WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Marine Water Column Ambient Monitoring Program: Annual Report for Wateryear 1991

Final Report

February 1993
Publication 93-13
printed on recycled paper

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Marine Water Column Ambient Monitoring Program: Annual Report for Wateryear 1991

Final Report

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February 1993
Publication 93-13

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Continued)

Page

LIST OF FIGURES (Continued)

LIST OF APPENDICES

ACKNOWLEDGMENTS

Special thanks go to all the following persons who contributed in various ways to the Wateryear 1991 monitoring effort.

Data Collection: Carol Janzen, Wayne Heath, and Bernard Strong who fearlessly went in the field to collect the data.

Paul Carlson, Jerry Bruder, and Bill Whitney for successfully piloting the aircraft used for sample collection. Thanks also to the staff at Kenmore Air Harbor for coordinating our complicated scheduling needs.

Laboratory Support: Despina Strong, Dave Thomson, Will White, Kitty Bickle, Michelle Elling, Nancy Jensen, Cyma Tupas, Pam Covey, and Stuart Magoon for making sample delivery and analysis procedures successful.

Technical Support and Peer Review: Ken Dzinbal, Sharon Bell, Bob Cusimano, Dave Thomson, and Art Johnson (EILS Program at the Washington State Department of Ecology); Chris Prescott (Puget Sound Water Quality Authority); Gerardo Chin-Leo (The Evergreen State College); John Armstrong (Environmental Protection Agency); Mary Kay Talbott and Mary Price (University of Washington).

Computer Support: Skip Albertson, John Tooley, Bob James, and Dave Hallock.

Word Processing and Editing: Kim Douglas

ABSTRACT

During Wateryear 1991 (October 1990 through September 1991), the Washington State Department of Ecology (Ecology) monitored water quality monthly at 28 stations in Puget Sound, four stations in Grays Harbor, and five stations in Willapa Bay. Of the 28 stations in Puget Sound, 23 sites showed dissolved oxygen concentrations below the water quality standards for marine waters one or more times, and 11 exceeded fecal coliform counts of 14 organisms/100 milliliters (mL) one or more times. Nutrient depletion was observed at 20 Puget Sound stations. Of the nine coastal stations, none violated dissolved oxygen standards, and four exceeded fecal coliform counts of 14 organisms/100 mL one or more times. Nutrient depletion was only observed at the Willapa Bay stations. Stations that did not experience nutrient depletion as defined by this report, were well mixed and lacked observable ongoing density stratification. At several Puget Sound stations, chlorophyll *a* concentrations were inversely proportional to nutrient concentrations, with maximum chlorophyll *a* concentrations and minimum nutrient concentrations observed simultaneously. Chlorophyll *a* concentrations were highest during the spring and summer months and lowest during late fall and winter months for Puget Sound stations. The coastal stations exhibited two chlorophyll *a* peaks, one during mid-summer and again in mid-fall. To assess the quality of the marine water column data, a detailed quality assurance assessment was conducted on the Wateryear 1991 (WY 1991) results. Ninety-four percent of the nitrite results were below detection limits. Discontinuing dissolved nitrite analysis until lower detection limits can be achieved by the laboratory was recommended. The quality assurance assessment also revealed that the fecal coliform bacteria results did not achieve precision objectives in either the field or laboratory replication. Procedures for future collection and analysis of fecal coliform bacteria should be amended to improve the quality of these data. In general, to improve temporal and spatial coverage for shorter term and episodic water quality events not caught by the monthly sampling component of the program, continued monitoring efforts should include a seasonal monitoring component. Sites showing signs of nutrient depletion and/or conditions that promote biological activity (stratification) should be priority candidates for seasonal monitoring.

INTRODUCTION

This report is the second annual report prepared as part of the Washington State Department of Ecology's (Ecology) Marine Water Column Monitoring Program. This report is only intended to present and discuss the full suite of marine water quality data collected during WY 1991 (October 1990 through September 1991). Historical analyses of water quality trends at specific stations or comparisons to other monitoring efforts fell outside the scope of this report.

One important focus of this report is to identify regions of nutrient depletion (or limitation) associated with phytoplankton blooms. Water column stratification, dissolved oxygen concentrations and fecal coliform bacteria results are also discussed. The objectives of the monitoring program do not include source identification of pollutants entering the marine waters sampled. However, potential sources/causes of water quality conditions are suggested in some cases.

Marine Water Column Monitoring Program

The Marine Water Column Monitoring Program is primarily designed to measure ambient water quality conditions in Puget Sound and the coastal estuaries. It also is designed to monitor the cumulative effects of contamination and habitat degradation resulting from human activities (Janzen, 1992b). For instance, it is important to be able to determine the Puget Sound embayments susceptible to eutrophication (excessive algal growth as a result of large nutrient inputs) in order to avoid future water quality problems affiliated with increased nutrient inputs. Better marine water quality management decisions for Puget Sound and the outer coastal estuaries can be made based on quantitative water quality information.

Monitoring Goals and Objectives

Ecology's goals for both Puget Sound and coastal estuarine monitoring are to:

1) Characterize spatial and temporal patterns of ambient water quality conditions.

2) Identify significant changes in key environmental indicators.

3) Provide water quality information to support specific programs in Ecology, other agencies, and those programs identified in the Puget Sound Water Quality Management Plan (PSWQMP).

4) Determine the effectiveness of regulatory agencies in improving marine water quality through regulatory activities.

5) Support environmental research activities through the availability of consistent, scientifically, and statistically valid data.

6) Provide baseline water quality data to the public, managers, private institutions, and other data users.

The specific objectives for WY 1991 monitoring included:

1) Collecting long-term spatial and temporal water quality data in open basins and in embayments.

2) Identifying water quality sensitive areas and possible emerging problems in embayments.

3) Providing baseline data to water quality managers to help assess compliance with state and federal water quality regulations.

4) Providing information to managers and environmental scientists to help describe the water quality dynamics of Puget Sound and the coastal waters.

5) Providing general water quality information to the public through data requests and reports.

Background

Ecology initiated its statewide marine water monitoring program in 1967. The original purpose of the program was to determine existing water quality conditions on a regular basis, and identify spatial and temporal trends from the results. Many of the sampling sites were located near municipal and industrial discharges in order to measure the effectiveness of agency regulatory programs.

During the program's twenty year history, minor changes were made to the original program to meet growing information needs. For instance, due to agency regulatory actions, point source discharges of oxygen-consuming wastes markedly declined. Ecology subsequently shifted its emphasis to monitoring the effects of nonpoint source pollution, which motivated a change in monitoring strategy.

Recently, state and federal agencies developed a comprehensive Puget Sound environmental protection program known as the Puget Sound Water Quality Management Plan (PSWQMP) (Puget Sound Water Quality Authority (PSWQA, 1988)). This management plan calls for many activities of which coordinated information gathering is one.

In 1988, the Puget Sound Ambient Monitoring Program (PSAMP) was developed by a regional committee of environmental scientists known as the Monitoring Management Committee (MMC). A specific task-oriented monitoring plan was designed to guide comprehensive long-term monitoring in Puget Sound (PSAMP Final Report; MMC, 1988).

The PSAMP Final Report describes a program which includes tasks for monitoring the marine water column, marine sediments, fish, shellfish, and freshwater entering Puget Sound. One of Ecology's responsibilities as part of PSAMP is the marine water column monitoring task. A Marine Water Column Ambient Monitoring Plan was prepared by Ecology to describe in detail the marine water column monitoring portion of PSAMP and the coastal monitoring being conducted by Ecology (Janzen, 1992b).

METHODS

Monitoring Approach

The Marine Water Column Ambient Monitoring Plan (Janzen, 1992b) describes three inter-related strategies for marine water column monitoring: long-term monitoring, seasonal monitoring, and solstice monitoring. With full implementation, all three strategies would be employed in Puget Sound, and both long-term and seasonal monitoring would be conducted in the coastal estuaries. In WY 1991, funding allowed only the long-term monitoring strategy to be conducted in both Puget Sound and the coastal estuaries.

The long-term monitoring strategy includes sampling at stations identified as core, rotating, and floating stations. As a rule, core stations are visited every month each year; rotating stations are visited every month for one year, then every third year; and floating stations are sampled every month for one year, and not revisited on any set schedule.

Experimental Design

Long-term sampling was conducted on a monthly basis in Puget Sound, Grays Harbor, and Willapa Bay during WY 1991 at stations annotated on Figures 1 and 2. Table 1 lists the parameters collected at each of these stations.

The final long-term station selection process conducted by the PSAMP Steering Committee located sampling sites in each of the major basins and embayments in both rural and urban areas of Puget Sound. Most of the Puget Sound basin stations have been monitored for a long period of time and were considered adequate locations for continued monitoring. Two newer sites were located in the Strait of Georgia and the Strait of Juan de Fuca to complete the Puget Sound basin network. Core stations were also located in urban bays where changes in water quality are expected to occur. Most of the urban sites were also historical.

During WY 1991, final selection of Puget Sound long-term core, rotating, and floating station locations had not been made. Therefore, the 1991 Puget Sound sampling network was considered interim. The interim Puget Sound network consisted of nine additional stations not listed in the final network. The final selected station locations are shown and described in the Marine Water Column Ambient Monitoring Plan (Janzen, 1992b).

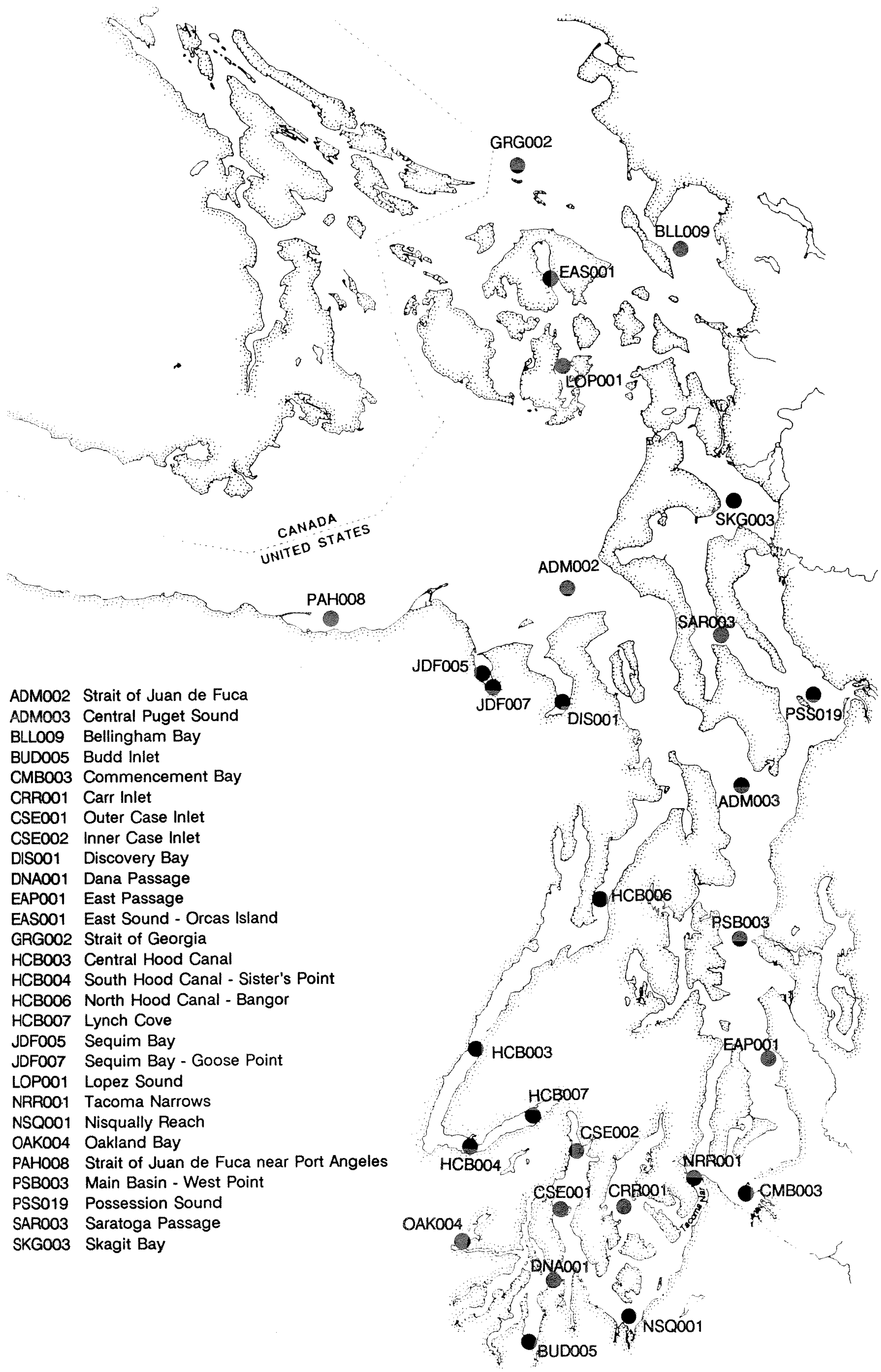


Figure 1. Long-term monitoring stations in Puget Sound for WY 1991.

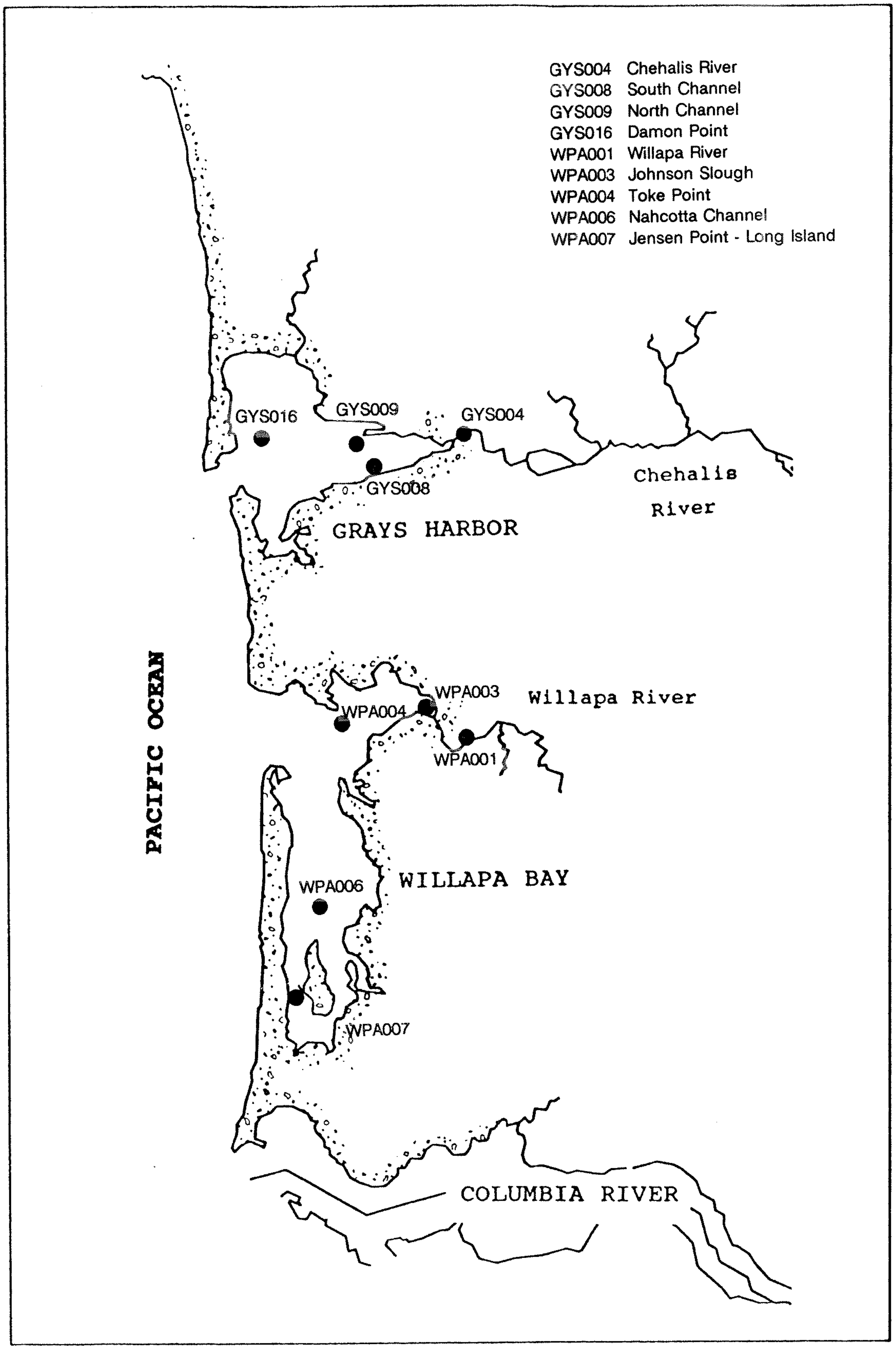


Figure 2. Long-term monitoring stations in Grays Harbor and Willapa Bay for WY 1991.

