		42	*		*		33.9	*

* No sample sent to participant - sample not requested, parameter or concentration range not routine
"W" Warn and "F" Fail based on standard deviation of all participants' reported concentrations

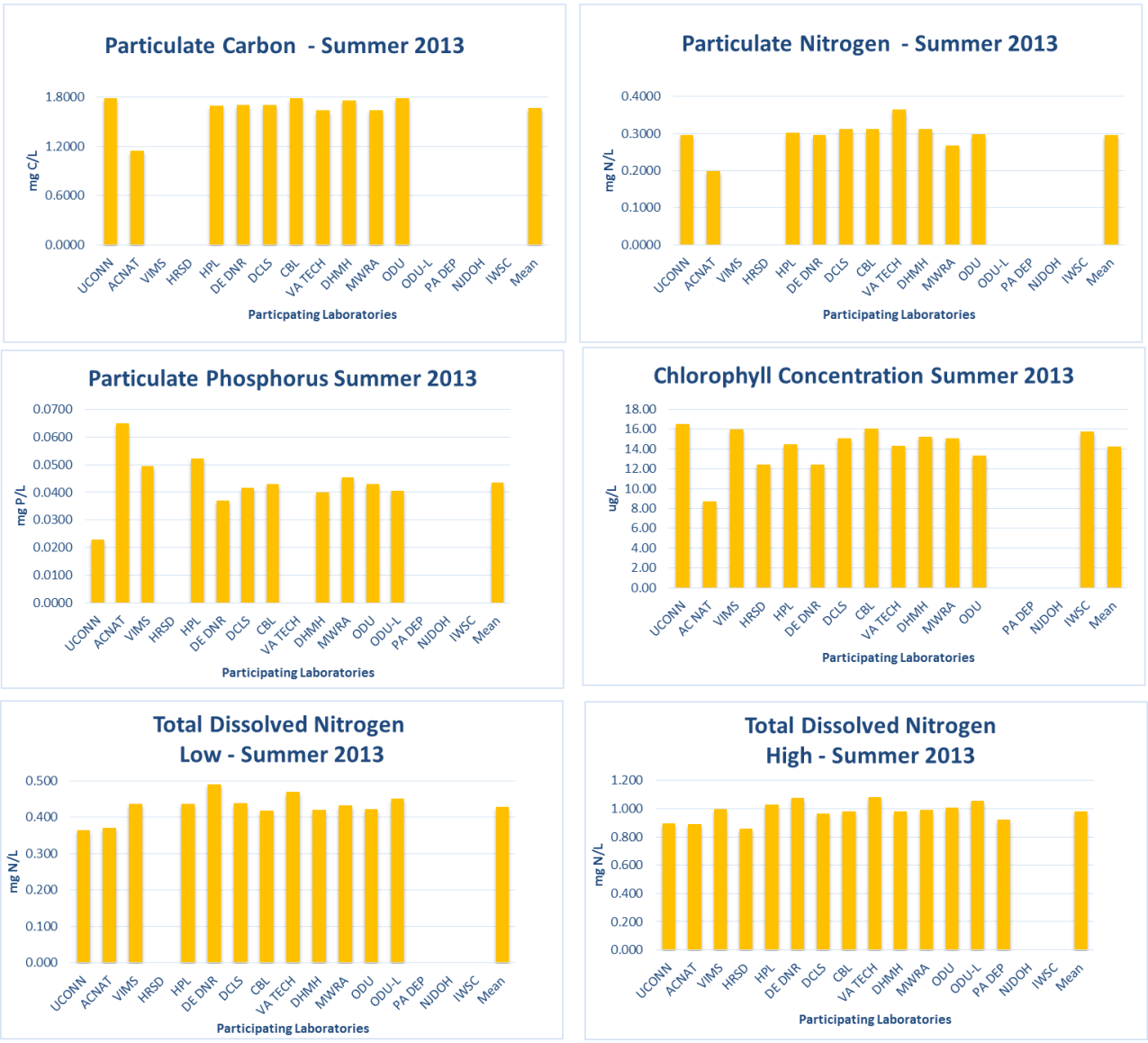


Figure 1. Particulate carbon, nitrogen and phosphorus; Chlorophyll *a*, and total dissolved nitrogen. Summer 2013

