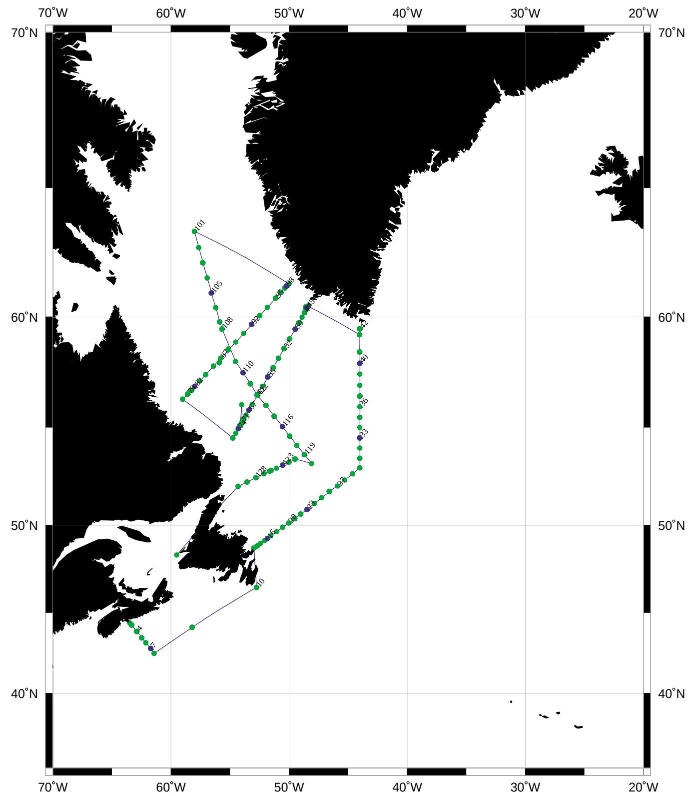
Last updated 11/1/2001

A. Cruise Narrative AR07W, AR13, AR27 (LABRADOR SEA)



A.1. Highlights

WHP Cruise Summary Information

WOCE section designation	**AR07W, AR13, AR27**
Expedition designation (EXPOCODE)	**18HU97009_1**
Chief Scientist(s) and their affiliation	**R. Allyn Clarke***
Dates	1997.05.09 - 1997.06.11
Ship	CCGS Hudson
Ports of call	BIO, Dartmouth, NS, Canada
Number of stations	113 Full depth WHP small volume CTD stns.
Geographic boundaries of the stations	62° N 62° W 50° E 50° N
Floats and drifters deployed	6 ALACE floats; 9 RAFOS floats
Moorings deployed or recovered	1 mixed layer Lagrangian drifter recovered

Contributing Authors: M. Levasseur, J. Anning, J. Bugden, K. Clemente, L Harris, R. Campbell, A. Isenor, B. Ryan, I Yashayaev, R. Boyce, P. Strain, P. Clement, M. Poliquin, B. Gershey, M. Hingston, R. Ugstad, A. Clarke,

*Chief Scientist
Ocean Sciences Division
Department of Fisheries and Oceans
Bedford Institute of Oceanography

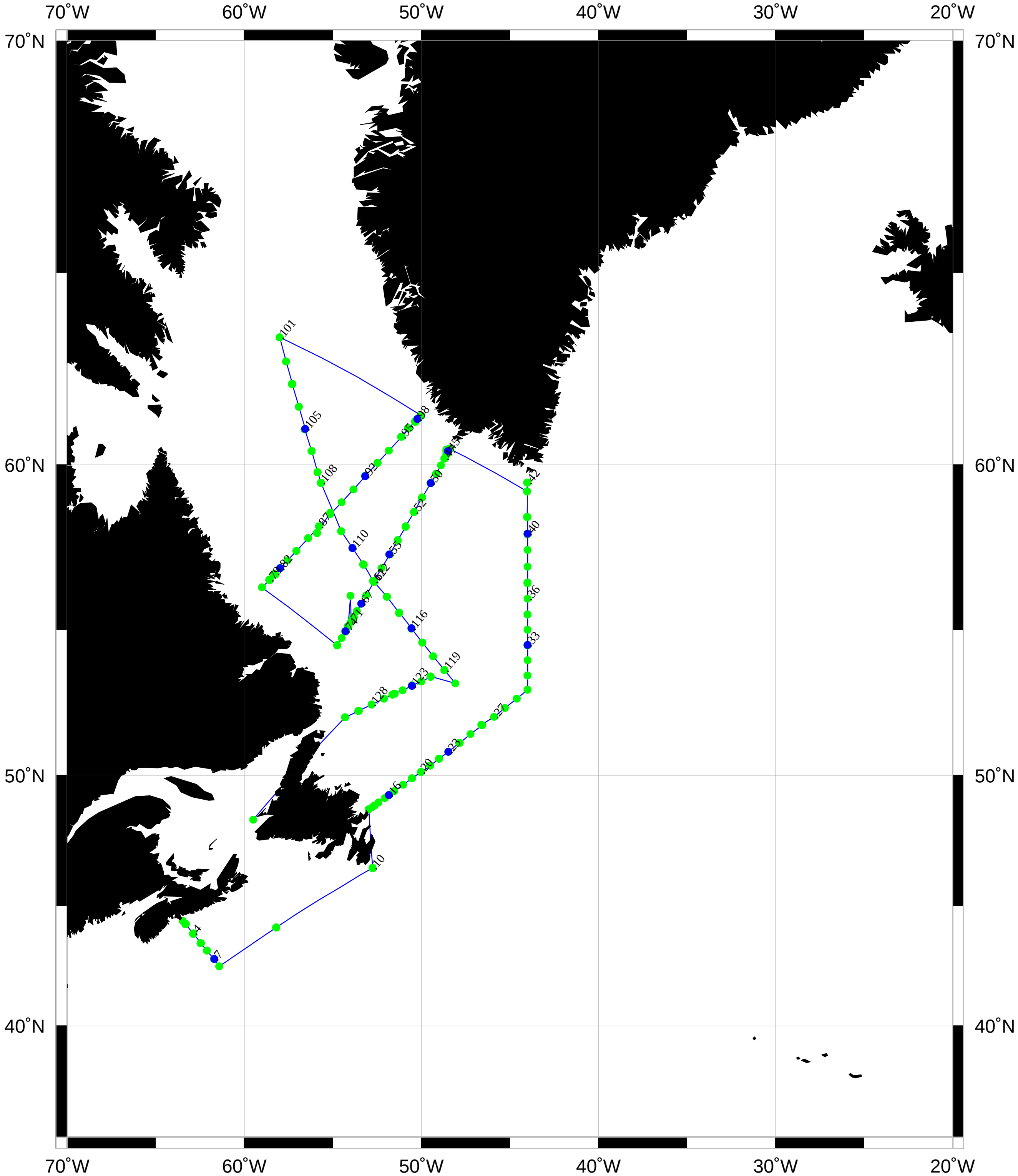
PO Box 1006
Dartmouth, NS, Canada B2Y 2A4
FAX 902 426 7827
Internet ClarkeA@mar.dfo-mpo.gc.ca

WHP Cruise and Data Information

Instructions: Click on any item to locate primary reference(s) or use navigation tools above.

Cruise Summary Information	Hydrographic Measurements
Description of scientific program	CTD - general
	CTD - pressure
Geographic boundaries of the survey	CTD - temperature
Cruise track (figure)	CTD - conductivity/salinity
Description of stations	CTD - dissolved oxygen
Description of parameters sampled	
	Salinity
Floats and drifters deployed	Oxygen
Moorings deployed or recovered	Nutrients
	CFCs
Principal Investigators for all measurements	
Cruise Participants	
Problems and goals not achieved	CO2 system parameters
Other incidents of note	Other parameters
Underway Data Information	
Navigation	**References**
Bathymetry	
Acoustic Doppler Current Profiler (ADCP)	
XBT and/or XCTD	
Meteorological observations	
Atmospheric chemistry data	
	Data Processing Notes

Station locations for AR07WH :CLARKE



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2. Cruise Summary Information

a. Cruise Track

A cruise track is shown in Figure 1. Ship position at midnight on each day of the cruise is indicated with an asterisk.

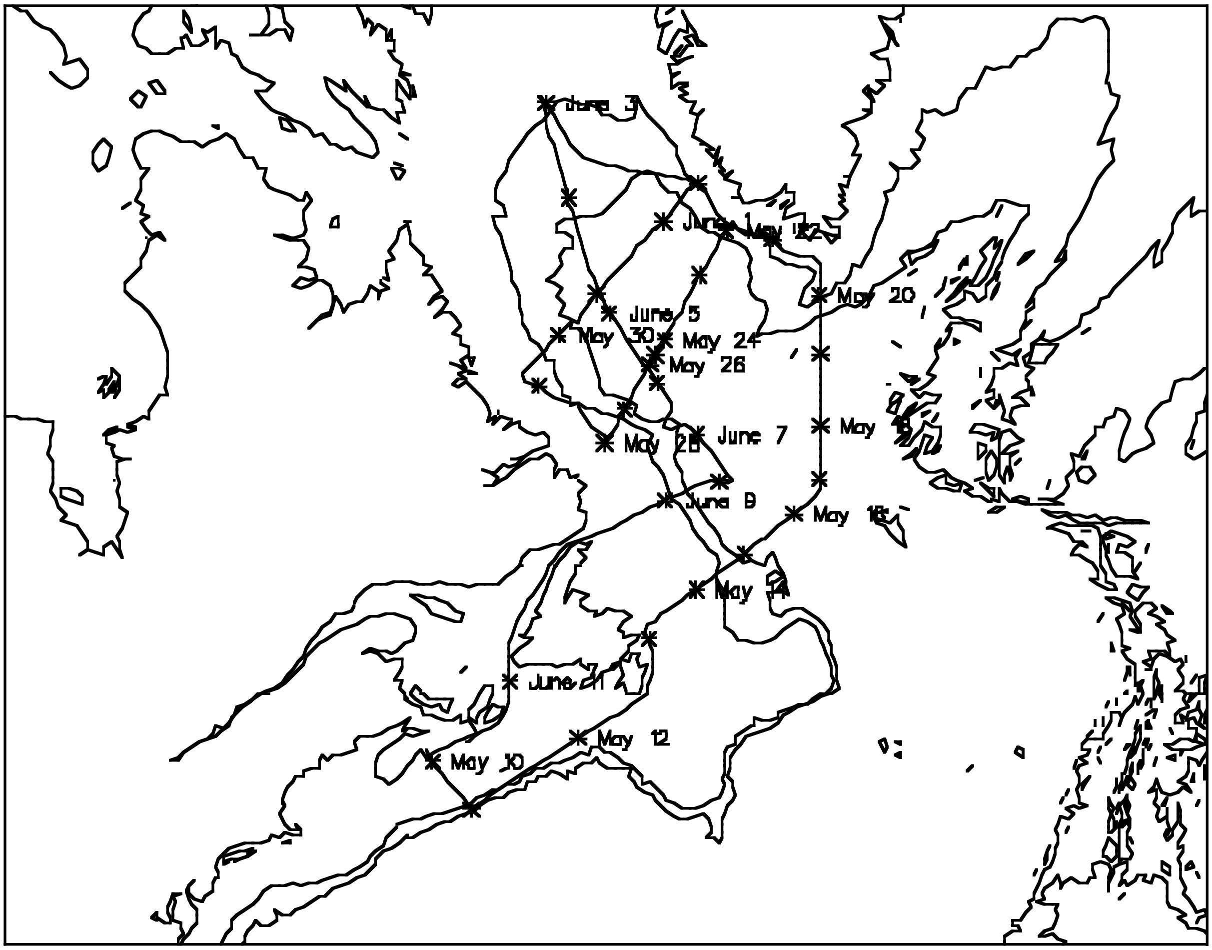


Figure 1. Cruise track for 18HU97009/1; * marks Hudson s position at 0000Z each day with some day labels indicated.

b. Total Number of Stations Occupied

The CTD and ROS station positions are shown in Figure 2. The WHP stations are all contained in the box defined by 50-62°N and 43-60°W. Test CTD stations were also occupied outside of this box and are not shown here.

113 Full depth WHP small volume CTD stations with up to 24 rosette bottles. Depending on the station, water samples were analyzed for CFCs, carbon tetrachloride, methyl chloroform, total carbonate, alkalinity, oxygen, salinity, nutrients, oxygen isotopes, helium and tritium, DMS, DOC, and chlorophyll.

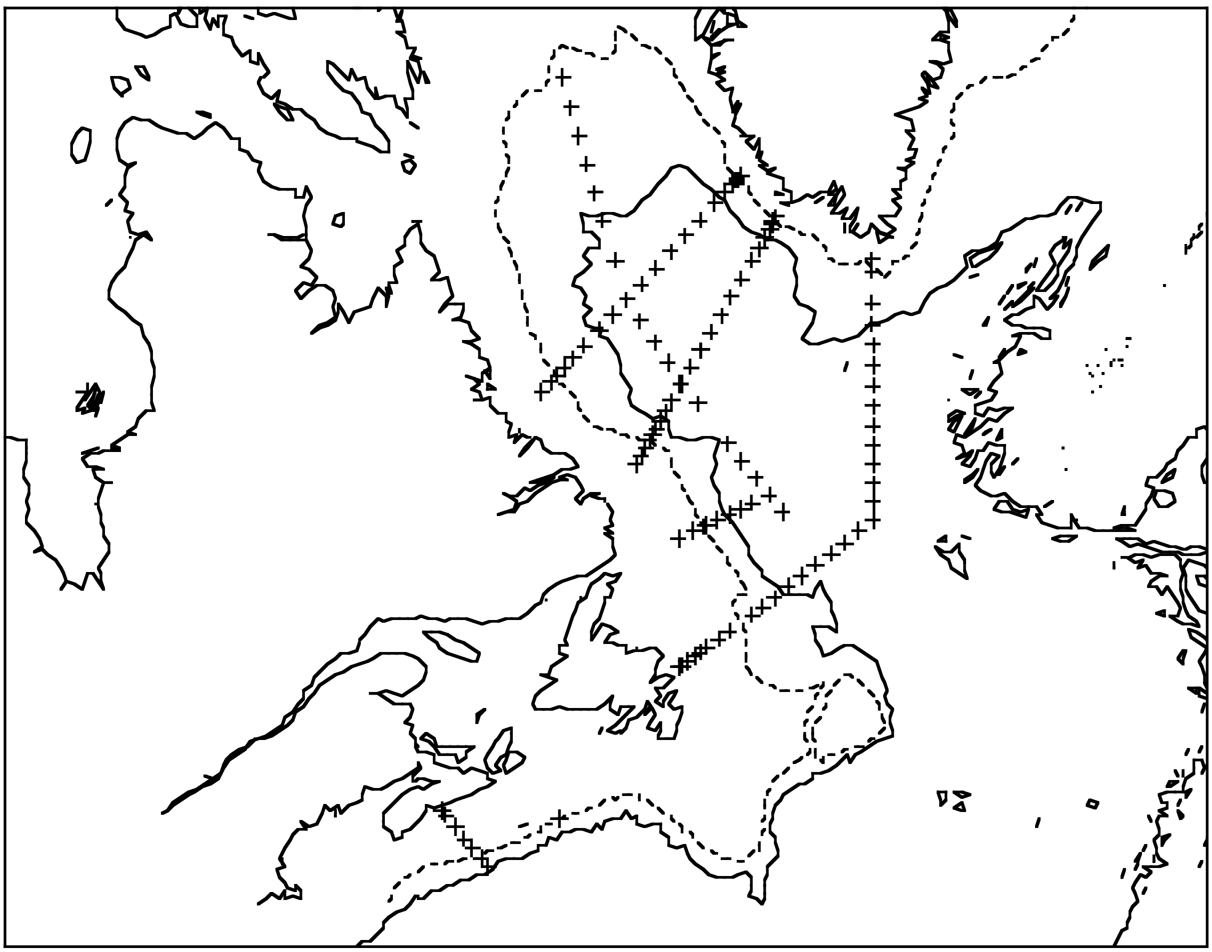


Figure 2. CTD/ROS/Tracer station positions for Hudson 18HU97009/1.

15	Shallow small volume CTD casts for DMS sampling
1	CTD cast with no water samples
7	aborted CTD casts
29	spectral radiometer profile stations to 100 metres
26	pump lowerings to 100 metres
12	stations sampled for DOC profiles
22	stations sampled for plankton respiration and size fractionation of DOC
167	vertical net hauls between 100 to 3000 metres

c. Floats and Drifters Deployed or Recovered

The profiling ALACE floats (o) and RAFOS floats (+) deployment sites are shown in Figure 3.

6	profiling ALACE floats launched at 6 stations
9	RAFOS floats launched at 9 stations
1	mixed layer Lagrangian drifter recovered

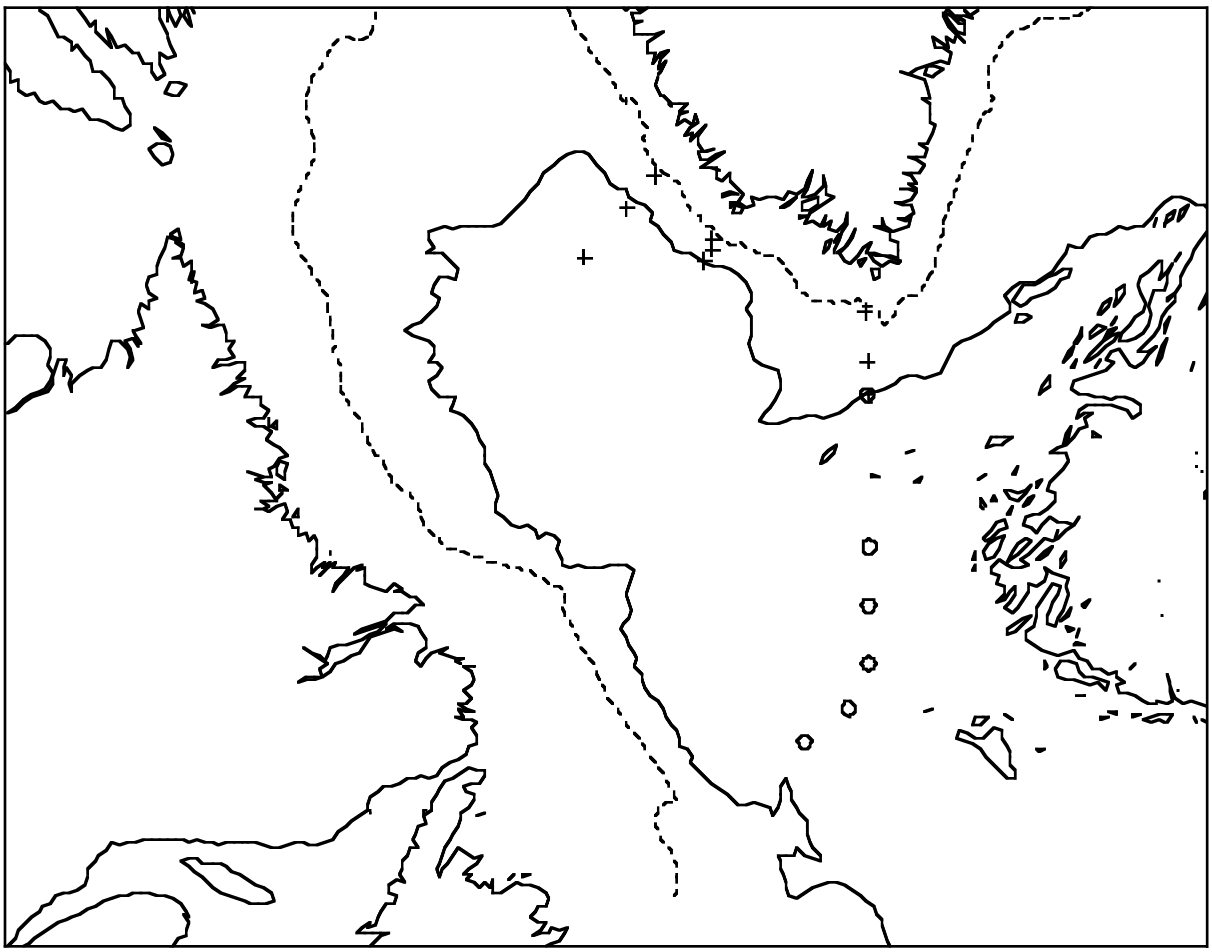


Figure 3. RAFOS (+) and ALACE (o) float deployment positions during Hudson 18HU97009/1.

d. Moorings Deployed or Recovered

The deployment and recovery sites of the various moorings are shown in Figure 4. The following summarizes the mooring operations and provides a legend for Figure 4.

Recovered

1 (BIO number M1226) multi-instrument mooring was recovered near OWS Bravo on AR7W. The mooring consisted of 6 Seacat temperature/conductivity recorders, 6 Aanderaa current meters, 1 acoustic doppler current profiler (ADCP), 1 WOTAN (weather observations through ambient noise) and 1 CTD with a device for measuring the total partial pressure of dissolved gas in the water; denoted in Figure 4 as 1226.

1 (BIO number M1227) mooring consisting of 1 current meter positioned 15 m off the bottom on the 1000 m isobath on the Labrador side of AR7W; denoted in Figure 4 as 1227.

1 surface mooring of a SIO/OSU meteorological buoy located near OWS Bravo site (deployed during 18HU96026) ; denoted in Figure 4 as Met.

1 profiling CTD mooring on AR7W section for WHOI (deployed during 18HU96026) ; denoted in Figure 4 as CTD.

1 profiling CTD system set by IMF-Kiel from the ship Validivia in July 1996; denoted in Figure 4 as K5.

2 IMF-Kiel tomographic moorings around the periphery of the Labrador Sea; denoted in Figure 4 as K1 and L0.

3 Transponder array around K1; denoted in Figure 4 as K1-T1, K1-T2 and K1-T3.

1 top of the WHOI moored vertical profiler (MVP) mooring was recovered. This was the surface instrumentation of the WHOI mooring recovered previously in the cruise. The top was recovered at the location denoted in Figure 4 as TOP.

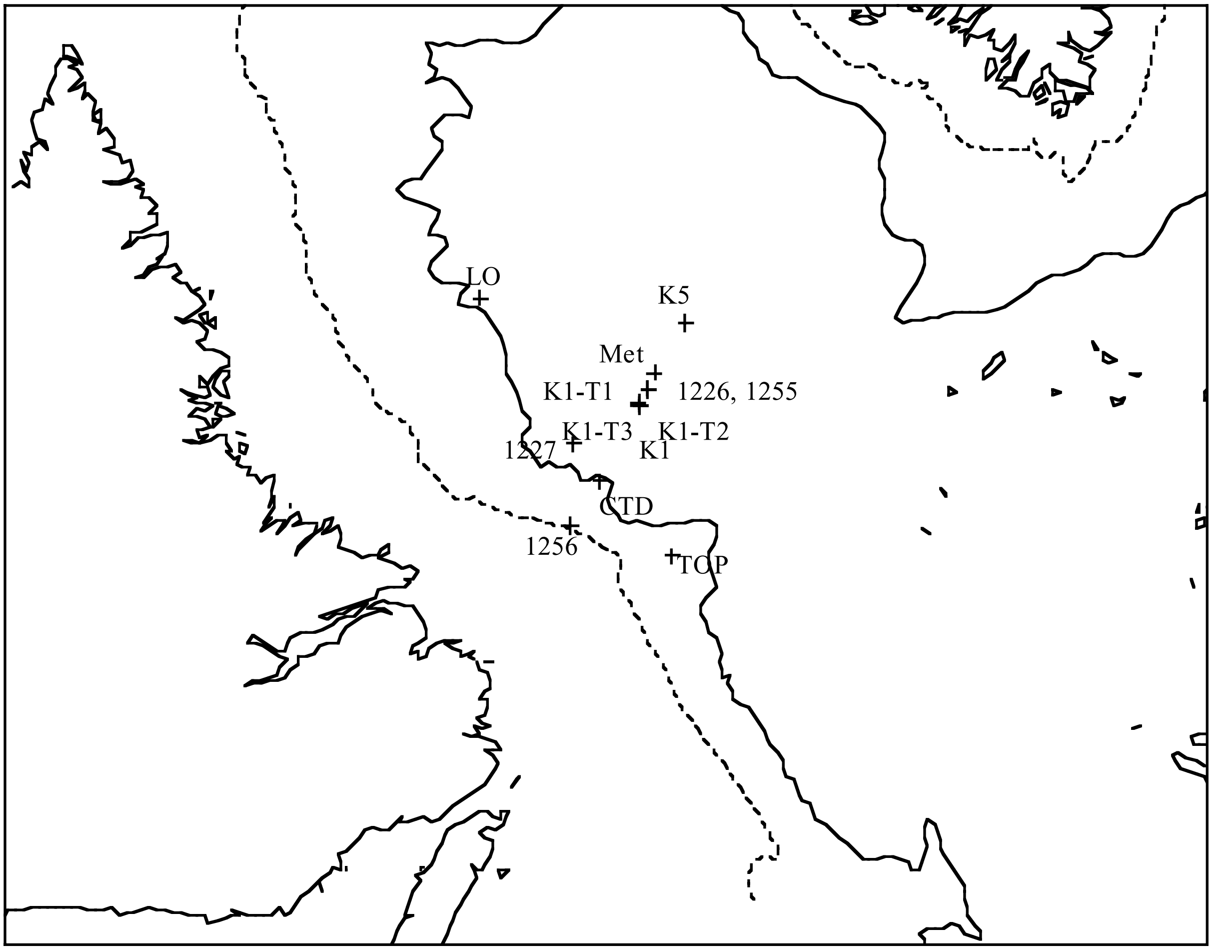


Figure 4. Mooring positions during Hudson 18HU97009/1. See text for label description.

Deployed

1 (BIO number M1255) multi-instrument mooring was deployed near OWS Bravo on AR7W replacing the mooring M1226 set in 1996 (WOCE Expocode 18HU96026). The deployed mooring consisted of 6 Seacat temperature/conductivity recorders, 6 Aanderaa current meters, 1 acoustic doppler current profiler (ADCP), 1 WOTAN (weather observations through ambient noise) and 1 CTD with a device for measuring the total partial pressure of dissolved gas in the water; denoted in Figure 4 as 1255.

1 (BIO number M1256) mooring consisted of 1 current meter positioned 15 m off the bottom on the 1000 m isobath on the Labrador side of AR7W; denoted in Figure 4 as 1256.

3. List of Principal Investigators

Name	Affiliation	Responsibility
Allyn Clarke	BIO ClarkeA@mar.dfo-mpo.gc.ca	Senior scientist Overall co-ordination
Glenn Cota	Old Dominion University cota@ccpo.odu.edu	Bio-Optical properties of the upper ocean
Russ Davis	SIO davis@nemo.ucsd.edu	Profiling ALACE floats
John Smith	BIO smithj@mar.dfo-mpo.gc.ca	^{129}I, ^{137}Cs
Bob Gershey	BDR Research rgershey@fox.nstn.ns.ca	Alkalinity, carbonate, CFCs
Glen Harrison	BIO HarrisonG@mar.dfo-mpo.gc.ca	Co-ordinator biological program nitrate and ammonium utilization by phytoplankton
Erica Head	BIO HeadE@mar.dfo-mpo.gc.ca	Macrozooplankton distribution, abundance and metabolism
Robert Houghton	LDEO Houghton@ldeo.columbia.edu	Oxygen isotopes
Paul Kepkay	BIO KepkayP@mar.dfo-mpo.gc.ca	Dissolved organic carbon, colloid chemistry and plankton respiration
Maurice Levasseur	IML levasseur@dfo-mpo.gc.ca	Dimethyl sulphide
Peter Jones	BIO JonesP@mar.dfo-mpo.gc.ca	Alkalinity, carbonate, CFCs
John R. N. Lazier	BIO LazierJ@mar.dfo-mpo.gc.ca	Oxygen, CTD data, moored instrument data
Bill Li	BIO LiB@maritimes.dfo.ca	Pico-plankton distribution and abundance
Mark Prater	URI mark@seip.gso.uri.edu	RAFOS floats and Sound Sources
Peter Rhines	UW rhines@killer.ocean.washington.edu	Moored instrumentation data
Peter Schlosser	LDEO peters@ldeo.columbia.edu	Helium, Tritium
Uwe Send	IFM Kiel usend@ifm.uni-kie.de	Tomography mooring
Peter Strain	BIO StrainP@mar.dfo-mpo.gc.ca	Nutrients
John Toole	WHOI toole@whoi.edu	CTD profiling mooring

See Section 7 for addresses.

4. Scientific Program and Methods

4.1 Physical - Chemical Program

a. Narrative

This cruise resulted in a complete physical and biological occupation of the Halifax section with all systems fully functioning.

In the Labrador Sea, 3.5 of the planned hydrographic / tracer sampling sections (see Figure 5 for the planned sections) were completed, plus the longitudinal section that was occupied in November 1996 by Hudson (Expocode 18HU96026) and March 1997 by Knorr (Expocode 316N147/5). On this voyage the longitudinal section was extended northward to the 2000 metre isobath in Davis Strait.

The quality of the CTD data is very good. The entire expedition was completed using the same two sensor sets, a new Seabird carousel unit, a new package frame and a new set of SIO bottles. This cruise will provide a good mapping of the waters sampled during the Knorr winter cruise and hence achieve our objective of locating the waters transformed during the 1996/97 winter cooling season. Our deployments of six ALACE floats and nine RAFOS floats along the inflow regions for the Labrador Sea should ensure a continued coverage of the Labrador Sea through the coming summer and fall seasons.

The completed tracer program included sampling for He, tritium, ^{18}O, ^{129}I (denoted in the WOCE SUM file as parameter number 129), and ^{137}Cs along AR7W and along the Greenland and Labrador shelves and slopes. Samples for the other tracers were collected and analyzed for nearly all the stations.

All planned mooring operations were successfully completed. Six full depth moorings, three bottom-moored transponders, and a surface meteorological buoy were recovered and two current meter moorings were deployed. Unfortunately two of the current meters recovered had leaked so that our data recovery rate might be less than 100%.
This cruise also allowed an extensive inter-comparison between a modified BIO oxygen titration system and a Scripps oxygen titration system. The precision of the two systems are identical, however, there is a small but significant offset between the systems. Since both systems were standardized using the same standards, the source of this offset is unknown. It is believed to have arisen from the various corrections that are applied by the Scripps system. A detailed comparison of the datasets originating from the two systems is carried out and reported in the oxygen section of this document.

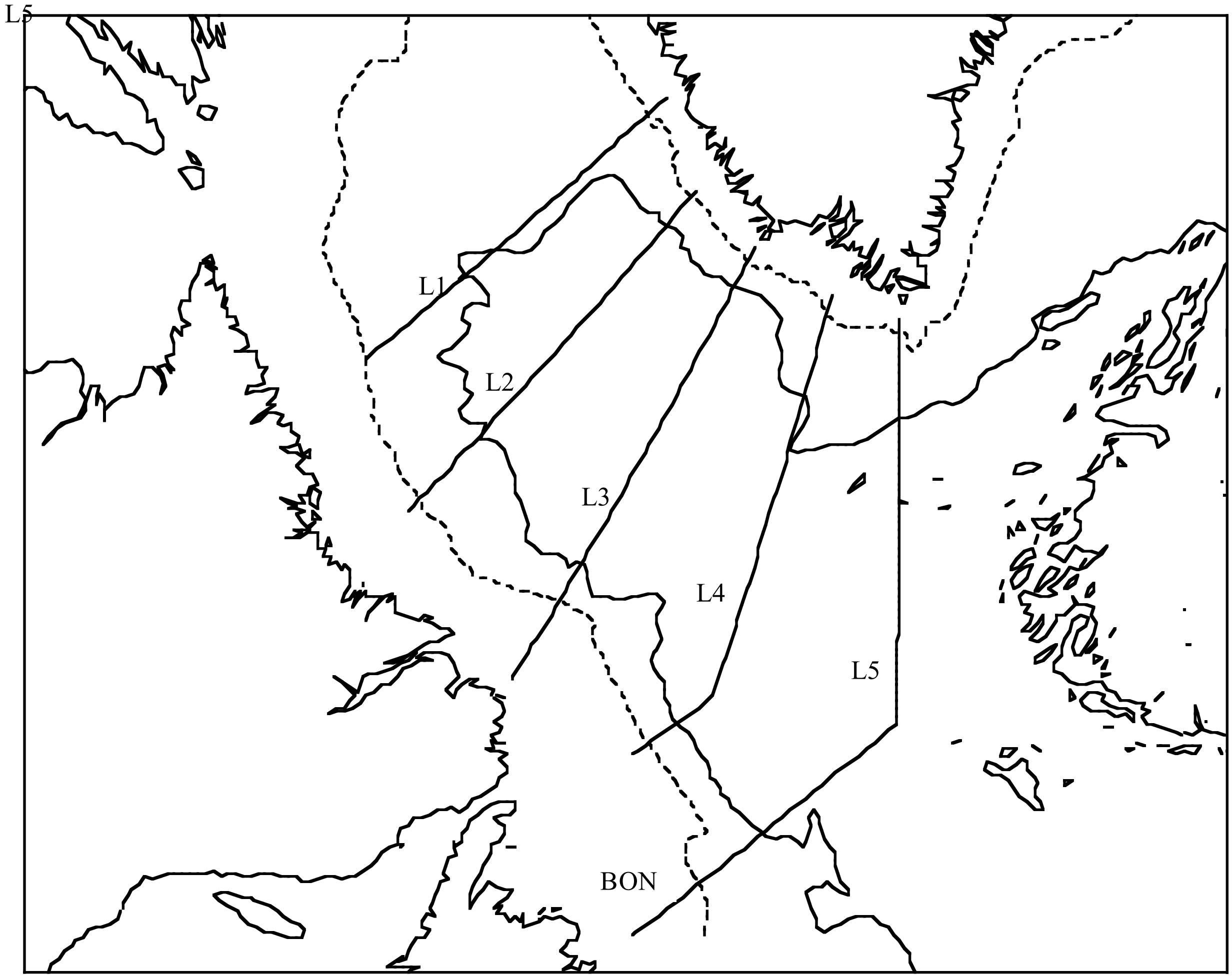


Figure 5. Initially planned lines L1 to L5. Refer to Figure 1 for actual cruise track.

4.2 Biological Program

a. Narrative

The objectives of the biological program of Hudson 97009 were two fold:

- to provide a historical perspective on the large-scale distribution of the major plankton groups in the Labrador Sea for comparison with studies done in the mid-60 s and mid 80 s and
- to provide new information on other important biogeochemical properties of the region as background for the proposed Phase III of Canadian JGOFS. Objective (1) will contribute to the debate about the link between northern fish stock declines and long-term changes in food chain structure; objective (2) will contribute to DFO s role in Canadian Climate Change research.

4.2.1 DMS
(Maurice Levasseur)

Our objectives were fourfold:

- map the distribution of DMSP, DMS and DMSO in the upper 200 m of the Labrador Sea,
- determine the distribution of DMSP in different particle size classes,
- determine the bacterial net production rate of DMS and,
- quantify the contribution of microzooplankton grazing to DMS production.

The cruise has been successful and all objectives have been achieved. Samples have been collected at 48 stations providing a good coverage of the study area. More than 25 incubation experiments on bacterial and microzooplankton production of DMS have been performed. A total of 3,500 DMSP and DMS samples have been analyzed on board. Additional samples have been collected for nutrients, chlorophyll *a*, phytoplankton enumeration, and particulate carbon and nitrogen. These data will soon feed a coupled ocean-atmosphere model of DMS production currently developed at IML aiming to explore the potential role of ocean DMS production on climate.

The highlight of the cruise has been the encounter of a *Phaeocystis* bloom in the Labrador Sea. *Phaeocystis* is known as a strong DMS producer in many parts of the world. This represented a unique opportunity to look at the dynamics of DMS production and the contribution of bacteria in such bloom. Overall, this cruise will provide the first extensive data set on DMS dynamics in cold waters including bacterial and zooplankton activity.

4.2.2 Primary Production Program
(Jeff Anning)

Profiles of the water column were collected at the stations listed in Table 1. Samples were drawn at 10 m intervals for chlorophyll, and nutrients at all these stations. At the stations where the biological pumping system was used (see Figure 6), water was also collected at two depths in the photic zone for Photosynthesis vs. Irradiance (P.I.) incubations.

Date	Station	Cast	Type
05/09/97	HFX 1	2	CTD
05/09/97	HFX 2	3	CTD
05/10/97	HFX 3	4	CTD
05/10/97	HFX 4	5	CTD
05/10/97	HFX 5	6	CTD
05/10/97	HFX 6	7	CTD
05/10/97	HFX 7	8	CTD
05/11/97	LL 14	9	CTD
05/12/97	Cape Race	10	PUMP
05/13/97	BON 1	11	CTD
05/13/97	BON3	13	CTD
05/13/97	BON 6	16	PUMP
05/13/97	BON 9	19	CTD
05/14/07	BON 10	20	CTD
05/14/07	BON 11	21	CTD
05/14/07	BON 12	22	PUMP
05/14/07	BON 13	23	CTD
05/15/97	BON 16	26	PUMP
05/17/97	L5 16	33	PUMP
05/18/97	L5 20	37	PUMP
05/19/97	L5 23	40	PUMP
05/20/97	L5 27	42	PUMP
05/21/97	L3 27	44	CTD
05/21/97	L3 26	45	PUMP
05/22/97	L3 22	49	PUMP
05/22/97	L3 21	50	PUMP
05/23/97	L3 18	53	PUMP
05/28/97	L3 05	76	CTD
05/29/97	L2 B7	78	CTD
05/24/97	L3 16	57	PUMP
05/26/97	L3 12	67	PUMP
05/27/97	L3 08	73	PUMP
05/27/97	L3 07	74	CTD
05/29/97	L2 01	79	CTD
05/29/97	L2 02	80	PUMP
05/30/97	PHAEO	88	PUMP
05/31/97	L2 11	92	PUMP
05/31/97	L2 12	93	PUMP
06/01/97	L2 15	96	PUMP
06/01/97	L2 17	98	CTD
06/01/97	L2 18	99	CTD
06/02/97	L2 19	100	CTD
06/03/97	L6 16	103	PUMP
06/04/97	L6 11.5	108	PUMP
05/05/97	L6 07	111	PUMP
06/05/97	K1 T1	112	CTD
06/06/97	L6 04	114	PUMP
06/07/97	L6 01	119	PUMP
06/08/97	L4 08	123	PUMP
06/08/97	L4 05	126	CTD
06/09/97	L4 04	127	CTD
06/09/97	L4 03	128	CTD
06/09/97	L4 02	129	CTD
06/09/97	L4 01	130	CTD

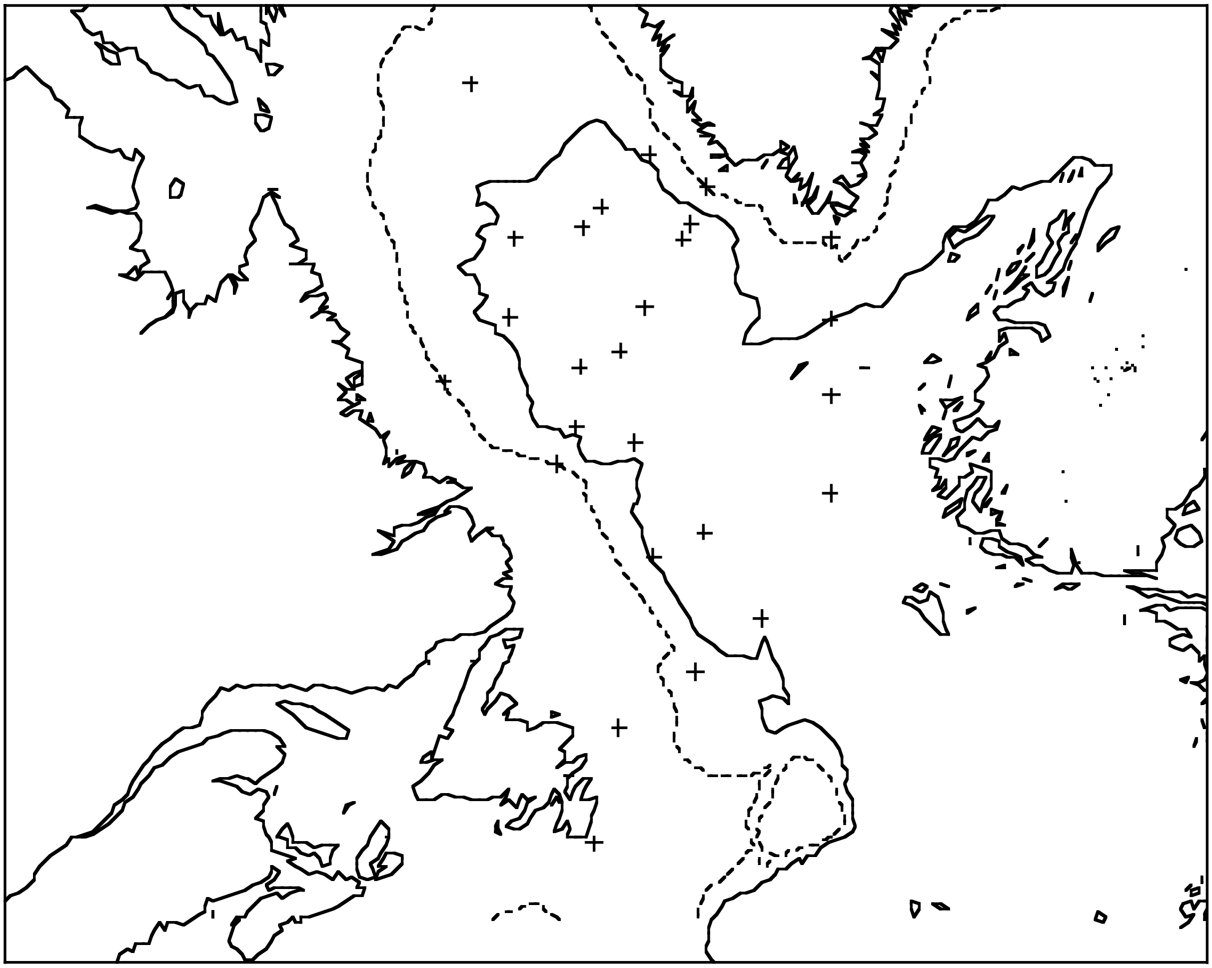


Figure 6. Biological pump locations for 18HU97009/1.

4.2.3 Sea Surface Monitoring System
(Jeff Anning)
See Part B, section 3

4.2.4 DOC Sampling
(Jay Bugden)

Samples for DOC profiles, size fractionation of DOC (ultrafiltration), and community respiration were collected. Twenty-two (22) stations (see Table 2) were sampled for ultrafiltration and respiration (lines BON, L2, L3, L5 and L6), and 12 stations were sampled for DOC profiles (line L3 or AR7W / WOCE). Ultrafiltration and rates of respiration for seawater samples were carried out at the time of sample collection - the ultrafiltration samples were frozen for laboratory analysis. The DOC profile samples were filtered and then frozen for laboratory analysis.

Additional samples were collected for flow cytometry (38 stations) and phytoplankton identification (14 stations) (W. Li and P. Dickie, BOS, OSD) at various stations (see Table 1). The flow cytometry samples were frozen in liquid nitrogen and the phytoplankton samples were preserved with fixative and cold stored, for laboratory analysis.
As well, samples for microzooplankton identification (17 stations) were collected at various stations from the biological pump (see Table 2). This was performed for a group from Newfoundland. The samples were preserved and stored cold for transportation to this group.

Table 2. DOC and related sampling during 18HU97009/1.

Station #	Date	Respi-ration	Ultra filtration	Flow Cytometry	DOC	Phyto plankton	Microzoo plankton
Hfx-1	9-5-97			X			
Hfx-2	9-5-97			X			
Hfx-3	10-5-97			X			
Hfx-4	10-5-97			X			
Hfx-5	10-5-97			X			
Hfx-6	10-5-97			X			
Hfx-7	10-5-97			X			
(Ship 10)	11-5-97			X			
Bon-6	13-5-97	X	X	X			X
Bon-12	14-5-97	X	X	X			X
Bon-16	15-5-97	X	X	X			X
L5-16	17-5-97	X	X	X			X
L5-20	18-5-97	X	X	X			X
L5-23	19-5-97	X	X	X			X
L5-27	20-5-97			X			
L3-27	21-5-97			X	X		
L3-26	21-5-97	X	X	X	X	X	X
L3-25	21-5-97			X		X	

Station #	Date	Respi-ration	Ultra filtration	Flow Cytometry	DOC	Phyto plankton	Microzoo plankton
L3-24	21-5-97			X	X		
L3-22	22-5-97	X	X	X		X	X
L3-21	22-5-97	X	X	X	X	X	X
L3-20	22-5-97			X	X		
L3-18	23-5-97	X	X	X	X	X	X
L3-16	24-5-97	X	X	X	X	X	X
L3-14	25-5-97			X	X	X	
L3-13	26-5-97			X		X	
L3-12	26-5-97	X	X	X	X	X	X
L3-11	26-5-97			X		X	
L3-9	27-5-97			X	X		
L3-8	27-5-97	X	X	X		X	X
L3-7	27-5-97			X	X		
L3-6	27-5-97			X	X	X	
L3-5	27-5-97			X		X	
L2-2	29-5-97	X	X	X			X
L2-7	30-5-97			X			
L2-PH	30-5-97	X	X	X		X	X
L2-11	31-5-97	X	X	X			X
L2-15	1-6-97	X	X	X			X
L6-16	3-6-97	X	X				
L6-11.5	4-6-97	X	X				
L6-7	5-6-97	X	X				
L6-4	6-6-97	X	X				
L6-1	7-6-97	X	X				

4.2.5 Radiometer and Spectrophotometer
(Kurt Clemente)

Satlantic Profiling Multichannel Radiometer

Profiles of spectral light characteristics were taken at 28 stations (see Figure 7) from the surface to below 0.01% surface PAR (Photosynthetically Active Radiation) (in most cases >70 m). On 06 June the instrument developed problems not rectifiable on board and the last 4 stations were not sampled. Spectral profiles will be processed to calculate values of water-leaving radiance at 13 wavelengths. Two and three channel band ratios will be correlated with values of biomass and production in the Labrador Sea.

Shimadzu Scanning Spectrophotometer

Particulate (a_p), non-pigmented (a_n) and dissolved (a_d/a_s) absorption spectrum samples were taken at 33 stations from the biological pump, CTD and bucket samples. In most cases, depths sampled were 0, 10, 20 and 30 m. In certain instances where the fluorescence trace indicated a sinking bloom, as many as 8 depths were sampled. At two stations depth samples were duplicated to test precision of a_p measurements. One station was chosen to test differences between surface sampling using the biological pump and bucket.

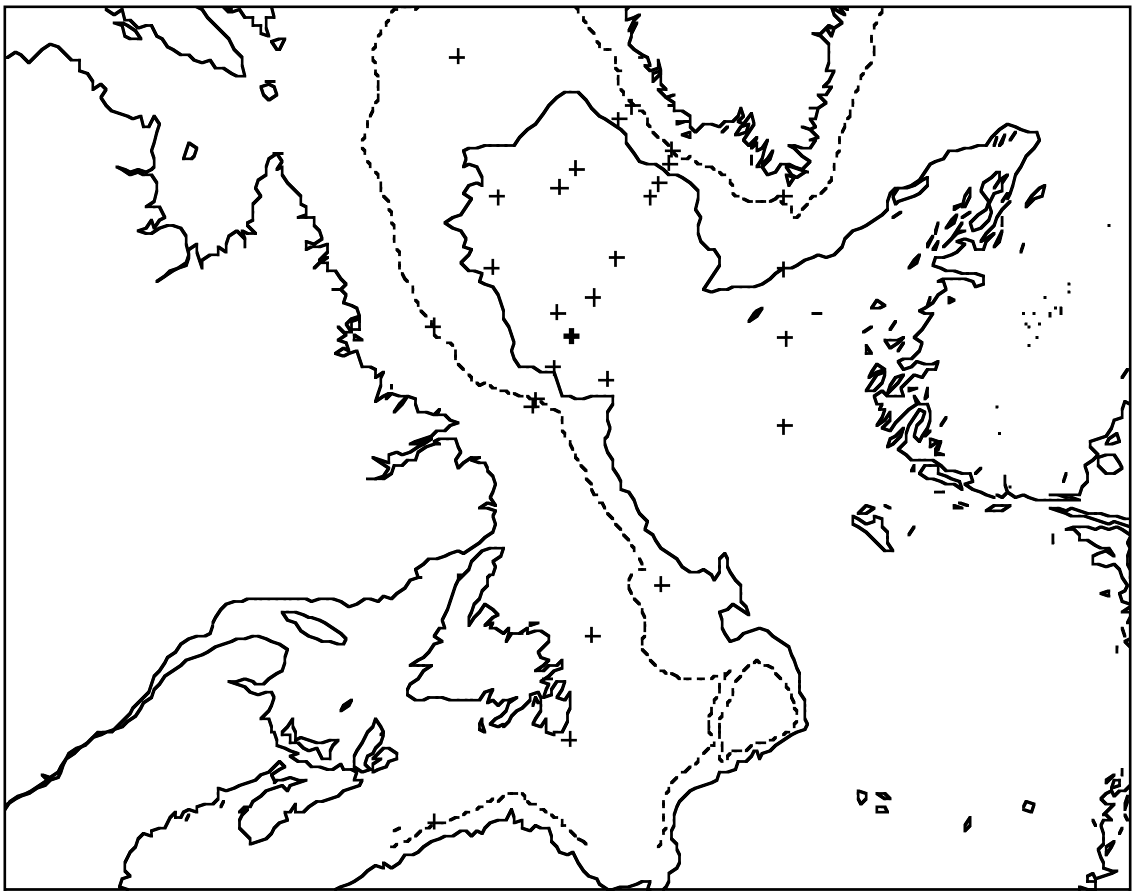


Figure 7. Light meter stations during 18HU97009/1.

Satlantic Sea WIFS Aircraft Simulator

A 7 channel E_d sensor was deployed above the bridge before leaving port, and a corresponding 7 channel L_u sensor was placed on the starboard rail approximately 20 m behind the bow of the ship, fixed with two C clamps. The Ed sensor was aimed straight up and was reasonably free from shading. The L_u sensor was pointed at the water approximately 40° away from the ship. Soon after clearing Bedford Basin, it became obvious that the clamps did not secure the L_u sensor in even moderate weather. A hole was drilled in the base of the L_u mount and in the rail only 10m from the bow of the ship. This made the sensor more secure to weather and was more satisfactorily placed to see the water beyond the ships wake. The weather soon built, however, and a decision was reached with the Captain s consent to drill another hole in the rail above the bridge (near the E_d sensor) which would secure the L_u sensor in all but the most severe weather.

Band ratio data from these two instruments will be used to calculate water-leaving radiance values, which will then be used to generate chlorophyll-predicting algorithms in a manner similar to the Profiling Radiometer.

4.2.6 Vertical Net Tows
(Les Harris)

A total of 167 vertical net tows were taken at 86 stations (see Figure 8) using a _ metre 200 µm mesh ring net. At all of these stations tows from 100 - 0 metres were carried out, at 9 stations, additional deep tows were taken from depths between 400 and 2500 metres to the surface. Samples will be analyzed for species composition, copepod stage distribution and biomass.

Water Column Sampling
At 18 stations water was collected at the chlorophyll maximum and size fractionated at 3 µm. The fractions were then filtered to collect samples for HPLC pigments and particulate carbon and nitrogen. These samples were collected in order to assess the phytoplankton composition and the proportion of the total particulate matter that would be available for copepod grazing.

Measurements of Copepod Metabolic Rates
Respiration rates (CO_2 production) of the copepod communities were determined at 8 stations.

4.2.7 Egg Production Rates and Hatching Success of *Calanus finmarchicus*
(Rob Campbell)

Egg Production Rates
Female *C. finmarchicus* were collected with vertical net tows (200 µm mesh) from 0 — 75 m (daylight hours) or 0 - 50 m (at night). Subsamples of 30 females were incubated individually in 50 ml Petri dishes at approximate ambient temperatures for 24h, and the number of eggs produced in that time counted. The size of clutches produced by each female and the frequency of spawning events (inferred from the number of females who spawned over the incubation period) will be used to calculate egg production rates.

Hatching Success
In order to test the hypothesis that certain diatom species reduce the hatching success of copepod eggs; eggs collected from the egg production experiments above were incubated for 72 hours in one of three treatments. The experiments were: (1) filtered salt water, (2) water taken from the depth of the chlorophyll maximum, and (3) a concentrated culture of *Thalassiosira* sp. (a diatom species which may contain a compound which inhibits the development of copepod eggs). Hatching success (% hatching) will be determined by comparing the initial number of eggs in each treatment to the number of unhatched eggs after the 72 hour incubation period.

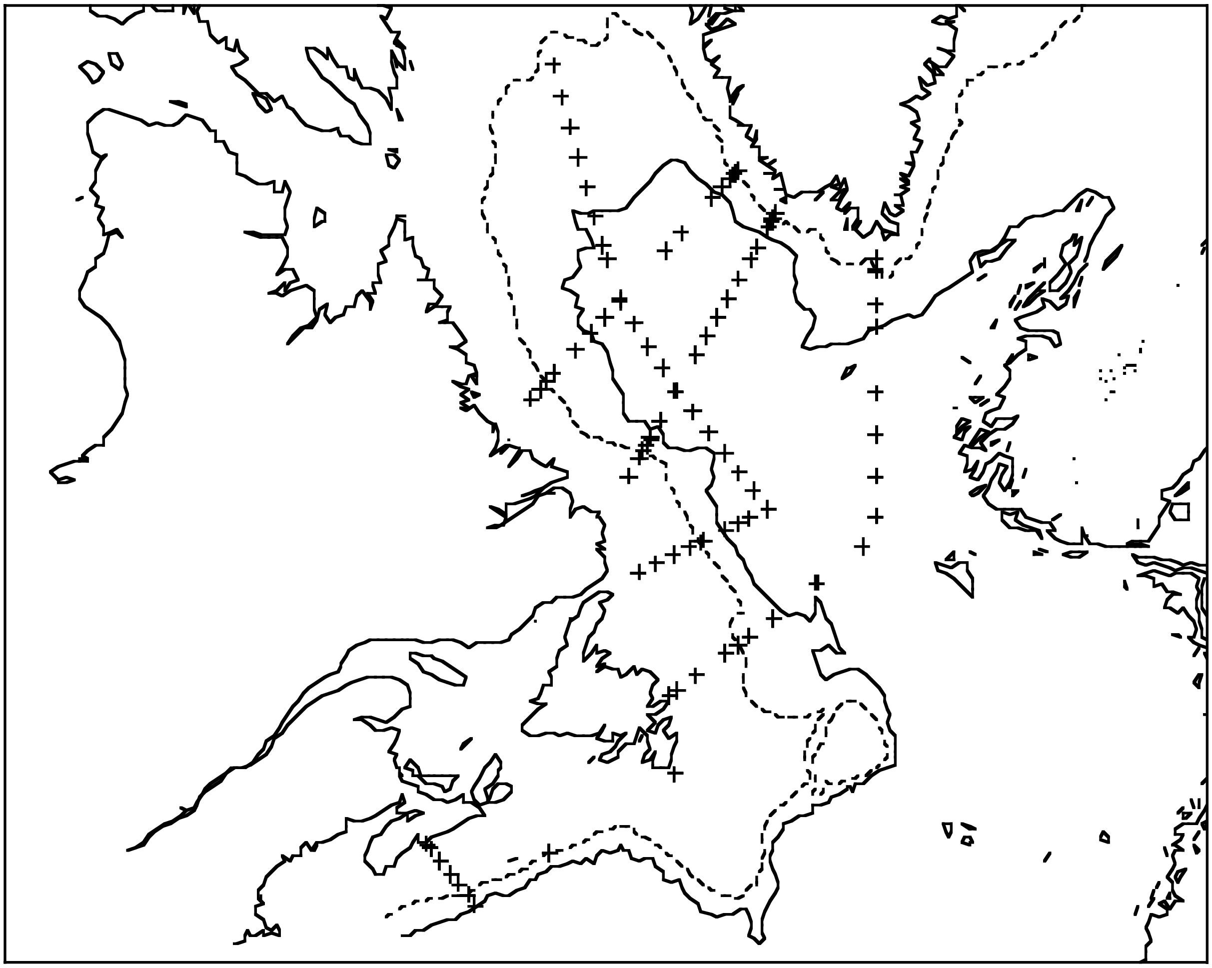


Figure 8. Net tow locations during 18HU97009/1.

5. Major Problems and Goals Not Achieved

The inshore station denoted Site 28 on the Greenland side and inshore stations denoted Sites 4 to 1 on the Labrador side of AR7W were missed because of ice conditions.

A station was missed off Cape Farewell because of strong and persistent winds.

6. Other Incidents of Note

This was a remarkably problem free voyage from the point of view of the scientific party once we got to sea.

Intensive use of the GeoChem laboratory was made during this trip. Before departing BIO, the fume hood in the lab failed its inspection and it was only after considerable bureaucratic effort that a temporary modification was made and a certificate was issued. The odour problem in the lab is less than it has been but still exists. Taping over all of the scuppers solved the problem. This was acceptable because the lab was being used as a dry chemical analysis laboratory.

The laser printer connected to the MicroVAX failed during this trip. There was no spare to replace this unit. But two other printers brought on board by the science programs we were able to replace its functions. This unit will be repaired on return to BIO and perhaps a spare unit should be placed on board as well. There was also considerable difficulty with the EXABYTE units on the MicroVAX. The MicroVAX computers are completely obsolete and are only being used as file storage devices. Unfortunately, we are losing our ability to manage this relatively complicated operating system when something goes wrong. It is past due that a modern computer with an operating system that is in common use in the region (i.e. UNIX or NT) should replace these systems.

The transducers on the ram were lost (and perhaps the ram itself) in the last week of operations. Fortunately the intensive use of this facility was complete by this time and the weather conditions were such that we were able to complete our deep CTD casts using the hull transducers.

The navigation logging PC experienced unknown problems on June 9 (day 160) that resulted in a navigation data gap of about 23 hours, between June 9 and 10, 1997. However, it may be possible to retrieve this data from the ADCP data stream, which merges the velocity data with the navigation data in real-time. This problem resulted in no position for June 10 at 0000Z in Figure 1.

Date and times incorporated into the header of the CTD files are obtained from two sources: the PC clock running the acquisition software and the GPS strings. The date/time strings from the PC clock were noted to have an inconsistent offset from GMT. Some casts had the correct time in GMT, while others were off by -3 hours or +3 hours. To correct this problem, all CTD cast times were corrected to the independent time noted in the Station Summary file (WOCE SUM file). The UTC string contained within the header of the original Seabird DAT file can be used as a check on the start_date_time parameter within the ODF file.

7. List of Cruise Participants

Name	**Responsibility**	**Affiliation**
Jeff Anning	Biological Underway Sampling	BIO
Larry Bellefontaine	Watchkeeper	BIO
Rene Bouillon	DMS	IML
Rick Boyce	Salts, Moorings	BIO
Jay Bugden	DOC Levels	BIO
Rob Campbell	Net Tows	Dal
Guy Cantin	DMS	IML
Allyn Clarke	Chief Scientist	BIO
Kurt Clemente	Ocean optics	ODU
Pierre Clement	Nutrients/Oxygen	BIO
Bob Gershey	CFC / Alkalinity / Carbonate	BDR Research

Les Harris	Net Tows	BIO
Michael Hingston	CFC / Alkalinity / Carbonate	BDR Research
Detlef Kindler	Moorings / Watchkeeper	IFM
Anthony Isenor	Data Quality / Watchkeeper	BIO
Maurice Levasseur	Assistant Scientist, DMS	IML
Sonya Michaud	DMS	IML
Manon Poliquin	Oxygen	Polytech Sci. Ser.
Bob Ryan	Technician, CTD	BIO
Sabina Schultes	DMS	IML
Rochelle Ugstad	Helium / Tritium	LDEO
Gordan Wolfe	DMS	IML
Igor Yashayaev	Scientist	BIO

BIO	Bedford Institute of Oceanography PO Box 1006 Dartmouth, NS, B2Y 2A4
BDR	BDR Research Ltd. Box 652, Station M Halifax, N.S.,
IFM-Kiel	Institut f r Meereskunde an der Universit t Kiel D sternbrooker Weg 20 D-24105 Kiel, Germany
IML	Institute Maurice-Lamontagne C.P. 1000 850 Route de la Mer Monti Joli, P.Q. G5H 3Z4
IOS-Pat Bay	Institute of Ocean Sciences P.O. Box 6000 Sidney, B.C., V8L 4B2
LDEO	Lamont -Doherty Geological Observatory Columbia University Palisades, New York 10964
SIO	Scripps Institute of Oceanography University of California at San Diego La Jolla, CA 92093

ODU	CCPO Old Dominion University Norfolk, VA 23529 USA
URI	University of Rhode Island Narragansett Marine Lab South Ferry Road, Narragansett Rhode Island 02882
UW	University of Washington Seattle, WA 98195
WHOI	Woods Hole Oceanographic Institution Woods Hole, MA 02543

B. UNDERWAY MEASUREMENTS

1. Navigation and Bathymetry
(Anthony W. Isenor)

The navigation system onboard CCGS Hudson consisted of a Trimble Navigation Loran-GPS 10X decoder and AGCNAV software. AGCNAV is a PC based display, and waypoint setting software package developed at the Atlantic Geoscience Centre at BIO. This software graphically displayed the ship position, waypoints, course, speed, etc. to the various science working areas. The 10X decoder received the satellite fixes and decoded the signals to obtain NMEA strings (containing latitude, longitude, time, etc.) that were sent to a bridge PC running the AGCNAV software in master mode. The bridge PC then broadcasted the NMEA strings over the ships network, to be accessed by other PCs running AGCNAV in slave mode. These NMEA strings were broadcast at about 1 Hz. The navigation data were logged at one minute intervals on a dedicated logging PC.

The echo sounder system used for collecting bathymetric data consisted of a Raytheon Line Scan Recorder, Model LSR˚1811-2 (serial number A117) connected to a hull mounted 12kHz transducer. The transducer beam width was 15 degrees. The sweep rate of the recorder was adjusted throughout the course of data collection to aid in identifying the bottom signal. The recorder was also linked to a clock, and thus could indicate 5 minute intervals on the sounder paper. The system was used to collect bathymetric soundings at 5 minute intervals while underway between stations. Approximately 5500 kilometres of deep sea bathymetric sounding data was collected.

2. Acoustic Doppler Current Profiler
(Bob Ryan)

The Hudson was equipped with a hull mounted RDI Acoustic Doppler Current Profiler (ADCP). The transducer (serial number 177) had SC ADCP electronics (serial number 607) converted for ship board use. Logging, using Transect software on a HP Vectra 486 PC running Windows 95, was started on May 9, 1997 at 1545Z in Bedford Basin. The configuration of the equipment resulted in a bin length of 4 metres and a total of 128 bins. The raw data were stored to disk and backed up every few days to writable CD. The data were also averaged in real-time over 5 minute intervals, except along the Scotian Shelf Halifax Line where the averaging was every 2 minutes. ADCP logging was stopped on June 10, 1997 at 1510Z. In total, 750 hours of along track ADCP data was collected

3. Sea Surface Monitoring System
Jeff Anning

Water from approximately 4 m was pumped continuously up to the forward lab. The temperature, conductivity and fluorescence of this flow was continuously measured and logged every 30 seconds. The temperature and conductivity were measured with Seabird sensors and the fluorescence by a Wetlabs flowthrough fluorometer. Incident downward irradiance (Photosynthetically Active Radiation, or PAR) was measured with a Biospherical PAR sensor and the data merged with the sea water parameters. Exact positions were logged at the same time from a Northstar GPS. In total, 800 hours of along track surface temperature, salinity, chlorophyll and nutrient data was collected.

Discrete water samples were collected every 15 minutes by an auto sampler for later analysis for phosphate, nitrate and silicate.

A NAS 2E nitrate analyser was incorporated into the flowthrough system. Nitrate concentration was measured every 15 minutes. However the sensors performance was erratic and unreliable.

In the Hudson s GP lab, a second set of conductivity, temperature and fluorescence sensors were employed in the ship s transducer well. This conductivity cell failed early in the cruise yielding very little useful data.

4. XBT and XCTD
No probes were used

5. Meteorological observations
The ship s crew carried out routine reporting of meteorological variables.

6. Atmospheric Chemistry
There was no atmospheric chemistry programme.

C. HYDROGRAPHIC MEASUREMENTS DESCRIPTIONS, TECHNIQUES AND CALIBRATIONS

1. CTD Measurements

(Igor Yashayaev and Anthony Isenor)

a. Description of the Equipment and technique

The CTD measurements were made with a standard SEABIRD model 11 Plus deck unit (S/N 11P7032-0268) and a model 9 Plus CTD probe (S/N 09P15349-0475) equipped with a paroscientific digiquartz model 410K-105 pressure sensor (S/N 69009). This probe was replaced on station 107 due to a malfunction. The replacement probe (S/N 09P7356-0289) had a new pressure sensor (S/N 51403). There were also two temperature sensors (primary S/N 03P2298 and secondary S/N 03P2303), two conductivity sensors (primary S/N 041873 and secondary S/N 041874), two model 13-02 dissolved oxygen sensors (primary S/N 130265 and secondary S/N 130266) and a Chelsea fluorometer (S/N 088172) used. All sensors except the pressure sensor were mounted in one of two ducts through which separate pumps pulled seawater. Hence, the water flow past the actual sensors was independent of the lowering rate; this simplified the data processing considerably.

The Seabird CTD was mounted vertically within a custom designed and built CTD/Rosette frame. All the pressure cases as well as the sample bottles are mounted vertically to improve the package's stability as it descends through the water column. In the centre of the frame is an aluminum tube, which contains at its upper end a Seabird Carousel 24 bottle rosette unit. The frame itself is subdivided into four quadriants. In one quadriant is a RDI 150 khz Broadband ADCP in a shortened pressure case. In the next quadriant is the pressure case for the Seabird CTD and directly below the CTD probe is a Benthos altimeter. The third quadriant contains the battery pack for the LADCP, the fluorometer and a General Oceanics model 6000 12 Khz pinger unit. The last quadriant contains the dual CTD sensors and pump.

One unique aspect of this frame is the adjustable legs. The base of the frame is circular with six vertical tubes, or legs, extending upward from the base. These legs end, and can slide within, a slightly larger tube at the base of a second circular frame. Each vertical leg has two fixed positions within the larger tube, and is held in these positions by stainless steel pins. In the deployment position, the legs are retracted. When personnel are drawing water samples, the legs are extended thus raising the frame by about 40 cm. This makes drawing the water samples much easier.

The rosette bottles were made by the Physical and Chemical Oceanographic Data Facility of the Scripps Institution of Oceanography (SIO). Each bottle collects 10 litres of water.

b. Sampling Procedure and data processing techniques

The CTD was deployed with a lowering rate of 60 metres/min (40 metres/min in the upper 200 metres or deeper if the conditions were rough). It was recovered at a rate of 75 metres/min (60 metres/min when deeper than 4000 metres or when conditions were rough).

The CTD data was recorded onto disk by a 486 computer using SEABIRD SEASOFT Version 4.205 software. A screen display of temperature, oxygen and salinity profiles vs pressure was used to decide bottle trip locations on the up cast. The bottles were tripped using the enable and fire buttons on the SEABIRD deck unit.

At the end of each station, the SEASAVE software was used to create 1 and 2 dbar processed data files, an IGOSS TESAC message and a processed rosette trip file. All the raw and processed data files associated with the station were then transferred to the ship's MicroVAX computer for archive and subsequent access and distribution to various users on the vessel.

