

# **FINAL REPORT**

## **CHESAPEAKE BAY PROGRAM BLIND AUDIT**

**Fiscal Year 2015 Final Report**

**PREPARED FOR:**

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Water and Habitat Quality Program  
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## **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 NH<sub>4</sub>-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 seventeenth 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 29 September 2014 and 1 April 2015. 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°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 2014 and winter 2015 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 2014 and winter 2015 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 winter 2015 were extremely close to the prepared concentration (prepared low: 0.423 mg N/L with mean reported concentration of 0.419 mg N/L).

Total Dissolved Phosphorus: Most reported concentrations for both summer 2014 and winter 2015 samples were consistently close to other laboratories' reported concentrations and closely reflected the prepared concentrations; e.g., prepared low winter concentration of 0.0269 mg P/L with a (remarkable) mean reported concentration of all participants of 0.0269 mg P/L.

Ammonium: Analysis of low level samples for summer 2014 provided a mean concentration of 0.042 mg N/L compared to the prepared concentration of 0.048 mg N/L. Low level winter 2015 results were similar with 0.035 mg N/L mean reported concentration compared to the prepared concentration of 0.034 mg N/L. Although one laboratory's reported concentration was over double that of any other reported concentration, there were twelve laboratories reporting approximately the same concentration, so the mean low level ammonium concentration was not impacted much. Variation around that mean for low level ammonium reported concentrations resulted in coefficients of variation of 11% for summer 2014; 38% for winter 2015. Results for both summer 2014 and winter 2015 high level concentrations were in close agreement with prepared concentrations and other reported values. Coefficients of variation of less than 8% were obtained.

Nitrate + Nitrite: Particularly good agreement was found among most laboratories for low concentrations, resulting in a mean concentration of 0.0419 mg N/L for summer 2014 and 0.0448 mg N/L for summer 2015 compared to the prepared concentration of 0.0422 mg N/L for both audits. Results for both summer 2014 and winter 2015 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 3-5 %.

Orthophosphate: Low level concentrations for summer 2014 and winter 2015 were somewhat variable, with coefficients of variation of 15% and 10%. Analysis of low level samples for summer 2014 provided a mean concentration of 0.0112 mg P/L compared to the prepared concentration of 0.0111 mg P/L. Low level winter 2015 results were similar with 0.0131 mg P/L mean reported concentration compared to the prepared concentration of 0.0134 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 summer 2014: 0.0669 mg P/L with mean reported concentration of 0.0668 mg P/L).

Dissolved Organic Carbon: Particularly good agreement was found among most laboratories for low and high concentrations for the summer 2014 audit. Coefficients of variation were 2-8% for both concentration ranges for that audit, with most laboratories reporting concentrations within 10% of the prepared concentration. Particularly good agreement was found among most laboratories for low and high concentrations for the winter 2015 audit; however, one laboratory reported a low level concentration nearly double the prepared concentration for the low level sample and also significantly higher than the prepared concentration for the high level 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 close for both the summer 2014 and winter 2015 audits with coefficients of variation of only 5-8%.

Particulate Nitrogen: Results for particulate nitrogen followed the same pattern as particulate carbon for both audits with coefficients of variation 6-11%. One laboratory's reported concentration was significantly lower than any another laboratory's reported concentration.

Particulate Phosphorus: Particulate phosphorus concentrations showed some variability between the participating laboratories (coefficients of variation of 13-14%) for the summer 2014 and winter 2015 audits.

Chlorophyll: Most chlorophyll *a* results for the summer 2014 and winter 2015 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 double those of the "consensus" concentrations for the winter 2015 audit. The coefficients of variation were 17% for the summer 2014 samples and 39% for the winter 2015 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 2014 sample, 53.4 mg/L was prepared with a coefficient of variation of only 5%. For the winter 2015 sample, 30.0 mg/L was prepared with a coefficient of variation only 3%.

## **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 three values in the entire study "failed."

Data sets with relatively small standard deviations yielded more potentially extraneous "warning" points. For example, in the winter 2015 blind audit of high level dissolved organic carbon concentration, the prepared concentration was 5.00 mg C/L and the mean reported concentration was 5.10 mg C/L (!) and reported concentrations ranged from 4.96-5.39 mg C/L. The coefficient of variation was ONLY 2.3%! Nine laboratories reported results for this high level sample that were within two standard deviations (S.D. 0.12 mg C/L) of the mean. Since the standard deviation was so small, one laboratory's 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 one was "warned." This dissolved organic carbon 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 8% 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 summer 2014 blind audit of 0.048 mg N/L prepared for ammonium has a PASS category (+/-10%) of only 0.043 - 0.051 mg N/L. For the summer 2014 blind audit, seven out of thirteen participating laboratories reported results that fell in the WARN or FAIL category, indicating that their reported concentrations were greater than +/-10% 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, summer 2014 reported data based on comparisons with other participants, the mean was 0.042 mg N/L, S.D. 0.0048, C.V. 11%.

There was less divergence between participants for the summer 2012 through summer 2014 low level ammonium samples than in audits of summer 2011 and winter 2012. For the summer 2014 prepared 0.048 ammonium sample, the proportion of the standard deviation to the mean was smaller than it had been for the last few years. For the winter 2015 audit, although one laboratory's reported concentration was over double that of any other reported concentration, there were twelve laboratories reporting approximately the same concentration, so the mean low level ammonium concentration was just slightly impacted. Variation around that mean for low level ammonium reported concentrations resulted in coefficients of variation of 11% for summer 2014; 38% for winter 2015. For the winter 2014 audit, the coefficient of variation for 0.022 mg NH<sub>4</sub>-N/L was 20%. The coefficient of variation was 16% for 0.042 mg NH<sub>4</sub>-N/L (Summer 2006) and 39% for 0.036 mg NH<sub>4</sub>-N/L (Winter 2007). This indicates that inter-laboratory comparisons of any ammonium data prepared by most laboratories from concentrates below 0.042 mg N/L could probably be somewhat improving!

There were seventeen 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 14% of the mean reported concentrations for particulate carbon, nitrogen and phosphorus for the summer 2014 and winter 2015 audits. One laboratory's reported particulate nitrogen



concentration was significantly lower than all other laboratories' reported mean concentrations for both audits, although their reported particulate carbon concentration was not significantly different than the mean of the other participants.

Particulate phosphorus concentrations showed some variability between the participating laboratories (coefficients of variation of 13-14%) for the summer 2014 and winter 2015 audits. One laboratory's reported particulate phosphorus concentration was significantly lower than all other laboratories' reported mean concentrations for the summer 2014 audit, although their reported particulate phosphorus concentration was not significantly different than the mean of the other participants for the winter 2015 audit, when the concentration of the measured natural sample was less than half the concentration it had been in summer 2014.

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. Particulate phosphorus in winter 2014 was 0.0091 mg P/L and in winter 1999 was 0.0529 mg P/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. Happily, for the next five audits (winter 2012 through winter 2014), no participant noted any discrepancies when all were contacted to review their data. Sadly, this improvement in reporting did not extend to the summer 2014 and winter 2015 audits. Results were AGAIN (!) reported and then later corrected.

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 2015 participants reported only two significant digits for some analytes, thus potentially giving substantial under or over estimates for the comparisons.