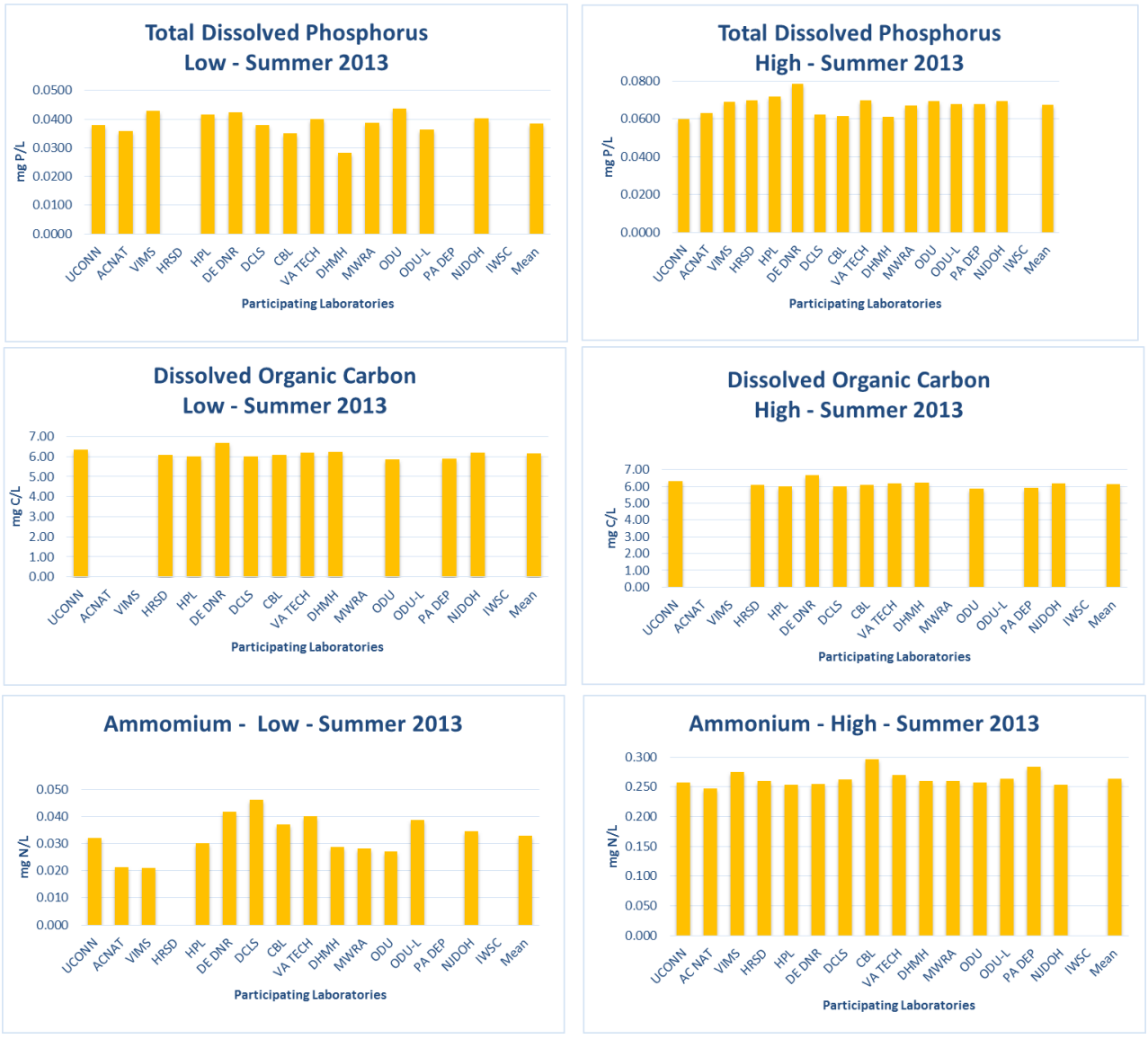


Figure 2. Total dissolved phosphorus; dissolved organic carbon, amd ammonium. Summer 2013