The data processing takes the following steps:

DATCNV	Converted the raw data to physical parameters.
SPLIT	Split the data into DOWN and UP cast.
WILDEDIT	This program took consecutive blocks of 12 scans and flagged all scans whose pressure, temperature and conductivity values differed from the mean by more than 2 standard deviations. Then the mean and standard deviation were recomputed using the unflagged data and all scans exceeding 4 standard deviations from this new mean were marked as bad.
FILTER	Low pass filtered pressure and conductivity channels. Time constant used for conductivity was 0.045 seconds, for pressure 0.150 seconds.
LOOPEDIT	Marked as bad, all cycles on the down trace for which the vertical velocity of the CTD unit was less than 0.1 meters/sec.
ALIGNCTD	Aligned the temperature, conductivity and oxygen values relative to the pressure values to account for the time delays in the system. The time offsets for the primary sensors were 0.010 seconds for conductivity, 0.000 seconds for temperature and 3.000 seconds for oxygen. The time offsets for the secondary sensors were 0.083 seconds for conductivity, 0.000 seconds for temperature and 3.000 seconds for oxygen (NOTE: the primary conductivity was adjusted by 0.073 seconds in the Deck unit while the secondary conductivity was not adjusted in the Deck unit.).
CELLTM	A recursive filter was used to remove the thermal mass effects from the conductivity data. Thermal anomaly amplitude and time constants of 0.0300 and 9.0000 were used.
DERIVE	Computed oxygen values.
BINAVG	Averaged the down cast into 1 and 2 dbar pressure bins.
DERIVE	Computed salinity, potential temperature and sigma-theta.
ROSSUM	Averaged 3 seconds of CTD data after every bottle trip. Used in comparison with water sample data.

c. Calibration data

The CTD calibrations used during this cruise were supplied by Seabird Electronics. The applied calibrations are as follows:

BIO Seabird CTD Probes

Pressure Sensor (69009)

$$pressure = c\,(1 - T_o^2/T^2)\,(1 - d[1 - T_o^2/T^2])\ \text{(psia)}$$

where

T is the pressure period

$c = c_1 + c_2 U + c_3 U^2$

$d = d_1 + d_2 U$

$T_o = T_1 + T_2 U + T_3 U^2 + T_4 U^3 + T_5 U^4$

U is the temperature

c_1 = -5.396574 E+04 psia

c_2 = -1.03726 E-01 psia/°C

c_3 = 1.54367 E-02 psia/°C^2

d_1 = 3.8800 E-02

d_2 = 0

T_1 = 2.985151 E+01 µsec

T_2 = -3.76105 E-04 µsec/°C

T_3 = 3.76392 E-06 µsec/°C^2

T_4 = 3.18753 E-09 µsec/°C^3

T_5 = 0

AD590M = 1.28164 E-02

AD590B = -9.1487184 E+00

slope = 1.0, offset = 0.0 (Seabird calibration dated Feb. 26, 1997)

Pressure Sensor (51403)

$$pressure = c\,(1 - T_o^2/T^2)\,(1 - d[1 - T_o^2/T^2])\ \text{(psia)}$$

where

T is the pressure period

$c = c_1 + c_2 U + c_3 U^2$

$d = d_1 + d_2 U$

$T_o = T_1 + T_2 U + T_3 U^2 + T_4 U^3 + T_5 U^4$

U is the temperature

c_1 = -3.862588 E+04 psia

c_2 = 2.78422 E-01 psia/°C

c_3 = 1.40578 E-02 psia/°C^2

d_1 = 3.8824 E-02

d_2 = 0

T_1 = 3.062824 E+01 µsec

T_2 = -1.73280 E-04 µsec/°C

T_3 = 4.72380 E-06 µsec/°C^2

T_4 = 3.33300 E-09 µsec/°C^3

T_5 = 0

AD590M = 1.14200 E-02

AD590B = -9.1170000 E+00
slope = 1.0, offset = 0.0 (Seabird calibration dated Feb. 26, 1997)

BIO SEABIRD System # 9 Sensors ---

Temperature Sensor (3P2298)

$T = 1/\{a + b[\ln(f_o/f)] + c[\ln^2[f_o/f] + d[\ln^3(f_o/f)]\} - 273.15$ (°C)

where

ln indicates a natural logarithm,
f is the frequency
(Seabird calibration Feb. 20, 1997)
a = 3.68023488 E-03
b = 6.00208161 E-04
c = 1.62157135 E-05
d = 2.22368203 E-06
f_o = 2917.298
slope = 0.99998, offset = 0.0 (Calculated in March 1997)
Tpcor = -2.060 E-07 (recommended by Seabird on Feb. 26, 1997)

Conductivity Sensor (041873)

conductivity = $(g + hf^2 + if^3 + jf^4)/[10(1 + \{CTcor\ t\} + \{CPcor\ p\})]$ (Siemens/m)

where

f is the frequency,
p is pressure in dbar,
t is the temperature in deg C
(Seabird Calibration dated Feb. 21 1997)
g = -4.13982358 E+00
h = 5.40882425 E-01
i = -8.15812766 E-04
j = 6.91367207 E-05
CPcor = -1.00 E-07
CTcor = 3.25 E-06
Slope = 1.000115 (Calculated March 1997)
Offset = -0.00005 (Calculated May 25, 2000)

BIO SEABIRD System # 10 Sensors ---

Temperature Sensor (3P2303)

$T = 1/\{a + b[\ln(f_o/f)] + c[\ln^2[f_o/f] + d[\ln^3(f_o/f)]\} - 273.15$ (°C)

where

ln indicates a natural logarithm,
f is the frequency
(Seabird calibration Feb. 20, 1997)
a = 3.68023493 E-03
b = 5.98790237 E-04
c = 1.58353945 E-05
d = 2.23034109 E-06
f_o = 2896.266

slope = 1.0, offset = -0.0005   (Calibration dated March 1997)

Conductivity Sensor (041874)

conductivity = $(g + hf^2 + if^3 + jf^4)/[10(1 + \{CTcor\ t\} + \{CPcor\ p\})]$ (Siemens/m)

where

f is the frequency,
p is pressure (decibars),
t is the temperature (°C)
(Seabird Calibration dated Feb. 21 1997)
g = -4.08770679 E+00
h = 5.15866320 E-01
i = -1.06080083 E-03
j = 7.93277368 E-05
CPcor = -1.00 E-07
CTcor = 3.25 E-06
Slope = 1.000113 (Calculated March 1997)
Offset = 0.00011 (Calculated May 25, 2000)

Oxygen Sensor (130265)

Oxygen = $[Soc \times (oc + tau \times \frac{doc}{dt}) + Boc] \times OXSAT(T,S) \times e^{\{tcor \times [T + wt \times (T_o - T)] + pcor \times P\}}$

where

Seabird Calibration dated Feb. 12, 1992.
Soc, Boc, tcor and pcor were produced from a calibration performed on Jan. 25, 2001.
Soc = 3.2020
oc is the oxygen sensor current (μamps)
oc = mV + b
m = 2.4608 E-07
V is the oxygen temperature sensor voltage signal
b = -4.9216 E-10
tau = 2.0
$\frac{doc}{dt}$ is the time derivative of oc
Boc = -0.0080
OXSAT is the oxygen saturation value dependent on T and S
T is the water temperature (°C)
S is salinity (psu)
e is natural log base
tcor = -0.036
wt = 0.670
T_o oxygen sensor internal temperature (°C)
T_o = kV + c
k = 8.9939
c = -6.8210
pcor = 1.39 E-04
P is the pressure (psia)

Oxygen Sensor (130266)

Oxygen = $[Soc \times (oc + tau \times \frac{doc}{dt}) + Boc] \times OXSAT(T,S) \times e^{\{tcor \times [T + wt \times (T_o - T)] + pcor \times P\}}$

where

Seabird Calibration dated Feb. 12, 1992.

Soc, Boc, tcor and pcor were produced from a calibration performed on Jan. 25, 2001.

Soc = 2.8330

oc is the oxygen sensor current (μamps)

oc = mV + b

m = 2.4692 E-07

V is the oxygen temperature sensor voltage signal

b = -4.1977 E-10

tau = 2.0

$\frac{doc}{dt}$ is the time derivative of oc

Boc = 0.0480

OXSAT is the oxygen saturation value dependent on T and S

T is the water temperature (°C)

S is salinity (psu)

e is natural log base

tcor = -0.041

wt = 0.670

T_o oxygen sensor internal temperature (°C)

T_o = kV + c

k = 8.9883

c = -7.0715

pcor = 1.27 E-04 (Calculated Jan. 25, 2001)

P is the pressure (psia)

Chelsea Fluorometer (088172)

concentration [g/l] = slope * (10 exp (V/sf) - 10 exp (VB)) / (10 exp (V1 g/l) - 10 exp (Vacetone)) + offset

where

Seabird Calibration dated Feb. 10, 1997.

slope = 1.0

V (fluorometer output voltage in-situ)

sf (scale factor) = 1.0

VB (electrical zero) = 0.212

V1(fluorometer output voltage at 1 g/l) = 1.974

Vacetone (fluorometer output voltage at zero chlorophyll) = 0.334

offset = 0.0

2. Salinity
(Rick Boyce)

a. Description of Equipment and Technique
Salinity samples were analyzed using a Guildline Autosal model 8400B s/n 60968 salinometer. Samples were drawn into 150 ml medicine bottles. New caps, equipped with plastic liners, were placed on the sample bottles for each use. The caps were retightened when the samples reached room temperature.

The salinometer cell was filled and rinsed three times with sample water before readings were recorded. Readings from the salinometer were recorded for every sample and standardization. The reading entered into the water sample database as the conductivity of the water sample represents the operators best determination of the conductivity of the sample.

b. Sampling Procedure and Data Processing Technique
Salinity samples were drawn into 150 ml medicine bottles after three rinses. The bottles were filled up to the shoulders and then capped with new caps with plastic liners.

One conductivity file for the entire cruise was prepared. The file consisted of a sequential record number, the bath temperature, sample ID number, average conductivity ratio and a quality flag. A PC based program running under a commercial DBMS computed the salinity using the average conductivity ratio and the standard IAPSO formula. Any changes in the salinometer readings between successive standardizations were assumed to have occurred as a linear drift of the instrument. Thus, the program applied a correction to the ratios, which varied linearly with the samples analyzed. The salinity data was then placed in the water sample database.

c. Laboratory and Sample Temperatures
Full cases of samples were taken from the winch room to the GP lab where they were left for a period of at least 10 hours to equilibrate to laboratory temperature before being analyzed.

The bath in the salinometer was kept at 21°C.

d. Replicate Analysis
One or two replicate salinity samples were drawn from one of the rosette bottles on every cast. In some cases, one or two samples from some of the bottles were analyzed within normal time frame (12-24 hours), while other replicate samples were stored in the laboratory until the last week of the cruise before being analyzed.

The following is a list of the number of sample id numbers that had replicate samples and when the samples were analyzed:

- 87 ids had two normal samples and no later samples
- 12 ids had two normal samples and 1 later sample
- 154 ids had one normal sample and one later sample
- 1 id had one normal sample and 2 later samples

Thus, there were:

87 + 12 = 99 normal — normal replicate differences

(12 * 2) + 154 + (1 * 2) = 180 normal — later replicate differences

The statistics of the normal — normal differences are as follows:

Statistic	Value
Number of Points	99
Minimum	0.000
Maximum	0.1893
Mean	0.0032
Median	0.0004
Standard Deviation	0.0199

The later replicate values will be compared with the samples analyzed previously to determine the magnitude of instrument or standard drift during the cruise. Statistics of the (normal — later) replicate differences follow.

Statistic	Value
Number of Points	180
Minimum	-0.0147
Maximum	0.0831
Mean	0.0008
Median	0.0006
Standard Deviation	0.0067

Only acceptable values were used in calculating the replicate differences. All of the replicate sample values and their quality flags are listed in Table C.2 below.

e. Standards Used

The salinometer was standardized on May 11, 1997 using IAPSO standard water, Batch P129, prepared on November 22, 1995. During subsequent standardizations on May 11th and May 14th, the standardize dial of the Autosal was adjusted to force the salinometer to read the conductivity ratio of the new ampoules of standard seawater. However, it was determined later that a few ampoules of standard seawater must have been contaminated as the Autosal readings of some standards varied by more than what could be accounted for by the usual drift of the Autosal. At this point it was decided to not adjust the standardize dial when a new standard was used. The conductivity ratio of the Autosal was simply recorded for each new ampoule and then seawater samples were run. This way any contaminated standards could be immediately identified and discarded. Standards were run at the beginning and end of every 32 bottle case.

Sample ID Number	Salinity	WOCE QF	Sample ID Number	Salinity	WOCE QF
186050	32.3393	2	186741	34.9263	2
186050	32.3387	2	186741	34.9242	2
186132	32.6810	2	186780	34.9193	2
186132	32.7409	2	186780	34.9193	2
186144	31.9321	2	186804	34.8980	2
186144	31.9322	2	186804	34.8980	2
186150	32.9709	2	186827	33.2511	2
186150	32.9700	2	186827	33.2515	2
186241	34.7732	2	186845	34.8906	2
186241	34.7738	2	186845	34.8902	2
186266	34.6060	2	186857	34.3535	2
186266	34.6062	2	186857	34.3541	2
186298	34.8556	2	186880	34.8664	2
186298	34.8564	2	186880	34.8666	2
186319	34.8823	2	186910	34.8605	2
186319	34.8819	2	186910	34.8607	2
186340	34.8859	2	186931	34.8666	2
186340	34.8859	2	186931	34.8670	2
186373	34.8048	2	186954	34.8592	2
186373	34.8056	2	186954	34.8594	2
186411	34.9167	2	186974	34.9051	2
186411	34.9171	2	186974	34.9075	2
186430	34.8786	2	187018	34.8669	2
186430	34.8784	2	187018	34.8671	2
186432	34.8961	2	187045	34.8305	2
186432	34.8965	2	187045	34.8309	2
186446	34.7897	2	187065	34.8448	2
186446	34.7900	2	187065	34.8452	2
186456	34.9010	2	187099	34.9085	2
186456	34.9010	2	187099	34.9077	2
186493	34.9002	2	187124	34.9035	2
186493	34.9000	2	187124	34.9047	2
186523	34.9037	2	187171	34.9053	2
186523	34.9035	2	187171	34.9055	2
186543	34.9197	2	187215	34.8451	2
186543	34.9199	2	187215	34.8451	2
186606	34.9357	2	187229	34.8800	2
186606	34.9359	2	187229	34.8827	2
186633	34.9112	2	187279	34.8498	2
186633	34.9110	2	187279	34.8506	2
186657	34.9120	2	187312	34.8985	2
186657	34.9122	2	187312	34.9049	2
186693	34.9232	2	187339	34.8531	2
186693	34.9274	2	187339	34.8537	2
186714	34.9018	2	187361	34.8674	2
186714	34.9018	2	187361	34.8672	2

Sample ID Number	Salinity	WOCE QF	Sample ID Number	Salinity	WOCE QF
187373	34.8813	2	187877	34.9143	2
187373	34.8845	2	187877	34.9143	2
187403	34.8305	2	187893	33.5569	2
187403	34.8311	2	187893	33.5579	2
187413	34.7200	2	187908	34.8770	2
187413	34.7213	2	187908	34.8774	2
187434	34.1063	2	187909	34.8650	2
187434	34.1065	2	187909	34.8647	2
187439	33.7955	2	187909	34.8640	2
187439	33.7959	2	187910	34.8739	2
187453	33.8022	2	187910	34.8728	2
187453	33.8028	2	187911	34.8823	2
187468	34.4790	2	187911	34.8827	2
187468	34.4796	2	187912	34.8880	2
187490	34.8285	2	187912	34.8882	2
187490	34.8279	2	187913	34.8878	2
187516	34.8870	2	187913	34.8884	2
187516	34.8872	2	187915	34.8513	2
187531	34.9020	2	187915	34.8509	2
187531	34.9024	2	187916	34.8302	2
187554	34.8495	2	187916	34.8307	2
187554	34.8495	2	187922	34.8943	2
187575	34.9031	2	187922	34.8951	2
187575	34.9035	2	187923	34.8907	2
187596	34.8906	2	187923	34.8914	2
187596	34.8912	2	187924	34.8836	2
187642	34.9008	2	187924	34.8851	2
187642	34.9010	2	187926	34.8617	2
187670	34.8472	2	187926	34.8619	2
187670	34.8472	2	187927	34.8733	2
187705	34.7563	2	187927	34.8593	2
187705	34.5670	2	187927	34.8599	2
187718	34.8574	2	187928	34.8642	2
187718	34.8576	2	187928	34.8649	2
187736	34.9085	2	187929	34.8736	2
187736	34.9096	2	187929	34.8739	2
187767	34.8507	2	187931	34.8870	2
187767	34.8507	2	187931	34.8872	2
187779	34.8892	2	187940	34.8939	2
187779	34.8892	2	187940	34.8931	2
187818	34.8391	2	187942	34.8971	2
187818	34.8391	2	187942	34.8970	2
187830	34.9002	2	187944	34.9009	2
187830	34.9008	2	187944	34.9022	2
187857	34.8923	2	187945	34.8993	2
187857	34.8908	2	187945	34.9018	2

Sample ID Number	Salinity	WOCE QF	Sample ID Number	Salinity	WOCE QF
187946	34.8973	2	188013	34.8806	2
187946	34.8976	2	188014	34.9079	2
187946	34.8952	2	188014	34.9083	2
187947	34.8878	2	188015	34.9071	2
187947	34.8869	2	188015	34.9049	2
187948	34.8653	2	188016	34.9008	2
187948	34.8668	2	188016	34.9020	2
187950	34.8679	2	188017	34.8944	2
187950	34.8682	2	188017	34.8961	2
187964	34.8949	2	188018	34.8842	2
187964	34.8941	2	188018	34.8843	2
187966	34.9020	2	188020	34.8525	2
187966	34.8999	2	188020	34.8512	2
187968	34.9006	2	188021	34.8599	2
187968	34.9101	2	188021	34.8590	2
187969	34.8973	2	188034	34.8880	2
187969	34.8999	2	188034	34.8890	2
187970	34.8912	2	188036	34.8924	2
187970	34.8908	2	188036	34.8931	2
187971	34.8765	2	188037	34.9000	2
187971	34.8768	2	188037	34.8998	2
187973	34.8552	2	188038	34.9048	2
187973	34.8556	2	188038	34.9053	2
187974	34.8635	2	188039	34.9049	2
187974	34.8639	2	188039	34.9109	2
187974	34.8641	2	188040	34.9025	2
187988	34.8910	2	188040	34.9026	2
187988	34.8914	2	188041	34.8940	2
187990	34.8998	2	188041	34.8965	2
187990	34.8998	2	188043	34.8615	2
187990	34.9020	2	188043	34.8614	2
187992	34.9042	2	188044	34.8516	2
187992	34.9045	2	188044	34.8521	2
187993	34.9018	2	188064	34.8854	2
187993	34.9009	2	188064	34.8861	2
187994	34.8977	2	188065	34.8893	2
187994	34.8978	2	188065	34.8902	2
187995	34.8886	2	188068	34.9045	2
187995	34.8894	2	188068	34.9062	2
187997	34.8511	2	188069	34.9074	2
187997	34.8513	2	188069	34.9071	2
187998	34.8588	2	188070	34.9004	2
187998	34.8584	2	188070	34.9010	2
188011	34.8898	2	188071	34.8945	2
188011	34.8897	2	188071	34.8957	2
188013	34.7974	2	188073	34.8474	2

Sample ID Number	Salinity	WOCE QF	Sample ID Number	Salinity	WOCE QF
188073	34.8474	2	188138	34.8931	2
188074	34.8471	2	188140	34.9101	2
188074	34.8472	2	188140	34.9100	2
188074	34.8480	2	188141	34.9208	2
188075	34.8554	2	188141	34.9204	2
188075	34.8556	2	188142	34.9189	2
188088	34.8863	2	188142	34.9197	2
188088	34.8859	2	188143	34.9098	2
188090	34.8985	2	188143	34.9199	2
188090	34.8994	2	188145	34.8789	2
188092	34.9081	2	188145	34.8786	2
188092	34.9086	2	188146	34.8483	2
188093	34.9055	2	188146	34.8505	2
188093	34.9069	2	188161	34.7106	2
188094	34.9001	2	188161	34.7106	2
188094	34.8990	2	188171	34.8874	2
188095	34.8882	2	188171	34.8965	2
188095	34.8879	2	188172	34.8908	2
188097	34.8531	2	188172	34.8904	2
188097	34.8537	2	188173	34.8945	2
188097	34.8539	2	188173	34.8945	2
188098	34.8442	2	188175	34.9098	2
188098	34.8485	2	188175	34.9102	2
188112	34.8890	2	188176	34.9128	2
188112	34.8912	2	188176	34.9132	2
188114	34.8947	2	188177	34.9051	2
188114	34.8938	2	188177	34.9028	2
188115	34.9033	2	188178	34.8975	2
188115	34.9035	2	188178	34.9122	2
188116	34.9089	2	188180	34.8569	2
188116	34.9094	2	188180	34.8582	2
188117	34.9045	2	188181	34.8429	2
188117	34.9048	2	188181	34.8433	2
188118	34.8970	2	188195	34.8890	2
188118	34.8971	2	188195	34.8884	2
188119	34.8788	2	188197	34.8969	2
188119	34.8794	2	188197	34.8955	2
188120	34.8456	2	188199	34.9000	2
188120	34.8464	2	188199	34.9002	2
188122	34.8504	2	188200	34.9064	2
188122	34.8513	2	188200	34.9071	2
188136	34.8898	2	188201	34.9179	2
188136	34.8881	2	188201	34.9163	2
188137	34.8896	2	188202	34.9100	2
188137	34.8896	2	188202	34.9116	2
188138	34.8921	2	188204	34.8794	2

Sample ID Number	Salinity	WOCE QF	Sample ID Number	Salinity	WOCE QF
188204	34.8812	2	188272	34.9169	2
188205	34.8441	2	188272	34.9171	2
188205	34.8458	2	188273	34.9216	2
188207	34.8505	2	188273	34.9242	2
188207	34.8505	2	188274	34.9177	2
188219	34.8819	2	188274	34.9179	2
188219	34.8809	2	188274	34.9184	2
188221	34.8827	2	188276	34.8862	2
188221	34.8829	2	188276	34.8867	2
188223	34.9009	2	188277	34.8586	2
188223	34.9018	2	188277	34.8607	2
188224	34.9119	2	188291	34.8758	2
188224	34.9085	2	188291	34.8762	2
188225	34.9124	2	188293	34.8920	2
188225	34.9149	2	188293	34.8920	2
188226	34.9045	2	188295	34.9086	2
188226	34.9124	2	188295	34.9100	2
188227	34.9006	2	188296	34.9177	2
188227	34.9008	2	188296	34.9163	2
188228	34.8856	2	188297	34.9195	2
188228	34.8865	2	188297	34.9210	2
188229	34.8581	2	188298	34.9151	2
188229	34.8590	2	188298	34.9165	2
188243	34.8761	2	188300	34.8497	2
188243	34.8762	2	188300	34.8503	2
188245	34.8918	2	188301	34.8405	2
188245	34.8927	2	188301	34.8419	2
188247	34.9093	2	188302	34.8399	2
188247	34.9110	2	188302	34.8399	2
188248	34.9173	2	188315	34.8745	2
188248	34.9177	2	188315	34.8768	2
188249	34.9265	2	188317	34.8859	2
188249	34.9239	2	188317	34.8876	2
188250	34.9219	2	188317	34.8878	2
188250	34.9244	2	188319	34.9045	2
188252	34.9005	2	188319	34.9067	2
188252	34.9016	2	188320	34.9096	2
188253	34.8742	2	188320	34.9134	2
188253	34.8751	2	188321	34.9189	2
188253	34.8749	2	188321	34.9208	2
188267	34.8857	2	188322	34.9220	2
188267	34.8873	2	188322	34.9224	2
188269	34.8927	2	188324	34.9057	2
188269	34.8941	2	188324	34.9061	2
188271	34.9094	2	188325	34.8886	2
188271	34.9093	2	188325	34.8904	2

Sample ID Number	Salinity	WOCE QF	Sample ID Number	Salinity	WOCE QF
188341	34.8851	2	188396	34.8484	2
188341	34.8859	2	188397	34.8521	2
188343	34.8998	2	188397	34.8558	2
188343	34.9016	2	188422	34.8566	2
188344	34.9085	2	188422	34.8568	2
188344	34.9069	2	188436	34.8590	2
188345	34.9098	2	188436	34.8590	2
188345	34.9102	2	188467	33.2803	2
188346	34.9104	2	188467	33.2797	2
188346	34.9088	2	188474	34.6639	2
188346	34.9098	2	188474	34.6648	2
188348	34.8980	2	188490	34.6574	2
188348	34.8951	2	188490	34.6582	2
188349	34.8660	2	188510	33.8075	2
188349	34.8662	2	188510	33.8072	2
188363	34.8861	2			
188363	34.8868	2			
188365	34.8890	2			
188365	34.8898	2			
188365	34.8874	2			
188367	34.9031	2			
188367	34.9008	2			
188368	34.9061	2			
188368	34.9069	2			
188369	34.8986	2			
188369	34.9045	2			
188370	34.8918	2			
188370	34.8902	2			
188372	34.8523	2			
188372	34.8499	2			
188373	34.8499	2			
188373	34.8507	2			
188387	34.9012	2			
188387	34.9014	2			
188389	34.9014	2			
188389	34.9002	2			
188391	34.9077	2			
188391	34.9069	2			
188391	34.9069	2			
188392	34.8990	2			
188392	34.9006	2			
188393	34.8837	2			
188393	34.8857	2			
188394	34.8633	2			
188394	34.8643	2			
188396	34.8468	2			

3. Oxygen

(Peter Strain, Pierre Clement and Manon Poliquin)

a. General

Samples for the determination of dissolved oxygen were drawn from each rosette water-sampling bottle. Analyses were done using the Winkler titration technique with the computer driven automated system developed at BIO. In total 2013 samples were run for oxygen content.

After about 300 samples had been run the values were found to be about 3% higher than those obtained on previous cruises to the region. This discrepancy was removed when the 0.01N Potassium Iodate standardization solution prepared by BDH Inc. of Toronto was replaced by the 0.1N solution prepared by Frank Zemlyak at BIO. The BIO standard was used for the remainder of the voyage.

b. Description of Equipment and Technique

The oxygen samples are analyzed using one of two systems: 1) an automated procedure developed by the Physical and Chemical Sciences Branch of the Bedford Institute of Oceanography (BIO) from a manual titration system (Levy et al. 1977), 2) the Scripps Institute of Oceanography (SIO) system.

The BIO system uses a modified Winkler titration from Carritt and Carpenter (1966), using a whole bottle titration. In this method there is no starch indicator and a wetting agent (Wetting Agent A, BDH) is introduced to reduce bubble formation. The automated titration system consists of an IBM PC linked to a Brinkmann PC800 colorimeter and a Metrohm 665 Multi-Dosimat Automatic Titrator. A full description of the system and method can be found in Jones, et al. (1992) with the following exception: Page 2-4, section 2.3 Method - Sample titration should read, *The stopper is not replaced and the acid rinsed down the stopper s end into the flask. The end is then rinsed into the flask with deionized water. One drop of wetting agent and the magnetic stirring bar are then added.*

The SIO system also uses a modified Winkler titration from Carritt and Carpenter (1966), using a whole bottle titration. However, the SIO system differs from the Bedford Institute's titration system in several ways. Most significant is the 365nm UV light source, followed by different standard and titer concentrations. Standards and blanks are run at least once a day, or whenever the system had been idle for a number of hours.

Before titrating with the SIO system, the top of the oxygen flask is washed a minimum of two times with deionized water before the glass stopper is withdrawn. At that point, 1.5ml of sulphuric acid is added to the sample, a magnetic stir bar is introduced, the sample is then titrated immediately.

During the titration, the oxygen flask is immersed in a water bath and is held firm in the centre of the 365nm UV light path. Starch as an indicator is not needed and the addition of a wetting agent to minimize the formation of micro bubbles is unnecessary.

c. Sampling Procedure and Data Processing Technique

The sampling bottles are 125ml Iodine flasks with custom ground stoppers (Levy et al. 1977). The flask volumes are determined gravimetrically. The matched flasks and stoppers are etched with Identification numbers and entered into the Oxygen program database.

For this cruise 10 litre rosette bottles were used to obtain the original sample. The oxygen subsamples are drawn following the CFC, DOC and Helium subsamples. The oxygen subsamples are drawn through the bottles spigot with a latex or silicone tube attached so as to introduce the water to the bottom of the flask. The flask and its stopper are thoroughly rinsed and filled to overflowing. The flow is allowed to continue until at least two to three flask volumes overflowed. The flask is then slowly retracted with continuous low flow to ensure that no air gets trapped in the flask. The flask is then brought to the reagent station and one ml each of the Alkaline Iodide and Manganous Chloride Reagents are added and the stoppers carefully inserted, again ensuring that no air gets into the flasks. The flasks are thoroughly shaken then carried to the lab for analysis.

d. Replicate Analysis

There were 2013 unique sample id numbers that were analyzed for dissolved oxygen, of which 1520 had one sample value, 419 had two sample values, 74 had three sample values. Statistics of the replicate differences follow. Only acceptable values were used in calculating the replicate differences. The calculated replicate statistics used the absolute value of the replicate differences. All of the replicate sample values and their quality flags are listed in Table C.3 below.

Number of replicate differences

= (419) sample id numbers having one replicate * (1) possible difference
+ (74) sample id numbers having two replicates * (3) possible differences
= 641

Median of [(absolute difference/sample mean concentration of all samples) * 100%] = 0.21 %

Statistic	Value (µmoles/kg)
Minimum	0.0
Maximum	23.3
Mean	0.9
Median	0.5
Standard Deviation	1.4

Cumulative Frequency	Oxygen Difference (µmoles/kg)
50 %	≤ 0.6
68 %	≤ 0.9
95 %	≤ 2.4

The comparison of the BIO and SIO oxygen values posed two difficulties. In particular we needed to resolve the following questions:

- What were the relative purities of the two different KIO3 standards used on the cruise ? (They were solid KIO3 from Aldrich and Fisher).
- Can we determine an absolute reference for these batches of KIO3 ? (ie Can we establish the accuracy of the analysis ?)

Two reasonable answers now exist to both of these questions.

In two separate lots, we analyzed over 600 standards, prepared from 9 different KIO3 or KH(IO3)2 sources. Our best estimate for the absolute purity of the Fisher standard used on 97009 is 99.61 %; for the Aldrich AA standard it is 102.29 %. Applying these purities to the 97009 data leads to an average difference in concentration of 0.22 % between the SIO and BIO systems (for this difference, n = 382, one standard dev. = 0.02 %). The large offset between the SIO and BIO data that occurred in the raw data when the systems were using different KIO3 standards has disappeared. This analysis has produced the following conclusions:

- A few outliers have been removed on the basis of one analysis of a sample being different from two others, or because one analysis produced a near zero result. These edits are noted in processing documentation not included with this cruise report. Also, a small number of replicate samples with unusually large differences are identified in the processing documentation as 'suspect'. These differences are large enough that looking at the data in their oceanographic context will probably identify which analysis is correct. Note that the data from the BIO and SIO systems in this file have been processed in essentially the same way. A number of corrections have been applied for temperature effects:

  contraction of sample bottles at time of sampling, expansion/contraction of KIO3 and NaS2O3 solutions during sample and standard analyses.

  These corrections are usually each less than 0.04 %, and are not normally applied to the BIO system data.

- It is strongly recommend that all future deep ocean work use GFS certified KIO3 solution (nominal normality 0.1) as the KIO3 standard. This material is traceable to a NIST primary reference for redox chemistry. Staff at NIST and GFS report that KIO3 is not a suitable primary standard at the required deep-ocean accuracy; it can not be made pure enough (in the redox sense). KH(IO3)2 (potassium bi-iodate or potassium hydrogen iodate) is a suitable primary standard. We included two different sources of KH(IO3)2 in our comparison of standards. Comparing these to the GFS 0.1 N KIO3 solution gives a range of 0.4 % in purity, which is considered to be an upper limit on the accuracy of the data. We recommend the GFS solution because of its ease of use, and the belief that GFS are better equipped than we are to evaluate its absolute concentration.
- It may be possible to use the information we have gained from this analysis to refine the data from other WOCE cruises. This will depend on whether we have a record of which suppliers and lot numbers of KIO3 were used on each cruise, and whether we have, or can get, comparative data on these standards. One disappointing note: two different lots of the BDH 0.01 N KIO3 that we 'traditionally' used as our standard were included in our tests. Their purities were 100.26 and 101.79 %, showing a lot-to-lot variation of more than 1.5 %. We are unlikely to have enough information to correct data from cruises using these standards.

Table C.3 Replicate water sample oxygen values in µmoles/kg, along with their quality flags.

Sample ID #	Oxygen	WOCE QF	Sample ID #	Oxygen	WOCE QF
186007	391.0	2	186082	223.5	2
186007	390.4	2	186083	261.4	2
186011	239.9	2	186083	261.8	2
186011	246.8	2	186084	282.1	2
186028	165.7	2	186084	282.5	2
186028	165.8	2	186085	323.8	2
186048	238.9	2	186085	343.5	4
186048	237.8	2	186086	330.5	2
186052	332.9	2	186086	330.6	2
186052	333.2	2	186088	329.1	2
186056	220.4	2	186088	329.6	2
186056	220.6	2	186095	163.0	2
186066	250.0	4	186095	163.1	2
186066	250.2	4	186104	227.6	2
186067	221.2	4	186104	227.0	2
186067	221.0	4	186132	357.7	2
186068	158.2	2	186132	362.5	2
186068	158.2	2	186135	376.0	2
186069	157.7	2	186135	384.5	2
186069	158.2	2	186143	381.7	2
186070	158.0	2	186143	381.5	2
186070	158.4	2	186151	344.6	2
186071	158.2	2	186151	342.5	2
186071	158.0	2	186158	375.6	2
186072	160.0	2	186158	378.4	2
186072	160.3	2	186165	323.0	2
186073	161.1	2	186165	323.3	2
186073	161.6	2	186173	282.7	2
186074	164.7	2	186173	282.0	2
186074	165.2	2	186191	287.1	2
186075	166.1	2	186191	287.3	2
186075	166.7	2	186202	299.6	2
186076	172.3	2	186202	300.1	2
186076	173.5	2	186211	282.4	2
186077	177.3	2	186211	282.5	2
186077	177.9	2	186220	292.5	2
186078	160.6	2	186220	292.3	2
186078	183.9	2	186251	307.4	2
186079	201.6	2	186251	307.0	2
186079	201.7	2	186260	294.3	2
186080	200.8	2	186260	294.5	2
186080	200.8	2	186301	294.3	2
186081	214.2	2	186301	295.1	2
186081	213.9	2	186314	288.5	2
186082	223.1	2	186314	288.5	2

Table C.3 Replicate water sample oxygen values in µmoles/kg, along with their quality flags.

Sample ID #	Oxygen	WOCE QF	Sample ID #	Oxygen	WOCE QF
186349	294.7	2	186377	309.8	2
186349	294.7	2	186378	318.7	2
186354	330.7	2	186378	320.0	2
186354	330.7	2	186386	278.5	2
186358	293.0	2	186386	278.9	2
186358	294.2	2	186405	296.6	2
186360	282.8	2	186405	294.6	2
186360	281.8	2	186441	285.4	2
186360	282.4	2	186441	288.6	2
186361	280.6	2	186453	291.9	2
186361	281.6	2	186453	292.8	2
186362	278.7	2	186454	290.4	2
186362	279.9	2	186454	291.2	2
186363	281.0	2	186455	286.7	2
186363	281.7	2	186455	286.1	2
186363	281.8	2	186456	281.1	2
186364	280.3	2	186456	280.2	2
186364	279.7	2	186456	280.2	2
186365	284.9	2	186457	277.7	2
186365	286.2	2	186457	279.3	2
186366	294.1	2	186459	280.6	2
186366	294.1	2	186459	281.4	2
186366	295.3	2	186459	281.9	2
186368	292.8	2	186460	279.5	2
186368	290.3	2	186460	280.0	2
186368	291.8	2	186460	280.3	2
186369	290.5	2	186461	288.7	2
186369	289.3	2	186461	289.3	2
186369	289.0	2	186462	292.3	2
186370	284.5	2	186462	292.4	2
186370	285.9	2	186462	293.5	2
186371	280.6	2	186463	292.4	2
186371	282.0	2	186463	294.0	2
186372	294.6	2	186463	293.1	2
186372	293.2	2	186464	291.3	2
186373	291.7	2	186464	292.4	2
186373	292.6	2	186464	292.8	2
186374	283.1	2	186465	288.2	2
186374	283.6	2	186465	288.9	2
186375	288.7	2	186466	285.7	2
186375	289.9	2	186466	287.7	2
186376	308.1	2	186467	279.5	2
186376	307.5	2	186467	279.8	2
186377	310.8	2	186467	278.5	2
			186468	268.3	2

Table C.3 Replicate water sample oxygen values in µmoles/kg, along with their quality flags.

Sample ID #	Oxygen	WOCE QF	Sample ID #	Oxygen	WOCE QF
186468	271.1	2	186549	287.9	2
186469	267.0	2	186550	291.0	2
186469	266.4	2	186550	291.3	2
186470	272.5	2	186550	290.7	2
186470	269.5	2	186551	289.7	2
186471	292.0	2	186551	290.5	2
186471	294.1	2	186552	287.1	2
186472	279.2	2	186552	286.7	2
186472	280.3	2	186553	283.8	2
186473	291.9	2	186553	282.8	2
186473	290.3	2	186579	280.1	2
186474	282.4	2	186579	280.5	2
186474	283.9	2	186615	287.2	2
186475	275.0	2	186615	287.4	2
186475	276.1	2	186633	279.0	2
186476	290.1	2	186633	278.8	2
186476	290.9	2	186651	280.1	2
186492	285.2	2	186651	282.7	2
186492	285.3	2	186652	278.3	2
186503	286.2	2	186652	278.3	2
186503	286.4	2	186652	280.1	2
186536	276.9	2	186653	276.9	2
186536	277.4	2	186653	278.1	2
186540	281.3	2	186654	276.2	2
186540	281.5	2	186654	274.8	2
186540	281.6	2	186655	274.8	2
186541	278.4	2	186655	273.6	2
186541	278.2	2	186656	274.4	2
186542	276.4	2	186656	275.8	2
186542	276.5	2	186656	275.9	2
186543	276.1	2	186657	277.4	2
186543	276.1	2	186657	278.8	2
186544	271.0	2	186658	283.7	2
186544	271.8	2	186658	283.7	2
186545	273.8	2	186658	284.9	2
186545	272.6	2	186659	291.5	2
186546	275.4	2	186659	292.9	2
186546	275.3	2	186660	295.8	2
186546	274.7	2	186660	296.9	2
186547	279.3	2	186661	247.3	4
186547	279.8	2	186661	293.4	2
186548	282.2	2	186662	292.9	2
186548	282.4	2	186662	291.0	2
186549	288.5	2	186662	291.2	2
186549	288.6	2	186663	289.3	2

Table C.3 Replicate water sample oxygen values in μmoles/kg, along with their quality flags.

Sample ID #	Oxygen	WOCE QF	Sample ID #	Oxygen	WOCE QF
186663	290.8	2	186744	280.3	2
186664	287.2	2	186744	282.0	2
186664	288.7	2	186745	291.3	2
186665	284.6	2	186745	292.1	2
186665	281.9	2	186745	292.4	2
186666	284.5	2	186746	294.9	2
186666	282.7	2	186746	296.3	2
186666	282.7	2	186747	296.3	2
186667	286.3	2	186747	295.6	2
186667	287.9	2	186748	294.2	2
186668	305.1	2	186748	295.1	2
186668	307.5	2	186749	292.9	2
186669	311.6	2	186749	294.3	2
186669	313.1	2	186750	290.4	2
186670	312.2	2	186750	291.6	2
186670	314.2	2	186751	289.1	2
186671	315.7	2	186751	290.1	2
186671	317.2	2	186752	288.2	2
186672	325.6	2	186752	289.7	2
186672	327.8	2	186753	305.0	2
186673	328.3	2	186753	306.1	2
186673	330.0	2	186754	307.3	2
186674	329.0	2	186754	308.2	2
186674	329.2	2	186755	303.4	2
186674	327.1	2	186755	303.9	2
186690	283.7	2	186756	304.3	2
186690	284.0	2	186756	305.5	2
186712	329.2	2	186757	306.4	2
186712	329.3	2	186757	305.6	2
186721	293.5	2	186758	311.2	2
186721	293.8	2	186758	313.3	2
186738	295.0	2	186759	315.8	2
186738	296.1	2	186759	318.2	2
186739	284.7	2	186779	289.8	2
186739	285.0	2	186779	295.6	2
186739	285.8	2	186803	284.0	2
186740	286.7	2	186803	284.1	2
186740	278.2	2	186819	324.4	2
186741	275.5	2	186819	324.7	2
186741	274.4	2	186842	287.4	2
186741	274.8	2	186842	287.8	2
186742	276.1	2	186857	320.8	2
186742	276.5	2	186857	322.2	2
186743	275.6	2	186857	322.4	2
186743	276.5	2	186859	321.0	2

Table C.3 Replicate water sample oxygen values in µmoles/kg, along with their quality flags.

Sample ID #	Oxygen	WOCE QF	Sample ID #	Oxygen	WOCE QF
186859	322.6	2	186981	289.2	2
186861	324.9	2	186981	288.6	2
186861	326.6	2	186982	288.4	2
186866	392.5	2	186982	289.4	2
186866	390.0	2	186983	289.9	2
186866	390.6	2	186983	290.3	2
186876	290.1	2	186985	294.7	2
186876	290.0	2	186985	295.0	2
186905	284.9	2	186985	295.1	2
186905	285.2	2	186986	299.9	2
186928	283.9	2	186986	300.0	2
186928	284.0	2	186987	301.0	2
186951	283.3	2	186987	301.7	2
186951	283.2	2	186988	318.3	2
186967	296.6	2	186988	318.4	2
186967	296.1	2	186989	343.7	2
186967	296.4	2	186989	343.9	2
186968	296.1	2	186990	382.8	2
186968	296.4	2	186990	383.4	2
186969	291.7	2	187017	296.3	2
186969	293.0	2	187017	296.0	2
186970	288.0	2	187035	281.2	2
186970	288.2	2	187035	295.9	4
186971	284.9	2	187042	294.9	2
186971	284.9	2	187042	295.1	2
186972	281.1	2	187054	296.6	2
186972	281.2	2	187054	296.2	2
186973	282.8	2	187055	295.3	2
186973	282.5	2	187055	295.1	2
186973	282.5	2	187056	290.0	2
186974	281.4	2	187056	290.1	2
186974	281.5	2	187056	291.2	2
186975	283.7	2	187057	284.2	2
186975	284.1	2	187057	286.6	2
186976	289.1	2	187058	282.3	2
186976	289.2	2	187058	282.3	2
186976	289.5	2	187058	282.8	2
186977	296.3	2	187059	280.9	2
186977	295.8	2	187059	281.8	2
186978	295.2	2	187060	280.2	2
186978	295.1	2	187060	280.9	2
186979	292.7	2	187061	279.6	2
186979	292.9	2	187061	278.6	2
186980	289.9	2	187062	282.3	2
186980	290.0	2	187062	282.2	2

Table C.3 Replicate water sample oxygen values in µmoles/kg, along with their quality flags.

Sample ID #	Oxygen	WOCE QF	Sample ID #	Oxygen	WOCE QF
187063	290.8	2	187230	294.8	2
187063	291.4	2	187230	294.8	2
187064	294.8	2	187231	288.1	2
187064	295.9	2	187231	288.1	2
187065	296.3	2	187232	282.7	2
187065	297.1	2	187232	283.3	2
187065	296.3	2	187233	279.5	2
187066	296.0	2	187233	279.9	2
187066	295.5	2	187234	277.7	2
187067	297.1	2	187234	278.1	2
187067	297.9	2	187235	277.2	2
187067	297.9	2	187235	277.4	2
187068	296.5	2	187235	277.7	2
187068	297.0	2	187236	278.1	2
187069	295.2	2	187236	278.2	2
187069	295.7	2	187237	282.1	2
187070	292.6	2	187237	282.8	2
187070	293.5	2	187238	292.1	2
187071	295.3	2	187238	292.0	2
187071	296.1	2	187239	296.3	2
187072	294.7	2	187239	296.2	2
187072	296.3	2	187240	295.6	2
187073	300.1	2	187240	296.1	2
187073	300.9	2	187241	294.3	2
187074	303.7	2	187241	294.9	2
187074	303.1	2	187242	294.5	2
187075	314.0	2	187242	293.8	2
187075	314.2	2	187243	293.7	2
187076	320.2	2	187243	294.2	2
187076	321.3	2	187244	295.1	2
187077	326.4	2	187244	295.3	2
187077	327.0	2	187245	298.4	2
187108	297.7	2	187245	298.8	2
187108	298.2	2	187246	298.3	2
187128	296.4	2	187246	298.9	2
187128	296.6	2	187247	298.0	2
187178	295.3	2	187247	297.3	2
187178	295.4	2	187248	300.4	2
187219	291.6	2	187248	300.4	2
187219	291.6	2	187248	301.1	2
187228	298.5	2	187268	295.5	2
187228	295.6	2	187268	295.6	2
187229	297.4	2	187269	291.6	2
187229	297.6	2	187269	291.4	2
187230	294.8	2	187270	285.1	2

Table C.3 Replicate water sample oxygen values in μmoles/kg, along with their quality flags.

Sample ID #	Oxygen	WOCE QF	Sample ID #	Oxygen	WOCE QF
187270	283.1	2	187353	286.0	2
187270	283.5	2	187354	285.0	2
187271	280.8	2	187354	283.8	2
187271	281.4	2	187355	284.1	2
187272	280.1	2	187355	282.5	2
187272	281.3	2	187355	283.7	2
187273	277.4	2	187356	283.9	2
187273	279.1	2	187356	285.1	2
187273	277.9	2	187357	285.1	2
187274	278.4	2	187357	285.4	2
187274	279.3	2	187357	286.2	2
187275	281.5	2	187358	291.1	2
187275	282.6	2	187358	291.8	2
187275	282.7	2	187359	293.0	2
187276	292.6	2	187359	294.4	2
187276	292.7	2	187360	291.6	2
187276	293.5	2	187360	293.2	2
187277	296.3	2	187361	289.5	2
187277	297.3	2	187361	291.0	2
187277	298.0	2	187362	290.1	2
187278	295.4	2	187362	291.5	2
187278	296.7	2	187363	295.0	2
187279	295.0	2	187363	293.4	2
187279	294.3	2	187364	294.6	2
187280	296.1	2	187364	295.9	2
187280	295.3	2	187365	294.8	2
187281	297.5	2	187365	295.9	2
187281	298.0	2	187366	294.7	2
187282	296.1	2	187366	296.1	2
187282	296.3	2	187367	294.4	2
187282	297.0	2	187367	295.8	2
187285	299.5	2	187368	291.9	2
187285	299.6	2	187368	293.3	2
187315	296.6	2	187369	372.9	2
187315	296.2	2	187369	375.0	2
187342	296.3	2	187376	294.4	2
187342	296.4	2	187376	294.8	2
187350	287.6	2	187418	315.1	2
187350	288.4	2	187418	315.1	2
187351	285.1	2	187435	315.8	2
187351	286.2	2	187435	316.0	2
187352	284.7	2	187440	327.2	2
187352	285.8	2	187440	327.5	2
187352	284.1	2	187454	319.7	2
187353	283.7	2	187454	319.7	2

Table C.3 Replicate water sample oxygen values in µmoles/kg, along with their quality flags.

Sample ID #	Oxygen	WOCE QF	Sample ID #	Oxygen	WOCE QF
187478	329.4	2	187588	296.9	2
187478	329.1	2	187588	297.1	2
187487	288.5	2	187589	298.8	2
187487	288.9	2	187589	295.1	2
187515	284.4	2	187590	298.6	2
187515	284.5	2	187590	298.2	2
187536	294.1	2	187591	297.9	2
187536	293.9	2	187591	298.6	2
187549	289.9	2	187592	298.6	2
187549	290.3	2	187592	299.6	2
187572	293.5	2	187593	297.7	2
187572	293.9	2	187593	297.3	2
187572	294.4	2	187643	286.2	2
187573	293.2	2	187643	286.7	2
187573	294.1	2	187676	300.1	2
187574	288.0	2	187676	300.2	2
187574	288.9	2	187683	294.4	2
187575	284.9	2	187683	294.8	2
187575	284.7	2	187683	295.9	2
187576	282.0	2	187684	294.3	2
187576	283.2	2	187684	293.4	2
187577	283.0	2	187685	288.6	2
187577	282.5	2	187685	287.2	2
187577	282.6	2	187686	281.2	2
187578	284.4	2	187686	282.3	2
187578	283.6	2	187687	280.1	2
187578	284.2	2	187687	282.1	2
187579	287.3	2	187688	279.6	2
187579	287.7	2	187688	281.0	2
187580	291.6	2	187688	279.6	2
187580	292.1	2	187689	282.3	2
187581	294.8	2	187689	281.2	2
187581	294.0	2	187690	281.7	2
187582	294.4	2	187690	282.4	2
187582	293.6	2	187691	288.3	2
187583	291.5	2	187691	290.1	2
187583	292.8	2	187692	295.9	2
187584	289.8	2	187692	297.4	2
187584	290.5	2	187693	296.6	2
187585	288.0	2	187693	298.0	2
187585	287.2	2	187693	296.3	2
187586	289.3	2	187694	295.5	2
187586	289.6	2	187694	296.2	2
187587	295.5	2	187695	296.1	2
187587	295.8	2	187695	295.0	2

Table C.3 Replicate water sample oxygen values in µmoles/kg, along with their quality flags.

Sample ID #	Oxygen	WOCE QF	Sample ID #	Oxygen	WOCE QF
187696	299.7	2	187815	293.8	2
187696	297.5	2	187815	296.3	2
187696	299.3	2	187816	296.0	2
187697	298.7	2	187816	33.7	4
187697	298.9	2	187816	293.9	2
187698	297.0	2	187817	297.9	2
187698	299.3	2	187817	300.2	2
187699	299.8	2	187818	298.9	2
187699	299.9	2	187818	300.4	2
187699	299.6	2	187819	295.0	2
187700	300.0	2	187819	295.1	2
187700	300.4	2	187820	301.6	2
187716	295.2	2	187820	290.9	2
187716	295.4	2	187820	291.9	2
187731	295.1	2	187821	299.8	2
187731	295.5	2	187821	298.8	2
187759	282.8	2	187822	299.0	2
187759	283.0	2	187822	299.2	2
187780	295.2	2	187823	309.6	2
187780	294.9	2	187823	316.6	2
187803	289.8	2	187828	290.5	2
187803	290.8	2	187828	290.1	2
187803	291.4	2	187853	290.0	2
187804	291.7	2	187853	290.1	2
187804	287.4	2	187880	313.3	2
187805	287.2	2	187880	313.6	2
187805	285.1	2	187898	345.7	2
187806	281.4	2	187898	345.7	2
187806	283.6	2	187916	292.0	2
187807	281.9	2	187916	292.2	2
187807	282.1	2	187922	283.2	2
187807	284.0	2	187922	284.0	2
187808	280.9	2	187923	285.8	2
187808	282.7	2	187923	286.1	2
187810	285.4	2	187923	286.4	2
187810	283.9	2	187924	287.6	2
187811	290.8	2	187924	288.5	2
187811	293.0	2	187925	289.8	2
187812	295.6	2	187925	290.4	2
187812	297.3	2	187925	289.5	2
187812	297.5	2	187926	293.1	2
187813	294.6	2	187926	292.8	2
187813	296.5	2	187927	293.5	2
187814	292.7	2	187927	294.3	2
187814	294.9	2	187928	293.3	2

Table C.3 Replicate water sample oxygen values in µmoles/kg, along with their quality flags.

Sample ID #	Oxygen	WOCE QF	Sample ID #	Oxygen	WOCE QF
187928	292.5	2	188041	284.5	2
187928	293.2	2	188042	287.4	2
187929	289.6	2	188042	288.0	2
187929	289.3	2	188043	293.3	2
187930	285.6	2	188043	293.6	2
187930	286.3	2	188043	293.6	2
187931	281.8	2	188044	295.8	2
187931	282.6	2	188044	296.3	2
187932	285.5	2	188045	295.3	2
187932	285.4	2	188045	296.0	2
187933	293.0	2	188046	295.1	2
187933	293.0	2	188046	296.1	2
187934	289.7	2	188047	292.5	2
187934	290.5	2	188047	293.6	2
187935	291.0	2	188048	295.5	2
187935	292.0	2	188048	295.7	2
187936	289.4	2	188049	295.3	2
187936	289.7	2	188049	294.9	2
187937	297.6	2	188050	294.9	2
187937	297.9	2	188050	295.3	2
187938	356.4	2	188051	295.9	2
187938	357.1	2	188051	295.6	2
187948	292.3	2	188051	295.6	2
187948	292.3	2	188052	295.1	2
187971	290.0	2	188052	294.8	2
187971	290.1	2	188054	298.3	2
187999	290.2	2	188054	298.6	2
187999	290.6	2	188055	301.7	2
188020	296.0	2	188055	302.2	2
188020	295.8	2	188056	315.2	2
188034	295.6	2	188056	313.9	2
188034	296.0	2	188084	296.3	2
188035	295.3	2	188084	296.4	2
188035	296.0	2	188088	296.0	2
188036	292.8	2	188088	296.7	2
188036	292.9	2	188089	292.5	2
188037	287.1	2	188089	292.6	2
188037	287.1	2	188089	292.8	2
188038	283.7	2	188090	286.7	2
188038	284.5	2	188090	286.7	2
188039	282.8	2	188091	282.7	2
188039	283.7	2	188091	282.3	2
188040	283.7	2	188092	281.7	2
188040	284.0	2	188092	281.7	2
188041	285.6	2	188093	281.6	2

Table C.3 Replicate water sample oxygen values in μmoles/kg, along with their quality flags.

Sample ID #	Oxygen	WOCE QF	Sample ID #	Oxygen	WOCE QF
188093	282.0	2	188173	288.1	2
188093	284.9	2	188173	287.5	2
188094	283.4	2	188174	282.9	2
188094	283.6	2	188174	283.0	2
188095	286.7	2	188174	283.5	2
188095	286.5	2	188175	281.0	2
188096	288.3	2	188175	281.6	2
188096	288.4	2	188176	279.3	2
188097	295.3	2	188176	279.9	2
188097	297.4	2	188177	281.9	2
188098	295.0	2	188177	281.3	2
188098	297.4	2	188178	283.8	2
188099	296.0	2	188178	284.0	2
188099	296.7	2	188178	284.0	2
188100	292.5	2	188179	285.5	2
188100	293.0	2	188179	285.0	2
188100	293.2	2	188180	294.0	2
188101	297.9	2	188180	293.6	2
188101	297.7	2	188180	293.2	2
188102	299.1	2	188181	298.9	2
188102	299.3	2	188181	304.3	4
188103	299.1	2	188182	296.9	2
188103	299.2	2	188182	297.4	2
188104	299.5	2	188183	296.3	2
188104	299.7	2	188183	294.6	2
188105	298.8	2	188184	298.0	2
188105	299.5	2	188184	298.3	2
188106	301.3	2	188185	297.7	2
188106	301.8	2	188185	297.9	2
188107	298.5	2	188186	298.3	2
188107	298.9	2	188186	298.6	2
188108	299.2	2	188187	299.2	2
188108	299.4	2	188187	299.2	2
188109	301.6	2	188188	299.7	2
188109	301.6	2	188188	299.1	2
188122	295.5	2	188189	303.6	2
188122	295.6	2	188189	303.7	2
188139	284.7	2	188190	298.1	2
188139	284.5	2	188190	299.1	2
188162	311.6	2	188191	295.4	2
188162	311.7	2	188191	294.5	2
188171	296.2	2	188201	279.1	2
188171	298.2	2	188201	279.2	2
188172	296.4	2	188224	282.7	2
188172	295.3	2	188224	283.8	2

Table C.3 Replicate water sample oxygen values in µmoles/kg, along with their quality flags.

Sample ID #	Oxygen	WOCE QF	Sample ID #	Oxygen	WOCE QF
188243	297.8	2	188264	308.9	2
188243	298.2	2	188264	309.5	2
188244	294.9	2	188270	280.7	2
188244	295.7	2	188270	280.7	2
188244	294.8	2	188293	285.7	2
188245	286.2	2	188293	285.8	2
188245	286.7	2	188321	277.4	2
188246	282.2	2	188321	277.4	2
188246	282.4	2	188350	294.9	2
188247	279.2	2	188350	295.2	2
188247	278.7	2	188371	290.9	2
188247	279.1	2	188371	291.0	2
188248	277.5	2	188395	292.9	2
188248	278.0	2	188395	297.0	2
188249	275.8	2	188424	294.5	2
188249	276.4	2	188424	294.6	2
188249	276.5	2	188440	296.8	2
188250	276.0	2	188440	296.9	2
188250	276.5	2	188458	291.9	2
188251	277.3	2	188458	291.8	2
188251	277.9	2	188477	319.2	2
188252	280.9	2	188477	319.8	2
188252	280.9	2	188492	281.7	2
188253	287.9	2	188492	281.8	2
188253	288.3	2	188515	337.0	9
188254	294.4	2	188515	336.2	9
188254	294.8	2			
188255	294.2	2			
188255	294.7	2			
188256	292.4	2			
188256	291.6	2			
188257	288.6	2			
188257	289.4	2			
188258	285.7	2			
188258	286.8	2			
188259	281.3	2			
188259	281.3	2			
188260	277.9	2			
188260	276.4	2			
188261	285.4	2			
188261	285.5	2			
188262	292.6	2			
188262	293.3	2			
188263	283.0	2			
188263	282.6	2			

4. Nutrients
(Pierre Clement)

a. Description of Equipment and Technique
Nutrient concentrations were determined using a Technicon Autoanalyser II. The chemistries are standard Technicon (Silicate 186-72W, Phosphate 155-71W, Nitrate/Nitrite 158-71W) except for Phosphate which was modified by separating the Ascorbic Acid (4.0 gms/L) from the Mixed Reagent. This alteration was achieved by introducing the modified Mixed Reagent instead of water at the start of the sample stream at 0.23 ml/min and the Ascorbic Acid was pumped into the stream between the two mixing coils at 0.32 ml/min.

b. Sampling Procedure and Data Processing Technique
Duplicate nutrient subsamples were drawn into 30 ml HDPE (Nalge) wide mouth sample bottles from 10 L Niskin bottles. The bottles were washed with 10% HCl, rinsed once with tap water, rinsed three times with Super-Q and oven dried at >100 Degrees F.

A sample run included six Working Standards run at the beginning and end. Duplicate Check Standards were run every 16 samples followed by blanks as a Baseline Check. These Standards were made up in 33 ppt NaCl (VWR, Analar grade), as is the wash water. The Standards were tested against CSK Solution Standards (Sagami Chemical Center, Japan).

Analog data is converted to digital, processed and statistics calculated by a Pascal 6.0 in house program (Logger) on a PC. Chart recordings, hard copy and disk copies of the data are kept for reference.

c. Replicate Analysis
A total of 4573 seawater samples were analyzed for silicate, phosphate and NO_2+NO_3. Included in these samples were a total of 2023 duplicate samples and one quadruplicate sample. Statistics relating to the precision of the sample values follow. All values are given in μmoles/kg. All of the samples values were included in calculating the statistics. All replicate values and their quality flags are given in Table

C.4.

Precision is a measure of the variability of individual measurements and in the following analysis two categories of precision were determined: field and analytical precision. Analytical precision is based on the pooled estimate of the standard deviation of the check standards over the course of a complete autoanalyzer run and is a measure of the greatest precision possible for a particular analysis. Field precision is based on the analysis of two or more water samples taken from a single Niskin sampling bottle and has an added component of variance due to subsampling, storage and natural sample variability.

The precision was calculated using the standard deviation and the full-scale values of 50, 2, and 30 _ mole/litre for silicate, phosphate and NO2+NO3 respectively.

Both categories of precision were determined by computing the variance, σ_i^2, of each replicate set, where i is the index of the replicate set. In the case of analytical (field) precision, a replicate set consisted of all the check standards (duplicate samples). Given p replicate sets and n samples within any replicate set, the mean standard deviation, $\bar{\sigma}$, was determined from

$$\bar{\sigma} = \sqrt{\frac{\sum_{i=1}^{p} (n-1)_i \sigma_i^2}{\sum_{i=1}^{p} (n-1)_i}}$$

The precision expressed in percent was based on the mean concentration (M) of the check standards (analytical precision) or water samples (field precision) and was given by

$$P_{\%} = \frac{\bar{\sigma}}{M} \times 100\%$$

The following table indicates the analytical and field precision obtained for this cruise.

Statistic	Silicate	Phosphate	NO2+NO3
Number of Samples	4045	4039	4042
Number of Replicates	1498	1492	1495
Mean concentration (µmoles/kg)	9.24	0.97	14.22
Field Precision (µmoles/kg)	0.13	0.03	0.15
Field Precision (%)	1.44	3.43	1.04
Analytical Precision (µmoles/kg)	0.38	0.05	0.38
Analytical Precision (%)	1.36	3.87	2.20
Detection Limit (µmoles/kg)	0.188	0.048	0.149

The laboratory temperature during all analyses was between 21 and 23 °C.

The conversion to mass units for the analytical precision and detection limits used a standard density of 1.02443 kg/litre corresponding to 33 ppt and 15°C. The conversion of individual sample values from volume to mass units used a potential density with a fixed temperature of 15°C.

Duplicate samples were drawn from each rosette bottle for the determination of silicate, phosphate and nitrate concentrations.

The nutrient detection limits noted in the above table were applied to the data set. All values at or below the detection limits were set to zero.

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF
186001	3.52	0.76	3.78	2 2 2
186001	3.40	0.78	3.71	2 2 2
186002	2.52	0.73	2.95	2 2 2
186002	2.54	0.75	2.93	2 2 2
186003	1.31	0.62	1.51	2 2 2
186003	1.35	0.63	1.51	2 2 2
186004	1.26	0.61	1.38	2 2 2
186004	1.33	0.62	1.40	2 2 2
186005	0.25	0.49	0.45	2 2 2
186005	0.39	0.49	0.43	2 2 2
186006	0.00	0.35	0.00	2 2 2
186006	0.00	0.37	0.00	2 2 2
186007	0.00	0.37	0.00	2 2 2
186007	0.00	0.33	0.00	2 2 2
186008	0.00	0.37	0.00	2 2 2
186008	0.00	0.35	0.00	2 2 2
186009	0.00	0.37	0.00	2 2 2
186009	0.00	0.35	0.00	2 2 2
186010	10.43	0.97	11.38	2 2 2
186010	10.59	0.96	11.60	2 2 2
186011	7.48	0.88	9.05	2 2 2
186011	7.54	0.88	9.35	2 2 2
186012	7.28	0.91	8.34	2 2 2
186012	7.37	0.89	8.36	2 2 2
186013	7.39	1.00	7.53	2 3 2
186013	7.30	0.90	7.59	2 3 2
186014	7.12	0.93	7.06	2 2 2
186014	7.13	0.89	7.03	2 2 2
186015	6.46	0.90	6.37	2 2 2
186015	6.47	0.87	6.33	2 2 2
186016	4.25	0.79	4.38	2 2 2
186016	4.25	0.77	4.44	2 2 2
186017	1.95	0.74	2.18	2 2 2
186017	1.97	0.69	2.21	2 2 2
186018	1.83	0.68	2.23	2 2 2
186018	1.87	0.65	2.21	2 2 2
186019	2.04	0.68	2.50	2 2 2
186019	2.11	0.70	2.57	2 2 2
186020	0.64	0.58	1.10	2 2 2
186020	0.65	0.57	1.04	2 2 2
186021	0.00	0.43	0.00	2 2 2
186021	0.00	0.44	0.00	2 2 2
186022	0.00	0.40	0.00	2 2 2
186022	0.00	0.40	0.00	2 2 2
186023	0.00	0.38	0.00	2 2 2
186023	0.00	0.38	0.00	2 2 2
186024	0.00	0.37	0.00	2 2 2
186024	0.58	0.38	0.00	2 2 2
186025	0.00	0.38	0.00	2 2 2
186025	0.00	0.41	0.00	2 2 2
186026	16.51	1.29	18.77	2 2 2
186026	16.60	1.24	18.84	2 2 2
186027	13.84	1.22	18.11	2 2 2
186027	14.04	1.23	17.85	2 2 2
186028	12.26	1.17	17.08	2 2 2
186028	12.36	1.16	16.92	2 2 2
186029	11.50	1.12	16.81	2 2 2
186029	11.46	1.15	16.79	2 2 2
186030	11.69	1.13	16.53	2 2 2
186030	11.75	1.14	16.44	2 2 2
186031	11.31	1.12	16.25	2 2 2
186031	11.35	1.10	15.83	2 2 2
186032	10.88	1.10	15.61	2 2 2
186032	10.91	1.09	15.61	2 2 2
186033	10.61	1.05	14.87	2 2 2
186033	10.65	1.10	14.61	2 2 2
186034	9.85	1.00	14.09	2 2 2
186034	9.95	1.03	14.09	2 2 2
186035	10.11	1.03	13.39	2 2 2
186035	10.17	1.03	13.30	2 2 2
186036	9.41	0.99	12.71	2 2 2
186036	9.50	0.99	12.85	2 2 2
186037	9.56	0.99	12.59	2 2 2
186037	9.59	1.01	12.43	2 2 2
186038	9.45	1.16	11.72	2 3 2
186038	9.45	1.03	11.59	2 3 2
186039	6.07	0.86	8.61	2 3 2
186039	6.00	1.17	8.64	2 3 2
186040	3.08	0.67	4.13	2 3 2
186040	3.01	0.80	4.13	2 3 2
186041	2.21	0.67	2.61	2 2 2
186041	2.32	0.67	2.61	2 2 2
186042	1.02	0.54	0.90	2 2 2
186042	1.03	0.53	0.90	2 2 2
186043	0.82	0.48	0.33	2 2 2
186043	0.81	0.47	0.29	2 2 2
186044	0.66	0.52	0.00	2 2 2
186044	0.70	0.46	0.00	2 2 2
186045	0.62	0.45	0.00	2 2 2
186045	0.66	0.44	0.00	2 2 2
186046	0.74	0.48	0.00	2 2 2
186046	0.76	0.60	0.00	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
186047	7.87	0.85	8.88	2 2 2	186071	10.95	1.31	17.10	3 3 3
186047	7.84	0.86	8.91	2 2 2	186071	11.05	1.31	17.06	3 3 3
186048	7.70	0.86	9.08	2 2 2	186072	10.51	1.28	16.33	3 3 3
186048	7.66	0.85	8.97	2 2 2	186072	10.56	1.38	16.61	3 3 3
186049	3.73	0.64	4.08	3 3 3	186073	10.50	1.27	16.69	3 3 3
186049	3.74	0.64	4.16	3 3 3	186073	10.53	1.26	16.87	3 3 3
186050	1.92	0.56	2.02	3 3 3	186074	10.11	1.17	16.18	3 3 3
186050	1.97	0.58	2.08	3 3 3	186074	10.13	1.21	16.90	3 3 3
186051	1.18	0.50	0.68	3 3 3	186075	9.52	1.20	15.49	3 3 3
186051	1.11	0.48	0.68	3 3 3	186075	9.69	1.17	15.54	3 3 3
186052	0.81	0.45	0.17	3 3 3	186076	8.80	1.11	14.04	3 3 3
186052	0.82	0.45	0.17	3 3 3	186076	8.92	1.25	14.23	3 3 3
186053	0.75	0.46	0.15	3 3 3	186077	8.23	1.06	13.10	3 3 3
186053	0.84	0.46	0.15	3 3 3	186077	8.03	1.07	12.99	3 3 3
186054	0.80	0.47	0.15	3 3 3	186078	7.46	1.09	12.34	3 3 3
186054	0.81	0.47	0.20	3 3 3	186078	7.48	1.01	12.35	3 3 3
186055	9.84	0.84	10.44	3 3 3	186079	5.94	0.87	10.26	3 3 3
186055	9.44	0.85	10.24	3 3 3	186079	6.00	0.85	10.32	3 3 3
186056	10.01	0.83	10.35	3 3 3	186080	6.77	0.90	10.65	3 3 3
186056	9.91	0.85	10.20	3 3 3	186080	6.82	0.91	10.64	3 3 3
186057	9.68	0.86	10.17	3 3 3	186081	6.14	0.84	9.34	3 3 3
186057	9.85	0.87	10.04	3 3 3	186081	6.34	0.82	9.35	3 3 3
186058	7.02	0.78	8.00	3 3 3	186082	5.98	0.79	8.34	3 3 3
186058	7.15	0.78	7.84	3 3 3	186082	6.11	0.82	8.40	3 3 3
186059	1.85	0.57	2.22	3 3 3	186083	3.00	0.72	4.70	3 3 3
186059	1.80	0.58	2.24	3 3 3	186083	3.02	0.61	4.67	3 3 3
186060	0.71	0.46	0.38	3 3 3	186084	2.78	0.64	3.55	3 3 3
186060	0.77	0.47	0.38	3 3 3	186084	2.80	0.64	3.62	3 3 3
186061	0.60	0.39	-0.06	3 3 3	186085	0.95	0.52	0.59	3 3 3
186061	0.61	0.40	-0.09	3 3 3	186085	0.94	0.53	0.51	3 3 3
186062	0.57	0.40	-0.05	3 3 3	186086	0.73	0.45	-0.01	3 3 3
186062	0.62	0.40	-0.11	3 3 3	186086	0.78	0.59	0.01	3 3 3
186063	0.60	0.38	-0.11	3 3 3	186088	0.75	0.44	-0.11	3 3 3
186063	0.58	0.39	-0.08	3 3 3	186088	0.77	0.44	-0.11	3 3 3
186064	0.57	0.39	-0.10	3 3 3	186089	10.32	1.12	13.65	3 3 3
186064	0.52	0.39	-0.10	3 3 3	186089	10.34	1.10	13.45	3 3 3
186066	11.11	1.14	15.46	3 3 3	186090	10.00	1.14	13.76	3 3 3
186066	11.23	1.12	15.30	3 3 3	186090	10.06	1.14	13.70	3 3 3
186067	12.31	1.25	16.78	3 3 3	186091	11.16	1.30	14.86	3 3 3
186067	12.40	1.28	16.76	3 3 3	186091	11.17	1.33	14.67	3 3 3
186068	12.74	1.42	18.71	3 3 3	186092	10.26	1.34	15.49	3 3 3
186068	12.97	1.39	18.73	3 3 3	186092	10.34	1.35	15.20	3 3 3
186069	11.72	1.34	17.75	3 3 3	186093	9.27	1.27	14.48	3 3 3
186069	11.77	1.34	18.18	3 3 3	186093	9.61	1.28	14.77	3 3 3
186070	11.00	1.30	17.10	3 3 3	186094	9.31	1.24	14.42	3 3 3
186070	11.16	1.30	17.27	3 3 3	186094	9.21	1.24	14.46	3 3 3