Table 1. Sample types and depths for long-term monitoring in WY 1991.

Sample Type	Depth in Meters
Secchi Depth	*
CTD Parameter: +	
Temperature	0-30-m ǂ
Conductivity (Salinity)	0-30-m
pH	0-30-m
Dissolved Oxygen	0-30-m
Light Transmissivity	0-30-m
Dissolved Nutrients	0, 10, 30-m
Chlorophyll *a* and Phaeopigments	0, 10. 30-m
Fecal Coliform Bacteria	Surface only

* Depth at which the Secchi disk disappears

\+ Only selected depths will be in the database. Entire CTD profile data is available from the Ambient Monitoring Section.

ǂ Beginning in the spring of 1992, CTD casts will be conducted to the bottom of each station.

Coastal stations were located in channels and embayments based on specific hydrographic water quality conditions, such as water mass types (brackish water versus marine dominated water masses). In general, selected stations were generally located away from any direct sources of pollutants in order to yield ambient (background) water quality conditions.

Materials and Procedures

Sampling was conducted from a DeHaviland Beaver floatplane which allowed a large geographic area to be sampled in a short amount of time. Sampling at all stations was accomplished with four separate surveys each month.

A Sea-Bird Electronics Seacat® (model SBE-19) CTD profiler was used for collecting continuous water column profile data. Parameters measured by the CTD included temperature, conductivity (used to compute salinity and density), pressure, pH, dissolved oxygen, and light transmissivity. CTD profiles at each station were conducted to 30-meters (m) depth. When depths were less than 30-m, casts were conducted to the bottom. Sampling procedures followed the manufacturer's instructions (Sea-Bird Electronics, 1990), and are also described in the Marine Water Column Ambient Monitoring Plan (Janzen, 1992b).

Secchi depth measurements were taken at each station using a solid white, 20-centimeter (cm) disk. Values were recorded to the nearest tenth of a meter. Secchi depth results were used to indicate water clarity and incident light penetration through the water column.

A 1.2 liter (L) Niskin® bottle was manually deployed to collect water at the surface, 10-m, and at 30-m. These depths were selected when the program was initiated (1967) to encompass the photic zone of the water column. Inability to gather real-time data using the CTD precluded sampling above and below the pycnocline. Discrete water samples were collected for dissolved nutrients (unionized ammonia, nitrite, nitrite-nitrate, and orthophosphorus), and chlorophyll *a* (and phaeopigment) analyses. Conductivity and dissolved oxygen samples were also drawn during most surveys for comparison with CTD values. Fecal coliform bacteria were collected in grab samples from the surface water using sterile glass sample bottles. All sampling methods followed the Recommended Protocols and Guidelines for Measuring Conventional Water Column Variables in Puget Sound (Puget Sound Estuary Program (PSEP), 1990). Sampling methods are also described in the Marine Water Column Ambient Monitoring Plan (Janzen, 1992b).

Water samples collected during the surveys were analyzed at Ecology's Manchester Environmental Laboratory. Beginning in WY 1991, all nutrient samples were filtered (using 0.45 μm pore filters) upon arrival to the lab (within 24 hours of sample collection). If immediate analysis was not possible, samples were frozen after being filtered. Results were reported as dissolved nutrients. Fecal coliform bacteria were analyzed using the membrane filter method (APHA, 1989). The Laboratory User's Manual (Ecology, 1992) and the Manchester Quality Assurance Manual (Ecology, 1988) describe analytical procedures followed by Manchester Laboratory.

Data Processing and Analysis

Ecology maintained discrete water sample results from each WY 1991 station using the Ambient Monitoring Database (AMS Database). Following quality assurance checks, these data were uploaded into STORET, a national environmental database managed by the United States Environmental Protection Agency (USEPA). Data were also uploaded into PC STORET, a PC version of the mainframe STORET.

Data were then summarized using commercially available spreadsheet and statistical software packages. Time series plots were produced using EXCEL®. The quality assurance assessment calculations were conducted using LOTUS® spreadsheets and a statistical package called WQHYDRO (Aroner, 1991).

CTD data were processed using SEASOFT® Software designed specifically for the Sea-Bird Electronic's CTD outputs. Calibrated CTD data were bin-averaged using half-meter bins. Bin-averaging translates the CTD data into ASCII engineering units. (The user can select either pressure, depth, or time bins and designate the bin size.) Profiles of salinity and density were derived using current average values of temperature, conductivity, and pressure. Further details on WY 1991 CTD processing procedures can be found in Sea-Bird Electronics, Inc., CTD Data Acquisition Software Manual (1989).

Discrete CTD data points from the surface (upper half-meter), 10-m, and 30-m were entered into the AMS Database, and stored and processed with the discrete nutrient, chlorophyll *a*, fecal coliform bacteria, and Secchi depth sample results. Complete CTD profile data were archived in hard-copy and on computer diskettes for subsequent data analysis and retrieval.

Quality Assurance/Quality Control

<u>CTD Calibration Procedures</u>

CTD calibration procedures are described in detail in the Marine Water Column Ambient Monitoring Plan (Janzen, 1992b), and in the Seacat® CTD Operator's Manual (Sea-Bird Electronics, 1990). Discrete water samples for conductivity and dissolved oxygen analyses were collected during surveys as part of the quality assurance checks conducted on the CTD sensors. The accuracy of these discrete sample results did not allow for direct calibration corrections to be made to the CTD data. However, these values were used to verify that the sensors were performing to the needed resolution (salinity to the nearest 0.01 parts per thousand (ppt), and dissolved oxygen to the nearest 0.5 milligram per liter (mg/L)). If a significant discrepancy existed, the data were flagged as estimated values. Factory and in-house laboratory calibrations were used for calibration coefficient calculation. These coefficients were computed with the needed accuracy and were applied during data processing. Annual factory calibration results and plots for the CTD temperature and conductivity probes, and biennial plots for the CTD pressure sensor, are provided in Appendix A. Factory calibration information on the CTD pH probe, dissolved oxygen probe, and light transmissometer are also in Appendix A.

Quality Assurance/Quality Control Objectives and Procedures

The quality assurance/quality control (QA/QC) objectives for discrete water column samples collected during the ambient marine water column program were determined by the MMC and are listed in the PSAMP Plan (MMC, 1988). Table 2 lists the current objectives met by Ecology's marine water column program. PSAMP objectives that differ from Ecology's current objectives include:

1) the detection limits (reporting limits) for nitrite (PSAMP requests 0.005 mg/L with an accuracy of +/- 20%);
2) the detection limits for orthophosphate (PSAMP requests 0.002 mg/L);
3) the precision (relative standard deviation) for chlorophyll *a* (PSAMP requests +/- 10%); and
4) the precision for fecal coliform bacteria (PSAMP requests +/- 25%).

All other objectives meet or exceed those listed in the PSAMP document.

The CTD parameter quality objectives were determined by the specifications generated by the factory.

Table 3 summarizes quality control procedures conducted by Manchester Laboratory during WY 1991. Additional laboratory quality assurance procedures are described in the Marine Water Column Ambient Monitoring Plan (Janzen, 1992b) and in the Manchester Quality Assurance Manual (Ecology, 1988). Data qualifiers for laboratory results are given with the station data reports in Appendix B.

In-Field Quality Assurance/Quality Control Procedures

During WY 1991, the field quality assurance procedure was modified. One station per survey was randomly selected for water sample replication. Surface water samples were collected using three separate surface bottle casts at each selected station. The replicates were sent to the laboratory as blind samples and analyzed for the full suite of dissolved nutrients and chlorophyll *a* (plus phaeopigment). Duplicate surface samples (two separate samples) for fecal coliform bacteria analysis were also collected at these selected stations.

Table 2. Marine water column quality assurance/quality control objectives.

Analytical Parameters	Ecology's Reporting Units	PSAMP's Reporting Units	Ecology Reporting Limit		Relative Standard Deviation (RSD)
Laboratory Sample Parameters:					
Ammonia	mg/L*	μg-at/L†	0.01*	0.71†	±10%
Nitrite	mg/L	μg-at/L	0.01	0.71	±10%
Nitrite-Nitrate	mg/L	μg-at/L	0.01	0.71	±10%
Orthophosphate	mg/L	μg-at/L	0.01	0.32	±10%
Chlorophyll & phaeopigments	μg/L		0.05		±20%
Fecal Coliform	#/100 mL		1		±20%
Conductivity	μmhos/cm @ 25 degrees Celcius (°C)		1		±3%
Salinity	parts per thousand (ppt)		2		±5%
CTD Parameters:					
Conductivity/ Salinity	ppt		0.01		±8%
Temperature	(°C)		0.1		±5%
pH	pH units		0.1		±0.1 pH unit
Dissolved Oxygen	mg/L		0.05		±8%
Light Transmissivity	% Light		0.01		±5%

* STORET units

† PSAMP units ((mg/L X 1000) ÷ 14.01) for nitrogen; ((mg/L X 1000) ÷ 30.97)) for phosphorus.

Table 3. Quality assurance/quality control procedures for water column parameter analysis in the laboratory.

Analytical Parameters	Calibration and Standardization	Check (control)* Standard (20 or less samples)	Replicates+ (20 or less samples)	Blanks per batch	Spiked Samples per batch
Ammonia	3 point Calibration (at beginning & end of ea. batch)	2 (per batch)	1	2	1
Nitrite	3 point Calibration (at beginning & end of ea. batch)	2 (per batch)	1	2	1
Nitrite-Nitrate	3 point Calibration (at beginning & end of ea. batch)	2 (per batch)	1	2	1
Orthophosphate	3 point Calibration (at beginning & end of ea. batch)	2 (per batch)	1	2	1
Chlorophyll & phaeopigments	1 per year	1 per year	1	2	N/A**
Fecal Coliform Bacteria	N/A	N/A	1	2	N/A
Conductivity	1 (batch)	1	1	N/A	N/A
Salinity	1 (batch)	1	1	N/A	N/A

* 1 high, 1 low standard

\+ Nutrients and chlorophyll *a* are replicated in the field. Fecal coliform bacteria samples are duplicated in the field.

** Not applicable

RESULTS

This section of the report presents the results from the water column sampling conducted during WY 1991. A later section discusses the results and correlates the findings. Surveys were conducted monthly at 28 stations throughout Puget Sound (Figure 1). Four stations in Grays Harbor and five stations in Willapa Bay were also sampled monthly (Figure 2). Inclement weather or other logistical constraints occasionally prevented a survey from being completed. A total of thirty-two surveys (of 36 planned) were conducted in Puget Sound, and 11 surveys (of 12 planned) were conducted in the coastal estuaries. The complete set of WY 1991 data (with qualifiers) are presented in Appendix B.

Vertical Profiles

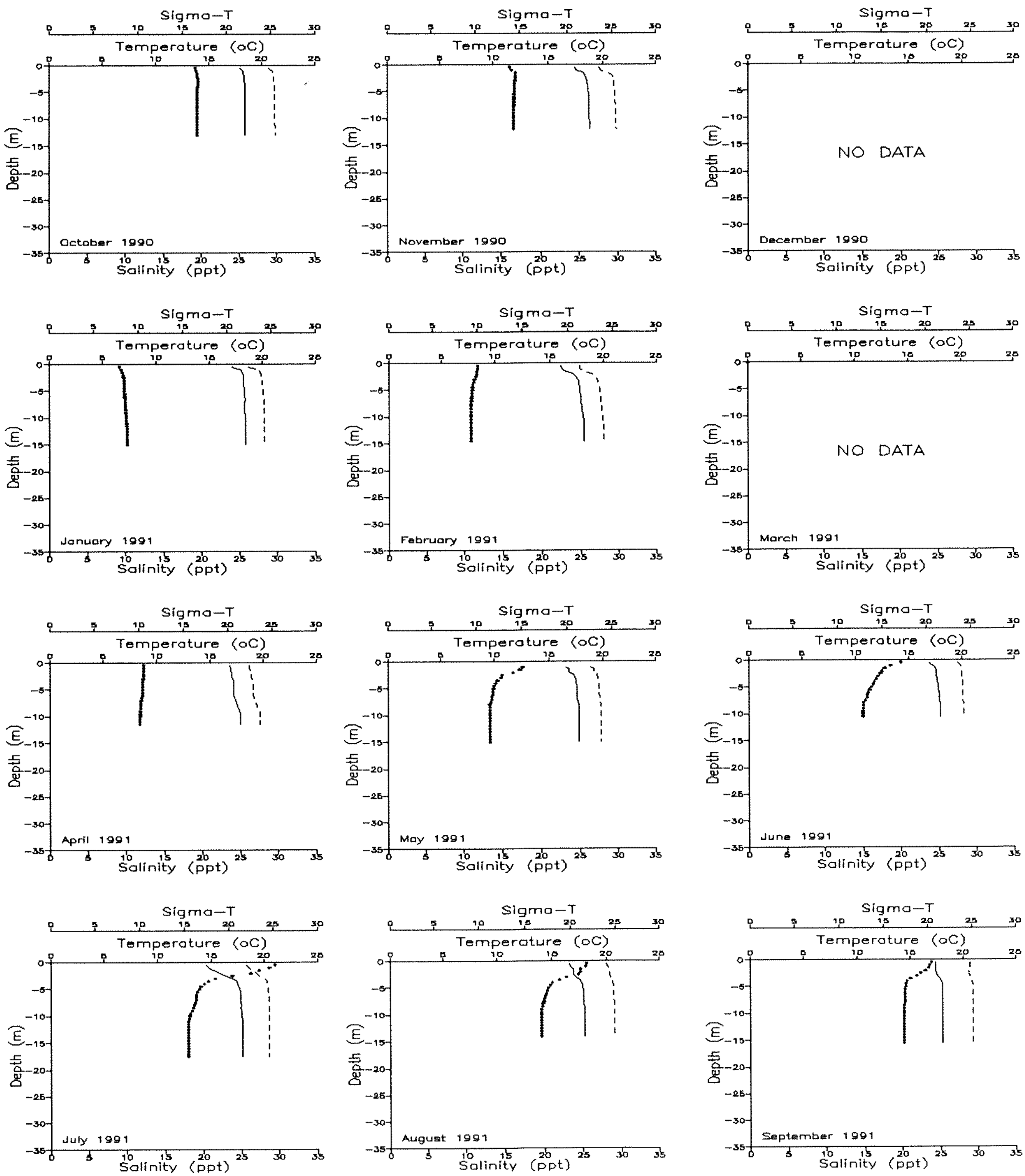
Vertical profile data were collected at all Puget Sound and coastal stations during WY 1991 using a continuously recording profiling CTD. Profiles were conducted to 30-m, the maximum depth of water sample collection. The profile data are important to the understanding of water column stratification, stability, and determination of the mixed layer. However, the exact depth of the mixed layer could not be determined accurately for this program's deeper stations (greater than 30-m), since the CTD profiles were not taken deeper than 30-m. Sigma-*t* units were used to illustrate density structure (stratification) in the water column. Sigma-*t* units represent the density of a particle of water at atmospheric pressure and are used as a convenient measure of water column density. Monthly vertical profile plots of temperature/salinity/density (T/S/D) for each station are in Appendix C.

Evidence of water column stratification was documented one or more times at 34 of the 37 locations profiled. Stronger stratification was observed at sites near freshwater sources and in areas of restricted circulation. As expected, vertical profiles varied by station, region, and season. The range of variation observed is illustrated in the following six examples:

> Central Budd Inlet (BUD005) in South Puget Sound showed density stratification in the very near surface waters (upper 2-m) from November 1990 through February 1991 (Figure 3). As expected, this density structure mimicked the salinity profile from the same periods during high freshwater discharge periods. By May 1991, thermal stratification developed in the upper 5-m and was well established by July 1991. Thermal stratification appeared to persist in the upper 5-m through September 1991. Salinity stratification during the 1991 summer period was relatively weak, except in July.
>
> In the Main Basin, just south of Whidbey Island (ADM003), vertical stratification was restricted to the near surface waters (upper 4-m) (Figure 4). The most significant density stratification was observed during October 1990, February, May, and August 1991. Thermal stratification, with warmer temperatures on the surface, was evidenced in the May, August, and September 1991 profiles. Reverse thermal stratification was seen starting with the October 1990 profile, likely a result of fall-winter surface cooling. Profiles were not collected until February, thus it was impossible to document the longevity of this condition.