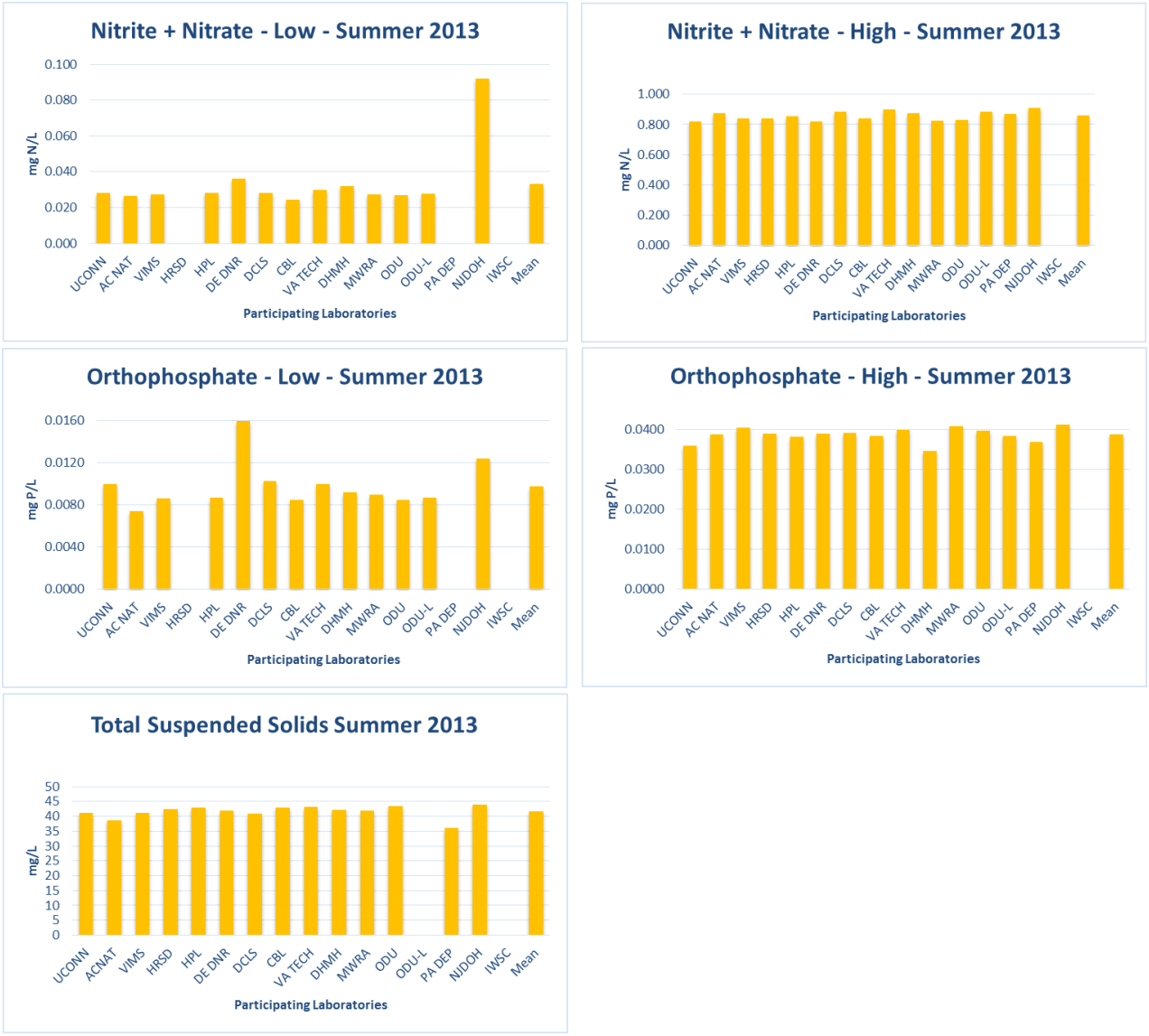
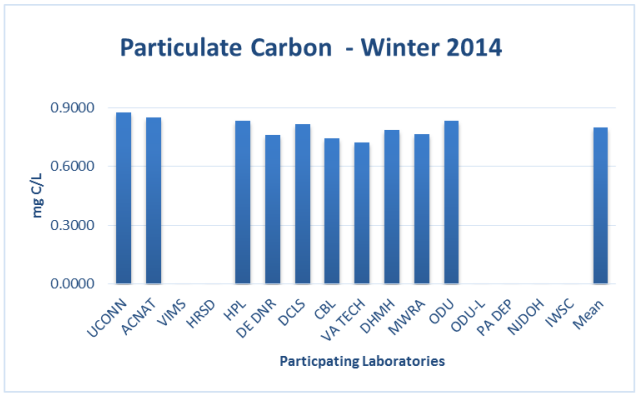
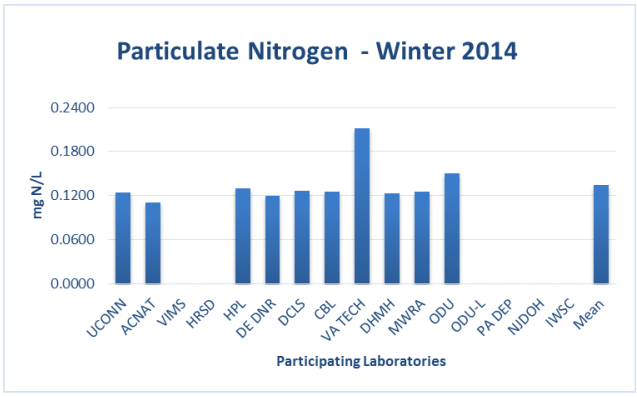