## CONCLUSION

Now that thirty-five 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. One laboratory's reported particulate nitrogen concentration was significantly lower than all other laboratories' reported mean concentrations for both audits, although their reported particulate carbon concentration was not significantly different than the mean of the other participants.
2. In contrast to particulate carbon and nitrogen, particulate phosphorus concentrations have shown more variability between participating laboratories in some audit years. For example, there was more particulate phosphorus concentration variability for the summer 2014 and winter 2015 audits than in most years, although the concentrations were not particularly different than had been measured in past audits. One laboratory's reported particulate phosphorus concentration was significantly lower than all other laboratories' reported mean concentrations for the summer 2014 audit, although their reported particulate phosphorus concentration was not significantly different than the mean of the other participants for the winter 2015 audit when the concentration of the measured natural sample was less than half the concentration it had been in summer 2014.
3. 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.
4. Most of the chlorophyll *a* results for the summer 2014 and winter 2015 audits displayed the usual close agreement that was remarkable for multi-laboratory comparison of low concentrations of an environmentally transitory compound. Results from no laboratory were consistently different from those of the "consensus" concentrations for both audits.
5. 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 both 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.
6. 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.
7. 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.

8. Care should continue to be taken when completing report forms. For the summer 2014 and winter 2015 blind audits, some results were AGAIN (!) reported with insufficient significant digits. For the summer 2014 and winter 2015 blind audits, some results were reported and subsequently corrected. It is hoped that corrections of these lapses have served as reminders of the importance to continuously check many aspects of sample preparation and data management to ensure overall data quality.

Table 1. Participants in the Summer 2014 and Winter 2015 Blind Audit Program.

<b>Participant Institution</b>	<b>Point of Contact</b>	<b>Phone</b>	<b>Dissolved</b>	<b>Particulate</b>	<b>Chlorophyll a</b>	<b>DOC</b>	<b>TSS</b>
Old Dominion University, Water Quality Laboratory ( <b>ODU</b> )	Suzanne Doughton	757-451-3044	X	X	X	X	X
University of Maryland, Horn Point Laboratory ( <b>HPL</b> )	Erica Kiss	410-221-8317	X	X	X	X	X
Virginia Institute of Marine Science, Analytical Service Center ( <b>VIMS</b> )	Carol Pollard	804-684-7213	X	PP ONLY	X	NO	X
Virginia Division of Consolidated Laboratory Services ( <b>DCLS</b> )	Jay Armstrong	804-648-4480 x328	X	X	X	X	X
Maryland Department of Health and Mental Hygiene ( <b>DHMH</b> )	Shala Ameli	410-767-6190	X	X	X	X	X
University of Maryland Chesapeake Biological Laboratory ( <b>CBL</b> )	Jerry Frank	410-326-7252	X	X	X	X	X
Delaware Department of Natural Resources ( <b>DNREC</b> )	Ben Pressly	302-739-9942	X	X	X	X	X
Academy of Natural Science of Philadelphia ( <b>ACNAT</b> )	Paul Kiry	215-299-1076	NH4 ONLY	PCPN ONLY	X	NO	X
Pennsylvania DEP, Bureau of Laboratories ( <b>PADEP</b> )	Rebecca Keyes	717-346-8233	HIGH SAMPLES	NO	NO	X	X
Massachusetts Water Resources Authority, Central Laboratory ( <b>MWRA</b> )	Cara Seaman	617-660-7808	X	X	X	NO	X
Hampton Roads Sanitation District, Central Environmental Laboratory ( <b>HRSD</b> )	Chris Bolling	757-460-4217	HIGH SAMPLES	NO	X	X	X
Occoquan Watershed Monitoring Lab ( <b>OCC</b> )	Dongmei Wang	703-361-5606	X	NO PP	X	X	X
University of Connecticut Center for Environmental Science & Engineering ( <b>UCONN</b> )	Chris Perkins	860-486-2668	X	PCPN	X	X	X
US Geological Survey Indianapolis, IN ( <b>IWSC</b> )	Aubrey Bunch	317-600-2783	NO	NO	X	NO	NO
New Jersey Department of Health ( <b>NJDH</b> )	Doug Haltmeier	609-530-2801	TDP	PCPN		NO	X
Klamath Tribes Research Station	Craig Spoonmoore	541-783-2149	X	X	X	NO	X

Table 2. Summary of Mean Concentration and Standard Deviation for Each Group of Analytes in the Summer 2014 and the Winter 2015 Blind Audit, Including Distribution of Reported Concentrations from the Mean.

Parameter	Concentration in mg/L		Number of Laboratories			
			Standard Deviations from Mean			
	Mean	S.D.	<1 PASS	1-2 PASS	2-3 WARN	>3 FAIL
<b>Summer 2014</b>						
Total Dissolved Nitrogen	0.377	0.062	10		1	
Total Dissolved Nitrogen	0.820	0.152	10	2	1	
Total Dissolved Phosphorus	0.0265	0.0041	9	3		
Total Dissolved Phosphorus	0.0544	0.0045	9	4	1	
Ammonium	0.042	0.005	10	2	1	
Ammonium	0.344	0.026	11	3	1	
Nitrate + Nitrite	0.042	0.003	11	1	1	
Nitrate + Nitrite	0.852	0.044	13	1	1	
Orthophosphate	0.0112	0.0011	10	2	1	
Orthophosphate	0.0668	0.0038	11	4		
Dissolved Organic Carbon	2.04	0.15	8	1	1	
Dissolved Organic Carbon	5.10	0.12	8	1	1	
Particulate Carbon	1.62	0.082	8	2	1	
Particulate Nitrogen	0.275	0.0298	8	2	1	
Particulate Phosphorus	0.0355	0.0047	7	1	1	
Total Suspended Solids	50.9	2.56	13	1		1
<b>Winter 2015</b>						
Total Dissolved Nitrogen	0.419	0.0174	8	4		
Total Dissolved Nitrogen	0.859	0.0975	12	1	1	
Total Dissolved Phosphorus	0.0269	0.0039	10	2	1	
Total Dissolved Phosphorus	0.0575	0.0038	9	5	1	
Ammonium	0.035	0.013	10	2	1	
Ammonium	0.354	0.023	12	1	2	
Nitrate + Nitrite	0.0448	0.0055	10	2	1	
Nitrate + Nitrite	0.846	0.0230	12	2	1	
Orthophosphate	0.0131	0.0019	10	2	1	
Orthophosphate	0.0733	0.0037	11	3	1	
Dissolved Organic Carbon	2.31	0.62	9	1	1	
Dissolved Organic Carbon	5.02	0.48	10		1	
Particulate Carbon	0.974	0.0763	6	4		
Particulate Nitrogen	0.139	0.0084	9		1	
Particulate Phosphorus	0.0113	0.0016	7	4		
Total Suspended Solids	29.9	0.95	10	4		