WATERYEAR 1991

Budd Inlet (Station BUD005)

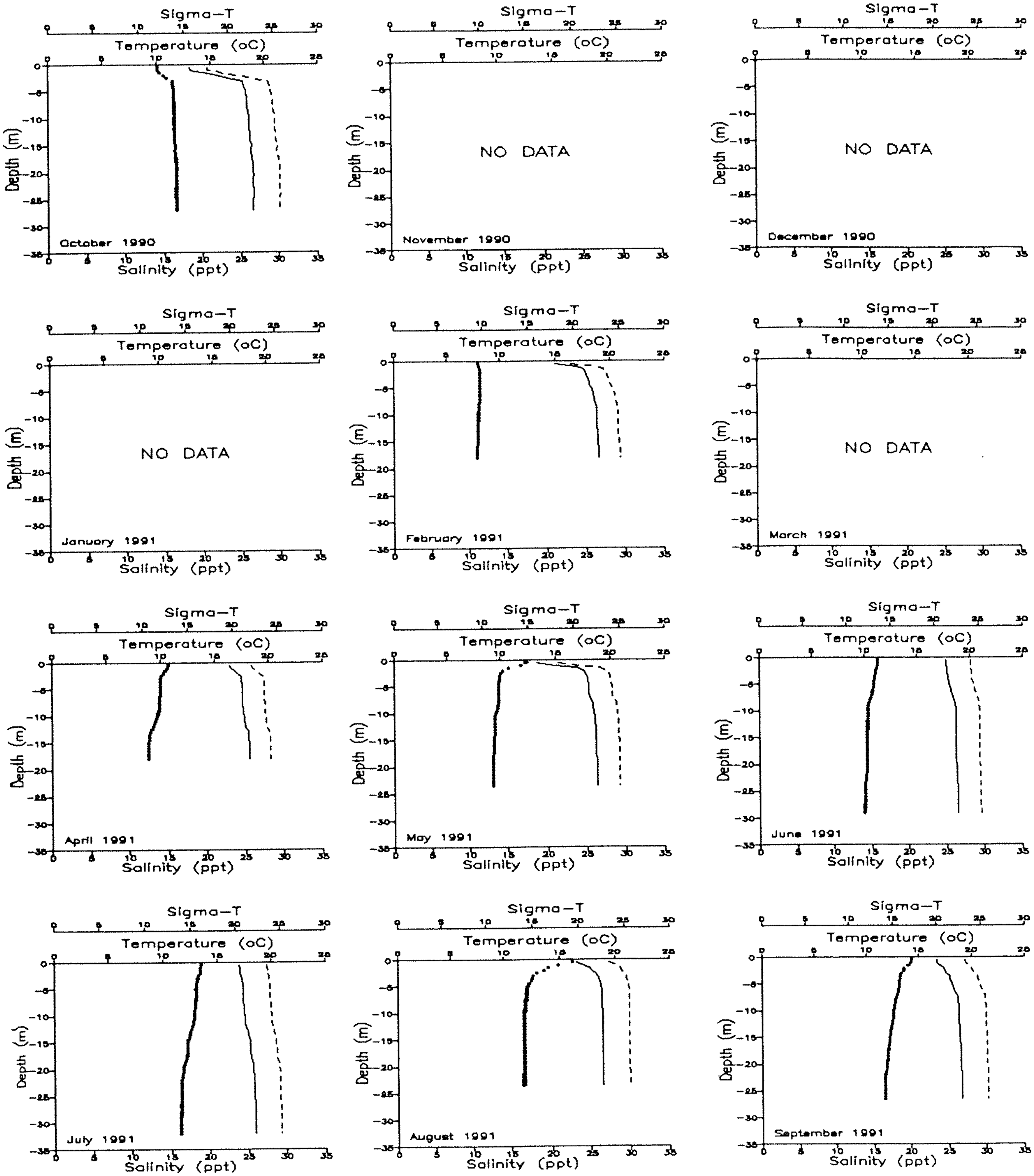


Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

Figure 3. Monthly temperature/salinity/density plots for Budd Inlet Station BUD005 during WY 1991.

WATERYEAR 1991

Central Puget Sound (Station ADM003)



Key:

Temperature = Dotted line

Salinity = Dashed line

Sigma-t = Solid line

Figure 4. Monthly temperature/salinity/density plots for Puget Sound Main Basin Station ADM003 during WY 1991.

Bellingham Bay (BLL009) in North Puget Sound illustrated an embayment stratified primarily as a result of strong seasonal freshwater inputs from the Nooksak River (Figure 5). Observed density stratification appeared strongest in October 1990 and July 1991 due to fresher surface waters. BLL009 in July 1991 was stratified in both the temperature and salinity profiles, resulting in a change of density from 16 to 22 sigma-*t* units within the upper 10-m.

Station NRR001 near Point Defiance in the Tacoma Narrows demonstrated a well mixed water column (Figure 6). This was likely because the tidal currents through the Narrows induce strong vertical mixing over the sill zone that separates the Southern Basin from the Main Basin. Although water temperatures and salinity values changed with the seasons, no visible thermal or salinity stratification was observed at NRR001 during WY 1991. As expected, temperatures cooled by December 1990 and showed signs of warming by April 1991. Salinity remained around 30 ppt, with slightly lower water column salinities visible in April 1991, presumably as a result of melting snow pack and subsequent increased freshwater discharge from rivers entering Puget Sound.

Station GYS009 in the north channel of Grays Harbor showed observable salinity stratification on several occasions as seen in the November 1990, February, May, and July 1991 profiles (Figure 7). Stratification observed at this station likely depended on both the amount of freshwater discharge from the Chehalis River and on the stage of the tide during sampling.

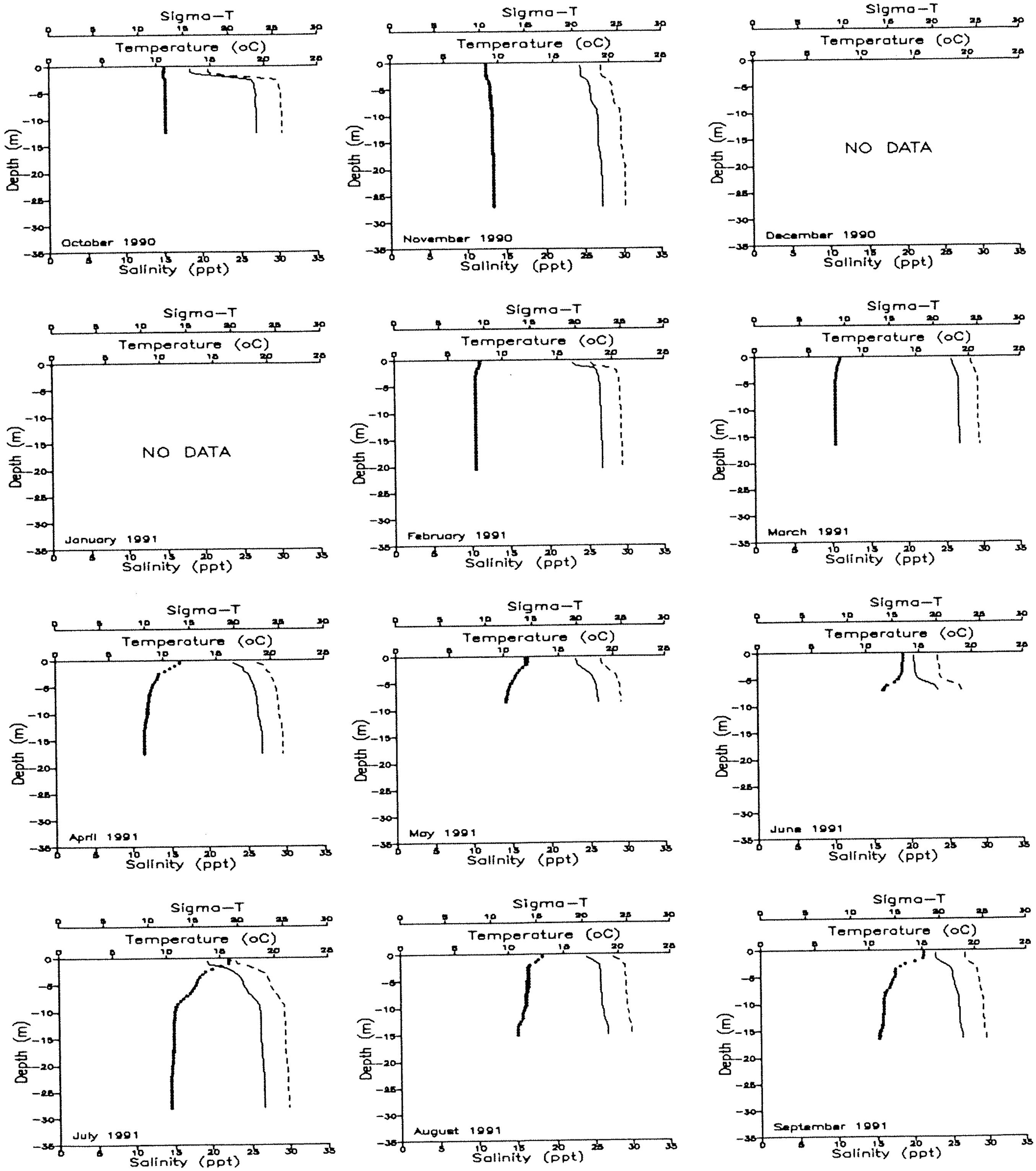
Station WPA004 in the northern portion of Willapa Bay was influenced both by river discharge from the Willapa River, and by the incoming oceanic waters from the Pacific Ocean (Figure 8). Surface salinity ranged from 21 ppt to 32 ppt, with the lowest water column salinity occurring from January 1991 through June 1991 (high discharge months). The highest salinities were recorded in October 1990 and September 1991. Temperatures were lowest in winter and started warming by April. Surface water temperatures dropped almost 3 degrees Celcius (°C) from July to August. Little thermal stratification was observed throughout the entire wateryear. The profiles showed near surface stratification during the high discharge periods, and illustrated a fairly mixed water column during low discharge periods.

Dissolved Oxygen

Dissolved oxygen was measured at all Puget Sound and coastal stations during WY 1991. All stations sampled during WY 1991 were in Class A or AA waterbodies (WAC 173-201, 1991). Of the 28 Puget Sound stations, 23 violated dissolved oxygen standards for Class AA (less than 7.0 mg/L) and A (less than 6.0 mg/L) marine waters during WY 1991. None of the coastal stations violated state water quality standards for dissolved oxygen. Most of the violations in Puget Sound occurred in the mid-summer through fall months, though some stations were in violation year-round (Table 4).

WATERYEAR 1991

Bellingham Bay (Station BLL009)

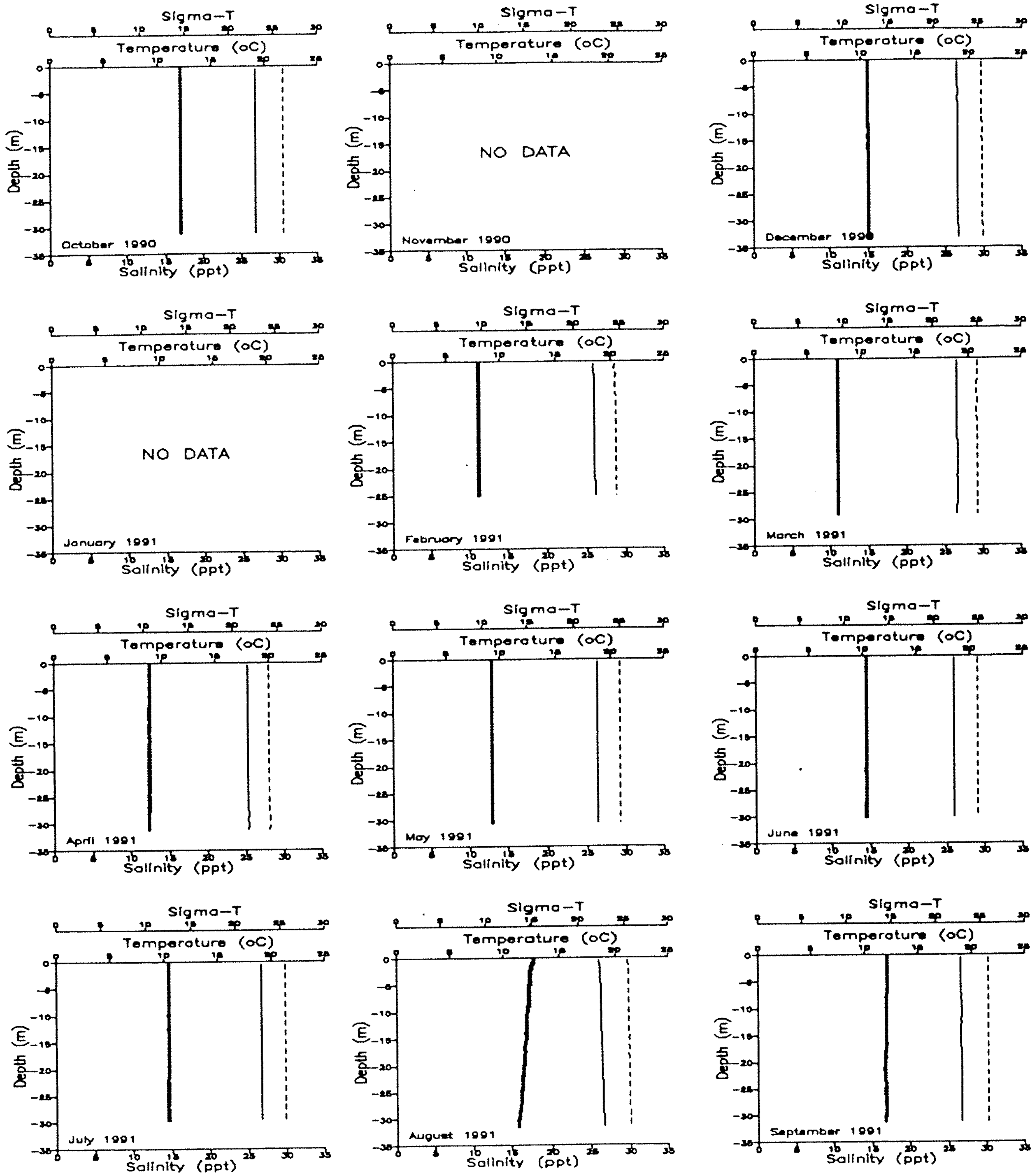


Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

Figure 5. Monthly temperature/salinity/density plots for Bellingham Bay Station BLL009 during WY 1991.

WATERYEAR 1991

Tacoma Narrows (Station NRR001)

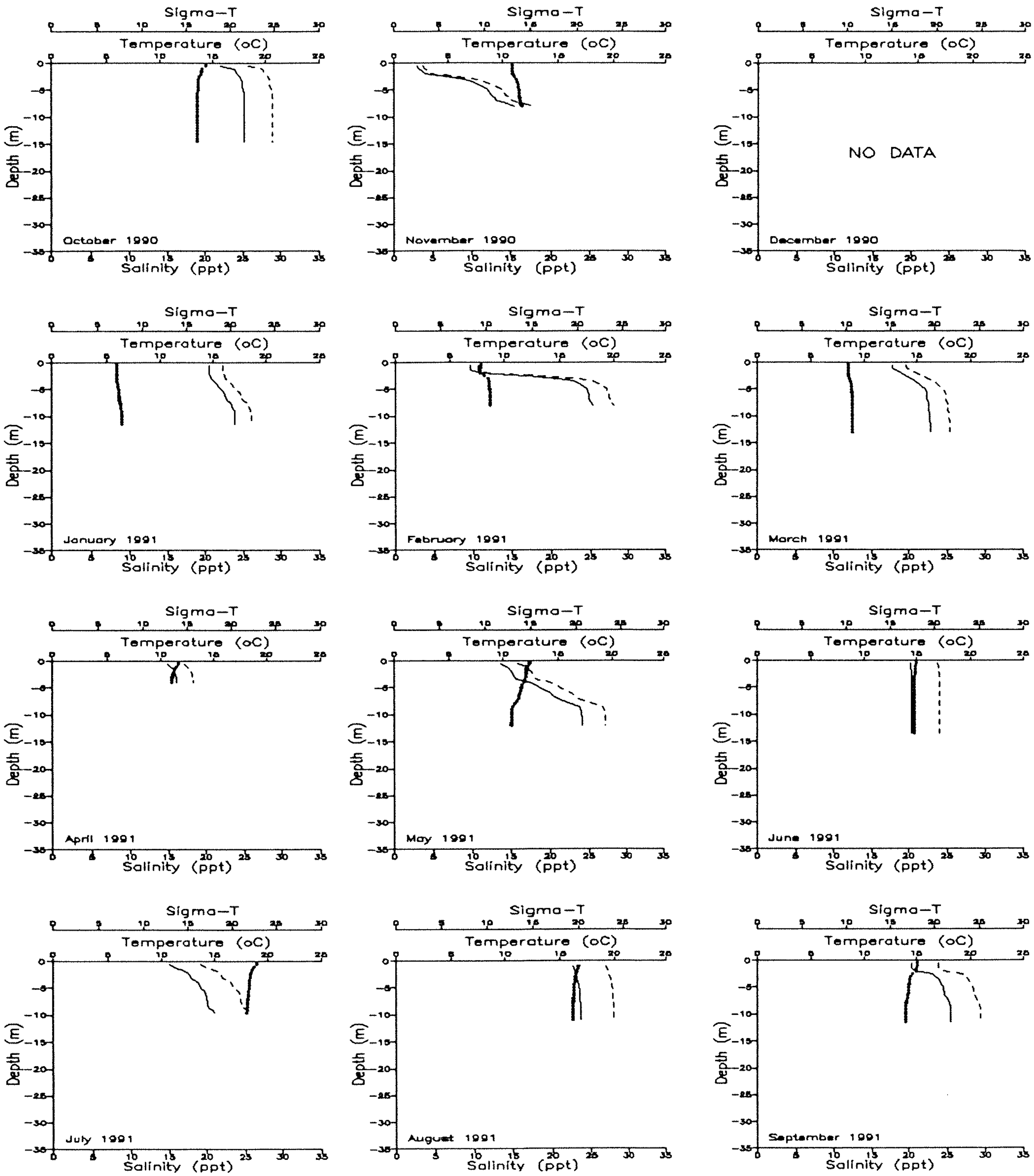


Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

Figure 6. Monthly temperature/salinity/density plots for Tacoma Narrows Station NRR001 during WY 1991.