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
186095	8.67	1.19	13.98	3 3 3	186135	2.69	0.60	2.91	2 2 3
186095	8.80	1.20	14.15	3 3 3	186135	2.65	0.57	2.35	2 2 3
186096	8.36	1.16	13.64	3 3 3	186136	1.73	0.50	1.78	2 2 3
186096	8.40	1.17	13.83	3 3 3	186136	1.77	0.56	1.45	2 2 3
186097	7.78	1.13	12.84	3 3 3	186137	0.79	0.41	0.18	2 3 2
186097	7.86	1.14	12.90	3 3 3	186137	0.85	0.74	0.46	2 3 2
186098	7.64	1.26	12.80	3 3 3	186138	0.20	0.36	0.00	2 2 2
186098	7.66	1.09	12.81	3 3 3	186138	0.23	0.32	0.00	2 2 2
186099	7.26	1.00	12.13	3 3 3	186139	9.80	0.89	7.95	2 2 2
186099	7.27	1.00	12.35	3 3 3	186139	9.89	0.89	7.99	2 2 2
186100	6.62	0.95	11.22	3 3 3	186140	9.15	0.89	7.76	2 2 2
186100	6.67	0.96	11.31	3 3 3	186140	9.28	0.88	7.71	2 2 2
186101	5.61	0.83	9.44	3 3 3	186141	7.47	0.83	6.27	2 2 2
186101	5.71	0.83	9.57	3 3 3	186141	7.52	0.85	6.28	2 2 2
186102	5.57	0.78	8.66	3 3 3	186142	7.45	0.84	6.30	2 2 2
186102	5.56	0.79	8.72	3 3 3	186142	7.57	0.84	6.32	2 2 2
186103	5.17	0.76	8.38	3 3 3	186143	2.31	0.60	1.76	2 2 2
186103	5.21	0.76	8.07	3 3 3	186143	2.28	0.55	1.60	2 2 2
186104	5.02	0.76	8.05	3 3 3	186144	0.71	0.38	0.00	2 2 2
186104	5.22	0.78	8.08	3 3 3	186144	0.76	0.40	0.00	2 2 2
186105	4.94	0.75	7.32	3 3 3	186145	0.72	0.33	0.00	2 2 2
186105	4.94	0.76	7.28	3 3 3	186145	0.78	0.33	0.00	2 2 2
186106	3.45	0.68	4.90	3 3 3	186146	14.42	1.06	16.27	2 2 2
186106	3.46	0.68	4.93	3 3 3	186146	14.61	1.08	16.28	2 2 2
186107	1.62	0.58	1.67	3 3 3	186147	12.87	0.98	12.61	2 2 2
186107	1.65	0.56	1.72	3 3 3	186147	13.02	0.96	12.67	2 2 2
186108	1.17	0.47	0.46	3 3 3	186148	11.19	0.94	9.93	2 2 2
186108	1.17	0.46	0.39	3 3 3	186148	11.30	0.95	9.74	2 2 2
186109	1.14	0.45	0.28	3 3 3	186149	10.57	0.92	8.76	2 2 2
186109	1.14	0.45	0.28	3 3 3	186149	10.62	0.92	8.75	2 2 2
186110	1.24	0.46	0.26	3 3 3	186150	10.19	0.92	8.34	2 2 2
186110	1.17	0.46	0.24	3 3 3	186150	10.35	0.91	8.38	2 2 2
186111	9.49	1.10	12.52	3 3 3	186151	10.01	0.94	8.25	2 2 2
186111	9.49	1.08	12.38	3 3 3	186151	10.11	0.91	8.09	2 2 2
186112	1.24	0.46	0.22	3 3 3	186152	9.61	0.92	8.08	2 3 2
186112	1.27	0.46	0.35	3 3 3	186152	9.70	0.98	8.00	2 3 2
186130	10.05	0.90	7.96	2 2 2	186153	9.65	0.93	7.87	2 2 2
186130	10.06	0.92	8.03	2 2 2	186153	9.59	0.91	8.05	2 2 2
186131	7.78	0.81	6.53	2 2 2	186154	8.16	0.94	7.01	2 2 2
186131	7.78	0.81	6.45	2 2 2	186154	8.14	0.84	7.03	2 2 2
186132	6.60	0.77	5.49	2 2 2	186155	6.96	0.78	6.35	2 2 2
186132	6.65	0.76	5.51	2 2 2	186155	6.99	0.78	6.29	2 2 2
186133	6.17	0.76	5.28	2 2 2	186156	8.30	0.86	7.05	2 2 2
186133	6.19	0.76	5.34	2 2 2	186156	8.37	0.86	7.11	2 2 2
186134	5.54	0.74	4.96	2 2 2	186157	8.04	0.96	6.85	2 3 2
186134	5.62	0.76	5.06	2 2 2	186157	7.96	0.85	6.83	2 3 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF
186158	2.64	0.55	1.83	2 2 3
186158	2.69	0.49	2.16	2 2 3
186159	1.13	0.45	0.23	2 2 3
186159	1.18	0.46	0.55	2 2 3
186160	0.89	0.38	0.00	2 3 2
186160	0.89	0.35	0.00	2 3 2
186161	0.84	0.43	0.00	2 3 2
186161	0.82	0.35	0.00	2 3 2
186162	12.01	1.07	15.32	2 2 2
186162	12.00	1.00	14.78	2 2 2
186163	12.85	0.96	13.29	2 2 2
186163	12.92	0.97	13.07	2 2 2
186164	10.60	0.87	11.93	2 2 2
186164	10.78	0.88	12.17	2 2 2
186165	11.12	0.92	9.99	2 2 2
186165	11.05	0.91	9.91	2 2 2
186166	9.61	0.88	8.87	2 2 2
186166	9.71	0.88	8.85	2 2 2
186167	6.69	0.83	7.90	2 2 2
186167	6.71	0.81	8.02	2 2 2
186168	5.44	0.71	5.57	2 2 2
186168	5.54	0.70	5.61	2 2 2
186169	3.42	0.45	2.15	2 2 3
186169	3.35	0.48	1.77	2 2 3
186170	1.98	0.36	0.02	2 2 3
186170	1.91	0.41	0.16	2 2 3
186171	1.82	0.38	0.04	2 2 3
186171	1.86	0.36	0.04	2 2 3
186173	12.33	1.02	13.09	2 2 2
186173	12.43	0.95	12.99	2 2 2
186174	10.39	0.90	11.83	2 2 2
186174	10.18	0.89	11.77	2 2 2
186175	11.80	0.93	10.83	2 2 2
186175	11.81	0.93	10.63	2 2 2
186176	9.84	0.90	9.29	2 2 2
186176	9.86	0.90	9.31	2 2 2
186177	7.88	0.85	8.39	2 2 2
186177	7.89	0.85	8.67	2 2 2
186178	5.48	0.72	5.82	2 2 2
186178	5.34	0.75	5.78	2 2 2
186179	3.89	0.65	2.45	2 2 2
186179	3.88	0.56	2.39	2 2 2
186180	2.60	0.46	0.40	2 3 3
186180	2.76	0.47	0.72	2 3 3
186181	2.47	0.49	0.30	2 3 3
186181	2.49	0.42	0.48	2 3 3
186182	2.53	0.45	0.28	2 3 3
186182	2.66	0.46	0.87	2 3 3
186190	11.84	1.15	16.62	2 2 2
186190	12.09	1.05	16.64	2 2 2
186191	11.10	1.00	15.59	2 2 2
186191	11.23	1.01	16.59	2 2 2
186192	12.46	1.01	14.30	2 2 2
186192	12.66	1.02	14.30	2 2 2
186193	11.36	0.94	12.63	2 2 2
186193	11.40	0.93	12.57	2 2 2
186194	10.88	1.05	11.27	2 2 2
186194	10.95	0.95	11.53	2 2 2
186195	9.24	0.87	9.24	2 2 2
186195	9.34	0.87	9.18	2 2 2
186196	5.60	0.82	6.44	2 3 2
186196	5.64	0.72	6.40	2 3 2
186197	1.83	0.46	1.43	2 3 3
186197	1.85	0.54	1.15	2 3 3
186198	2.48	0.53	1.77	2 2 3
186198	2.41	0.50	1.04	2 2 3
186199	2.48	0.53	0.68	2 2 3
186199	2.55	0.55	1.09	2 2 3
186200	11.93	1.08	16.18	2 2 2
186200	12.12	1.15	16.28	2 2 2
186201	10.94	1.03	15.11	2 2 2
186201	11.16	1.04	15.25	2 2 2
186202	9.68	0.98	12.00	2 2 2
186202	9.79	0.98	11.94	2 2 2
186203	10.33	1.03	10.94	2 2 2
186203	10.42	1.00	11.30	2 2 2
186204	10.54	0.94	9.56	2 2 2
186204	10.55	0.92	9.50	2 2 2
186205	10.36	0.97	8.88	2 2 2
186205	10.47	0.94	8.98	2 2 2
186206	6.94	0.79	6.54	2 2 2
186206	6.86	0.82	6.06	2 2 2
186207	1.06	0.47	0.00	2 2 2
186207	1.07	0.46	0.00	2 2 2
186208	0.53	0.41	0.00	2 2 2
186208	0.55	0.43	0.00	2 2 2
186209	0.56	0.41	0.00	2 2 2
186209	0.62	0.41	0.00	2 2 2
186211	12.11	1.19	15.37	2 2 2
186211	12.14	1.10	15.27	2 2 2
186212	10.73	1.02	13.63	2 2 2
186212	10.90	1.02	14.10	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
186213	11.73	1.02	12.38	2 2 2	186238	10.18	1.06	16.80	2 2 3
186213	11.88	1.03	12.65	2 2 2	186238	10.24	1.02	16.39	2 2 2
186214	10.00	0.94	11.50	2 2 2	186239	9.03	1.00	15.97	2 2 2
186214	10.05	0.96	11.44	2 2 2	186239	8.97	0.99	15.73	2 2 2
186215	7.30	0.78	7.19	2 2 2	186240	8.84	0.98	15.54	2 2 2
186215	7.27	0.80	7.19	2 2 2	186240	8.90	1.00	15.56	2 2 2
186216	4.02	0.59	3.74	2 2 2	186241	8.95	0.98	15.28	2 2 2
186216	4.03	0.61	3.92	2 2 2	186241	9.07	0.99	15.49	2 2 2
186217	3.08	0.50	2.26	2 2 2	186242	9.00	0.95	15.13	2 2 2
186217	3.13	0.49	2.16	2 2 2	186242	9.09	0.95	15.17	2 2 2
186218	2.88	0.49	1.70	2 2 2	186243	10.22	0.98	14.76	2 2 2
186218	2.91	0.49	1.80	2 2 2	186243	10.19	0.97	14.65	2 2 2
186219	11.90	1.11	15.46	2 2 2	186244	10.33	0.95	14.46	2 2 2
186219	11.91	1.02	15.50	2 2 2	186244	10.30	0.95	14.80	2 2 2
186220	10.32	0.96	15.38	2 2 2	186245	10.60	0.94	14.16	2 2 2
186220	10.55	0.98	15.07	2 2 2	186245	10.67	0.95	14.17	2 2 2
186221	10.81	1.01	14.65	2 2 2	186246	10.58	0.95	14.03	2 2 2
186221	10.98	0.97	14.69	2 2 2	186246	10.62	0.94	13.99	2 2 2
186222	12.64	1.00	14.00	2 2 2	186247	10.40	0.96	13.60	2 2 2
186222	12.66	1.00	14.06	2 2 2	186247	10.32	0.95	13.71	2 2 2
186223	9.76	0.91	12.51	2 2 2	186248	10.32	0.96	13.81	2 2 2
186223	9.84	0.92	12.65	2 2 2	186248	10.36	0.98	13.79	2 2 2
186224	9.80	0.90	11.80	2 2 2	186249	10.03	0.94	13.51	2 2 2
186224	9.84	0.90	11.98	2 2 2	186249	10.11	0.96	13.34	2 2 2
186225	9.88	0.93	11.18	2 2 2	186250	9.79	0.92	12.94	2 2 2
186225	9.74	0.91	11.26	2 2 2	186250	9.99	0.92	12.98	2 2 2
186226	10.76	0.94	10.41	2 2 2	186251	9.83	0.92	12.45	2 2 2
186226	10.63	0.92	10.73	2 2 2	186251	9.82	0.91	13.19	2 2 2
186227	9.91	0.84	10.15	2 2 2	186252	9.80	0.88	12.04	2 2 3
186227	9.93	1.01	10.17	2 2 2	186252	9.78	0.91	11.83	2 2 3
186228	9.50	0.87	10.05	2 2 2	186253	2.98	0.52	1.51	2 3 3
186228	9.81	0.85	9.77	2 2 2	186253	3.06	0.43	2.88	2 3 3
186229	9.12	0.88	9.54	2 2 2	186254	1.88	0.32	0.00	2 3 2
186229	9.05	0.87	9.59	2 2 2	186254	1.90	0.33	0.00	2 3 2
186230	8.82	0.85	8.92	2 2 2	186255	1.92	0.36	0.00	2 3 2
186230	8.86	0.87	9.02	2 2 2	186255	1.87	0.34	0.00	2 3 2
186231	7.03	0.76	7.02	2 2 2	186256	9.83	1.01	16.56	2 2 2
186231	7.04	0.77	7.00	2 2 2	186256	9.85	1.01	16.58	2 2 2
186232	4.73	0.66	4.84	2 2 2	186257	9.57	1.01	16.71	2 2 2
186232	4.74	0.65	4.86	2 2 2	186257	9.59	1.01	16.58	2 2 2
186233	4.56	0.62	4.28	2 2 2	186258	9.51	1.01	16.66	2 2 2
186233	4.49	0.63	4.18	2 2 2	186258	9.62	1.01	16.68	2 2 2
186234	4.52	0.61	4.12	2 2 2	186259	9.55	1.02	16.50	2 2 2
186234	4.48	0.62	4.10	2 2 2	186259	9.50	1.02	16.16	2 2 2
186235	4.49	0.60	4.10	2 2 2	186260	9.20	1.00	16.31	2 2 2
186235	4.61	0.59	4.10	2 2 2	186260	9.09	1.00	16.06	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
186261	9.13	1.04	16.08	2 3 2	186300	9.91	1.01	16.91	2 2 2
186261	9.23	0.99	15.87	2 3 2	186300	9.90	1.02	16.76	2 2 2
186262	8.91	0.97	15.70	2 2 2	186301	9.53	1.00	16.98	2 2 2
186262	9.06	0.97	15.76	2 2 2	186301	9.54	1.00	16.94	2 2 2
186263	9.08	0.97	15.82	2 2 2	186302	9.10	0.99	16.45	2 2 2
186263	8.89	0.95	15.94	2 2 2	186302	9.24	0.99	16.68	2 2 2
186264	9.00	0.95	15.71	2 2 2	186303	9.11	0.99	16.36	2 2 2
186264	9.41	0.94	15.67	2 2 2	186303	9.12	1.01	16.38	2 2 2
186265	9.21	0.93	15.26	2 2 2	186304	8.94	0.99	16.32	2 2 2
186265	9.22	0.93	15.13	2 2 2	186304	8.96	0.99	16.23	2 2 2
186266	9.23	0.93	14.60	2 2 2	186305	8.92	0.97	16.02	2 2 2
186266	9.33	0.94	15.36	2 2 2	186305	8.97	0.99	16.08	2 2 2
186267	9.32	0.91	14.01	2 2 2	186306	8.95	0.98	16.10	2 2 2
186267	9.28	0.92	14.11	2 2 2	186306	9.06	0.98	16.13	2 2 2
186268	9.45	0.93	14.23	2 2 2	186307	8.79	0.97	16.02	2 2 2
186268	9.43	0.94	14.11	2 2 2	186307	8.93	0.97	16.13	2 2 2
186269	9.59	0.91	13.69	2 2 2	186308	8.78	0.96	15.48	2 2 2
186269	9.66	0.92	13.55	2 2 2	186308	8.95	0.97	15.47	2 2 2
186270	9.96	0.93	13.84	2 2 2	186309	8.95	0.92	14.96	2 2 2
186270	10.00	0.93	13.59	2 2 2	186309	8.99	0.93	14.83	2 2 2
186271	10.20	0.92	13.14	2 2 2	186310	8.66	0.80	12.07	2 2 2
186271	10.01	0.92	13.23	2 2 2	186310	8.80	0.79	12.10	2 2 2
186272	10.45	0.91	12.51	2 2 2	186311	9.04	0.74	9.61	2 2 2
186272	10.47	0.92	12.47	2 2 2	186311	9.15	0.75	9.46	2 2 2
186273	10.41	0.89	11.27	2 2 2	186312	9.67	0.79	9.75	2 2 2
186273	10.49	0.89	11.27	2 2 2	186312	9.56	0.77	9.71	2 2 2
186274	10.41	0.83	9.22	2 2 2	186313	11.74	1.12	15.69	2 3 2
186274	10.55	0.82	9.47	2 2 2	186313	11.75	0.97	15.76	2 3 2
186275	8.09	0.65	5.74	2 2 2	186314	11.86	0.96	15.66	2 2 2
186275	8.08	0.64	6.01	2 2 2	186314	11.90	0.95	15.67	2 2 2
186276	10.37	0.76	7.40	2 2 2	186315	12.12	0.98	15.77	2 2 2
186276	10.32	0.75	7.42	2 2 2	186315	12.32	0.99	15.64	2 2 2
186277	10.51	0.76	7.62	2 2 2	186316	12.03	1.05	16.14	2 2 2
186277	10.55	0.75	7.33	2 2 2	186316	12.17	0.98	16.09	2 2 2
186294	11.92	0.98	16.25	2 2 2	186317	11.68	0.97	16.02	2 2 2
186294	11.94	0.97	16.23	2 2 2	186317	11.73	0.98	15.91	2 2 2
186295	11.74	0.99	16.22	2 2 2	186318	11.24	1.01	16.24	2 2 2
186295	11.69	0.99	16.39	2 2 2	186318	11.29	1.01	16.37	2 2 2
186296	11.01	1.00	16.32	2 2 2	186319	10.65	1.01	16.84	2 2 2
186296	11.02	0.99	16.39	2 2 2	186319	10.67	1.02	16.76	2 2 2
186297	10.66	0.99	16.86	2 2 2	186320	10.26	1.04	16.69	2 2 2
186297	10.70	0.98	16.26	2 2 2	186320	10.24	1.02	16.90	2 2 2
186298	10.04	1.01	16.97	2 2 2	186321	9.83	1.03	16.64	2 2 2
186298	10.06	1.00	16.92	2 3 2	186321	10.00	1.01	16.81	2 2 2
186299	9.90	1.07	16.90	2 3 2	186322	9.77	1.04	16.47	2 2 2
186299	9.89	0.99	16.85	2 2 2	186322	9.82	1.04	16.60	2 2 2

Table C.4 Replicate nutrient water sample values in μmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
186323	9.49	1.01	16.72	2 2 2	186347	9.19	1.03	16.07	2 2 2
186323	9.50	1.00	16.74	2 2 2	186347	9.03	1.03	16.21	2 2 2
186324	9.14	1.01	16.34	2 2 2	186348	9.22	1.05	16.13	2 2 2
186324	9.25	1.01	16.57	2 2 2	186348	9.17	1.04	16.06	2 2 2
186325	9.04	0.99	16.30	2 2 2	186349	9.11	1.01	15.54	2 2 2
186325	9.06	0.99	16.36	2 2 2	186349	9.18	1.02	15.46	2 2 2
186326	9.05	0.99	15.92	2 2 2	186350	8.95	1.01	15.38	2 2 2
186326	9.13	0.98	15.90	2 2 2	186350	9.02	1.02	15.71	2 2 2
186327	8.96	0.99	15.50	2 2 2	186351	9.00	1.00	14.86	2 2 2
186327	9.03	1.01	15.60	2 2 2	186351	8.95	0.99	14.88	2 2 2
186328	9.12	0.97	15.68	2 2 2	186352	9.06	0.98	15.00	2 2 2
186328	9.10	0.98	15.24	2 2 2	186352	9.11	0.98	14.79	2 2 2
186329	8.93	0.95	14.97	2 3 2	186353	8.70	0.97	14.19	2 2 2
186329	8.95	1.13	14.99	2 3 2	186353	8.72	0.96	14.08	2 2 2
186330	8.72	0.90	13.20	2 2 2	186354	8.58	0.74	9.55	2 2 2
186330	8.79	0.90	13.39	2 2 2	186354	8.60	0.75	9.47	2 2 2
186331	8.83	0.84	12.08	2 2 2	186355	8.63	0.75	9.65	2 2 2
186331	8.92	0.82	12.20	2 2 2	186355	8.59	0.76	9.69	2 2 2
186333	10.88	0.95	14.91	2 2 2	186358	11.77	0.99	14.62	2 2 2
186333	10.93	0.94	14.87	2 2 2	186358	11.76	0.95	14.73	2 2 2
186334	10.90	0.94	14.75	2 2 2	186359	13.46	1.00	15.39	2 2 2
186334	10.93	0.93	14.79	2 2 2	186359	13.99	1.01	15.30	2 2 2
186335	11.00	0.95	15.02	2 2 2	186360	14.26	1.02	15.78	2 2 2
186335	11.07	0.95	15.01	2 2 2	186360	14.44	1.03	16.01	2 2 2
186336	12.23	1.00	15.70	2 2 2	186361	12.95	1.01	15.72	2 2 2
186336	12.33	1.00	15.63	2 2 2	186361	12.80	1.03	15.78	2 2 2
186337	12.08	1.02	15.96	2 2 2	186362	12.73	1.03	16.28	2 2 2
186337	12.10	1.01	15.94	2 2 2	186362	12.73	1.03	16.15	2 2 2
186338	12.03	1.03	16.48	2 2 2	186363	11.56	1.03	16.26	2 2 2
186338	12.08	1.04	16.06	2 2 2	186363	11.59	1.04	16.01	2 2 2
186339	11.71	1.03	16.68	2 2 2	186364	11.54	1.04	16.50	2 2 2
186339	11.70	1.04	16.66	2 2 2	186364	11.70	1.04	16.26	2 2 2
186340	10.99	1.05	16.45	2 2 2	186365	10.75	1.04	16.55	2 2 2
186340	10.76	1.05	16.42	2 2 2	186365	10.53	1.05	16.63	2 2 2
186341	10.04	1.04	16.36	2 2 2	186366	9.76	1.03	16.63	2 2 2
186341	10.11	1.04	16.52	2 2 2	186366	9.74	1.06	16.03	2 2 2
186342	9.79	1.09	16.53	2 2 2	186367	9.67	1.05	16.67	2 2 2
186342	9.90	1.05	16.49	2 2 2	186367	9.73	1.04	16.88	2 2 2
186343	9.62	1.04	16.34	2 2 2	186368	9.74	1.04	16.90	2 2 2
186343	9.61	1.04	16.21	2 2 2	186368	9.77	1.05	16.41	2 2 2
186344	9.92	1.06	16.64	2 2 2	186369	9.79	1.06	16.99	2 2 2
186344	9.93	1.04	16.58	2 2 2	186369	9.81	1.05	16.86	2 2 2
186345	9.49	1.05	16.12	2 2 2	186370	9.97	1.05	17.46	2 2 2
186345	9.66	1.07	16.37	2 2 2	186370	10.01	1.06	16.69	2 2 2
186346	9.20	1.03	15.97	2 2 2	186371	9.77	1.08	17.24	2 2 2
186346	9.36	1.04	16.24	2 2 2	186371	9.79	1.07	17.16	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
186372	8.91	1.01	16.27	2 2 2	186397	9.27	1.32	16.97	2 3 2
186372	8.98	1.02	16.12	2 2 2	186397	9.40	1.04	17.22	2 3 2
186373	8.91	1.03	16.31	2 2 2	186398	8.63	1.17	16.01	2 3 2
186373	8.93	1.01	15.87	2 2 2	186398	8.66	1.11	16.01	2 3 2
186374	8.89	1.03	16.42	2 2 2	186399	8.45	0.99	15.80	2 2 2
186374	8.93	1.05	16.32	2 2 2	186399	8.53	1.00	15.76	2 2 2
186375	8.65	1.01	16.00	2 2 2	186400	8.01	0.98	15.06	2 2 2
186375	8.68	1.01	15.60	2 2 2	186400	8.20	0.97	14.96	2 2 2
186376	7.92	0.94	14.59	2 2 2	186401	8.08	0.96	14.94	2 2 2
186376	8.01	0.93	14.38	2 2 2	186401	8.11	0.97	15.02	2 2 2
186377	7.88	0.91	13.77	2 2 2	186402	7.47	0.87	13.07	2 3 2
186377	7.93	0.91	13.64	2 2 2	186402	7.52	0.94	12.99	2 3 2
186378	7.78	0.85	12.32	2 2 2	186403	4.86	0.54	7.30	2 3 2
186378	7.76	0.83	12.21	2 2 2	186403	4.90	0.63	7.42	2 3 2
186379	7.22	0.70	9.35	2 2 2	186404	4.76	0.55	7.24	2 2 2
186379	7.28	0.70	9.37	2 2 2	186404	4.74	0.54	7.26	2 2 2
186382	11.19	0.98	15.35	2 2 2	186405	11.38	1.00	15.19	2 2 2
186382	11.30	0.95	15.33	2 2 2	186405	11.41	1.01	15.19	2 2 2
186383	13.53	1.01	15.56	2 2 2	186406	11.84	0.97	15.28	2 2 2
186383	13.55	1.00	15.99	2 2 2	186406	11.89	0.97	15.21	2 2 2
186384	14.53	1.01	16.24	2 2 2	186407	13.27	1.00	16.08	2 2 2
186384	14.63	1.05	16.20	2 2 2	186407	13.39	0.98	16.16	2 2 2
186385	14.23	1.03	16.66	2 2 2	186408	14.90	1.05	16.25	2 2 2
186385	14.82	1.04	16.77	2 2 2	186408	14.95	1.01	16.39	2 2 2
186386	12.30	1.07	16.30	2 2 2	186409	14.06	1.04	16.26	2 2 2
186386	12.39	1.02	16.45	2 2 2	186409	14.25	1.05	16.64	2 2 2
186387	11.36	1.02	16.75	2 2 2	186410	14.26	1.14	16.78	2 3 2
186387	11.50	1.01	16.70	2 2 2	186410	14.35	1.05	16.36	2 3 2
186388	11.09	1.04	16.66	2 2 2	186411	12.85	1.03	16.88	2 2 2
186388	11.00	1.03	16.53	2 2 2	186411	13.14	1.03	17.11	2 2 2
186389	10.39	1.03	17.15	2 2 2	186412	11.82	1.04	16.89	2 2 2
186389	10.50	1.03	17.02	2 2 2	186412	11.79	1.04	16.55	2 2 2
186390	9.88	1.06	17.04	2 2 2	186413	10.62	1.04	16.63	2 2 2
186390	9.88	1.03	16.91	2 2 2	186413	10.76	1.07	16.92	2 2 2
186391	9.69	1.04	17.19	2 2 2	186414	10.06	1.04	16.88	2 2 2
186391	9.70	1.02	17.27	2 2 2	186414	10.11	1.05	16.81	2 2 2
186392	9.83	2.30	16.93	2 3 2	186415	9.73	1.03	16.74	2 3 2
186392	9.89	0.98	16.95	2 2 2	186415	9.75	1.12	16.61	2 3 2
186393	9.79	1.10	17.01	2 2 2	186416	9.75	1.05	16.98	2 2 2
186393	9.82	1.04	17.14	2 2 2	186416	9.84	1.07	16.81	2 2 2
186394	9.69	1.07	17.37	2 2 2	186417	9.77	1.03	17.14	2 2 2
186394	9.69	1.05	17.16	2 2 2	186417	9.97	1.06	17.27	2 2 2
186395	9.65	1.05	17.33	2 2 2	186418	10.05	1.07	16.99	2 2 2
186395	9.70	1.06	17.26	2 2 2	186418	10.10	1.07	17.05	2 2 2
186396	9.87	1.08	17.86	2 2 2	186419	10.17	1.07	17.35	2 2 2
186396	9.75	1.07	17.82	2 2 2	186419	10.24	1.08	17.37	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
186420	10.34	1.11	17.77	2 2 2	186443	9.69	1.07	16.85	2 2 2
186420	10.30	1.09	17.49	2 2 2	186443	9.74	1.06	16.93	2 2 2
186421	9.40	1.05	16.43	2 2 2	186444	10.32	1.11	17.45	2 2 2
186421	9.46	1.05	16.77	2 2 2	186444	10.34	1.10	17.36	2 2 2
186422	9.68	1.07	17.74	2 2 2	186445	10.62	1.13	17.42	2 2 2
186422	9.82	1.10	17.53	2 2 2	186445	10.73	1.13	17.99	2 2 2
186423	9.20	1.03	16.51	2 2 2	186446	9.36	1.06	16.33	2 2 2
186423	9.20	1.06	16.68	2 2 2	186446	9.25	1.07	16.69	2 2 2
186424	8.93	1.06	15.99	2 2 2	186447	9.32	1.06	16.01	2 2 2
186424	8.99	1.03	15.99	2 2 2	186447	9.26	1.08	15.96	2 2 2
186425	9.09	1.03	16.46	2 2 2	186448	7.92	0.90	13.48	2 2 2
186425	9.12	1.04	15.99	2 2 2	186448	7.95	0.95	13.44	2 2 2
186426	7.86	0.95	14.40	2 2 2	186449	7.54	0.94	14.08	2 2 2
186426	7.96	0.95	14.92	2 2 2	186449	7.59	0.91	14.04	2 2 2
186427	6.81	0.79	11.02	2 2 2	186450	7.38	0.86	12.02	2 2 2
186427	6.91	0.81	10.82	2 2 2	186450	7.35	0.86	11.75	2 2 2
186428	4.76	0.51	6.62	2 2 2	186451	5.64	0.62	7.70	2 2 2
186428	4.70	0.53	6.49	2 2 2	186451	5.66	0.64	7.76	2 2 2
186429	11.30	0.95	14.95	2 2 2	186452	5.27	0.64	7.10	2 2 2
186429	11.36	0.97	14.85	2 2 2	186452	5.31	0.60	7.14	2 2 2
186430	11.78	0.96	14.82	2 2 2	186453	12.29	0.97	14.75	2 2 2
186430	11.85	0.95	15.14	2 2 2	186453	12.32	0.97	14.79	2 2 2
186431	12.53	1.00	15.02	2 2 2	186454	12.43	0.98	14.73	2 2 2
186431	12.70	0.98	15.10	2 2 2	186454	12.42	0.96	14.86	2 2 2
186432	14.70	1.02	16.13	2 2 2	186455	14.15	1.01	15.27	2 2 2
186432	14.74	1.05	15.86	2 2 2	186455	13.94	1.01	15.33	2 2 2
186433	14.54	1.05	16.14	2 2 2	186456	14.86	1.06	16.16	2 2 2
186433	14.55	1.03	16.23	2 2 2	186456	14.94	1.03	16.09	2 2 2
186434	13.31	1.04	16.54	2 2 2	186457	14.56	1.03	16.22	2 2 2
186434	13.40	1.05	16.02	2 2 2	186457	14.66	1.03	15.96	2 2 2
186435	12.31	1.03	16.75	2 2 2	186459	11.63	1.03	15.88	2 2 2
186435	12.51	1.06	16.70	2 2 2	186459	11.47	1.04	15.99	2 2 2
186436	11.33	1.04	16.34	2 2 2	186460	11.81	1.05	16.22	2 2 2
186436	11.37	1.05	16.43	2 2 2	186460	11.82	1.06	16.66	2 2 2
186437	10.43	1.04	16.40	2 2 2	186461	10.29	1.04	16.44	2 2 2
186437	10.48	1.05	16.63	2 2 2	186461	10.40	1.06	16.44	2 2 2
186438	10.13	1.07	16.69	2 2 2	186462	9.96	1.02	16.66	2 2 2
186438	10.06	1.04	16.71	2 2 2	186462	9.98	1.04	16.19	2 2 2
186439	10.08	1.05	16.62	2 2 2	186463	10.02	1.04	16.69	2 2 2
186439	10.02	1.08	16.47	2 2 2	186463	10.02	1.09	16.92	2 2 2
186440	10.08	1.09	16.75	2 2 2	186464	9.94	1.04	16.56	2 2 2
186440	10.10	1.06	16.79	2 2 2	186464	9.91	1.04	16.95	2 2 2
186441	10.27	1.07	17.12	2 2 2	186465	10.28	1.05	17.06	2 2 2
186441	10.29	1.08	16.74	2 2 2	186465	10.37	1.05	16.73	2 2 2
186442	10.14	1.07	16.75	2 2 2	186466	10.01	1.07	17.19	2 2 2
186442	10.10	1.07	16.81	2 2 2	186466	10.04	1.04	16.82	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
186467	10.11	1.05	16.91	2 2 2	186505	10.30	1.07	16.76	2 2 2
186467	10.17	1.05	17.34	2 2 2	186505	10.37	1.19	17.11	2 2 2
186468	10.24	1.08	17.56	2 2 2	186506	10.36	1.07	17.33	2 2 2
186468	10.36	1.09	17.71	2 2 2	186506	10.49	1.09	17.15	2 2 2
186469	10.03	1.12	17.32	2 2 2	186507	10.45	1.09	17.11	2 2 2
186469	10.13	1.11	17.28	2 2 2	186507	10.29	1.07	17.24	2 2 2
186470	9.59	1.07	16.65	2 2 2	186508	10.11	1.10	17.46	2 2 2
186470	9.62	1.08	16.63	2 2 2	186508	10.26	1.10	17.09	2 2 2
186471	8.29	0.98	14.92	2 2 2	186509	9.68	1.06	16.77	2 2 2
186471	8.41	1.03	15.01	2 2 2	186509	9.75	1.07	16.88	2 2 2
186472	8.59	0.99	14.94	2 2 2	186510	8.38	0.98	14.65	2 2 2
186472	8.65	0.99	15.25	2 2 2	186510	8.44	0.98	15.14	2 2 2
186473	7.43	0.90	13.44	2 2 2	186511	8.13	0.96	14.54	2 2 2
186473	7.49	0.91	13.42	2 2 2	186511	8.13	0.94	14.65	2 2 2
186474	6.46	0.77	10.57	2 2 2	186512	7.97	0.95	13.76	2 2 2
186474	6.46	0.77	10.61	2 2 2	186512	7.99	0.93	14.02	2 2 2
186475	5.54	0.66	9.45	2 2 2	186513	7.93	0.93	13.68	2 2 2
186475	5.57	0.68	9.47	2 2 2	186513	7.99	0.93	13.72	2 2 2
186476	4.84	0.57	7.97	2 2 2	186514	4.43	0.63	8.29	2 2 2
186476	4.81	0.57	7.82	2 2 2	186514	4.52	0.64	8.31	2 2 2
186492	13.72	1.01	15.42	2 2 2	186515	1.27	0.44	6.00	2 2 2
186492	13.81	1.00	15.51	2 2 2	186515	1.28	0.43	6.08	2 2 2
186493	15.44	1.02	15.94	2 2 2	186516	13.93	0.99	15.21	2 2 2
186493	15.45	1.03	15.86	2 2 2	186516	14.09	1.00	15.54	2 2 2
186494	15.14	1.06	16.38	2 2 2	186517	15.71	1.03	15.50	2 2 2
186494	15.17	1.05	16.42	2 2 2	186517	15.58	1.02	15.43	2 2 2
186495	15.42	1.06	16.66	2 2 2	186518	15.83	1.05	16.23	2 2 2
186495	15.52	1.06	16.29	2 2 2	186518	15.77	1.03	16.19	2 2 2
186496	14.23	1.06	16.38	2 2 2	186519	15.40	1.04	16.32	2 2 2
186496	14.42	1.07	16.55	2 2 2	186519	15.58	1.05	16.04	2 2 2
186497	13.29	1.05	16.66	2 2 2	186520	14.36	1.06	16.34	2 2 2
186497	13.41	1.06	16.36	2 2 2	186520	14.39	1.04	16.17	2 2 2
186498	12.25	1.04	16.34	2 2 2	186521	13.33	1.04	16.39	2 2 2
186498	12.50	1.06	16.62	2 2 2	186521	13.33	1.04	16.26	2 2 2
186499	11.64	1.07	16.64	2 2 2	186522	12.45	1.04	16.24	2 2 2
186499	11.61	1.05	16.58	2 2 2	186522	12.51	1.05	16.19	2 2 2
186500	10.51	1.06	16.43	2 2 2	186523	11.82	1.06	16.28	2 2 2
186500	10.66	1.05	16.51	2 2 2	186523	11.89	1.04	16.54	2 2 2
186501	10.30	1.04	16.50	2 2 2	186524	10.54	1.04	16.28	2 2 2
186501	10.36	1.04	16.45	2 2 2	186524	10.60	1.06	16.43	2 2 2
186502	10.29	1.07	16.97	2 2 2	186525	10.31	1.03	16.63	2 2 2
186502	10.39	1.09	16.45	2 2 2	186525	10.19	1.04	16.50	2 2 2
186503	10.19	1.06	16.71	2 2 2	186526	10.28	1.04	16.72	2 2 2
186503	10.35	1.05	16.82	2 2 2	186526	10.25	1.03	16.37	2 2 2
186504	10.56	1.20	17.17	2 2 2	186527	10.22	1.06	16.37	2 2 2
186504	10.62	1.06	16.98	2 2 2	186527	10.25	1.07	16.66	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
186528	10.47	1.05	16.66	2 2 2	186551	10.11	1.05	17.55	2 2 2
186528	10.54	1.12	17.07	2 2 2	186551	10.13	1.05	17.19	2 2 2
186529	10.60	1.07	17.03	2 2 2	186552	10.09	1.03	17.30	2 2 2
186529	10.44	1.06	16.55	2 2 2	186552	10.22	1.04	17.18	2 2 2
186530	10.63	1.07	17.18	2 2 2	186553	10.27	1.06	17.67	2 2 2
186530	10.66	1.07	16.81	2 2 2	186553	10.20	1.06	17.38	2 2 2
186531	10.63	1.09	17.20	2 2 2	186579	15.17	1.02	16.64	2 2 2
186531	10.82	1.15	17.49	2 2 2	186579	15.33	1.01	16.26	2 2 2
186532	10.10	1.08	16.62	2 2 2	186580	14.56	1.04	16.44	2 2 2
186532	10.16	1.07	17.01	2 2 2	186580	14.69	1.04	17.05	2 2 2
186533	9.17	1.01	15.97	2 2 2	186581	14.22	1.04	17.04	2 2 2
186533	9.02	1.01	15.34	2 2 2	186581	14.40	1.02	16.99	2 2 2
186534	8.51	0.96	14.74	2 2 2	186582	13.80	1.03	16.84	2 2 2
186534	8.44	0.98	14.63	2 2 2	186582	13.73	1.03	16.84	2 2 2
186535	7.55	0.92	13.58	2 2 2	186583	12.53	1.06	17.12	2 2 2
186535	7.58	0.89	13.70	2 2 2	186583	12.51	1.02	16.96	2 2 2
186536	7.88	0.90	13.84	2 2 2	186584	11.87	1.04	16.95	2 2 2
186536	7.92	0.92	13.94	2 2 2	186584	11.87	1.06	17.07	2 2 2
186537	3.28	0.57	7.81	2 2 2	186585	10.96	1.04	16.92	2 2 2
186537	3.21	0.55	7.62	2 2 2	186585	10.98	1.04	16.83	2 2 2
186538	2.80	0.52	7.49	2 2 2	186586	10.20	1.05	17.28	2 2 2
186538	2.82	0.52	7.41	2 2 2	186586	10.19	1.05	17.24	2 2 2
186539	2.75	0.54	7.39	2 2 2	186587	9.81	1.02	17.00	2 2 2
186539	2.81	0.53	7.22	2 2 2	186587	9.84	1.03	17.09	2 2 2
186540	15.23	1.04	16.23	2 2 2	186588	9.73	1.03	17.34	2 2 2
186540	15.38	1.00	15.95	2 2 2	186588	9.77	1.05	17.00	2 2 2
186541	15.59	1.02	16.22	2 2 2	186589	9.67	1.04	16.68	2 2 2
186541	15.37	1.02	16.11	2 2 2	186589	9.69	1.04	17.09	2 2 2
186542	15.70	1.06	17.02	2 2 2	186590	9.80	1.04	17.18	2 2 2
186542	15.60	1.03	16.63	2 2 2	186590	9.69	1.05	17.27	2 2 2
186543	14.90	1.03	16.62	2 2 2	186591	9.89	1.04	17.30	2 2 2
186543	15.07	1.03	16.78	2 2 2	186591	9.88	1.06	17.11	2 2 2
186544	14.49	1.04	16.75	2 2 2	186592	9.94	1.05	17.39	2 2 2
186544	14.67	1.05	16.95	2 2 2	186592	10.12	1.07	17.84	2 2 2
186545	13.42	1.04	16.76	2 2 2	186593	9.83	1.07	17.52	2 2 2
186545	13.35	1.04	16.77	2 2 2	186593	9.83	1.07	17.57	2 2 2
186546	12.31	1.05	17.10	2 2 2	186594	8.46	0.99	15.94	2 2 2
186546	12.44	1.04	16.54	2 2 2	186594	8.42	1.01	15.89	2 2 2
186547	11.61	1.04	17.06	2 2 2	186595	9.13	1.05	16.60	2 2 2
186547	11.70	1.04	16.97	2 2 2	186595	9.24	1.05	16.87	2 2 2
186548	10.98	1.04	16.61	2 2 2	186596	8.55	1.02	15.96	2 2 2
186548	11.07	1.02	16.92	2 2 2	186596	8.64	1.03	16.02	2 2 2
186549	10.47	1.04	17.27	2 2 2	186597	8.54	1.02	15.99	2 2 2
186549	10.40	1.04	17.27	2 2 2	186597	8.64	1.01	15.79	2 2 2
186550	10.03	1.04	17.05	2 2 2	186598	8.19	0.97	15.31	2 2 2
186550	9.99	1.05	17.34	2 2 2	186598	8.00	0.97	15.03	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
186599	7.75	0.95	14.62	2 2 2	186622	7.64	1.05	12.48	2 2 2
186599	7.68	0.96	14.77	2 2 2	186622	7.66	1.06	12.60	2 2 2
186600	3.80	0.70	10.47	2 2 2	186623	7.69	1.04	12.47	2 2 2
186600	3.81	0.69	10.57	2 2 2	186623	7.74	1.06	13.02	2 2 2
186601	2.37	0.60	9.03	2 2 2	186624	7.36	1.02	12.47	2 2 2
186601	2.47	0.66	9.43	2 2 2	186624	7.42	1.02	12.84	2 2 2
186602	2.34	0.61	9.09	2 2 2	186625	4.20	0.73	8.91	2 2 2
186602	2.39	0.66	9.21	2 2 2	186625	4.27	0.73	8.90	2 2 2
186603	14.61	1.06	15.89	2 2 2	186626	4.13	0.72	8.85	2 2 2
186603	14.78	1.01	15.86	2 2 2	186626	4.13	0.70	8.87	2 2 2
186604	14.35	1.04	16.15	2 2 2	186627	14.60	1.09	14.50	2 2 2
186604	14.48	1.07	16.54	2 2 2	186627	14.42	1.09	14.33	2 2 2
186605	14.39	1.06	16.15	2 2 2	186628	14.28	1.09	14.49	2 2 2
186605	14.45	1.05	16.34	2 2 2	186628	14.38	1.09	14.83	2 2 2
186606	13.72	1.05	16.42	2 2 2	186629	14.40	1.09	14.80	2 2 2
186606	13.79	1.05	16.27	2 2 2	186629	14.42	1.07	14.84	2 2 2
186607	13.24	1.07	16.23	2 2 2	186630	13.45	1.08	15.11	2 2 2
186607	13.28	1.04	16.34	2 2 2	186630	13.48	1.07	15.30	2 2 2
186608	12.45	1.08	16.48	2 2 2	186631	12.76	1.08	15.18	2 2 2
186608	12.49	1.06	16.53	2 2 2	186631	12.91	1.08	15.08	2 2 2
186609	11.20	1.05	16.44	2 2 2	186632	12.27	1.11	15.32	2 2 2
186609	11.25	1.07	16.54	2 2 2	186632	12.28	1.09	15.49	2 2 2
186610	10.50	1.06	16.57	2 2 2	186633	11.43	1.10	15.34	2 2 2
186610	10.53	1.05	16.45	2 2 2	186633	11.64	1.08	15.33	2 2 2
186611	9.93	1.06	16.24	2 2 2	186634	10.79	1.09	15.40	2 2 2
186611	9.83	1.06	16.25	2 2 2	186634	10.80	1.08	15.47	2 2 2
186612	9.67	1.06	16.53	2 2 2	186635	9.79	1.07	15.26	2 2 2
186612	9.70	1.06	16.51	2 2 2	186635	9.82	1.07	15.14	2 2 2
186613	9.82	1.07	15.64	2 2 2	186636	9.71	1.08	15.39	2 2 2
186613	9.84	1.07	15.63	2 2 2	186636	9.75	1.08	15.45	2 2 2
186614	9.90	1.06	16.31	2 2 2	186637	9.98	1.05	15.47	3 3 3
186614	9.92	1.06	16.43	2 2 2	186637	9.93	1.06	15.44	3 3 3
186615	10.13	1.08	16.28	2 2 2	186638	10.01	1.07	16.02	3 3 3
186615	10.16	1.08	16.56	2 2 2	186638	9.94	1.06	16.07	3 3 3
186616	10.15	1.07	16.97	2 2 2	186639	10.02	1.07	16.14	3 3 3
186616	10.28	1.11	16.92	2 2 2	186639	10.21	1.06	16.07	3 3 3
186617	10.11	1.10	17.11	2 2 2	186640	9.89	1.06	16.49	3 3 3
186617	10.23	1.10	16.88	2 2 2	186640	9.94	1.05	16.33	3 3 3
186618	8.51	1.03	15.49	2 2 2	186641	10.12	1.07	16.56	3 3 3
186618	8.52	1.01	15.38	2 2 2	186641	10.12	1.08	16.94	3 3 3
186619	8.90	1.04	15.82	2 2 2	186642	9.89	1.07	16.91	3 3 3
186619	8.84	1.06	15.79	2 2 2	186642	9.92	1.07	16.92	3 3 3
186620	8.76	1.07	14.72	2 2 2	186643	9.29	1.03	16.10	3 3 3
186620	8.89	1.06	15.30	2 2 2	186643	9.32	1.04	16.20	3 3 3
186621	8.01	1.07	12.80	2 2 2	186644	8.87	1.02	15.82	3 3 3
186621	8.02	1.08	12.86	2 2 2	186644	8.94	1.02	15.70	3 3 3