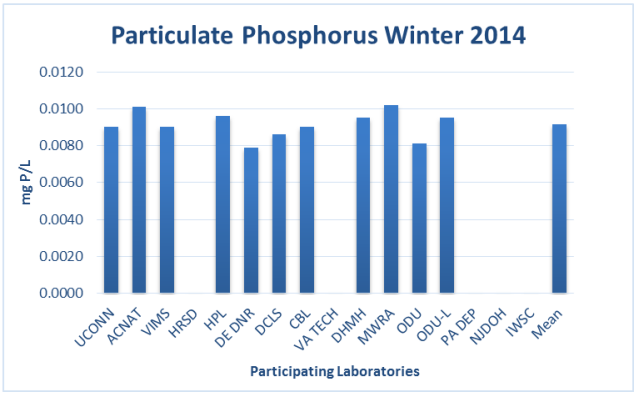
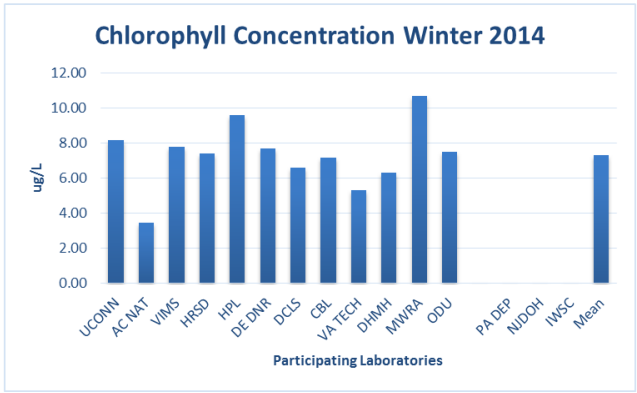