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

Parameter	Prepared Concentration mg/L	Reported Concentration Range mg/L	Number of Laboratories		
			Within 90% - 110% of Prepared Concentration	Within 80 -90%, or 110-120% of Prepared Concentration	<80%, or >120% of Prepared Concentration
			PASS	WARN	FAIL
<b>Summer 2014</b>					
Total Dissolved Nitrogen	0.368	0.320-0.551	8	2	1
Total Dissolved Nitrogen	0.793	0.570-1.22	10		3
Total Dissolved Phosphorus	0.0230	0.0200-0.0341	5	3	4
Total Dissolved Phosphorus	0.0480	0.0450-0.0620	5	5	4
Ammonium	0.048	0.032-0.050	6	6	1
Ammonium	0.334	0.311-0.420	13	1	1
Nitrate + Nitrite	0.0422	0.0382-0.0500	12	1	
Nitrate + Nitrite	0.844	0.773-0.980	14	1	
Orthophosphate	0.0111	0.0100-0.0140	12		1
Orthophosphate	0.0669	0.0613-0.0740	14	1	
Dissolved Organic Carbon	2.00	1.71-2.37	8	2	
Dissolved Organic Carbon	5.00	4.96-5.39	10		
Total Suspended Solids	53.4	43.0-53.0	14	1	
<b>Winter 2015</b>					
Total Dissolved Nitrogen	0.423	0.400-0.467	11		
Total Dissolved Nitrogen	0.846	0.800-1.19	12	1	
Total Dissolved Phosphorus	0.0269	0.0173-0.0335	6	5	2
Total Dissolved Phosphorus	0.0577	0.0500-0.0662	12	3	
Ammonium	0.034	0.026-0.080	8	3	2
Ammonium	0.340	0.320-0.410	12	3	
Nitrate + Nitrite	0.0422	0.0390-0.0600	10	1	2
Nitrate + Nitrite	0.8441	0.790-0.880	15		
Orthophosphate	0.0134	0.0090-0.0160	6	6	1
Orthophosphate	0.0743	0.0670-0.0800	15		
Dissolved Organic Carbon	2.00	1.75-4.06	5	3	2
Dissolved Organic Carbon	5.00	4.68-6.42	9		1
Total Suspended Solids	30.0	28.2-31.6	15		

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

**Appendix 1 Summer 2014 and Winter 2015 Reported Concentrations, Prepared Concentrations and Recoveries****University of Connecticut Center for Environmental Science and Engineering (UCONN)**

	Summer 2014 Reported Concentration		Summer 2014 Prepared Concentration	Summer 2014 Percent Recovered		Winter 2015 Reported Concentration		Winter 2015 Prepared Concentration	Winter 2015 Percent Recovered
TDN (mg N/L)	0.327		0.368	88.9		0.415		0.4230	98.1
TDN (mg N/L)	0.747		0.793	94.2		0.870		0.8461	102.8
TDP (mg P/L)	0.0240		0.023	104.3		0.0260		0.0269	96.6
TDP (mg P/L)	0.0450	W	0.048	93.8		0.0500		0.0577	86.7
NH4 (mg N/L)	0.0320	W	0.048	66.7		0.032		0.0340	94.0
NH4 (mg N/L)	0.333		0.334	99.7		0.343		0.3404	100.8
NO23 (mg N/L)	0.0400		0.0422	94.8		0.0390		0.0422	92.4
NO23 (mg N/L)	0.812		0.8441	96.2		0.844		0.8441	100.0
PO4 (mg P/L)	0.0110		0.0111	99.1		0.0090	W	0.0134	67.3
PO4 (mg P/L)	0.0630		0.0669	94.2		0.0670		0.0743	90.2
PC (mg C/L)	1.73		NA	NA		0.9825		NA	NA
PN (mg N/L)	0.241		NA	NA		0.1345		NA	NA
PP (mg P/L)	0.0245	W	NA	NA		0.0110		NA	NA
CHL (ug/L)	6.72		NA	NA		3.07		NA	NA
DOC (mg C/L)	1.98		2.0	99.0		*		2.0	*
DOC (mg C/L)	5.12		5.0	102.4		*		5.0	*
TSS (mg/L)	51.3		53.4	96.1		29.7		30	99.0

\* 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

**Academy of Natural Science of Philadelphia (ACNAT)**

	Summer 2014 Reported Concentration		Summer 2014 Prepared Concentration	Summer 2014 Percent Recovered		Winter 2015 Reported Concentration		Winter 2015 Prepared Concentration	Winter 2015 Percent Recovered
TDN (mg N/L)	*		0.368	*		*		0.4230	*
TDN (mg N/L)	*		0.793	*		*		0.8461	*
TDP (mg P/L)	*		0.023	*		0.0173	W	0.0269	64.3
TDP (mg P/L)	*		0.048	*		0.0512		0.0577	88.8
NH4 (mg N/L)	0.0393		0.048	81.9		0.028		0.0340	81.1
NH4 (mg N/L)	0.335		0.334	100.3		0.355		0.3404	104.3
NO23 (mg N/L)	0.0392		0.0422	92.9		0.0448		0.0422	106.2
NO23 (mg N/L)	0.830		0.8441	98.3		0.850		0.8441	100.7
PO4 (mg P/L)	0.0106		0.0111	95.5		0.0116		0.0134	86.8
PO4 (mg P/L)	0.0639		0.0669	95.5		0.0703		0.0743	94.6
PC (mg C/L)	1.41	W	NA	NA		1.0965		NA	NA
PN (mg N/L)	0.247		NA	NA		0.1490		NA	NA
PP (mg P/L)	*		NA	NA		*		NA	NA
CHL (ug/L)	5.40		NA	NA		9.20		NA	NA
DOC (mg C/L)	*		2.0	*		*		2.0	*
DOC (mg C/L)	*		5.0	*		*		5.0	*
TSS (mg/L)	50.3		53.4	94.2		29.6		30	98.7

\* 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 2014 and Winter 2015 Reported Concentrations, Prepared Concentrations and Recoveries**

**Virginia Institute of Marine Science, Analytical Service Center (VIMS)**

	Summer 2014 Reported Concentration	Summer 2014 Prepared Concentration	Summer 2014 Percent Recovered	Winter 2015 Reported Concentration	Winter 2015 Prepared Concentration	Winter 2015 Percent Recovered
TDN (mg N/L)	0.356	0.368	96.6	0.467	W	0.4230
TDN (mg N/L)	0.779	0.793	98.3	0.839		0.8461
TDP (mg P/L)	0.0284	0.023	123.5	0.0300		0.0269
TDP (mg P/L)	0.0533	0.048	111.0	0.0576		0.0577
NH4 (mg N/L)	0.0409	0.048	85.2	0.026		0.0340
NH4 (mg N/L)	0.3109	0.334	93.1	0.332		0.3404
NO23 (mg N/L)	0.0382	0.0422	90.5	0.0479		0.0422
NO23 (mg N/L)	0.773	0.844	91.6	0.790	W	0.8441
PO4 (mg P/L)	0.0102	0.0111	91.9	0.0110		0.0134
PO4 (mg P/L)	0.0613	0.0669	91.6	0.0694		0.0743
PC (mg C/L)	1.69	NA	NA	1.0945		NA
PN (mg N/L)	0.297	NA	NA	0.1535		NA
PP (mg P/L)	0.0401	NA	NA	0.0106		NA
CHL (ug/L)	8.01	NA	NA	4.21		NA
DOC (mg C/L)	*	2.0	*	*		2.0
DOC (mg C/L)	*	5.0	*	*		5.0
TSS (mg/L)	52.7	53.4	98.7	30.2		30

\* 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 Environmental Laboratory (HRSD)**

	Summer 2014 Reported Concentration	Summer 2014 Prepared Concentration	Summer 2014 Percent Recovered	Winter 2015 Reported Concentration	Winter 2015 Prepared Concentration	Winter 2015 Percent Recovered
TDN (mg N/L)	*	0.368	*	*	0.4230	*
TDN (mg N/L)	1.000	0.793	126.1	1.190	F	0.8461
TDP (mg P/L)	*	0.023	*	*	0.0269	*
TDP (mg P/L)	0.060	0.048	125.0	0.0600	0.0577	104.0
NH4 (mg N/L)	*	0.048	*	*	0.0340	*
NH4 (mg N/L)	0.420	F	0.334	125.7	0.350	0.3404
NO23 (mg N/L)	*	0.0422	*	*	0.0422	*
NO23 (mg N/L)	0.830	0.8441	98.3	0.830	0.8441	98.3
PO4 (mg P/L)	*	0.0111	*	*	0.0134	*
PO4 (mg P/L)	0.073	0.0669	109.1	0.0750	0.0743	101.0
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)	4.75	NA	NA	3.20	NA	NA
DOC (mg C/L)	*	2.0	*	2.19	2.0	109.5
DOC (mg C/L)	*	5.0	*	4.90	5.0	98.0
TSS (mg/L)	52.8	53.4	98.9	29.8	30	99.3