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
186645	8.44	0.98	15.54	3 3 3	186668	8.62	0.98	15.81	2 2 2
186645	8.43	0.98	15.67	3 3 3	186668	8.69	0.98	15.56	2 2 2
186646	8.33	0.96	15.21	3 3 3	186669	8.39	0.98	15.72	2 2 2
186646	8.27	0.96	15.26	3 3 3	186669	8.39	0.97	15.74	2 2 2
186647	8.17	0.93	14.40	3 3 3	186670	8.28	0.97	15.46	2 2 2
186647	8.25	0.93	14.68	3 3 3	186670	8.37	0.96	15.46	2 2 2
186648	4.30	0.68	10.37	3 3 3	186671	8.23	0.95	15.40	2 2 2
186648	4.37	0.69	10.44	3 3 3	186671	8.24	0.95	15.32	2 2 2
186649	3.58	0.65	9.80	3 3 3	186672	7.72	0.75	11.55	2 2 2
186649	3.50	0.65	9.87	3 3 3	186672	7.78	0.76	11.49	2 2 2
186650	3.51	0.65	9.81	4 3 3	186673	7.58	0.75	11.39	2 2 2
186650	5.51	0.63	9.64	4 3 3	186673	7.67	0.74	11.62	2 2 2
186651	14.30	1.03	15.76	2 2 2	186674	7.60	0.73	11.31	2 2 2
186651	14.34	1.01	15.76	2 2 2	186674	7.53	0.74	11.29	2 2 2
186652	14.94	1.02	15.88	2 2 2	186690	14.27	1.01	15.47	2 2 2
186652	15.02	1.02	15.88	2 2 2	186690	14.29	0.99	15.76	2 2 2
186653	14.77	1.03	16.19	2 2 2	186691	14.75	1.00	16.03	2 2 2
186653	14.63	1.05	15.96	2 2 2	186691	15.29	1.01	16.25	2 2 2
186654	13.89	1.02	16.44	2 2 2	186692	14.74	1.03	16.17	2 2 2
186654	13.87	1.04	16.32	2 2 2	186692	14.86	1.02	16.46	2 2 2
186655	13.27	1.04	16.32	2 2 2	186693	13.60	1.01	16.46	2 2 2
186655	13.31	1.05	16.07	2 2 2	186693	13.62	1.02	16.34	2 2 2
186656	12.57	1.06	16.55	2 2 2	186694	12.55	1.03	16.44	2 2 2
186656	12.81	1.04	16.75	2 2 2	186694	12.60	1.03	16.71	2 2 2
186657	11.75	1.04	16.65	2 2 2	186695	11.94	1.02	16.65	3 2 2
186657	11.73	1.06	16.46	2 2 2	186695	12.87	1.04	16.46	3 2 2
186658	10.77	1.05	16.48	2 2 2	186696	10.89	1.03	16.65	2 2 2
186658	10.94	1.06	16.51	2 2 2	186696	11.16	1.03	16.88	2 2 2
186659	10.11	1.02	16.63	2 2 2	186697	10.08	1.02	16.40	2 2 2
186659	10.11	1.05	16.47	2 2 2	186697	9.99	1.03	16.53	2 2 2
186660	9.79	1.03	16.67	2 2 2	186698	9.75	1.02	16.76	2 2 2
186660	10.10	1.02	16.41	2 2 2	186698	9.79	1.04	16.49	2 2 2
186661	10.19	1.01	16.88	2 2 2	186699	9.77	1.03	16.53	3 2 2
186661	10.16	1.01	16.80	2 2 2	186699	11.42	1.04	16.92	3 2 2
186662	10.28	1.05	16.95	2 2 2	186700	9.80	1.02	16.54	2 2 2
186662	10.12	1.03	16.58	2 2 2	186700	9.90	1.03	16.70	2 2 2
186663	10.12	1.03	16.64	2 2 2	186701	9.94	1.03	16.80	2 2 2
186663	10.21	1.02	17.07	2 2 2	186701	10.07	1.04	16.95	2 2 2
186664	10.18	1.04	16.95	2 2 2	186702	10.04	1.03	16.76	2 2 2
186664	10.18	1.02	17.17	2 2 2	186702	10.18	1.04	16.80	2 2 2
186665	10.86	1.05	17.03	3 2 2	186703	9.86	1.06	16.87	2 2 2
186665	11.40	1.04	16.97	3 2 2	186703	10.03	1.06	16.82	2 2 2
186666	10.01	1.04	17.14	2 2 2	186704	9.06	1.01	16.56	2 2 2
186666	10.14	1.06	17.26	2 2 2	186704	9.13	1.02	16.60	2 2 2
186667	9.49	1.05	16.97	2 2 2	186705	9.04	1.02	16.25	2 2 2
186667	9.61	1.03	16.91	2 2 2	186705	8.99	1.03	16.44	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
186706	9.07	1.03	16.18	2 2 2	186730	9.19	1.04	16.18	2 2 2
186706	9.11	1.02	16.20	2 2 2	186730	9.07	1.05	16.19	2 2 2
186708	8.49	1.00	15.97	2 2 2	186731	8.80	1.03	15.63	2 2 2
186708	8.53	1.00	15.44	2 2 2	186731	9.00	1.03	16.08	2 2 2
186709	8.35	0.98	15.69	3 2 2	186732	8.79	1.03	15.69	2 2 2
186709	10.25	0.99	15.75	3 2 2	186732	8.89	1.04	15.85	2 2 2
186710	8.17	0.93	14.35	2 2 2	186733	8.74	1.07	16.06	2 2 2
186710	8.20	0.95	14.64	2 2 2	186733	8.82	1.03	15.84	2 2 2
186711	6.89	0.77	11.89	2 2 2	186734	8.79	1.01	15.92	3 2 2
186711	6.90	0.77	11.87	2 2 2	186734	9.46	1.03	15.49	3 2 2
186712	6.46	0.73	11.12	2 2 2	186735	8.73	1.01	15.22	2 2 2
186712	6.47	0.73	11.18	2 2 2	186735	8.77	1.01	15.53	2 2 2
186713	6.66	0.73	11.35	2 2 2	186736	8.17	0.88	13.43	2 2 2
186713	6.67	0.73	11.20	2 2 2	186736	8.18	0.89	13.55	2 2 2
186714	13.13	0.99	15.39	2 2 2	186737	8.07	0.85	12.48	2 2 2
186714	13.12	1.01	15.60	2 2 2	186737	8.09	0.85	12.73	2 2 2
186715	14.51	1.05	15.76	2 2 2	186738	8.70	0.91	13.70	2 2 2
186715	14.54	1.03	15.82	2 2 2	186738	8.63	0.92	13.76	2 2 2
186716	14.48	1.03	16.36	2 2 2	186739	11.84	0.98	14.93	2 2 2
186716	14.57	1.03	16.30	2 2 2	186739	11.84	0.99	14.99	2 2 2
186717	13.94	1.08	16.26	2 2 2	186740	13.59	1.02	16.09	2 2 2
186717	14.03	1.03	16.24	2 2 2	186740	13.62	1.01	15.68	2 2 2
186718	12.90	1.06	16.38	2 2 2	186741	13.45	1.04	16.34	2 2 2
186718	12.96	1.05	16.53	2 2 2	186741	13.45	1.04	16.34	2 2 2
186719	12.20	1.05	16.24	2 2 2	186742	12.51	1.13	16.21	2 2 2
186719	12.24	1.05	16.40	2 2 2	186742	12.58	1.14	16.09	2 2 2
186720	11.42	1.06	16.20	2 2 2	186743	12.03	1.15	16.36	2 2 2
186720	11.61	1.07	16.73	2 2 2	186743	12.57	1.14	16.71	2 2 2
186721	10.10	1.09	16.57	2 2 2	186744	11.00	1.14	16.48	2 2 2
186721	10.16	1.04	16.45	2 2 2	186744	11.13	1.12	16.52	2 2 2
186722	9.91	1.09	16.47	2 2 2	186745	9.81	1.14	16.19	2 2 2
186722	9.75	1.05	16.26	2 2 2	186745	9.91	1.17	16.33	2 2 2
186723	9.94	1.05	16.25	2 2 2	186746	9.47	1.03	16.44	2 2 2
186723	10.08	1.06	16.33	2 2 2	186746	9.69	1.04	16.64	2 2 2
186724	9.97	1.05	16.19	2 2 2	186747	9.62	1.03	16.60	2 2 2
186724	10.05	1.05	16.52	2 2 2	186747	9.78	1.03	16.77	2 2 2
186725	10.04	1.06	16.47	2 2 2	186748	9.74	1.04	16.48	2 2 2
186725	10.30	1.05	16.52	2 2 2	186748	9.61	1.02	16.50	2 2 2
186726	10.16	1.06	16.64	2 2 2	186749	9.73	1.04	16.54	2 2 2
186726	10.18	1.05	16.74	2 2 2	186749	9.69	1.04	16.87	2 2 2
186727	10.01	1.07	16.74	2 2 2	186750	9.82	1.04	16.87	2 2 2
186727	10.14	1.08	16.70	2 2 2	186750	9.97	1.07	16.80	2 2 2
186728	9.16	1.03	16.25	2 2 2	186751	9.77	1.05	16.95	2 2 2
186728	9.34	1.04	15.93	2 2 2	186751	9.81	1.06	16.53	2 2 2
186729	9.23	1.04	16.15	3 2 2	186752	9.60	1.05	17.03	2 2 2
186729	9.68	1.02	16.13	3 2 2	186752	9.58	1.03	17.11	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
186753	8.83	1.02	16.18	2 2 2	186791	8.80	1.03	16.19	2 2 2
186753	8.90	1.01	16.14	2 2 2	186791	8.90	1.03	16.26	2 2 2
186754	8.75	0.98	15.68	2 2 2	186792	8.76	1.02	16.15	2 2 2
186754	8.77	0.98	16.24	2 2 2	186792	8.82	1.03	15.94	2 2 2
186755	8.70	1.00	16.34	2 2 2	186793	8.74	1.01	15.90	2 2 2
186755	8.83	0.99	16.28	2 2 2	186793	8.77	1.02	16.35	2 2 2
186756	8.76	1.01	16.11	2 2 2	186794	8.73	1.02	16.23	2 2 2
186756	8.72	1.00	15.76	2 2 2	186794	8.76	1.02	16.17	2 2 2
186757	8.59	1.00	16.28	2 2 2	186795	8.81	1.02	16.21	2 2 2
186757	8.59	1.02	16.15	2 2 2	186795	8.85	1.03	15.69	2 2 2
186758	8.52	0.99	15.82	2 2 2	186796	8.68	1.04	15.81	2 2 2
186758	8.71	0.99	15.57	2 2 2	186796	8.68	1.01	15.98	2 2 2
186759	8.45	0.96	15.32	2 2 2	186797	8.19	0.91	13.80	2 2 2
186759	8.51	0.95	15.24	2 2 2	186797	8.29	0.91	13.37	2 2 2
186760	8.02	0.85	13.05	2 2 2	186798	8.28	0.88	13.43	2 2 2
186760	7.96	0.83	12.95	2 2 2	186798	8.34	0.87	13.28	2 2 2
186761	7.82	0.81	12.47	2 2 2	186800	8.43	0.87	13.30	2 2 2
186761	7.95	0.80	12.51	2 2 2	186800	8.46	0.89	13.02	2 2 2
186777	8.31	0.88	13.93	2 2 2	186801	10.08	1.07	15.06	2 3 2
186777	8.40	0.90	14.22	2 2 2	186801	9.72	1.01	14.94	2 3 2
186778	11.55	0.97	15.19	2 2 2	186802	10.21	0.98	15.02	2 2 2
186778	11.61	0.99	15.25	2 2 2	186802	10.24	1.79	14.73	2 3 2
186779	9.44	0.96	14.82	2 2 2	186803	10.59	1.11	15.72	2 2 2
186779	9.37	0.94	14.69	2 2 2	186803	10.65	1.02	15.37	2 2 2
186780	13.35	1.02	15.83	2 2 2	186804	10.89	1.86	16.42	2 3 2
186780	13.28	1.02	15.81	2 2 2	186804	10.96	1.08	16.16	2 2 2
186781	12.80	1.04	16.54	2 2 2	186805	9.90	1.16	16.07	2 2 2
186781	12.93	1.04	16.58	2 2 2	186805	9.93	1.06	16.26	2 2 2
186782	11.51	1.04	16.18	2 2 2	186806	9.57	1.10	16.63	2 2 2
186782	11.52	1.04	16.51	2 2 2	186806	9.67	1.11	16.53	2 2 2
186783	10.39	1.03	16.18	2 2 2	186807	9.75	1.12	16.69	2 2 2
186783	10.35	1.03	16.20	2 2 2	186807	9.78	1.10	16.61	2 2 2
186784	9.77	1.03	16.57	2 2 2	186808	9.65	1.04	16.73	2 2 2
186784	9.87	1.04	16.43	2 2 2	186808	9.81	1.06	16.65	2 2 2
186785	9.69	1.00	16.36	2 2 2	186809	8.97	1.03	16.07	2 2 2
186785	9.71	1.03	16.32	2 2 2	186809	8.94	1.03	15.65	2 2 2
186786	9.74	1.04	16.57	2 2 2	186810	9.33	1.04	15.94	2 2 2
186786	9.77	1.04	16.65	2 2 2	186810	9.45	1.04	16.04	2 2 2
186787	9.82	1.05	16.80	2 2 2	186811	9.22	1.03	16.13	2 2 2
186787	9.70	1.04	16.65	2 2 2	186811	9.25	1.09	15.63	2 2 2
186788	9.88	1.04	17.05	2 2 2	186812	8.80	1.04	14.28	2 2 2
186788	9.85	1.03	17.01	2 2 2	186812	8.86	1.07	14.73	2 2 2
186789	9.75	1.06	17.00	2 2 2	186813	8.34	1.05	12.95	2 2 2
186789	9.81	1.06	16.63	2 2 2	186813	8.44	1.04	13.41	2 2 2
186790	8.81	1.01	15.92	2 2 2	186814	7.88	1.03	12.31	2 2 2
186790	8.88	1.02	15.92	2 2 2	186814	7.99	1.02	12.60	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF
186815	7.75	1.05	11.11	2 2 2
186815	7.88	0.96	11.26	2 2 2
186816	7.77	1.01	10.64	2 2 2
186816	7.84	1.00	10.86	2 2 2
186817	7.80	1.07	10.88	2 2 2
186817	7.76	1.01	10.84	2 2 2
186819	5.90	0.75	10.60	2 2 2
186819	5.97	0.78	10.49	2 2 2
186821	5.04	0.68	7.85	2 2 2
186821	5.28	0.66	8.01	2 2 2
186823	4.67	0.64	7.34	2 2 2
186823	4.74	0.64	7.26	2 2 2
186825	4.60	0.62	7.12	2 2 2
186825	4.62	0.65	7.06	2 2 2
186827	4.47	0.62	6.88	2 2 2
186827	4.49	0.63	6.96	2 2 2
186832	4.39	0.63	6.63	2 2 2
186832	4.42	0.62	6.59	2 2 2
186842	9.00	1.01	15.68	2 2 2
186842	9.02	1.01	16.05	2 2 2
186843	8.81	1.04	16.37	2 2 2
186843	8.83	1.04	16.29	2 2 2
186844	8.90	1.05	16.42	2 2 2
186844	8.94	1.04	16.42	2 2 2
186845	8.87	1.03	16.48	2 2 2
186845	8.79	1.04	16.29	2 2 2
186847	8.23	1.01	15.53	2 2 2
186847	8.21	1.01	15.85	2 2 2
186848	7.81	0.97	15.19	2 2 2
186848	7.90	0.99	15.06	2 2 2
186849	7.33	0.94	14.68	2 2 2
186849	7.44	0.96	15.08	2 2 2
186850	7.11	0.94	14.03	2 2 2
186850	7.10	0.92	13.96	2 2 2
186851	6.61	0.86	12.50	2 2 2
186851	6.68	0.84	12.45	2 2 2
186852	6.58	0.85	12.50	2 2 2
186852	6.66	0.87	12.47	2 2 2
186853	6.34	0.83	12.11	2 2 2
186853	6.38	0.82	11.60	2 2 2
186854	6.30	0.84	11.93	2 2 2
186854	6.22	0.82	11.99	2 2 2
186855	6.08	0.80	11.33	2 2 2
186855	5.91	0.81	10.89	2 2 2
186856	5.80	0.76	10.65	2 2 2
186856	5.89	0.78	10.71	2 2 2
186857	6.18	0.79	10.61	2 2 2
186857	6.23	0.81	10.77	2 2 2
186859	6.20	0.80	10.90	2 2 2
186859	6.09	0.79	10.90	2 2 2
186861	5.78	0.76	10.27	2 2 2
186861	5.80	0.78	10.19	2 2 2
186866	1.50	0.27	0.47	2 2 2
186866	1.52	0.26	0.39	2 2 2
186873	8.81	1.05	15.95	2 2 2
186873	9.04	1.04	15.64	2 2 2
186874	8.59	1.02	15.62	2 2 2
186874	8.53	1.00	15.83	2 2 2
186875	8.81	1.02	15.62	2 2 2
186875	8.41	1.02	15.42	2 2 2
186876	8.04	0.99	15.33	2 2 2
186876	8.07	0.98	15.21	2 2 2
186877	7.99	1.01	15.37	2 2 2
186877	8.07	1.00	15.27	2 2 2
186878	7.93	0.98	15.19	2 2 2
186878	7.90	0.98	15.06	2 2 2
186879	7.61	0.98	15.12	2 2 2
186879	7.64	0.97	14.94	2 2 2
186880	7.58	0.95	14.75	2 2 2
186880	7.61	0.96	14.55	2 2 2
186881	7.46		14.51	2 5 2
186881	7.32	0.91	14.05	2 2 2
186882	6.95	0.90	12.83	2 2 2
186882	6.87	0.88	12.96	2 2 2
186883	6.18	0.81	11.73	2 2 2
186883	6.18	0.82	11.59	2 2 2
186884	3.43	0.50	5.64	2 2 2
186884	3.92	0.49	5.72	2 2 2
186902	10.74	1.02	15.48	2 2 2
186902	11.03	1.01	15.36	2 2 2
186903	10.91	1.00	15.05	2 2 2
186903	10.89	1.00	15.54	2 2 2
186904	10.71	1.02	15.50	2 2 2
186904	10.80	1.02	15.48	2 2 2
186905	10.77	1.02	15.28	2 2 2
186905	10.89	1.01	15.54	2 2 2
186907	10.51	1.05	15.80	2 2 2
186907	10.54	1.06	15.93	2 2 2
186908	11.21	1.08	15.52	3 2 2
186908	10.11	1.06	15.62	3 2 2
186909	10.00	1.06	15.68	2 2 2
186909	9.88	1.08	15.64	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
186910	9.68	1.07	16.23	2 2 2	186934	9.66	1.10	16.43	2 2 2
186910	9.79	1.10	16.17	2 2 2	186934	9.66	1.06	16.79	2 2 2
186911	9.82	1.05	16.63	2 2 2	186935	9.28	1.07	16.25	2 2 2
186911	9.85	1.05	16.49	2 2 2	186935	9.33	1.07	16.53	2 2 2
186912	9.74	1.06	16.65	2 2 2	186936			16.92	5 5 2
186912	9.74	1.04	16.67	2 2 2	186936	8.98	1.16	16.29	2 2 2
186913	9.39	1.06	16.79	2 2 2	186937	8.78	1.01	16.04	2 2 2
186913	9.42	1.05	16.61	2 2 2	186937	8.95	1.05	15.78	2 2 2
186914	9.19	1.03	16.56	2 2 2	186938	8.39	1.02	15.82	2 2 2
186914	9.22	1.04	16.58	2 2 2	186938	8.48	1.02	15.42	2 2 2
186915	8.41	1.01	15.69	2 2 2	186939	8.13	0.97	15.01	2 2 2
186915	8.46	1.01	16.26	2 2 2	186939	8.13	0.99	14.87	2 2 2
186916	8.00	0.97	15.57	2 2 2	186940	7.69	0.90	13.72	2 2 2
186916	7.97	0.98	15.51	2 2 2	186940	7.86	0.91	13.33	2 2 2
186917	7.54	0.95	14.28	2 2 2	186941	7.51	0.85	12.55	2 2 2
186917	7.54	0.95	14.59	2 2 2	186941	7.77	0.86	12.58	2 2 2
186918	7.33	0.94	14.00	2 2 2	186943	9.32	0.93	14.34	2 2 2
186918	7.36	0.92	14.16	2 2 2	186943	9.35	0.93	14.23	2 2 2
186920	4.89	0.68	8.99	2 2 2	186944	9.60	0.92	14.37	2 2 2
186920	5.27	0.65	8.99	2 2 2	186944	9.63	0.92	14.48	2 2 2
186921	2.34	0.38	2.64	2 3 2	186945	9.51	0.93	14.64	2 2 2
186921	2.25	0.37	2.57	2 3 2	186945	9.57	0.94	14.79	2 2 2
186922	9.45	0.97	14.56	2 2 2	186946	11.13	0.95	15.00	2 2 2
186922	9.60	0.96	14.53	2 2 2	186946	11.24	0.96	15.16	2 2 2
186923	9.45	0.96	14.69	2 2 2	186947	11.51	0.98	15.47	2 2 2
186923	9.89	0.96	14.71	2 2 2	186947	11.50	0.98	15.36	2 2 2
186924	9.85		15.18	2 5 2	186948	11.88	0.98	15.54	2 2 2
186924	9.66	0.97	14.65	2 2 2	186948	12.05	0.97	15.59	2 2 2
186925	9.98	0.97	15.17	2 2 2	186949	12.43	1.00	16.15	2 2 2
186925	9.92	0.98	14.97	2 2 2	186949	12.52	1.01	16.21	2 2 2
186926	11.52	1.02	15.48	2 2 2	186950	11.26	1.00	15.85	2 2 2
186926	11.52	1.00	15.31	2 2 2	186950	11.31	1.02	15.90	2 2 2
186927	11.44	1.01	15.66	2 2 2	186951	10.57	1.02	16.27	2 2 2
186927	11.47	1.03	15.62	2 2 2	186951	10.69	1.03	16.14	2 2 2
186928	11.24	1.03	15.55	2 2 2	186952	9.93	1.02	16.42	2 2 2
186928	11.32	1.00	15.47	2 2 2	186952	9.93	1.02	16.21	2 2 2
186929	10.30	1.03	16.02	2 2 2	186953	9.75	1.04	16.54	3 2 2
186929	10.27	1.02	15.95	2 2 2	186953	10.33	1.05	16.62	3 2 2
186930	10.21	1.06	15.85	2 2 2	186954	9.43	1.04	16.67	3 2 2
186930	10.42	1.06	16.12	2 2 2	186954	10.53	1.04	16.86	3 2 2
186931	9.42	1.04	16.62	2 2 2	186955	9.71	1.06	17.01	2 2 2
186931	9.57	1.06	16.52	2 2 2	186955	9.62	1.06	16.97	2 2 2
186932	9.63	1.05	16.60	2 2 2	186956	9.50	1.05	16.94	2 2 2
186932	9.63	1.06	16.15	2 2 2	186956	9.53	1.05	16.73	2 2 2
186933	9.54	1.07	16.77	2 2 2	186957	9.12	1.04	17.03	2 2 2
186933	9.45	1.05	16.79	2 2 2	186957	9.23	1.03	16.68	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
186958	8.99	1.03	16.54	2 2 2	186981	9.27	1.04	16.81	2 2 2
186958	9.00	1.03	16.40	2 2 2	186981	9.24	1.05	16.61	2 2 2
186959	8.86	1.01	16.43	2 2 2	186982	9.18	1.04	16.75	2 2 2
186959	8.92	1.01	16.40	2 2 2	186982	9.17	1.05	16.57	2 2 2
186960	8.45	0.98	15.79	2 2 2	186983	8.95	1.04	16.22	2 2 2
186960	8.48	0.99	15.68	2 2 2	186983	9.04	1.04	16.39	2 2 2
186961	8.01	0.97	15.38	2 2 2	186985	8.24	1.01	16.20	2 2 2
186961	8.01	0.98	15.49	2 2 2	186985	8.71	1.02	15.98	2 2 2
186962	7.69	0.94	14.68	2 2 2	186986	8.18	0.98	15.83	2 2 2
186962	7.74	0.93	14.70	2 2 2	186986	8.09	0.98	15.61	2 2 2
186963	7.60	0.93	14.13	2 2 2	186987	7.67	0.96	14.81	2 2 2
186963	7.57	0.92	14.22	2 2 2	186987	7.76	0.94	14.87	2 2 2
186964	7.21	0.85	13.00	2 2 2	186988	7.43	0.88	13.40	2 2 2
186964	7.76	0.86	13.08	2 2 2	186988	7.54	0.88	13.59	2 2 2
186965	7.18	0.80	12.10	2 2 2	186989	5.90	0.65	9.82	2 2 2
186965	7.29	0.79	12.19	2 2 2	186989	5.99	0.66	9.91	2 2 2
186966	0.75	0.26		2 2 5	186990	1.01	0.24	2.74	2 2 2
186966	0.77	0.26	3.76	2 2 2	186990	0.91	0.25		2 2 5
186967	10.12	0.93	14.80	2 2 2	187006	10.09	0.96	15.04	2 2 2
186967	10.12	0.93	14.60	2 2 2	187006	9.98	0.94	15.02	2 2 2
186968	9.91	0.94	14.68	2 2 2	187007	9.72	0.96	14.82	2 2 2
186968	10.00	0.92	14.81	2 2 2	187007	9.75	0.94	14.75	2 2 2
186969	10.00	0.95	15.01	2 2 2	187008	10.10	0.97	15.14	2 2 2
186969	10.02	0.93	15.09	2 2 2	187008	10.16	0.97	14.96	2 2 2
186970	11.55	0.98	15.45	2 2 2	187009	12.34	1.01	16.05	2 2 2
186970	11.55	0.99	15.45	2 2 2	187009	12.16	1.02	16.00	2 2 2
186971	11.51	1.03	15.79	2 2 2	187010	10.51	1.01	15.81	2 2 2
186971	11.99	0.98	15.72	2 2 2	187010	10.57	1.01	16.01	2 2 2
186972	12.22	1.02	16.09	2 2 2	187011	10.53	1.02	15.91	2 2 2
186972	12.34	1.01	16.13	2 2 2	187011	10.62	1.01	15.99	2 2 2
186973	11.18	1.00	16.18	2 2 2	187012	10.38	1.02	15.96	2 2 2
186973	11.06	1.01	16.08	2 2 2	187012	10.53	1.01	16.17	2 2 2
186974	11.47	1.01	16.44	2 2 2	187013	10.43	1.02	16.10	2 2 2
186974	11.18	1.02	16.19	2 2 2	187013	10.34	1.02	16.04	2 2 2
186975	10.31	1.02	16.44	2 2 2	187014	11.17	1.06	16.79	2 2 2
186975	10.45	1.02	16.49	2 2 2	187014	11.03	1.05	16.74	2 2 2
186976	9.94	1.05	16.84	2 2 2	187015	9.96	1.04	16.55	2 2 2
186976	9.95	1.04	16.67	2 2 2	187015	10.03	1.05	16.50	2 2 2
186977	9.53	1.04	17.02	2 2 2	187016	9.66	1.05	17.05	2 2 2
186977	9.38	1.05	17.00	2 2 2	187016	9.84	1.04	16.76	2 2 2
186978	9.52	1.06	16.81	2 2 2	187017	9.71	1.07	16.90	2 2 2
186978	9.58	1.04	16.76	2 2 2	187017	9.72	1.06	16.90	2 2 2
186979	9.52	1.07	16.72	2 2 2	187018	9.68	1.05	17.00	2 2 2
186979	9.72	1.06	17.09	2 2 2	187018	9.89	1.06	17.03	2 2 2
186980	9.57	1.05	16.85	2 2 2	187019	9.73	1.06	17.13	2 2 2
186980	9.63	1.05	16.78	2 2 2	187019	9.79	1.06	16.99	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF
187020	9.49	1.05	17.02	2 2 2
187020	9.58	1.06	16.93	2 2 2
187021	9.60	1.07	17.05	2 2 2
187021	9.72	1.07	17.44	2 2 2
187022	9.30	1.05	16.72	2 2 2
187022	9.39	1.07	16.85	2 2 2
187023	9.19	1.02	16.47	2 2 2
187023	9.19	1.03	16.70	2 2 2
187024	8.85	1.03	16.44	2 2 2
187024	8.97	1.03	16.25	2 2 2
187025	8.79	1.02	16.47	2 2 2
187025	8.82	1.02	16.44	2 2 2
187026	8.51	1.00	16.15	2 2 2
187026	8.48	1.01	15.93	2 2 2
187027	8.06	0.98	15.26	2 2 2
187027	8.14	0.98	15.92	2 2 2
187029	7.31	0.76	11.55	2 2 2
187029	7.39	0.75	11.53	2 2 2
187030	9.72	0.94	14.87	2 2 2
187030	9.81	0.95	14.77	2 2 2
187031	10.38	0.94	15.32	2 2 2
187031	10.56	1.00	15.51	2 2 2
187032	11.60	0.97	15.63	2 2 2
187032	11.60	0.97	15.60	2 2 2
187033	13.62	1.04	15.68	3 2 2
187033	14.17	1.02	15.88	3 2 2
187034	13.07	1.02	16.46	2 2 2
187034	13.44	1.04	16.41	2 2 2
187035	13.01	1.04	16.53	2 2 2
187035	12.91	1.05	16.27	2 2 2
187036	12.00	1.05	16.30	2 2 2
187036	12.12	1.06	16.13	2 2 2
187037	11.39	1.05	16.48	2 2 2
187037	11.45	1.05	16.49	2 2 2
187038	10.54	1.07	16.36	2 2 2
187038	10.81	1.06	16.29	2 2 2
187039	9.78	1.08	16.69	2 2 2
187039	9.99	1.05	16.43	2 2 2
187040	9.55	1.06	16.53	2 2 2
187040	9.61	1.06	16.37	2 2 2
187041	9.54	1.07	16.31	2 2 2
187041	9.61	1.07	16.42	2 2 2
187042	9.63	1.09	16.50	2 2 2
187042	9.63	1.09	16.18	2 2 2
187043	9.29	1.08	16.44	2 2 2
187043	9.26	1.07	16.44	2 2 2
187044	8.68	1.04	15.99	2 2 2
187044	8.83	1.05	15.76	2 2 2
187045	8.70	1.04	15.98	2 2 2
187045	8.70	1.04	15.72	2 2 2
187046	8.33	1.03	15.64	2 2 2
187046	8.39	1.03	15.71	2 2 2
187047	8.27	1.02	15.53	2 2 2
187047	8.35	1.03	15.24	2 2 2
187048	8.30	1.01	15.26	2 2 2
187048	8.64	1.01	15.24	2 2 2
187049	8.15	1.00	14.90	2 2 2
187049	8.20	1.02	15.27	2 2 2
187050	7.86	1.01	14.91	2 2 2
187050	7.96	1.00	14.88	2 2 2
187051	7.61	0.93	13.41	2 2 2
187051	7.46	0.93	13.54	2 2 2
187052	7.52	0.92	13.07	2 2 2
187052	7.55	0.92	13.18	2 2 2
187053	7.17	0.81	11.36	2 2 2
187053	7.21	0.81	11.26	2 2 2
187054	9.96	0.94	14.41	3 2 2
187054	10.97	0.96	14.52	3 2 2
187055	9.79	0.94	14.41	2 2 2
187055	9.87	0.93	14.59	2 2 2
187056	10.97	0.98	15.10	2 2 2
187056	11.00	0.95	15.24	2 2 2
187057	11.79	1.02	15.39	2 2 2
187057	11.93	1.01	15.41	2 2 2
187058	12.72	1.07	16.09	2 2 2
187058	12.75	1.04	15.84	2 2 2
187059	12.05	1.04	15.95	2 2 2
187059	11.88	1.05	15.93	2 2 2
187060	11.64	1.05	16.18	2 2 2
187060	11.65	1.05	16.00	2 2 2
187061	11.46	1.07	16.24	2 2 2
187061	11.58	1.06	16.38	2 2 2
187062	10.63	1.07	16.42	2 2 2
187062	10.70	1.08	16.40	2 2 2
187063	9.83	1.08	16.31	2 2 2
187063	9.92	1.06	16.31	2 2 2
187064	9.33	1.06	16.65	2 2 2
187064	9.42	1.08	16.69	2 2 2
187065	9.47	1.08	16.60	2 2 2
187065	9.53	1.09	16.51	2 2 2
187066	9.38	1.08	16.78	2 2 2
187066	9.40	1.09	16.71	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
187067	9.17	1.08	16.33	2 2 2	187105	9.49	1.09	16.67	3 2 2
187067	9.11	1.07	16.56	2 2 2	187105	9.81	1.08	16.43	3 2 2
187068	9.10	1.08	16.22	2 2 2	187106	9.05	1.06	16.47	2 2 2
187068	9.10	1.08	16.56	2 2 2	187106	9.07	1.05	16.47	2 2 2
187069	8.86	1.07	16.54	2 2 2	187107	9.17	1.06	16.72	2 2 2
187069	8.95	1.06	16.18	2 2 2	187107	9.28	1.06	16.61	2 2 2
187070	8.78	1.07	15.96	2 2 2	187108	8.99	1.05	16.21	2 2 2
187070	8.89	1.04	16.33	2 2 2	187108	8.99	1.11	16.27	2 2 2
187071	8.60	1.04	15.84	2 2 2	187109	8.59	1.04	15.76	2 2 2
187071	8.76	1.05	15.84	2 2 2	187109	8.53	1.03	16.07	2 2 2
187072	8.38	1.03	16.11	2 2 2	187110	8.43	1.03	15.90	2 2 2
187072	8.42	1.04	15.89	2 2 2	187110	8.44	1.03	15.98	2 2 2
187073	8.49	1.04	15.51	3 2 2	187111	8.26	1.02	15.72	2 2 2
187073	9.09	1.05	15.44	3 2 2	187111	8.37	1.04	15.59	2 2 2
187074	7.86	1.02	15.31	2 2 2	187112	9.10	1.05	15.61	3 2 2
187074	8.05	1.00	15.24	2 2 2	187112	8.47	1.03	15.98	3 2 2
187075	7.65	0.95	13.71	2 2 2	187113	8.29	1.03	15.65	2 2 2
187075	7.64	0.95	14.02	2 2 2	187113	8.32	1.03	15.63	2 2 2
187076	7.44	0.90	12.96	2 2 2	187114	7.89	0.98	14.46	3 2 2
187076	7.60	0.89	12.94	2 2 2	187114	8.28	0.96	14.61	3 2 2
187077	7.31	0.85	12.14	2 2 2	187115	7.53	0.91	13.99	2 2 2
187077	7.48	0.84	12.74	2 2 2	187115	7.67	0.93	13.81	2 2 2
187093	9.98	0.97	14.51	2 2 2	187116	2.83	0.50	7.76	2 2 2
187093	10.04	0.98	14.31	2 2 2	187116	2.77	0.51	7.59	2 2 2
187094	9.80	0.98	14.40	2 2 2	187117	10.31	0.98	14.83	2 2 2
187094	9.83	0.97	14.58	2 2 2	187117	10.26	0.99	14.46	2 2 2
187095	10.19	1.00	14.96	2 2 2	187118	10.25	1.00	14.81	2 2 2
187095	10.33	1.00	14.73	2 2 2	187118	10.30	1.07	14.70	2 2 2
187096	12.26	1.03	15.74	2 2 2	187119	10.43	1.00	14.92	2 2 2
187096	12.47	1.03	15.33	2 2 2	187119	10.47	1.00	14.63	2 2 2
187097	13.48	1.06	15.96	2 2 2	187120	12.06	1.04	15.43	3 2 2
187097	13.51	1.07	16.18	2 2 2	187120	11.20	1.01	15.28	3 2 2
187098	12.56	1.06	16.36	2 2 2	187121	11.96	1.04	15.54	2 2 2
187098	12.67	1.07	16.27	2 2 2	187121	12.05	1.04	15.43	2 2 2
187099	11.40	1.06	16.00	2 2 2	187122	11.67	1.04	16.03	2 2 2
187099	11.44	1.06	15.74	2 2 2	187122	11.69	1.04	16.19	2 2 2
187100	11.06	1.06	16.36	2 2 2	187123	10.86	1.08	15.92	2 2 2
187100	10.97	1.07	16.49	2 2 2	187123	11.00	1.07	15.88	2 2 2
187101	10.43	1.07	16.52	2 2 2	187124	11.16	1.11	16.32	2 2 2
187101	10.39	1.07	16.61	2 2 2	187124	11.10	1.06	16.01	2 2 2
187102	9.62	1.07	16.61	2 2 2	187125	10.76	1.08	16.30	2 2 2
187102	9.65	1.05	16.54	2 2 2	187125	10.70	1.06	16.43	2 2 2
187103	9.41	1.06	16.58	2 2 2	187126	9.64	1.07	16.72	2 2 2
187103	9.44	1.08	16.36	2 2 2	187126	9.66	1.07	16.43	2 2 2
187104	9.54	1.07	16.87	2 2 2	187127	9.48	1.08	16.41	2 2 2
187104	9.40	1.07	16.67	2 2 2	187127	9.48	1.09	16.41	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF
187128	9.56	1.08	16.34	2 2 2
187128	9.47	1.08	16.90	2 2 2
187129	9.35	1.08	16.74	2 2 2
187129	9.46	1.09	16.63	2 2 2
187130	8.96	1.06	16.23	2 2 2
187130	8.97	1.07	16.03	2 2 2
187131	8.81	1.07	16.32	2 2 2
187131	8.90	1.06	16.41	2 2 2
187132	8.72	1.06	15.92	2 2 2
187132	8.71	1.05	15.90	2 2 2
187133	8.60	1.04	15.90	2 2 2
187133	8.57	1.05	15.64	2 2 2
187134	8.36	1.03	16.12	2 2 2
187134	8.45	1.03	15.97	2 2 2
187135	8.38	1.05	15.88	2 2 2
187135	8.41	1.04	15.66	2 2 2
187136	8.23	1.02	15.33	2 2 2
187136	8.23	1.02	15.59	2 2 2
187137	8.13	1.01	15.46	2 2 2
187137	8.24	1.01	15.28	2 2 2
187138	7.75	0.94	13.83	2 2 2
187138	7.78	0.96	13.96	2 2 2
187140	3.10	0.53	8.29	2 2 2
187140	3.12	0.56	8.46	2 2 2
187165	10.20	0.97	14.72	2 2 2
187165	10.17	0.96	14.59	2 2 2
187166	10.37	0.97	14.75	2 2 2
187166	10.32	0.96	14.75	2 2 2
187167	11.12	1.02	15.42	2 2 2
187167	11.17	0.98	15.41	2 2 2
187168	12.00	1.02	15.66	2 2 2
187168	12.00	1.01	15.58	2 2 2
187169	12.03	1.02	16.11	2 2 2
187169	11.94	1.01	15.98	2 2 2
187170	11.69	1.03	16.18	2 2 2
187170	11.86	1.03	16.14	2 2 2
187171	11.13	1.04	16.08	3 2 2
187171	11.75	1.02	15.86	3 2 2
187172	10.85	1.03	16.48	2 2 2
187172	10.96	1.04	16.68	2 2 2
187173	10.25	1.03	16.48	2 2 2
187173	10.25	1.03	16.33	2 2 2
187174	9.68	1.01	16.44	2 2 2
187174	9.57	1.03	16.48	2 2 2
187175	9.64	1.04	16.77	2 2 2
187175	9.65	1.03	16.31	2 2 2
187176	9.58	1.02	16.64	2 2 2
187176	9.64	1.03	16.88	2 2 2
187177	9.80	1.03	16.31	2 2 2
187177	9.77	1.04	17.00	2 2 2
187178	9.51	1.03	16.80	2 2 2
187178	9.57	1.03	16.84	2 2 2
187179	9.19	1.02	16.45	2 2 2
187179	9.20	1.01	16.41	2 2 2
187180	9.11	1.01	16.63	2 2 2
187180	9.59	1.02	16.50	2 2 2
187181	8.71	1.01	15.86	2 2 2
187181	8.71	1.00	15.87	2 2 2
187182	8.67	1.02	16.02	2 2 2
187182	8.58	1.02	16.22	2 2 2
187183	8.63	1.00	15.65	2 2 2
187183	8.63	1.00	15.78	2 2 2
187184	8.25	0.99	15.47	2 2 2
187184	8.31	0.99	15.41	2 2 2
187185	8.01	0.97	15.23	2 2 2
187185	8.21	1.00	15.25	2 2 2
187186	7.71	0.95	14.46	3 2 2
187186	8.54	0.95	14.35	3 2 2
187187	7.19	0.82	12.36	2 2 2
187187	7.31	0.82	12.51	2 2 2
187188	6.69	0.78	11.55	2 2 2
187188	6.76	0.78	11.35	2 2 2
187204	10.39	0.95	14.30	2 2 2
187204	10.48	0.95	14.33	2 2 2
187205	9.99	0.95	14.59	3 2 2
187205	10.70	0.97	14.76	3 2 2
187206	10.35	0.98	14.87	2 2 2
187206	10.44	0.98	14.49	2 2 2
187207	12.60	1.02	15.59	2 2 2
187207	12.69	1.02	15.70	2 2 2
187208	12.03	1.03	15.67	3 2 2
187208	12.66	1.04	15.39	3 2 2
187209	13.23	1.05	16.35	2 2 2
187209	13.11	1.04	16.15	2 2 2
187210	13.45	1.08	16.26	2 2 2
187210	13.53	1.07	15.93	2 2 2
187211	12.61	1.06	16.54	2 2 2
187211	12.81	1.08	16.61	2 2 2
187212	11.85	1.07	16.20	2 2 2
187212	12.02	1.07	16.25	2 2 2
187213	11.64	1.07	16.71	2 2 2
187213	11.67	1.09	16.38	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
187214	10.14	1.07	16.38	2 2 2	187237	11.04	1.05	16.61	2 2 2
187214	10.21	1.06	16.38	2 2 2	187237	11.09	1.08	16.34	2 2 2
187215	9.71	1.06	16.64	2 2 2	187238	9.98	1.06	16.45	2 2 2
187215	9.77	1.07	16.36	2 2 2	187238	10.04	1.06	16.34	2 2 2
187216	9.90	1.09	16.40	2 2 2	187239	9.65	1.06	16.58	2 2 2
187216	9.93	1.08	16.47	2 2 2	187239	9.68	1.06	16.36	2 2 2
187217	9.97	1.07	16.84	2 2 2	187240	9.57	1.07	16.29	2 2 2
187217	9.95	1.08	16.60	2 2 2	187240	9.64	1.08	16.32	2 2 2
187218	10.00	1.10	16.67	2 2 2	187241	9.74	1.07	16.25	2 2 2
187218	10.05	1.08	16.65	2 2 2	187241	9.70	1.06	16.38	2 2 2
187219	9.67	1.09	16.78	2 2 2	187242	9.61	1.06	16.58	3 2 2
187219	9.76	1.08	16.60	2 2 2	187242	10.90	1.07	16.60	3 2 2
187220	9.16	1.06	16.14	2 2 2	187243	9.45	1.06	16.42	2 2 2
187220	9.29	1.05	16.12	2 2 2	187243	9.62	1.06	16.27	2 2 2
187221	9.05	1.07	16.12	2 2 2	187244	9.07	1.06	15.95	2 2 2
187221	9.11	1.05	16.42	2 2 2	187244	9.30	1.05	16.19	2 2 2
187222	9.06	1.05	16.29	2 2 2	187245	8.86	1.02	16.08	2 2 2
187222	9.06	1.07	16.11	2 2 2	187245	8.89	1.04	15.95	2 2 2
187223	8.84	1.06	16.05	2 2 2	187246	8.86	1.05	16.10	2 2 2
187223	8.93	1.06	16.49	2 2 2	187246	8.89	1.03	16.10	2 2 2
187224	8.46	1.03	15.43	2 2 2	187247	8.59	1.03	15.43	2 2 2
187224	8.48	1.02	15.63	2 2 2	187247	8.71	1.03	15.72	2 2 2
187225	9.21	1.02	15.23	3 2 2	187248	8.62	1.02	15.87	2 2 2
187225	8.14	1.02	15.12	3 2 2	187248	8.68	1.01	15.80	2 2 2
187226	7.73	0.87	12.42	2 2 2	187249	8.64	1.00	15.10	2 2 2
187226	7.81	0.89	12.58	2 2 2	187249	8.18	1.01	14.85	2 2 2
187227	7.51	0.82	11.61	2 2 2	187250	7.92	0.87	12.74	2 2 2
187227	7.54	0.82	11.61	2 2 2	187250	7.92	0.87	12.57	2 2 2
187228	10.28	0.96	14.34	2 2 2	187251	7.68	0.80	11.41	2 2 2
187228	10.28	0.96	14.38	2 2 2	187251	7.74	0.81	11.46	2 2 2
187229	10.39	0.97	14.51	2 2 2	187267	10.42	1.00	14.45	2 2 2
187229	10.53	0.96	14.62	2 2 2	187267	10.62	0.97	14.70	2 2 2
187230	10.39	0.99	14.68	2 2 2	187268	10.19	0.95	14.59	2 2 2
187230	10.39	0.97	14.95	2 2 2	187268	10.26	0.96	14.65	2 2 2
187231	11.68	1.00	15.12	2 2 2	187269	10.63	0.98	15.26	2 2 2
187231	11.74	1.01	15.12	2 2 2	187269	10.69	0.98	14.74	2 2 2
187232	13.23	1.03	15.77	2 2 2	187270	12.54	1.00	15.73	2 2 2
187232	13.29	1.04	15.62	2 2 2	187270	12.61	1.02	15.80	2 2 2
187233	13.20	1.04	16.03	2 2 2	187271	12.09	1.04	15.64	2 2 2
187233	13.11	1.07	16.14	2 2 2	187271	12.12	1.04	16.11	2 2 2
187234	12.79	1.06	16.16	2 2 2	187272	12.16	1.02	16.02	2 2 2
187234	12.82	1.10	16.18	2 2 2	187272	12.02	1.03	16.14	2 2 2
187235	12.39	1.06	16.42	2 2 2	187273	12.24	1.04	16.04	2 2 2
187235	12.56	1.05	16.40	2 2 2	187273	12.34	1.04	15.91	2 2 2
187236	11.76	1.05	16.48	2 2 2	187274	11.82	1.03	16.38	2 2 2
187236	11.80	1.05	16.24	2 2 2	187274	11.94	1.03	16.29	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
187275	10.75	1.07	16.37	2 2 2	187315	9.68	1.05	16.58	2 2 2
187275	10.74	1.03	16.71	2 2 2	187315	9.62	1.04	16.47	2 2 2
187276	9.79	1.01	16.48	2 2 2	187316	9.59	1.04	16.85	2 2 2
187276	9.82	1.02	16.64	2 2 2	187316	9.47	1.06	16.58	2 2 2
187277	9.52	1.04	16.50	2 2 2	187317	9.58	1.06	16.69	2 2 2
187277	9.54	1.03	16.46	2 2 2	187317	9.64	1.06	16.89	2 2 2
187278	9.44	1.07	16.86	2 2 2	187318	9.15	1.03	16.48	2 2 2
187278	9.44	1.05	16.46	2 2 2	187318	9.22	1.05	16.50	2 2 2
187279	9.55	1.05	16.84	2 2 2	187319	9.17	1.03	16.68	2 2 2
187279	9.61	1.15	16.86	2 2 2	187319	9.03	1.02	16.12	2 2 2
187280	9.30	1.07	16.36	2 2 2	187320	9.19	1.03	16.68	2 2 2
187280	9.30	1.04	16.70	2 2 2	187320	9.22	1.06	16.79	2 2 2
187281	9.06	1.06	16.25	2 2 2	187321	8.91	1.02	16.14	2 2 2
187281	9.11	1.06	16.40	2 2 2	187321	9.13	1.05	16.50	2 2 2
187282	8.99	1.05	16.49	2 2 2	187322	8.49	1.01	15.73	2 2 2
187282	8.98	1.04	16.33	2 2 2	187322	8.50	1.00	15.86	2 2 2
187283	8.56	1.02	16.15	2 2 2	187323	8.81	1.02	16.06	2 2 2
187283	8.54	1.02	16.04	2 2 2	187323	8.63	1.02	16.04	2 2 2
187284	8.49	1.02	15.74	2 2 2	187324	8.66	1.04	15.68	2 2 2
187284	8.53	1.04	15.81	2 2 2	187324	8.62	1.01	15.83	2 2 2
187285	8.49	1.03	15.85	2 2 2	187325	8.67	1.01	16.06	2 2 2
187285	8.63	1.01	15.89	2 2 2	187325	8.79	1.02	16.08	2 2 2
187286	8.60	1.03	16.23	2 2 2	187326	8.64	0.99	15.78	2 2 2
187286	8.47	1.02	16.14	2 2 2	187326	8.72	1.00	15.76	2 2 2
187287	8.23	1.00	15.39	2 2 2	187327	8.77	1.00	15.49	2 2 2
187287	8.26	1.00	15.73	2 2 2	187327	8.80	0.99	15.78	2 2 2
187288	8.01	0.94	14.81	2 2 2	187328	8.64	0.91	13.89	2 2 2
187288	8.10	0.97	15.01	2 2 2	187328	9.35	0.92	13.98	2 2 2
187290	7.59	0.76	11.03	2 2 2	187329	6.65	0.60	6.70	2 2 2
187290	7.59	0.76	11.26	2 2 2	187329	6.73	0.62	6.68	2 2 2
187306	10.35	0.93	14.53	2 2 2	187330	10.39	0.96	14.90	2 2 2
187306	10.15	0.95	14.40	2 2 2	187330	10.44	0.94	15.01	2 2 2
187307	10.26	0.95	14.61	2 2 2	187331	10.32	0.96	14.94	2 2 2
187307	10.20	0.98	14.26	2 2 2	187331	10.40	0.96	14.87	2 2 2
187308	10.13	0.94	14.93	2 2 2	187332	10.39	0.96	15.00	2 2 2
187308	10.36	0.96	15.11	2 2 2	187332	10.52	1.00	15.07	2 2 2
187309	11.62	1.00	15.31	2 2 2	187333	11.30	0.99	15.56	2 2 2
187309	11.63	1.01	15.40	2 2 2	187333	11.53	0.99	15.31	2 2 2
187310	12.44	1.02	15.64	2 2 2	187334	11.31	1.01	15.99	2 2 2
187310	12.02	1.01	15.62	2 2 2	187334	11.38	1.02	16.08	2 2 2
187311	11.24	1.02	16.09	2 2 2	187335	10.96	1.02	16.12	2 2 2
187311	11.34	1.01	16.05	2 2 2	187335	11.10	1.03	15.69	2 2 2
187312	10.82	1.02	15.75	3 2 2	187336	10.65	1.04	16.59	2 2 2
187312	10.83	1.03	16.18	3 2 2	187336	10.53	1.05	16.41	2 2 2
187314	9.78	1.02	16.38	2 2 2	187337	9.75	1.05	16.18	2 2 2
187314	9.78	1.05	16.47	2 2 2	187337	9.82	1.03	16.54	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
187338	9.48	1.04	16.79	2 2 2	187361	9.43	1.08	16.23	2 2 2
187338	9.57	1.05	16.90	2 2 2	187361	9.46	1.08	16.34	2 2 2
187339	9.50	1.05	16.72	2 2 2	187362	9.25	1.06	16.04	2 2 2
187339	9.61	1.06	16.51	2 2 2	187362	9.24	1.06	16.07	2 2 2
187340	9.00	1.07	16.37	2 2 2	187363	9.26	1.04	16.02	3 2 2
187340	9.02	1.02	16.48	2 2 2	187363	8.80	1.02	16.00	3 2 2
187341	8.99	1.05	16.28	2 2 2	187364	8.56	1.06	15.32	2 2 2
187341	9.22	1.02	16.30	2 2 2	187364	8.61	1.04	15.36	2 2 2
187342	9.68	1.02	16.10	2 2 2	187365	8.67	1.02	15.74	2 2 2
187342	9.74	1.04	16.12	2 2 2	187365	8.69	1.02	15.70	2 2 2
187343	8.55	1.03	16.05	2 2 2	187366	8.66	1.02	15.61	2 2 2
187343	8.56	1.02	16.12	2 2 2	187366	8.59	1.01	15.49	2 2 2
187344	8.55	1.03	16.03	2 2 2	187367	8.58	1.01	15.36	2 2 2
187344	8.54	1.01	15.67	2 2 2	187367	8.59	1.01	15.42	2 2 2
187345	8.39	0.98	15.48	2 2 2	187368	8.40	0.99	14.86	2 2 2
187345	8.54	1.02	15.62	2 2 2	187368	8.40	1.00	15.09	2 2 2
187346	8.76	1.01	15.48	3 2 2	187369	6.21	0.53	2.69	2 2 2
187346	9.52	1.01	15.39	3 2 2	187369	6.22	0.50	2.89	2 2 2
187347	8.69	0.97	15.17	2 2 2	187370	11.12	1.03	16.27	2 2 2
187347	8.74	0.99	15.14	2 2 2	187370	11.03	1.02	15.92	2 2 2
187348	8.33	0.86	11.13	2 2 2	187371	11.08	1.04	16.02	2 2 2
187348	8.34	0.88	11.25	2 2 2	187371	11.02	1.04	15.92	2 2 2
187349	4.95	0.29	0.20	2 2 2	187372	10.70	1.05	16.02	2 2 2
187349	5.06	0.33	0.00	2 2 2	187372	10.76	1.05	15.95	2 2 2
187350	11.03	1.00	15.42	2 2 2	187373	10.32	1.05	16.54	2 2 2
187350	11.12	1.02	14.73	2 2 2	187373	10.44	1.06	16.57	2 2 2
187351	11.14	1.01	15.74	2 2 2	187374	9.71	1.05	16.32	2 2 2
187351	11.20	1.01	15.78	2 2 2	187374	9.69	1.04	16.59	2 2 2
187352	11.19	1.02	15.58	2 2 2	187375	9.52	1.06	16.59	2 2 2
187352	11.10	1.02	15.44	2 2 2	187375	9.62	1.06	16.62	2 2 2
187353	11.30	1.01	15.67	2 2 2	187376	9.52	1.08	16.74	2 2 2
187353	11.32	1.00	15.64	2 2 2	187376	9.67	1.08	16.99	2 2 2
187354	11.13	1.04	15.89	2 2 2	187377	9.54	1.08	16.81	2 2 2
187354	11.23	1.02	15.87	2 2 2	187377	9.54	1.06	16.96	2 2 2
187355	11.15	1.02	15.50	2 2 2	187378	9.15	1.04	16.51	2 2 2
187355	11.19	1.02	15.91	2 2 2	187378	9.12	1.05	16.73	2 2 2
187356	10.66	1.06	15.88	2 2 2	187379	8.99	1.02	16.55	2 2 2
187356	10.71	1.01	15.83	2 2 2	187379	8.96	1.02	16.50	2 2 2
187357	10.46	1.05	16.17	2 2 2	187380	8.61	1.02	16.03	2 2 2
187357	10.73	1.06	16.10	2 2 2	187380	8.64	1.01	16.03	2 2 2
187358	9.87	1.07	16.50	2 2 2	187381	8.45	1.02	16.05	2 2 2
187358	9.87	1.07	16.46	2 2 2	187381	8.48	1.02	16.03	2 2 2
187359	9.62	1.07	16.59	2 2 2	187382	8.76	1.01	16.25	2 2 2
187359	9.63	1.06	16.57	2 2 2	187382	8.53	1.02	16.22	2 2 2
187360	9.50	1.06	16.63	2 2 2	187383	8.60	1.04	16.10	2 2 2
187360	9.52	1.07	16.68	2 2 2	187383	8.66	1.02	15.80	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
187384	8.49	0.99	15.97	2 2 2	187433	8.19	0.95	13.46	2 2 2
187384	8.62	1.00	15.67	2 2 2	187433	8.29	0.95	13.53	2 2 2
187385	8.46	0.97	14.70	2 2 2	187434	11.53	1.00	13.48	2 2 2
187385	8.59	0.99	15.15	2 2 2	187434	11.56	1.00	13.36	2 2 2
187386	5.29	0.46	3.26	2 2 2	187435	11.48	1.01	11.18	2 2 2
187386	5.26	0.51	3.21	2 2 2	187435	11.52	1.01	11.11	2 2 2
187402	8.76	1.02	16.03	2 2 2	187436	12.25	1.03	9.84	2 2 2
187402	8.63	1.01	16.11	2 2 2	187436	12.23	1.03	9.82	2 2 2
187403	8.57	0.99	15.98	2 2 2	187437	11.85	1.00	8.61	2 2 2
187403	8.63	1.03	16.16	2 2 2	187437	11.74	0.99	8.31	2 2 2
187404	8.72	1.00	16.23	2 2 2	187438	9.23	0.81	5.32	2 2 2
187404	8.74	1.00	16.28	2 2 2	187438	9.30	0.80	5.25	2 2 2
187405	8.71	0.99	16.05	2 2 2	187439	12.45	1.02	12.31	2 2 2
187405	8.67	1.00	16.03	2 2 2	187439	12.55	1.02	12.38	2 2 2
187406	8.64	0.99	16.18	2 2 2	187440	10.39	0.94	9.45	2 2 2
187406	8.67	0.99	16.10	2 2 2	187440	10.38	0.95	9.55	2 2 2
187407	8.60	0.99	15.53	2 2 2	187441	12.21	1.03	10.09	2 2 2
187407	8.61	0.97	15.60	2 2 2	187441	12.33	1.02	10.01	2 2 2
187408	8.53	0.95	15.33	2 2 2	187444	12.10	1.04	8.53	2 2 2
187408	8.63	0.98	15.40	2 2 2	187444	12.11	1.04	8.73	2 2 2
187409	8.18	0.97	14.90	2 2 2	187448	11.50	0.99	7.73	2 2 2
187409	8.14	0.96	15.28	2 2 2	187448	11.68	0.98	7.78	2 2 2
187410	7.47	0.90	13.49	2 2 2	187451	10.24	0.90	6.31	2 2 2
187410	7.38	0.91	13.64	2 2 2	187451	10.19	0.90	6.43	2 2 2
187411	5.12	0.75	8.94	2 2 2	187453	10.78	0.93	10.09	2 2 2
187411	5.16	0.76	8.94	2 2 2	187453	10.46	0.95	10.06	2 2 2
187412	5.37	0.55	2.50	2 2 2	187454	9.88	0.93	9.87	2 2 2
187412	5.49	0.53	2.48	2 2 2	187454	9.94	0.93	9.84	2 2 2
187413	8.90	0.97	15.12	2 2 2	187459	10.92	1.02	8.64	2 2 2
187413	8.89	0.98	15.07	2 2 2	187459	10.93	1.01	8.67	2 2 2
187414	8.63	0.96	14.82	3 2 2	187465	9.71	0.91	6.51	2 2 2
187414	9.14	0.96	14.85	3 2 2	187465	10.03	0.92	6.46	2 2 2
187415	8.71	1.00	14.87	2 2 2	187468	7.47	0.91	11.41	2 2 2
187415	8.78	0.98	14.72	2 2 2	187468	7.55	0.90	11.49	2 2 2
187416	8.60	0.99	14.89	2 2 2	187469	8.54	0.92	11.85	2 2 2
187416	8.65	0.98	14.84	2 2 2	187469	8.58	0.93	11.86	2 2 2
187417	8.74	0.95	13.61	2 2 2	187470	5.72	0.77	8.73	2 2 2
187417	8.67	0.94	13.61	2 2 2	187470	6.53	0.76	8.63	2 2 2
187418	11.53	1.02	11.28	2 2 2	187473	8.05	0.85	10.02	2 2 2
187418	11.42	1.02	11.11	2 2 2	187473	8.15	0.86	10.04	2 2 2
187421	12.13	1.04	9.35	2 2 2	187478	9.61	0.91	8.41	2 2 2
187421	12.22	1.03	9.25	2 2 2	187478	9.69	0.92	8.36	2 2 2
187426	11.42	1.01	8.03	2 2 2	187482	8.11	0.84	6.52	2 2 2
187426	11.46	1.00	8.20	2 2 2	187482	8.16	0.85	6.55	2 2 2
187430	9.82	0.84	5.75	2 2 2	187485	10.52	1.04	16.49	2 2 2
187430	9.67	0.86	5.77	2 2 2	187485	10.56	1.08	15.94	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF
187486	9.94	1.04	16.61	2 2 2
187486	9.98	1.05	16.65	2 2 2
187487	9.90	1.03	16.26	2 2 2
187487	9.64	1.04	16.51	2 2 2
187488	9.39	1.03	16.24	2 2 2
187488	9.52	1.04	16.39	2 2 2
187489	8.64	1.00	15.92	2 2 2
187489	8.71	1.00	15.96	2 2 2
187490	8.56	0.99	15.81	2 2 2
187490	8.69	1.01	15.73	2 2 2
187491	8.58	0.99	15.87	2 2 2
187491	8.69	0.99	15.30	2 2 2
187492	8.67	0.99	15.84	2 2 2
187492	8.84	0.97	15.86	2 2 2
187493	8.07	0.92	13.78	2 2 2
187493	8.14	0.94	13.81	2 2 2
187494	9.04	0.99	15.57	2 2 2
187494	9.13	0.99	15.41	2 2 2
187495	8.06	0.92	13.65	2 2 2
187495	8.02	0.92	13.70	2 2 2
187496	5.94	0.77	9.56	2 2 2
187496	5.95	0.77	9.56	2 2 2
187497	8.02	0.95	13.89	2 2 2
187497	8.05	0.93	13.73	2 2 2
187513	11.12	1.04	15.81	2 2 2
187513	11.32	1.03	15.97	2 2 2
187514	11.01	1.03	16.54	2 2 2
187514	11.05	1.02	16.29	2 2 2
187515	10.87	1.03	16.45	2 2 2
187515	10.88	1.03	16.54	2 2 2
187516	10.71	1.03	16.46	2 2 2
187516	10.72	1.06	16.53	2 2 2
187517	10.43	1.04	16.37	2 2 2
187517	10.59	1.04	16.71	2 2 2
187518	9.91	1.03	16.66	2 2 2
187518	9.90	1.07	16.32	2 2 2
187519	9.95	1.06	16.23	2 2 2
187519	9.99	1.06	16.27	2 2 2
187520	10.00	1.05	16.00	2 2 2
187520	10.11	1.05	16.16	2 2 2
187521	9.74	1.05	16.50	2 2 2
187521	10.05	1.04	16.50	2 2 2
187522	9.26	1.01	15.91	2 2 2
187522	9.30	1.02	16.22	2 2 2
187523	8.87	0.99	16.02	2 2 2
187523	8.94	1.01	15.86	2 2 2
187524	8.85	1.00	15.97	2 2 2
187524	8.86	1.00	15.41	2 2 2
187525	8.97	0.99	15.79	2 2 2
187525	9.05	0.99	15.81	2 2 2
187526	8.76	0.97	15.45	2 2 2
187526	8.90	0.97	15.18	2 2 2
187527	7.91	0.90	12.38	2 2 2
187527	7.92	0.88	12.52	2 2 2
187528	6.06	0.42	3.59	2 2 2
187528	6.05	0.43	3.53	2 2 2
187529	11.57	0.98	15.29	2 2 2
187529	11.45	0.97	15.10	2 2 2
187530	11.77	0.98	15.62	2 2 2
187530	11.93	0.99	15.69	2 2 2
187531	11.72	1.00	15.67	2 2 2
187531	11.89	0.99	15.49	2 2 2
187532	11.91	1.00	15.89	2 2 2
187532	11.55	1.06	15.64	2 2 2
187533	11.03	1.03	16.23	2 2 2
187533	11.17	1.02	16.23	2 2 2
187534	10.68	1.03	16.37	2 2 2
187534	10.91	1.02	16.23	2 2 2
187535	10.50	1.04	16.21	2 2 2
187535	10.59	1.05	16.54	2 2 2
187536	9.90	1.05	17.04	2 2 2
187536	9.90	1.05	16.98	2 2 2
187537	10.27	1.04	16.73	2 2 2
187537	10.06	1.04	16.68	2 2 2
187538	10.35	1.06	16.59	2 2 2
187538	10.38	1.04	16.59	2 2 2
187539	9.97	1.03	16.97	2 2 2
187539	10.09	1.05	16.93	2 2 2
187540	9.65	1.04	16.53	2 2 2
187540	9.54	1.01	16.30	2 2 2
187541	9.06	1.00	15.90	2 2 2
187541	9.16	1.01	15.81	2 2 2
187542	9.14	0.99	15.88	2 2 2
187542	9.18	1.00	15.69	2 2 2
187543	8.90	0.99	15.69	2 2 2
187543	8.96	0.99	15.55	2 2 2
187544	8.95	0.99	15.72	2 2 2
187544				5 5 5
187545	8.79	0.84	14.89	2 2 2
187545				5 5 5
187546				5 5 5
187546	8.98	0.83	14.38	2 2 2