WATERYEAR 1991

North Channel, Gray's Harbor (Station GYS009)



Key:

Temperature = Dotted line

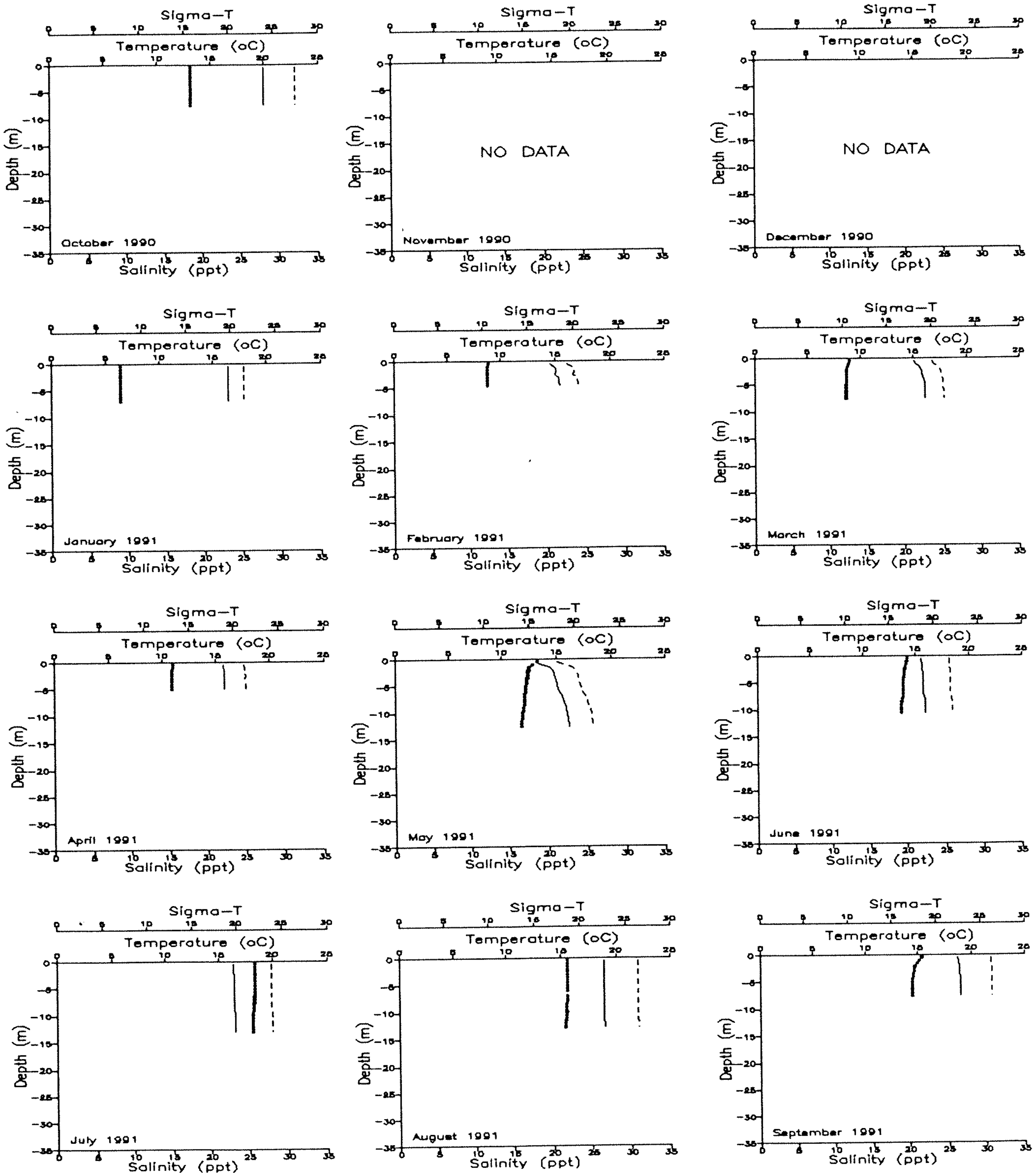
Salinity = Dashed line

Sigma-t = Solid line

Figure 7. Monthly temperature/salinity/density plots for Grays Harbor Station GYS009 during WY 1991.

WATERYEAR 1991

North Willapa Bay (Station WPA004)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

Figure 8. Monthly temperature/salinity/density plots for Willapa Bay Station WPA004 during WY 1991.

Table 4. WY 1991 marine water column stations that violated marine dissolved oxygen water quality standards one or more times.

	Water Quality Class	Depths Violated	Number of Months Violated	Months of Violation
North Puget Sound Stations				
GRG002	AA	all depths	4	July-Nov
BLL009	A	10-m	4	July-Oct
ADM002	AA	all depths	4	June-Sept
SAR003	A	30-m	3	July-Oct
JDF005	AA	10, 30-m	2	Sept-Nov
PAH008	AA	all depths	6	July-Oct
LOP001	AA	10-m	2	July-Aug
EAS001	AA	10-m	2	July-Aug
PSS019	A	10, 30-m	2	July-Oct
Central Puget Sound Stations				
ADM003	AA	10, 30-m	3	Aug-Oct
PSB003	AA	10, 30-m	2	Sept-Oct
EAP001	AA	10, 30-m	1	Oct
CMB003	A	10, 30-m	1	Oct
NRR001	AA	all depths	5	July-Oct
South Puget Sound Stations				
DNA001	AA	all depths	2	Oct-Nov
BUD005	A	all depths	1	Nov
NSQ001	AA	all depths	1	Oct
CSE001	AA	all depths	1	Oct
CRR001	AA	10, 30-m	2	Sept-Oct
Hood Canal Stations				
HCB006	AA	all depths	4	July-Oct
HCB003	AA	30-m	9	all year
HCB004	AA	10, 30-m	10	all year
HCB007	AA	10-m	5	Feb-Apr & Aug-Sept

Of special interest were sites that experienced dissolved oxygen concentrations of 5.0 mg/L or less, since at this concentration, biota begin to experience stress (see Discussion). Seven stations visited during WY 1991 experienced dissolved oxygen concentrations of 5.0 mg/L or less and are listed in Table 5 and shown in Figure 9.

Dissolved oxygen and light transmissivity profiles for all stations are presented in Appendix D.

Fecal Coliform Bacteria

Fecal coliform bacteria samples were collected at 26 of the 28 Puget Sound stations, at three of the Grays Harbor stations, and at three of the Willapa Bay stations. Fifteen Puget Sound and coastal stations had fecal counts above 14 organisms/100 mL (Table 6; Figures 10 and 11). Of these fifteen stations, all the six sampled coastal stations, and five of the Puget Sound urban bay stations surpassed 14 organisms/100 mL two or more times (Table 6 lists the three highest counts for the stations that exceeded 14 organisms/100 mL one or more times). Counts above 14 organisms/100 mL occurred during the fall through spring months for Puget Sound, and year-round for the coastal stations (Table 6).

This value (14 organisms/100 mL) was selected for flagging data based on the water quality standards for Class AA and A marine waters, since all but one of the ambient stations sampled in WY 1991 were either in Class AA or A waterbodies. The absolute standard of 14 organisms/100 mL is based on a geometric mean of multiple results. The ambient data cannot be directly applied to this standard, because an insufficient number of samples were collected to calculate a geometric mean during a given sampling period. The data should be used with caution when compared to the standards. Fecal coliform bacteria results from all WY 1991 stations are provided in Appendix B.

Nutrient Concentrations

Nutrient samples were collected at 26 of the 28 Puget Sound stations, at three of the five Willapa Bay stations, and at three of the four Grays Harbor stations. Higher surface nutrient concentrations were seen year-round at offshore stations that were well mixed. Areas that showed lower surface nutrient concentrations were in more stratified environments where seasonal influences (river discharge, thermal warming, photosynthesis by phytoplankton) have a larger effect on water quality characteristics. Plots of surface, 10-m, and 30-m nutrient concentrations for nitrite-nitrate (NO_2-NO_3), orthophosphorus (O-PO_4), and ammonia (NH_3) for each WY 1991 station are included in Appendices E, F, and G, respectively.

In this report, nutrient depletion was based on nitrite-nitrate (NO_2-NO_3) concentrations. The NO_2-NO_3 concentration used to define depletion was an estimated value used for all marine stations. This estimated value was derived during a primary productivity study conducted in Budd Inlet by URS Consultants (URS, 1986). The NO_2-NO_3 concentration considered depleted (thus limiting to phytoplankton growth) was a concentration at or below 0.04 mg/L (2.86 μmol/L Nitrogen; see Discussion).

Table 5. Stations with low dissolved oxygen concentrations (below 5.0 mg/L) during WY 1991.

Station	Depth (m)*	Month	D.O. (mg/L)
North Sound			
ADM002 (depth > 30-m)	28.5-32.0	September	5.0-4.5
PAH008	8.5-18.0	October	5.0-4.5
PSS019 (depth > 30-m)	28.5-29.0	October	5.0
SAR003 (depth > 30-m)	14.0-31.5	October	5.0-4.4
Hood Canal			
HCB003 (depth > 30-m)	22.5-25.5	July	5.0-4.7
	18.0-32.0	August	4.9-3.2
	14.5-33.0	September	4.7-2.4
HCB004 (depth > 30-m)	13.5-29.5	December	5.0-3.8
	24.5-32.0	January	5.0-4.6
	16.5-32.5	February	4.9-4.1
	13.5-31.5	March	5.0-4.0
	7.5-31.0	April	4.9-3.7
	12.5-30.0	May	5.0-3.3
	18.5-31.0	June	4.9-1.7
	15.5-29.0	July	4.6-1.1
	10.5-33.0	August	4.9-0.7
	11.0-30.0	September	4.8-0.2
HCB007	17.0-24.0	December	5.0-3.5
	13.0-22.0	February	5.0-3.4
	12.0-15.5	March	5.0-3.9
	7.0-12.0	April	5.0-3.0
	14.0-15.5	May	4.7-3.3
	10.5-14.5	August	4.2-1.7
	11.0-15.0	September	4.8-0.9

* Depths of oxygen changes are likely affected by tidal action, thus may fluctuate over a tidal cycle.

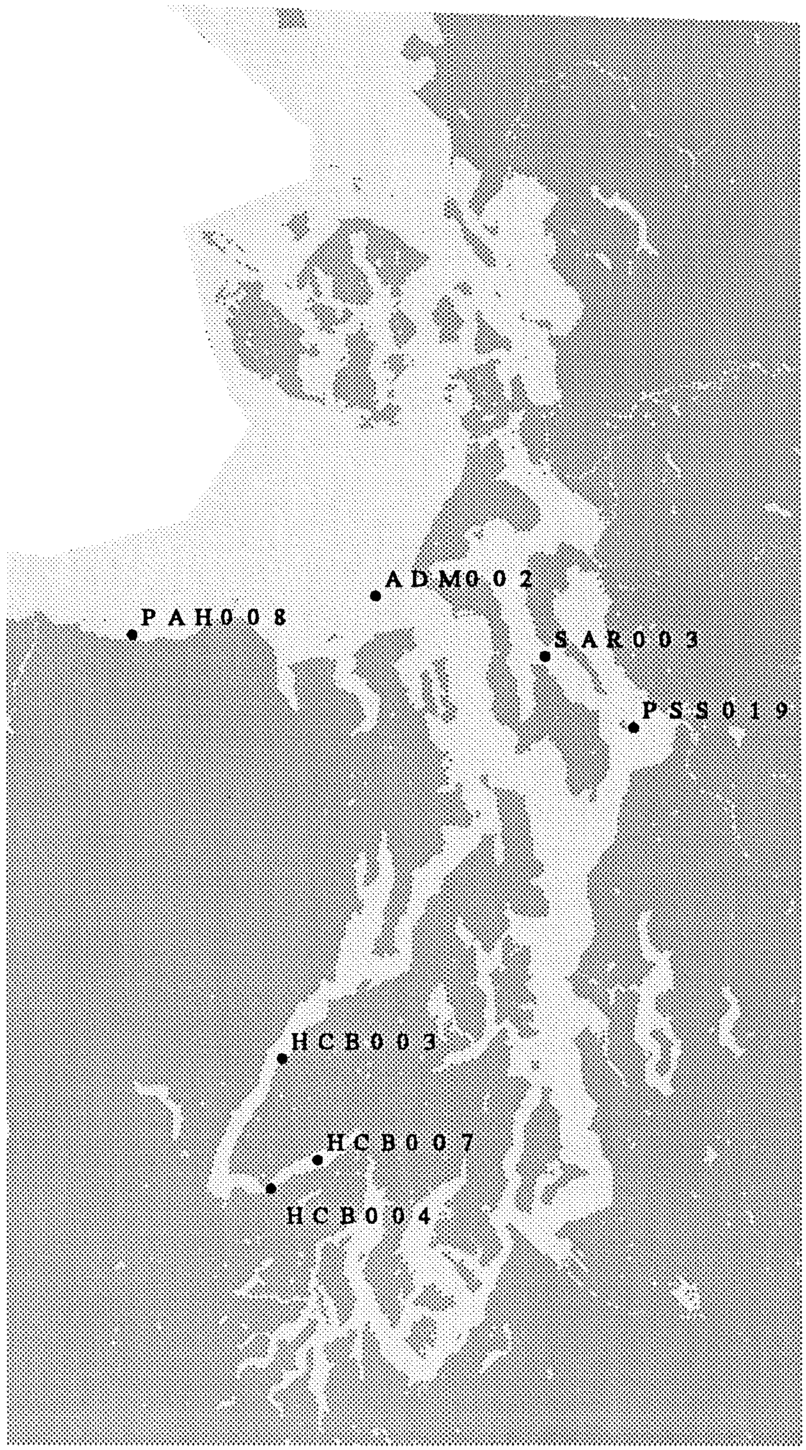


Figure 9. WY 1991 Puget Sound stations that experienced oxygen concentrations less than 5.0 mg/L.

Table 6. WY 1991 water column stations that exceeded a fecal coliform bacteria count of 14 organisms/100 mL one or more times.