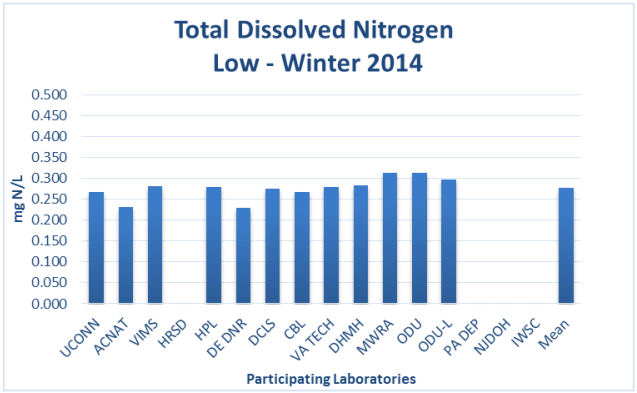
Figure 3. Nitrite plus nitrate, orthophosphate, and total suspended solids. Summer 2013











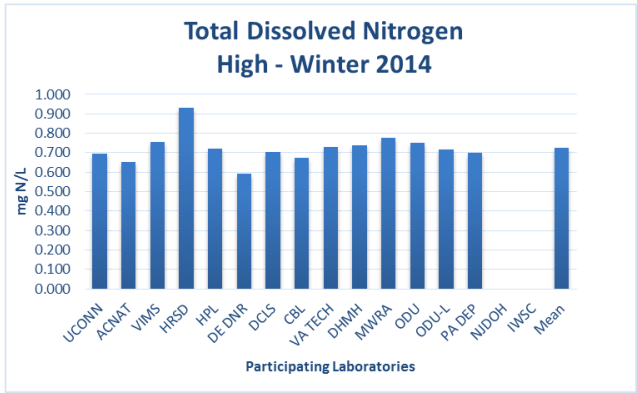
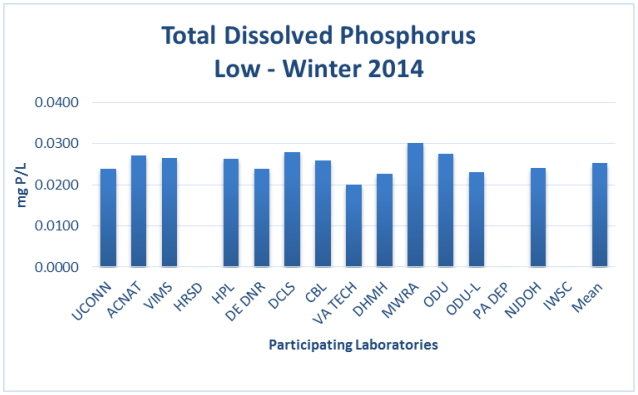
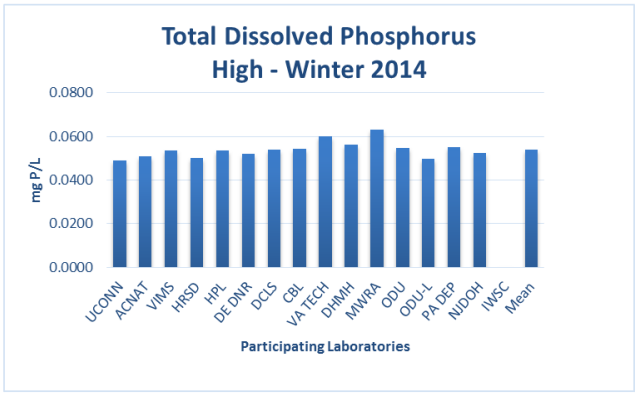
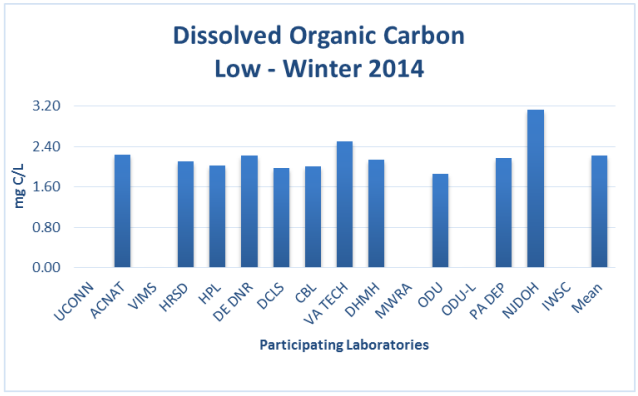
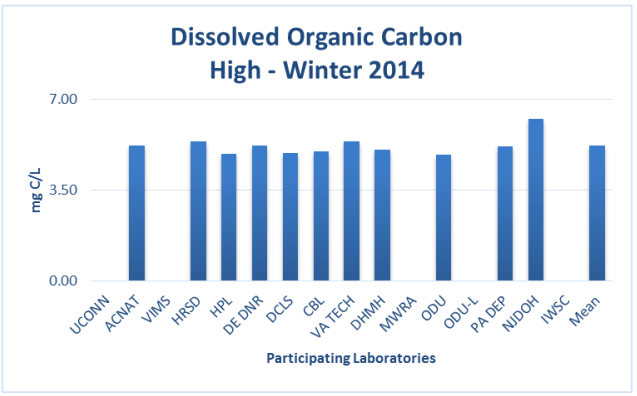