\* 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



**Appendix 1 Cont'. Summer 2014 and Winter 2015 Reported Concentrations, Prepared Concentrations and Recoveries**

**University of Maryland, Horn Point Laboratory (HPL)**

	Summer 2014 Reported Concentration		Summer 2014 Prepared Concentration	Summer 2014 Percent Recovered		Winter 2015 Reported Concentration		Winter 2015 Prepared Concentration	Winter 2015 Percent Recovered
TDN (mg N/L)	0.347		0.368	94.3		0.422		0.4230	99.8
TDN (mg N/L)	0.792		0.793	99.9		0.825		0.8461	97.5
TDP (mg P/L)	0.0252		0.023	109.6		0.0276		0.0269	102.6
TDP (mg P/L)	0.0552		0.048	115.0		0.0602		0.0577	104.4
NH4 (mg N/L)	0.0387		0.048	80.6		0.029		0.0340	84.0
NH4 (mg N/L)	0.337		0.334	100.9		0.355		0.3404	104.3
NO23 (mg N/L)	0.0443		0.0422	105.0		0.0427		0.0422	101.2
NO23 (mg N/L)	0.856		0.8441	101.4		0.852		0.8441	100.9
PO4 (mg P/L)	0.0112		0.0111	100.9		0.0131		0.0134	98.0
PO4 (mg P/L)	0.065		0.0669	97.2		0.0754		0.0743	101.5
PC (mg C/L)	1.61		NA	NA		0.916		NA	NA
PN (mg N/L)	0.286		NA	NA		0.138		NA	NA
PP (mg P/L)	0.0407		NA	NA		0.0110		NA	NA
CHL (ug/L)	8.44		NA	NA		4.24		NA	NA
DOC (mg C/L)	2.05		2.0	102.5		1.97		2.0	98.5
DOC (mg C/L)	5.03		5.0	100.6		4.82		5.0	96.4
TSS (mg/L)	52.7		53.4	98.7		29.1		30	97.0

\* 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

**Delaware Department of Natural Resources (DNREC)**

	Summer 2014 Reported Concentration		Summer 2014 Prepared Concentration	Summer 2014 Percent Recovered		Winter 2015 Reported Concentration		Winter 2015 Prepared Concentration	Winter 2015 Percent Recovered
TDN (mg N/L)	0.551	W	0.368	149.7		0.411		0.4230	97.2
TDN (mg N/L)	1.22	W	0.793	154.0		0.813		0.8461	96.1
TDP (mg P/L)	0.028		0.023	121.7		0.0300		0.0269	111.5
TDP (mg P/L)	0.062		0.048	129.2		0.0610		0.0577	105.8
NH4 (mg N/L)	0.0459		0.048	95.6		0.033		0.0340	96.9
NH4 (mg N/L)	0.353		0.334	105.6		0.383		0.3404	112.5
NO23 (mg N/L)	0.042		0.0422	99.5		0.0440		0.0422	104.3
NO23 (mg N/L)	0.846		0.8441	100.2		0.849		0.8441	100.6
PO4 (mg P/L)	0.014	W	0.0111	126.1		0.0160		0.0134	119.7
PO4 (mg P/L)	0.074		0.0669	110.6		0.0780		0.0743	105.0
PC (mg C/L)	1.52		NA	NA		1.0850		NA	NA
PN (mg N/L)	0.287		NA	NA		0.1460		NA	NA
PP (mg P/L)	0.0363		NA	NA		0.0090		NA	NA
CHL (ug/L)	7.34		NA	NA		4.89		NA	NA
DOC (mg C/L)	2.37		2.0	118.7		2.29		2.0	114.4
DOC (mg C/L)	5.39	W	5.0	107.8		4.82		5.0	96.4
TSS (mg/L)	52.1		53.4	97.6		31.6		30.0	105.3

\* 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

**Appendix 1 Cont'. Summer 2014 and Winter 2015 Reported Concentrations, Prepared Concentrations and Recoveries****Division of Consolidated Laboratory Services (DCLS)**

	Summer 2014 Reported Concentration	Summer 2014 Prepared Concentration	Summer 2014 Percent Recovered	Winter 2015 Reported Concentration	Winter 2015 Prepared Concentration	Winter 2015 Percent Recovered
TDN (mg N/L)	0.357	0.368	97.0	0.421	0.4230	99.5
TDN (mg N/L)	0.777	0.793	98.0	0.813	0.8461	96.1
TDP (mg P/L)	0.026	0.023	113.0	0.0270	0.0269	100.3
TDP (mg P/L)	0.053	0.048	110.4	0.0560	0.0577	97.1
NH4 (mg N/L)	0.048	0.048	100.0	0.031	0.0340	91.1
NH4 (mg N/L)	0.346	0.334	103.6	0.340	0.3404	99.9
NO23 (mg N/L)	0.043	0.0422	101.9	0.0420	0.0422	99.5
NO23 (mg N/L)	0.884	0.8441	104.7	0.843	0.8441	99.9
PO4 (mg P/L)	0.011	0.0111	99.1	0.0150	0.0134	112.2
PO4 (mg P/L)	0.066	0.0669	98.7	0.0780	0.0743	105.0
PC (mg C/L)	1.61	NA	NA	0.9405	NA	NA
PN (mg N/L)	0.278	NA	NA	0.1360	NA	NA
PP (mg P/L)	0.0328	NA	NA	0.0096	NA	NA
CHL (ug/L)	7.81	NA	NA	5.09	NA	NA
DOC (mg C/L)	2.11	2.0	105.5	2.03	2.0	101.5
DOC (mg C/L)	4.96	5.0	99.2	4.83	5.0	96.6
TSS (mg/L)	53	53.4	99.3	30.0	30	100.0

\* 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

**University of Maryland, Chesapeake Biological Laboratory (CBL)**

	Summer 2014 Reported Concentration	Summer 2014 Prepared Concentration	Summer 2014 Percent Recovered	Winter 2015 Reported Concentration	Winter 2015 Prepared Concentration	Winter 2015 Percent Recovered
TDN (mg N/L)	0.374	0.368	101.6	0.433	0.4230	102.4
TDN (mg N/L)	0.807	0.793	101.8	0.840	0.8461	99.3
TDP (mg P/L)	0.0227	0.023	98.7	0.0256	0.0269	95.1
TDP (mg P/L)	0.0498	0.048	103.8	0.0583	0.0577	101.1
NH4 (mg N/L)	0.047	0.048	97.9	0.034	0.0340	99.9
NH4 (mg N/L)	0.355	0.334	106.3	0.366	0.3404	107.5
NO23 (mg N/L)	0.0402	0.0422	95.3	0.0420	0.0422	99.5
NO23 (mg N/L)	0.8674	0.8441	102.8	0.861	0.8441	102.0
PO4 (mg P/L)	0.0111	0.0111	100.0	0.0126	0.0134	94.2
PO4 (mg P/L)	0.0647	0.0669	96.7	0.0762	0.0743	102.6
PC (mg C/L)	1.65	NA	NA	0.9120	NA	NA
PN (mg N/L)	0.297	NA	NA	0.1410	NA	NA
PP (mg P/L)	0.0369	NA	NA	0.0106	NA	NA
CHL (ug/L)	7.91	NA	NA	4.34	NA	NA
DOC (mg C/L)	2.03	2.0	101.5	2.04	2.0	102.0
DOC (mg C/L)	5.02	5.0	100.4	4.97	5.0	99.4
TSS (mg/L)	47.9	53.4	89.7	28.9	30	96.3