Station	Highest Count	2nd Highest Count	3rd Highest Count
North Sound			
BLL009+*	18 (15OCT90)	NA	NA
PSS019+*	>200 (15OCT90)	88 (04MAR91)	38 (05DEC91)
SKG003*	20 (23SEP91)	16 (04MAR91)	NA
Central Sound			
ADM003	84 (05FEB91)	14 (22OCT90)	NA
CMB003+*	220 (05FEB91)	100 (05DEC90)	96 (04MAR91)
NRR001	14 (02FEB91)	NA	NA
PSB003+	200 (05DEC90)	190 (05 FEB91)	44 (22OCT90)
South Sound			
BUD005+*	32 (12NOV90)	14 (08JAN91)	NA
NSQ001*	23 (08APR91)	NA	NA
OAK004*	79 (08JAN91)	73 (12DEC90)	21 (06MAY91)
CSE002	35 (11FEB91)	NA	NA
Coastal			
GYS004+*	140 (28JAN91)	120 (25JUN91)	73 (12NOV90)
GYS008+*	250 (20SEP91)	110 (26AUG91)	14 (25JUN91)
GYS009+*	92 (12NOV90)	73 (29JUL91)	67 (20SEP91)
WPA001+*	100 (25JUN91)	46 (26MAR91)	25 (20MAY91)

NA = Not Applicable
\+ = Close to Urban Areas
* = Close to Major Riverine Input

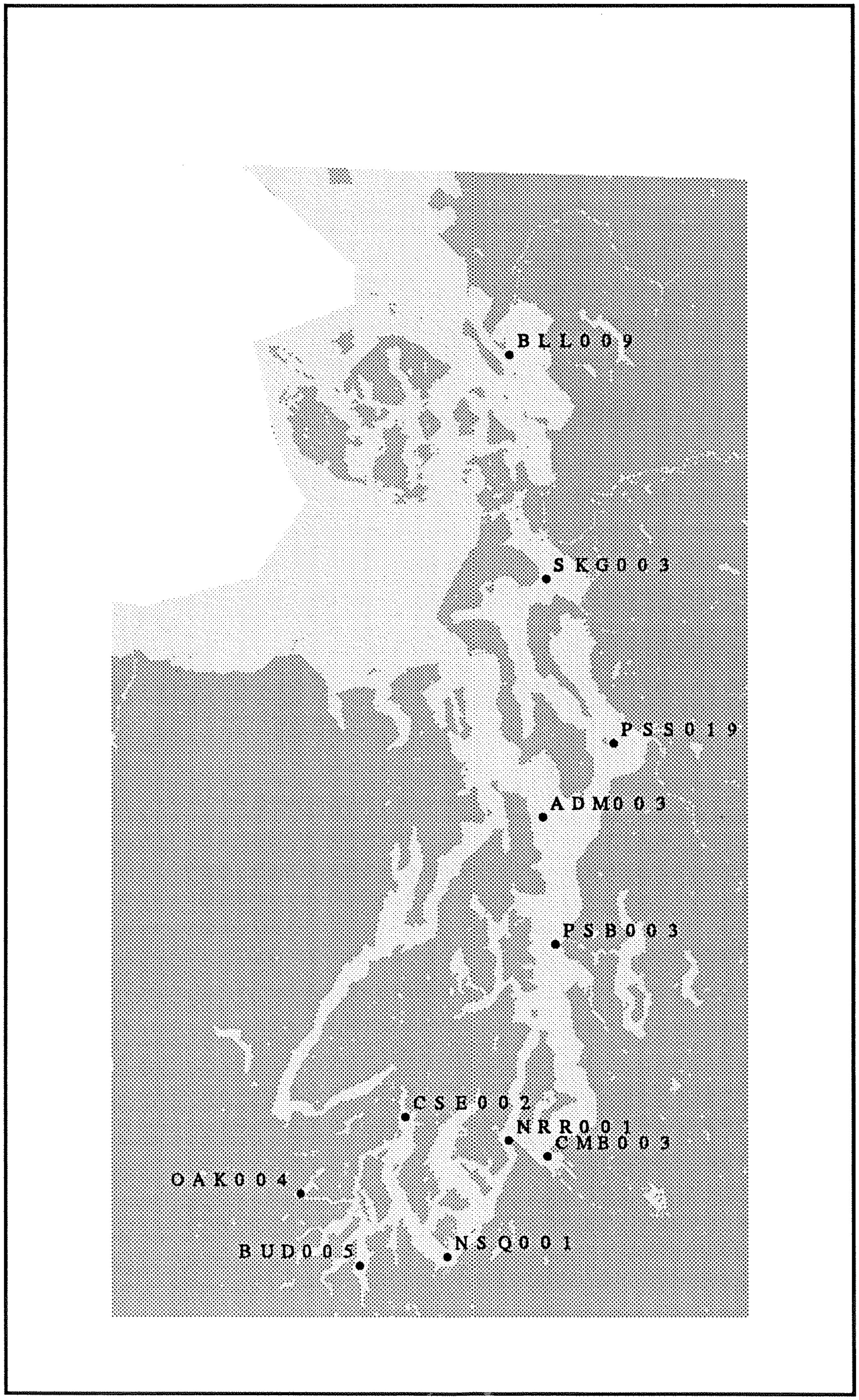


Figure 10. WY 1991 Puget Sound stations that exceeded a fecal coliform bacteria count of 14 organisms/100 mL one or more times.

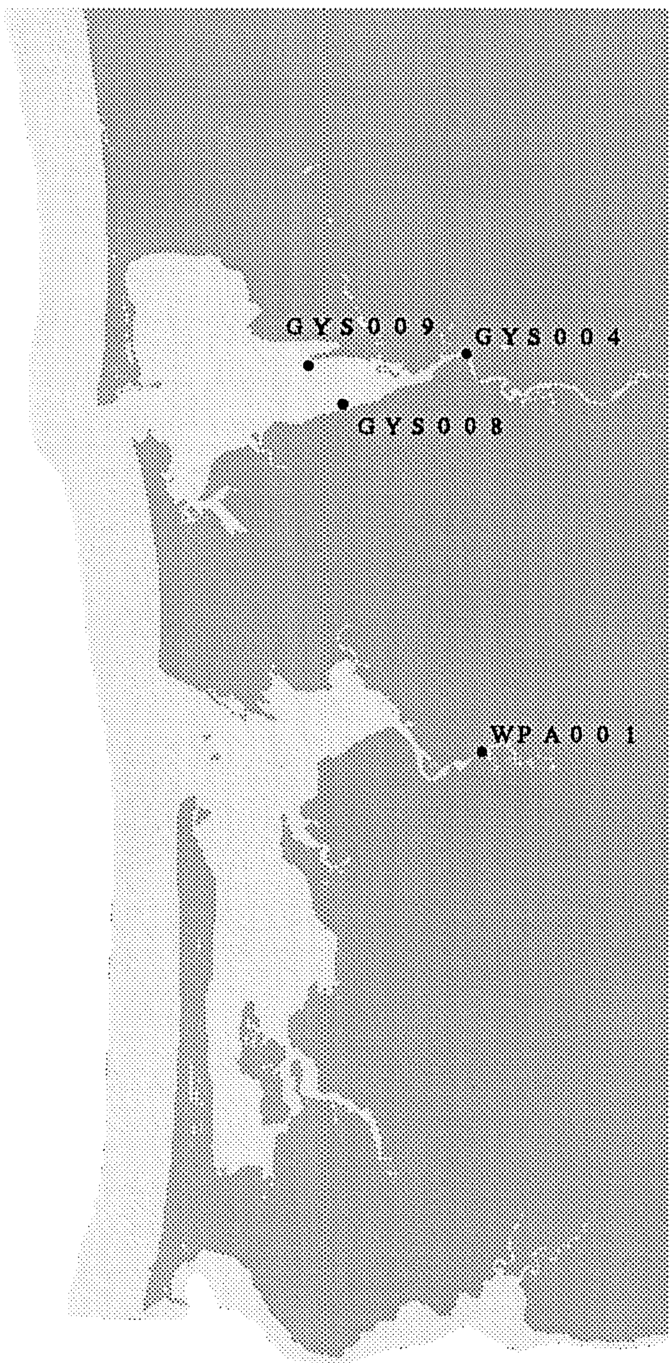


Figure 11. WY 1991 coastal stations that exceeded a fecal coliform bacteria count of 14 organisms/100 mL one or more times.

Of the 26 stations for which nutrient data were collected, NO_2-NO_3 depletion was observed at 20 Puget Sound stations, and three Willapa Bay stations. Depletion was not observed at any of the Grays Harbor stations.

In general, nutrient concentrations decreased from March 1991 through July 1991, with the lowest values occurring during the late spring, summer or early fall months (depending on the station). The NO_2-NO_3 concentrations in Puget Sound and the coastal estuaries were highest during the winter months (November 1990 through March 1991) (Appendix B). The observed dates of NO_2-NO_3 depletion varied from station to station and are presented in Table 7.

Surface NO_2-NO_3 depletion that occurred for two or more consecutive months may have indicated nutrient uptake exceeding the rate of replenishment. WY 1991 stations that showed surface NO_2-NO_3 depletion for two or more consecutive months are listed in Table 8 and shown in Figures 12 and 13.

During WY 1991 sampling efforts, surface NO_2-NO_3 depletion was observed only once at the following stations:

- LOP001 Lopez Sound, Lopez Island (June 1991);
- ADM003 Northern Main Basin, south of Whidbey Island (May 1991);
- CMB003 Commencement Bay (May 1991).

Surface NO_2-NO_3 depletion was observed simultaneously at surface and 10-m depths at the stations listed in Table 9 and shown in Figure 14. Stations that did not show any NO_2-NO_3 depletion during WY 1991 monitoring are listed in Table 10 and shown in Figures 15 and 16.

Chlorophyll *a* Concentrations

As expected, chlorophyll *a* concentrations in Puget Sound increased during the spring and summer months (March through August), and were generally lowest during the late fall and winter months (October through February). The coastal stations exhibited the highest chlorophyll *a* concentrations during mid-summer (July 1991) and mid-fall (October 1990). Chlorophyll *a* results for late August and September 1991 did not meet the program quality assurance/control objectives (Eisner, 1992; Appendix H), therefore were not included in this analysis.

Nutrient/Chlorophyll *a* Time Series

Time series plots comparing surface NO_2-NO_3 with surface chlorophyll *a* concentrations at all WY 1991 stations are presented in Appendix I. Select time series plots of 10-m nitrogen and chlorophyll *a* concentrations are presented in Appendix J.

Table 7. WY 1991 stations that showed nutrient depletion and observable density, salinity, and/or temperature stratification.

	Months in WY 1991											
Station	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
ADM002 Straight of Juan de Fuca	ND	ND	ND		ND							
ADM003 Central Puget Sound	D,S,T	ND	ND	ND	D,S	ND	D,S	▲,D,S,T		▲	D,S,T	D,S
BLL009 Bellingham Bay	D,S	D,S	ND	ND	D,S		D,S,T	D,S,T	▲,D,S,T	▲,D,S,T	D,S,T	▲,D,S,T
BUD005 Budd Inlet		D,S	ND	D,S	D,S	ND		▲,D,S,T	▲,T	▲,D,S,T	▲,D,T	▲,D,T
CMB003 Commencement Bay	D,S,T	ND	D,S	ND	D,S	D,S	D,S,T	▲,D,S,T	D,S,T	D,S,T	D,S,T	
CRR001 Carr Inlet		ND						▲	▲,T	▲,D,T	▲,D,T	▲,T
CSE002 Case Inlet - Inner*	ND	D,S			D,S		D,S	T	T	D,T	D,T	
CSE001 Case Inlet - Outer		ND						▲,T	▲,T	▲,T	▲,T	▲
DIS001 Discovery Bay	ND					▲		▲,T	▲,T	▲,T	▲,T	▲,T
DNA001 Dana Passage							D,S			T		
EAP001 East Passage - Central		ND		ND				▲,D,S,T	▲,D,S,T	▲,T	▲,T	
EAS001 East Sound - Orcas Island	ND			ND			▲,T	▲,T	▲,D,S,T	D,S,T	T	T
GRG002 Strait of Georgia	ND		ND	ND	D,S			D,S			D,S,T	D,S,T
GYS004 Chehalis R. - Grays Harbor	D,S		ND	D,S	D,S	D,S		D,S	D,S	D,S	ND	D,S
GYS008 S Channel - Grays Harbor		ND	ND	D,S	D,S	D,S		D,S				D,S
GYS009 N Channel - Grays Harbor	D,S	D,S	ND	D,S	D,S	D,S		D,S,T		D,S,T		D,S
GYS016 Damon Pt - Grays Harbor*	ND	ND	ND		D,S	D,S		D,S				
HCB003 C Hood Canal Eldon	ND	ND	D,S		D,S	D,S	D,S	▲,D,S,T	▲,D,S,T	▲,D,S,T	▲,D,S,T	▲,D,S,T
HCB004 S Hood Canal Sister's Pt	ND	ND	D,S	D,S	D,S	▲,D,S	D,S	▲,D,S,T	▲,D,S,T	▲,D,S,T	▲,D,S,T	▲,D,S,T
HCB006 N Hood Canal Bangor		ND			D,S	▲,D,S	D,S	▲,D,S,T		▲,D,T	▲,T	T
HCB007 S Hood Canal Lynch Cove	ND	ND	D,S		D,S	▲,D,S	D,S	▲,D,S,T	▲,D,S,T	▲,D,S,T	▲,D,S,T	▲,D,S,T

Table 7. (Continued)

Station	Months in WY 1991											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
JDF005 Sequim Bay Central	ND						▲	T	▲,T	▲,T	▲,T	▲,T
JDF007 Sequim Bay South*	ND					T	T	T	T	T	T	T
LOP001 Lopez Sound	ND			ND		T	T		▲,T			T
NRR001 Tacoma Narrows		ND		ND								
NSQ001 Nisqually Reach	D,S	ND	ND	D,S		D,S	D,S	D,S	D,S,T	T		T
OAK004 Oakland Bay		ND	D,S	D,S	D,S	D,S	D,S	▲,D,S,T	▲,D,S,T	▲	▲,T	
PAH008 Straits of Juan de Fuca												
Near Port Angeles		ND	ND						D,S,T	T		
PSB003 Puget Sound Main Basin	D,S	ND		ND	D,S		D,S			▲		
PSS019 Possession Sound	D,S	ND	D,S	ND	D,S	D,S	▲,D,S,T	▲,D,S,T	▲,D,S,T	▲,D,S,T	▲,D,S,T	▲,D,S,T
SAR003 Saratoga Passage	D,S	ND	D,S	ND	D,S	D,S	▲,D,S,T	▲,D,S,T	▲,D,S,T	▲,D,S,T	▲,D,S,T	▲,D,S,T
SKG003 Skagit Bay	ND	ND	D,S	ND	D,S	D,S	D,S,T	D,S,T	▲,D,S,T	▲,D,S,T	▲,D,S,T	D,S,T
WPA001 Willapa R. – Willapa Bay	D,S,T	ND	ND			D,S	D,S,T	D,S	▲,D,S			D,S,T
WPA003 Johnson Slough – Willapa Bay		ND	ND	D,S	D,S	D,S	T	D,S,T	▲	▲	▲	D,S,T
WPA004 N Willapa Bay		ND	ND		D,S	▲	▲	D,S	▲	▲		T
WPA006 Nahcotta Channel*	ND	ND	ND					D,S,T				
WPA007 Jenson Pt – Long Is*	ND	ND	ND	ND	ND							

ND = no data

▲ = denotes nutrient depletion (concentration at or below 0.04 mg/L)

D = density stratification

S = salinity stratification

T = temperature stratification

* = no nutrient data collected at this site

Table 8. WY 1991 stations that showed surface NO_2-NO_3 depletion for two or more consecutive months.

Region/Station	Description	Number of Months
North Puget Sound Stations		
BLL009	Bellingham Bay	2
SKG003	Skagit Bay	3
EAS001	East Sound - Orcas Island	3
JDF005	Sequim Bay	4
DIS001	Discovery Bay	5
SAR003	Saratoga Passage	6
PSS019	Possession Sound	6
Central Puget Sound Stations		
EAP001	East Passage - Main Basin	4
South Puget Sound Stations		
OAK004	Oakland Bay	4
BUD005	Budd Inlet	5
CRR001	Carr Inlet - Green Point	5
CSE001	Case Inlet - Heron Island	5
Hood Canal Stations		
HCB006	N. Hood Canal - Bangor	2
HCB003	C. Hood Canal - Eldon	5
HCB004	S. Hood Canal - Sister's Point	5
HCB007	S. Hood Canal - Lynch Cove	5
Coastal Stations		
WPA003	Willapa Bay - Johnson Slough	3
WPA004	Willapa Bay - Toke Point	4

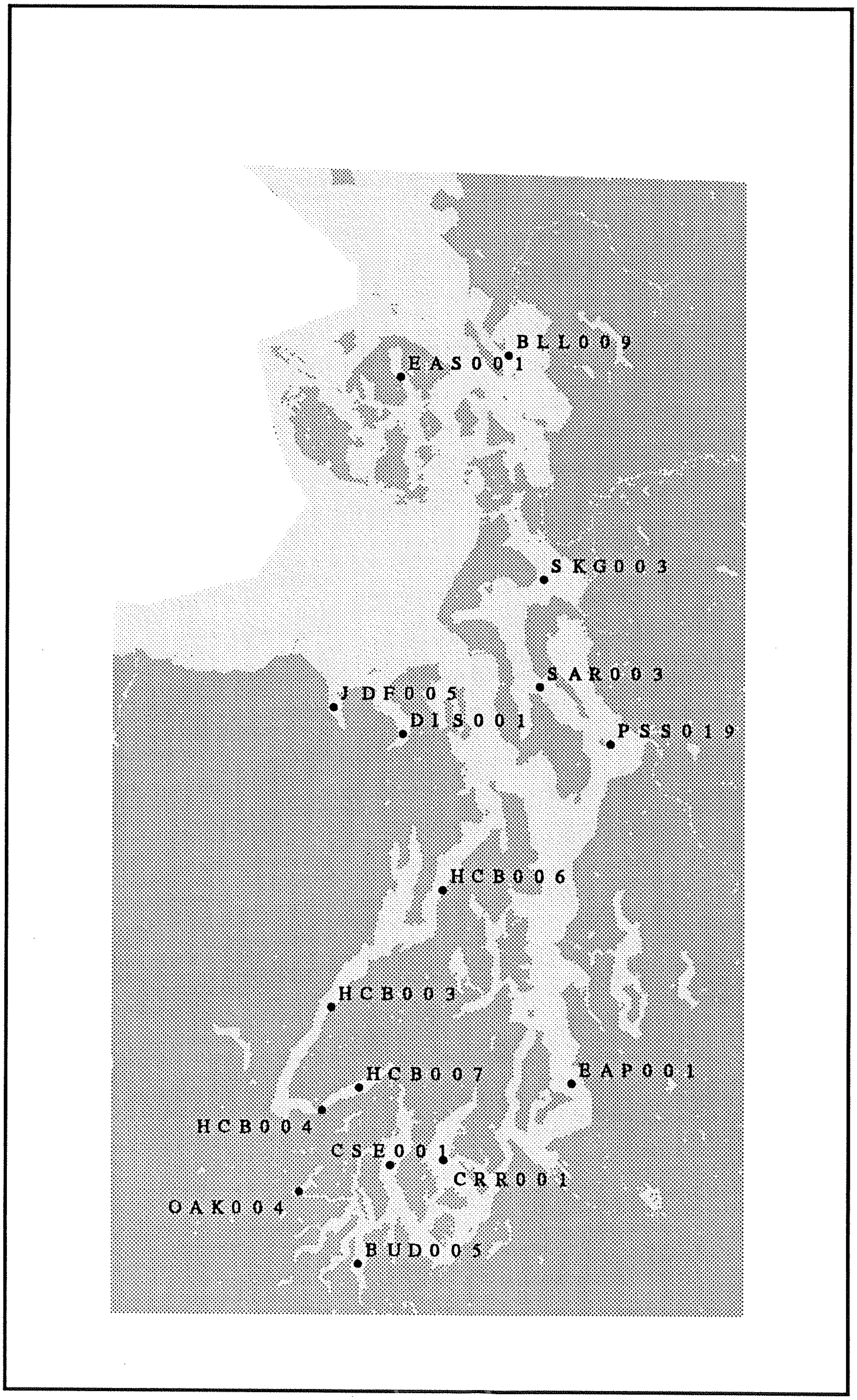


Figure 12. WY 1991 Puget Sound stations that showed surface NO_2-NO_3 depletion for two or more consecutive months.