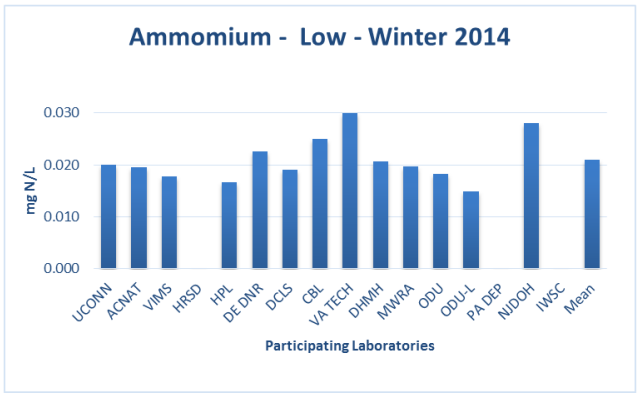
Figure 4. Particulate carbon, nitrogen and phosphorus; Chlorophyll *a*, and total dissolved nitrogen. Winter 2014.











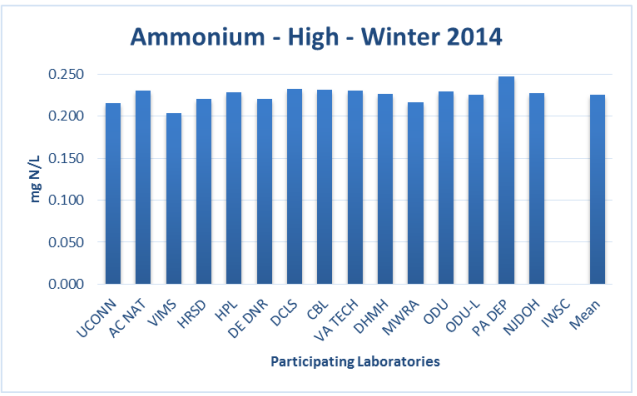
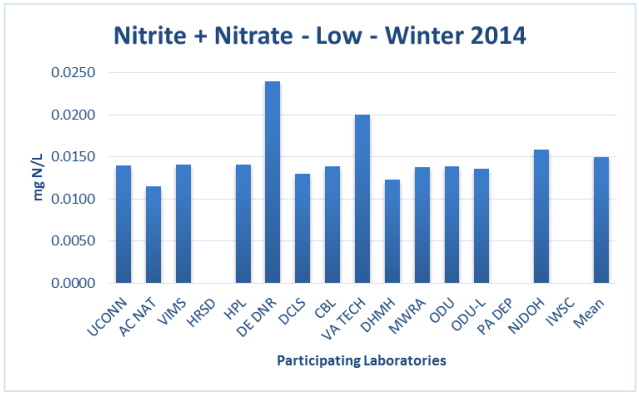
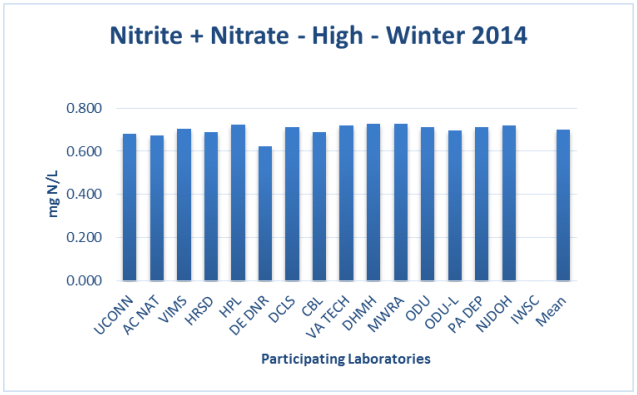