\* 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

**Appendix 1 Cont'. Summer 2014 and Winter 2015 Reported Concentrations, Prepared Concentrations and Recoveries**

**Virginia Polytechnic Institute, Occoquan Watershed Monitoring Laboratory (OCC)**

	Summer 2014 Reported Concentration		Summer 2014 Prepared Concentration	Summer 2014 Percent Recovered		Winter 2015 Reported Concentration		Winter 2015 Prepared Concentration	Winter 2015 Percent Recovered
TDN (mg N/L)	0.320		0.368	87.0		0.400		0.4230	94.6
TDN (mg N/L)	0.570		0.793	71.9		0.860		0.8461	101.6
TDP (mg P/L)	0.0200		0.023	87.0		0.0270		0.0269	100.3
TDP (mg P/L)	0.0600		0.048	125.0		0.0590		0.0577	102.3
NH4 (mg N/L)	0.0500		0.048	104.2		0.080	F	0.0340	235.0
NH4 (mg N/L)	0.380		0.334	113.8		0.410	W	0.3404	120.4
NO23 (mg N/L)	0.0400		0.0422	94.8		0.0600	W	0.0422	142.2
NO23 (mg N/L)	0.980	W	0.8441	116.1		0.880		0.8441	104.3
PO4 (mg P/L)	0.0100		0.0111	90.1		0.0160		0.0134	119.7
PO4 (mg P/L)	0.0700		0.0669	104.6		0.0800		0.0743	107.7
PC (mg C/L)	1.64		NA	NA		0.9520		NA	NA
PN (mg N/L)	0.205	W	NA	NA		0.1200	W	NA	NA
PP (mg P/L)	*		NA	NA		*		NA	NA
CHL (ug/L)	7.84		NA	NA		6.10		NA	NA
DOC (mg C/L)	2		2.0	100.0		2.26		2.0	113.0
DOC (mg C/L)	5.2		5.0	104.0		4.96		5.0	99.2
TSS (mg/L)	49.3		53.4	92.3		31.5		30.0	105.0

\* 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 2014 Reported Concentration		Summer 2014 Prepared Concentration	Summer 2014 Percent Recovered		Winter 2015 Reported Concentration		Winter 2015 Prepared Concentration	Winter 2015 Percent Recovered
TDN (mg N/L)	0.382		0.368	103.8		0.408		0.4230	96.4
TDN (mg N/L)	0.865		0.793	109.1		0.812		0.8461	96.0
TDP (mg P/L)	0.0273		0.023	118.7		0.0230		0.0269	85.5
TDP (mg P/L)	0.0519		0.048	108.1		0.0550		0.0577	95.4
NH4 (mg N/L)	0.0390		0.048	81.3		0.031		0.0340	91.4
NH4 (mg N/L)	0.339		0.334	101.5		0.331		0.3404	97.2
NO23 (mg N/L)	0.0428		0.0422	101.4		0.0518		0.0422	122.7
NO23 (mg N/L)	0.846		0.8441	100.2		0.871		0.8441	103.2
PO4 (mg P/L)	0.01		0.0111	90.1		0.0134		0.0134	100.2
PO4 (mg P/L)	0.0634		0.0669	94.8		0.0719		0.0743	96.8
PC (mg C/L)	1.59		NA	NA		0.877		NA	NA
PN (mg N/L)	0.288		NA	NA		0.137		NA	NA
PP (mg P/L)	0.0340		NA	NA		0.0136		NA	NA
CHL (ug/L)	*		NA	NA		*		NA	NA
DOC (mg C/L)	2.088		2.0	104.4		2.54		2.0	127.0
DOC (mg C/L)	5.044		5.0	100.9		5.09		5.0	101.8
TSS (mg/L)	50.6		53.4	94.8		28.2		30.0	94.0

\* 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

**Appendix 1 Cont'. Summer 2014 and Winter 2015 Reported Concentrations, Prepared Concentrations and Recoveries****Massachusetts Water Resource Authority, Central Laboratory (MWRA)**

	Summer 2014 Reported Concentration	Summer 2014 Prepared Concentration	Summer 2014 Percent Recovered	Winter 2015 Reported Concentration	Winter 2015 Prepared Concentration	Winter 2015 Percent Recovered
TDN (mg N/L)	0.392	0.368	106.5	0.403	0.4230	95.3
TDN (mg N/L)	0.775	0.793	97.7	0.835	0.8461	98.7
TDP (mg P/L)	0.0341	0.023	148.3	0.0298	0.0269	110.7
TDP (mg P/L)	0.0564	0.048	117.5	0.0662	W 0.0577	114.8
NH4 (mg N/L)	0.0396	0.048	82.5	0.031	0.0340	91.1
NH4 (mg N/L)	0.339	0.334	101.5	0.345	0.3404	101.4
NO23 (mg N/L)	0.0404	0.0422	95.7	0.0416	0.0422	98.6
NO23 (mg N/L)	0.833	0.8441	98.7	0.877	0.8441	103.9
PO4 (mg P/L)	0.0121	0.0111	109.0	0.0136	0.0134	101.7
PO4 (mg P/L)	0.0683	0.0669	102.1	0.0753	0.0743	101.4
PC (mg C/L)	1.66	NA	NA	0.996	NA	NA
PN (mg N/L)	0.286	NA	NA	0.142	NA	NA
PP (mg P/L)	0.0343	NA	NA	0.0116	NA	NA
CHL (ug/L)	9.02	NA	NA	5.94	NA	NA
DOC (mg C/L)	*	2.0	*	*	2.0	*
DOC (mg C/L)	*	5.0	*	*	5.0	*
TSS (mg/L)	51.7	53.4	96.8	31.4	30.0	104.7

\* 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 2014 Reported Concentration	Summer 2014 Prepared Concentration	Summer 2014 Percent Recovered	Winter 2015 Reported Concentration	Winter 2015 Prepared Concentration	Winter 2015 Percent Recovered
TDN (mg N/L)	0.375	0.368	101.9	0.415	0.4230	98.1
TDN (mg N/L)	0.784	0.793	98.9	0.822	0.8461	97.2
TDP (mg P/L)	0.0251	0.023	109.1	0.0288	0.0269	107.0
TDP (mg P/L)	0.0532	0.048	110.8	0.0562	0.0577	97.5
NH4 (mg N/L)	0.0400	0.048	83.3	0.029	0.0340	85.2
NH4 (mg N/L)	0.340	0.334	101.8	0.341	0.3404	100.1
NO23 (mg N/L)	0.0430	0.0422	101.9	0.0408	0.0422	96.7
NO23 (mg N/L)	0.859	0.8441	101.8	0.828	0.8441	98.1
PO4 (mg P/L)	0.0110	0.0111	99.1	0.0116	0.0134	86.8
PO4 (mg P/L)	0.0652	0.0669	97.5	0.0697	0.0743	93.8
PC (mg C/L)	1.66	NA	NA	0.9600	NA	NA
PN (mg N/L)	0.313	NA	NA	0.138	NA	NA
PP (mg P/L)	0.0397	NA	NA	0.0145	NA	NA
CHL (ug/L)	8.76	NA	NA	5.16	NA	NA
DOC (mg C/L)	1.71	W 2.0	85.5	1.75	2.0	87.5
DOC (mg C/L)	5.14	5.0	102.7	4.74	5.0	94.8
TSS (mg/L)	51.3	53.4	96.1	29.7	30.0	98.9