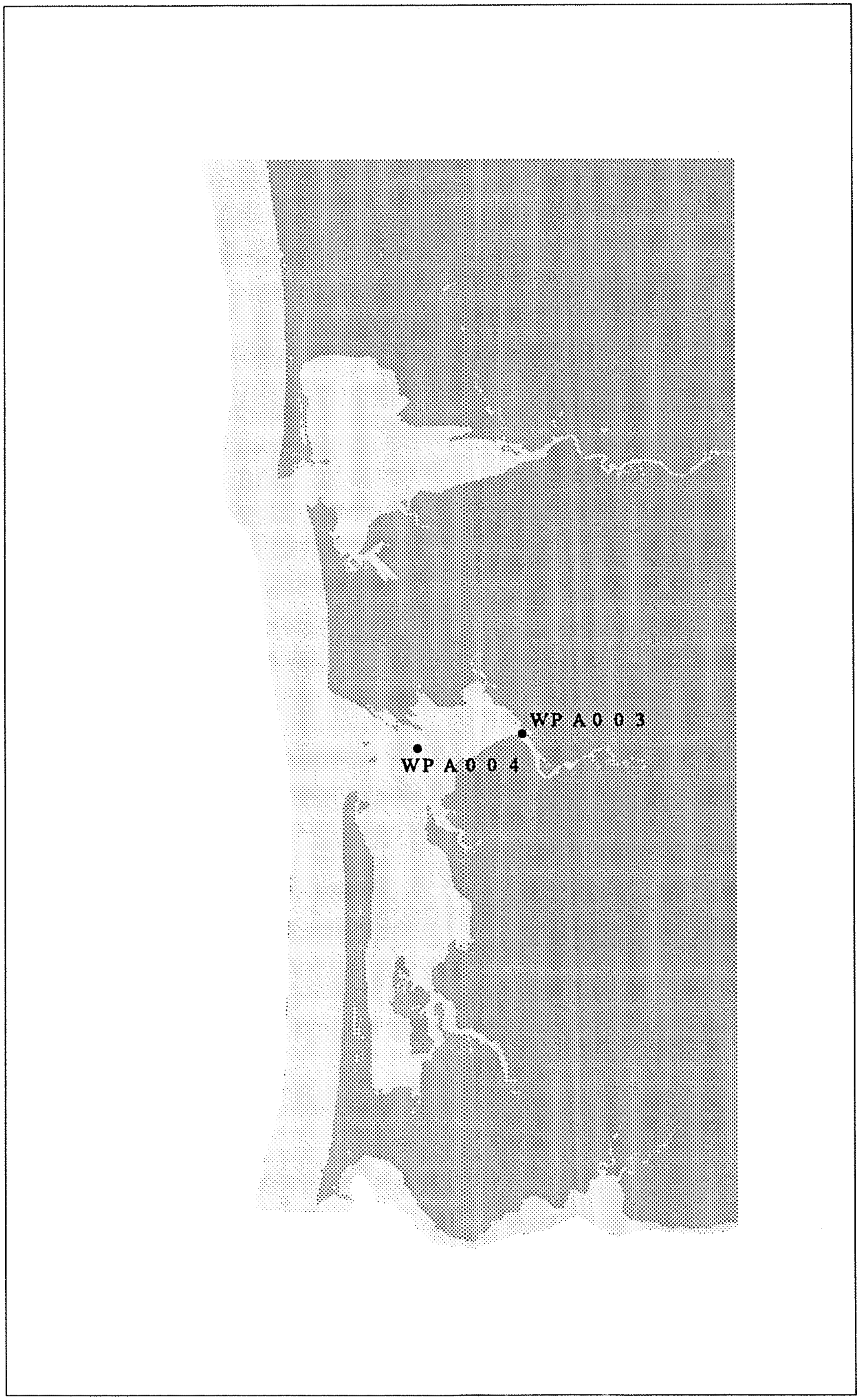


Figure 13. WY 1991 coastal stations that showed surface NO_2-NO_3 depletion for two or more consecutive months.

Table 9. WY 1991 stations that showed simultaneous surface and 10-m NO_2 and NO_3 depletion.

Region/Station	Description	Months
North Puget Sound Stations	NA	
Central Puget Sound Stations	NA	
South Puget Sound Stations		
OAK004	Oakland Bay	May, July, August 1991
BUD005	Budd Inlet	August, September 1991
CRR001	Carr Inlet - Green Point	September 1991
CSE001	Case Inlet - Heron Island	June 1991
Hood Canal Stations		
HCB006	N. Hood Canal - Bangor	August 1991
HCB003	C. Hood Canal - Eldon	July 1991
HCB004	S. Hood Canal - Sister's Point	June, July, August 1991
HCB007	S. Hood Canal - Lynch Cove	June, July 1991
Coastal Stations	NA	

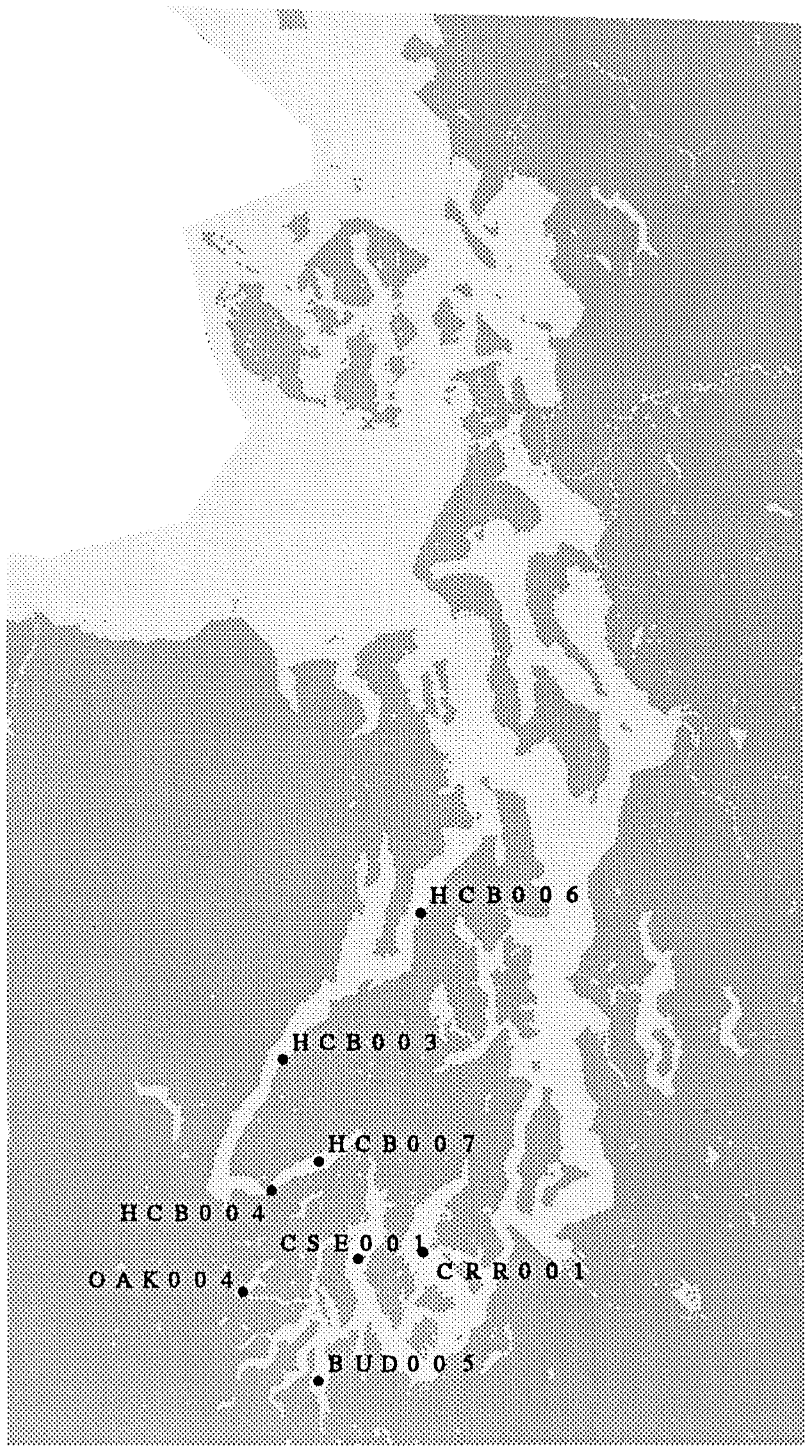


Figure 14. WY 1991 Puget Sound stations that showed simultaneous surface and 10-m NO_2-NO_3 depletion.

Table 10. Stations that did not show NO_2-NO_3 depletion during WY 1991.

Region/Station	Description
North Puget Sound Stations	
ADM002	Strait of Juan de Fuca, north of Admiralty Inlet
GRG002	Strait of Georgia - Patos Island
PAH008	Strait of Juan de Fuca, near Port Angeles
Central Puget Sound Stations	
PSB003	Puget Sound Main Basin - West Point
NRR001	Tacoma Narrows
South Puget Sound Stations	
DNA001	Dana Passage
NSQ001	Nisqually Reach
Hood Canal Stations	
NA	
Coastal Stations	
GYS004	Grays Harbor - Chehalis River
GYS008	Grays Harbor - South Channel
GYS009	Grays Harbor - North Channel

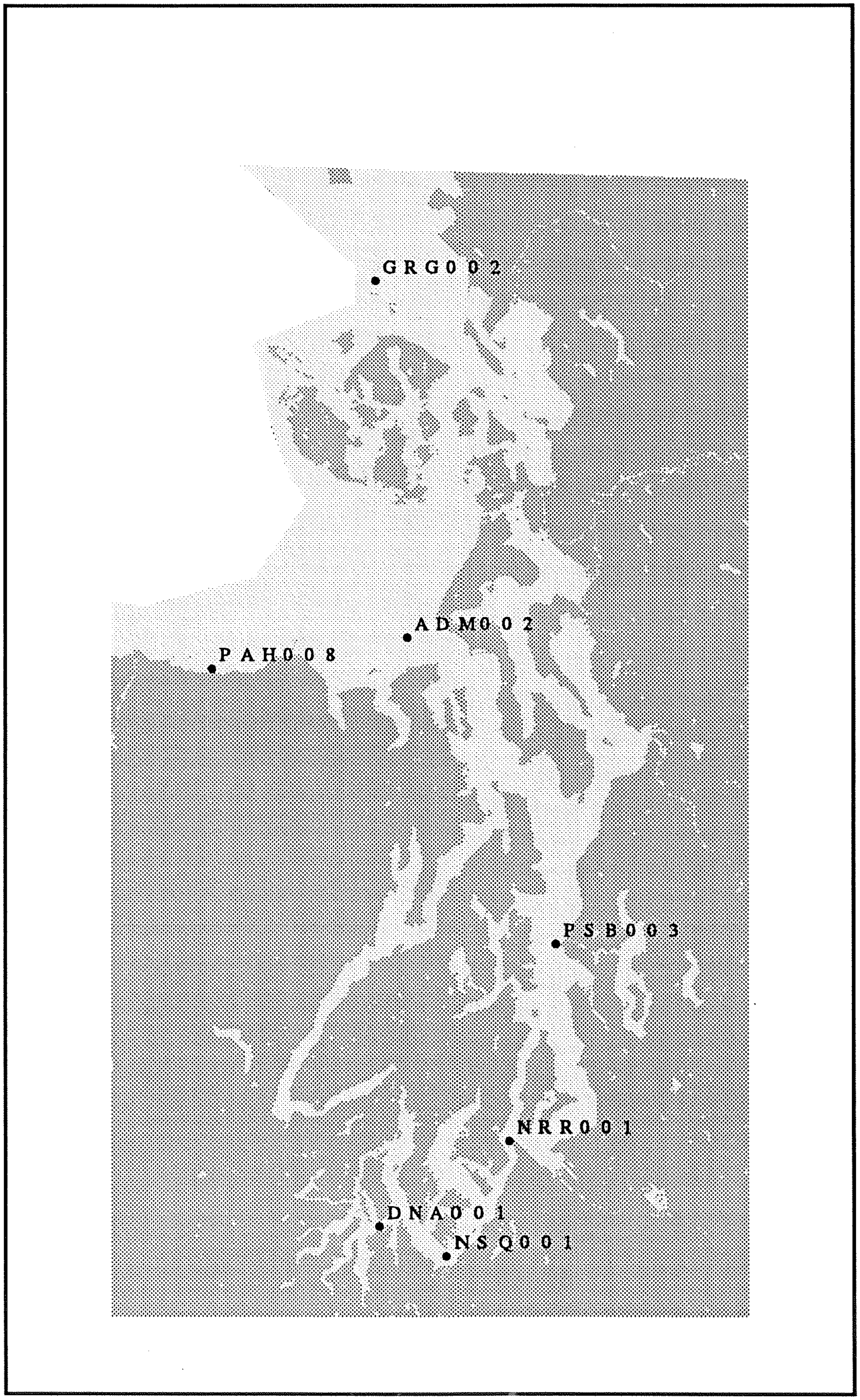


Figure 15. WY 1991 Puget Sound stations that showed no observable NO2-NO3 depletion.

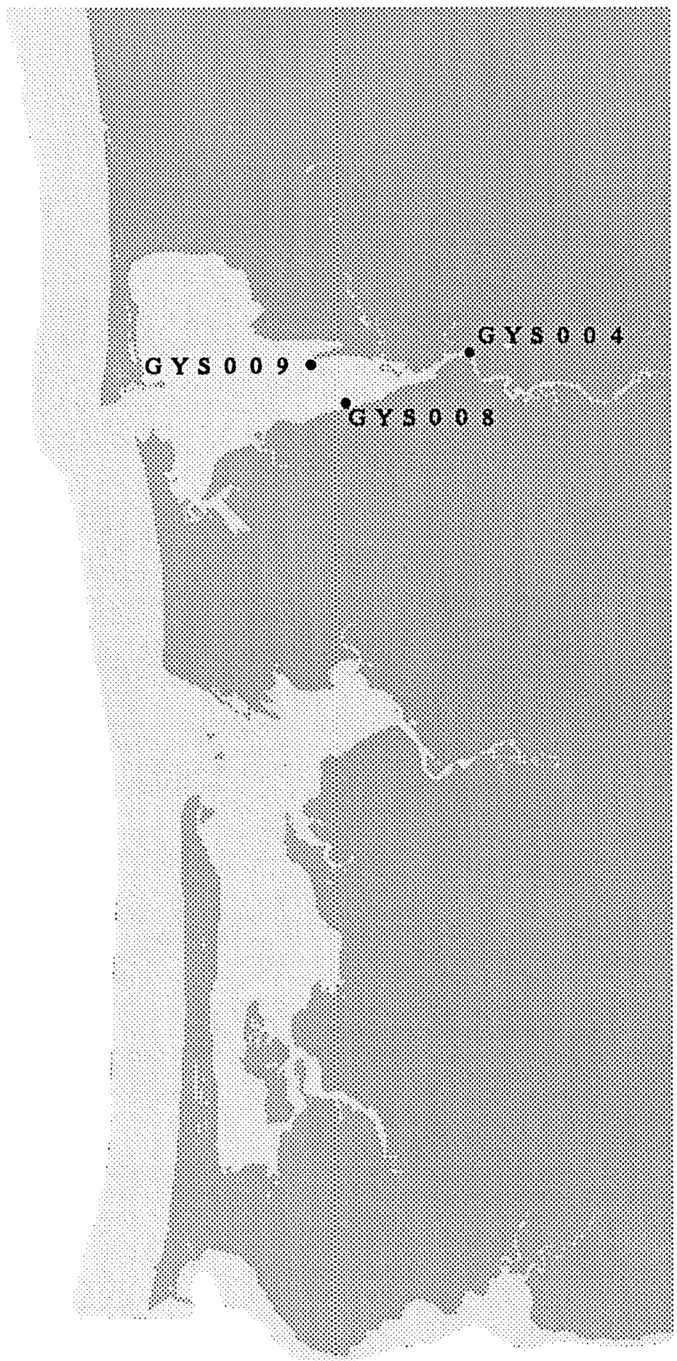


Figure 16. WY 1991 coastal stations that showed no observable NO_2-NO_3 depletion.