Table C.4 Replicate nutrient water sample values in μmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF
187547	5.23	0.27	0.73	2 2 2
187547	5.30	0.25	0.78	2 2 2
187548	10.79	0.95	14.40	2 2 2
187548	10.64	1.01	14.58	2 2 2
187549	11.35	0.98	14.59	2 2 2
187549	11.46	0.97	14.48	2 2 2
187550	11.91	1.04	15.24	2 2 2
187550	11.97	1.01	15.15	2 2 2
187551	11.39	1.02	15.56	2 2 2
187551	11.45	1.03	15.01	2 2 2
187552	10.80	1.04	15.32	2 2 2
187552				5 5 5
187553	10.46	1.04	15.41	2 2 2
187553	10.31	0.93	15.07	2 2 2
187554	9.68	1.06	15.29	2 2 2
187554	9.77	1.05	15.45	2 2 2
187555	9.69	1.07	15.33	2 2 2
187555	9.83	1.06	15.62	2 2 2
187556	9.80	1.06	14.76	2 2 2
187556	9.81	1.07	14.66	2 2 2
187557	9.89	1.06	14.91	2 2 2
187557	9.94	1.06	14.85	2 2 2
187558	9.86	1.04	15.39	2 2 2
187558	9.88	1.05	15.44	2 2 2
187559	9.83	1.10	15.44	2 2 2
187559	9.88	1.06	15.37	2 2 2
187560	9.24	1.04	14.99	2 2 2
187560	9.36	1.03	14.99	2 2 2
187561	8.76	1.01	14.86	2 2 2
187561	8.84	1.04	14.87	2 2 2
187562	8.55	1.03	14.61	2 2 2
187562	8.66	0.99	14.58	2 2 2
187563	8.36	0.99	14.39	2 2 2
187563	8.40	1.01	14.33	2 2 2
187564	8.15	0.97	14.15	2 2 2
187564	8.21	0.98	14.08	2 2 2
187566	4.14	0.42	4.45	2 2 2
187566	4.08	0.43	4.46	2 2 2
187572	10.33	0.95	12.96	2 2 2
187572	10.39	0.95	13.44	2 2 2
187573	10.28	0.93	13.70	2 2 2
187573	10.32	0.94	13.62	2 2 2
187574	11.16	1.00	14.29	2 2 2
187574	11.26	1.00	14.41	2 2 2
187575	11.73	1.00	15.06	2 2 2
187575	11.73	1.00	14.94	2 2 2
187576	11.46	1.01	15.13	2 2 2
187576	11.72	1.03	15.23	2 2 2
187577	11.09	1.05	15.56	2 2 2
187577	11.16	1.02	15.45	2 2 2
187578	10.70	1.02	15.51	2 2 2
187578	10.81	1.02	15.57	2 2 2
187579	10.55	1.03	15.73	2 2 2
187579	10.45	1.03	15.70	2 2 2
187580	10.03	1.10	16.10	2 2 2
187580	10.06	1.04	16.12	2 2 2
187581	9.74	1.05	16.12	2 2 2
187581	9.91	1.06	16.38	2 2 2
187582	9.80	1.05	16.14	2 2 2
187582	9.86	1.04	16.15	2 2 2
187583	9.94	1.06	16.19	2 2 2
187583	10.05	1.05	16.04	2 2 2
187584	9.93	1.04	16.56	2 2 2
187584	10.00	1.06	16.42	2 2 2
187585	9.92	1.06	16.05	2 2 2
187585	9.94	1.04	16.21	2 2 2
187586	9.56	1.05	16.17	2 2 2
187586	9.86	1.05	16.34	2 2 2
187587	8.86	1.01	15.87	2 2 2
187587	8.72	1.02	15.88	2 2 2
187588	8.73	1.00	15.44	2 2 2
187588	8.81	1.00	15.68	2 2 2
187589	8.40	0.95	14.48	2 2 2
187589	8.55	0.95	14.40	2 2 2
187590	8.39	1.00	15.28	2 2 2
187590	8.45	1.00	15.42	2 2 2
187591	8.40	0.99	15.27	2 2 2
187591	8.47	0.99	15.31	2 2 2
187592	8.45	0.98	14.87	2 2 2
187592	8.48	0.98	14.90	2 2 2
187593	8.15	0.98	14.98	2 2 2
187593	8.26	0.99	14.73	2 2 2
187594	7.99	0.94	14.41	2 2 2
187594	8.01	0.95	14.20	2 2 2
187595	6.78	0.62	7.05	2 2 2
187595	6.64	0.64	6.97	2 2 2
187596	10.24	1.02	14.18	2 2 2
187596	10.24	0.98	14.34	2 2 2
187597	10.18	1.00	14.54	2 2 2
187597	10.21	0.98	14.49	2 2 2
187599	11.24	1.06	15.61	2 2 2
187599	11.27	1.05	15.63	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
187600	11.56	1.06	15.96	2 2 2	187639	11.66	1.05	15.76	2 2 2
187600	11.72	1.05	15.83	2 2 2	187639	11.91	1.04	15.79	2 2 2
187601	11.14	1.06	15.92	2 2 2	187640	11.67	1.07	15.72	2 2 2
187601	11.24	1.07	15.92	2 2 2	187640	11.68	1.07	15.79	2 2 2
187602	10.98	1.09	16.21	2 2 2	187641	11.21	1.05	15.81	2 2 2
187602	10.99	1.09	16.46	2 2 2	187641	11.25	1.06	15.88	2 2 2
187603	10.09	1.08	16.48	2 2 2	187642	11.01	1.09	16.41	2 2 2
187603	10.19	1.08	16.52	2 2 2	187642	11.04	1.07	16.39	2 2 2
187604	9.71	1.08	16.17	2 2 2	187643	10.64	1.09	16.35	2 2 2
187604	9.58	1.09	16.41	2 2 2	187643	10.65	1.08	16.57	2 2 2
187605	9.54	1.07	16.57	2 2 2	187644	9.86	1.09	16.39	2 2 2
187605	9.68	1.06	16.48	2 2 2	187644	9.93	1.09	16.39	2 2 2
187606	9.60	1.08	16.44	2 2 2	187645	9.50	1.08	16.00	2 2 2
187606	9.63	1.09	16.42	2 2 2	187645	9.56	1.08	16.51	2 2 2
187607	9.65	1.11	16.17	2 2 2	187646	9.63	1.07	16.46	2 2 2
187607	9.72	1.11	16.46	2 2 2	187646	9.55	1.08	16.51	2 2 2
187608	9.29	1.11	16.22	2 2 2	187647	10.09	1.08	16.26	2 2 2
187608	9.39	1.10	16.17	2 2 2	187647	9.65	1.08	16.31	2 2 2
187609	9.28	1.08	16.18	2 2 2	187648	9.44	1.08	16.22	2 2 2
187609	9.35	1.09	16.24	2 2 2	187648	9.53	1.18	16.44	2 2 2
187610	9.04	1.07	16.29	2 2 2	187649	9.23	1.09	16.36	2 2 2
187610	9.14	1.08	16.33	2 2 2	187649	9.29	1.06	16.22	2 2 2
187611	9.17	1.09	16.31	2 2 2	187650	9.18	1.08	16.16	2 2 2
187611	9.19	1.08	16.13	2 2 2	187650	9.14	1.04	16.47	2 2 2
187612	9.09	1.08	16.07	2 2 2	187651	8.97	1.06	16.20	2 2 2
187612	8.99	1.07	15.98	2 2 2	187651	8.99	1.06	16.27	2 2 2
187614	8.60	1.03	15.76	2 2 2	187652	8.84	1.05	15.71	2 2 2
187614	8.64	1.05	15.89	2 2 2	187652	8.88	1.03	16.00	2 2 2
187615	8.53	1.05	15.69	2 2 2	187653	8.75	1.02	15.65	2 2 2
187615	8.72	1.05	15.65	2 2 2	187653	8.79	1.01	15.58	2 2 2
187616	8.61	1.03	15.47	2 2 2	187654	8.74	1.02	15.58	2 2 2
187616	8.68	1.11	15.45	2 2 2	187654	8.73	1.02	15.96	2 2 2
187617	8.35	0.98	15.00	2 2 2	187655	8.61	1.02	15.69	2 2 2
187617	8.37	1.00	14.96	2 2 2	187655	8.56	1.03	15.76	2 2 2
187618	8.07	0.90	13.47	2 2 2	187656	8.38	1.02	15.43	2 2 2
187618	8.11	0.91	13.54	2 2 2	187656	8.43	1.02	15.61	2 2 2
187619	4.13	0.43	6.43	2 2 2	187657	8.39	0.95	13.96	2 2 2
187619	4.13	0.42	6.58	2 2 2	187657	8.45	0.94	13.87	2 2 2
187635	10.31	0.97	14.29	2 2 2	187658	7.51	0.74	10.11	2 2 2
187635	10.34	0.97	14.34	2 2 2	187658	7.48	0.74	10.14	2 2 2
187636	10.10	0.98	14.49	2 2 2	187659	10.51	0.97	14.65	2 2 2
187636	10.00	0.97	14.23	2 2 2	187659	10.63	0.96	14.61	2 2 2
187637	11.04	0.99	15.07	2 2 2	187660	10.16	0.97	14.41	2 2 2
187637	11.21	1.00	14.96	2 2 2	187660	10.24	0.99	14.43	2 2 2
187638	13.11	1.06	15.76	2 2 2	187661	11.71	1.01	15.30	2 2 2
187638	13.21	1.04	15.74	2 2 2	187661	11.92	1.01	15.30	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
187662	13.96	1.06	15.81	2 2 2	187685	11.77	0.96	15.42	2 2 2
187662	13.92	1.06	15.74	2 2 2	187685	11.77	0.97	15.14	2 2 2
187663	12.05	1.03	15.63	2 2 2	187686	13.04	1.02	15.87	2 2 2
187663	11.98	1.05	15.37	2 2 2	187686	13.07	1.02	15.85	2 2 2
187664	11.58	1.06	16.04	2 2 2	187687	12.15	1.03	15.76	2 2 2
187664	11.66	1.06	15.95	2 2 2	187687	12.24	1.03	16.10	2 2 2
187665	11.28	1.08	16.10	2 2 2	187688	11.58	1.03	16.33	2 2 2
187665	11.29	1.07	16.17	2 2 2	187688	11.65	1.03	16.26	2 2 2
187666	11.05	1.09	16.24	2 2 2	187689	11.12	1.04	16.05	2 2 2
187666	10.91	1.10	16.17	2 2 2	187689	11.15	1.05	16.20	2 2 2
187667	10.29	1.10	16.35	2 2 2	187690	11.01	1.03	16.22	2 2 2
187667	10.36	1.14	16.31	2 2 2	187690	11.08	1.05	16.26	2 2 2
187668	9.64	1.14	16.51	2 2 2	187691	10.20	1.05	16.31	2 2 2
187668	9.76	1.10	16.60	2 2 2	187691	10.17	1.08	16.15	2 2 2
187669	9.53	1.08	16.53	2 2 2	187692	9.47	1.04	16.59	2 2 2
187669	9.78		16.32	2 5 2	187692	9.71	1.05	16.47	2 2 2
187670	9.96		17.10	2 5 2	187693	9.53	1.04	16.64	2 2 2
187670	9.55	1.08	16.67	2 2 2	187693	9.63	1.04	16.53	2 2 2
187671	9.67	1.14	16.44	2 2 2	187694	9.59	1.05	16.49	2 2 2
187671	9.63	1.11	16.36	2 2 2	187694	9.62	1.06	16.29	2 2 2
187672	9.33	1.08	16.29	2 2 2	187695	9.38	1.05	16.84	2 2 2
187672	9.34	1.08	16.20	2 2 2	187695	9.42	1.05	16.77	2 2 2
187673	9.26	1.10	16.51	2 2 2	187696	9.18	1.05	16.27	2 2 2
187673	9.27	1.07	16.42	2 2 2	187696	9.21	1.03	16.55	2 2 2
187674	8.87	1.08	15.98	2 2 2	187697	9.01	1.04	16.21	2 2 2
187674	8.97	1.05	16.25	2 2 2	187697	9.14	1.04	16.20	2 2 2
187675	9.05	1.08	16.22	2 2 2	187698	8.97	1.04	16.39	2 2 2
187675	9.31		16.83	2 5 2	187698	9.03	1.04	16.37	2 2 2
187676	8.88	1.07	16.09	2 2 2	187699	8.81	1.03	16.38	2 2 2
187676	8.92	1.10	16.29	2 2 2	187699	8.78	1.04	16.15	2 2 2
187677	8.75	1.04	15.96	2 2 2	187700	8.70	1.04	15.89	2 2 2
187677	8.81	1.05	16.05	2 2 2	187700	8.74	1.03	16.00	2 2 2
187678	8.67	1.04	15.67	2 2 2	187701	8.49	1.01	16.04	2 2 2
187678	8.68	1.04	15.69	2 2 2	187701	8.50	1.04	15.74	2 2 2
187679	8.41	1.04	15.61	2 2 2	187702	8.19	1.02	15.75	2 2 2
187679	8.56	1.06	15.87	2 2 2	187702	8.23	1.03	15.77	2 2 2
187680	8.65	1.04	15.72	2 2 2	187703	8.12	1.00	14.80	2 2 2
187680	8.70	1.06	15.68	2 2 2	187703	8.19	1.00	15.11	2 2 2
187681	8.34	0.99	13.99	2 2 2	187704	7.92	0.93	14.08	2 2 2
187681	8.66		14.46	2 5 2	187704	7.94	0.91	14.07	2 2 2
187682	4.86	0.68	9.41	2 2 2	187705	1.78	0.31	4.56	2 2 2
187682	4.88	0.67	9.36	2 2 2	187705	1.79	0.29	4.71	2 2 2
187683	10.48	0.97	14.53	2 2 2	187706	0.79	0.21	3.78	2 2 2
187683	10.48	0.92	14.53	2 2 2	187706	0.89	0.23	3.82	2 2 2
187684	10.51	0.92	14.69	2 2 2	187707	10.20	0.91	14.60	2 2 2
187684	10.54	0.94	14.61	2 2 2	187707	10.46	0.92	14.66	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
187708	10.42	0.94	14.54	2 2 2	187731	9.70	0.96	14.91	2 2 2
187708	10.45	0.95	14.62	2 2 2	187731	9.74	0.93	14.91	2 2 2
187709	10.67	0.95	14.95	2 2 2	187732	9.43	0.97	14.71	2 2 2
187709	10.51	0.95	15.04	2 2 2	187732	9.46	0.95	14.49	2 2 2
187710	11.95	1.00	15.47	2 2 2	187733	10.81	0.96	15.13	2 2 2
187710	11.91	1.02	15.77	2 2 2	187733	10.68	0.98	15.14	2 2 2
187711	11.48	1.00	15.80	2 2 2	187734	12.75	1.03	15.76	2 2 2
187711	11.93	1.02	15.74	2 2 2	187734	12.72	1.02	15.51	2 2 2
187712	11.27	1.02	15.78	2 2 2	187735	11.98	1.03	16.11	2 2 2
187712	11.30	1.03	15.79	2 2 2	187735	12.02	1.04	16.09	2 2 2
187713	10.94	1.03	16.34	2 2 2	187736	11.68	1.05	16.21	2 2 2
187713	10.93	1.02	16.25	2 2 2	187736	11.71	1.07	16.26	2 2 2
187714	10.66	1.01	16.33	2 2 2	187737	11.43	1.07	16.13	2 2 2
187714	10.70	1.03	16.62	2 2 2	187737	11.24	1.07	16.36	2 2 2
187715	10.11	1.02	16.65	2 2 2	187738	11.03	1.03	16.25	2 2 2
187715	10.11	1.05	16.42	2 2 2	187738	11.03	1.04	16.30	2 2 2
187716	9.64	1.04	16.41	2 2 2	187739	10.48	1.08	16.62	2 2 2
187716	9.71	1.03	16.59	2 2 2	187739	10.57	1.03	16.49	2 2 2
187717	9.63	1.04	16.44	2 2 2	187740	9.71	1.09	16.63	2 2 2
187717	9.57	1.05	16.57	2 2 2	187740	9.74	1.08	16.63	2 2 2
187718	9.76	1.05	16.31	2 2 2	187741	9.67	1.08	16.46	2 2 2
187718	9.72	1.05	16.72	2 2 2	187741	9.60	1.08	16.87	2 2 2
187719	9.65	1.04	16.89	2 2 2	187742	9.69	1.08	16.95	2 2 2
187719	9.69	1.06	16.86	2 2 2	187742	9.66	1.08	16.75	2 2 2
187720	9.28	1.04	16.44	2 2 2	187743	9.75	1.07	16.62	2 2 2
187720	9.32	1.01	16.51	2 2 2	187743	9.82	1.08	16.59	2 2 2
187721	9.24	1.05	16.34	2 2 2	187744	9.54	1.08	16.69	2 2 2
187721	9.11	1.04	16.36	2 2 2	187744	9.58	1.08	16.51	2 2 2
187722	8.77	1.02	16.30	2 2 2	187745	9.66	1.05	16.54	2 2 2
187722	8.80	1.03	16.21	2 2 2	187745	9.30	1.04	16.63	2 2 2
187723	8.51	1.01	15.82	2 2 2	187746	9.20	1.07	16.52	2 2 2
187723	8.77	0.99	15.74	2 2 2	187746	9.32	1.08	16.48	2 2 2
187724	8.53	1.01	15.81	2 2 2	187747	8.84	1.06	16.09	2 2 2
187724	8.57	1.00	15.79	2 2 2	187747	8.87	1.08	16.23	2 2 2
187725	8.52	1.01	15.94	2 2 2	187748	8.76	1.06	15.62	2 2 2
187725	8.50	1.01	15.89	2 2 2	187748	8.80	1.03	15.94	2 2 2
187726	8.06	0.98	15.35	2 2 2	187749	8.82	1.03	15.95	2 2 2
187726	7.92	0.96	15.35	2 2 2	187749	8.62	1.04	16.06	2 2 2
187727	7.72	0.94	14.73	2 2 2	187750	8.64	1.05	15.59	2 2 2
187727	7.79	0.96	15.04	2 2 2	187750	8.58	1.03	15.84	2 2 2
187728	7.44	0.94	14.44	2 2 2	187751	8.33	1.03	15.09	2 2 2
187728	7.45	0.96	14.37	2 2 2	187751	8.44	1.03	15.11	2 2 2
187729	6.29	0.90	13.76	2 2 2	187752	7.96	0.97	14.50	2 2 2
187729	6.25	0.90	14.02	2 2 2	187752	8.03	0.96	14.40	2 2 2
187730	0.00	0.13	0.65	2 2 2	187753	7.79	0.96	14.09	2 2 2
187730	0.00	0.18	0.80	2 2 2	187753	7.72	0.93	14.05	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
187754	2.54	0.37	5.69	2 2 2	187777	6.35	0.68	13.49	2 3 2
187754	2.97	0.36	5.73	2 2 2	187777	6.36	0.67	13.70	2 3 2
187755	10.22	0.92	14.40	2 3 2	187778	1.16	0.15	3.45	2 3 2
187755	10.31	0.89	14.37	2 3 2	187778	1.16	0.17	3.43	2 3 2
187756	10.26	0.90	14.49	2 3 2	187779	10.26	1.22	14.38	2 3 2
187756	10.30	0.93	14.42	2 3 2	187779	10.36	1.08	15.14	2 3 2
187757	10.51	0.87	15.02	2 3 2	187780	10.28	1.09	15.19	2 3 2
187757	10.45	0.94	14.88	2 3 2	187780	10.44	1.06	15.21	2 3 2
187758	12.58	0.95	15.76	2 3 2	187781	11.91	1.12	15.65	2 3 2
187758	12.44	0.94	15.71	2 3 2	187781	11.93	1.12	15.65	2 3 2
187759	12.00	0.94	15.80	2 3 2	187782	12.22	1.16	16.23	2 3 2
187759	12.07	0.95	15.78	2 3 2	187782	12.26	1.14	15.97	2 3 2
187760	11.56	0.94	16.01	2 3 2	187783	11.91	1.15	16.62	2 3 2
187760	11.69	0.97	16.17	2 3 2	187783	11.91	1.17	16.60	2 3 2
187761	10.98	1.00	16.17	2 3 2	187784	11.40	1.15	16.32	2 3 2
187761	10.96	0.98	16.15	2 3 2	187784	11.41	1.16	16.57	2 3 2
187762	10.34	1.00	16.27	2 3 2	187785	10.87	1.15	16.48	2 3 2
187762	10.61	0.99	16.38	2 3 2	187785	10.90	1.16	16.78	2 3 2
187763	9.91	1.00	16.54	2 3 2	187786	10.63	1.18	17.11	2 3 2
187763	9.92	0.97	16.31	2 3 2	187786	10.62	1.18	16.78	2 3 2
187764	9.53	1.03	16.50	2 3 2	187787	10.06	1.20	17.25	2 3 2
187764	9.64	1.00	16.54	2 3 2	187787	10.16	1.21	17.01	2 3 2
187765	9.69	0.97	16.91	2 3 2	187788	9.94	1.19	17.06	2 3 2
187765	9.59	0.98	16.94	2 3 2	187788	9.95	1.19	17.11	2 3 2
187766	9.81	0.97	17.01	2 3 2	187789	9.93	1.18	16.99	2 3 2
187766	9.67	0.98	16.61	2 3 2	187789	9.94	1.19	17.01	2 3 2
187767	9.69	0.96	16.85	2 3 2	187790	9.88	1.19	17.43	2 3 2
187767	9.73	0.96	16.73	2 3 2	187790	10.41	1.19	17.02	2 3 2
187768	9.39	0.92	16.73	2 3 2	187791	9.93	1.18	17.34	2 3 2
187768	9.48	0.92	17.01	2 3 2	187791	10.07	1.19	17.39	2 3 2
187769	9.47	0.89	16.91	2 3 2	187792	9.95	1.20	17.13	2 3 2
187769	9.50	0.94	16.89	2 3 2	187792	9.99	1.20	17.06	2 3 2
187770	9.29	0.96	16.73	2 3 2	187793	9.78	1.19	17.25	2 3 2
187770	9.30	0.91	16.45	2 3 2	187793	9.94	1.19	17.32	2 3 2
187771	8.86	0.91	16.13	2 3 2	187794	9.51	1.19	16.99	2 3 2
187771	8.95	0.83	16.43	2 3 2	187794	9.47	1.18	16.97	2 3 2
187772	8.81	0.96	16.55	2 3 2	187795	9.44	1.17	16.83	2 3 2
187772	8.82	0.87	16.50	2 3 2	187795	9.49	1.17	16.93	2 3 2
187773	8.47	0.85	16.71	2 3 2	187796	9.23	1.15	16.65	2 3 2
187773	8.63	0.85	16.20	2 3 2	187796	9.28	1.15	16.56	2 3 2
187774	8.53	0.86	15.99	2 3 2	187797	9.02	1.16	16.44	2 3 2
187774	8.59	0.87	16.04	2 3 2	187797	9.56	1.15	16.79	2 3 2
187775	8.05	0.80	15.07	2 3 2	187798	8.42	1.12	16.14	2 3 2
187775	8.15	0.84	15.21	2 3 2	187798	8.51	1.10	16.12	2 3 2
187776	7.88	0.79	15.74	2 3 2	187799	8.20	1.10	15.57	2 3 2
187776	7.97	0.85	15.44	2 3 2	187799	8.27	1.10	15.66	2 3 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF
187800	8.00	1.07	15.13	2 3 2
187800	8.02	1.05	15.13	2 3 2
187801	7.49	0.99	13.57	2 3 2
187801	7.50	1.00	13.57	2 3 2
187802	1.31	0.28		2 3 5
187802	1.34	0.34		2 3 5
187803	10.63	1.06	15.36	2 3 2
187803	10.64	1.06	15.22	2 3 2
187804	10.62	1.06	15.57	2 3 2
187804	10.52	1.08	15.43	2 3 2
187805	11.97	1.10	16.26	2 3 2
187805	11.88	1.10	16.12	2 3 2
187806	12.59	1.12	16.47	2 3 2
187806	12.71	1.12	16.28	2 3 2
187807	11.06	1.12	16.31	2 3 2
187807	11.17	1.11	16.24	2 3 2
187808	11.31	1.14	16.81	2 3 2
187808	11.22	1.13	16.77	2 3 2
187810	10.84	1.14	17.07	2 3 2
187810	10.88	1.16	17.09	2 3 2
187811	10.01	1.15	17.23	2 3 2
187811	10.09	1.17	16.77	2 3 2
187812	9.61	1.15	17.05	2 3 2
187812	9.62	1.16	16.86	2 3 2
187813	9.83	1.17	17.23	2 3 2
187813	9.77	1.15	17.21	2 3 2
187814	9.82	1.17	17.21	2 3 2
187814	9.81	1.15	16.93	2 3 2
187815	9.61	1.15	17.33	2 3 2
187815	9.61	1.15	17.21	2 3 2
187816	9.31	1.14	17.33	2 3 2
187816	9.40	1.16	17.07	2 3 2
187817	9.06	1.13	16.66	2 3 2
187817	8.99	1.13	16.56	2 3 2
187818	8.91	1.14	17.03	2 3 2
187818	8.95	1.12	16.54	2 3 2
187819	9.16	1.20	16.98	2 3 2
187819	9.27	1.15	17.07	2 3 2
187820	9.09	1.12	16.77	2 3 2
187820	9.16	1.15	16.70	2 3 2
187821	8.63	1.09	16.13	2 3 2
187821	8.59	1.08	16.38	2 3 2
187822	8.32	1.09	15.92	2 3 2
187822	8.31	1.07	15.64	2 3 2
187823	7.94	1.04	15.00	2 3 2
187823	7.95	1.05	15.37	2 3 2
187824	7.12	0.89	12.08	2 3 2
187824	7.13	0.90	12.24	2 3 2
187825	3.00	0.38	3.10	2 3 2
187825	3.00	0.40	3.01	2 3 2
187827	10.18	1.05	14.59	2 3 2
187827	10.40	1.04	14.65	2 3 2
187828	10.65	1.05	14.79	2 3 2
187828	10.69	1.04	14.79	2 3 2
187829	10.87	1.06	15.25	2 3 2
187829	11.30	1.08	15.18	2 3 2
187830	11.18	1.12	16.31	2 3 2
187830	10.96	1.10	15.99	2 3 2
187831	11.04	1.16	16.73	2 3 2
187831	11.00	1.15	16.91	2 3 2
187832	10.05	1.12	16.43	2 3 2
187832	10.09	1.12	15.97	2 3 2
187833	9.91	1.13	16.87	2 3 2
187833	10.04	1.14	16.71	2 3 2
187834	9.70	1.14	16.57	2 3 2
187834	9.74	1.14	16.64	2 3 2
187835	9.72	1.14	16.64	2 3 2
187835	9.89	1.14	16.57	2 3 2
187836	9.74	1.15	17.01	2 3 2
187836	9.77	1.15	16.89	2 3 2
187837	9.41	1.14	16.52	2 3 2
187837	9.47	1.15	16.62	2 3 2
187838	9.00	1.13	16.16	2 3 2
187838	9.01	1.12	16.18	2 3 2
187839	8.99	1.12	16.02	2 3 2
187839	9.02	1.11	15.81	2 3 2
187840	8.75	1.12	16.09	2 3 2
187840	8.88	1.11	16.18	2 3 2
187841	8.60	1.09	15.56	2 3 2
187841	8.74	1.10	15.81	2 3 2
187842	8.14	1.09	15.51	2 3 2
187842	8.18	1.06	15.37	2 3 2
187843	7.77	1.00	13.81	2 3 2
187843	7.74	1.00	13.72	2 3 2
187844	7.37	0.93	12.57	2 3 2
187844	7.37	0.94	12.22	2 3 2
187845	6.10	0.86	10.90	2 3 2
187845	6.11	0.86	10.76	2 3 2
187846	1.68	0.37	2.41	2 3 2
187846	1.77	0.40	2.53	2 3 2
187847	1.28	0.36	1.30	2 3 2
187847	1.31	0.34	1.09	2 3 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
187851	9.78	1.09	16.00	2 3 2	187893	5.25	0.56	8.72	2 3 2
187851	9.84	1.10	16.07	2 3 2	187893	5.37	0.55	8.77	2 3 2
187852	9.84	1.08	16.00	2 3 2	187898	5.04	0.58	8.10	2 3 2
187852	9.86	1.10	16.09	2 3 2	187898	5.04	0.53	8.12	2 3 2
187853	9.78	1.11	15.98	2 3 2	187902	0.37	0.20	0.15	2 3 3
187853	9.89	1.08	16.14	2 3 2	187902	0.41	0.19	0.29	2 3 3
187854	9.84	1.12	16.55	2 3 2	187908	10.41	1.06	16.00	2 2 2
187854	9.51	1.12	16.67	2 3 2	187908	10.47	1.16	15.99	2 2 2
187855	9.11	1.09	16.14	2 3 2	187909	9.89	1.10	16.53	2 2 2
187855	9.15	1.08	16.39	2 3 2	187909	9.86	1.10	16.39	2 2 2
187856	8.84	1.08	16.14	2 3 2	187910	9.73	1.00	16.16	2 3 2
187856	8.91	1.08	15.86	2 3 2	187910	9.86	1.09	16.37	2 3 2
187857	8.41	1.04	15.84	2 3 2	187911	10.01	1.11	16.65	2 2 2
187857	8.48	1.05	15.42	2 3 2	187911	10.04	1.08	16.55	2 2 2
187858	8.02	1.04	15.38	2 3 2	187912	9.62	1.09	16.16	2 2 2
187858	8.07	1.04	15.40	2 3 2	187912	9.69	1.08	16.46	2 2 2
187859	7.74	0.98	14.48	2 3 2	187913	9.52	1.10	16.64	2 2 2
187859	7.84	0.99	14.46	2 3 2	187913	9.58	1.11	16.60	2 2 2
187860	7.21	0.94	13.35	2 3 2	187914	8.58	1.08	15.48	2 2 2
187860	7.25	0.93	13.17	2 3 2	187914	8.68	1.05	15.81	2 2 2
187861	6.85	0.90	12.64	2 3 2	187915	8.35	1.05	15.64	2 2 2
187861	6.91	0.89	12.87	2 3 2	187915	8.35	1.08	15.58	2 2 2
187862	5.36	0.72	9.18	2 3 2	187916	8.11	1.04	14.97	2 2 2
187862	5.03	0.72	9.13	2 3 2	187916	8.11	1.10	14.92	2 2 2
187867	1.74	0.35	2.79	9 9 9	187917	7.85	1.05	15.00	2 2 2
187867	1.77	0.36	2.49	9 9 9	187917	7.82	1.05	15.20	2 2 2
187872	1.67	0.35	2.12	2 3 3	187918	7.39	1.00	14.27	2 2 2
187872	1.70	0.35	1.98	2 3 3	187918	7.68	1.02	14.18	2 2 2
187875	8.19	0.88	15.06	2 3 2	187919	5.81	0.96	12.12	2 2 2
187875	8.47	0.90	15.29	2 3 2	187919	5.87	0.96	12.20	2 2 2
187876	8.14	0.91	15.38	2 3 2	187920	1.35	0.57	3.86	2 2 2
187876	8.20	0.90	15.38	2 3 2	187920	1.36	0.47	3.97	2 2 2
187877	7.99	0.88	15.06	2 3 2	187921	0.22	0.21	0.00	2 2 2
187877	8.06	0.91	15.11	2 3 2	187921	0.32	0.23	0.00	2 2 2
187878	7.79	0.89	15.15	2 3 2	187922	10.92	1.04	15.56	2 3 2
187878	7.82	0.88	14.71	2 3 2	187922	11.14	0.87	15.82	2 3 2
187879	7.33	0.84	13.82	2 3 2	187923	10.42	1.04	16.13	2 2 2
187879	7.35	0.81	13.80	2 3 2	187923	10.54	1.02	16.06	2 2 2
187880	6.58	0.75	11.75	2 3 2	187924	10.13	1.04	15.79	2 2 2
187880	6.54	0.73	11.98	2 3 2	187924	10.20	1.04	16.13	2 2 2
187881	5.15	0.65	9.23	2 3 2	187925	9.86	0.94	16.32	2 3 2
187881	5.21	0.65	9.23	2 3 2	187925	9.85	1.04	16.44	2 3 2
187886	1.58	0.31	3.12	2 3 3	187926	9.64	1.03	16.22	2 2 2
187886	1.61	0.31	2.06	2 3 3	187926	9.71	1.03	16.48	2 2 2
187891	1.41	0.28	1.21	2 3 2	187927	9.53	0.87	16.26	2 3 2
187891	1.47	0.27	1.37	2 3 2	187927	9.60	1.05	16.29	2 3 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
187928	9.54	1.01	16.55	2 2 2	187951	9.56	1.06	16.78	2 2 2
187928	9.55	1.06	16.31	2 2 2	187951	9.52	1.05	16.65	2 2 2
187929	9.69	1.05	16.52	2 2 2	187952	10.00	1.06	16.46	2 2 2
187929	10.19	1.05	16.62	2 2 2	187952	9.34	1.06	16.44	2 2 2
187930	9.62	0.96	16.37	2 3 2	187953	8.78	1.03	16.24	2 2 2
187930	9.64	1.02	16.44	2 3 2	187953	8.94	1.03	16.24	2 2 2
187931	9.36	1.04	16.29	2 2 2	187954	8.27	1.00	15.68	2 2 2
187931	9.44	1.04	16.39	2 2 2	187954	8.28	0.99	15.47	2 2 2
187932	8.79	1.05	16.15	2 2 2	187955	8.07	0.97	15.37	2 2 2
187932	8.87	1.02	16.22	2 2 2	187955	8.03	0.99	15.42	2 2 2
187933	8.13	1.03	15.62	2 2 2	187956	7.85	0.98	15.17	2 2 2
187933	8.29	1.01	15.59	2 2 2	187956	7.89	0.99	15.20	2 2 2
187934	8.34	1.01	15.47	2 2 2	187957	7.74	0.97	14.69	2 2 2
187934	10.40	1.00	15.50	3 2 2	187957	7.80	0.98	14.74	2 2 2
187935	7.94	1.01	15.21	2 2 2	187958	6.89	0.93	12.50	2 2 2
187935	7.90	1.00	14.97	2 2 2	187958	7.10	0.93	12.56	2 2 2
187936	7.56	0.99	15.13	2 2 2	187959	3.38	0.63	5.47	2 2 2
187936	7.53	1.01	15.28	2 2 2	187959	3.21	0.63	5.47	2 2 2
187937	6.87	0.98	14.08	2 2 2	187960	1.09	0.34	1.15	2 2 2
187937	6.92	0.96	13.86	2 2 2	187960	1.06	0.35	1.16	2 2 2
187938	0.00	0.20	0.00	2 2 2	187964	10.27	0.97	14.35	2 2 2
187938	0.00	0.21	0.00	2 2 2	187964	10.36	0.96	14.97	2 2 2
187939	0.00	0.18	0.00	2 2 2	187965	10.74	0.97	14.82	2 2 2
187939	0.00	0.15	0.00	2 2 2	187965	10.93	0.97	15.08	2 2 2
187940	10.65	0.96	14.64	2 2 2	187966	11.01	1.01	15.63	2 2 2
187940	10.81	0.97	14.90	2 2 2	187966	11.05	1.00	15.70	2 2 2
187941	10.86	0.96	14.90	2 2 2	187967	10.90	1.01	15.86	2 2 2
187941	11.12	0.96	14.89	2 2 2	187967	10.93	1.01	15.48	2 2 2
187942	10.78	0.98	15.01	2 2 2	187968	10.68	1.02	15.91	2 2 2
187942	10.81	0.98	14.99	2 2 2	187968	10.69	1.02	15.76	2 2 2
187943	10.96	1.01	15.20	2 2 2	187969	10.54	1.02	16.15	2 2 2
187943	10.92	1.00	15.37	2 2 2	187969	10.57	1.04	16.17	2 2 2
187944	11.07	1.00	15.63	2 2 2	187970	10.16	1.05	16.17	2 2 2
187944	10.85	1.00	15.56	2 2 2	187970	10.27	1.05	16.26	2 2 2
187945	10.77	1.02	15.82	2 2 2	187971	9.79	1.05	16.38	2 2 2
187945	10.89	1.01	15.77	2 2 2	187971	9.83	1.04	16.40	2 2 2
187946	10.55	1.00	15.86	2 2 2	187972	9.46	1.06	16.69	2 2 2
187946	10.61	1.00	15.97	2 2 2	187972	9.48	1.04	16.71	2 2 2
187947	10.28	1.02	16.21	2 2 2	187973	9.47	1.05	16.42	2 2 2
187947	10.14	1.03	16.23	2 2 2	187973	9.53	1.04	16.58	2 2 2
187948	9.60	1.04	16.16	2 2 2	187974	9.45	1.04	16.65	2 2 2
187948	9.64	1.04	16.07	2 2 2	187974	9.46	1.06	16.80	2 2 2
187949	9.42	1.04	16.54	2 2 2	187975	9.31	1.05	16.53	2 2 2
187949	9.50	1.05	16.37	2 2 2	187975	9.27	1.07	16.60	2 2 2
187950	9.55	1.04	16.76	2 2 2	187976	9.33	1.06	16.74	2 2 2
187950	9.60	1.09	16.61	2 2 2	187976	9.38	1.06	16.67	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
187977	9.08	1.06	16.55	2 2 2	188003	8.32	1.02	15.79	2 2 2
187977	9.17	1.04	16.47	2 2 2	188003	8.35	1.04	15.50	2 2 2
187978	8.83	1.04	15.99	2 2 2	188004	8.07	1.03	15.14	2 2 2
187978	9.17	1.02	16.11	2 2 2	188004	8.05	1.04	15.05	2 2 2
187980	8.49	1.00	15.73	2 2 2	188005	8.00	1.02	15.16	2 2 2
187980	8.50	1.01	15.78	2 2 2	188005	7.99	1.02	15.16	2 2 2
187982	7.67	0.98	14.86	2 2 2	188006	7.62	1.01	13.99	2 2 2
187982	7.74	0.97	15.20	2 2 2	188006	7.69	1.01	14.06	2 2 2
187983	8.18	0.99	14.93	2 2 2	188007	7.48	0.99	13.87	2 2 2
187983	8.24	0.98	15.02	2 2 2	188007	8.10	0.99	13.41	2 2 2
187984	7.45	0.96	13.47	2 2 2	188008	6.02	0.84	10.20	2 2 2
187984	7.48	0.96	13.89	2 2 2	188008	5.98	0.82	10.25	2 2 2
187985	5.98	0.82	10.06	2 2 2	188009	2.18	0.58	5.46	2 2 2
187985	5.91	0.81	9.97	2 2 2	188009	2.18	0.58	5.49	2 2 2
187986	1.74	0.34	1.77	2 2 2	188010	0.27	0.18	0.00	2 2 2
187986	1.75	0.34	1.84	2 2 2	188010	0.31	0.14	0.00	2 2 2
187988	10.21	0.97	14.58	2 2 2	188011	10.12	0.98	14.11	2 2 2
187988	10.27	0.97	14.84	2 2 2	188011	10.12	0.97	14.06	2 2 2
187989	10.36	0.96	14.89	2 2 2	188012	11.23	1.01	14.87	2 2 2
187989	10.38	0.97	14.79	2 2 2	188012	11.04	1.01	14.75	2 2 2
187990	10.99	0.99	15.12	2 2 2	188013	10.19	1.06	15.81	2 2 2
187990	11.18	1.01	14.91	2 2 2	188013	10.15	1.04	15.78	2 2 2
187991	11.23	1.00	15.70	2 2 2	188014	11.42	1.04	15.35	2 2 2
187991	11.29	1.00	15.65	2 2 2	188014	11.46	1.04	15.66	2 2 2
187992	10.75	1.01	15.54	2 2 2	188015	11.15	1.05	15.94	2 2 2
187992	10.79	1.01	15.59	2 2 2	188015	11.18	1.06	15.89	2 2 2
187993	10.41	1.03	15.51	2 2 2	188016	10.65	1.05	15.65	2 2 2
187993	10.45	1.02	15.66	2 2 2	188016	10.65	1.04	15.77	2 2 2
187994	10.53	1.05	15.78	2 2 2	188017	10.38	1.07	15.76	2 2 2
187994	10.46	1.05	16.13	2 2 2	188017	10.53	1.05	15.79	2 2 2
187995	10.16	1.05	16.25	2 2 2	188018	10.13	1.06	16.22	2 2 2
187995	10.26	1.05	16.33	2 2 2	188018	10.20	1.07	16.10	2 2 2
187996	9.59	1.06	16.20	2 2 2	188019	9.64	1.09	16.19	2 2 2
187996	9.66	1.06	16.18	2 2 2	188019	9.73	1.07	16.00	2 2 2
187997	9.45	1.07	16.30	2 2 2	188020	9.65	1.06	16.55	2 2 2
187997	9.54	1.06	16.17	2 2 2	188020	9.65	1.07	16.47	2 2 2
187998	9.53	1.07	16.32	2 2 2	188021	10.60	1.09	16.16	3 2 2
187998	9.62	1.07	16.63	2 2 2	188021	9.51	1.08	16.42	2 2 2
187999	9.41	1.08	16.53	2 2 2	188022	9.59	1.08	16.42	2 2 2
187999	9.42	1.07	16.60	2 2 2	188022	9.65	1.08	16.54	2 2 2
188000	9.27	1.05	16.35	2 2 2	188023	9.24	1.08	16.15	2 2 2
188000	9.27	1.06	16.28	2 2 2	188023	9.28	1.05	16.32	2 2 2
188001	8.93	1.06	15.85	2 2 2	188024	8.78	1.04	15.79	2 2 2
188001	8.93	1.04	16.21	2 2 2	188024	8.74	1.04	16.00	2 2 2
188002	8.68	1.05	16.20	2 2 2	188025	8.89	1.05	15.88	2 2 2
188002	8.73	1.05	16.04	2 2 2	188025	8.90	1.04	16.12	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
188026	8.65	1.05	15.78	2 2 2	188049	9.26	1.11	16.37	2 2 2
188026	8.69	1.04	15.80	2 2 2	188049	9.32	1.10	16.35	2 2 2
188027	8.60	1.04	15.78	2 2 2	188050	8.93	1.08	16.00	2 2 2
188027	8.61	1.10	15.35	2 2 2	188050	8.97	1.06	15.95	2 2 2
188028	8.33	1.02	15.53	2 2 2	188051	8.61	1.06	15.71	2 2 2
188028	8.26	1.01	15.63	2 2 2	188051	8.67	1.07	15.62	2 2 2
188029	8.09	1.01	15.10	2 2 2	188052	8.69	1.04	15.40	2 2 2
188029	8.06	1.01	15.15	2 2 2	188052	8.69	1.03	15.35	2 2 2
188030	7.72	1.01	14.72	2 2 2	188053	8.46	1.05	15.49	2 2 2
188030	7.91	1.00	14.69	2 2 2	188053	8.39	1.05	15.40	2 2 2
188031	7.42	0.98	14.45	2 2 2	188054	8.23	1.04	15.16	2 2 2
188031	7.44	0.97	14.43	2 2 2	188054	8.25	1.05	15.16	2 2 2
188032	3.78	0.76	8.80	2 2 2	188055	8.15	1.03	15.11	2 2 2
188032	3.72	0.76	8.80	2 2 2	188055	8.18	1.03	15.13	2 2 2
188033	0.47	0.15	0.16	2 2 2	188056	7.47	0.97	12.57	2 2 2
188033	0.48	0.15	0.23	2 2 2	188056	7.31	0.96	12.45	2 2 2
188034	10.49	1.02	14.35	2 2 2	188064	10.43	0.97	13.88	2 2 2
188034	10.50	1.03	14.26	2 2 2	188064	10.48	0.95	13.97	2 2 2
188035	10.29	1.00	14.30	2 2 2	188065	10.14	1.00	13.72	2 2 2
188035	10.46	1.04	14.37	2 2 2	188065	10.20	0.99	13.86	2 2 2
188036	10.44	1.02	14.55	2 2 2	188066	10.61	1.00	14.30	2 2 2
188036	10.32	1.06	14.27	2 2 2	188066	10.76	0.99	14.35	2 2 2
188037	11.49	1.05	15.24	2 2 2	188067	11.68	1.01	15.00	2 2 2
188037	11.42	1.04	15.36	2 2 2	188067	11.61	1.02	14.97	2 2 2
188038	11.60	1.07	15.40	2 2 2	188068	11.28	1.03	15.20	2 2 2
188038	11.64	1.05	15.35	2 2 2	188068	11.25	1.08	15.02	2 2 2
188039	11.21	1.08	15.66	2 2 2	188069	11.14	1.10	15.29	2 2 2
188039	11.30	1.07	15.32	2 2 2	188069	11.15	1.07	15.29	2 2 2
188040	11.04	1.10	15.93	2 2 2	188070	10.75	1.07	15.66	2 2 2
188040	10.95	1.09	15.82	2 2 2	188070	10.85	1.06	15.47	2 2 2
188041	10.62	1.12	16.07	2 2 2	188071	10.49	1.07	15.70	2 2 2
188041	10.64	1.09	15.88	2 2 2	188071	10.64	1.10	15.77	2 2 2
188042	10.19	1.05	16.22	2 2 2	188072	9.93	1.07	15.65	2 2 2
188042	10.29	1.07	16.10	2 2 2	188072	9.93	1.06	15.84	2 2 2
188043	9.77	1.06	16.10	2 2 2	188073	9.42	1.09	16.03	2 2 2
188043	9.77	1.07	16.38	2 2 2	188073	9.52	1.09	15.87	2 2 2
188044	10.08	1.07	16.14	3 2 2	188074	9.41	1.08	15.86	2 2 2
188044	9.53	1.10	16.26	3 2 2	188074	9.41	1.08	15.91	2 2 2
188045	11.82	1.10	16.42	2 2 2	188075	9.43	1.08	15.90	2 2 2
188045	9.65	1.07	15.87	2 2 2	188075	9.62	1.07	15.95	2 2 2
188046	9.77	1.09	16.55	2 2 2	188076	9.52	1.08	16.04	2 2 2
188046	9.80	1.07	16.46	2 2 2	188076	9.64	1.10	16.17	2 2 2
188047	9.56	1.12	16.29	2 2 2	188077	9.25	1.12	16.13	2 2 2
188047	10.75	1.10	16.24	2 2 2	188077	9.28	1.07	15.87	2 2 2
188048	9.42	1.08	16.00	2 2 2	188078	9.01	1.06	15.68	2 2 2
188048	9.27	1.13	16.05	2 2 2	188078	9.08	1.08	15.66	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
188079	9.01	1.05	15.67	2 2 2	188102	8.90	1.04	16.44	2 2 2
188079	9.04	1.12	15.44	2 2 2	188102	9.03	1.08	15.86	2 2 2
188080	8.77	1.08	15.25	2 2 2	188103	8.88	1.02	16.19	2 2 2
188080	8.71	1.05	15.20	2 2 2	188103	8.88	1.07	15.54	2 2 2
188081	8.74	1.04	15.39	2 2 2	188104	8.74	1.04	16.12	2 2 2
188081	9.32	1.07	15.30	2 2 2	188104	8.90	1.04	16.15	2 2 2
188082	8.38	1.02	15.02	2 2 2	188105	8.50	1.04	15.79	2 2 2
188082	8.38	1.03	15.00	2 2 2	188105	8.54	1.11	15.80	2 2 2
188083	8.49	1.04	15.13	2 2 2	188106	8.18	1.04	15.47	2 2 2
188083	8.53	1.08	14.76	2 2 2	188106	8.18	1.04	15.31	2 2 2
188084	8.71	1.07	15.38	2 2 2	188107	8.36	1.09	15.79	2 2 2
188084	10.87	1.06	15.29	3 2 2	188107	8.32	1.06	15.71	2 2 2
188085	8.79	1.05	15.05	2 2 2	188108	8.28	1.04	15.16	2 2 2
188085	8.80	1.09	15.07	2 2 2	188108	9.02	1.04	15.44	2 2 2
188086	7.61	0.96	12.49	2 2 2	188109	8.15	1.04	14.84	2 2 2
188086	7.99	1.02	12.23	2 2 2	188109	8.21	1.04	14.98	2 2 2
188087	1.71	0.28	0.00	2 2 2	188110	7.76	1.09	13.81	2 2 2
188087	2.02	0.23	0.00	2 2 2	188110	7.66	1.01	13.83	2 2 2
188088	10.51	0.98	13.79	2 2 2	188111	4.53	0.57	3.98	2 2 2
188088	10.38	0.97	14.02	2 2 2	188111	4.56	0.57	3.84	2 2 2
188089	10.54	0.99	14.41	2 2 2	188112	10.46	0.97	14.28	2 2 2
188089	10.66	1.00	14.63	2 2 2	188112	10.52	0.96	14.33	2 2 2
188090	11.75	1.05	14.74	2 2 2	188113	10.28	0.97	14.65	2 2 2
188090	11.80	1.00	15.00	2 2 2	188113	10.32	0.96	14.78	2 2 2
188091	12.35	1.05	15.39	2 2 2	188114	11.07	0.99	15.30	2 2 2
188091	12.36	1.04	15.43	2 2 2	188114	10.98	0.98	14.90	2 2 2
188092	11.64	1.05	15.59	2 2 2	188115	11.92	1.00	15.68	2 2 2
188092	11.69	1.12	15.57	2 2 2	188115	11.85	1.00	15.68	2 2 2
188093	11.10	1.07	15.50	2 2 2	188116	11.53	1.03	15.56	2 2 2
188093	11.21	1.13	15.68	2 2 2	188116	11.55	1.01	16.13	2 2 2
188094	10.66	1.05	15.79	2 2 2	188117	10.91	1.02	16.03	2 2 2
188094	10.68	1.07	15.63	2 2 2	188117	11.07	1.02	16.08	2 2 2
188095	10.10	1.05	15.51	2 2 2	188118	10.74	1.04	15.94	2 2 2
188095	10.34	1.05	15.79	2 2 2	188118	10.67	1.02	16.56	2 2 2
188096	10.42	1.04	16.67	2 2 2	188119	10.06	1.01	16.29	2 2 2
188096	10.18	1.16	16.47	2 2 2	188119	10.19	1.03	16.51	2 2 2
188097	9.70	1.05	16.70	2 2 2	188120	9.30	1.01	16.40	2 2 2
188097	9.71	1.06	16.27	2 2 2	188120	9.30	1.01	16.25	2 2 2
188098	9.55	1.05	16.70	2 2 2	188121	9.39	1.01	16.58	2 2 2
188098	9.69	1.03	16.27	2 2 2	188121	9.45	1.00	16.48	2 2 2
188099	9.60	1.04	16.13	2 2 2	188122	9.53	1.00	16.38	2 2 2
188099	9.65	1.07	16.57	2 2 2	188122	9.47	1.02	16.46	2 2 2
188100	9.65	1.05	16.53	2 2 2	188123	9.43	1.01	16.53	2 2 2
188100	9.70	1.03	16.02	2 2 2	188123	9.21	1.00	16.36	2 2 2
188101	9.07	1.00	15.84	2 2 2	188124	9.16	1.00	16.39	2 2 2
188101	9.31	1.05	16.35	2 2 2	188124	9.20	1.00	16.46	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF
188125	8.90	1.00	16.34	2 2 2
188125	8.94	0.98	16.12	2 2 2
188126	9.05	1.00	16.54	2 2 2
188126	8.98	1.03	16.45	2 2 2
188127	8.75	1.02	16.17	2 2 2
188127	8.82	1.04	16.35	2 2 2
188128	8.53	0.99	15.86	2 2 2
188128	8.54	0.99	15.71	2 2 2
188129	8.39	0.99	15.94	2 2 2
188129	8.40	0.98	15.84	2 2 2
188130	8.29	0.99	15.77	2 2 2
188130	8.26	0.98	15.72	2 2 2
188131	8.32	0.98	15.80	2 2 2
188131	8.21	0.98	15.87	2 2 2
188132	8.08	0.98	15.63	2 2 2
188132	8.17	0.97	15.36	2 2 2
188133	7.51	0.93	14.30	2 2 2
188133	7.56	0.93	14.40	2 2 2
188134	5.42	0.79	11.87	2 2 2
188134	5.48	0.79	11.85	2 2 2
188136	9.75	0.92	14.44	2 2 2
188136	9.75	0.92	14.04	2 2 2
188137	10.08	0.95	14.86	2 2 2
188137	10.15	0.94	14.91	2 2 2
188138	11.81	0.99	15.16	2 2 2
188138	11.85	0.99	15.18	2 2 2
188139	12.62	1.00	15.73	2 2 2
188139	12.71	0.99	15.91	2 2 2
188140	13.14	1.03	15.83	2 2 2
188140	13.15	1.03	16.03	2 2 2
188141	13.51	1.04	16.36	2 2 2
188141	13.60	1.04	16.61	2 2 2
188142	12.65	1.05	16.01	2 2 2
188142	12.65	1.04	16.19	2 2 2
188143	11.63	1.02	16.46	2 2 2
188143	11.66	1.04	16.44	2 2 2
188144	11.40	1.06	16.37	2 2 2
188144	11.38	1.03	16.32	2 2 2
188145	10.57	1.04	16.58	2 2 2
188145	10.61	1.04	16.38	2 2 2
188146	9.72	1.04	16.65	2 2 2
188146	9.78	1.05	16.63	2 2 2
188147	9.70	1.06	16.88	2 2 2
188147	9.83	1.06	16.61	2 2 2
188148	9.72	1.07	16.78	2 2 2
188148	9.73	1.05	16.86	2 2 2
188149	9.72	1.07	16.49	2 2 2
188149	9.75	1.07	16.64	2 2 2
188150	9.64	1.07	16.94	2 2 2
188150	9.80	1.06	17.04	2 2 2
188151	9.86	1.08	16.87	2 2 2
188151	9.88	1.08	17.19	2 2 2
188152	9.25	1.03	16.60	2 2 2
188152	9.07	1.03	16.50	2 2 2
188153	8.72	1.04	15.91	2 2 2
188153	8.74	1.04	15.77	2 2 2
188154	8.64	1.04	15.97	2 2 2
188154	8.83	1.03	15.94	2 2 2
188155	8.60	1.03	15.85	2 2 2
188155	8.63	1.02	15.90	2 2 2
188156	8.46	1.03	15.53	2 2 2
188156	8.47	1.03	15.51	2 2 2
188157	8.29	1.00	15.31	2 2 2
188157	8.30	1.01	15.46	2 2 2
188158	2.24	0.59	8.48	2 2 2
188158	2.24	0.60	8.74	2 2 2
188159	1.58	0.45	6.59	2 2 2
188159	1.64	0.45	6.54	2 2 2
188160	7.99	0.98	15.05	2 2 2
188160	7.96	0.99	14.99	2 2 2
188161	8.15	0.97	14.72	2 2 2
188161	8.21	0.98	15.16	2 2 2
188162	8.14	0.99	15.24	2 2 2
188162	8.14	0.99	15.33	2 2 2
188163	8.04	0.99	14.82	2 2 2
188163	8.07	1.00	14.77	2 2 2
188164	7.84	0.99	14.58	2 2 2
188164	7.99	0.99	14.75	2 2 2
188165	7.86	0.97	13.70	2 2 2
188165	8.11	0.97	13.85	2 2 2
188166	7.85	0.92	12.54	2 2 2
188166	7.94	0.91	12.52	2 2 2
188167	4.17	0.72	9.96	2 2 2
188167	4.20	0.69	9.85	2 2 2
188168	3.45	0.61	8.78	2 2 2
188168	3.42	0.61	8.68	2 2 2
188169	3.93	0.63	8.95	2 2 2
188169	3.94	0.63	8.80	2 2 2
188170	3.86	0.62	8.76	2 2 2
188170	3.90	0.63	8.88	2 2 2
188171	10.16	0.97	14.30	2 2 2
188171	10.17	0.99	14.33	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
188172	9.80	0.97	14.33	2 2 2	188197	10.79	1.01	14.68	2 2 2
188172	9.83	0.98	14.23	2 2 2	188197	10.81	0.99	15.38	2 2 2
188173	11.99	1.02	14.94	2 2 2	188198	10.93	1.00	15.46	2 2 2
188173	12.02	1.03	15.34	2 2 2	188198	11.03	0.99	15.56	2 2 2
188174	12.74	1.05	15.88	2 2 2	188199	11.17	1.03	15.49	2 2 2
188174	12.87	1.05	15.83	2 2 2	188199	11.20	1.02	15.39	2 2 2
188175	11.99	1.05	15.65	2 2 2	188200	12.11	1.04	15.82	2 2 2
188175	12.06	1.04	15.75	2 2 2	188200	12.14	1.04	15.90	2 2 2
188176	11.88	1.07	15.86	2 2 2	188201	12.63	1.06	16.41	2 2 2
188176	11.85	1.08	15.96	2 2 2	188201	12.70	1.06	16.43	2 2 2
188177	11.13	1.06	16.32	2 2 2	188202	11.47	1.06	16.46	2 2 2
188177	11.20	1.07	15.78	2 2 2	188202	11.48	1.04	16.51	2 2 2
188178	10.63	1.07	16.32	2 2 2	188203	11.28	1.08	16.64	2 2 2
188178	10.74	1.06	16.27	2 2 2	188203	11.43	1.08	16.62	2 2 2
188179	10.34	1.07	16.02	2 2 2	188204	10.37	1.07	16.47	2 2 2
188179	10.37	1.06	16.20	2 2 2	188204	10.36	1.07	16.31	2 2 2
188180	9.62	1.06	16.23	2 2 2	188205	9.50	1.05	16.53	2 2 2
188180	9.66	1.06	16.38	2 2 2	188205	9.34	1.06	16.25	2 2 2
188181	9.29	1.07	16.41	2 2 2	188206	9.46	1.06	16.35	2 2 2
188181	9.33	1.06	16.38	2 2 2	188206	9.51	1.06	16.66	2 2 2
188182	9.40	1.08	16.13	2 2 2	188207	9.50	1.06	17.04	2 2 2
188182	9.44	1.07	16.41	2 2 2	188207	9.60	1.06	16.94	2 2 2
188183	9.52	1.08	16.39	2 2 2	188208	9.42	1.07	16.76	2 2 2
188183	9.55	1.08	16.54	2 2 2	188208	9.40	1.07	16.79	2 2 2
188184	9.13	1.07	16.52	2 2 2	188209	9.16	1.07	16.51	2 2 2
188184	9.09	1.07	16.49	2 2 2	188209	9.19	1.06	16.51	2 2 2
188185	8.91	1.08	16.47	2 2 2	188210	9.14	1.07	16.82	2 2 2
188185	8.98	1.07	16.39	2 2 2	188210	9.24	1.06	16.69	2 2 2
188186	9.03	1.06	16.09	2 2 2	188211	9.80	1.10	17.41	2 2 2
188186	9.06	1.06	16.24	2 2 2	188211	10.01	1.10	17.10	2 2 2
188187	8.67	1.05	15.97	2 2 2	188212	9.08	1.07	16.21	2 2 2
188187	8.86	1.04	16.15	2 2 2	188212	9.06	1.06	16.39	2 2 2
188188	8.85	1.04	15.95	2 2 2	188213	8.76	1.04	15.92	2 2 2
188188	8.87	1.05	15.95	2 2 2	188213	8.57	1.03	16.04	2 2 2
188189	8.48	1.04	15.90	2 2 2	188214	8.68	1.04	15.77	2 2 2
188189	8.49	1.05	15.72	2 2 2	188214	8.69	1.04	15.77	2 2 2
188190	8.47	1.04	16.05	2 2 2	188215	8.67	1.04	16.10	2 2 2
188190	8.50	1.04	16.05	2 2 2	188215	8.71	1.07	15.54	2 2 2
188191	8.52	1.04	15.95	2 2 2	188216	8.47	1.02	15.75	2 2 2
188191	8.67	1.03	15.75	2 2 2	188216	8.37	1.03	15.77	2 2 2
188192	8.47	1.02	15.07	2 2 2	188217	8.80	1.00	14.66	2 2 2
188192	8.38	1.01	15.10	2 2 2	188217	8.83	0.99	14.54	2 2 2
188195	10.39	0.97	14.92	2 2 2	188218	5.97	0.66	8.41	2 2 2
188195	10.40	0.97	14.49	2 2 2	188218	6.07	0.65	8.53	2 2 2
188196	10.57	1.00	15.18	2 2 2	188219	10.39	0.98	14.56	2 2 2
188196	10.67	1.01	15.15	2 2 2	188219	10.45	0.98	14.61	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
188220	10.31	0.97	14.56	2 2 2	188243	11.08	0.93	14.28	2 2 2
188220	10.27	0.98	14.34	2 2 2	188243	11.33	0.93	14.42	2 2 2
188221	10.80	0.98	14.77	2 2 2	188244	10.69	0.95	14.49	2 2 2
188221	10.65	0.99	14.62	2 2 2	188244	10.72	0.96	14.57	2 2 2
188222	12.57	1.01	15.43	2 2 2	188245	13.23	1.00	15.39	2 2 2
188222	12.59	1.01	15.18	2 2 2	188245	13.30	1.01	15.29	2 2 2
188223	11.56	1.02	15.72	2 2 2	188246	14.07	1.04	15.97	2 2 2
188223	11.60	1.02	15.59	2 2 2	188246	14.24	1.04	15.90	2 2 2
188224	12.69	1.05	15.97	2 2 2	188247	14.45	1.04	16.14	2 2 2
188224	12.00	1.05	16.18	2 2 2	188247	14.47	1.05	16.14	2 2 2
188225	12.17	1.07	16.18	2 2 2	188248	14.08	1.06	16.23	2 2 2
188225	12.24	1.06	16.15	2 2 2	188248	14.18	1.07	16.28	2 2 2
188226	11.90	1.07	16.59	2 2 2	188249	13.54	1.06	16.01	2 2 2
188226	11.94	1.06	16.05	2 2 2	188249	13.50	1.06	16.45	2 2 2
188227	11.16	1.08	16.64	2 2 2	188250	12.77	1.06	16.50	2 2 2
188227	11.28	1.09	16.74	2 2 2	188250	12.89	1.08	16.60	2 2 2
188228	11.02	1.08	16.59	2 2 2	188251	12.10	1.07	16.23	2 2 2
188228	10.99	1.09	16.59	2 2 2	188251	12.13	1.07	16.54	2 2 2
188229	9.96	1.07	16.50	2 2 2	188252	11.27	1.06	16.74	2 2 2
188229	9.72	1.08	16.47	2 2 2	188252	11.52	1.07	16.57	2 2 2
188230	9.85	1.08	16.48	2 2 2	188253	10.54	1.07	16.54	2 2 2
188230	9.86	1.07	16.53	2 2 2	188253	10.59	1.08	16.56	2 2 2
188231	9.78	1.07	17.01	2 2 2	188254	9.89	1.08	16.32	2 2 2
188231	9.84	1.10	16.94	2 2 2	188254	9.89	1.08	16.54	2 2 2
188232	10.02	1.11	17.09	2 2 2	188255	9.78	1.08	16.75	2 2 2
188232	10.14	1.10	17.04	2 2 2	188255	9.88	1.08	16.63	2 2 2
188233	9.40	1.07	16.66	2 2 2	188256	10.09	1.08	16.88	2 2 2
188233	9.41	1.09	16.61	2 2 2	188256	10.12	1.09	16.90	2 2 2
188234	9.45	1.10	17.05	2 2 2	188257	10.14	1.11	17.00	2 2 2
188234	9.58	1.10	17.07	2 2 2	188257	10.11	1.10	16.90	2 2 2
188235	9.63	1.09	16.74	2 2 2	188258	10.09	1.10	16.94	2 2 2
188235	9.66	1.09	17.07	2 2 2	188258	10.10	1.10	16.82	2 2 2
188236	8.98	1.07	16.31	2 2 2	188259	10.00	1.11	17.13	2 2 2
188236	9.08	1.09	16.18	2 2 2	188259	10.00	1.12	16.89	2 2 2
188237	9.01	1.08	16.24	2 2 2	188260	10.02	1.13	17.38	2 2 2
188237	9.06	1.06	16.55	2 2 2	188260	10.02	1.13	17.23	2 2 2
188238	8.99	1.05	16.09	2 2 2	188261	9.26	1.10	16.91	2 2 2
188238	9.03	1.06	16.32	2 2 2	188261	9.41	1.10	16.91	2 2 2
188239	8.34	1.04	15.71	2 2 2	188262	8.93	1.09	16.23	2 2 2
188239	8.45	1.03	15.66	2 2 2	188262	8.96	1.10	16.16	2 2 2
188240	8.15	1.03	15.28	2 2 2	188263	9.20	1.11	16.20	2 2 2
188240	8.36	1.02	15.08	2 2 2	188263	9.20	1.10	16.45	2 2 2
188241	7.82	0.98	13.67	2 2 2	188264	8.02	1.05	15.06	2 2 2
188241	7.78	0.97	13.87	2 2 2	188264	8.03	1.04	15.11	2 2 2
188242	1.67	0.45	6.72	2 2 2	188265	7.95	1.15	14.52	2 2 2
188242	1.69	0.46	6.50	2 2 2	188265	7.98	1.17	14.54	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
188266	0.00	0.58	6.79	2 2 2	188291	11.61	1.01	14.95	2 2 2
188266	0.00	0.56	6.89	2 2 2	188291	11.76	1.01	14.97	2 2 2
188267	12.41	1.01	15.24	2 2 2	188292	12.75	1.03	15.41	2 2 2
188267	12.35	1.03	15.07	2 2 2	188292	12.82	1.04	15.41	2 2 2
188268	12.43	1.02	15.04	2 2 2	188293	14.20	1.04	16.01	2 2 2
188268	12.36	1.02	15.14	2 2 2	188293	14.11	1.03	15.62	2 2 2
188269	14.53	1.06	15.55	2 2 2	188294	15.45	1.08	16.21	2 2 2
188269	14.62	1.06	16.02	2 2 2	188294	15.42	1.08	16.38	2 2 2
188270	15.46	1.09	16.40	2 2 2	188295	14.96	1.09	16.30	2 2 2
188270	15.53	1.08	16.48	2 2 2	188295	14.97	1.10	16.50	2 2 2
188271	14.98	1.09	16.28	2 2 2	188296	14.01	1.08	16.33	2 2 2
188271	14.97	1.09	16.21	2 2 2	188296	14.16	1.10	16.60	2 2 2
188272	14.08	1.08	16.25	2 2 2	188297	13.06	1.08	16.62	2 2 2
188272	14.12	1.10	16.23	2 2 2	188297	12.99	1.08	16.64	2 2 2
188273	13.29	1.10	16.86	2 2 2	188298	12.22	1.10	16.64	2 2 2
188273	13.37	1.10	16.76	2 2 2	188298	12.23	1.10	16.69	2 2 2
188274	12.48	1.09	16.49	2 2 2	188299	11.05	1.09	16.69	2 2 2
188274	12.55	1.11	16.86	2 2 2	188299	11.09	1.10	16.74	2 2 2
188275	11.63	1.09	16.59	2 2 2	188300	9.82	1.08	16.37	2 2 2
188275	11.60	1.09	16.86	2 2 2	188300	9.84	1.09	16.57	2 2 2
188276	10.87	1.09	16.66	2 2 2	188301	9.47	1.08	16.41	2 2 2
188276	10.83	1.10	16.59	2 2 2	188301	9.47	1.08	16.63	2 2 2
188277	9.97	1.08	16.46	2 2 2	188302	9.62	1.10	16.51	2 2 2
188277	10.01	1.10	16.51	2 2 2	188302	9.52	1.08	16.48	2 2 2
188278	9.93	1.08	16.53	2 2 2	188303	9.61	1.08	16.66	2 2 2
188278	10.05	1.09	16.97	2 2 2	188303	9.76	1.09	16.75	2 2 2
188279	10.05	1.10	17.07	2 2 2	188304	9.75	1.09	17.00	2 2 2
188279	10.01	1.10	17.00	2 2 2	188304	9.78	1.10	16.95	2 2 2
188280	10.03	1.11	16.82	2 2 2	188305	9.77	1.11	17.14	2 2 2
188280	10.04	1.11	16.92	2 2 2	188305	9.73	1.11	16.72	2 2 2
188281	9.93	1.11	16.85	2 2 2	188306	9.97	1.11	16.92	2 2 2
188281	10.11	1.11	16.80	2 2 2	188306	10.01	1.11	16.92	2 2 2
188282	10.16	1.12	17.48	2 2 2	188307	10.06	1.11	16.99	2 2 2
188282	10.20	1.13	17.60	2 2 2	188307	10.09	1.12	17.41	2 2 2
188283	10.13	1.11	17.01	2 2 2	188308	10.11	1.14	17.67	2 2 2
188283	10.04	1.12	17.08	2 2 2	188308	10.11	1.15	17.77	2 2 2
188284	9.97	1.12	17.47	2 2 2	188309	10.14	1.12	17.72	2 2 2
188284	9.96	1.11	17.55	2 2 2	188309	10.11	1.12	16.98	2 2 2
188285	9.20	1.08	16.81	2 2 2	188310	8.81	1.07	16.08	2 2 2
188285	9.23	1.10	16.69	2 2 2	188310	8.71	1.07	16.03	2 2 2
188286	8.12	1.03	15.32	2 2 2	188311	7.80	1.00	14.53	2 2 2
188286	8.34	1.03	15.30	2 2 2	188311	7.86	1.00	14.46	2 2 2
188287	8.01	1.01	15.00	2 2 2	188312	7.81	1.00	14.41	2 2 2
188287	7.99	1.01	14.71	2 2 2	188312	7.82	0.99	14.26	2 2 2
188288	7.50	0.95	13.68	2 2 2	188313	6.24	0.94	13.13	2 2 2
188288	7.50	0.97	13.73	2 2 2	188313	6.20	0.93	13.13	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
188315	11.09	1.01	14.57	2 2 2	188338	0.52	0.31	2.54	2 2 2
188315	11.18	0.99	14.33	2 2 2	188338	0.56	0.29	2.57	2 2 2
188316	11.02	0.99	14.67	2 2 2	188339	11.14	0.92	14.41	2 2 2
188316	11.07	1.02	14.74	2 2 2	188339	10.99	0.92	13.97	2 2 2
188317	12.07	1.02	15.30	2 2 2	188340	10.69	0.91	14.41	2 2 2
188317	12.10	1.04	15.23	2 2 2	188340	10.71	0.92	14.36	2 2 2
188318	14.20	1.06	16.03	2 2 2	188341	10.32	0.92	14.52	2 2 2
188318	14.17	1.06	15.84	2 2 2	188341	10.39	0.93	14.29	2 2 2
188319	14.32	1.07	16.06	2 2 2	188342	11.25	0.94	14.91	2 2 2
188319	14.28	1.07	15.96	2 2 2	188342	11.36	0.95	14.96	2 2 2
188320	14.30	1.07	15.96	2 2 2	188343	12.00	0.98	15.52	2 2 2
188320	14.49	1.09	16.13	2 2 2	188343	12.01	0.98	15.15	2 2 2
188321	14.07	1.09	16.52	2 2 2	188344	12.40	1.00	15.70	2 2 2
188321	14.07	1.09	16.10	2 2 2	188344	12.53	0.99	15.80	2 2 2
188322	13.40	1.09	16.57	2 2 2	188345	11.88	0.99	16.07	2 2 2
188322	13.30	1.09	16.54	2 2 2	188345	11.92	1.00	15.28	2 2 2
188323	12.63	1.09	16.39	2 2 2	188346	11.45	1.00	15.86	2 2 2
188323	12.67	1.10	16.42	2 2 2	188346	11.49	1.02	16.02	2 2 2
188324	11.94	1.08	16.37	2 2 2	188347	11.38	1.04	16.13	2 2 2
188324	12.12	1.11	16.49	2 2 2	188347	11.29	1.03	15.94	2 2 2
188325	11.23	1.10	16.71	2 2 2	188348	10.87	1.06	16.07	2 2 2
188325	11.24	1.10	16.81	2 2 2	188348	10.99	1.04	16.13	2 2 2
188326	10.32	1.09	16.61	2 2 2	188349	9.96	1.06	16.13	2 2 2
188326	10.26	1.09	16.29	2 2 2	188349	10.03	1.04	16.29	2 2 2
188327	10.22	1.09	16.75	2 2 2	188350	9.57	1.05	15.95	2 2 2
188327	10.15	1.10	16.73	2 2 2	188350	9.63	1.04	16.05	2 2 2
188328	10.33	1.09	16.50	2 2 2	188351	9.62	1.06	16.03	2 2 2
188328	10.36	1.12	16.87	2 2 2	188351	9.66	1.05	16.26	2 2 2
188329	10.32	1.12	17.12	2 2 2	188352	9.41	1.05	16.16	2 2 2
188329	10.35	1.12	17.07	2 2 2	188352	9.48	1.04	16.00	2 2 2
188330	10.27	1.11	16.82	2 2 2	188353	9.22	1.05	15.93	2 2 2
188330	10.31	1.11	16.97	2 2 2	188353	9.30	1.04	15.80	2 2 2
188331	10.14	1.11	16.92	2 2 2	188354	9.26	1.04	16.06	2 2 2
188331	10.20	1.10	16.79	2 2 2	188354	9.36	1.05	16.48	2 2 2
188332	9.97	1.12	17.28	2 2 2	188355	9.13	1.02	16.06	2 2 2
188332	10.10	1.12	16.87	2 2 2	188355	9.03	1.03	16.30	2 2 2
188333	9.96	1.13	17.38	2 2 2	188356	8.93	1.04	15.88	2 2 2
188333	10.02	1.11	17.28	2 2 2	188356	9.01	1.04	16.09	2 2 2
188334	9.37	1.08	16.42	2 2 2	188357	8.94	1.04	16.38	2 2 2
188334	9.52	1.08	16.61	2 2 2	188357	9.01	1.04	16.44	2 2 2
188335	8.60	1.03	15.31	2 2 2	188358	8.89	1.02	16.28	2 2 2
188335	8.63	1.05	15.24	2 2 2	188358	8.93	1.04	15.68	2 2 2
188336	8.40	1.04	15.21	2 2 2	188359	8.25	1.02	15.73	2 2 2
188336	8.44	1.04	15.33	2 2 2	188359	8.59	1.02	15.63	2 2 2
188337	8.65	1.02	14.23	2 2 2	188360	8.33	1.01	15.47	2 2 2
188337	8.83	1.03	14.35	2 2 2	188360	8.36	1.00	15.37	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
188361	7.93	0.97	14.53	2 2 2	188384	6.95	0.83	11.22	2 2 2
188361	8.03	0.98	14.61	2 2 2	188384	7.03	0.84	11.04	2 2 2
188362	0.00	0.16	0.00	2 2 2	188387	11.16	1.01	15.55	2 2 2
188362	0.00	0.14	0.16	2 2 3	188387	11.20	1.01	15.03	2 2 2
188363	10.28	0.94	14.30	2 2 2	188388	11.12	1.02	15.53	2 2 2
188363	10.24	0.94	14.51	2 2 2	188388	11.27	1.01	15.47	2 2 2
188364	10.17	0.94	14.57	2 2 2	188389	11.10	1.02	15.29	2 2 2
188364	10.33	0.94	14.54	2 2 2	188389	11.01	1.01	15.22	2 2 2
188365	10.60	0.97	14.52	2 2 2	188390	11.03	1.02	15.59	2 2 2
188365	10.63	0.96	14.70	2 2 2	188390	11.03	1.02	15.30	2 2 2
188366	11.47	0.98	15.07	2 2 2	188391	11.24	1.04	16.01	2 2 2
188366	11.48	1.00	15.38	2 2 2	188391	11.24	1.03	15.90	2 2 2
188367	11.34	1.01	15.25	2 2 2	188392	10.77	1.03	15.69	2 2 2
188367	11.56	1.02	15.44	2 2 2	188392	10.81	1.04	15.90	2 2 2
188368	11.35	1.02	15.80	2 2 2	188393	10.22	1.04	16.33	2 2 2
188368	11.36	1.03	15.67	2 2 2	188393	10.26	1.04	16.43	2 2 2
188369	10.61	1.03	15.60	2 2 2	188394	9.72	1.05	16.04	2 2 2
188369	10.68	1.03	15.78	2 2 2	188394	9.76	1.04	16.17	2 2 2
188370	10.34	1.04	16.04	2 2 2	188395	9.26	1.04	16.44	2 2 2
188370	10.41	1.03	15.81	2 2 2	188395	9.40	1.05	16.57	2 2 2
188371	9.79	1.02	16.18	2 2 2	188396	9.42	1.06	16.70	2 2 2
188371	9.79	1.03	16.15	2 2 2	188396	9.47	1.06	16.33	2 2 2
188372	9.52	1.04	16.16	2 2 2	188397	9.66	1.06	16.21	2 2 2
188372	9.56	1.04	15.94	2 2 2	188397	9.75	1.06	16.34	2 2 2
188373	9.35	1.03	16.37	2 2 2	188398	9.48	1.05	16.79	2 2 2
188373	9.45	1.05	16.47	2 2 2	188398	9.62	1.05	16.10	2 2 2
188374	9.44	1.06	16.13	2 2 2	188399	9.37	1.05	16.34	2 2 2
188374	9.59	1.06	16.24	2 2 2	188399	9.25	1.05	16.42	2 2 2
188375	9.16	1.04	16.11	2 2 2	188400	9.08	1.04	16.16	2 2 2
188375	9.23	1.05	15.90	2 2 2	188400	9.07	1.04	16.29	2 2 2
188376	8.93	1.04	16.21	2 2 2	188401	8.70	1.04	15.90	2 2 2
188376	9.05	1.05	16.06	2 2 2	188401	8.71	1.03	16.16	2 2 2
188377	9.20	1.05	16.27	2 2 2	188402	8.63	1.02	15.48	2 2 2
188377	9.33	1.06	16.24	2 2 2	188402	8.70	1.04	15.58	2 2 2
188378	9.16	1.05	16.48	2 2 2	188403	8.59	1.02	16.01	2 2 2
188378	9.18	1.06	16.43	2 2 2	188403	8.51	1.04	15.90	2 2 2
188379	8.66	1.02	15.57	2 2 2	188404	8.64	1.05	15.93	2 2 2
188379	8.41	0.99	15.54	2 2 2	188404	8.76	1.04	15.90	2 2 2
188380	8.81	1.04	16.02	2 2 2	188405	8.55	1.01	15.70	2 2 2
188380	8.85	1.04	15.78	2 2 2	188405	8.66	1.01	15.28	2 2 2
188381	8.61	1.03	15.91	2 2 2	188406	8.38	1.00	15.33	2 2 2
188381	8.63	1.04	15.83	2 2 2	188406	8.48	1.00	15.73	2 2 2
188382	8.46	1.03	15.36	2 2 2	188407	8.24	0.96	13.86	2 2 2
188382	8.56	1.03	15.36	2 2 2	188407	8.21	0.96	13.65	2 2 2
188383	7.94	0.98	14.92	2 2 2	188408	0.71	0.29	1.89	2 2 3
188383	8.01	0.99	14.76	2 2 2	188408	0.64	0.25	1.58	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
188419	9.85	1.05	16.02	2 2 2	188457	10.22	1.06	15.10	2 2 2
188419	10.03	1.06	16.13	2 2 2	188457	10.22	1.05	15.16	2 2 2
188420	9.83	1.05	16.31	2 2 2	188457	8.89	1.04	15.35	2 2 2
188420	9.93	1.06	16.18	2 2 2	188457	8.91	1.04	15.17	2 2 2
188421	9.75	1.07	16.29	2 2 2	188458	9.72	1.05	14.68	2 2 2
188421	9.63	1.07	16.52	2 2 2	188458	9.72	1.04	14.89	2 2 2
188423	9.45	1.06	16.13	2 2 2	188459	9.89	1.01	14.26	2 2 2
188423	9.58	1.06	16.16	2 2 2	188459	9.93	1.01	14.23	2 2 2
188424	9.41	1.05	16.16	2 2 2	188460	10.14	0.98	12.61	2 2 2
188424	9.50	1.05	16.14	2 2 2	188460	10.17	0.98	12.55	2 2 2
188425	9.11	1.04	15.98	2 2 2	188461	9.63	0.95	10.53	2 2 2
188425	9.13	1.05	15.82	2 2 2	188461	9.67	0.98	10.27	2 2 2
188426	8.90	1.04	15.53	2 2 2	188467	11.34	1.02	9.10	2 2 2
188426	8.87	1.04	15.53	2 2 2	188467	11.46	1.03	9.49	2 2 2
188427	8.79	1.02	15.30	2 2 2	188473	1.18	0.57	1.48	2 2 2
188427	8.69	1.04	15.11	2 2 2	188473	1.18	0.57	1.36	2 2 2
188428	8.61	1.02	14.98	2 2 2	188474	13.10	1.11	14.93	2 2 2
188428	8.68	1.03	15.11	2 2 2	188474	12.91	1.09	14.71	2 2 2
188429	8.53	1.01	14.70	2 2 2	188475	11.31	1.07	14.24	2 2 2
188429	8.64	1.01	14.62	2 2 2	188475	11.35	1.07	14.43	2 2 2
188430	7.34	0.92	11.47	2 2 2	188476	9.81	1.00	13.19	2 2 2
188430	7.27	0.91	11.42	2 2 2	188476	9.91	1.01	13.19	2 2 2
188431	0.46	0.17	0.00	2 2 2	188477	10.90	1.01	10.20	2 2 2
188431	0.49	0.19	0.00	2 2 2	188477	10.71	0.99	10.51	2 2 2
188435	9.77	1.05	15.01	2 2 2	188482	10.08	0.97	8.71	2 2 2
188435	9.79	1.06	15.43	2 2 2	188482	10.12	0.98	8.76	2 2 2
188436	9.54	1.07	15.72	2 2 2	188488	14.61	1.40	20.11	2 2 2
188436	9.58	1.06	15.80	2 2 2	188488	14.75	1.38	20.08	2 2 2
188438	8.88	1.05	15.04	2 2 2	188490	14.07	1.09	15.12	2 2 2
188438	8.57	1.03	15.52	2 2 2	188490	14.10	1.08	15.36	2 2 2
188439	8.68	1.05	15.12	2 2 2	188491	14.36	1.09	15.16	2 2 2
188439	8.68	1.05	15.09	2 2 2	188491	14.29	1.08	15.16	2 2 2
188440	8.57	1.04	14.88	2 2 2	188492	12.70	1.13	14.16	2 2 2
188440	8.63	1.04	14.94	2 2 2	188492	12.47	1.04	14.33	2 2 2
188441	8.58	1.03	15.15	2 2 2	188493	11.41	1.01	11.54	2 2 2
188441	8.62	1.03	15.12	2 2 2	188493	11.55	1.01	11.45	2 2 2
188442	8.67	1.04	14.91	2 2 2	188498	5.19	0.76	5.73	2 2 3
188442	8.70	1.03	14.65	2 2 2	188498	5.41	0.77	4.81	2 2 3
188443	8.69	1.00	14.64	2 2 2	188507	2.51	0.45	0.00	2 2 2
188443	8.74	1.00	14.64	2 2 2	188507	1.81	0.42	0.00	2 2 2
188444	8.51	1.01	13.84	2 2 2	188509	10.91	1.02	13.38	2 2 2
188444	8.50	1.00	14.27	2 2 2	188509	10.94	0.99	13.59	2 2 2
188450	6.88	0.84	10.02	2 2 2	188510	11.03	0.97	11.70	2 2 2
188450	6.92	0.85	9.96	2 2 2	188510	11.16	0.99	11.68	2 2 2
188455	0.48	0.19	0.00	2 2 2	188515	11.48	0.99	8.54	2 2 2
188455	0.41	0.18	0.00	2 2 2	188515	11.52	0.98	8.32	2 2 2

Table C.4 Replicate nutrient water sample values in µmoles/kg, along with their quality flags.

ID	SiO2	PO4	NO2+NO3	QF	ID	SiO2	PO4	NO2+NO3	QF
188521	0.83	0.38	0.00	2 2 2	188521	0.75	0.38	0.00	2 2 2

5 Dissolved Inorganic Carbon in Seawater

Bob Gershey

a. Description of Equipment and Technique

The total dissolved inorganic carbon content of seawater is defined as the total concentration of carbonate ion, bicarbonate ion and unionized species of carbon dioxide. Before analysis, the sample is treated with acid to convert all ionized species to the unionized form, which is then separated from the liquid phase and subsequently measured using a coulometric titration technique. This involves the reaction of carbon dioxide gas with a dimethylsulfoxide solution of ethanolamine to produce hydroxyethylcarbamic acid. The acidic solution is titrated with hydroxide ion formed by the electrolytic decomposition of water. The progress of the titration is followed through colorimetric measurement of the absorbance of a pH indicator dye (thymolphthalein) in the ethanolamine solution.

A known volume of seawater is dispensed into a stripping chamber from a pipet of known volume and temperature controlled to within 0.4°C. It is then acidified with ten percent its volume of a 10% solution of carbon dioxide-free phosphoric acid. The solution in stripped of carbon dioxide gas by bubbling with a stream of nitrogen gas directed through a glass frit. The carrier gas exiting the stripper passes through a magnesium perchlorate trap to remove water vapour and acidic water droplets. The gas stream is then directed into the coulometric titrator where the total amount of carbon dioxide gas is quantified.

b. Sampling Procedure and Data Processing Technique

Samples are drawn from the rosette immediately following the drawing of the oxygen samples in order to minimize exchange of carbon dioxide gas with the head space in the sampler. This exchange will typically result in a loss of carbon dioxide. It is desirable that the samples be drawn before half the sampler is emptied and within ten minutes of recovery. Clean borosilicate glass bottles are rinsed twice with 30 - 50 ml of the sample. The bottle is then filled from the bottom using a length of vinyl tubing attached to the spigot of the sampler. The sample is overflowed by at least a half of the volume of the bottle (typically 250 ml). A head space of 1% is left to allow for expansion without leakage. If samples are not to be analyzed within four to five hours, the sample is poisoned with 100 µl/250 ml of 50% saturated mercuric chloride solution. The bottle is tightly sealed and stored preferably at the temperature of collection in the dark.

Theoretically, the coulometer should give a direct measurement of the amount of carbon titrated based on calculations using the Nernst equation. In practice, the coulometer s calibration is checked using Certified Reference Materials obtained from the Scripps Institute of Oceanography, LaJolla, California. These samples are treated in the same manner as a seawater sample. Values are reported in units of µmol/kg. The overall precision of the analysis should be at least 1.5 µmol/kg for samples with concentrations in the range of 1800-2300 µmol/kg.

c. Replicate Analysis

The precision of this data was estimated as 4.2 μmol/kg. In total, 216 replicate carbonate measurements were obtained for 107 sample id numbers: 105 sample id numbers had one replicate and 2 sample id numbers had three replicates. The following is a statistical summary of the absolute value of the replicate differences; only acceptable values were used in calculating the statistics. Table C.5 lists all replicate measurements.

Number of Replicate Differences = 2 id had two replicates * 3 possible differences
+ 105 ids had one replicate * 1 possible difference = 6 + 105 = 111

Statistic	Value
Number of Acceptable Replicate Differences	102
Minimum (μmoles/kg)	0.0
Maximum (μmoles/kg)	9.2
Mean (μmoles/kg)	1.6
Median (μmoles/kg)	1.2
Standard Deviation (μmoles/kg)	1.6

Table C.5 Replicate water sample total carbon values in μmoles/kg.

Sample ID Number	Total Carbon	WOCE QF	Sample ID Number	Total Carbon	WOCE QF
186220	2139.9	2	186750	2153.0	2
186220	2139.9	2	186777	2148.3	2
186230	2106.1	2	186777	2149.5	2
186230	2106.6	2	186802	2152.9	2
186248	2131.9	2	186802	2155.9	2
186248	2133.9	2	186823	27.8	4
186266	2138.4	2	186823	134.7	4
186266	2139.2	2	186844	2152.6	2
186298	2148.2	2	186844	2154.4	2
186298	2148.7	2	186852	2124.8	2
186322	2151.1	2	186852	2129.0	2
186322	2152.6	2	186859	2114.9	2
186343	2148.2	2	186859	2117.2	2
186343	2148.5	2	186866	2021.2	3
186373	2146.6	2	186866	2021.4	3
186373	2126.0	3	186874	2148.8	2
186382	2154.4	2	186874	2150.8	2
186382	2155.2	2	186903	2150.7	2
186387	954.6	4	186903	2154.8	2
186387	2150.6	2	186933	2151.4	2
186406	2152.6	2	186933	2153.5	2
186406	2152.8	2	186941	2129.4	2
186446	2146.9	2	186941	2124.4	2
186446	2147.9	2	186956	2152.4	2
186461	2150.7	2	186956	2154.8	2
186461	2152.7	2	186968	2154.3	2
186495	2157.0	2	186968	2154.9	2
186495	2157.0	2	187007	2153.7	2
186537	2104.1	2	187007	2156.9	2
186537	2104.1	2	187037	2151.9	2
186582	2155.1	2	187037	2156.1	2
186582	2156.4	2	187039	2148.6	2
186611	2150.3	2	187039	2156.8	2
186611	2152.3	2	187040	2148.2	2
186662	2150.7	2	187040	2149.0	2
186662	2151.5	2	187055	408.7	4
186691	2157.2	2	187055	265.8	4
186691	2160.4	2	187061	2154.0	2
186722	2150.4	2	187061	2150.6	2
186722	2153.2	2	187068	153.0	3
186722	2149.5	3	187068	170.7	3
186729	2151.2	2	187093	2150.0	2
186729	2148.6	2	187093	2156.4	2
186750	2150.5	2	187117	2159.5	2

Table C.5 Replicate water sample total carbon values in µmoles/kg.

Sample ID Number	Total Carbon	WOCE QF	Sample ID Number	Total Carbon	WOCE QF
187117	2160.8	2	187688	2156.8	2
187170	2152.9	2	187699	2151.8	2
187170	2153.2	2	187699	2150.6	2
187205	2154.0	2	187708	2154.0	2
187205	2156.5	2	187708	2153.5	2
187220	2150.3	2	187734	2154.9	2
187220	2151.9	2	187734	2155.2	2
187234	2155.0	2	187762	2151.7	2
187234	2151.3	2	187762	2151.9	2
187280	2151.5	2	187807	2153.4	2
187280	2152.3	2	187807	2154.1	2
187307	2151.7	2	187829	2151.9	2
187307	2153.1	2	187829	2153.2	2
187336	2152.1	2	187855	2150.1	2
187336	2153.1	2	187855	2155.9	2
187360	2150.5	2	187872	2040.2	2
187360	2153.0	2	187872	2042.5	2
187404	2149.9	2	187886	2041.6	2
187404	2150.4	2	187886	2040.8	2
187414	2143.2	2	187893	2084.5	2
187414	2142.5	2	187893	2085.8	2
187434	2136.2	2	187910	2153.2	2
187434	2136.5	2	187910	2154.2	2
187448	2119.0	2	187929	2154.7	2
187448	2120.7	2	187929	2154.8	2
187459	2130.1	2	187943	2154.8	2
187459	2130.5	2	187943	2155.2	2
187470	2110.1	2	187968	2153.8	2
187470	2110.4	2	187968	2153.9	2
187486	2152.4	2	187993	2153.9	2
187486	2153.5	2	187993	2154.7	2
187514	2152.8	2	188015	2154.5	2
187514	2149.5	2	188015	2156.0	2
187529	2152.0	2	188040	2153.1	2
187529	2154.3	2	188040	2154.4	2
187561	2149.3	2	188065	2153.1	2
187561	2150.6	2	188065	2155.7	2
187579	2150.9	2	188092	2154.1	2
187579	2152.1	2	188092	2154.6	2
187636	2151.8	2	188113	2154.8	2
187636	2153.7	2	188113	2155.9	2
187667	2149.4	2	188142	2155.5	2
187667	2150.7	2	188142	2154.3	2
187688	2156.7	2	188154	2149.5	2

Table C.5 Replicate water sample total carbon values in µmoles/kg.

Sample ID Number	Total Carbon	WOCE QF	Sample ID Number	Total Carbon	WOCE QF
188154	2150.2	2			
188179	2151.9	2			
188179	2152.7	2			
188182	2150.1	2			
188182	2151.4	2			
188197	2154.2	2			
188197	2154.3	2			
188222	2153.3	2			
188222	2154.0	2			
188250	2154.6	2			
188250	2155.2	2			
188269	2157.9	2			
188269	2157.2	2			
188292	2157.5	2			
188292	2155.5	2			
188323	2151.2	2			
188323	2152.4	2			
188345	2151.0	2			
188345	2151.6	2			
188345	2152.0	2			
188363	2149.8	2			
188363	2153.1	2			
188389	2145.6	2			
188389	2154.8	2			
188391	2157.2	2			
188391	2154.5	2			
188425	2140.2	2			
188425	2164.2	3			
188439	2150.6	2			
188439	2150.7	2			
188460	2136.3	2			
188460	2137.2	2			
188475	2148.5	2			
188475	2149.0	2			
188491	2155.7	2			
188491	2158.1	2			
188498	2098.5	2			
188498	2100.2	2			
188515	2131.4	2			
188515	2130.3	2			

6. Alkalinity
(Bob Gershey)

a. Description of Equipment and Technique
The total alkalinity of seawater is defined as the number of moles of hydrogen ion equivalent to the excess of proton acceptors (bases formed from weak acids with dissociation constants of less than $K=10^{-4.5}$) over proton donors (acids with $K>10^{-4.5}$) in a one kilogram sample. An automated potentiometric titration system is used to determine this quantity. During the course of the titration the pH is measured using a Ross combination electrode standardized using a Hansson seawater buffer. A known volume (~25ml) of sample is measured in a calibrated, thermostated pipette and dispensed in to an open cup. The alkalinity of the sample is estimated from its salinity and acid equivalent to 0.7 of this amount is added and the pH measured. A further three aliquots of acids are added to bring the titration to 90% completion. The Gran Function F3 (Stumm and Morgan) is then applied to these points to obtain a more refined estimate of the alkalinity. Five additional aliquots are then added to complete the titration.

b. Sampling Procedure and Data Processing Technique
Samples are collected using the same procedure as for Dissolved Inorganic Carbon (see Section 5b).

The pH values for the last five points of the titration are used to evaluate the Gran Function F1 from which the final estimate of the equivalence point is obtained. Hydrochloric acid used in the titrations is calibrated is two ways: against a standard solution of sodium borate using an acid base titration and against potassium iodate using an iodometric titration with sodium thiosulphate. In addition, the calibration is checked using Certified Reference Materials obtained from the Scripps Institute of Oceanography, LaJolla, California. Values are reported in units of µmol/kg. The overall precision of the analysis is 1.5 µmol/kg for samples with concentrations in the range of 1900-2400 µmol/kg.

c. Replicate Analysis

The precision of the alkalinity data was 9.5 µmol/kg. The alkalinity replicates consisted of 93 duplicate measurements, 1 triplicate measurement and 1 quadruplicate measurement. A statistical summary of the absolute value of the replicate differences is given below. Only acceptable sample values were used when calculating replicate differences. All replicates and their quality flags are given in Table C.6.

Statistic	Value
Number of Acceptable Replicate Differences	79
Minimum (µmoles/kg)	0.1
Maximum (µmoles/kg)	13.1
Mean (µmoles/kg)	2.7
Median (µmoles/kg)	1.8
Standard Deviation (µmoles/kg)	2.6

Sample ID Number	Total Alkalinity	WOCE QF	Sample ID Number	Total Alkalinity	WOCE QF
186219	2267.8	3	186618	2279.9	2
186219	2264.4	2	186618	2280.1	2
186224	2213.2	2	186630	2293.3	2
186224	2214.5	2	186630	2290.3	2
186238	2298.0	2	186637	2287.9	2
186238	1008138	4	186637	2286.3	2
186239	2276.7	2	186672	2278.9	2
186239	2278.2	2	186672	1008138	4
186254	2232.8	2	186692	2298.7	2
186254	2235.2	2	186692	2301.2	2
186267	2265.5	2	186695	2280.6	3
186267	2258.6	2	186695	2293.2	2
186297	2275.1	2	186728	2285.0	2
186297	2277.0	2	186728	2285.1	2
186301	2280.8	2	186759	2285.7	2
186301	1008138	4	186759	2283.1	2
186315	2279.3	2	186778	2295.8	2
186315	2281.6	2	186778	2295.8	2
186321	2271.5	3	186821	2223.7	2
186321	2284.1	2	186821	2225.0	2
186330	2265.7	2	186823	2214.3	2
186330	2299.5	3	186823	2214.3	3
186344	2274.6	2	186843	2286.6	2
186344	2271.2	2	186843	2287.1	2
186370	2294.7	2	186859	2287.7	3
186370	2293.2	2	186859	2263.9	2
186407	2294.4	2	186859	2264.6	2
186407	2294.5	2	186859	2284.1	3
186440	2297.2	2	186873	2369.2	3
186440	2298.6	2	186873	2288.8	2
186474	2297.0	2	186902	2285.4	2
186474	2304.7	2	186902	2319.3	3
186494	2298.0	2	186914	2290.1	2
186494	2300.9	2	186914	2290.8	2
186521	2297.0	2	186927	2296.8	2
186521	2296.6	2	186927	2300.2	2
186545	2293.5	2	186946	2296.6	2
186545	2296.2	2	186946	2299.9	2
186580	2303.3	2	186967	2300.0	2
186580	2305.4	2	186967	2291.0	2
186596	2284.6	2	187006	2295.7	2
186596	2288.1	2	187006	2348.5	3
186617	2079.3	2	187036	2291.6	2
186617	1008138	4	187036	2292.0	2

Sample ID Number	Total Alkalinity	WOCE QF	Sample ID Number	Total Alkalinity	WOCE QF
187070	2289.4	2	187530	2291.6	2
187070	2290.4	2	187530	2291.7	2
187103	2292.1	2	187550	2290.1	2
187103	2294.1	2	187550	2291.0	2
187118	2302.8	3	187576	2290.6	2
187118	2307.3	3	187576	2291.8	2
187183	2287.1	2	187597	2290.9	2
187183	2284.6	2	187597	2296.5	2
187204	2290.9	2	187637	2285.7	2
187204	2304.0	2	187637	2292.1	2
187237	2288.2	2	187653	2291.3	2
187237	2291.0	2	187653	2286.6	2
187244	2287.1	2	187661	2294.4	2
187244	2288.4	2	187661	2290.3	2
187272	2292.1	2	187693	2289.9	2
187272	2293.6	2	187693	2290.5	2
187306	2290.3	2	187707	2300.7	2
187306	2300.2	2	187707	2316.1	3
187332	2288.4	2	187733	2298.5	2
187332	2286.7	2	187733	2299.1	2
187362	2282.7	2	188141	2305.9	2
187362	2284.4	2	188141	2306.6	2
187378	2278.6	2	188158	2294.5	2
187378	2281.8	2	188158	2290.3	2
187402	2280.3	2	188176	2298.6	2
187402	2283.7	2	188176	2300.3	2
187415	2269.9	2	188180	2291.8	2
187415	2271.6	2	188180	2294.1	2
187436	2221.5	2	188196	2297.1	2
187436	2222.7	2	188196	2299.0	2
187441	2223.6	2	188225	2300.2	2
187441	2218.7	2	188225	2300.9	2
187453	2248.1	2	188243	2297.2	2
187453	2247.0	2	188243	2298.7	2
187469	2270.9	2	188272	2313.0	2
187469	2277.1	2	188272	2306.5	2
187485	2285.2	2	188291	2304.8	2
187485	2286.3	2	188291	2315.3	3
187487	2227.8	3	188324	2305.8	2
187487	2290.5	2	188324	2306.4	2
187513	2288.9	2	188326	2301.2	2
187513	2356.5	3	188326	2302.1	2
187521	2290.4	2	188342	2301.7	2
187521	2289.2	2	188342	2306.5	2

Sample ID Number	Total Alkalinity	WOCE QF	Sample ID Number	Total Alkalinity	WOCE QF
188365	2302.1	2			
188365	2304.3	2			
188387	2298.8	2			
188387	2297.0	2			
188391	2306.4	2			
188391	2298.7	2			
188391	2300.5	2			
188423	2290.7	2			
188423	2291.7	2			
188444	2279.7	2			
188444	2284.2	2			
188457	2274.9	2			
188457	2283.7	2			
188482	2224.1	2			
188482	2224.8	2			
188509	1008138	4			
188509	2268.9	2			

7. Halocarbons

(Michael Hingston)

a. Description of Equipment and Technique

The suite of halocarbon compounds analyzed included the chlorofluorocarbons CFC-12, CFC-11, CFC-113 and the halocarbons carbon tetrachloride and methyl chloroform. The analyses were carried out on two purge and trap systems developed at the Bedford Institute of Oceanography. The water samples were injected into the systems directly from the syringes used to collect the samples. A minimum of two volumes of water were used to rinse the sample pipette. The samples were purged for four minutes with ultra high purity nitrogen at a flow rate of 80 ml/min. The components were trapped in Porapak-N trap which was cooled to a temperature of less than 10°C. They were then desorbed by heating the trap up to 170°C. The contents of the trap were then passed through a 75m DB-624 megabore column. The resolved components exiting the column were quantified using electron capture detection.

b. Sampling Procedure and Data Processing Technique

Samples are collected directly from the rosette using 100 ml syringes to avoid contact of the sample with the atmosphere. The syringes are rinsed three times before they are filled. To prevent contamination, the CFC samples are the first samples which are collected from the bottles. The samples are then stored in a water bath of continuously flowing surface sea water until analysis. Air samples are taken in the winch room at the start of the cruise to ensure that it is not contaminated. The analysis of the samples is always completed within 24 hours after they have been drawn. Duplicates are taken at each station, with some of these being run on each system to ensure that the results are comparable.