\* 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

**Appendix 1 Cont'. Summer 2014 and Winter 2015 Reported Concentrations, Prepared Concentrations and Recoveries****Pennsylvania Department of Environmental Protection, Bureau of Laboratories (PADEP)**

	Summer 2014 Reported Concentration		Summer 2014 Prepared Concentration	Summer 2014 Percent Recovered	Winter 2015 Reported Concentration		Winter 2015 Prepared Concentration	Winter 2015 Percent Recovered
TDN (mg N/L)	*		0.368	*	*		0.4230	*
TDN (mg N/L)	0.745		0.793	93.9	0.800		0.8461	94.6
TDP (mg P/L)	*		0.023	*	*		0.0269	*
TDP (mg P/L)	0.052		0.048	108.3	0.0590		0.0577	102.3
NH4 (mg N/L)	*		0.048	*	*		0.0340	*
NH4 (mg N/L)	0.313		0.334	93.7	0.320		0.3404	94.0
NO23 (mg N/L)	*		0.0422	*	*		0.0422	*
NO23 (mg N/L)	0.87		0.844	103.1	0.850		0.8441	100.7
PO4 (mg P/L)	*		0.0111	*	*		0.0134	*
PO4 (mg P/L)	0.068		0.0669	101.6	0.0720		0.0743	96.9
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		2.0	99.0	1.97		2.0	98.5
DOC (mg C/L)	5.00		5.0	100.0	4.68		5.0	93.6
TSS (mg/L)	43.0	f	53.4	80.5	29.0		30.0	96.7

\* 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

**New Jersey Department of Health (NJDH)**

	Summer 2014 Reported Concentration		Summer 2014 Prepared Concentration	Summer 2014 Percent Recovered	Winter 2015 Reported Concentration		Winter 2015 Prepared Concentration	Winter 2015 Percent Recovered
TDN (mg N/L)	*		0.368	*	*		0.4230	*
TDN (mg N/L)	*		0.793	*	*		0.8461	*
TDP (mg P/L)	0.0336		0.023	146.1	0.0335		0.0269	124.5
TDP (mg P/L)	0.0579		0.048	120.6	0.0546		0.0577	94.7
NH4 (mg N/L)	0.0469		0.048	97.7	0.033		0.0340	96.9
NH4 (mg N/L)	0.334		0.334	100.0	0.343		0.3404	100.8
NO23 (mg N/L)	0.0500	W	0.0422	118.5	0.0461		0.0422	109.2
NO23 (mg N/L)	0.858		0.8441	101.6	0.848		0.8441	100.5
PO4 (mg P/L)	0.0118		0.0111	106.3	0.0138		0.0134	103.2
PO4 (mg P/L)	0.0713		0.0669	106.6	0.0716		0.0743	96.4
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)	2.04		2.0	101.9	4.06	W	2.0	203.0
DOC (mg C/L)	5.14		5.0	102.8	6.42	W	5.0	128.4
TSS (mg/L)	51.8		53.4	97.0	29.7		30.0	99.0

\* 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

**Appendix 1 Cont'. Summer 2014 and Winter 2015 Reported Concentrations, Prepared Concentrations and Recoveries**

**USGS - Indiana Water Science Center (IWSC)**

	Summer 2014 Reported Concentration	Summer 2014 Prepared Concentration	Summer 2014 Percent Recovered	Winter 2015 Reported Concentration	Winter 2015 Prepared Concentration	Winter 2015 Percent Recovered
TDN (mg N/L)	*	0.368	*	*	0.4230	*
TDN (mg N/L)	*	0.793	*	*	0.8461	*
TDP (mg P/L)	*	0.023	*	*	0.0269	*
TDP (mg P/L)	*	0.048	*	*	0.0577	*
NH4 (mg N/L)	*	0.048	*	*	0.0340	*
NH4 (mg N/L)	*	0.334	*	*	0.3404	*
NO23 (mg N/L)	*	0.0422	*	*	0.0422	*
NO23 (mg N/L)	*	0.8441	*	*	0.8441	*
PO4 (mg P/L)	*	0.0111	*	*	0.0134	*
PO4 (mg P/L)	*	0.0669	*	*	0.0743	*
PC (mg C/L)	*	NA	*	*	NA	*
PN (mg N/L)	*	NA	*	*	NA	*
PP (mg P/L)	*	NA	*	*	NA	*
CHL (ug/L)	8.77	NA	NA	*	NA	NA
DOC (mg C/L)	*	2.0	*	*	2.0	*
DOC (mg C/L)	*	5.0	*	*	5.0	*
TSS (mg/L)	*	53.4	*	*	30.0	*

\* 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

**Klamath Tribe's Research Station (KLAM)**

	Summer 2014 Reported Concentration	Summer 2014 Prepared Concentration	Summer 2014 Percent Recovered	Winter 2015 Reported Concentration	Winter 2015 Prepared Concentration	Winter 2015 Percent Recovered
TDN (mg N/L)	0.366	0.368	99.5	0.415	0.4230	98.1
TDN (mg N/L)	0.796	0.793	100.4	0.853	0.8461	100.8
TDP (mg P/L)	0.023	0.023	100.0	0.0240	0.0269	89.2
TDP (mg P/L)	0.052	0.048	108.3	0.0580	0.0577	100.6
NH4 (mg N/L)	0.043	0.048	89.6	0.034	0.0340	99.9
NH4 (mg N/L)	0.331	0.334	99.1	0.389	0.3404	114.3
NO23 (mg N/L)	0.042	0.0422	99.5	0.0400	0.0422	94.8
NO23 (mg N/L)	0.837	0.8441	99.2	0.812	0.8441	96.2
PO4 (mg P/L)	0.011	0.0111	99.1	0.0130	0.0134	97.2
PO4 (mg P/L)	0.065	0.0669	97.2	0.0700	0.0743	94.2
PC (mg C/L)	*	NA	NA	0.8800	NA	NA
PN (mg N/L)	*	NA	NA	0.1300	NA	NA
PP (mg P/L)	*	NA	NA	0.0120	NA	NA
CHL (ug/L)	8.43	NA	NA	1.30	NA	NA
DOC (mg C/L)	*	2.0	*	*	2.0	*
DOC (mg C/L)	*	5.0	*	*	5.0	*
TSS (mg/L)	52.5	53.4	98.3	30.1	30.0	100.3

\* 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



Figure 1. Particulate carbon, nitrogen and phosphorus; Chlorophyll a, and total dissolved nitrogen. Summer 2014