Secchi Depths

Of the 37 stations monitored during WY 1991, 20 had one or more Secchi depth readings less than 2-m. Most of these sites were located near large rivers (Table 11; Figures 17 and 18). Time series bar graphs of Secchi depth measurements are presented in Appendix K.

Quality Assurance/Quality Control

A detailed assessment of field and laboratory QA/QC results was conducted by Eisner (1992) and is presented in Appendix H. Included in this assessment were field QA/QC results for the period January 1990 through September 1991, and laboratory QA/QC results for the period October 1990 through September 1991.

For all parameters, laboratory split sample results appeared to be more precise than field replicate results. The percentage of laboratory split samples (replicates) with relative standard deviations (RSDs) within the targeted ranges are listed in Table 12, Part a. The percentage of field replicate samples with RSDs within the targeted ranges are listed in Table 12, Part b.

Ninety-four percent of the nitrite results for WY 1991 were below detection limits. Only seven sets of nitrite laboratory split samples were at or above detection limits. Of these seven sets, six had an RSD less than the targeted 10 percent error.

DISCUSSION

Stratification

Estuaries can generally be classified as vertically mixed, slightly stratified, highly stratified, or salt wedge estuaries (Dyer, 1973; Pickard and Emery, 1982). In general, estuarine stratification is determined by salinity rather than temperature. Figure 19 illustrates typical salinity distributions for estuaries.

Puget Sound is typical of a fjord or deep basin system (type C in Figure 19). The Sound has a sill toward the seaward end which is shallower than both the Main Basin and the sea outside. This sill restricts the exchange of deep water between the Sound and the open ocean. Puget Sound consists of several basins and sub-basins separated by similar sill zones including a seaward sill near Admiralty Inlet that separates the Main Basin from the Strait of Juan de Fuca, and a secondary sill at the Tacoma Narrows that separates the Main Basin from the Southern Basin. Hood Canal has a sill at its mouth separating it from the Strait of Juan de Fuca. Whidbey Basin, though without a sill, has an outlet to the Strait of Juan de Fuca. Within these basins are embayments, which may be further separated by shallower sills. The estuarine flow in Puget Sound is strongly modified by enhanced vertical mixing of surface and deep water as it passes over these sills, and by exchange of waters between basins (Ebbesmeyer, *et al.*, 1982).

Table 11. WY 1991 stations that had one or more Secchi depth readings less than two meters.

Region/Station	Description	Nearby Major River Input
North Puget Sound Stations		
BLL009	Bellingham Bay	Nooksak River
SKG003	Skagit Bay	Skagit River
PSS019	Possession Sound	Snohomish River
DIS001	Discovery Bay	NA
SAR003	Saratoga Passage	Skagit/Snohomish Rivers
JDF007	Sequim Bay - Goose Point	NA
Central Puget Sound Station		
CMB003	Commencement Bay	Puyallup River
South Puget Sound Stations		
NSQ001	Nisqually Reach	Nisqually River
BUD005	Budd Inlet	Deschutes River
Hood Canal Stations		
HCB004	South Hood Canal - Sister's Point	Skokomish River
HCB007	South Hood Canal - Lynch Cove	Union River
Coastal Stations		
GYS004	Grays Harbor - Chehalis River	Chehalis River
GYS008	Grays Harbor - South Channel	Chehalis River
GYS009	Grays Harbor - North Channel	Chehalis River
GYS016	Grays Harbor - Damon Point	Chehalis River
WPA004	Willapa Bay - Toke Point	Willapa River
WPA003	Willapa Bay - Johnson Slough	Willapa River
WPA001	Willapa Bay - Raymond	Willapa River
WPA006	Willapa Bay - Nahcotta Channel	Naselle/Nemah Rivers
WPA007	Willapa Bay - Jenson Point	Bear River

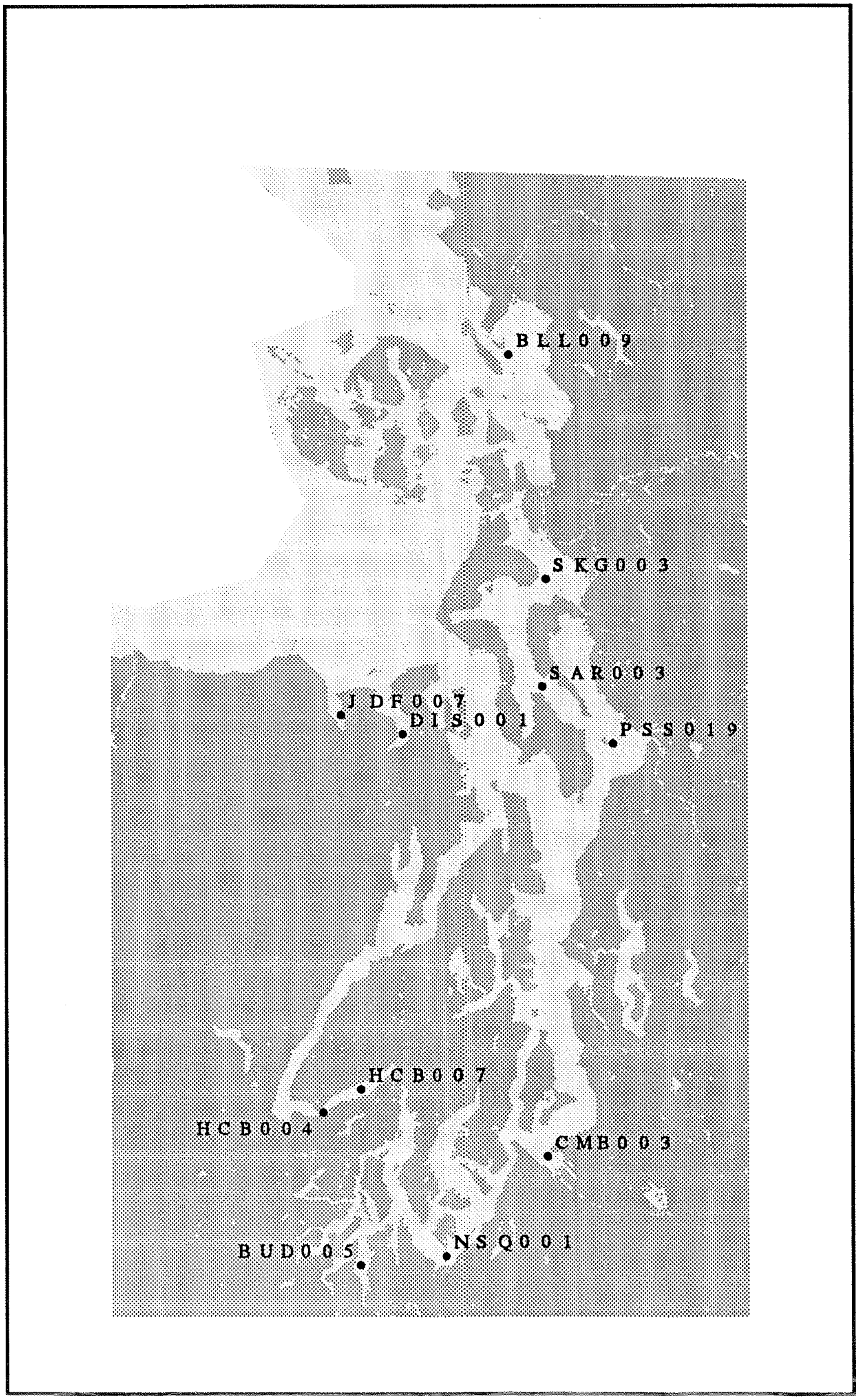


Figure 17. WY 1991 Puget Sound stations with observed Secchi depths of two meters or less.

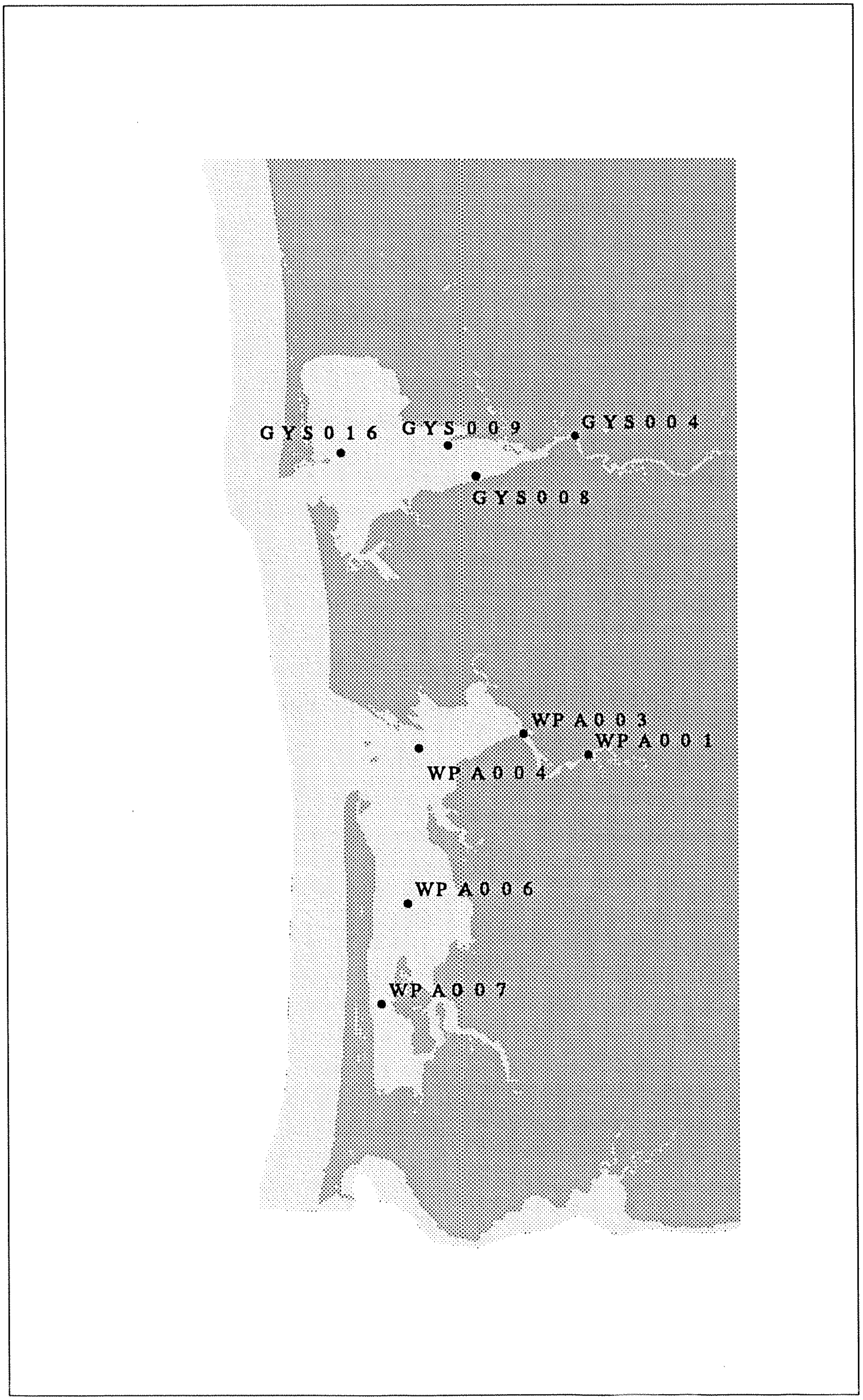


Figure 18. WY 1991 coastal stations with observed Secchi depths of two meters or less.

Table 12. Relative standard deviation (RSDs) for each laboratory analyzed parameter for a) laboratory split samples (replicate), and b) field replicate samples.

a. Laboratory Split Samples

Parameters	% Achieving Targeted Range
Fecal coliform bacteria	81% had RSDs < 20% error
Orthophosphate	92% had RSDs < 10% error
Ammonia	78% had RSDs < 10% error
Nitrite - Nitrate	99% had RSDs < 10% error
Chlorophyll *a* and phaeopigments	93% had RSDs < 20% error

b. Field Replicate Samples

Parameters	% Achieving Targeted Range
Fecal coliform bacteria	58-60% had RSDs < 20% error
Orthophosphate	77% had RSDs < 10% error
Ammonia	57% had RSDs < 10% error
Nitrite - Nitrate	83% had RSDs < 10% error
Chlorophyll *a* and phaeopigments	71% had RSDs < 20% error

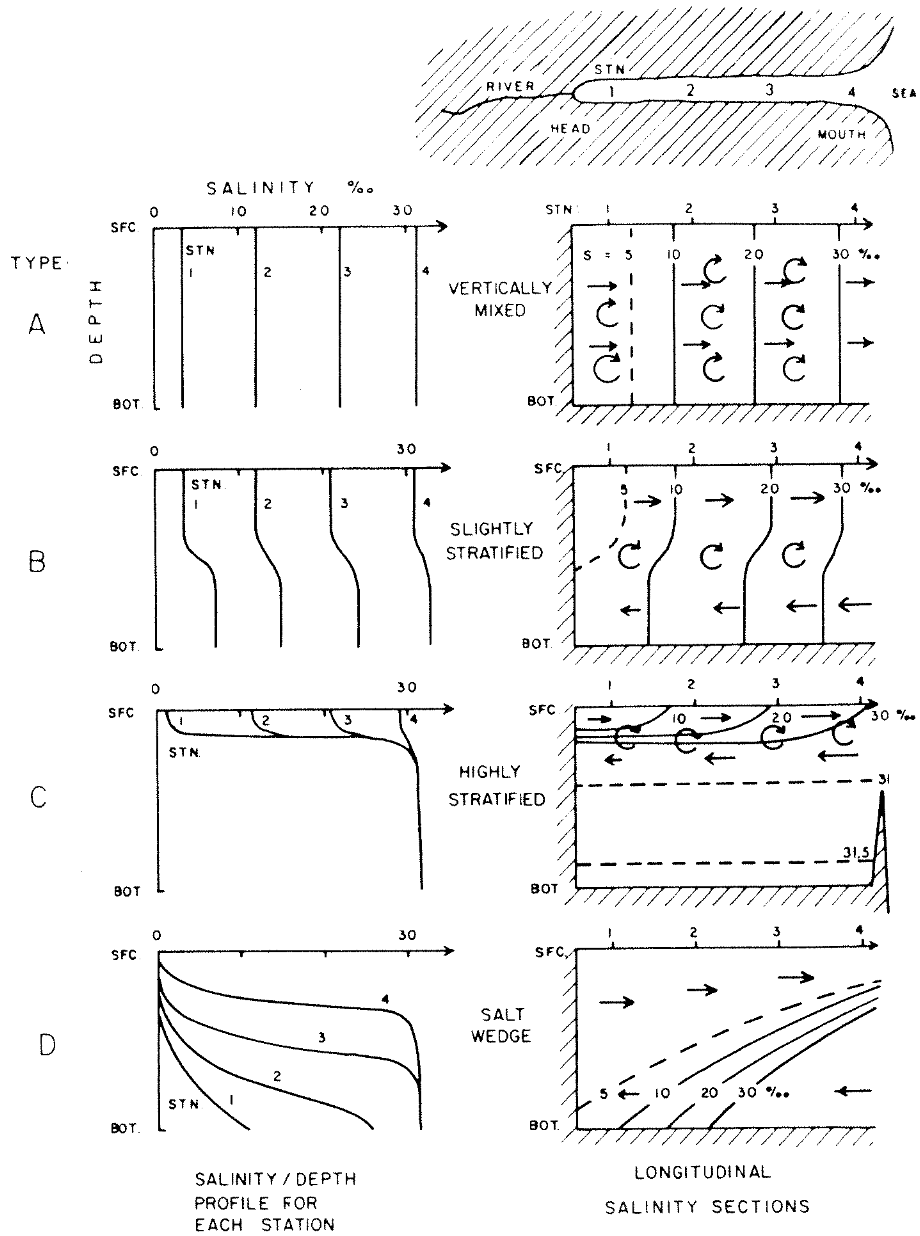


Figure 19. Typical salinity/depth profiles (left) and longitudinal salinity sections (right) in estuaries (schematic) (From: Pickard and Emery, 1982).