Chromatograms are analyzed using a commercial software package. Concentrations of the various components are evaluated from baseline-corrected peak areas. Calibration is carried out using working gas standards made up at Brookhaven National Laboratories. These standards have been calibrated in turn against a standard air sample ALM-64975 provided by CMDL/NOAA, Boulder Colorado. Standard volumes are corrected for lab temperature and pressure. Results are reported in units of pmol/kg of sea water. Clean air samples are also analyzed with each station, as a check on the standardization.

c. Replicate analysis

A total of 6 unique sample id numbers had duplicate CFC water samples drawn and a total of 81 unique sample id numbers had triplicate CFC water samples drawn. Replicates were taken at most stations, with some of these being run on each system to ensure that the results were comparable. A statistical summary of the absolute value of the replicate differences is below. Only acceptable sample values were used when calculating replicate differences. All replicates and their quality flags are given in Table C.7.

Statistic	CFC11	CFC12	CFC113	Carbon Tet.	Methyl Chl.
Number of Acceptable Replicate Differences	225	226	91	156	33
Minimum (pmoles/kg)	0.000	0.000	0.000	0.000	0.010
Maximum (pmoles/kg)	0.681	0.749	0.185	1.421	13.902
Mean (pmoles/kg)	0.087	0.090	0.024	0.171	1.974
Median (pmoles/kg)	0.058	0.068	0.010	0.126	1.002
Standard Deviation (pmoles/kg)	0.105	0.090	0.035	0.195	2.782
Detection Limits (pmoles/kg)	0.15	0.10	0.12	0.30	0.13

Sample ID Number	Freon 11	Freon 12	Freon 113	Carbon Tet.	Methyl Chl.	WOCE QF
186225	5.990	3.140			1007.760	2 2 5 5 4
186225	5.911	3.077	0.312	8.394	780.578	2 2 2 2 4
186225	5.804	2.980	0.292	8.559	686.619	2 2 2 2 4
186245	5.129	2.579	0.311	7.475	743.850	2 2 2 2 4
186245	4.662	2.667	0.341	7.475	27.252	2 2 2 2 2
186245	5.100	2.820		7.740	534.840	2 2 5 2 4
186263	4.379	2.326	0.341	6.432	108.585	2 2 2 2 4
186263	4.389	2.326	0.292	6.432	171.834	2 2 2 2 4
186263	4.427	2.277	0.350	6.578	119.172	2 2 2 2 4
186303	4.106	2.218	0.234	7.074	77.451	2 2 2 3 4
186303	4.126	2.296	0.214	6.928	52.581	2 2 2 2 4
186303	4.116	2.189	0.156	5.838	230.952	2 2 2 3 3
186320	3.425	1.761	0.175	5.877	26.698	2 2 2 2 3
186320	3.464	1.781	0.224	5.877	93.472	2 2 2 2 3
186320	3.396	1.810	0.292	5.877	49.582	2 2 2 2 3
186347	4.213	2.238	0.253	6.869	55.160	2 2 3 2 4
186347	4.194	2.257	0.214	6.869	1179.989	2 2 2 2 3
186347	4.390	2.420	0.260	7.060		2 2 3 2 5
186372	4.270	2.240			307.930	2 2 5 5 4
186372	4.135	2.228	0.214	6.655	159.487	2 2 2 2 3
186372	4.190	2.460			0.000	2 2 5 5 4
186395	3.510	1.880		5.980	32.630	2 2 5 2 2
186395	3.410			6.060	0.000	2 5 5 2 4
186395	3.405	1.751	0.175	5.819	272.634	2 2 3 2 4
186433	1.673	1.099	0.117	3.794	0.000	2 2 3 2 3
186433	1.790	0.866	0.146	3.804	24.575	2 2 3 2 2
186433	1.800	0.953	0.136	3.784	22.328	2 2 3 2 3
186465	3.259	1.605	0.234	4.807	42.208	2 2 2 2 4
186465	3.289	1.742	0.146	4.865	0.000	2 2 3 2 4
186465	3.308	1.800	0.263	4.466	0.000	2 2 2 3 4
186500	3.026	1.537	0.126	4.943	142.198	2 2 3 2 3
186500	3.060	1.510		6.020	805.440	2 2 5 3 3
186500	3.016	1.411	0.117	4.913	0.000	2 2 3 2 3
186524	2.958	1.605	0.272	4.777	0.000	2 2 3 2 3

Sample ID Number	Freon 11	Freon 12	Freon 113	Carbon Tet.	Methyl Chl.	WOCE QF
186524	2.977	1.605	0.146	4.680	0.000	2 2 2 2 3
186524	2.977	1.528	0.185	4.729	540.818	2 2 2 2 4
186541	1.703	0.827	0.000	3.405	128.564	2 2 2 2 3
186541	1.703	0.827	0.000	3.405	128.564	2 2 2 2 3
186542	1.508	0.700	0.000	3.172	8.911	2 2 2 2 3
186542	1.508	0.700	0.000	3.172	8.911	2 2 2 2 3
186543	1.518	0.720	0.000	2.909	84.436	2 2 2 2 3
186543	1.518	0.720	0.000	2.909	84.436	2 2 2 2 3
186553	3.114	1.567	0.204	5.196	98.009	2 2 2 2 3
186553	3.114	1.596	0.195	5.575	89.446	2 2 2 2 3
186553	3.160	1.680		5.530	-1.000	2 2 5 2 4
186599	4.590	2.680		8.010	-1.000	2 2 5 2 4
186599	4.457	2.482	0.311	7.815	13.158	2 2 2 2 3
186599	4.660	2.610		8.050	-1.000	2 2 5 2 4
186607	1.557	0.808	0.000	3.113	0.000	2 2 2 2 3
186607	1.469	0.671	0.000	3.152	-0.973	2 2 2 2 3
186607	1.498	0.720	0.000	3.191	44.442	2 2 2 2 4
186629	1.510	0.780		3.120	0.000	2 2 5 2 3
186629	1.470	0.800		3.310	12.720	2 2 5 2 2
186629	1.508	0.905	0.000	2.753	35.179	2 2 2 3 3
186660	3.629	1.761	0.243	6.120	56.948	2 2 2 3 3
186660	3.668	1.771	0.243	5.935	99.729	2 2 2 3 4
186660	3.760	1.940		6.200	21.680	2 2 5 3 3
186710	5.167	2.696	0.341	8.894	160.193	2 2 2 3 4
186710	5.187	2.803	0.311	7.551	-0.973	2 2 2 3 4
186710	5.157	2.900	0.360	6.987	0.000	2 2 2 3 3
186722	3.804	1.995	0.214	5.059	116.776	2 2 2 2 4
186722	3.688	1.790	0.292	5.176	-0.973	2 2 2 2 4
186722	3.824	1.917	0.243	5.526	80.367	2 2 2 3 3
186751	3.619	2.150	0.224	5.351	645.419	2 2 2 3 3
186751	3.551	2.072	0.204	4.690	0.000	2 2 2 3 3
186751	3.600	1.888	0.243	5.848	245.270	2 2 2 3 3
186785				5.150		5 5 5 2 5

Sample ID Number	Freon 11	Freon 12	Freon 113	Carbon Tet.	Methyl Chl.	WOCE QF
186785	3.830	2.090		5.150	-1.000	2 2 5 2 4
186785	3.911	2.199	0.204	5.439	69.587	2 2 2 2 3
186810					295.820	5 5 5 5 4
186810	3.892	2.102	0.311	4.894	-0.973	2 2 2 3 4
186810	4.070	2.300		4.630	-1.000	2 2 5 3 4
186825	6.623	3.165	0.214	8.269	323.855	2 2 2 2 3
186825	6.450	3.400		8.340	0.000	2 2 5 2 3
186825	6.555	3.311	0.263	7.986	94.404	2 2 2 2 3
186850	4.282	1.761	0.165	5.479	310.336	2 2 2 3 3
186850	4.438	2.287	0.165	6.559	299.466	2 2 2 3 3
186850	4.380	2.510		7.090	0.000	2 2 5 2 3
186861	5.100	2.657	0.311	6.862	0.000	2 2 2 2 3
186861	5.159	2.657	0.302	6.960	187.226	2 2 2 2 4
186861	5.188	2.813	0.311	7.057	0.000	2 2 2 2 3
186881	4.408	2.258	0.282	5.625	211.338	2 2 2 2 4
186881	4.068	2.413	0.321	5.625	-0.973	2 2 2 2 4
186881	4.510	2.560		9.600	0.000	2 2 5 3 3
186909	3.512	1.722	0.195	4.612	331.187	2 2 2 3 3
186909	3.600	1.730		4.880	0.000	2 2 5 3 3
186909	3.454	1.703	0.195	4.884	1118.867	2 2 2 2 3
186930	2.960	1.570		4.370	-1.000	2 2 5 2 4
186930	3.090			4.240	1250.590	2 5 5 2 4
186930	2.870	1.540		4.200	-1.000	2 2 5 2 4
186949	1.839	0.905	0.175	2.899	0.000	2 2 3 2 3
186949	1.868	0.924	0.000	2.899	62.168	2 2 2 2 3
186949	1.907	0.963	0.000	2.899	45.794	2 2 2 2 3
186971	2.630	1.250		4.260	145.480	2 2 5 2 4
186971	2.640	1.370		4.460	0.000	2 2 5 2 3
186971	2.680			4.260	-1.000	2 5 5 2 4
187012	2.773	1.352	0.000	5.040	57.032	2 2 2 3 3
187012	2.714	1.411	0.000	3.717	57.032	2 2 2 2 3
187012	2.530	1.304	0.000	3.911	132.842	2 2 2 2 4
187043	3.800	1.940		7.910	1001.400	2 2 5 3 4
187043	4.080	2.100		8.050	128.370	2 2 5 3 3

Sample ID Number	Freon 11	Freon 12	Freon 113	Carbon Tet.	Methyl Chl.	WOCE QF				
187043	3.970	2.160		8.050	279.560	2	2	5	3	4
187062	2.549	1.177	0.088	4.291	85.833	2	2	3	3	3
187062	2.432	1.206	0.000	4.690	254.502	2	2	2	3	3
187062	2.670	1.350	0.000	4.640		2	2	2	3	5
187101	2.850	1.390		4.930	302.830	2	2	5	2	4
187101	2.790	1.400		3.500	0.000	2	2	5	3	3
187101	2.820	1.460		3.870	0.000	2	2	5	3	3
187123	2.520	1.284	0.000	3.999	24.936	2	2	2	3	2
187123	2.520	1.206	0.136	3.833	25.607	2	2	2	3	2
187123	2.600	1.240		3.830	0.000	2	2	5	3	3
187181	4.349	2.656	0.311	6.101	51.365	2	2	2	3	4
187181	4.291	2.248	0.331	6.101	42.287	2	2	2	3	3
187181	4.310	2.452	0.234	5.867	50.353	2	2	3	3	4
187207	2.422	1.197	0.000	5.146	23.037	2	2	2	2	2
187207	2.422	1.333	0.136	5.253	23.991	2	2	2	2	2
187207	2.384	1.372	0.000	5.127	34.595	2	2	2	2	3
187233	1.926	0.856	0.185	4.135	21.900	2	2	2	3	2
187233	1.850	0.900		3.590	19.200	2	2	5	3	3
187233	1.868	1.012	0.146	5.049	35.802	2	2	3	3	2
187274	2.090	1.080	5.420	24.870	2	2	5	2	3	
187274	2.072	1.099	0.078	5.147	21.064	2	2	3	2	2
187274	2.092	1.109	0.088	5.390	21.394	2	2	3	2	2
187314	3.470	1.760		6.450	38.150	2	2	5	3	2
187314	3.510	1.840		5.880	15.350	2	2	5	3	3
187314	3.520	1.850		5.940	30.970	2	2	5	3	2
187335	2.670	1.430		5.070	32.900	2	2	5	3	2
187335	2.646	1.313	0.068	5.234	24.829	2	2	3	3	2
187359	3.259	1.781	0.282	4.894	97.024	2	2	2	3	4
187359	3.830	2.070		7.070	87.330	2	2	5	3	4
187359	3.880	2.070		6.360	36.650	2	2	5	3	3
187374	3.690	1.780		6.990	82.460	2	2	5	2	4
187374	3.590	1.790	0.175	6.713	32.935	2	2	2	2	2
187374	3.600	1.839	0.175	6.889	33.343	2	2	2	3	2

Sample ID Number	Freon 11	Freon 12	Freon 113	Carbon Tet.	Methyl Chl.	WOCE QF				
187410	4.652	2.443	0.253	7.620	40.084	2	2	3	2	4
187410	4.652	2.618	0.224	7.630	51.908	2	2	2	2	4
187410	4.710	2.744	0.185	7.688	65.231	2	2	3	2	3
187416	4.632	2.462	0.331	7.133	38.984	2	2	2	2	2
187416	4.496	2.540	0.389	7.299	49.572	2	2	3	2	3
187416	4.652	2.559	0.331	7.464	40.298	2	2	2	2	4
187453	5.569	2.901	0.263	10.427	49.672	2	2	2	3	4
187453	5.569	2.823	0.292	11.264	51.035	2	2	3	3	4
187453	5.403	2.853	0.263	10.846	61.968	2	2	2	3	3
187473	5.812	2.891	0.282	8.548	58.423	2	2	2	2	4
187473	5.617	2.823	0.292	8.723	50.187	2	2	2	2	4
187473	5.617	2.843	0.243	8.635	77.018	2	2	3	2	4
187489	4.437	2.384	0.214	5.838	38.065	2	2	2	2	2
187489	4.427	2.452	0.214	6.266	40.439	2	2	2	2	3
187489	4.379	2.471	0.165	6.052	58.021	2	2	3	2	3
187520	3.775	2.014	0.136	5.624	35.232	2	2	3	2	2
187520	3.717	2.034	0.165	5.536	36.847	2	2	3	2	2
187520	3.727	2.053	0.097	5.711	49.107	2	2	3	2	4
187532	2.675	1.333	0.000	5.536	26.113	2	2	2	2	2
187532	2.753	1.382	0.000	5.730	27.115	2	2	2	2	2
187532	2.598	1.401	0.029	5.633	33.147	2	2	3	2	3
187557	3.688	1.790	0.000	5.643	30.045	2	2	2	2	3
187557	3.795	1.888	0.000	5.692	35.864	2	2	2	2	3
187557	3.726	1.917	0.000	5.731	36.525	2	2	2	2	3
187581	3.619	1.839	0.156	6.013	31.115	2	2	2	3	2
187581	3.649	1.888	0.126	5.838	30.181	2	2	2	2	2
187581	3.590	1.917	0.146	5.682	31.028	2	2	2	2	2
187615	4.427	2.306	0.185	7.541	54.615	2	2	2	2	4
187615	4.486	2.501	0.195	7.852	60.433	2	2	2	2	4
187615	4.486	2.520	0.175	7.687	37.315	2	2	2	2	3
187654	4.758	2.676	0.243	7.307	42.744	2	2	2	3	4
187654	4.739	2.598	0.224	8.144	39.193	2	2	2	3	2
187654	4.476	2.608	0.214	7.706	62.905	2	2	2	3	3
187672	4.160	2.200	7.070	50.850	2	2	5	2	4	

Sample ID Number	Freon 11	Freon 12	Freon 113	Carbon Tet.	Methyl Chl.	WOCE QF				
187672	4.252	2.325	0.195	6.879	35.241	2	2	2	2	3
187706	5.353	2.823	0.311	6.998	50.387	2	2	3	2	3
187706	5.334	2.852	0.360	7.017	51.954	2	2	2	2	3
187706	5.295	2.900	0.331	7.008	70.700	2	2	2	2	3
187739	2.929	1.508	0.117	4.369	26.717	3	2	3	2	3
187739	3.327	1.421	0.000	4.417	46.974	2	2	2	2	4
187739	3.347	1.489	0.000	4.320	53.259	2	2	2	2	3
187768	4.408	2.316	0.165	5.351	39.591	2	2	2	2	2
187768	4.670	2.179	0.156	5.332	58.272	3	2	2	2	3
187768	4.447	2.209	0.195	5.312	37.820	2	2	2	2	2
187815	3.960	2.082	0.126	4.904	35.134	2	2	3	2	3
187815	3.970	2.082	0.204	4.982	61.463	2	2	2	2	4
187815	4.038	2.121	0.234	4.943	61.590	2	2	3	2	4
187835	3.756	1.868	0.136	5.040	33.626	2	2	3	2	2
187835	3.707	1.907	0.185	5.040	57.298	2	2	3	2	3
187835	3.765	1.936	0.156	5.050	34.998	2	2		2	2
187860	4.418	2.491	0.204	5.712	38.858	2	2	2	2	2
187860	4.476	2.598	0.185	6.121	53.192	2	2	2	2	3
187860	4.486	2.618	0.195	5.907	40.045	2	2	3	2	4
187878	4.204	2.355	0.204	5.440	35.761	2	2	2	2	2
187878	4.311	2.365	0.224	5.858	35.752	2	2	3	2	2
187878	4.223	2.394	0.165	5.644	36.530	2	2	3	2	2
187911	3.376	1.829	0.117	7.015	52.133	3	2	3	3	3
187911	3.843	1.927	0.000	6.665	34.998	2	2	2	3	2
187911	3.980	2.004	0.136	7.239	38.452	2	2	3	3	2
187931	3.493	1.975	0.165	7.366	50.781	2	2	2	3	4
187931	3.269	1.995	0.107	6.188	63.342	3	2	3	3	4
187931	3.697	2.014	0.204	6.792	34.717	2	2	2	2	3
187945	2.792	1.420	0.000	6.266	27.008	2	2	2	3	2
187945		1.400	0.000	6.610	43.230	5	2	2	3	3
187945	2.851	1.362	0.000	6.596	25.870	2	2	2	3	2
187980	4.583	2.520	0.243	8.086	38.863	3	3	2	2	2
187980	4.272	2.228	0.204	7.950	43.933	2	2	2	2	4
187980	4.223	2.257	0.234	8.222	46.541	2	2	2	2	4

Sample ID Number	Freon 11	Freon 12	Freon 113	Carbon Tet.	Methyl Chl.	WOCE QF
187997	3.760	1.870		6.870	38.440	2 2 5 3 2
187997	3.561	1.849	0.185	6.246	36.136	2 2 2 3 2
187997	3.678	1.917	0.204	7.180	38.277	2 2 3 3 2
188022	3.746	2.063	0.282	7.638	58.826	2 2 3 3 4
188022	3.795	2.043	0.165	7.307	60.694	2 2 2 3 4
188022	3.746	1.917	0.204	7.472	38.316	2 2 2 2 2
188050	4.281	2.287	0.175	7.190	37.110	2 2 3 2 2
188050	4.340	2.335	0.195	7.054	41.041	2 2 2 2 3
188050	4.250	2.310		7.320	61.240	2 2 5 2 3
188069	2.442	1.158	0.000	6.752	24.692	2 2 2 2 2
188069	2.354	1.206	0.000	6.625	21.365	2 2 2 2 2
188069	2.296	1.275	0.000	6.694	37.943	2 2 2 2 3
188095	2.920	1.490		6.240	23.230	2 3 5 2 3
188095	2.851	1.518	0.185	6.198	28.507	2 2 2 2 2
188095	2.987	1.673	0.000	6.130	28.196	2 2 2 2 2
188118	2.520	1.380		6.160	25.930	3 2 5 2 2
188118	2.520	1.372	0.000	5.964	24.975	2 2 2 2 2
188118	2.617	1.411	0.000	6.013	27.281	2 2 2 2 2
188143	2.130	1.150		5.490	21.560	2 2 5 2 2
188143	2.080	0.960		5.120	22.210	2 3 5 2 2
188143	2.160	1.060		5.910	56.770	2 2 5 2 3
188175	2.218	1.070	0.000	5.507	22.026	2 2 2 2 2
188175	2.111	1.070	0.097	5.302	22.746	3 2 3 2 2
188175	2.063	1.031	0.136	5.400	23.787	2 2 3 2 2
188200	2.170	1.030		5.770	32.110	2 2 5 2 3
188200	2.150	1.080		5.220	15.530	2 3 5 2 3
188200	2.100	1.190		5.480	24.760	2 2 5 2 3
188238	4.145	2.316	0.175	8.543	51.853	3 2 3 2 3
188238	4.388	2.335	0.224	9.331	37.121	2 2 2 2 2
188238	4.447	2.442	0.214	8.728	37.579	2 2 3 2 2
188258	3.260	1.693	0.146	6.490	46.917	2 2 2 2 4
188258	3.279	1.761	0.146	6.743	43.784	2 2 2 2 4
188258	3.230	1.771	0.146	6.607	31.243	2 2 2 2 3
188275	2.024	0.992	0.000	4.184	15.898	2 2 2 2 2

Sample ID Number	Freon 11	Freon 12	Freon 113	Carbon Tet.	Methyl Chl.	WOCE QF				
188275	2.004	1.002	0.019	4.184	13.553	2	2	3	3	2
188322	1.480	0.710		3.370	12.700	2	2	5	2	3
188322	1.700	0.830		3.470	82.960	3	2	5	2	3
188322	1.660	0.700		3.280	45.320	2	2	5	2	3
188358	4.280	2.210		8.080	124.950	2	3	5	2	3
188358	4.174	2.150	0.195	7.765	58.265	2	3	3	2	3
188358	4.184	2.296	0.165	7.969	99.862	2	2	2	2	3
188384	4.905	2.813	0.273	8.069	1497.751	2	2	2	2	3
188384	5.149	2.813	0.243	8.614	134.062	2	2	2	2	3
188384	5.100	2.900	0.380	9.237	870.976	2	2	3	3	3
188430	4.876	2.618	0.243	9.596	190.165	2	2	2	2	3
188430	4.896	2.618	0.273	9.664	1199.466	2	2	3	2	4
188430	4.905	2.638	0.243	9.733	375.786	2	2	2	3	3
188441	3.629	1.888	0.175	6.636	336.455	2	2	2	2	3
188441	4.311	2.131	0.214	8.057	354.505	2	2	3	2	3
188441	4.272	2.364	0.156	7.629	458.659	2	3	2	2	3
188461	5.208	2.658	0.253	8.314	411.665	2	2	2	2	3
188461	5.092	2.638	0.253	8.041	276.851	2	2	2	2	3
188461	5.150	2.638	0.292	7.574	235.359	2	2	3	2	3

8. Reversing Thermometers

Reversing thermometers were not used since the dual temperature sensors on the Seabird CTD provide a better in-the-field temperature calibration.

9. Helium / Tritium

(Rochelle Ugstad)

A total of 180 He and 177 Tr samples were collected by Rochelle Ugstad for Peter Schlosser of Lamont-Doherty Earth Observatory, Columbia University.

a. Description of Equipment and Technique

He samples were collected through tygon tubing into copper tubes (40 g capacity) bolted into aluminium channels for support and protection. Tr samples were collected into 250 ml brown glass bottles, directly from the Niskin spigot.

b. Sampling Procedure and Data Processing Technique

He samples were taken after CFCs and occasionally after DOC (WOCE parameter 43). Samples were drawn through tygon tubing that was cured in seawater to reduce bubbles. After all detected bubbles were worked out of the line, the metal channel holding the copper sample tube was lowered to allow a gravity feed of water through the tube. The channel was then struck several times on one side with a ratchet beginning at the intake end in order to pass any air bubbles out of the copper tube. Flushing of the copper tube took place during both parts of the bubble-removing procedure. When air removal and flushing were complete, both ends of the copper tube were sealed, starting at the outflow end, by tightening the two bolts at each end with a ratchet wrench. GMT time of sampling was noted on each sample. These samples will be shipped to Lamont for analysis.

Tritium samples were collected into bottles without rinsing or flushing; after all other samples were collected from the rosette. The bottle caps were secured with electrical tape after each station. These samples will be shipped to Lamont for analysis. Occasionally the water supply in the Niskin bottles was exhausted before the sample bottles could be filled completely. This was not a common problem and was avoided by monitoring the amount of water used to rinse sample bottles.

Replacement watches were handed out to all persons in the scientific party and the winch operators who normally wore luminous-dial watches. Signs were posted on each winch room door warning personnel to avoid wearing luminous-dial watches inside the room.

10. Oxygen Isotopes
(Rochelle Ugstad)

a. Sampling Procedure
Water samples were initially collected using a 10 litre rosette bottle. Samples for oxygen isotope analysis were collected last in the sampling. A total of about 450 isotope samples were drawn into 30 ml bottles. The bottles were sealed with electrical tape after each station. Samples are being sent to Peter Schlosser and Bob Houghton at Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY.

D. MOORED MEASUREMENTS - DESCRIPTIONS, TECHNIQUES AND CALIBRATIONS

1. Current Meter Moorings
(Allyn Clarke)

a. Description of the Equipment and Technique
The standard BIO deep sea mooring consists of a large streamlined subsurface buoyancy package supporting one or more Aanderaa Current Meters, back up buoyancy packages and an acoustic release. The subsurface buoyancy packages are either constructed using 9 glass balls supported in a fibreglass structure or using deep-sea syntactic foam formed in the same streamlined shape as the older glass floats. All of the moorings deployed on 97009 were constructed using jacketed 3/16 wire. Stainless steel shackles and swivels were used to connect the instruments and backup buoyancy packages to the wire lengths. All shackles were secured with a piece of jacketed seizing wire as the mooring was assembled and deployed. The acoustic releases were EG&G DAC model releases. Since these releases were rather old, we placed two releases on all of the moorings. The moorings have been designed for a 20 month deployment.

Our traditional back-up buoyancy packages consist of two 17 inch glass balls contained in plastic hard hats and fastened to a stainless steel tension bar one metre in length. These backup buoyancy packages are shackled together to form doubles and triples before they are shackled into the mooring line. During the recovery of M1094 during 96006, the shackles joining backup buoyancy packages came apart as the mooring was worked by relatively heavy sea conditions. We believe that the sea conditions caused a great deal of relative motion between packages. This caused the seizing wire to fail and then the shackles unscrewed themselves. For the moorings set on 97009, two modifications were implemented. First, the shackles on the backup buoyancy packages were secured by being pinned rather than seized. Second, a safety wire was stretched across the double and triple buoyancy packages to provide an additional tension element should one of the shackles fail.

Bathymetric surveys are conducted before beginning a mooring deployment in order to determine the depth of water at the intended mooring site. On some occasions, the mooring location needed to be moved several miles in order to find the appropriate depth. The raw soundings for all of these surveys were corrected using Matthews tables for area 12. The data for these sounding surveys is included with the deployment logs.

b. Sampling Procedure and Data Processing Techniques

The Aanderaa current meters are set with a sampling interval of two hours; the SEACAT temperature / salinity recorders to one hour. On recovery, the data is processed using standard software packages within the BIO Oceans suite of programs.

c. Calibration Data

The temperature, pressure, conductivity and direction sensors of the Aanderaa current meters are calibrated in the laboratory prior to deployment. The SEACAT instruments are calibrated before and after deployment. These calibrations will not be included in this cruise report.

d. Deployment and Recovery Logs

Placement

Mooring No.	**1244**	Geographic Area:	Labrador Sea
Intended Duration:	20 months	Ship:	Hudson
Cruise No:	96026	Date:	21 / 10 / 1996
Sea State:	1-2 m swell	Weather Conditions:	15 knots @ 310 T
Mooring Technician:	Scotney / Hartling	Navigation Inst:	GPS
Latitude:	55° 28.715 N	Longitude:	53° 39.300 W
Time of Fix:	13:51 Z		
Raw Depth:	1502 fathoms	Corrected Depth:	2801 m
Main Float Type:	Braincon 4 disc	Main Float Markings:	Nose 222, 223, 224
Radio Beacon Type:	Nil	Radio Beacon Freq.	
Light Type:	Nil	Color / Rate:	
Mooring Line Type:	Jacketed wire	Mooring Line Color:	Yellow
Release Type:	EGG / DAC	Release S/N:	502901
Release Code:	0126 / 2367 / 2345 (release / enable / disable)		
Release Type:	EGG / DAC	Release S/N:	701163
Release Code:	0345 / 4567 / 2456 (release / enable / disable)		

Placement Log

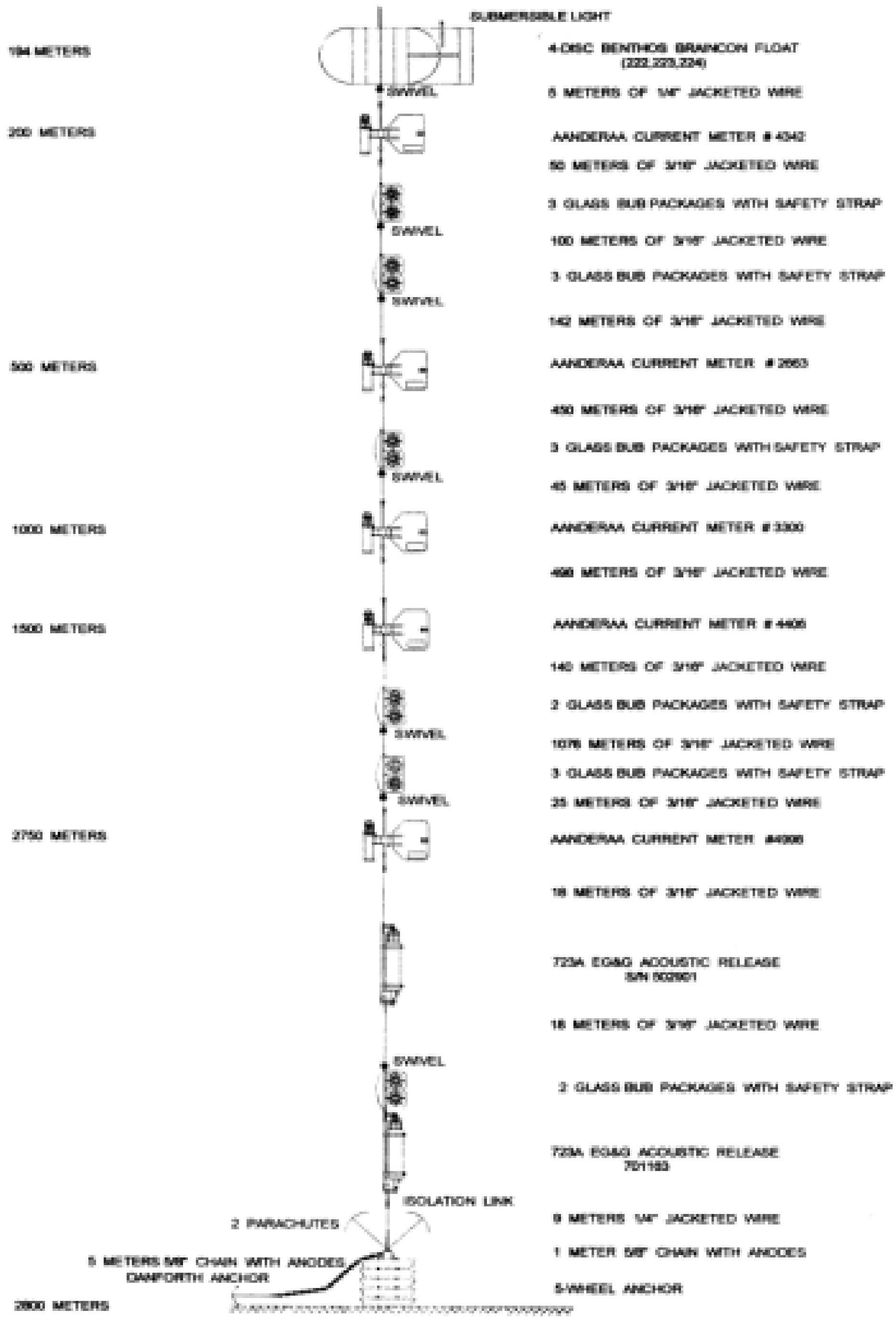
Time (Z)	Instrument	Remarks
1043	Braincon Float	Lifted off deck
1045	ACM 4342	in water, rotor ok
1046	Braincon Float	in water, released from hook
1056	3 bb / backup wire	in water / added second wire to lengthen backup wire across bb package
1104	100 m / 3bb	in water / 142 m length
1109	ACM 2663	In water
1119	3bb / backup wire	in water / 45 m
1221	ACM 3300	In water
1230	ACM 4406	In water
1235	2bb / 1076 m	In water
1250	3bb / 25 m	In water
	ACM 4998	36 m length replaced by two shorter shots for second release
1256	ACM 4998	in water / 18 m length
1258	502901	In water
1304	2bb / 701163	In water, begin tow to suitable depth. Note: strong easterly set during mooring. Ship did not advance on mooring site during entire deployment
1351		Anchor away
1428		Anchor on bottom
1457	closest approach	55 28.6233 N
1533	701163	Interrogate (1/2 sec for 1 min) and disabled
1534	502911	Interrogate (1/2 sec for 1 min) and disabled
1536		checked transponders, all silent

Sounding Survey - M1244
Date: October 21, 1996

Time (z)	Latitude	Longitude	Sounder Value (fathoms)	Corrected Depth (metres)
0900			1470	2740
0905			1472	2744
0910			1479	2757
0915			1479	2757
0920			1458	2718
0925			1439	2682
0930			1440	2684
0935			1440	2684
0940			1440	2684
0945			1439	2682
0950			1438	2680
0955			1437	2678
1000			1435	2675

Note: The Sounder Value was obtained from the winch room sounder, which was connected to a transducer on the ram. It was assumed that the sounding was based on a sound velocity of 800 fathoms/sec. This was then converted to a raw sounder value in metres based on a sound velocity of 1500 m/s by multiplying by 1.875 (1500/800). Six metres were added to account for the keel depth and two metres for the depth of the ram below the keel. The resulting raw depth was then corrected using Matthews Tables for area 12.

MOORING # 1244 LAZIER WOCE LAB SEA OCTOBER 1996
(AS DEPLOYED)



Placement

Mooring No.	**1245**	Geographic Area:	Labrador Sea
Intended Duration:	20 months	Ship:	Hudson
Cruise No:	96026	Date:	22 / 10 / 1996
Sea State:	1-2 m swell, .5 m waves	Weather Conditions:	20-25 knots @ 320
Mooring Technician:	Scotney / Hartling	Navigation Inst:	GPS
Latitude:	55^{o} 44.827 N	Longitude:	53^{o} 29.0772 W
Time of Fix:	14:44 Z		
Raw Depth:	1640 fathoms	Corrected Depth:	3061 m
Main Float Type:	Braincon glass	Main Float Markings:	78, 68, 62, 64
Radio Beacon Type:	Nil	Radio Beacon Freq.	
Light Type:	Nil	Light Color/Rate:	
Mooring Line Type:	Jacketed wire	Mooring Line Color:	Yellow
Release Type:	EGG / DAC	Release S/N:	205004
Release Code:	0347 / 1357 / 1356 (release / enable / disable)		
Release Type:	EGG / DAC	Release S/N:	308606
Release Code:	0247 / 2356 / 2347 (release / enable / disable)		

Placement Log

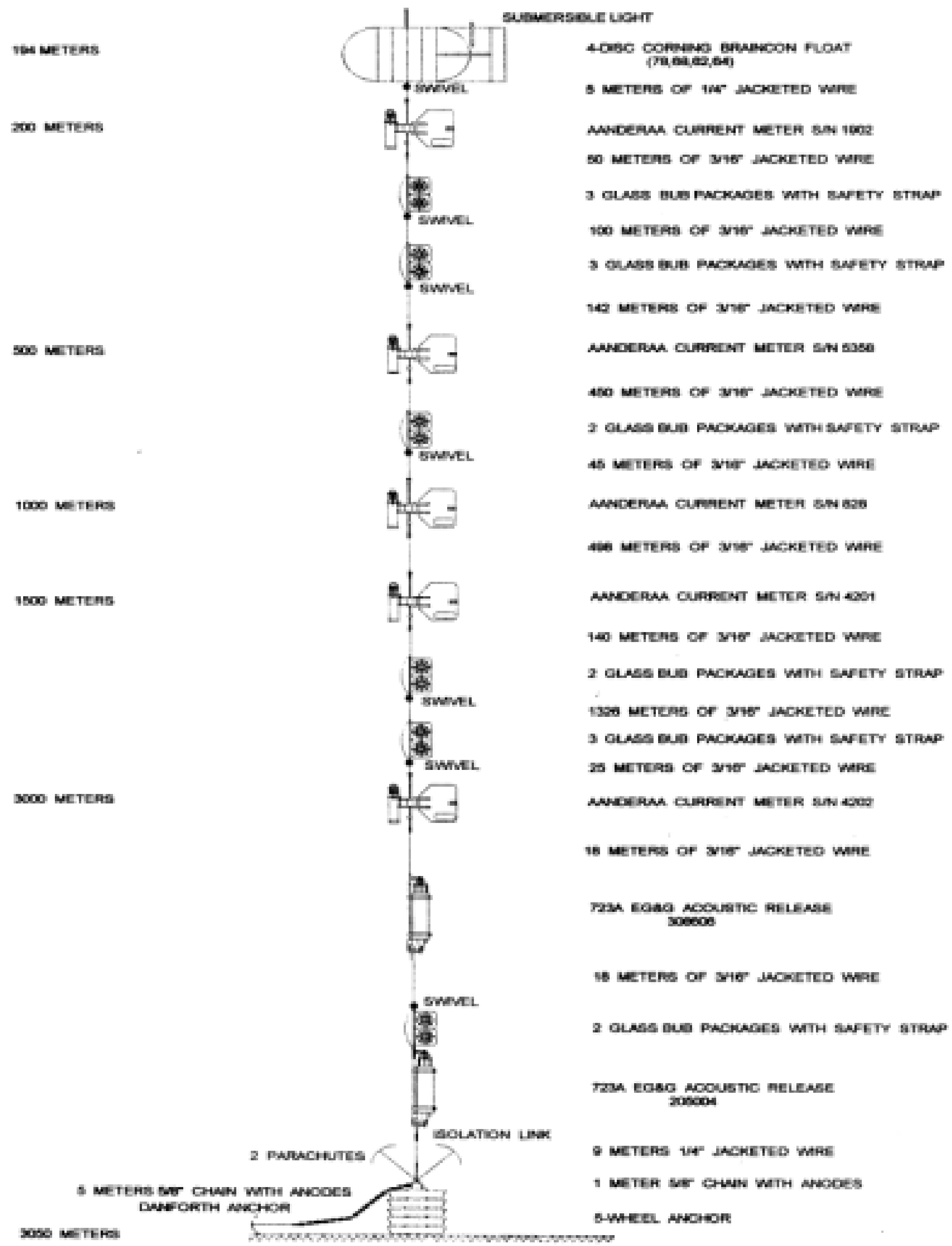
Time (Z)	Instrument	Remarks
1049	Float / 5m / ACM 1902 / 50 m	in water
1053	3bb / 100 m	in water
1056	3bb / 142 m	in water
1103	ACM 5358 / 450 m	in water
1112	2 bb / 45 m	in water
1114	ACM 828 / 498 m	in water
1123	ACM 4201 / 140 m	in water
1127	2bb / 1326 m	in water
1153	3bb / 25 m	1 ball casing broken and repaired in chute, in water
1157	ACM 4202 / 18 m	adding two 18 m lengths on drum
1158	308606 / 18 m	in water
1203	2bb / 205004	
1205		anchor away 55^{o} 44.988 N, 53^{o} 29.4862 W
1244		anchor on bottom, 4.5 cables from drop site, range on release 1740 fathoms
1444		best estimated position 55^{o} 44.827 N, 53^{o} 29.0772 W, 2.3 cables SE of anchor drop site
1450	205004	Interrogated and disabled
1452	308606	Interrogated (1/2 sec for 65 sec) and disabled

Sounding Survey - M1245
Date: October 22, 1996

Time (z)	Latitude	Longitude	Sounder Value (fathoms)	Corrected Depth (metres)
	55 41.67	53 32.12	1600	2986
	55 42.72	53 31.78	1610	3005
	55 42.79	53 31.29	1610	3005
	55 43.38	53 30.79	1620	3024
	55 43.94	53 30.35	1622	3027
	55 44.48	53 29.85	1620	3024
	55 45.06	53 29.38	1640	3062 A/C
	55 45.61	53 28.96	1632	3047
	55 46.19	53 28.46	1640	3062 A/C
	55 46.04	53 27.54	1638	3058
	55 45.39	53 26.75	1640	3062
	55 44.55	53 26.75	1628	3039
	55 43.96	53 26.23	1629	3041
1133	55 44.77	53 28.67	1638	3058

Note: The Sounder Value was obtained from the winch room sounder, which was connected to a transducer on the ram. It was assumed that the sounding was based on a sound velocity of 800 fathoms/sec. This was then converted to a raw sounder value in metres based on a sound velocity of 1500 m/s by multiplying by 1.875 (1500/800). Six metres were added to account for the keel depth and two metres for the depth of the ram below the keel. The resulting raw depth was then corrected using Matthews Tables for area 12.

MOORING # 1245 LAZIER WOCE LAB SEA OCTOBER 1996
(AS DEPLOYED)



Placement

Mooring No.	**1246**	Geographic Area:	Labrador Sea
Intended Duration:	20 months	Ship:	Hudson
Cruise No:	96026	Date:	22/10/1996
Sea State:	2-3 m swell, 0.5 m waves	Weather Conditions:	25-30 knots @ 320
Mooring Technician:	Scotney/Hartling	Navigation Inst:	GPS
Latitude:	56° 09.82 N	Longitude:	52° 58.43 W
Time of Fix:	2200Z		
Raw Depth:	1816 fathoms	Corrected Depth:	3397 m
Main Float Type:	Synt. Foam	Main Float Markings:	001
Radio Beacon Type:	Nil	Radio Beacon Freq.	
Light Type:	Nil	Light Color/Rate:	
Mooring Line Type:	Jacketed wire	Mooring Line Color:	Yellow
Release Type:	EGG/DAC	Release S/N:	503301
Release Code:	0256 / 1257 / 1256 (release / enable / disable)		
Release Type:	EGG/DAC	Release S/N:	100406
Release Code:	0157 / 3456 / 2567 (release / enable / disable)		

Placement Log

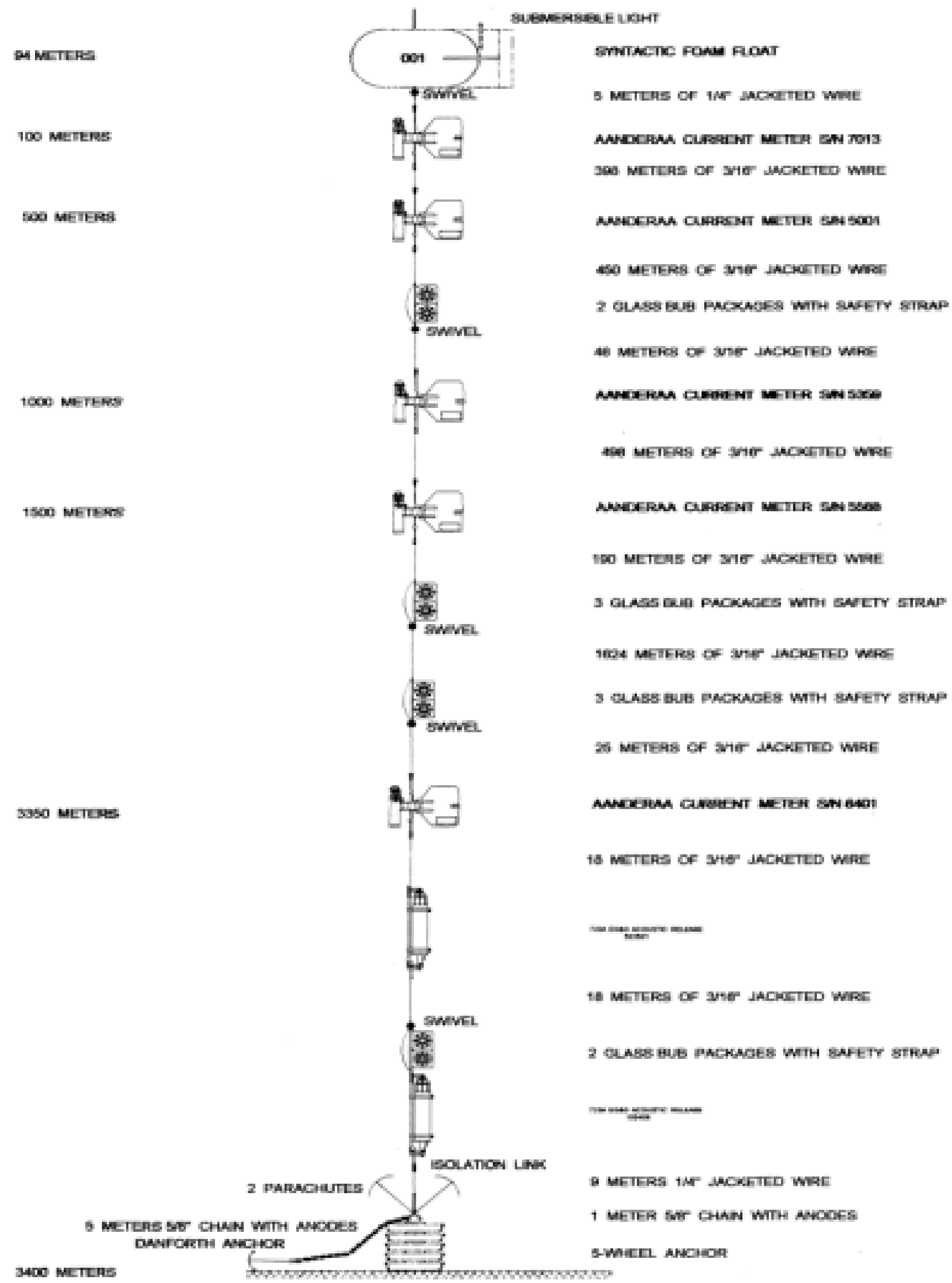
Time (Z)	Instrument	Remarks
1931	Float 001 / 5 m / ACM°7013 / 398 m	in water, the mooring wire got looped over the top of the buoy as it was being swung out but was quickly freed
1941	ACM 5001 / 450 m	in water
1950	2bb / 46 m	in water, grease on 46 m segment
1952	ACM 5359 / 498 m	in water
2001	ACM 5568 / 190 m	in water
2006	3bb / 1624 m	in water
2030	3bb / 25 m	in water
2033	ACM 6401 / 18	36 m length on drum replaced by two 18 m lengths
2035	503501 / 18 m	in water
2038	2bb / 100406	Weight being transferred to anchor, kevlar slip line caught up on release, pulling gear back in board to correct problem
2045		Weight transferred to anchor and slip line clear
2047		Anchor away 56° 10.036 N 52° 58.254W
2131		Anchor on bottom
2200		Closest approach
2215	100406	Interrogated, upright and disabled
2215	503301	Interrogated, upright and disabled

Sounding Survey - M1246
Date: October 22, 1996

Time (z)	Latitude	Longitude	Sounder Value (fathoms)	Corrected Depth (metres)
1735	56 07.15	53 04.82	1788	3343
1740	56 07.87	53 04.15	1800	3365
1745	56 08.62	53 03.36	1803	3371
1750	56 10.40	53 02.63	1806	3377
1755	56 10.14	53 01.76	1810	3385
1800	56 10.89	53 00.99	1820	3404
1805	56 11.00	54 00.00	1820	3404
1810	56 10.73	53 59.53	1815	3394
2007	56 09.88	53 58.13	1816	3396
	56 00.12	53 58.81	1820	3404

Note: The Sounder Value was obtained from the winch room sounder, which was connected to a transducer on the ram. It was assumed that the sounding was based on a sound velocity of 800 fathoms/sec. This was then converted to a raw sounder value in metres based on a sound velocity of 1500 m/s by multiplying by 1.875 (1500/800). Six metres were added to account for the keel depth and two metres for the depth of the ram below the keel. The resulting raw depth was then corrected using Matthews Tables for area 12.

MOORING # 1246 LAZIER WOCE LAB SEA OCTOBER 1996
(AS DEPLOYED)



Recovery

Mooring No.	**1194**	Ship:	Hudson
Cruise No:	96026	Date:	23/10/1996
Mooring Technician:	Scotney / Hartling	Sea State:	2-3 m swell / .5 m waves
Weather Conditions:	20 knots @ 325		

Recovery Log

Time (Z)	Instrument	Remarks
0955		Interrogate release / release responded
1041		Closest approach 5.5 cables to west of last spring s position. New position 56° 44.4032 N 52°28.7239 W
1145		3.5 miles NW of site, grapnel, chain, hooks deployed
1155		at join in the wire, nicol pressing in an eye, joining in main weight and the release
1212		Weight and release in water
1516		Bridge believes we are hooked on, insisting on recovering wire. We are 1.9 km from site, drag was 400 m from the mooring release. Drag release 3 km from vessel at closest approach
1536		Yellow object sighted on surface / wrong floats
1840		Caught mooring / begin hauling
1947		Yellow double at surface / 2 grapnels hooked into balls
1957		2 bb on deck - two wires leading into the water
2026		Recovered the rest of the drag line / lost all grappling equipment
2030		Started hauling yellow wire, much damage on jacket of wire
2044		Seacat and ACM on board / rest of wire broken
2052		Release on board

Placement

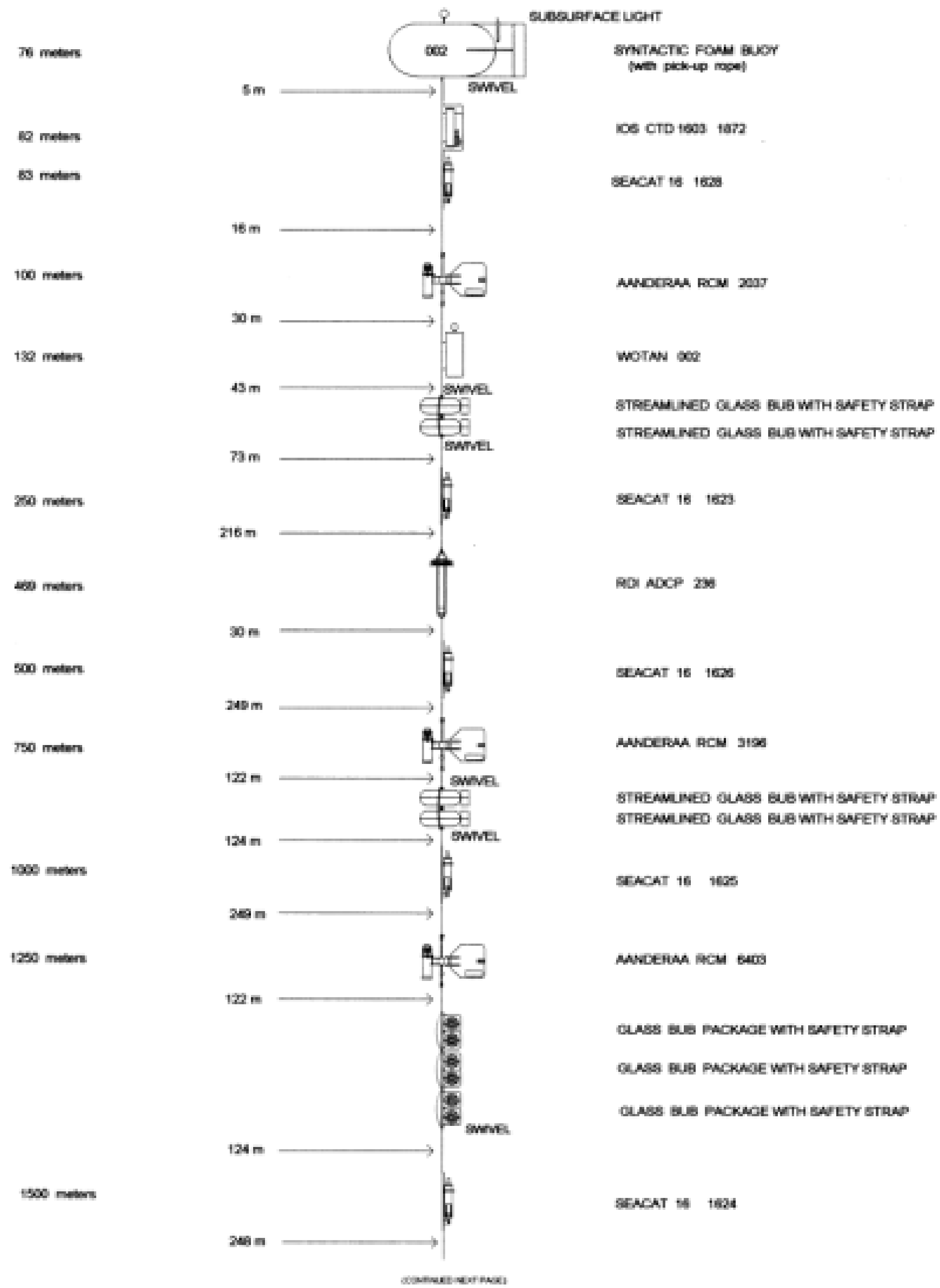
Mooring No.	**1226**	Geographic Area:	Labrador Sea
Intended Duration:	20 months	Ship:	Hudson
Cruise No:	96026	Date:	24/10/1996
Sea State:	2-3 m swell, 0.5 m waves	Weather Conditions:	10-15 knots @ 310 T
Mooring Technician:	Scotney/Hartling	Navigation Inst:	GPS
Latitude:	56° 44.62 N	Longitude:	52°26.61 W
Time of Fix::	1526 Z		
Raw Depth:	1778 fathoms	Corrected Depth:	3513 m
Main Float Type:	Synthetic Foam	Main Float Markings:	002
Radio Beacon Type:	Nil	Radio Beacon Freq.:	
Light Type:	Nil	Light Color/Rate:	
Mooring Line Type:	Jacketed wire	Mooring Line Color:	yellow
Release Type:	EGG/DAC	Release S/N:	107102
Release Code:	A0134		
Release Type:	EGG/DAC	Release S/N:	307405
Release Code:	A0457		

Placement Log

Time (Z)	Instrument	Remarks
1122	Float 002, IOS CTD, Seacat 1628	lifted off flight deck and over the stern and into the water. No tangles or snags. Two lines from buoy to IOS CTD
1125	ACM 2037 / 20 m	in water
1128	WOTAN 02 / 43 m	in water
1132	2 streamline bb / 73 m	extra safety wire across pair of floats
1137	Seacat 1623 / 216 m	in water
1144	RDI 236 / 30 m	in water
1147	Seacat 1626 / 249 m	in water
1152	ACM 3198 / 122 m	(ACM 3196 in records)
1157	2 streamline bb / 124 m	extra safety wire
1200	Seacat 1625 / 249 m	
1205	ACM 6403 / 122 m	in water
1209	3 bb / 124 m	
1213	Seacat 1624 / 248 m	
1218	ACM 7651 / 122 m	
1221	2 bb / 124 m	
1225	Seacat 1627 / 499 m	
1235	ACM 8695 / 442 m	
1243	2 bb / 134 m	
1248	107002 / 125 m	
1251	2 bb / 134 m	
1255	ACM 8696 / 21 m	
1300	2 bb / 307405 / chain	
1302	anchor away	56° 44.8801 N 52° 26.7721 W - 1778 fathoms corrected to 3513 m
1343	anchor on bottom	
1512	closest approach	56° 44.94 N 52 ° 26.74 W on SW to NE course
1528	307405	Interrogated and disabled

Time (Z)	Instrument	Remarks
1526	closest approach	56° 44.62 N 52 ° 26.61 W on NW to SE course (Best position for M1226)
1529	107002	Interrogated and disabled
1531	releases	Checked transponders, all silent

MOORING # 1226 LAZIER LAB SEA WOCE OCT 1996



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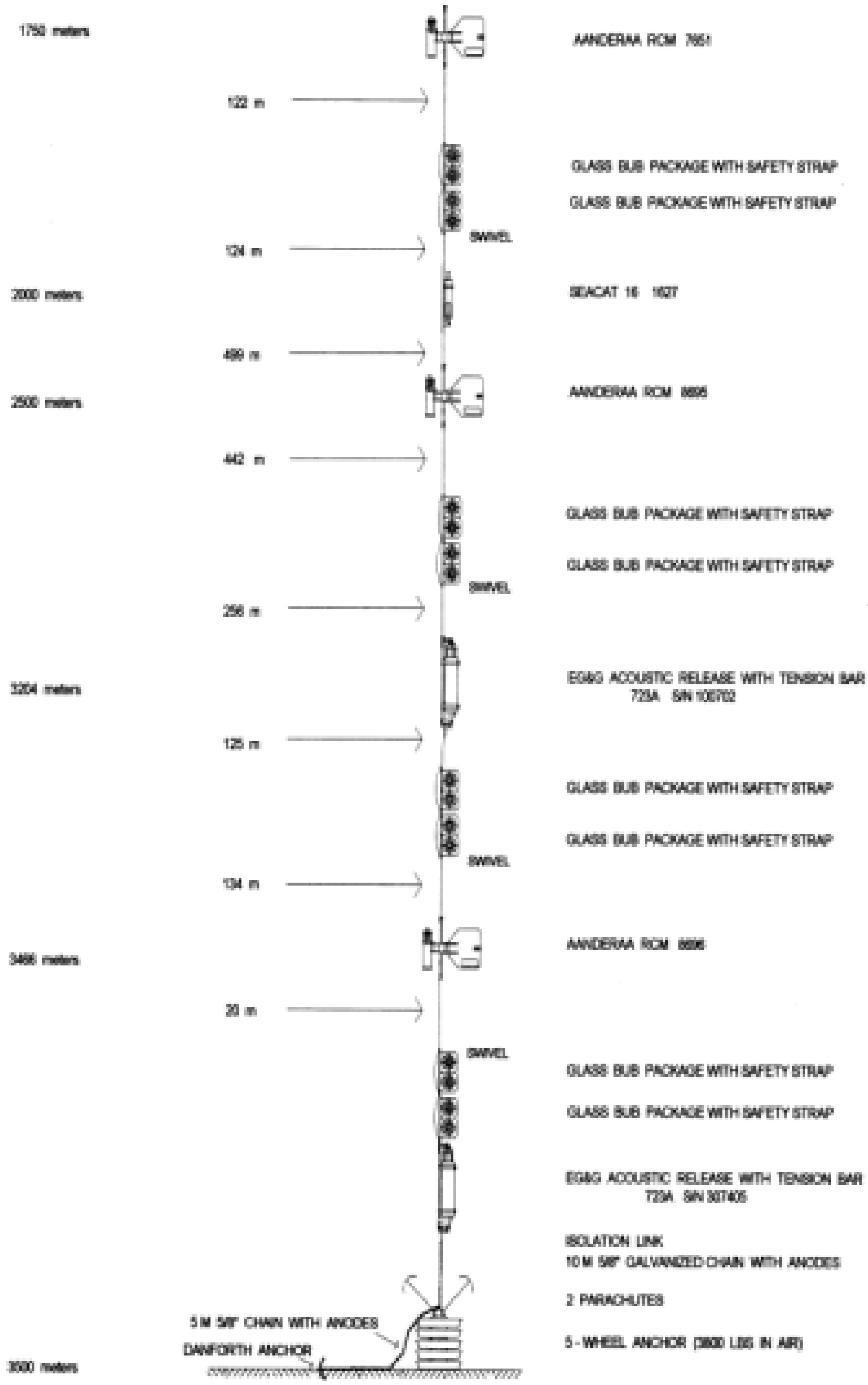
MOORING # 1226 LAZIER LAB SEA WOCE OCT 1996



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Recovery

Mooring No.	1230	**Ship:**	**Hudson**
Cruise No:	96026	Date:	26/10/96
Mooring Technician:	Scotney/Hartling	Sea State:	0.5 m swell
Weather Conditions:	10-12 knots @ 310		

Recovery Log

Time (Z)	Instrument	Remarks
1645	107402	3.2 nm range, release enabled, transponding on release, acoustic range 3850 fathoms
	742	ship stopped 2996 metres from site. Send enable and transpond commands; no reply
1715	742	ship stopped 2 miles from site. No response through ships transducers
1724	742	over the side transducer / send enable command, return ping 4 times and transpond. Acoustic range 5255 m
1740	742	0.4 miles, transponding on Benthos through EGG deck unit and sounder
1750	742	At site, disable, enable then release commands. Benthos released. On its way up, transpond 4 times mode.
1835	107402	enabled, _ sec for 60 sec, release, 1./sec for
1844	742	on surface and sighted by bridge
1856	742	Finally hooked. Hard hat broken by a hook. WHOI lost a hook.
1858	742	on board
1917	107402	on surface off starboard bow
1920		hooked on
1923		on board

2. Sound Source Moorings

Four sound source moorings were set around the periphery of the Labrador Sea.

Sound Source North

Launch Date	26 October, 1996	Time	1243 UTC
Latitude	58° 15.6551 N	Longitude	50° 49.1543 W
Position Source	GPS	Deployed by:	John / Paul
Recorder	Mark Prater	Ship and Cruise No	Hudson 97009
Corrected Water Depth		3551 metres	
Anchor Position Lat.	58°15.655N	Anchor Position Long.	50° 49.1543 W
Argos Platform ID No.	10778 / SN23104	Flasher ID No.	6435

Acoustic Release Information

Release No.	016780 EG&G	Tested to	1000metres
Receiver No.		Release Command	542430
Interrogate Freq.	11.0	Reply Freq.	12.0

Sound Source South

Launch Date	06 November 1996	Time	1829 UTC
Latitude	54° 58.76 N	Longitude	48° 43.03 W
Position Source	GPS		
Deployed by:	John / Paul	Recorder	Mark Prater
Ship and Cruise No	Hudson 97009	Corrected Water Depth	3792 metres
Anchor Position Lat	54° 58.76 N	Anchor Position Longitude	48° 43.03 W
Argos Platform ID No.	10775 SN 52265	Flasher ID No.	6425

Acoustic Release Information

Release No.	016779 EG&G	Tested to	1000 metres
Receiver No.		Release Command	542413
Interrogate Freq.	11.0	Reply Freq.	12.0

Sound Source East

Launch Date	08 November 1996	Time	1603 UTC
Latitude	56° 47.055 N	Longitude	43° 59.522 W
Position Source	GPS	Deployed by:	John / Paul
Recorder	Mark Prater	Ship and Cruise No	Hudson 97009
Corrected Water Depth	3422 metres		
Anchor Position Lat	56° 47.055 N	Anchor Position Longitude	43° 59.522 W
Argos Platform ID No.	10779	Flasher ID No.	1611

Acoustic Release Information

Release No.	016777 EG&G	Tested to	1000 metres
Receiver No.		Release Command	542357
Interrogate Freq.	11.0	Reply Freq.	12.0

Sounding Survey - Sound Source East
Date: November 08, 1996

Time (z)	Latitude	Longitude	Sounder Value (fathoms)	Corrected Depth (metres)	Note
1040	56 43.97	44 07.66	1840	3442	
1045	56 43.62	44 06.30	1805	3374	
1050	56 43.22	44 04.46	1755	3279	
1055	56 42.74	44 02.77	1710	3194	
1100	56 42.20	44 01.99	1665	3109	
1105	56 42.44	43 59.82	1675	3129	A/C to 000
1110	56 43.43	44 00.01	1660	3099	
1115	56 44.35	43 59.97	1575	2938	
1120	56 45.36	43 59.98	1785	3337	
1125	56 46.54	43 59.99	1790	3346	
1130	56 47.44	43 59.99	1835	3432	New mooring site
1135	56 48.19	43 59.96	1850	3461	
1140	56 48.86	43 59.86	1880	3517	A/C to 145
1145	56 49.04	43 59.37	1890	3537	
1150	56 48.47	43 58.55	1890	3537	
1155	56 47.90	43 58.31	1865	3489	A/C to 207
1200	56 47.36	43 58.51	1860	3480	
1205	56 47.41	43 57.95	1885	3527	
1210	56 47.46	43 57.76			Light and pump
1245	56 47.38	43 57.94	1885	3527	
1250	56 47.38	43 58.02	1885	3527	
1300	56 47.44	43 57.88	1885	3527	
1305	56 47.47	43 57.65	1885	3527	
1315	56 47.59	43 57.34	1885	3527	
1335	56 47.53	43 56.82	1890	3537	A/C to 250
1340	56 47.36	43 57.77	1885	3527	
1345	56 47.18	43 58.88	1835	3432	
1350	56 47.00	43 59.96	1825	3413	
1355	56 46.94	44 00.09	1795	3356	
1400	56 47.26	44 00.58	1820	3403	A/C to 070
1405	56 47.57	43 59.28	1845	3450	
1410	56 47.84	43 57.92	1865	3489	
1415	56 47.84	43 56.82	1885	3527	Begin deployment

Note: The Sounder Value was obtained from the winch room sounder, which was connected to a transducer on the ram. It was assumed that the sounding was based on a sound velocity of 800 fathoms/sec. This was then converted to a raw sounder value in metres based on a sound velocity of 1500 m/s by multiplying by 1.875 (1500/800). Six metres were added to account for the keel depth and two metres for the depth of the ram below the keel. The resulting raw depth was then corrected using Matthews Tables for area 12.

Sounding Survey - Sound Source South
Date: November 06, 1996

Time (z)	Latitude	Longitude	Sounder Value (fathoms)	Corrected Depth (metres)	Note
1230	54 57.65	48 37.65	2092	3922	
1235	54 57.71	48 37.86	2092	3922	
1240	54 57.83	48 38.13	2092	3921	
1245	54 57.95	48 38.48	2091	3920	
1250	54 58.20	48 38.95	2090	3919	
1255	54 58.37	48 39.26	2090	3918	
1300	54 58.63	48 39.71	2083	3904	
1305	54 58.90	48 40.14	2078	3895	
1310	54 59.10	48 40.50	2076	3892	
1315	54 59.31	48 40.87	2073	3885	
1320	54 59.47	48 41.17	2072	3884	
1325	54 59.73	48 41.58	2070	3880	
1230	54 59.95	48 41.92	2067	3874	
1335	55 00.15	48 42.35	2061	3862	
1340	55 00.48	48 43.96	2058	3857	
1345	55 00.77	48 43.33	2050	3842	beginturnto225
1350	55 00.40	48 43.96	2032	3807	
1355	54 59.88	48 44.56	2020	3785	begin turn to 135
1400	54 59.88	48 43.83	2022	3788	
1405	54 58.97	48 42.92	2026	3796	new mooring site
1410	54 58.47	48 42.08	2030	3803	
1415	54 58.04	48 41.37	2033	3809	
1420	54 57.71	48 40.75	2036	3816	
1425	54 57.40	48 40.31	2038	3820	
1430	54 57.18	48 39.87	2040	3823	
1435	54 56.91	48 39.44	2042	3827	
1829	54 58.92	48 43.22	2024	3792	anchor drop

Best estimated mooring positionLatitude: 54 58.78 Longitude: 48 43.04

Note: The Sounder Value was obtained from the winch room sounder, which was connected to a transducer on the ram. It was assumed that the sounding was based on a sound velocity of 800 fathoms/sec. This was then converted to a raw sounder value in metres based on a sound velocity of 1500 m/s by multiplying by 1.875 (1500/800). Six metres were added to account for the keel depth and two metres for the depth of the ram below the keel. The resulting raw depth was then corrected using Matthews Tables for area 12.

Sound Source West

Launch Date	21 October, 1996	Time	2257 UTC
Latitude	55^{o} 40.90 N	Longitude	53^{o} 29.63 W
Position Source	GPS	Deployed by:	John / Paul
Recorder	Mark Prater	Ship and Cruise No	Hudson 97009
Corrected Water Depth	2987 metres		
Anchor Position Latitude		55^{o} 40.660 N	
Anchor Position Longitude		53^{o} 28.9549 W	
1 cable to the west			
Argos Platform ID No.	23668 sub-buoy	Flasher ID No.	6436 sub-buoy

Acoustic Release Information

Release No.	246 Benthos	Tested to	1000 metres
Receiver No.		Release Command	D
Interrogate Freq.	10.0	Reply Freq.	12.0

3. CTD Profiler Mooring

Launch Date	21 October, 1996	Time	2257 UTC
Latitude	55^{o} 40.90 N	Longitude	53^{o} 29.63 W
Position Source	GPS	Deployed by:	John / Paul
Recorder	Mark Prater	Ship and Cruise No	Hudson 97009
Corrected Water Depth	2987 metres		
Anchor Position Latitude		55^{o} 40.660 N	
Anchor Position Longitude		53^{o} 28.9549 W	
1 cable to the west			
Argos Platform ID No.	23668 sub-buoy	Flasher ID No.	6436 sub-buoy

Acoustic Release Information

Release No.	246 Benthos	Tested to	1000 metres
Receiver No.		Release Command	D
Interrogate Freq.	10.0	Reply Freq.	12.0

Sounding Survey - CTD Profiler
Date: October 21, 1996

Time (z)	Latitude	Longitude	Sounder Value (fathoms)	Corrected Depth (metres)
1605	55 30.66	53 42.17	1521	2837
1610	55 31.40	53 42.54	1525	2844
1612	55 31.83	53 42.11	1534	2861
1615	55 32.29	53 41.76	1530	2853
1620	55 33.00	53 40.92	1539	2871
1625	55 33.79	53 40.08	1545	2881
1630	55 34.56	53 39.16	1545	2881
1635	55 35.32	53 38.36	1549	2889
1640	55 36.10	53 37.44	1559	2908
1645	55 36.85	53 36.52	1562	2914
1650	55 37.57	53 35.61	1570	2929
1655	55 38.34	53 34.77	1580	2949
1700	55 39.06	53 34.00	1584	2956
1705	55 39.82	53 33.19	1590	2967
1710	55 40.56	53 32.34	1598	2982
1715	55 41.25	53 31.50	1605	2995
1720	55 42.06	53 30.55	1612	3008
1725	55 42.79	53 29.73	1612	3009
1730	55 43.42	53 28.77	1620	3024
1735	55 43.12	53 27.16	1618	3020
1740	55 42.36	53 26.80	1616	3016
1745	55 41.40	53 27.49	1606	2997
1750	55 40.46	53 28.42	1596	2979
1755	55 39.61	53 29.31	1588	2964
2027	55 39.26	53 29.03	1582	2952
2103	55 40.38	53 29.61	1592	2971

Note: The Sounder Value was obtained from the winch room sounder, which was connected to a transducer on the ram. It was assumed that the sounding was based on a sound velocity of 800 fathoms/sec. This was then converted to a raw sounder value in metres based on a sound velocity of 1500 m/s by multiplying by 1.875 (1500/800). Six metres were added to account for the keel depth and two metres for the depth of the ram below the keel. The resulting raw depth was then corrected using Matthews Tables for area 12.