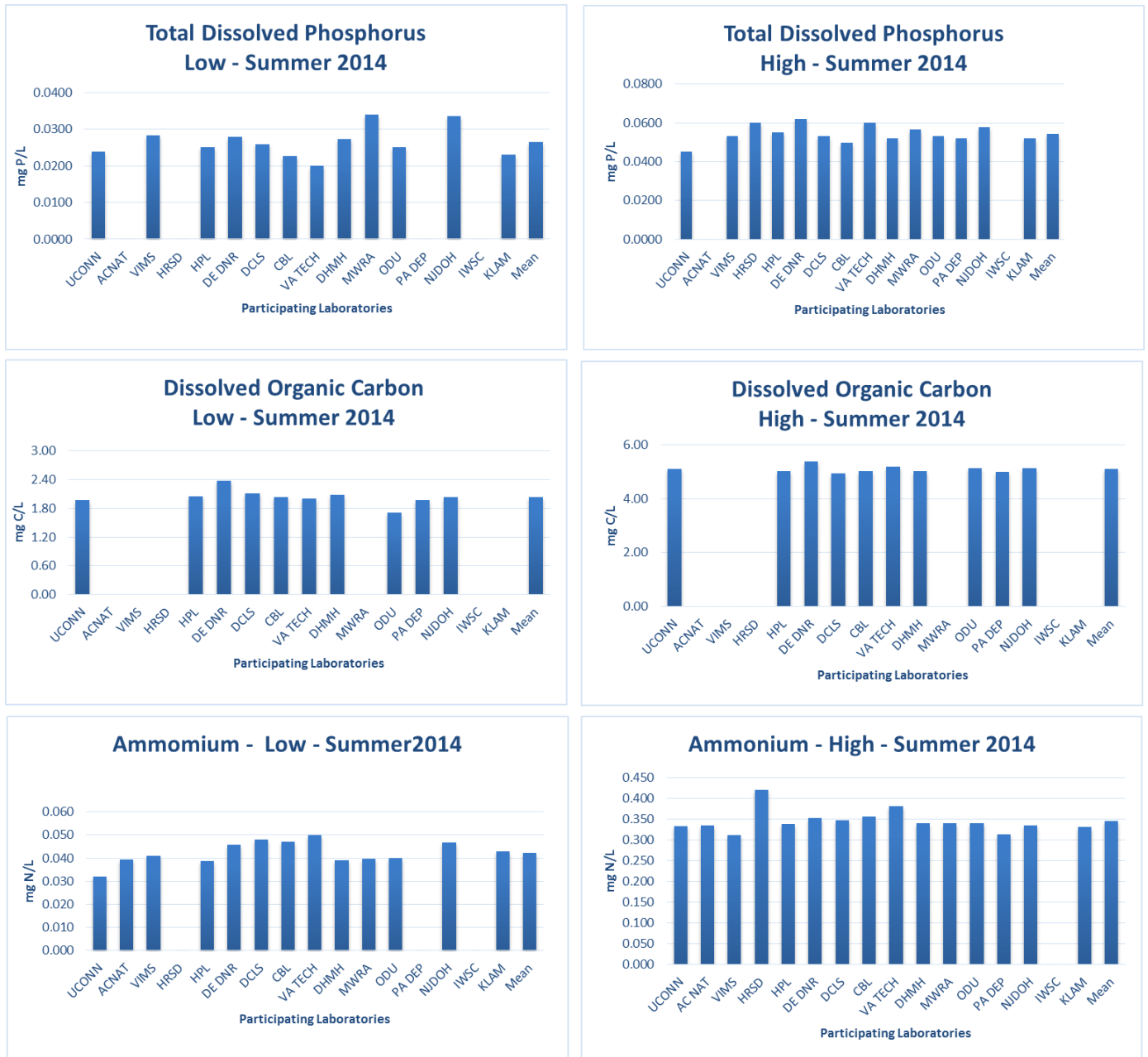


Figure 2. Total dissolved phosphorus; dissolved organic carbon, and ammonium. Summer 2014



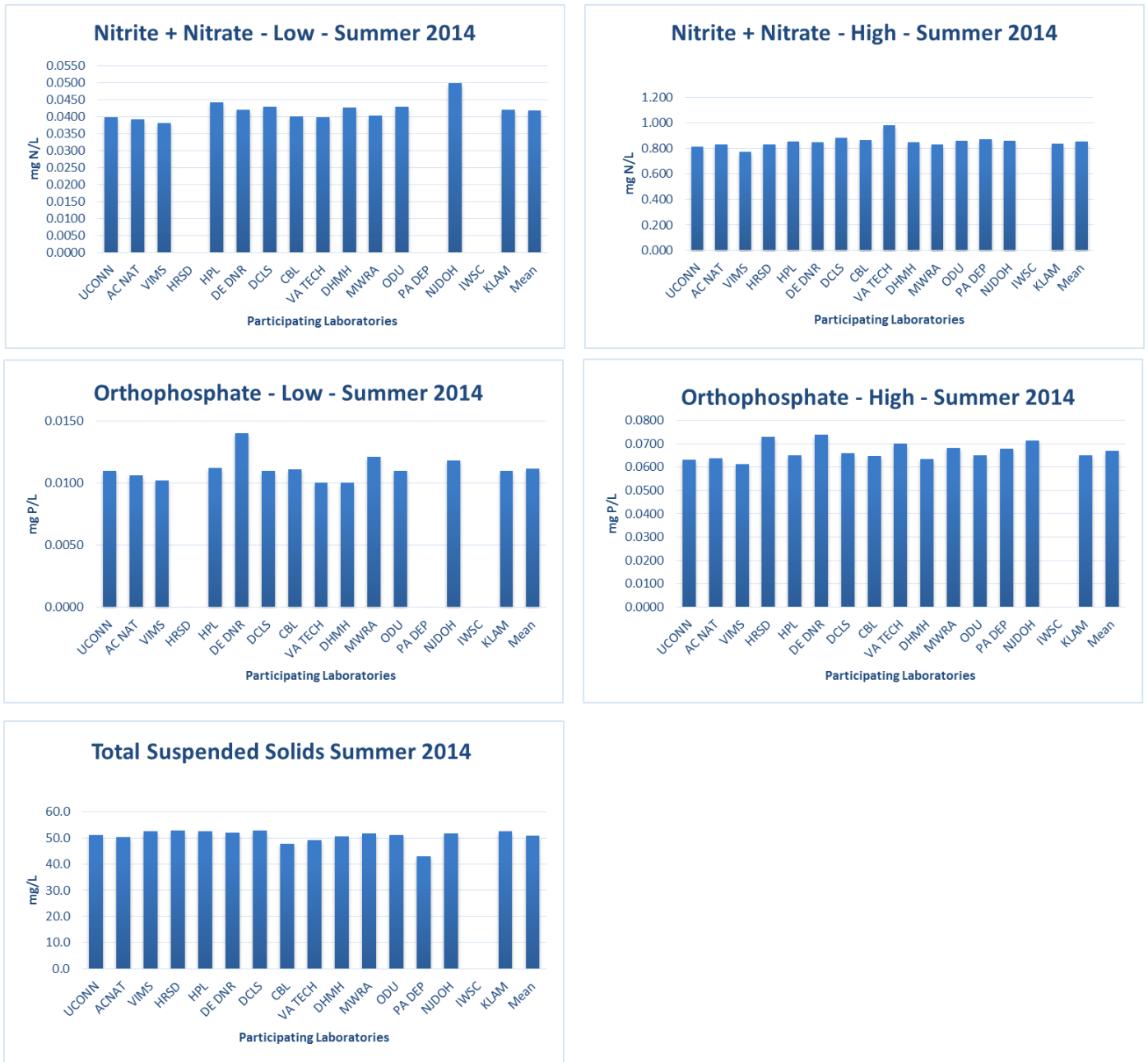


Figure 3. Nitrite plus nitrate, orthophosphate, and total suspended solids. Summer 2014