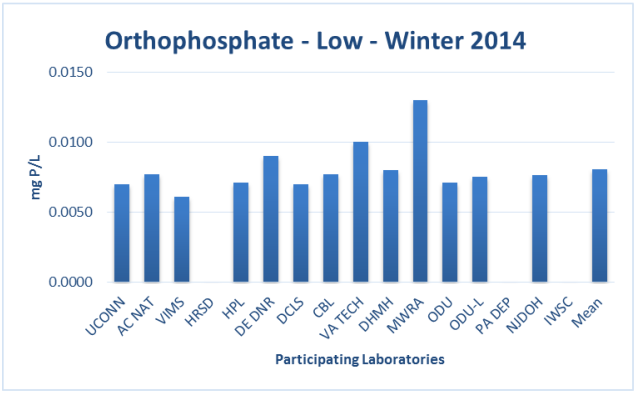
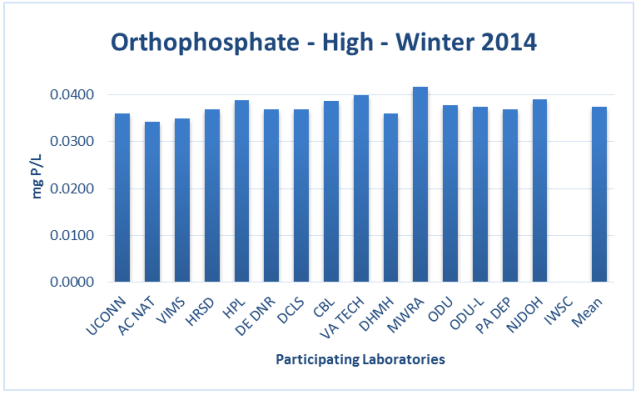


Figure 5. Total dissolved phosphorus; dissolved organic carbon, amd ammonium. Winter 2014.









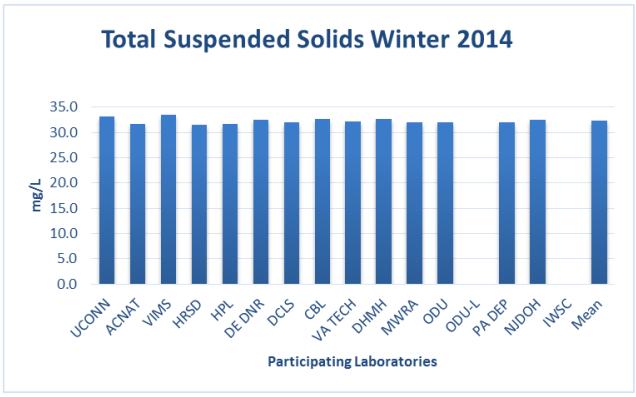


Figure 6. Nitrite plus nitrate, orthophosphate, and total suspended solids. Winter 2014.