4. Meteorological Mooring

5. Tomography Mooring

6. Inverted Echo Sounders

A. Labrador Sea Deployment

Three Inverted Echo Sounders (IES) were deployed to serve as a water-column calorimeter along the western end of WOCE repeat section AR7W. These will join the IES set near the OWS Bravo location during 96006. The vertically integrated acoustic travel time, which the IES measures round-trip from the ocean bottom to the surface, determines the vertically integrated heat content (relative to one or more calibration CTDs during its moored measurement period). The instrument also measures the bottom pressure field.

Deployment details:

- 14-Jun-1995 06:22Z. Deployed IES076 at Location 16 (Station 27) along WOCE line.
- 57_ 22.65 N, 51_ 47.07 W (by GPS), depth(corr) 3463m.
- CTD= site#16, event#28. Down time: 08:02Z @ 57_23.08 N 51_46.42 W.
- RADIO/FLASHER # 25 @ 156.875MHz
- Backup timed release is 800d from final reset @ 18:00Z 13-Jun-1995
- = (better double check this) 21-Aug-1997.

IES is pinging exactly on the hour; we tracked it in beacon mode to the bottom. It hit bottom in 38-39 minutes, after the first few pings of sample. It couldn t have drifted more than 0.3NM or 0.5km.

I reconfirmed this position against what the bridge recorded (57_ 22.72 N 51_ 47.19 W), which coincided more exactly with the launch time. (Ours was 4 minutes after launch). They were still getting ready to take the calibration CTD while the IES sank, and didn t begin until a few minutes after the IES was on the bottom; so the time is coincident.

E. ACKNOWLEDGEMENTS

F. APPENDICES

Appendix 1: Along Track CTD Calibration Information

BSB SEABIRD Model 25-03 Serial Number 258917-0116

Temperature Sensor (031548)

$T = 1/\{a + b[\ln(f_o/f)] + c[\ln^2[f_o/f] + d[\ln^3(f_o/f)]\} - 273.15$

Where
ln indicates a natural logarithm,
f is the frequency
a = 3.68120903 E-03
b = 6.05726873 E-04
c = 1.57453931 E-05
d = 2.37605653 E-06
f_o = 6145.410
slope = 1, offset = 0(Seabird calibration dated November 2, 1993)

Conductivity Sensor (041124)

$\text{Conductivity} = (af^m + bf^2 + c + dt)/[10(1\text{-}9.57(10^{-8})p)]$

Where
f is the frequency,
p is pressure in dbars,
t is the temperature
m = 4.4
a = 7.91164000 E-06
b = 4.91698742 E-01
c = -4.03526125 E+00
d = 6.64743265 E-05
Slope = 1.00000000
Offset = 0.000

Irradiance Sensor (1567)

Where
m = -0.7558000
b = -3.4702000
Calibration Constant = 3.34000
Multiplier = 1.000

Fluorometer Sensor (304)

Where
Scale Factor = 10.000
Offset = 0.000

Appendix 2: 97009 CTD Temperature, Salinity, and Oxygen Calibration
(Igor Yashayaev)

1 Comparison of Upcast Discrete CTD Data

During the 97009 calibration process, a comparison of different versions of discrete CTD data at the time of bottle trip was conducted. Typically, BIO discrete CTD data are produced based on a three-second average of the raw 24 Hz data immediately following the bottle firing. Previously these discrete CTD data have not been subject to the processing (editing, filtering, temporal alignment of the temperature, conductivity and oxygen data channels or the conductivity thermal mass compensation effect) that has been applied to the profile data. The effects of neglecting this processing were investigated.

The procedure compared the standard processing *qat* CTD salinities from the CTD with what was termed *qup* files. The *qup* files contained values similar to the *qat* files, but with the downcast processing included. All processing steps other than the Seasoft loopedit were included in the *qup* processing. The *qup* processing also used a slightly different time window for computing the average parameter values.

The *qat* file used an average of three seconds of data immediately following the bottle trip. The *qup* file used upcast data that was averaged into 1-second bins. The scan at the time of bottle trip was then compared to the centre scan from the 1-second records. All centre scans within ±51 scans of the bottle trip scan were identified. If no records were identified in this interval, the interval was systematically increased by 50 scans until at least one record was found. All records in the interval were averaged (weighted equally) to obtain the *qup* value.

For the comparison, resulting salinities from sensors 9 and 10 were combined to form a larger dataset. Matched pair differences between the *qat* and *qup* files were determined and a *t*-test performed. Considering only points deeper than 180 dbar, and only differences within a range of ±0.01, the computed *t*-statistic was 0.74 with a p_value of 0.94, which indicated strong evidence of a zero difference between the *qat* and *qup* salinities.

In addition to this analysis, we compared the water sample salinities with the *qat* and *qup* salinities. Using a two-sample *t*-test, again omitting all points shallower than 180 dbar and all differences outside the ±0.01 range, we computed 95% confidence intervals of:

Difference	Lower 95%	Upper 95%
ws - *qat*9	-0.00556	0.00542
ws - *qat*10	-0.00554	0.00486
ws - *qup*9	-0.00522	0.00503
ws - *qup*10	-0.00578	0.00507

At the 95 percentile, the *qat* and water sample confidence interval encompassed zero, indicating at the 95% level, a zero difference. Figure 1 shows histograms of the water sample minus *qat* and *qup* differences. Considering only the statistical results, one would not proceed with further calibration. However, considering oceanographic and instrumentation details, further calibration will be applied.

2 CTD Temperature Calibration

Through cruise 97009 sensor set #09 was used as the primary system and #10 as the secondary system. During Seasoft processing, *Tpcor* was adjusted via the command line of DATCNV to reflect the *Tpcor* values indicated by Seabird in a memo dated 26 February 1997. The values were:

Sensor	*Tpcor*
2298	-2.06e-07
2303	-0.80e-07

Upon completion of the cruise, all CTD casts were reprocessed from the raw data files applying a linear correction to temperature. This correction was based on the March, 1997 laboratory calibrations of sensor sets #09 and #10 shown in Figures 2a,b. Black circles and black lines represent the March 1997 calibration.

The ***slope*** and ***offset*** coefficients (Table 1), used in *.con* files were obtained from linear regressions of T_{Bath}-T_{CTD} on T_{CTD}.

3 CTD Pressure Calibration

There were two CTD probes (each with a unique pressure sensor) used during 97009. There was no noticeable change in *water sample salinity* - *CTD* salinity differences with the change in pressure sensors. Unless both sensors had a similar bias, both probes seemed to have produced highly accurate pressure readings. No additional treatment was applied to the CTD pressure measurements.

4 CTD Salinity Calibration

CTD sensor set #09 was used as the primary system and set #10 was used as the secondary system throughout the 97009 cruise.

CTD salinities were calibrated in two stages. First, the slope and offset coefficients were determined from the laboratory calibrations of conductivity sensors and in-*situ* measurements. These coefficients were applied in the Seabird processing via the *.con* files. The second stage in the calibration determined what additional correction was needed for CTD salinities to account for pressure dependence and/or station-by-station drift. Prior to each stage a calibration data set was created.

4.0 Calibration Data Set

On both of the salinity calibration stages a special data set was created from the CTD data (*cpcor*, *slope* and *offset* coefficients were applied to the data prior to the second stage) and the water sample data. This data set was based on discrete CTD readings of temperature, pressure, salinity, etc.; averaged over three seconds at the depth and time of bottle tripping. Using the *qat* and *qup* files as the source, the *qat*—based and *qup*—based calibration files were created. The creation process for both files is outlined below:

- all *qat* and *qup* files were merged into *all_qat.dat* and *all_qup.dat*;
- *all_qat.dat* and *all_qup.dat* were merged with water sample salinity measurements into *all_qat&bot.dat* and *all_qup&bot.dat*; if needed, the set was subdivided into homogeneous fragments (unique CTD set#, sensor behavior) from *all_qat&bot.dat* and *all_qup&bot.dat* (for 97009, this was skipped);
- S_{Bottle} - S_{CTD} differences were analyzed versus station number, pressure, temperature and salinity in an attempt to justify exclusion of problematic data.

4.1 Determination of coefficients for conductivity correction applied in Seabird processing.

To determine calibration coefficients (slope and offset) for a conductivity sensor in a laboratory, a sufficient number of data points must be collected over a wide range of conductivity values. The March 1997 laboratory calibration data collected for the two sensors used during 97009 are shown in Figures 2c,d. The Bath-CTD differences were linearly regressed on CTD conductivity to calculate the laboratory coefficients (or laboratory slope and offset). The slope and offset regression coefficients can also be independently determined by comparing CTD conductivities with in-*situ* conductivities derived from water sample salinities (these coefficients are named in-*situ* slope and offset). To conduct this comparison the CTD data must be reprocessed with temperature corrections (see above) applied and the conductivity slope and offset assumed to be 1.0 and 0.0, respectively. The in-*situ* water sample conductivity was computed from water sample salinity and in-*situ* temperature (measured by CTD), thus providing a measurement comparable to the in-*situ* CTD conductivity.

To achieve the best results when calibrating CTD salinities, the samples must be taken within relatively homogeneous[1] layers. Since such samples collected during 97009 do not provide measurements that cover a wide enough range of conductivity[2] values, the laboratory slope was used as the best available estimate. The CTD data have been reprocessed with the assumptions that the slope of conductivity correction was the same as the laboratory slope and the offset was 0. The recomputed CTD conductivities were then compared with the in-*situ* water sample conductivities, which permitted the determination of a more accurate offset.

The ***Cpcor*** coefficient (exponential pressure correction) was varied to minimize the pressure dependent drift of CTD —water sample conductivity differences. The Cpcor and linear coefficients (***slope*** and ***offset***) for conductivity are given in Table 1. These coefficients were applied in the Seabird processing via the *.con* files.

4.2 Post-Seabird Processing of CTD Salinity

The corrections for the CTD salinities determined in this step were required because the Seabird software can only apply corrections to temperature and conductivity measurements that are expressed as exponential pressure dependence. Invariant slope and offset coefficients do not account for the existence of a time drift in the characteristics of a CTD sensor. The drift can be compensated by introducing variation to the offset coefficient or by applying a correction in the *Post-Seabird* stage. To find out what additional corrections were to be applied to the CTD salinities, the following steps were used:

Medians of $S_{Bottle} - S_{CTD}$ in pressure bins of 180 dbar were determined. These bins were centred at 100 dbar intervals between 300 and 3600 dbar (e.g. intervals were 210-390, 310-490, etc). Only medians supported by 7 or more measurements were used in the evaluation of the polynomial coefficients. By using the medians to determine the pressure dependent calibrations, we hoped to reduce the influence of outliers on the aspects of the salinity calibration.

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[1] Characterized by small vertical gradients

[2] If a cruise provides enough samples to cover a wide range of conductivity values, the in-*situ* slope is usually used instead of the slope estimated from the laboratory calibrations. During long cruises the in-*situ* coefficients may be subject to variation in time (i.e. *time drift)*, in which case the computations involve intermediate steps of estimation and subtraction of the *drift* and revaluation of the slope and offset. These operations are conducted in iterations similarly to 5.1.1*-5.1.6*. The *time drift* is presented as a series of medians determined from an *n*-point moving window of stations.

S_{Bottle} - S_{CTD} medians in the pressure bins were used to fit a polynomial function (Figure 3) on pressure. Persistence in the shape of the S_{Bottle} - S_{CTD} medians versus pressure dictated our choice of a 2^{nd} degree order polynomial function (in the case of a cruise with deeper stations a choice of a 3^{rd} degree polynomial function would probably provide a better fit). The resulting coefficients are presented in Table 3. The 2^{nd} degree polynomial was further justified by a general *F*-test comparing the 1^{st} and 2^{nd} degree fits. The results of the test for conductivity sensor #10, using data in the 300 to 3600 dbar interval, were an *F*-statistic of 271.3 and *p*-value of 0. Note that the results from the F-test for the 1^{st} degree fit for sensor #10 were an *F*-statistic of 0.1 and *P*-value of 0.71, i.e. not a good fit. The statistical results comparing the 1^{st} and 2^{nd} degree fits for sensor#9 were less obvious numerically but Figure 3 indicated an obvious 2^{nd} order fit was required. Figure 4 shows the salinity difference plots after the pressure dependent signals have been removed.

The station medians of S_{Bottle} - S_{CTD} were calculated, using the data deeper than 300 dbar. The station-to-station progression of such medians is presented in Figure 5a (1-2). These values were computed by performing iterative re-evaluations of a *time drift* and the 2*nd* degree pressure-dependent polynomial correction. This procedure is similar to that described further in sections 5.2.1-5.2.7. The *time drift* corresponds to the station medians of the S_{Bottle} - S_{CTD} differences deeper than 300 dbar. Each median was calculated from at least 6 values of S_{Bottle} - S_{CTD}. If the number of measurements on a station was insufficient to meet this criterion, the neighboring stations were also involved in the computation of a median.

Both CTD systems showed a significant station-to-station variation in the S_{Bottle} - S_{CTD} station medians. The overall tendency for system #9 was about 0.001 psu, whereas it was 0.002 psu for system #10. In addition to this, the S_{Bottle} - S_{CTD} differences for both systems showed similar patterns for groups of stations. The medians between station 45 and 50 were the lowest. Stations 50 to 70 showed a rapid increase of the differences, which resulted in the highest overall median values. Between stations 71 and 81 the medians decreased by 0.001 for system #9 and 0.0005 for system #10.

Close to the end of the cruise we collected additional replicates of salinity samples (8-10 for each station). These were then divided into two groups, which were analyzed at different times. The purpose of this experiment was to see if the water sample salinity measurements changed over time[3]. That is, one group of samples was analyzed in the routine order (within 24 hours after collection), but the other groups of samples were not analyzed until after a few days or weeks had passed. If differences existed between the regular

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[3] This experiment was also aimed to determine the cause of the station-to-station drift of the S_{Bottle} - S_{CTD} differences. The time variation of the sample salinity measurements would result in a change of the S_{Bottle} - S_{CTD} differences between the groups

(measured at the usual time after water collection) conductivity values and those measured at a later time, the differences should show up in the analysis. From the start of this experiment there was no significant station-to-station change seen in the S_{Bottle} - S_{CTD} differences. No systematic differences were evident. Since there was no obvious reason for water sample salinity to change at the mentioned rates we can hardly base an explanation of the *time drift* in Figure 5a on a drift in the water sample salinities. It is proposed that in the future if this experiment is done throughout the entire cruise, it will greatly aid in identifying whether the water sample or CTD data are responsible for any apparent drift in the S_{Bottle} - S_{CTD} differences.

For most of the cruise, the CTD sensors were not properly soaked between stations. This could have led to the accumulation of residual material in both sensors conductivity cell. On the long steams when the systems were flushed the cells could have been partially or completely cleaned. The volume and characteristics of each cell would have responded accordingly to its cleanliness. This served as a motivation to attribute most of the station-to-station change in the S_{Bottle} - S_{CTD} differences to the *time drift* in the CTD salinities. To compensate this *time drift*, a special correction was constructed and added to 97009 CTD salinities.

On the other hand, the difference between primary and secondary salinities changed between stations 20 and 120 by about 0.0015 psu (Figure 5a (3-4), Figure 6).

Since the station medians were supported by a relatively small number of measurements, they could experience some noise originated from the CTD readings and the water sample measurements. Consistency in the *drifts* of S_{Bottle} - S_{CTD1} and S_{Bottle} - S_{CTD2} medians (Figure 5a, (1-2), Figure 6) suggested that there was a common cause in these signals. To determine the corresponding component a unified station-to-station correction was computed on consolidated data (primary joined with adjusted secondary). This station-to-station correction was thereafter added to the 97009 primary CTD salinities. The correction for the 97009 secondary CTD salinities in addition to the common correction had a component accounting for *inter-sensor time drift* (linear on station number). The following outlines the procedure of determination of time (station) dependent correction suggested for the 97009 CTD salinities:

- The differences between the station medians of primary and secondary CTD salinity (S_{CTD2} - S_{CTD1}, (3) in Figure 5a) were computed and linearly regressed on station number ($L_{SCTD2-SCTD1}$*(St#)*, (4) in Figure 5a).
- The S_{Bottle} - S_{CTD2} medians ((2) in Figure 5a) were corrected for $L_{SCTD2-SCTD1}$*(St#)* ((4)). This made the *time drift* in the adjusted S_{Bottle} - S_{CTD2} series ((5)) consistent with the *time drift* in S_{Bottle} - S_{CTD1} ((1)).

- The S_{Bottle} - S_{CTD1} and adjusted S_{Bottle} - S_{CTD2} medians were merged into a single dataset ((5) combined with (1a) in Figure 5a).
- The merged inter-system data set ((5)+(1a) in Figure 5a) was subdivided into fragments where the station medians were monotonous. This grouping resulted in seven fragments, which included the stations: 21-41, 45-53, 66-71, 80-91, 95-114, 117-118 and 120-126 ((6) in Figure 5a). Each fragment was processed as follows: a median of all inter-system medians in the fragment was computed and assigned to each station within the fragment as a correction for the *time drift*. The corrections for the stations between the fragments were computed by linear interpolation (using medians from the fragments closest on either side) and outside the fragments by extrapolation (for stations before 21 the 21-41 correction was used; for stations after 126 the 120-126 correction was used). The combined result was a unified station-to-station correction ((7) in Figure 5a).

- The unified station-to-station correction ((7) in Figure 5a,b) was applied to the primary salinity. In addition to the unified correction, the secondary salinity was also corrected for the *intersystem time drift*: $L_{SCTD2\text{-}SCTD1}(St\#) = 0.0000126 * St\# - 0.00132$, where *St#* - station number. The *intersystem time drift* ((9) in Figure 5b) was computed as a linear regression of the difference ((8)) between the S_{Bottle} - S_{CTD2} medians ((2)) and the unified correction ((7)) on the station number. The overall time correction for the secondary salinities is a sum of the unified and *intersystem* corrections ((10)).

- The station-to-station correction is summarized in Tables 4-5.

5 CTD Oxygen Calibration

Generally, calibration of CTD oxygen data involves two steps. In the first step non-linear *hardware* coefficients are computed and applied to the data in the Seabird processing via the *.con* files. The second step addresses an additional (secondary) correction that is applied to the oxygen concentrations derived in the Seabird processing. The second step is dictated by time drift in the sensors characteristics and effects of pressure, temperature and oxygen unaccounted for in Seabird processing.

The calibration parameters for the CTD oxygen data were based on down trace CTD data and measurements of water sample oxygen concentration from bottles tripped on the up trace. Though these datasets are inconsistent (to some degree) in time and spatial location, they were considered the only reliable source of information for calibration of CTD oxygen.

5.0 Calibration data set

On both stages of processing a calibration data set is created from the CTD data and the water sample data. The *calibration data file (set)* is used for finding and testing calibrations (coefficients in 5.1) later applied to the CTD data via the *.con* files or in the secondary correction (5.2). This file is based on discrete CTD temperature, pressure, salinity, etc.; averaged over three seconds at the depth and time of bottle tripping and is created as outlined below:
Since the oxygen sensors installed on the CTD package work more reliably on the down trace part of a CTD cast, all oxygen calibrations were based on down traces. Therefore, the down trace measurements were matched with the data from the *calibration file* in an attempt to locate a point or a group of points representative of a water type at the depth and time of bottle tripping. The match search was performed for each record of the *calibration file* and was designed as follows:

The data from a down trace profile were restricted to a certain pressure (or/and) density (or/and) temperature (or/and) salinity in the vicinity of the values in the *calibration file*. Typical criteria (definition of vicinity): differences between up trace and down trace pressure 25 dbar, potential temperature 0.5K, salinity 0.02; This defines a *group* .

Search the *group* for the point(s), which are (proved to be) *closest* to the bottle trip point (from the *calibration file*). If more than one point was found, the points were averaged. The measure of *closeness* was a distance, defined in multidimensional space, where dimensions are normalized (weighted or rescaled) pressure, potential temperature, salinity and density. Normalization for each axis was done according to expected variability within a water type. In ultimate cases only one or two dimensions were chosen. The found point was identified as a match to the up trace CTD data point at the time of bottle trip and its properties were added to the *calibration file*.

Water sample (*ws*) salinity and oxygen concentration determined onboard were added to the *calibration file*.

For initial indirect check of quality, the differences between water sample and calibrated CTD salinity were computed. If the absolute difference exceeded 0.004 the point (record) containing this data was considered unreliable and discarded from further analysis.

Next the data set was split into sets based on distinct changes in the sensors behavior. The set represented quasi-steady periods of oxygen sensor behavior. This avoided extreme temporal drifts in any of the sets and allowed the use of the same non-linear coefficients for each set .

Determination of Hardware Coefficients

A nonlinear multiparametric least square or least median absolute deviation technique was used to determine the oxygen sensor processing coefficients (*soc, boc, tcor,* and *pcor*) using $oxygen_{ws}$ vs. downcast $temperature_{ctd}$, $salinity_{ctd}$, $pressure_{ctd}$, $oxygen\ current_{ctd}$ and $oxygen\ temperature_{ctd}$ (where the *ws*/*ctd* subscripts represents water sample/CTD data).

Applying the results of step 5.1.1, the $oxygen_{ctd}$ was derived.

Computation of the difference $oxygen_{ws} - oxygen_{ctd}$. Statistics of the difference were computed and the records that produced outliers (whether caused by $oxygen_{ws}$ or $oxygen_{ctd}$) were marked or deleted from the *calibration file*. Repeat 5.1.1 - 5.1.2 until all obvious outliers are deleted from the data.

Checking the $oxygen_{ws} - oxygen_{ctd}$ ***distributions:***

if the differences ($oxygen_{ws} - oxygen_{ctd}$) are randomly distributed versus all parameters (temperature, pressure, oxygen current, and oxygen temperature) and there are no evident outliers, proceed to stage described in 5.2,otherwise, using the *calibration file* cleaned according to 5.1.3, repeat all the steps of stage 5.1 until the first part of the check 5.1.4 is satisfied (typically, 10 to 15 iterations are required to clean the *calibration file* and determine the oxygen sensor processing coefficients *soc, boc, tcor,* and *pcor*).

In the case of notable time drift the scheme 5.1.1 - 5.1.4 is transformed to the following (for simplicity assume that all records producing outliers in $oxygen_{ws} - oxygen_{ctd}$ differences were removed):

- Search for the best values of *soc, boc, tcor,* and *pcor*, using least square or least median absolute deviation technique (similar to 5.1.1).
- Applying the results of step 5.1.1* (*on the first pass*) or 5.1.5* (*subsequent iteration*), the $oxygen_{ctd}$ was derived.
- Computation of the difference $oxygen_{ws} - oxygen_{ctd}$. Determination of medians of $oxygen_{ws} - oxygen_{ctd}$ from a moving window. The window size is expressed either in a number of stations or in a number of samples. In both cases the search of $oxygen_{ws} - oxygen_{ctd}$ is conducted in a window of stations. In the last case the search starts with one station and continues by adding one station to either side of the window, until the total number of samples in the window is equal or greater than the required number of samples.
  Hereafter, the $oxygen_{ws} - oxygen_{ctd}$ medians are named $med_{ws\text{-}ctd}$.
- Adding $med_{ws\text{-}ctd}$ to $oxygen_{ws}$ forms $oxygen_{ws\#}$ with a time drift similar to that in $oxygen_{ctd}$.
- Analogous to 5.1.1* (search for the best values of *soc, boc, tcor,* and *pcor* via least square or least median absolute deviation technique), except $oxygen_{ws\#}$, is used instead of $oxygen_{ws}$.
- Checking the $oxygen_{ws\#} - oxygen_{ctd}$ distributions:
- if the differences ($oxygen_{ws\#} - oxygen_{ctd}$) are randomly distributed versus the variables used in regression (temperature, pressure, oxygen current, and

oxygen temperature) and the variance of the differences (or median absolute deviation) is not getting smaller with any subsequent iteration, proceed to the next stage of the calibration process (section 5.2),

- otherwise, repeat all instructions from 5.1.1* to 5.1.5* until the first part of 5.1.6* is satisfied. The number of sufficient iterations varies depending on the method (least square or least median absolute deviation), noise to *time drift* ratio, etc.

5.2 *Computing corrections of time drift and residual effects of pressure, temperature and oxygen*

After the coefficients *soc, boc, tcor,* and *pcor* have been updated and the *.con* files and the CTD data have been reprocessed, the *calibration file* is reconstructed. However, instead of computation of CTD oxygen from downcast parameters (as in section 5.1) all corrections found on this stage are applied directly to the oxygen values (ml/l) derived in the Seabird processing (ignored on stage 5.1).

Compute the differences $oxygen_{ws}$ - $oxygen_{ctd}$.

Using the differences from 5.2.1 (*in the first iteration on this stage*) or 5.2.5 (*in any subsequent iteration*), compute the median $oxygen_{ws}$ - $oxygen_{ctd}$ for each station. The series of station-by-station medians represents the *time drift* of the sensor.

- Subtract the individual station median (*time drift*, 5.2.2) from the differences $oxygen_{ws}$ - $oxygen_{ctd}$ for that station, which must be taken from 5.2.1.
- For each set of stations (as defined in 5.0.4) compute a polynomial fit of the residuals from 5.2.3 on pressure, temperature and oxygen.
- Subtract the polynomial correction, derived in 5.2.4, from the differences computed in 5.2.1 (before subtraction of the *time drift*). Check for the outliers, remove or flag if there are any.
- Subtract the *time drift* (station median) from the results of 5.2.5.
- If these (*new* 5.2.6) residuals don t depend on pressure, temperature, oxygen or time and their statistics are not improving with any subsequent iteration (in other words, the distributions are not getting tighter) advance to 5.2.7.
- Otherwise, use the results of step 5.2.5 and repeat all the steps of stage 5.2 until the first bulleted condition of 5.2.6 is satisfied. The search of the best CTD oxygen corrections (on time, pressure, etc.) typically requires 7 to 15 repetitions.
- Finalize calibration coefficients.

5.3 *Application of 5.0 - 5.2 to 97009 CTD oxygen data*

The CTD Set #09 was used as a primary and #10 as a secondary system through the 97009 cruise. Oxygen measurements from the primary CTD set were available through the whole cruise, whereas the secondary oxygen was successfully recorded only starting from the station #80 (due to failure of the first installation of the oxygen sensor on the secondary system).

The first step of calibration of the CTD oxygen data was based on the adjustment of the *soc, boc, tcor,* and *pcor* coefficients as described in 5.1. This was done by iterative reevaluations of these coefficients and *time drift* in the CTD oxygen.

The optimal *soc, boc, tcor,* and *pcor* coefficients are given in Table 2. These coefficients were entered into the corresponding *.con* files used in the reprocessing of the CTD data. The differences between the water sample and CTD oxygen values after the CTD data reprocessing are presented in Figures 7 and 8. Below 500 dbar the distribution of the differences is relatively uniform on pressure. Examination of the station-by-station evolution of the water sample *vs.* CTD oxygen differences (Figure 8) revealed their persistent station-to-station variation. The time drift in the oxygen current readings evidently caused this signal. The time drift identified in both primary and secondary CTD oxygen is shown as a solid line in Figure 8. Removal of the drift from the CTD oxygen[4] reduced the variance of the differences between the water sample and CTD oxygen values. There is no noticeable residual pressure and temperature dependence of the differences. Therefore, the second step of CTD oxygen calibration (described in 5.2) resulted in a simple station-by-station correction of the CTD oxygen. The corresponding values that were added to the CTD oxygen on each station are summarized in Table 5.

The water sample oxygen, shown in Figure 9a, shows considerable noise to signal ratio. However, there does appear to be a fluctuation at ~1000 dbar. The CTD oxygen, Figure 9b,c, does show the general features of the water sample data, including the noted fluctuation at ~1000 dbar that was evident in the water samples.

6 Summary

Usage of the same sets of temperature and conductivity sensors in all Labrador Sea cruises starting from 1997 allowed us to track a similar pattern in behavior of the sensors from cruise to cruise. In the case of insufficient information, such knowledge can provide a framework for a limited data set, providing a better solution for the calibration problem.

7 Acknowledgements

A hard work and help of my friends and colleagues from BIO, involved in the acquisition and verification of deep ocean data granted that the strategy of the CTD data processing and quality control outlined in this document has some rational grains in it. Allyn Clarke coordinated and supervised laboratory calibrations, cruise preparations and operations. Anthony Isenor is responsible

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[4] The time drift was greater in the primary CTD oxygen.

for the data management. He also generously helped me to edit this document and to conduct statistical testing of some results. Jeff Jackson made a number of useful comments on the text. Rick Boyce repeatedly and most accurately performs the laboratory calibrations and helps in conducting experiments aimed to provide better measurements of water sample salinities.

Table 1. Offset, slope and pressure coefficients for temperature and conductivity

CTD Set	Sensor	PCOR	Offset	Slope
09 (primary)	Temperature	-2.06e-7	0.0	0.99998
	Conductivity	-1.0e-7	-0.00005	1.000115
10 (secondary)	Temperature	-0.8e-7	-0.0005	1.0
	Conductivity	-1.0e-7	0.00011	1.000113

Table 2. Temperature, conductivity and oxygen coefficients used in *.con* files

Temperature Primary	
Tpcor: -2.060E-7	As recommended by Seabird (note of Feb. 26, 1997)
Slope: 0.99998 Offset: 0.0	Based on regressions using lab. temperature (March, 1997) and conductivity calibrations (March, 1997)
Temperature Secondary	
Tpcor: -0.800E-7	As recommended by Seabird (note of Feb. 26, 1997)
Slope: 1.0 Offset: -0.0005	Based on regressions using lab. temperature (March, 1997) and conductivity calibrations (March, 1997)
Conductivity Primary	
Cpcor: -1.00000E-007	The limit of Seasoft *Cpcor*'s *(I would use -1.1)* to account for pressure influence on conductivity
Slope: 1.000115	Based on regressions using lab. conductivity calibrations (March, 1997)
Offset: -0.00005	As revealed by fitting of CTD conductivities against those derived from the Bottle data (97009)
Conductivity Secondary	
Cpcor: -1.00000E-007	The limit of Seasoft *Cpcor*'s *(I would use -1.1)* to account for pressure influence on conductivity
Slope: 1.000113	Based on regressions using lab. conductivity calibrations (March, 1997)
Offset: 0.00011	As revealed by fitting of CTD conductivities against those derived from the Bottle data (97009)
Oxygen Primary	
SOC: 3.2020 BOC: -0.0080 TCOR: -0.0360 PCOR: 1.390E-004	All oxygen coefficients are based on fitting the CTD oxygen values to those from the water samples
Oxygen Secondary	
SOC: 2.8330 BOC: 0.0480 TCOR: -0.0410 PCOR: 1.270E-004	All oxygen coefficients are based on fitting the CTD oxygen values to those from the water samples

Table 3. Coefficients for pressure polynomial for salinity correction

CTD Set	Degree of polynomial term		
	0	1	2
09 (primary)	-0.00125	1.2168E-006	-2.459E-010
10 (secondary)	-0.00050	6.0973E-007	-1.606E-010

Table 4. Inflection points for the station based correction of CTD salinity

Station	CTD System		
	Primary	+	Secondary
21	-0.00048	-0.00106	-0.00154
41	-0.00048	-0.00080	-0.00128
45	-0.00093	-0.00075	-0.00168
53	-0.00093	-0.00065	-0.00158
66	0.0012	-0.00049	0.00071
71	0.0012	-0.00043	0.00077
80	0.00037	-0.00031	0.00006
91	0.00037	-0.00017	0.00019
95	0.0006	-0.00012	0.00047
114	0.0006	0.00012	0.00071
117	0.00047	0.00015	0.00062
118	0.00047	0.00017	0.00063
120	0.00022	0.00019	0.00041
126	0.00022	0.00027	0.00048

Table 4a. Station-by-station correction of CTD salinity

Station	Primary Correction	Secondary Correction
1	-0.00048	-0.00179
2	-0.00048	-0.00178
3	-0.00048	-0.00176
4	-0.00048	-0.00175
5	-0.00048	-0.00174
6	-0.00048	-0.00173
7	-0.00048	-0.00171
8	-0.00048	-0.00170
9	-0.00048	-0.00169
10	-0.00048	-0.00168
11	-0.00048	-0.00166
12	-0.00048	-0.00165
13	-0.00048	-0.00164
14	-0.00048	-0.00163
15	-0.00048	-0.00161
16	-0.00048	-0.00160
17	-0.00048	-0.00159
18	-0.00048	-0.00158
19	-0.00048	-0.00156
20	-0.00048	-0.00155
21	-0.00048	-0.00154
22	-0.00048	-0.00153
23	-0.00048	-0.00151
24	-0.00048	-0.00150
25	-0.00048	-0.00149
26	-0.00048	-0.00147
27	-0.00048	-0.00146
28	-0.00048	-0.00145
29	-0.00048	-0.00144
30	-0.00048	-0.00142
31	-0.00048	-0.00141
32	-0.00048	-0.00140
33	-0.00048	-0.00139
34	-0.00048	-0.00137
35	-0.00048	-0.00136
36	-0.00048	-0.00135
37	-0.00048	-0.00134
38	-0.00048	-0.00132
39	-0.00048	-0.00131
40	-0.00048	-0.00130
41	-0.00048	-0.00129
42	-0.00059	-0.00139
43	-0.000705	-0.00149
44	-0.00082	-0.00159
45	-0.00093	-0.00169
46	-0.00093	-0.00167
47	-0.00093	-0.00166
48	-0.00093	-0.00165
49	-0.00093	-0.00164
50	-0.00093	-0.00162
51	-0.00093	-0.00161
52	-0.00093	-0.00160
53	-0.00093	-0.00158
54	-0.00077	-0.00141
55	-0.00060	-0.00123
56	-0.00044	-0.00106
57	-0.00028	-0.00088
58	-0.00011	-0.00070
59	0.00005	-0.00053
60	0.00022	-0.00035
61	0.00038	-0.00017
62	0.00054	0.00000
63	0.00071	0.00018
64	0.00087	0.00036
65	0.00104	0.00053
66	0.0012	0.00071
67	0.0012	0.00072
68	0.0012	0.00073
69	0.0012	0.00075
70	0.0012	0.00076
71	0.0012	0.00077
72	0.00111	0.00069
73	0.00102	0.00061
74	0.00092	0.00053
75	0.00083	0.00045
76	0.00074	0.00037
77	0.00065	0.00029
78	0.00055	0.00021
79	0.00046	0.00013
80	0.00037	0.00006
81	0.00037	0.00007
82	0.00037	0.00008
83	0.00037	0.00009
84	0.00037	0.00011
85	0.00037	0.00012
86	0.00037	0.00013
87	0.00037	0.00014
88	0.00037	0.00016
89	0.00037	0.00017
90	0.00037	0.00018
91	0.00037	0.00019
92	0.00043	0.00026
93	0.00049	0.00033
94	0.00054	0.00040
95	0.0006	0.00047
96	0.0006	0.00049
97	0.0006	0.00050
98	0.0006	0.00051
99	0.0006	0.00052
100	0.0006	0.00054
101	0.0006	0.00055
102	0.0006	0.00056
103	0.0006	0.00057
104	0.0006	0.00059
105	0.0006	0.00060
106	0.0006	0.00061
107	0.0006	0.00063
108	0.0006	0.00064
109	0.0006	0.00065
110	0.0006	0.00066
111	0.0006	0.00068
112	0.0006	0.00069
113	0.0006	0.00070
114	0.0006	0.00071
115	0.00056	0.00068
116	0.00051	0.00065
117	0.00047	0.00062
118	0.00047	0.00063
119	0.00034	0.00052
120	0.00022	0.00041
121	0.00022	0.00042
122	0.00022	0.00043
123	0.00022	0.00045
124	0.00022	0.00046
125	0.00022	0.00047
126	0.00022	0.00048

Table 5. Station-by-station correction of CTD oxygen

Station	Primary Correction	Secondary Correction
4	0.14656	
5	0.14656	
6	0.08893	
7	0.14656	
8	0.14656	
9	0.14656	
10	0.08893	
11	0.08893	
12	0.37909	
13	0.38709	
14	0.38709	
15	0.63614	
16	0.91223	
17	1.16680	
18	1.67354	
19	1.86041	
20	1.09925	
21	0.92633	
22	0.00053	
23	-0.14928	
24	-0.33287	
25	-0.22102	
26	-0.27352	
27	-0.07800	
28	-0.18329	
29	-0.22311	
30	-0.23491	
31	-0.34488	
32	-0.32606	
33	-0.16202	
34	-0.19000	
35	-0.23961	
36	-0.27330	
37	-0.23203	
38	-0.28577	
39	-0.27323	
40	-0.24855	
41	-0.39190	
42	-0.38128	
43	-0.33115	
44	-0.30455	
45	-0.29813	
46	-0.38940	
47	-0.32237	
48	-0.16451	
49	-0.27895	
50	-0.32778	

Station	Primary Correction	Secondary Correction
51	-0.17744	
52	-0.22333	
53	-0.18131	
54	-0.13614	
55	-0.19250	
56	-0.19250	
57	-0.19250	
58	-0.28092	
59	-0.28092	
60	-0.28092	
61	-0.13790	
62	-0.13790	
63	-0.13790	
64	-0.22951	
65	-0.22951	
66	-0.22951	
67	-0.13382	
68	-0.13632	
69	-0.20198	
70	-0.06792	
71	-0.05891	
72	-0.07746	
73	-0.19449	
74	-0.21932	
75	-0.21932	
76	-0.21932	
77	-0.02738	
78	-0.01576	
79	-0.01576	
80	-0.01576	-0.16065
81	-0.07211	-0.03772
82	-0.12580	0.00036
83	-0.07979	-0.12234
84	0.12664	-0.08355
85	0.06170	-0.19972
86	0.05089	-0.16053
87	-0.00139	-0.10376
88	-0.02363	-0.10122
89	-0.02449	-0.07486
90	0.09417	-0.04149
91	0.03667	-0.01307
92	0.10144	0.00040
93	0.09230	-0.01139
94	0.03601	0.01147
95	0.01571	0.00721
96	-0.06298	-0.00932
97	0.18420	0.01003

Station	Primary Correction	Secondary Correction
98	0.15833	0.07562
99	0.15391	0.07319
100	0.16167	0.04023
101	0.23833	0.00496
102	0.18487	-0.06575
103	0.20528	-0.01895
104	0.22359	0.00328
105	0.22359	0.04992
106	0.35498	0.08364
107	0.43669	0.12467
108	0.43669	0.12981
109	0.21928	-0.01272
110	0.27262	0.01300
111	0.35636	0.04261
112	0.34090	0.03297
113	0.33597	0.02476
114	0.46924	0.08885
115	0.44528	0.08163
116	0.40725	0.05971
117	0.43984	0.08439
118	0.47175	0.07383
119	0.44866	0.07237
120	0.50829	0.10281
121	0.46205	0.05662
122	0.48253	0.07003
123	0.45970	0.06838
124	0.54977	0.09142
125	0.57681	0.10992
126	0.59439	0.07903
127	0.57958	0.04703
128	0.55214	-0.04207
129	0.55214	-0.04207

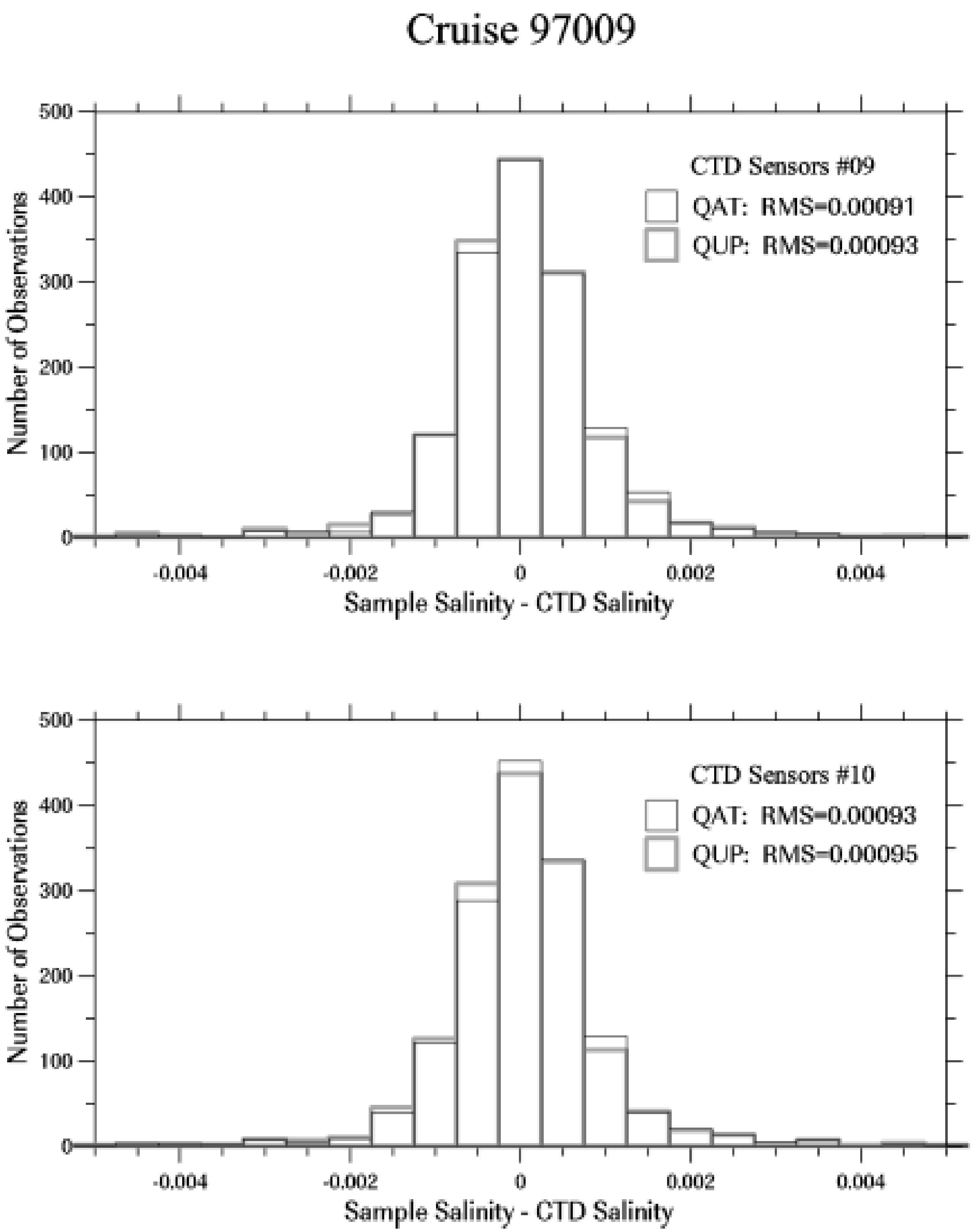

Figure 1. Historgram of water sample and *qat (qup)* differences

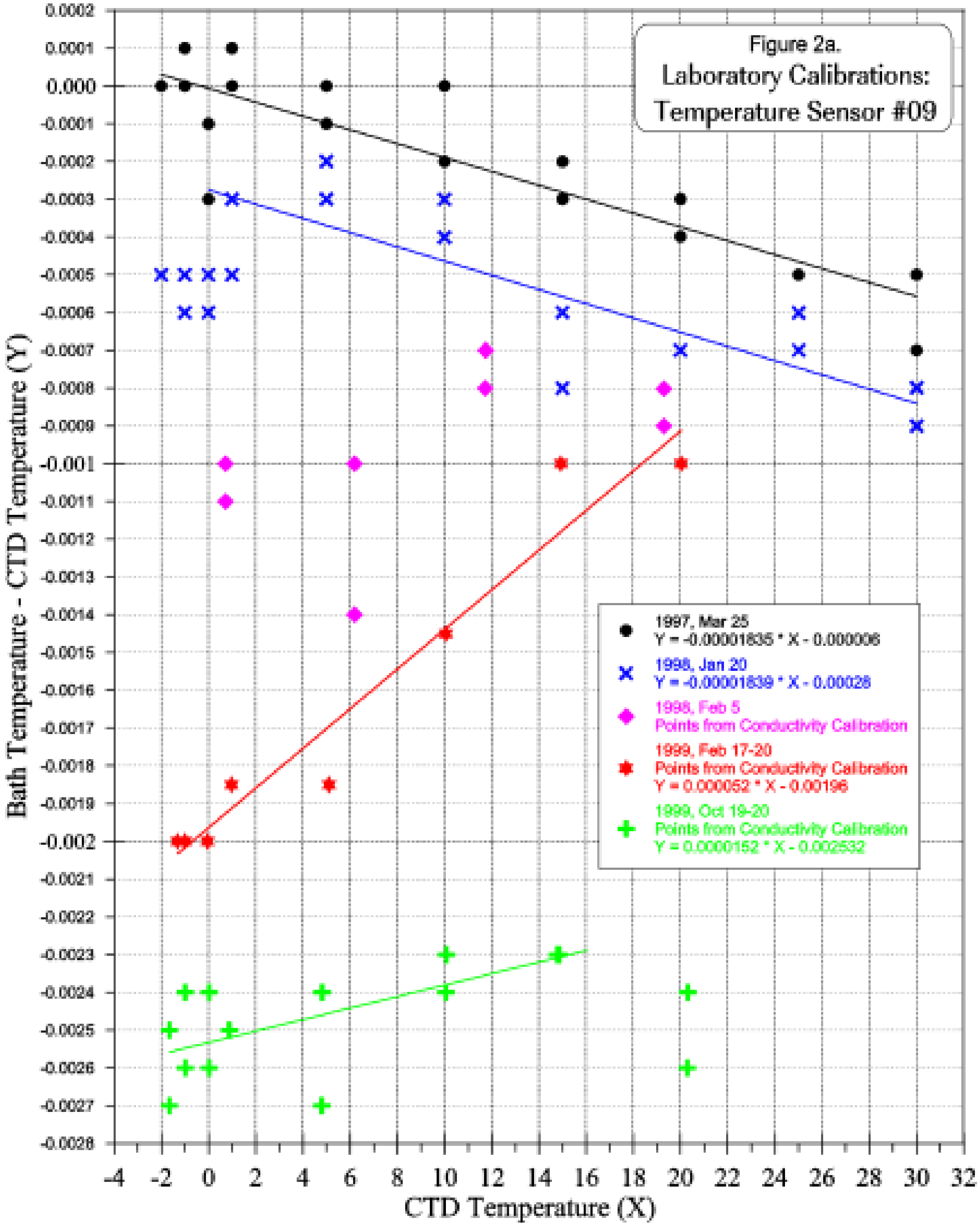

Figure 2a.
Laboratory Calibrations:
Temperature Sensor #09
1997, Mar 25
Y = -0.00001835 * X - 0.000006
1998, Jan 20
Y = -0.00001839 * X - 0.00028
1998, Feb 5
Points from Conductivity Calibration
1999, Feb 17-20
Points from Conductivity Calibration
Y = 0.000052 * X - 0.00196
1999, Oct 19-20
Points from Conductivity Calibration
Y = 0.0000152 * X - 0.002532
Bath Temperature - CTD Temperature (Y)
CTD Temperature (X)
0.0002
0.0001
0.000
-0.0001
-0.0002
-0.0003
-0.0004
-0.0005
-0.0006
-0.0007
-0.0008
-0.0009
-0.001
-0.0011
-0.0012
-0.0013
-0.0014
-0.0015
-0.0016
-0.0017
-0.0018
-0.0019
-0.002
-0.0021
-0.0022
-0.0023
-0.0024
-0.0025
-0.0026
-0.0027
-0.0028
-4
-2
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32

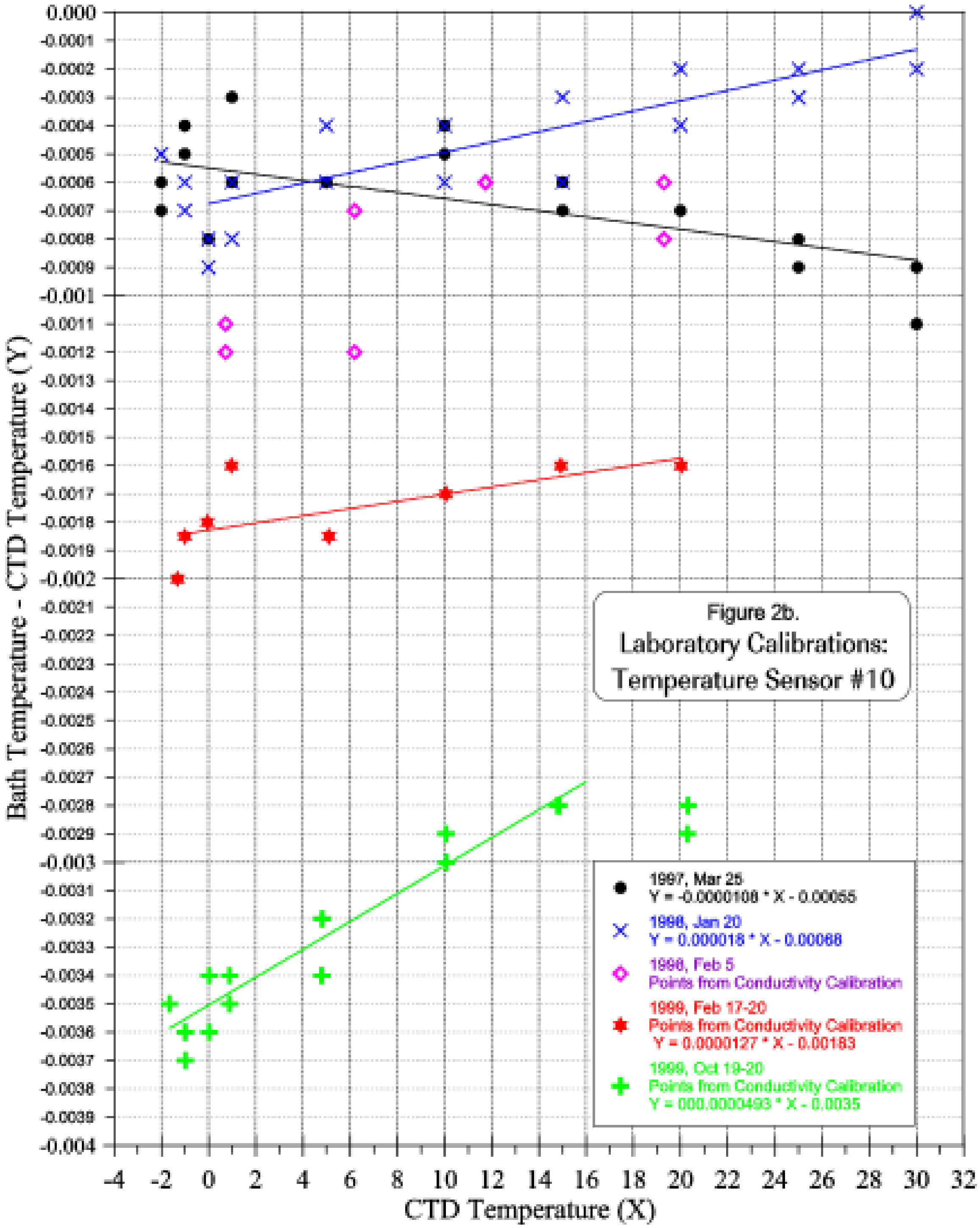
Figure 2b.
Laboratory Calibrations:
Temperature Sensor #10
1997, Mar 25
Y = -0.0000108 * X - 0.00055
1998, Jan 20
Y = 0.000018 * X - 0.00068
1998, Feb 5
Points from Conductivity Calibration
1999, Feb 17-20
Points from Conductivity Calibration
Y = 0.0000127 * X - 0.00183
1999, Oct 19-20
Points from Conductivity Calibration
Y = 000.0000493 * X - 0.0035
Bath Temperature - CTD Temperature (Y)
CTD Temperature (X)

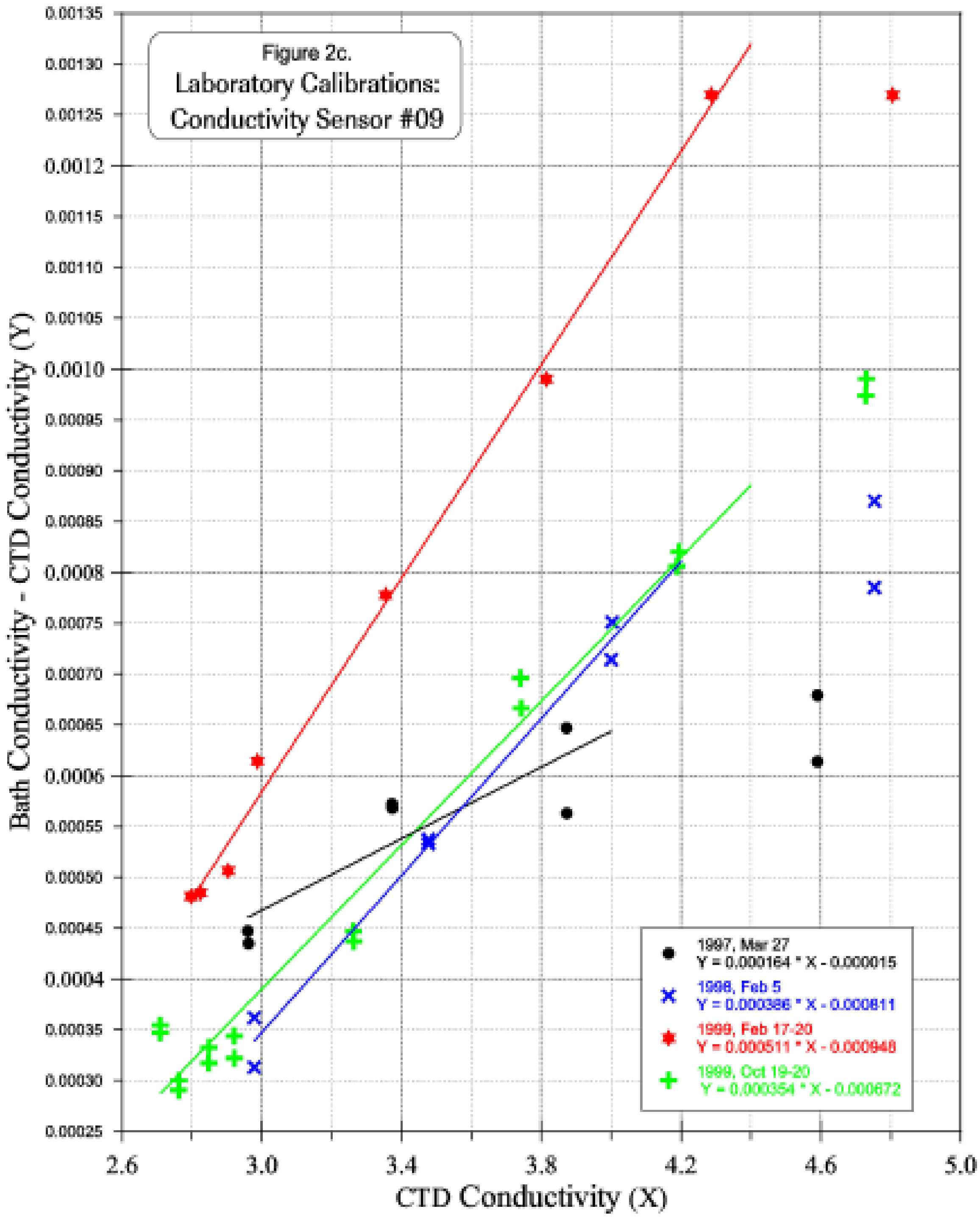

Figure 2c.
Laboratory Calibrations:
Conductivity Sensor #09
Bath Conductivity - CTD Conductivity (Y)
CTD Conductivity (X)
1997, Mar 27
Y = 0.000164 * X - 0.000015
1998, Feb 5
Y = 0.000386 * X - 0.000811
1999, Feb 17-20
Y = 0.000511 * X - 0.000948
1999, Oct 19-20
Y = 0.000354 * X - 0.000672

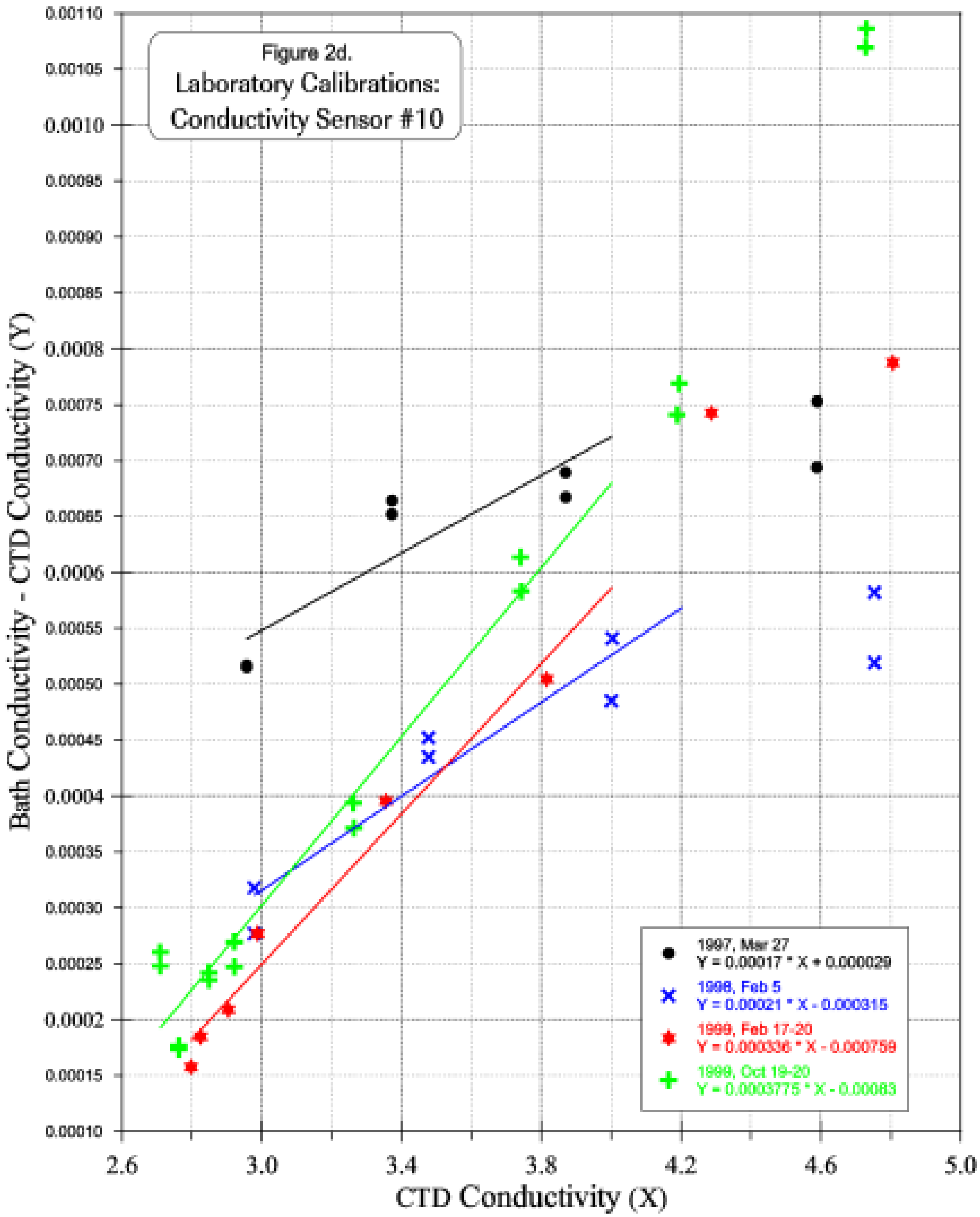

Figure 2d.
Laboratory Calibrations:
Conductivity Sensor #10
Bath Conductivity - CTD Conductivity (Y)
CTD Conductivity (X)
0.00110
0.00105
0.0010
0.00095
0.00090
0.00085
0.0008
0.00075
0.00070
0.00065
0.0006
0.00055
0.00050
0.00045
0.0004
0.00035
0.00030
0.00025
0.0002
0.00015
0.00010
2.6
3.0
3.4
3.8
4.2
4.6
5.0
1997, Mar 27
Y = 0.00017 * X + 0.000029
1998, Feb 5
Y = 0.00021 * X - 0.000315
1999, Feb 17-20
Y = 0.000336 * X - 0.000759
1999, Oct 19-20
Y = 0.0003775 * X - 0.00083

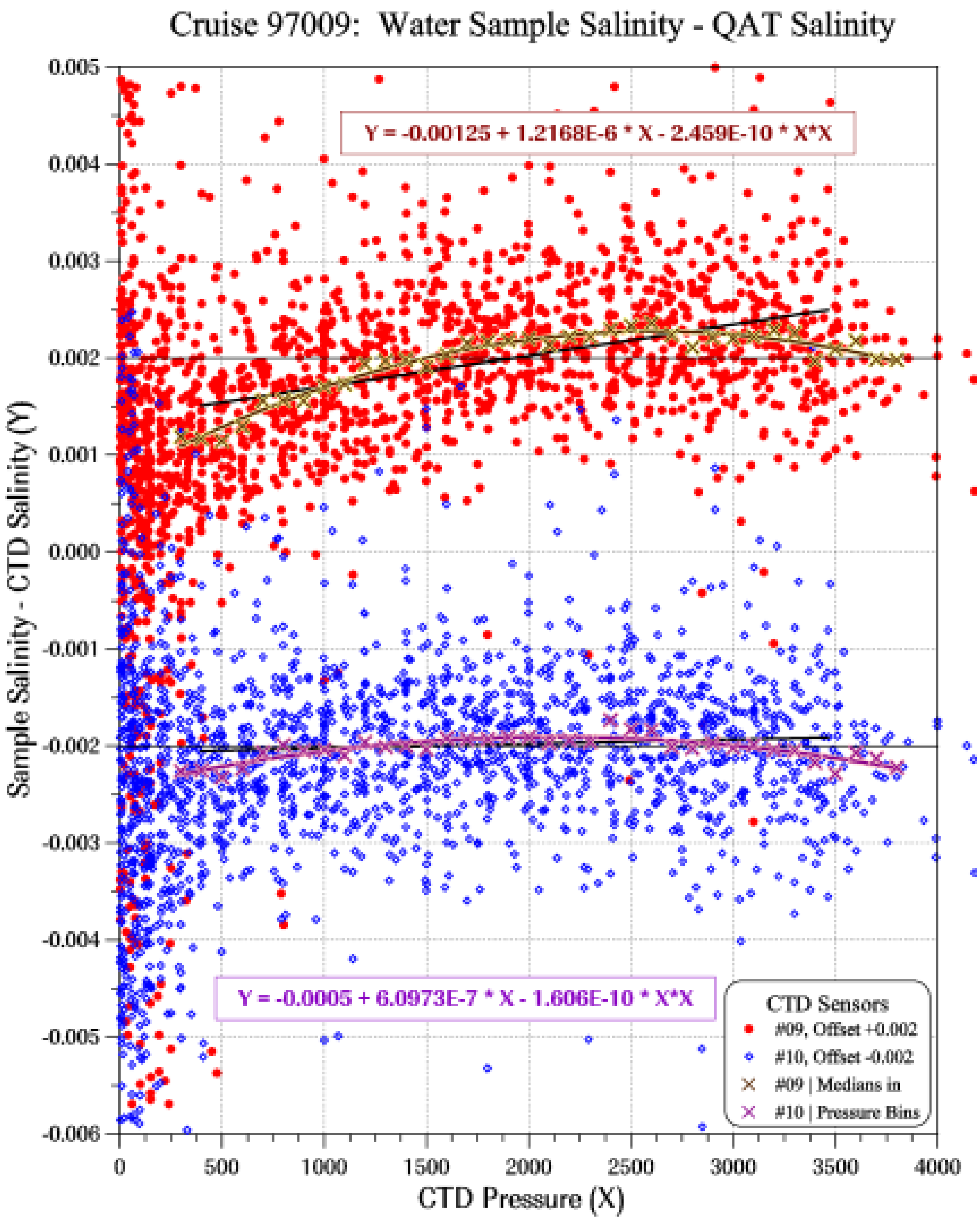

Figure 3. S_{WS}-S_{QAT} as a function of pressure.
S_{QAT} were corrected for the station-to-station change.

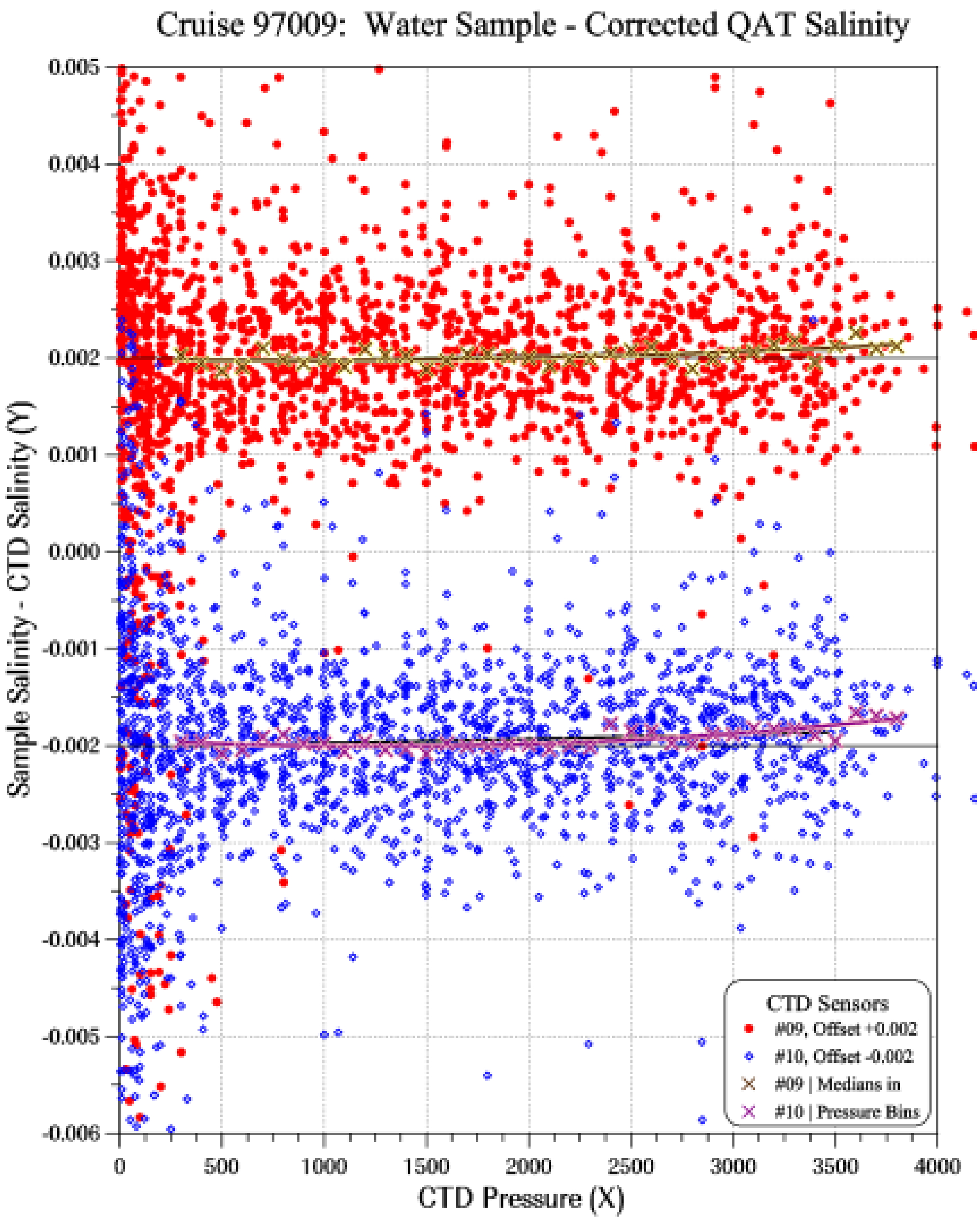

Figure 4. S_{WS}-S_{QAT} as a function of pressure. Suggested corrections station-to-station and polynmial on pressure were applied to S_{QAT}.

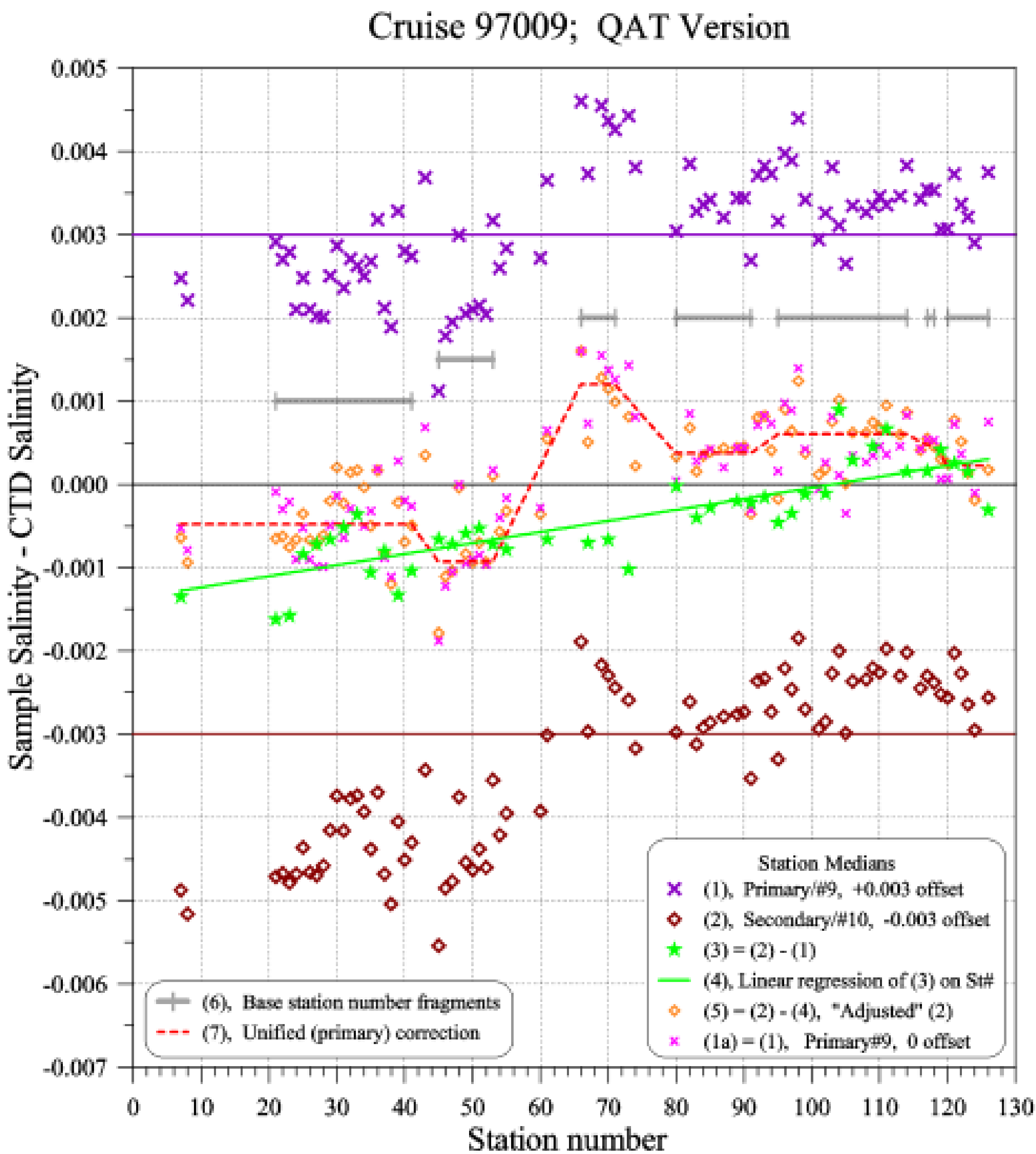

Figure 5a. Station-to-station evolution of S_{WS}-S_{QAT} medians calculated over station number segments (explanation in the text) and computation of the unified "inter-system" correction. S_{QAT} was already corrected for pressure effect.