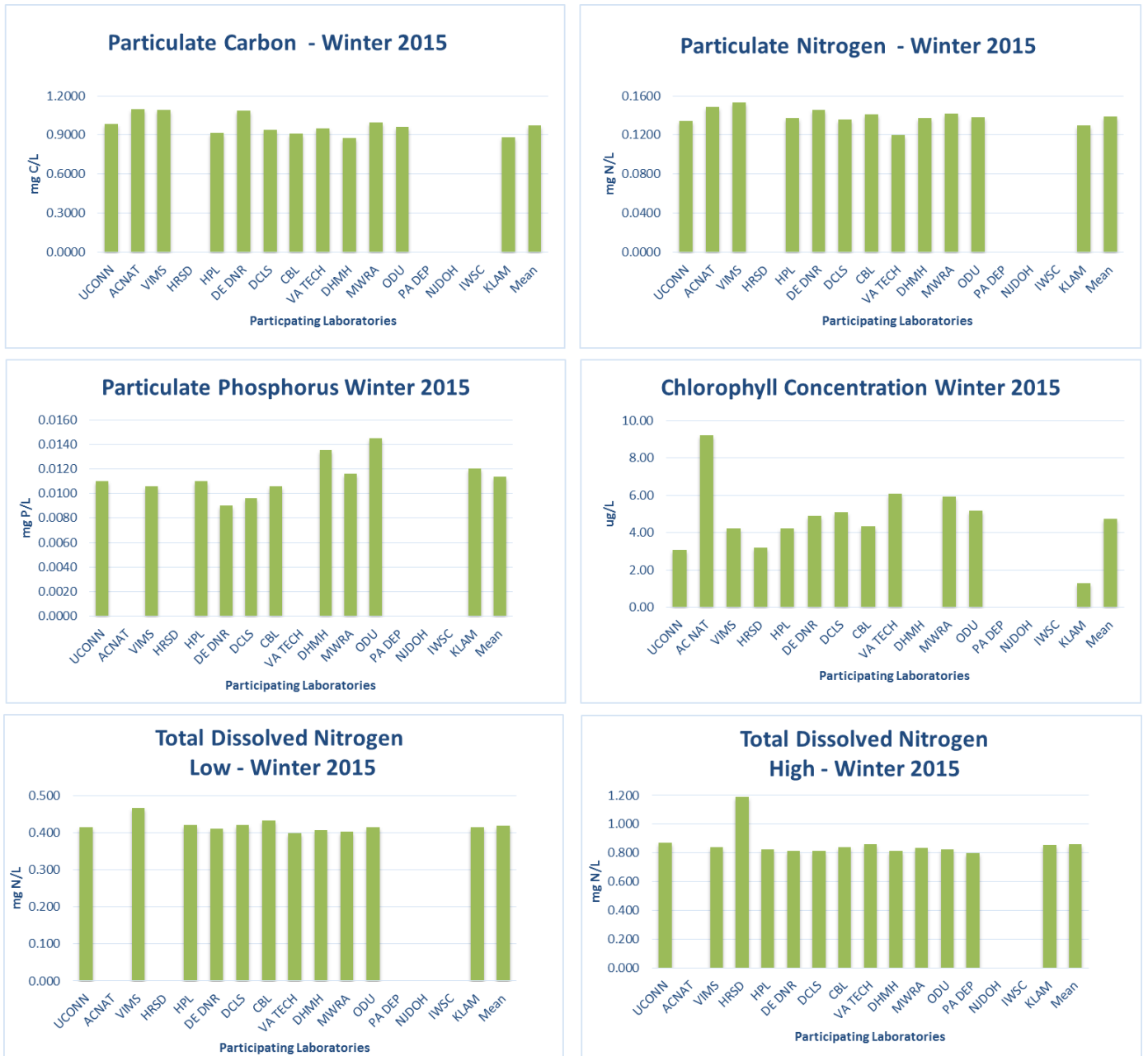


Figure 4. Particulate carbon, nitrogen and phosphorus; Chlorophyll a, and total dissolved nitrogen. Winter 2015.



Figure 5. Total dissolved phosphorus; dissolved organic carbon, and ammonium. Winter 2015.

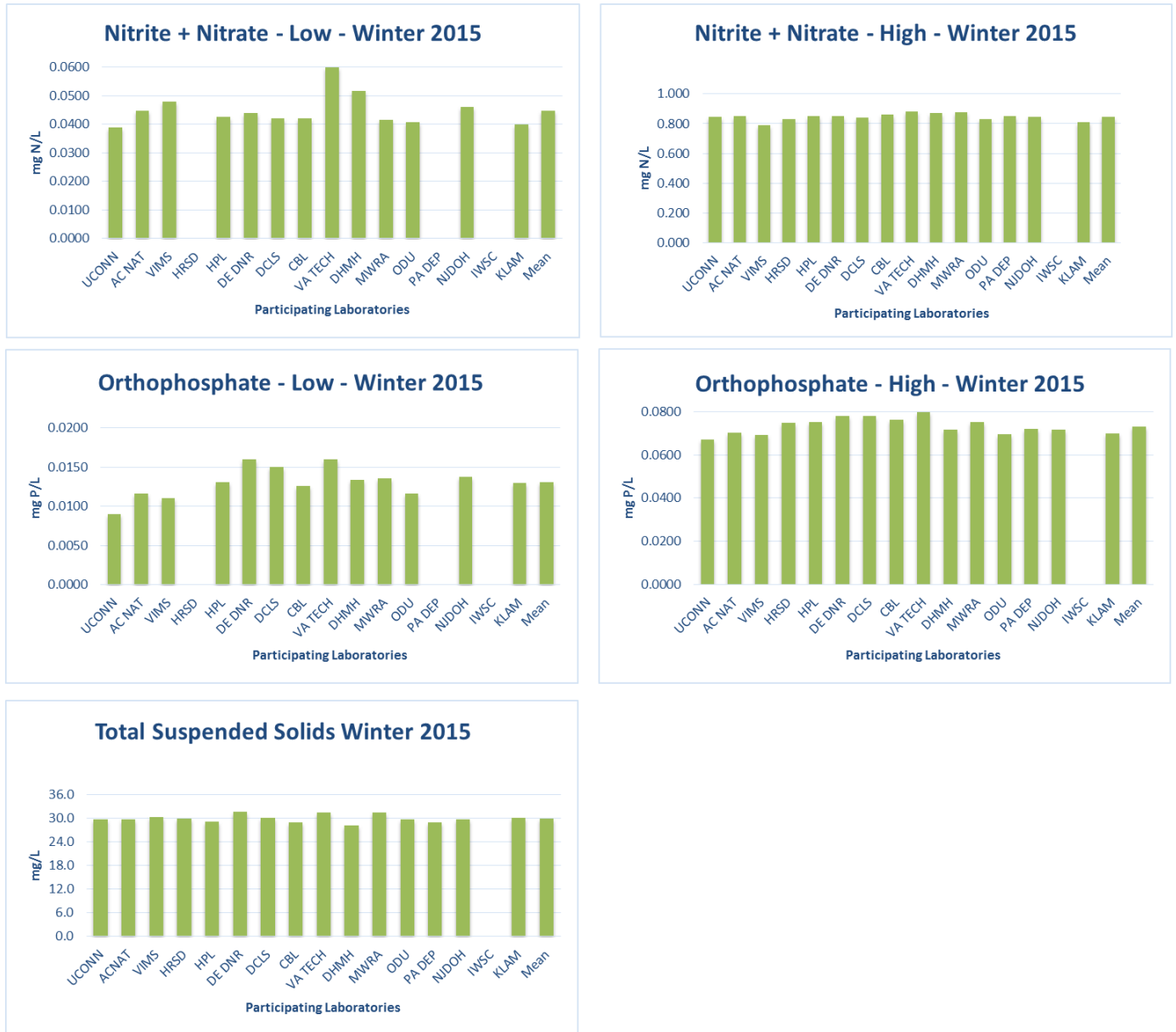


Figure 6. Nitrite plus nitrate, orthophosphate, and total suspended solids. Winter 2015.