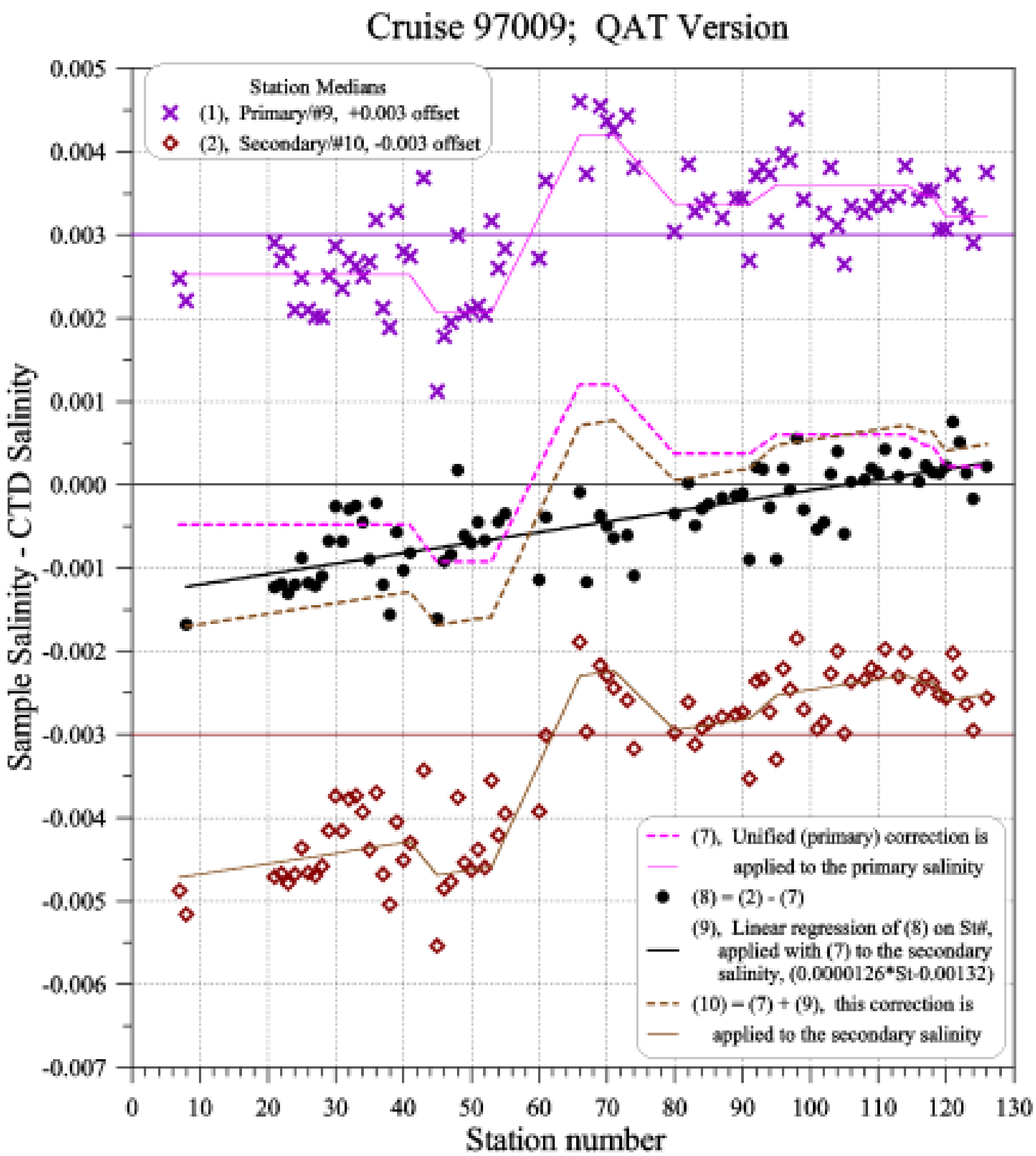

Figure 5b. Station-to-station correction to 97009 CTD salinity.
Correction on CTD pressure was added to S_{QAT}.

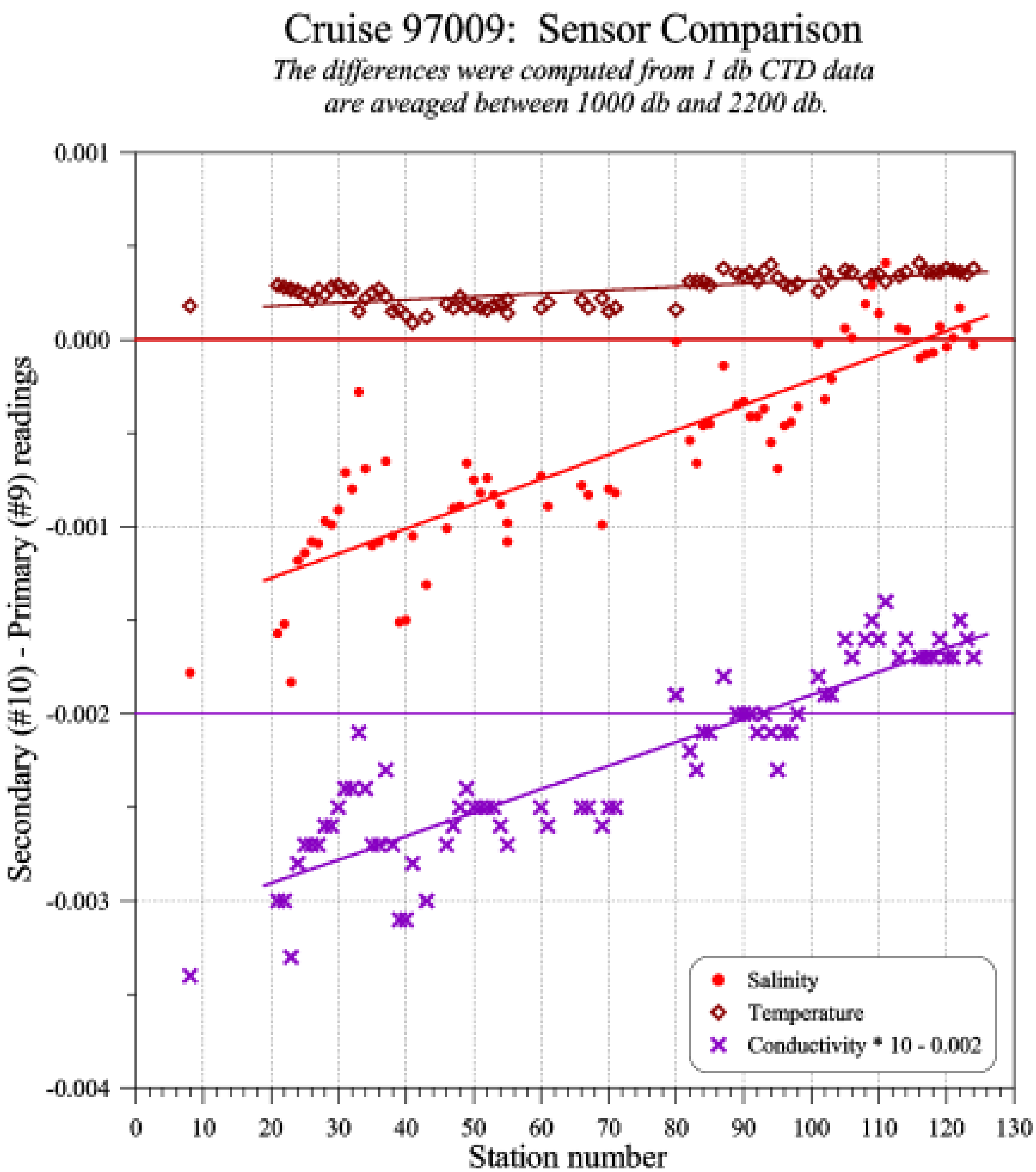

Figure 6. Station-to-station evolution of the differences between the readings of the sensors #9 and #10 (#10-#9).

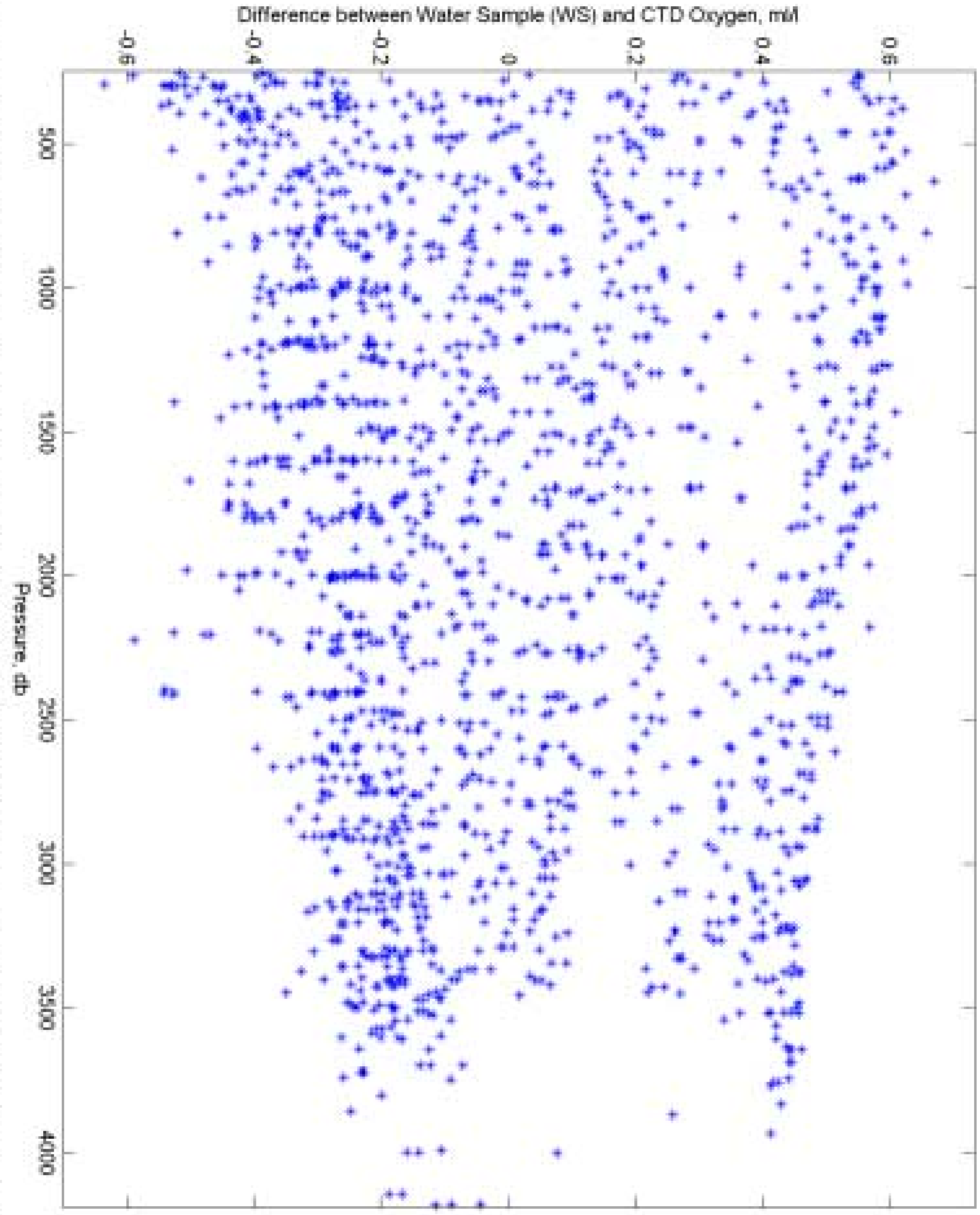

Figure 7a. Differences between the water sample and CTD oxygen values after reprocessing of the CTD data as a function of pressure. Primary system.

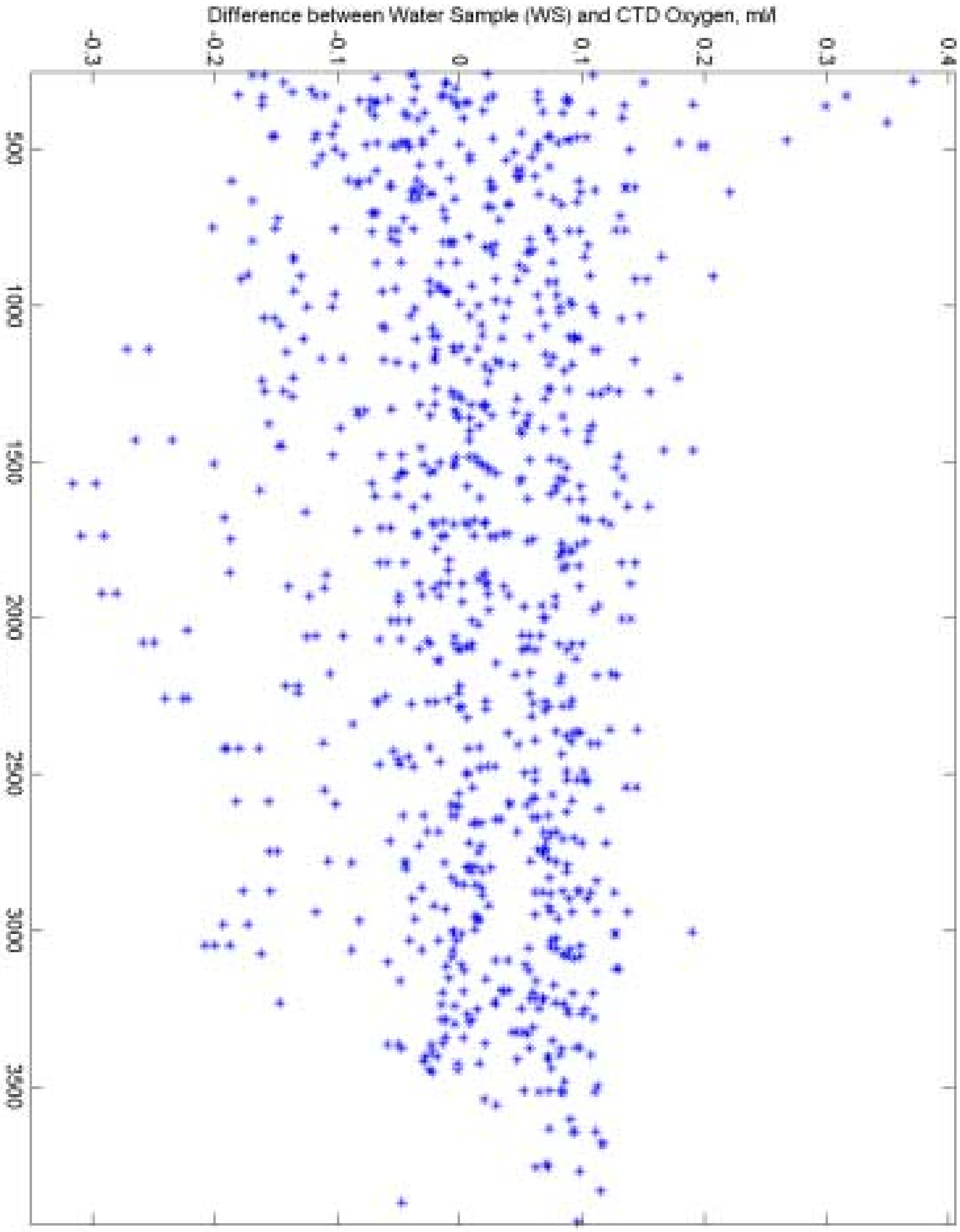

Figure 7b. Differences between the water sample and CTD oxygen values after reprocessing of the CTD data as a function of pressure: Secondary system.

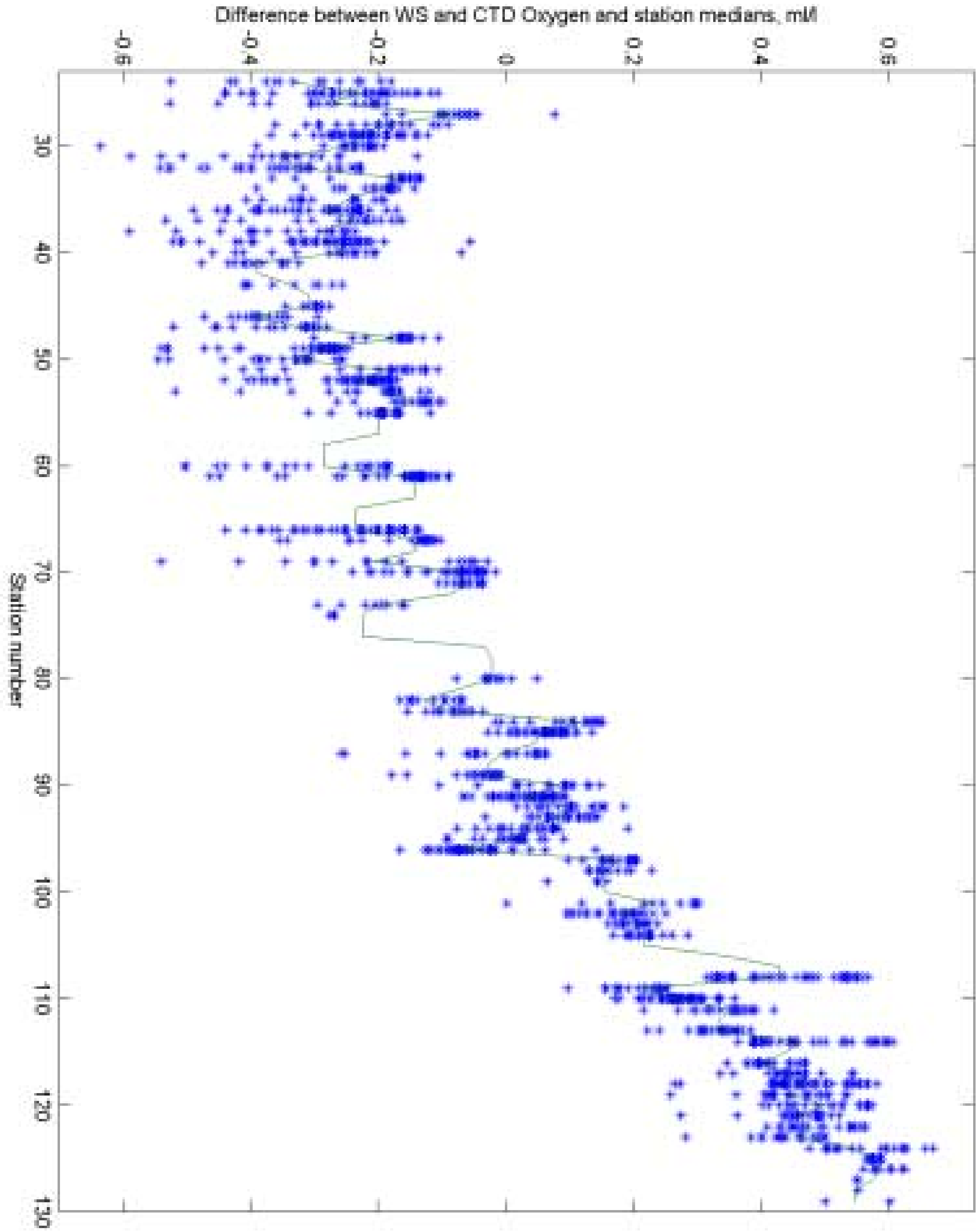

Figure 8a. Differences between the water sample and CTD oxygen values after reprocessing of the CTD data as a function of station number. Primary system.

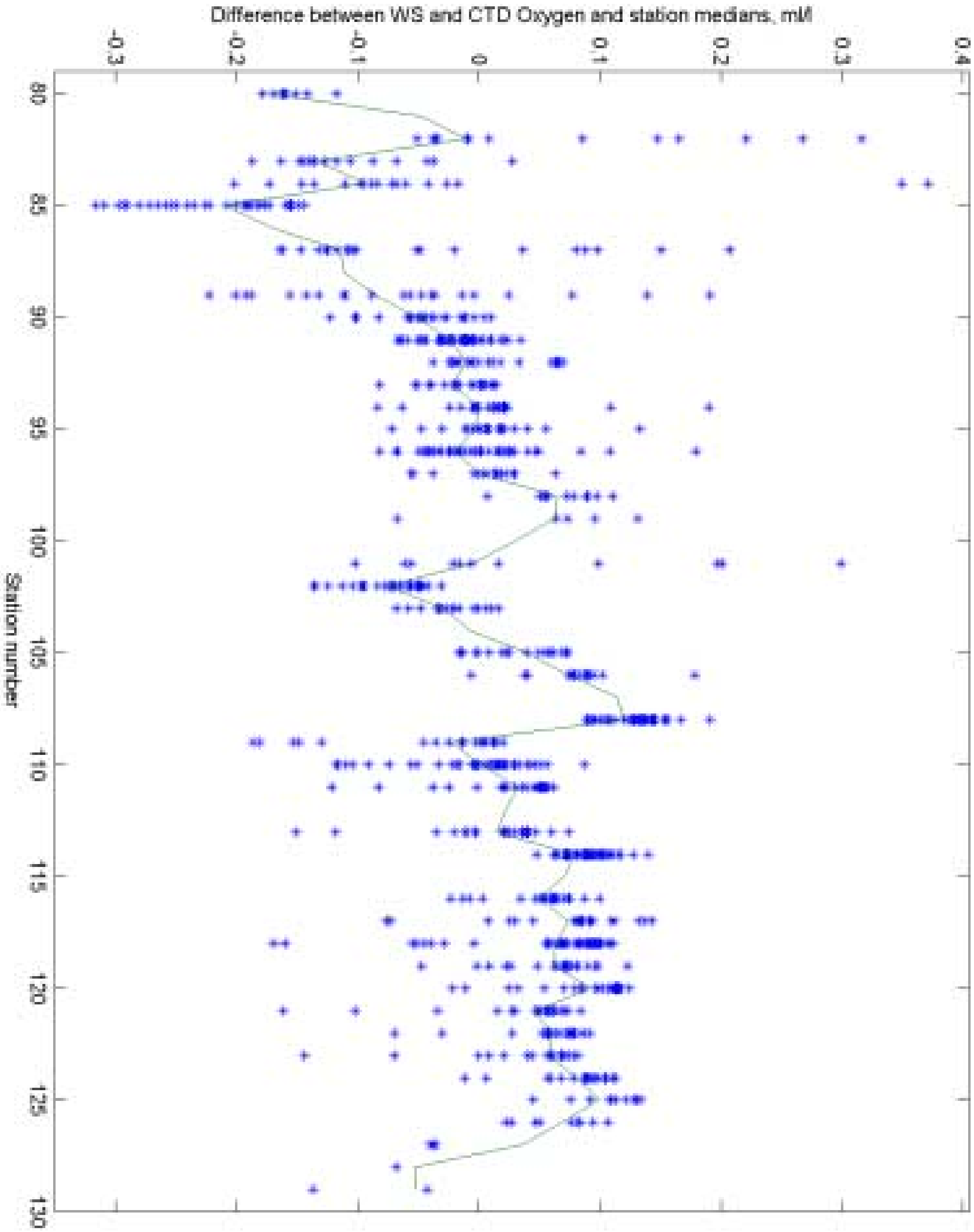

Figure 80. Differences between the water sample and CTD oxygen values after reprocessing of the CTD data as a function of station number. Secondary system

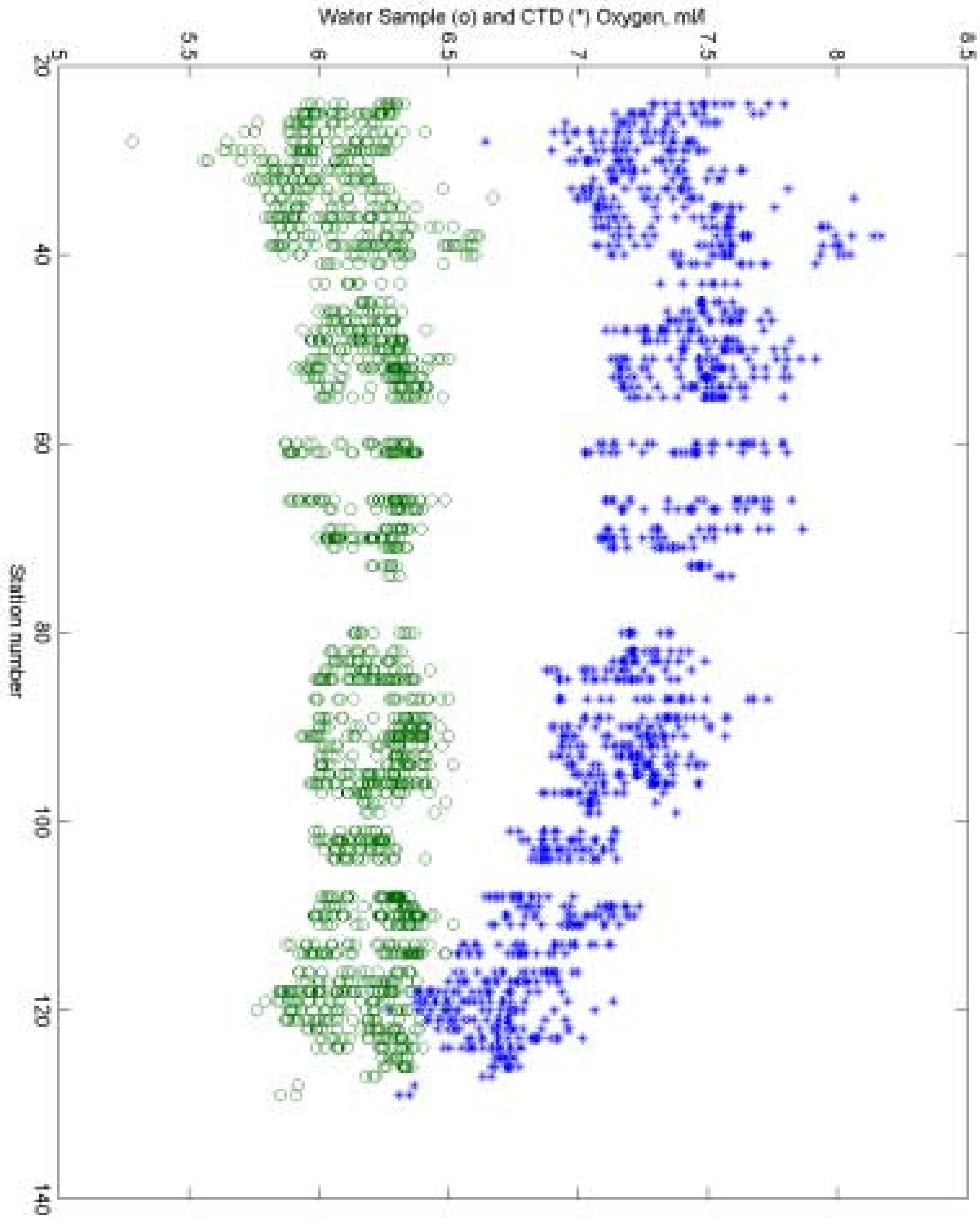

Figure 9a. Water sample and CTD oxygen values after reprocessing of the CTD data as a function of station number. Primary system.

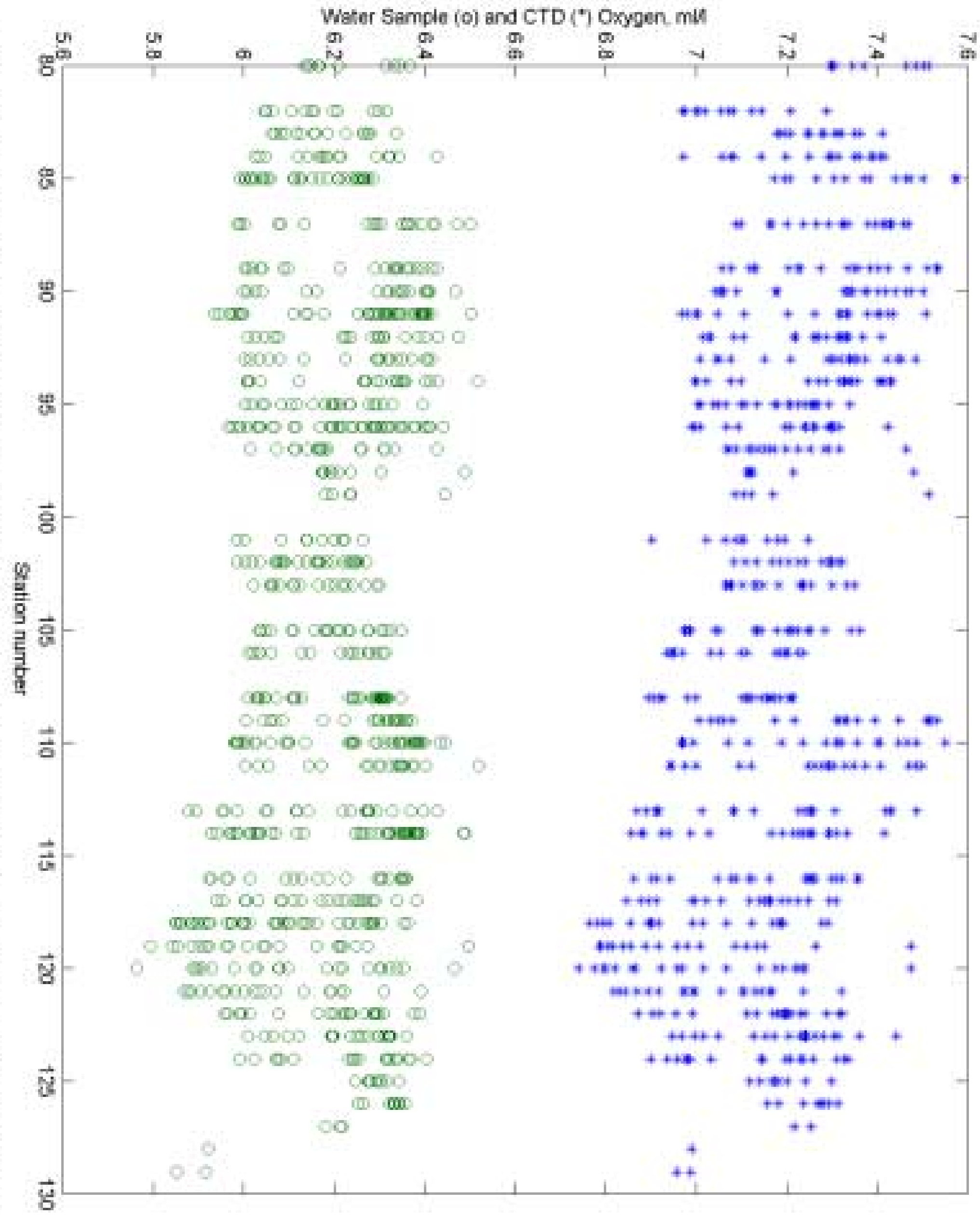

Figure 9b. Water sample and CTD oxygen values after reprocessing of the CTD data as a function of station number: Secondary system.

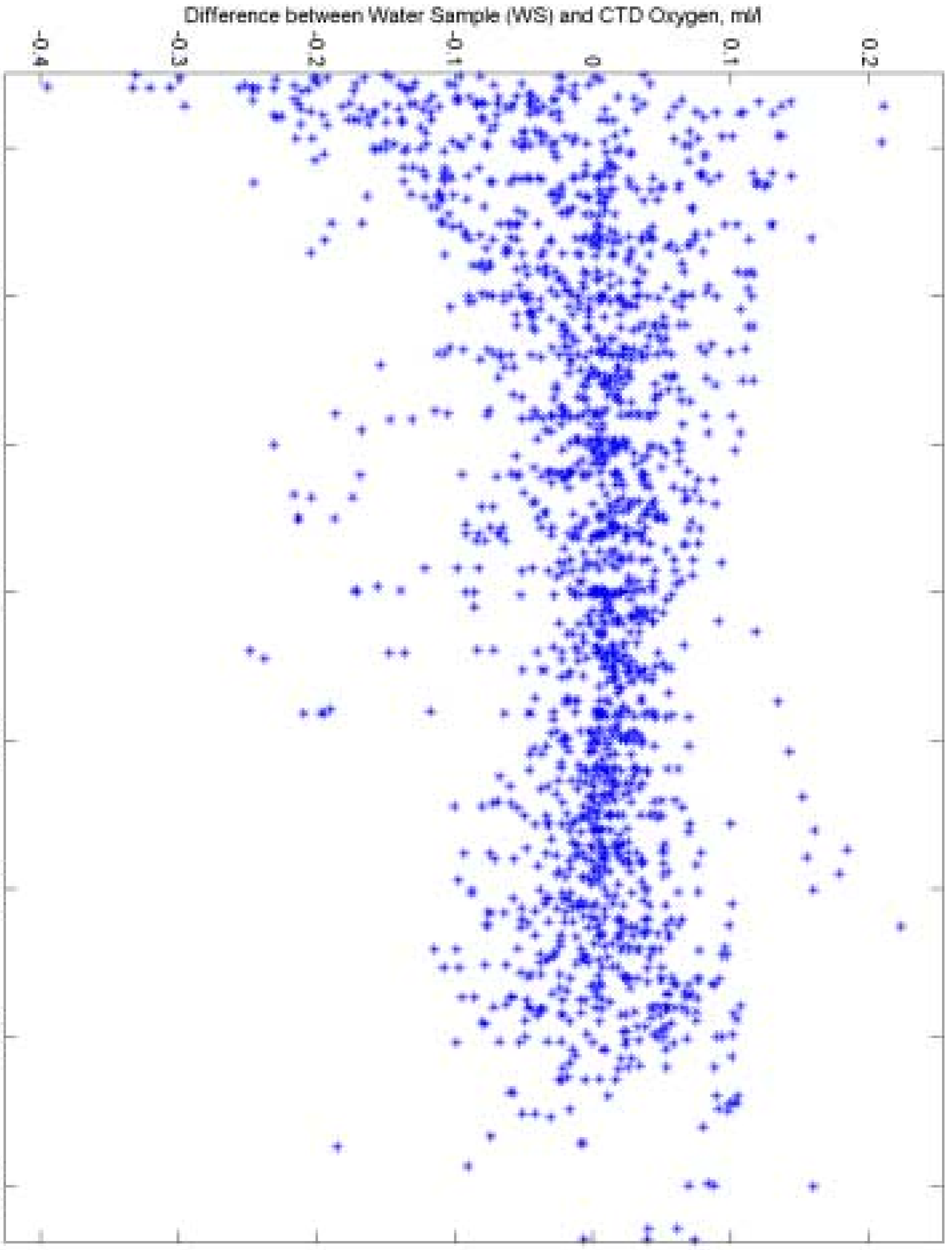

Figure 10a. Differences between the water sample and final CTD oxygen values as a function of pressure: Primary system.

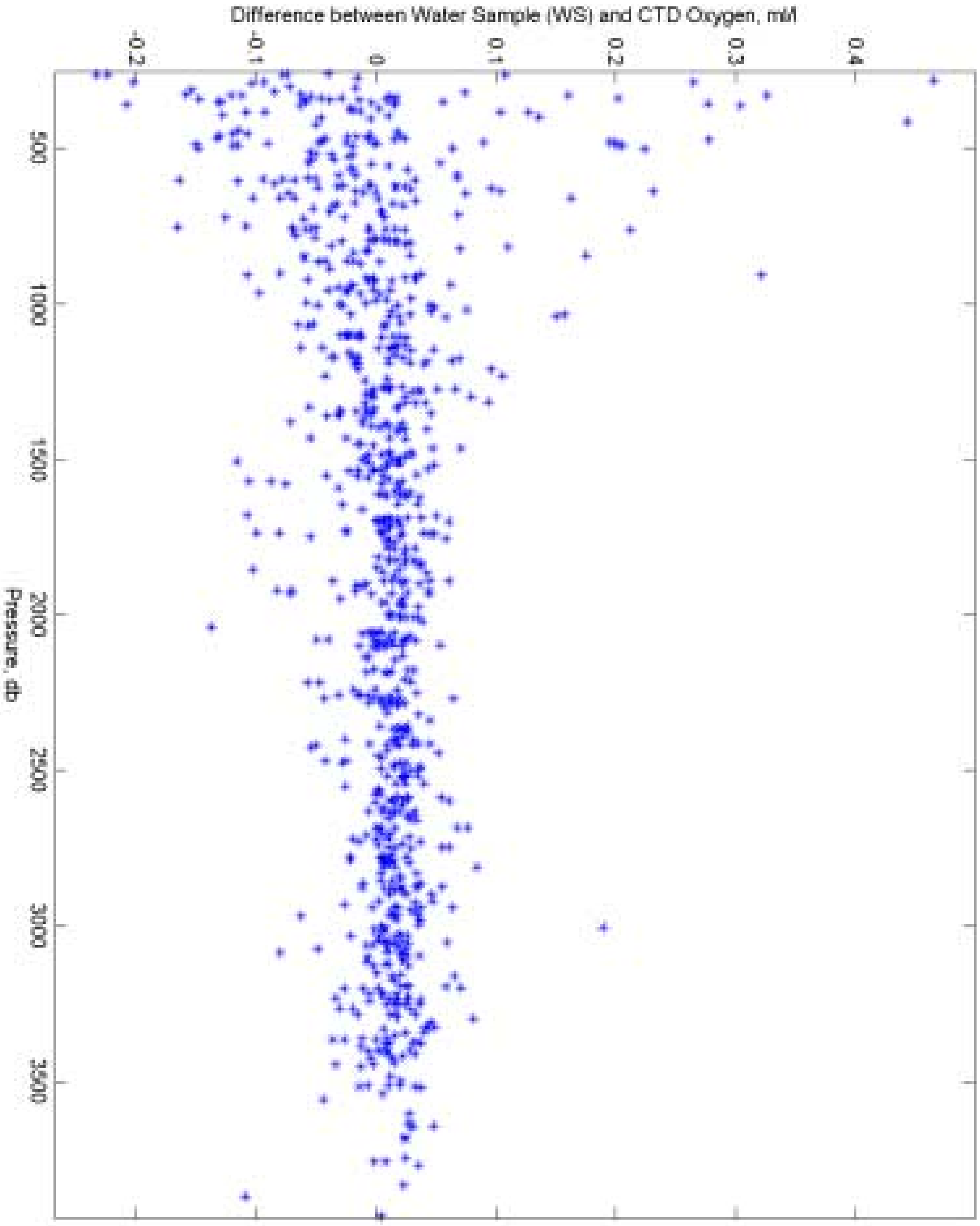

Figure 10b. Differences between the water sample and final CTD oxygen values as a function of pressure: Secondary system.

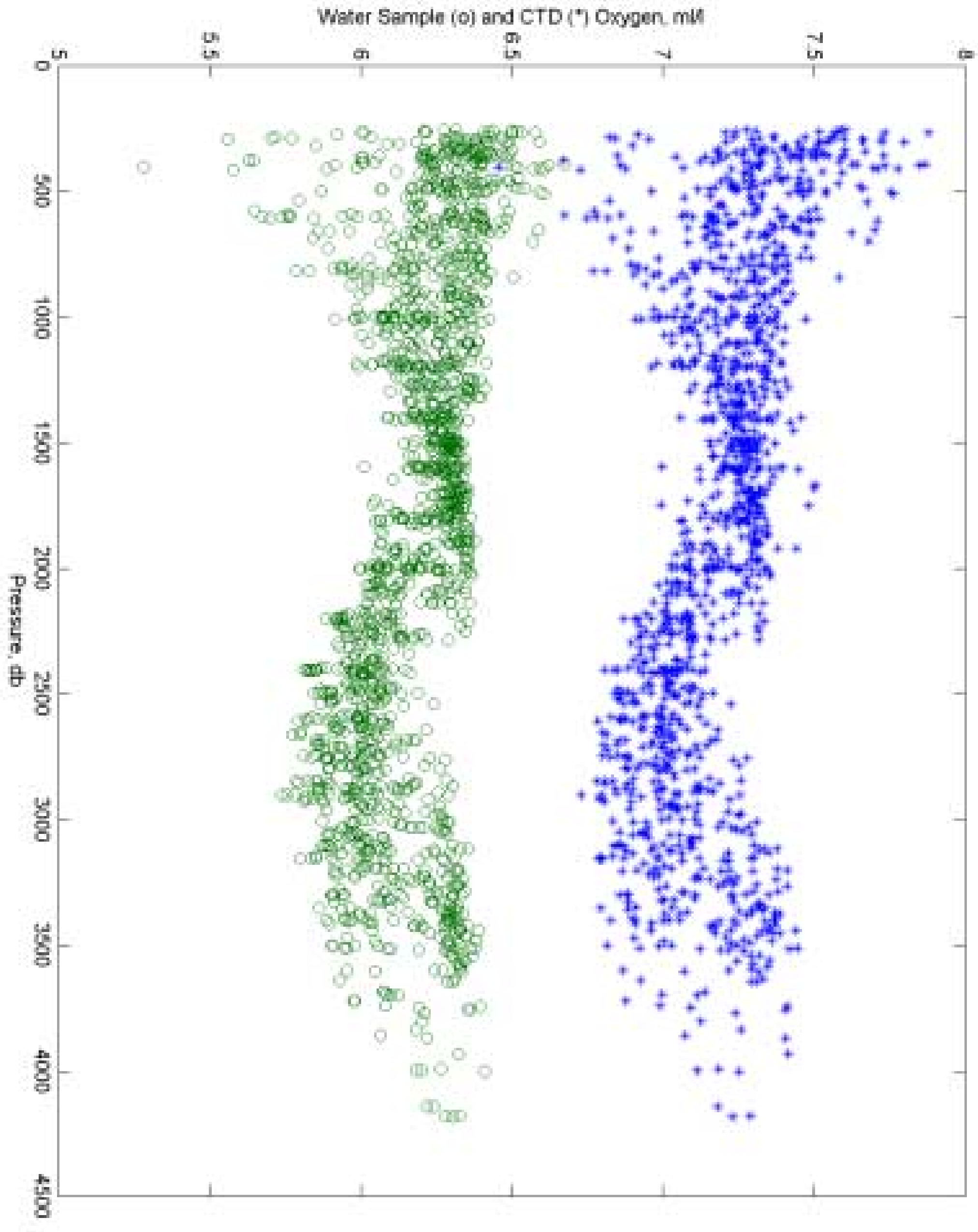

Figure 11a. Water sample and final CTD oxygen values as a function of pressure: Primary system.

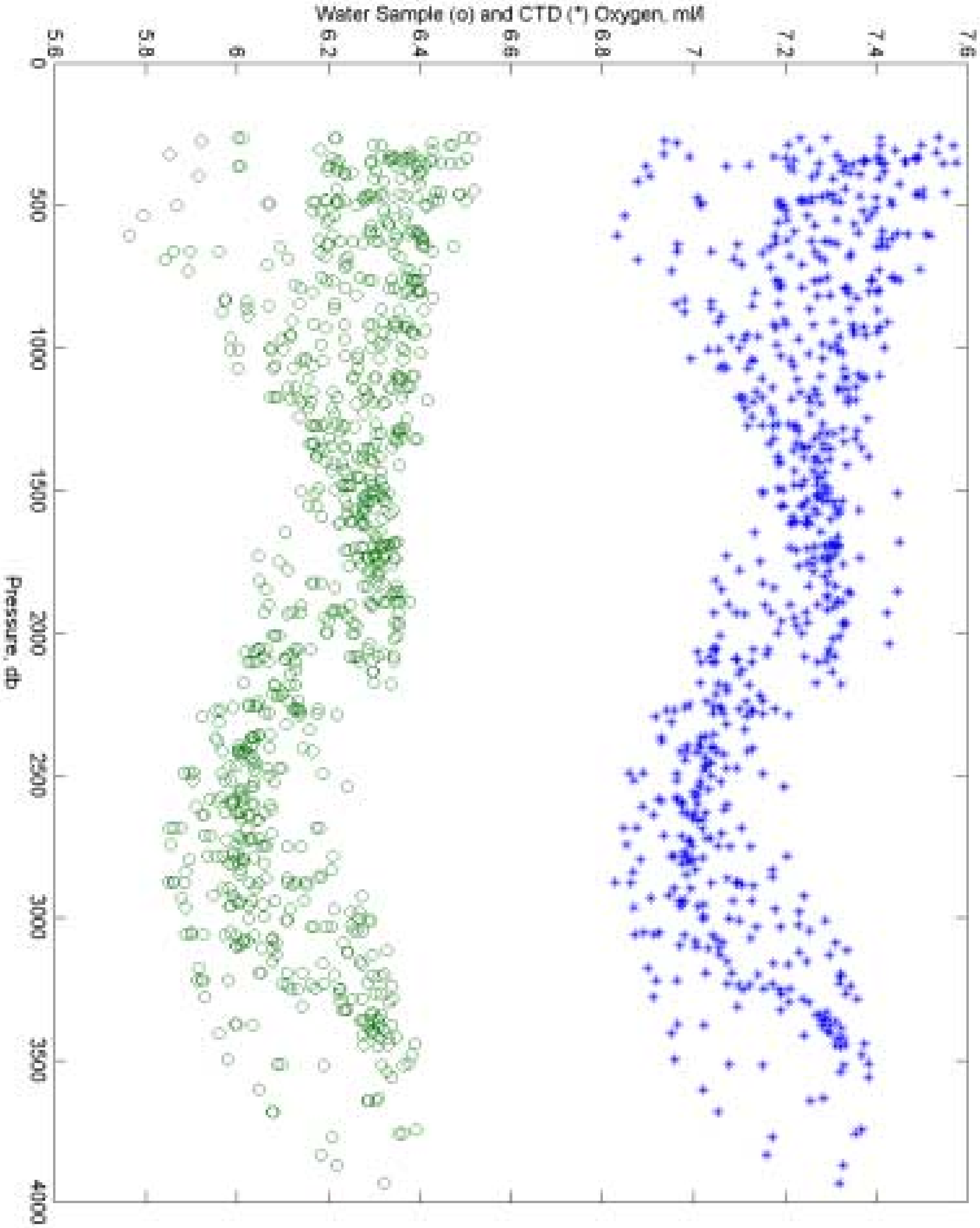

Figure 11b. Water sample and final CTD oxygen values as a function of pressure: Secondary system.

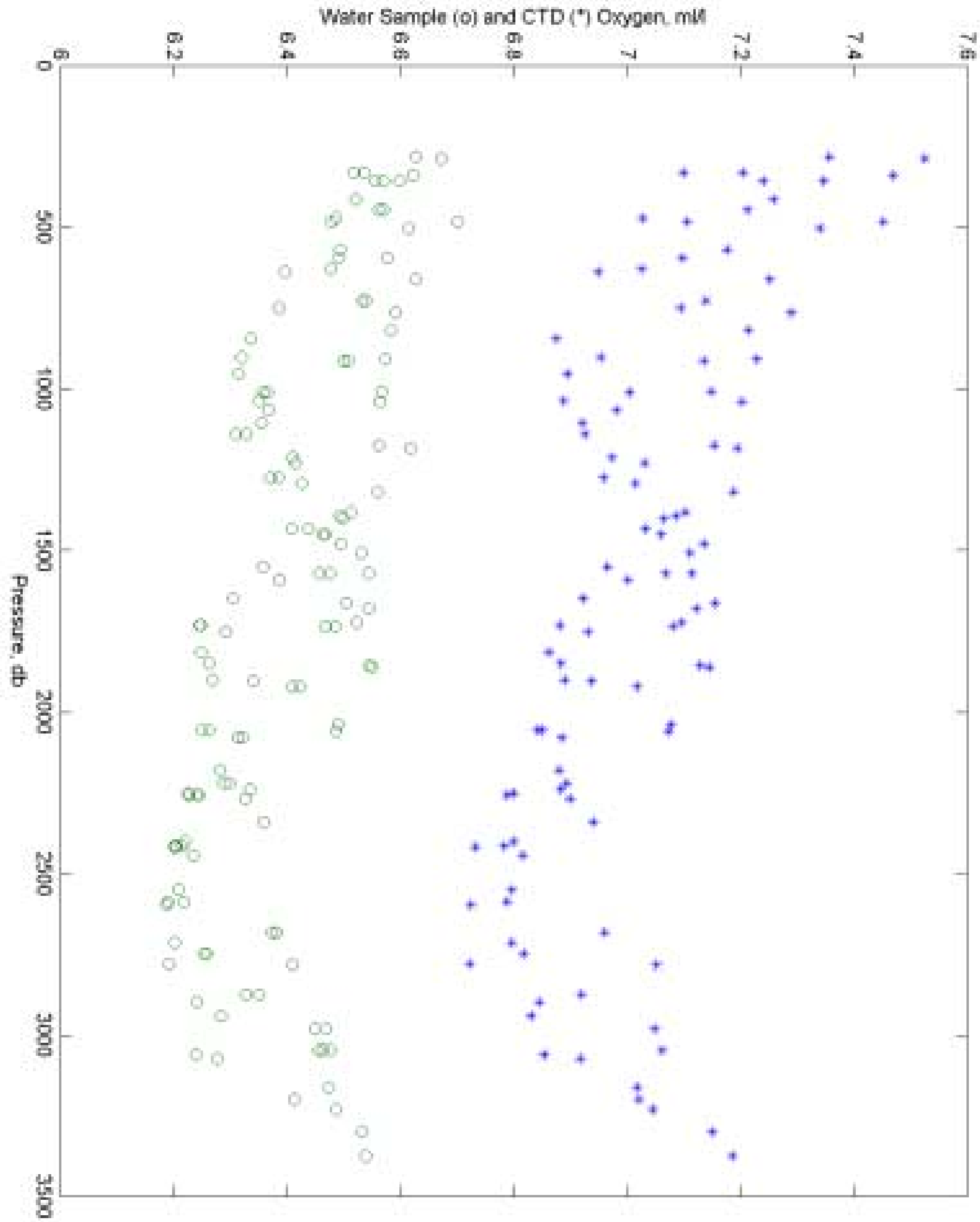

Figure 11c. Water sample and final CTD oxygen values as a function of pressure: Primary system, Station number range: 81-89.

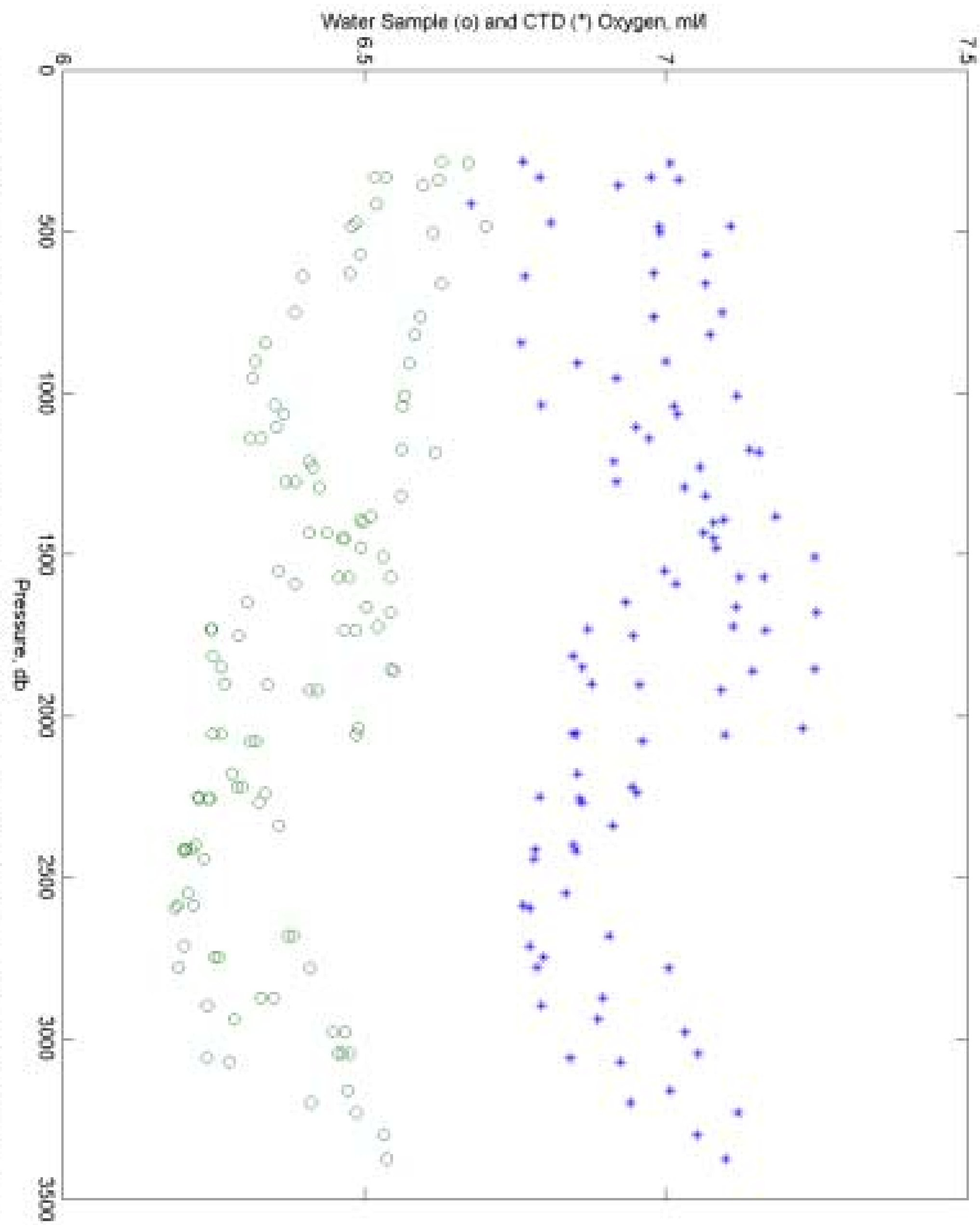

Figure 11d. Water sample and final CTD oxygen values as a function of pressure: Secondary system, Station number range: 61-80

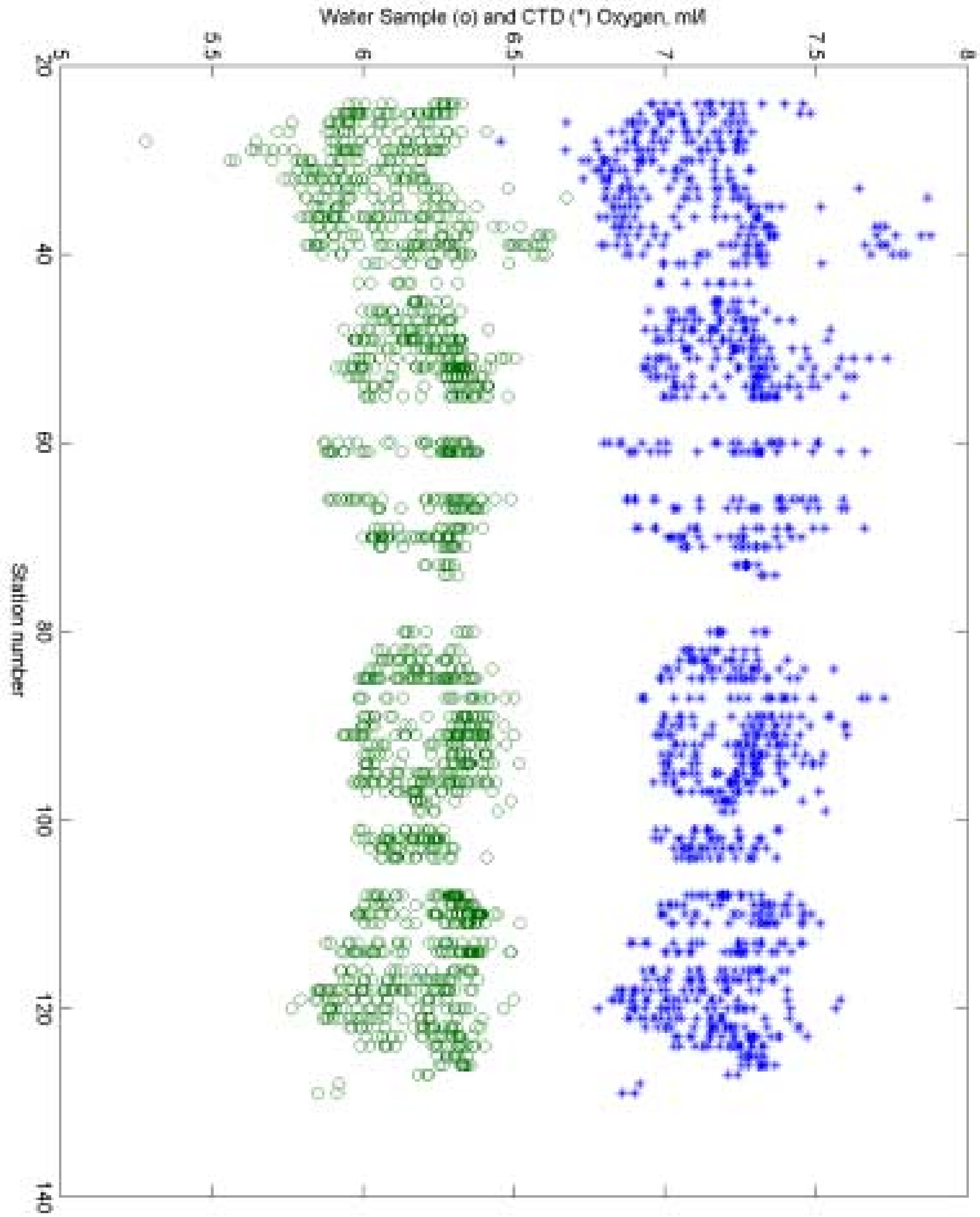

Figure 12a. Water sample and final CTD oxygen values as a function of station number. Primary system.

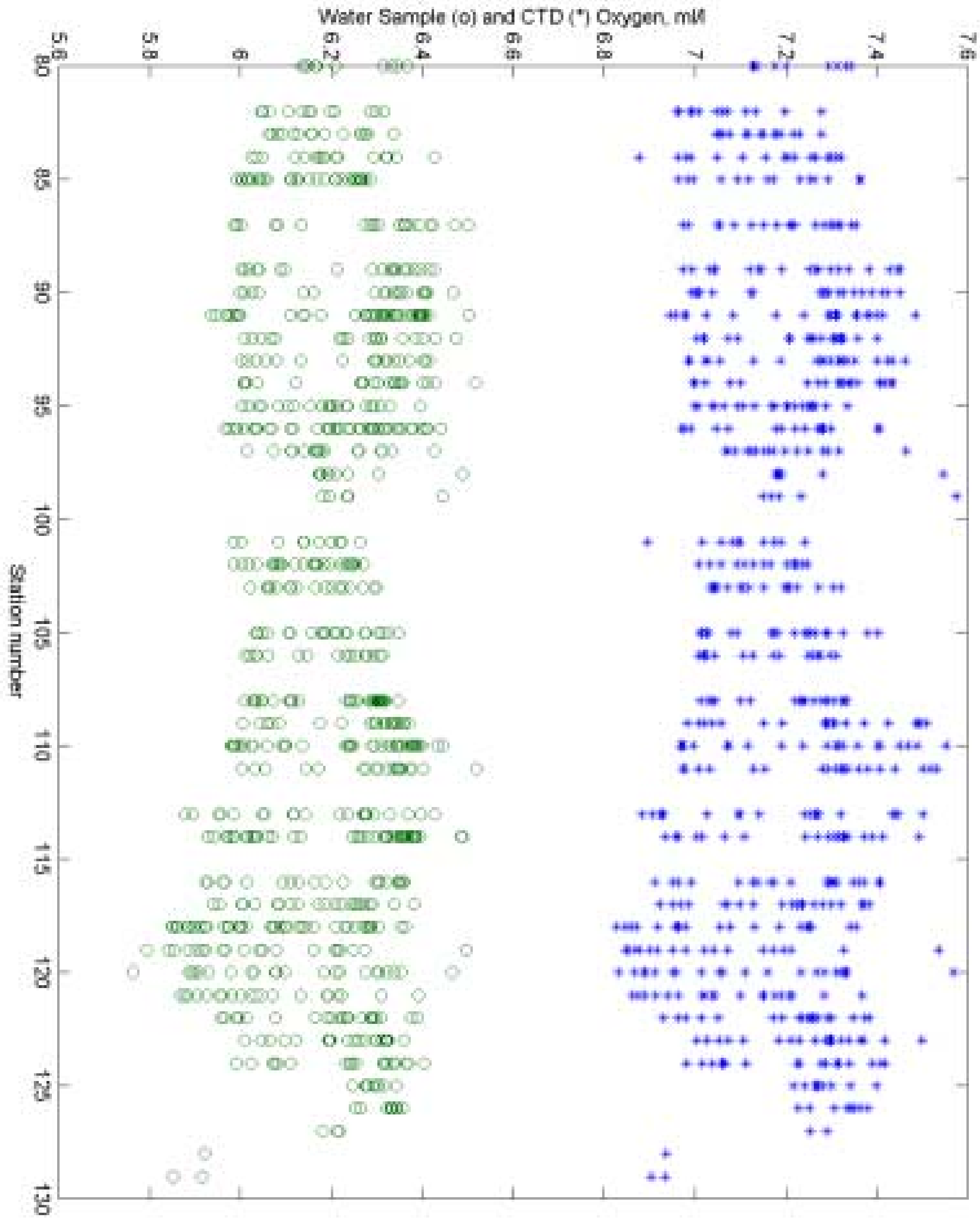

Figure 12b. Water sample and final CTD oxygen values as a function of station number: Secondary system.

G. REFERENCES

Carritt, D.E. and J.H. Carpenter. 1966. Comparison and Evaluation of Currently Employed Modifications of the Winkler Method for Determining Dissolved Oxygen in Seawater. A NASCO Report, Jour. Mar. Res., 24, 268-318.

Clarke, R. Allyn, Jean-Guy Dessureault and Geoff Lebans. 1995. Upper Ocean Profiling from Vessels Underway, Sea Technology, February 1995.

Jones, E.P., F. Zemlyak and P. Stewart. 1992. Operating Manual for the Bedford Institute of Oceanography Automated Dissolved Oxygen Titration System. Can. Tech. Rep. of Hydrography and Ocean Sci. 138: iv+51p.

Levy, E.M., C.C. Cunningham, C.D.W. Conrad and J.D. Moffatt. 1977. The Determination of Dissolved Oxygen in Sea Water, Bedford Institute of Oceanography Report Series, BI-R-77-9, August 1977.

WHPO DATA PROCESSING NOTES

Date	Contact	Data Type	Data Status	Summary
4/7/98	Schott	Cruise ID	Data Update	North Atlantic cruise list
	Enclosed please find a list of cruises (since 1990) we use as references for our work or are aware of in the North Atlantic.			
1/11/00	Clarke	DOC	Data Requested by jlk	figures missing
1/20/00	Huynh	DOC	Website Updated	pdf, txt versions online
3/24/00	Schlosser	He/Tr	Data are Public	See note:
	as mentioned in my recent message, we will release our data with a flag that indicates that they are not yet final. We started the process of transferring the data and we will continue with the transfer during the next weeks. I had listed the expected order of delivery in my last message.			
10/25/00	Clarke	CTD/BTL	No Data Submitted	See Note:
	The spring 1997 cruise was also an extended cruise. On this cruise, we used two different oxygen titration systems in parallel and in spite of using the same standards got systematic offsets between the two systems. We have decided on a course of action and plan to submit this data set by the end of this year.			
12/28/00	Buck	SUM	Website Updated	Unformattted SUM online
	Added SUM to website. Data is unformatted and has errors. Expocode is 18HU97009_1.			
4/19/01	Bartolacci	CTD/BTL/SUM	Clarification Request	Are Data Public?
	Regarding the 97007 data submission: · Are these data public? · Is the newly submitted sumfile to replace the current online sumfile? · And finally, the *.mgd file is not utilized by this office, is there some reason it was included? New data are encrypted until word from Isenor.			
4/19/01	Isenor	CTD/BTL/SUM	Submitted	Also Doc file, See note:
	Email from Anthony Isenor states that sumfile is to replace current online file, and that data are Non-public until further notice from his lab. Please see email below: Date: Thu, 19 Apr 2001 16:07:07 -0300 From: "Isenor, Anthony" <IsenorA@mar.dfo-mpo.gc.ca> Subject: RE: AR7W Data for 1997 Delivered To: "'Danie Bartolacci'" <danie@odf.ucsd.edu> MIME-version: 1.0 Hi Danie: Sorry about the upload. I will go to the web site and follow the current instructions next time. At this moment, you should consider the data non-public. When we send our submission to our national data centre, they will be public. At that time, I will let you know of the status change. Yes, the delivered SUM file should replace your current SUM file. The mgd file is included as per instructions in the WOCE reporting manual. I will also send a copy to National Geophysical Data Centre, so you can ignore that particular file. As for the other cruises: · 91007 - This is an ongoing saga.It is difficult to predict what exactly will happen.			

	· 96026 - This is a problem dataset because of multiple CTD systems. It is second on my list. · 98023 - This is next on my list. However, it shouldn't be as complicated as 97009. You should have initial cruise reports and SUM files for all three of these. However, no data yet. Regards, Anthony SUM, CTD, Bottle: (ctdraw, ctdprs, ctdtmp, ctdsal, ctdoxy, theta, salnty, oxygen, silcat, no2 no3, phspht, cfc-11, cfc-12, cfc113, ccl4, tcarbn, alkali, qualt1), DOC, bottle, sum, ctd and doc files were submitted by A. Isenor on 2001.04.19. In addition to the above bottle parameters, the bottle file also contains methyl chloroform. It was not indicated whether the new sumfile should replace the current online version, or if all data are to be public. Email confirmation on these matters was sent out on 2001.04.19 by DMB. Files were put online, but no diagnostic checks can be performed until a sumfile is designated and reformatted if necessary. Files will be in AS-IS condition until reply from Isenor.		
4/24/01	Bartolacci	CTD/BTL/SUM	New BTL, CTD, and SUM files reformatted
	I have reformatted the new bottle sum and ctd files for this cruise. As per Isenor the new sumfile is to be a replacement of the version currently online, and bottle and ctd files should be encrypted until further word from his lab. Notes on reformatting are located in the directory: ar07wh/original/ 2001.04.19 _AR07W _SUM _BOT_CTD_ISENOR and will be documented thru email as well. File BIO97009.zip obtained from ftp-incoming, sent by A. Isenor. (See email below) zip file contains: · 97009.mgd unknown file format and data (GPS navigation file?) · 97009.sum summary station file, differs from original version sent as per Isenor is to replace current online file. · c97009.doc cruise documentation word document format · 97009.sea bottle file, needs minor reformatting file contains: CTDPRS, · CTDTMP, CTDSAL, CTDOXY, THETA, SALNTY, OXYGEN, SILCAT, PHSPHT, NO2+NO3, CFC-11, CFC-12, CFC113, TCARBN, CCL4, MCHFRM, ALKALI and QUALT1 · *.wct 132 station ctd files · **BOT:** · bottle file header was edited to now contain the WHP-ID of AR07W, AR13 and AR27. · Dates and Expocode were included in header and a time/date stamp added. · Hard carriage returns were removed. · Pressure sorted all stations. · Several stations contained value columns filled with "******" specifically **Alkalinity column (columns 169-176).** These characters corresponded to a Q1 byte of 3 or 4. Since no values were given, the *'s were edited to -9.0.		

<table>
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occurrances of this edit were:
· lines 2154, 2124, 2118, 2096, 1767, 1721, 1392, 1102, 1062, 982, 685, 395, 388, 2076-2081, 2445, 2446

Several stations also contained columns of 7*'s in the MCHFRM column, these corresponded to a Q1 byte of 3 or 4 and were edited to -9.000.

occurrances of this edit were:
· lines 247, 248, 250, 252, 255, 359-368, 763, 765, 767, 768, 922, 927, 932, 2379, 2380, 2381, 2383, 2384, 2386, 2388

Several stations contained entire lines of -9 missing values except for bottle number. These appeared to be bottle numbering place holders and contained no data. These lines were deleted.
· Following lines were removed for this reason: 264, 359, 382, 405, 842, 864, 907, 908, 962
· Edited station 43's cast from 23 to 3 corresponding to the ROSette cast 3.
· Edited all decimal-leading spaces to a zero (i.e. .790 to 0.790 and -.259 to -0.259)
· File was renamed ar07whhy.txt
· Ran wocecvt with errors pertaining to sumfile missing lat/lons and truncated
· parameter lists.

CTD:
· Removed hard carriage returns.
· Edited expocode from 18HU97009/1 to 18HU97009_1
· Ran wctcvt with errors pertaining to sumfile missing lat/lons and truncated parameter lists.
· 132 station files.
· Zipped file name ar07whct.zip.

SUM:
· Removed hard carriage returns.
· changed expocode from 18HU97009/1 to 18HU97009_1
· changed line numbers to correspond to all WOCE line numbers designated in

current online version:
· stations 1-34 and 117-131 correspond to region AR13
· stations 35-44 and 77-116 correspond to region AR27
· stations 47-76 corresponds to AR07W (line)
· Added date/name stamp.
· Ran sumchk.
· Errors produced were related to missing lat/lon values and parameter list length, no other formatting errors existed.
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<tr>
<td>11/1/01</td>
<td>Isenor</td>
<td>Final Cruise Report Submitted</td>
</tr>
</table>