Grays Harbor is a partially mixed estuary with a large riverine source (Chehalis River) at the head of the bay, and a bar at the mouth where the bay meets the Pacific Ocean (type B in Figure 19).

Willapa Bay is a vertically mixed estuary with a large riverine source in the northern portion of the bay (Willapa River) and a series of channels created by smaller freshwater inputs in the southern portion of the bay (type A in Figure 19). Willapa Bay is bordered on its western shore by a sand peninsula known as Long Beach Peninsula, restricting exchange with the Pacific Ocean to the northwestern portion of the bay.

Where large rivers discharge into Puget Sound or the coastal estuaries, a localized condition often occurs, characteristic of a salt wedge estuary (type D in Figure 19). In salt wedge estuaries, saline waters intrude from the sea as a wedge below the river water. Examples of this include the Snohomish River in Everett, and the Chehalis River in Grays Harbor. Until the wedge reaches the salt waterbody at the river's mouth, the surface water remains fresh due to a large river discharge and minimal vertical mixing to the surface.

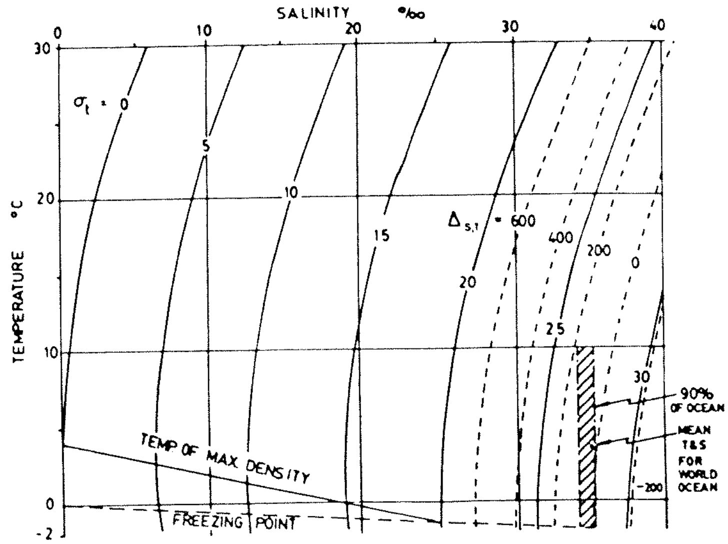
A number of different stratification regimes exist within Puget Sound and the coastal estuaries, as seen in the individual temperature/salinity/density profiles from WY 1991 (Appendix C). Areas receiving substantial freshwater inputs have water column density stratification largely determined by the salinity of the water. Density stratification in areas located away from riverine sources may be affected more by temperature changes in the water column and tidal and/or wind induced mixing (or the lack of). In general, density increases approximately one part in 1000 with the following changes in temperature, salinity, and/or pressure (Figure 20):

1) a change in temperature of -5°C,
2) a change in salinity of +1 ppt in salinity, or
3) a change in pressure of +2000 kPa (200 dbar or about 200-m).

Since stratification is affected by varying freshwater inputs, bathymetric features, and meteorological conditions, no single station can represent the stratification regime for an entire region. Individual embayments and waterways should be assessed individually.

Individual embayments and waterways display a variety of water quality conditions relative to the amount of stratification. One pattern observed during WY 1991 at stations that displayed some level of density stratification was seasonal nutrient depletion (e.g., stations HCB004 in South Hood Canal and SAR003 in Saratoga Passage; Figures 21 and 22). Stations that were well mixed, or had minimal density stratification did not have observed nutrient depletion, such as stations GRG002 in the Strait of Georgia and PAH008 in the Strait of Juan de Fuca (Figures 23 and 24). Stations that showed nutrient depletion and observable stratification are listed in Table 7 (Results).

Some areas had similar stratification regimes such as Carr and Case Inlets in the Southern Basin of Puget Sound (Figures 25 and 26). As will be discussed later, nutrient depletion and nutrient/chlorophyll patterns in both these embayments also mimicked each other.



Values of σ_t, $\Delta_{S,T}$, temperature of maximum density and freezing point (at atmospheric pressure) for sea-water as functions of temperature and salinity.

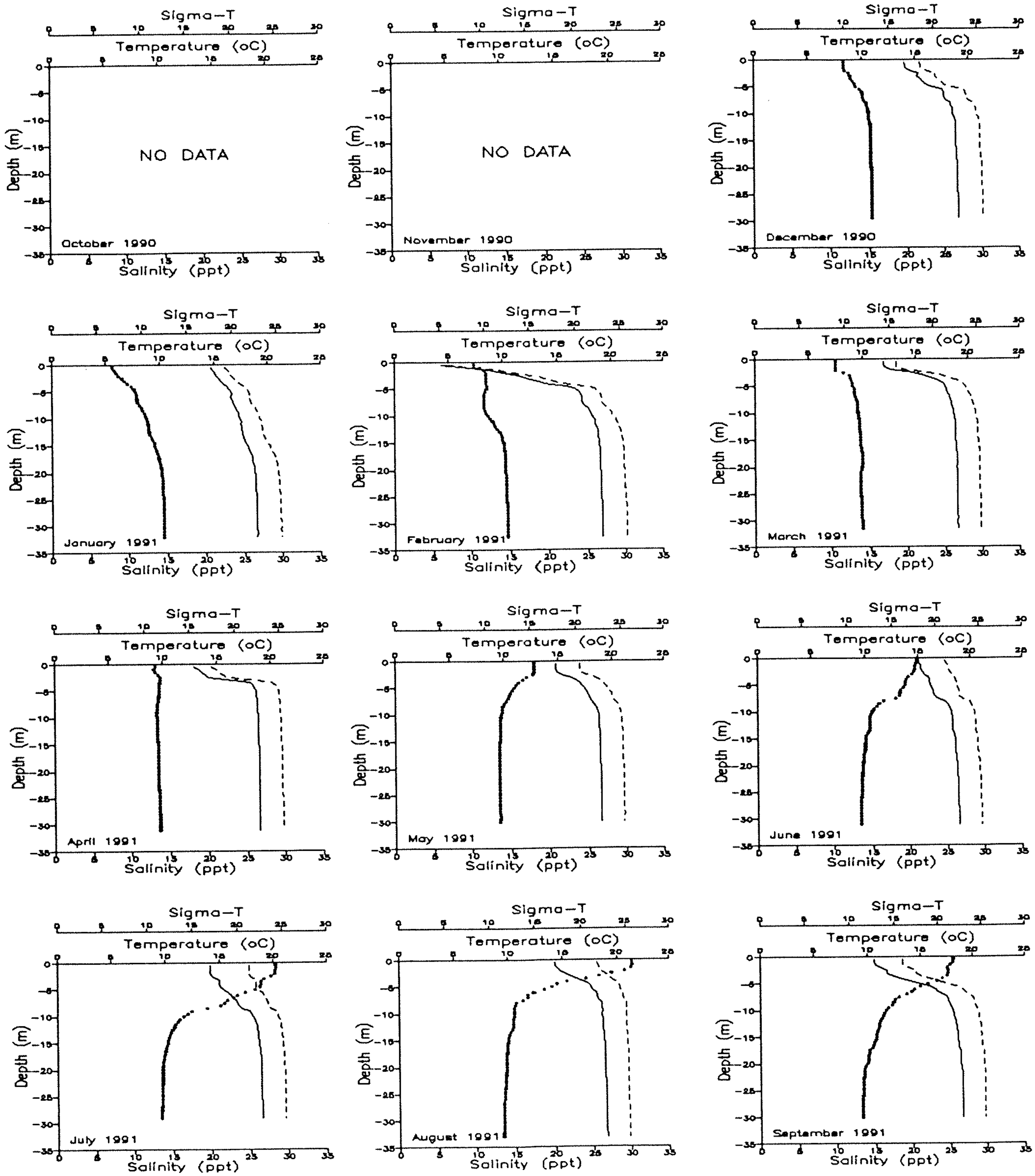
Variation of σ_t ($\Delta\sigma_t$) with variations of temperature (ΔT) and of salinity (ΔS) as functions of temperature and salinity

	$\Delta\sigma_t$ for $\Delta T = +1C°$			$\Delta\sigma_t$ for $\Delta S = +0.5‰$		
Salinity ‰	0	20	40	0	20	40
Temperature (°C)						
30	−0.30	−0.33	−0.34	0.39	0.38	0.38
20	−0.21	−0.24	−0.27	0.40	0.38	0.38
10	−0.09	−0.14	−0.18	0.41	0.39	0.39
0	+0.07	−0.01	−0.17	0.43	0.40	0.40

Figure 20. Temperature versus salinity diagram showing how sigma-*t* varies as a function of these two variables (From: Pickard and Emery, 1982).

WATERYEAR 1991

South Hood Canal at Sister's Point (Station HCB004)

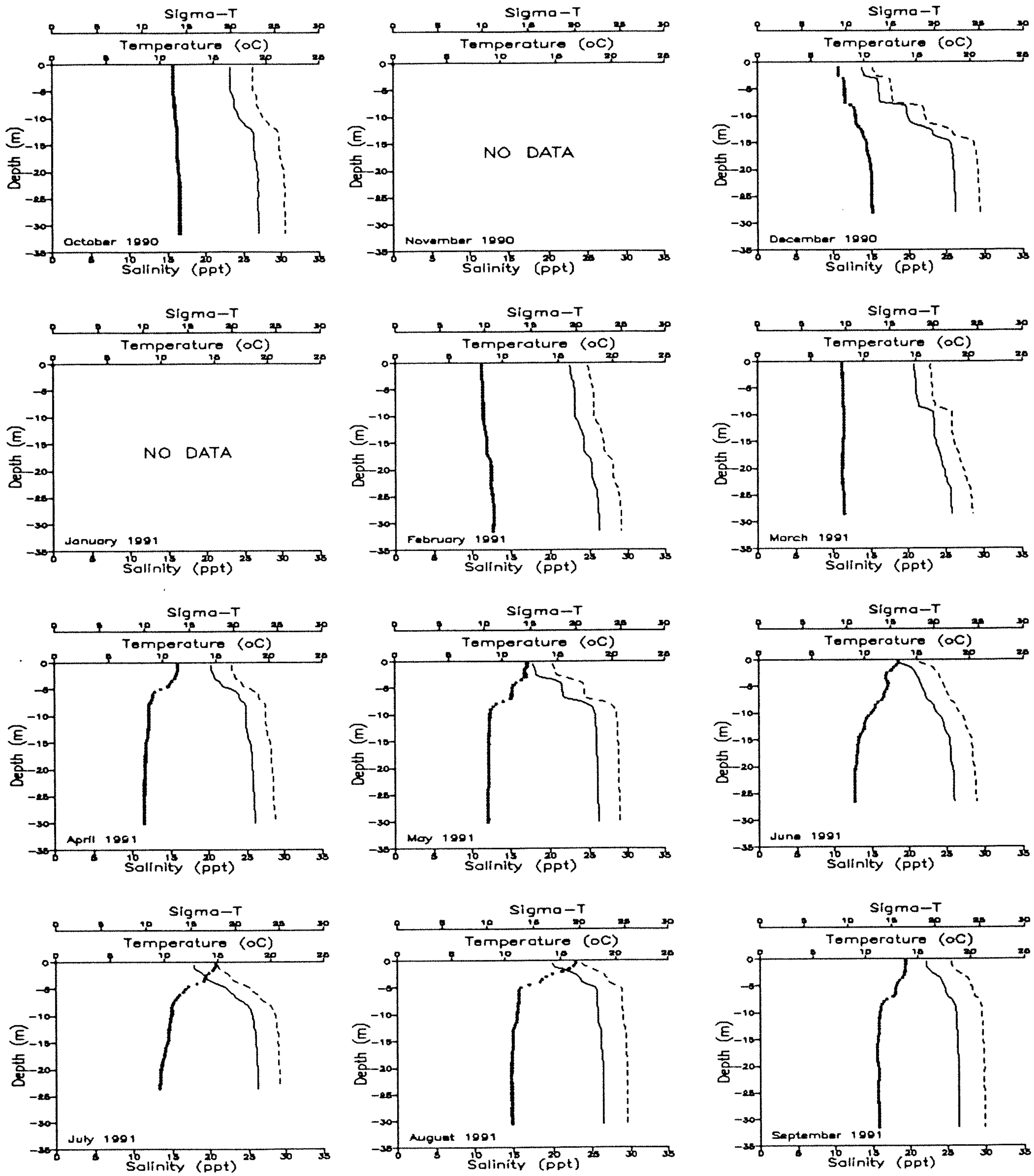


Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

Figure 21. Monthly temperature/salinity/density plots for South Hood Canal Station HCB004 during WY 1991.

WATERYEAR 1991

Saratoga Passage (Station SAR003)

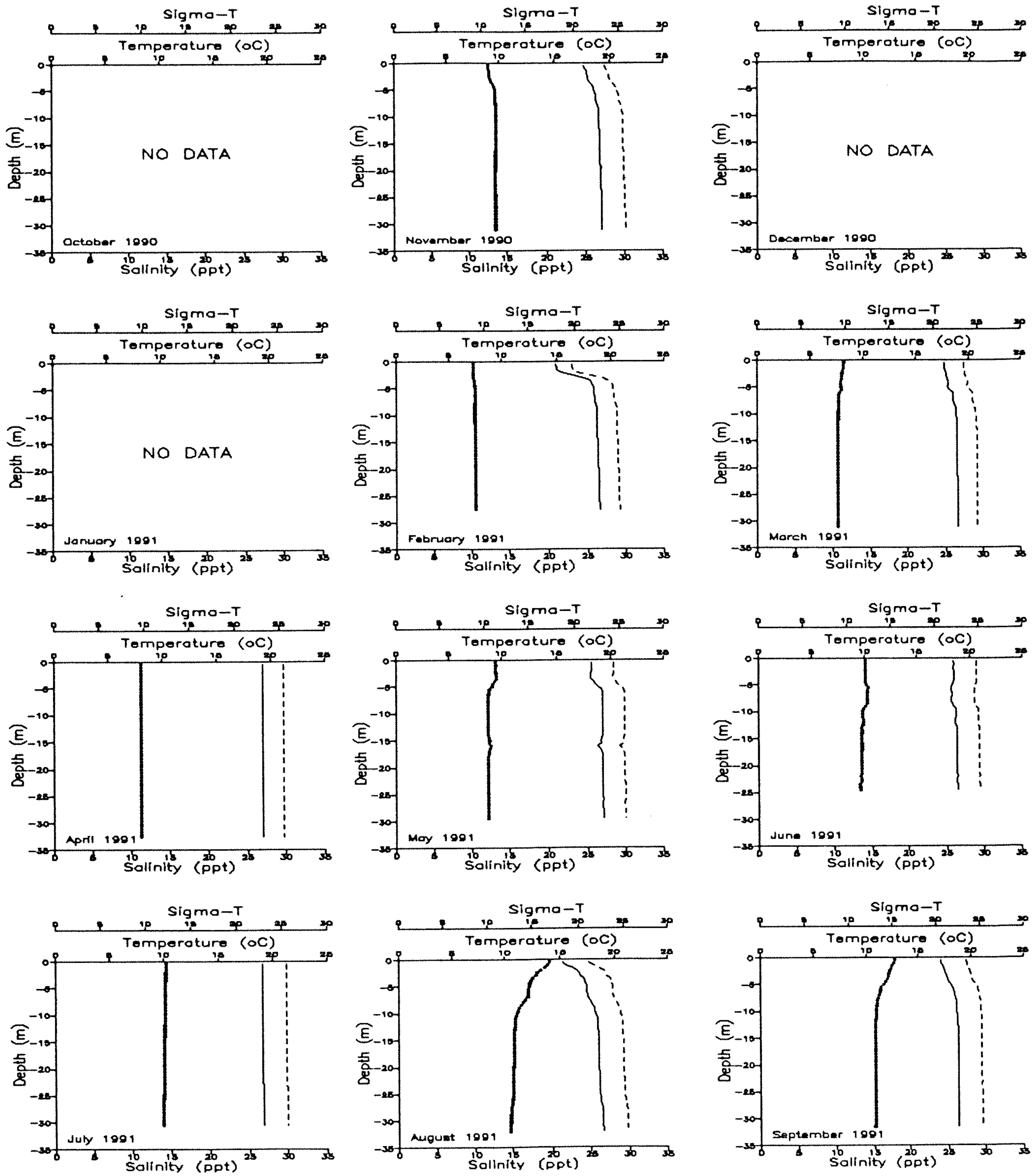


Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

Figure 22. Monthly temperature/salinity/density plots for Saratoga Passage Station SAR003 during WY 1991.

WATERYEAR 1991

Straits of Georgia (Station GRG002)



Key:

Temperature = Dotted line

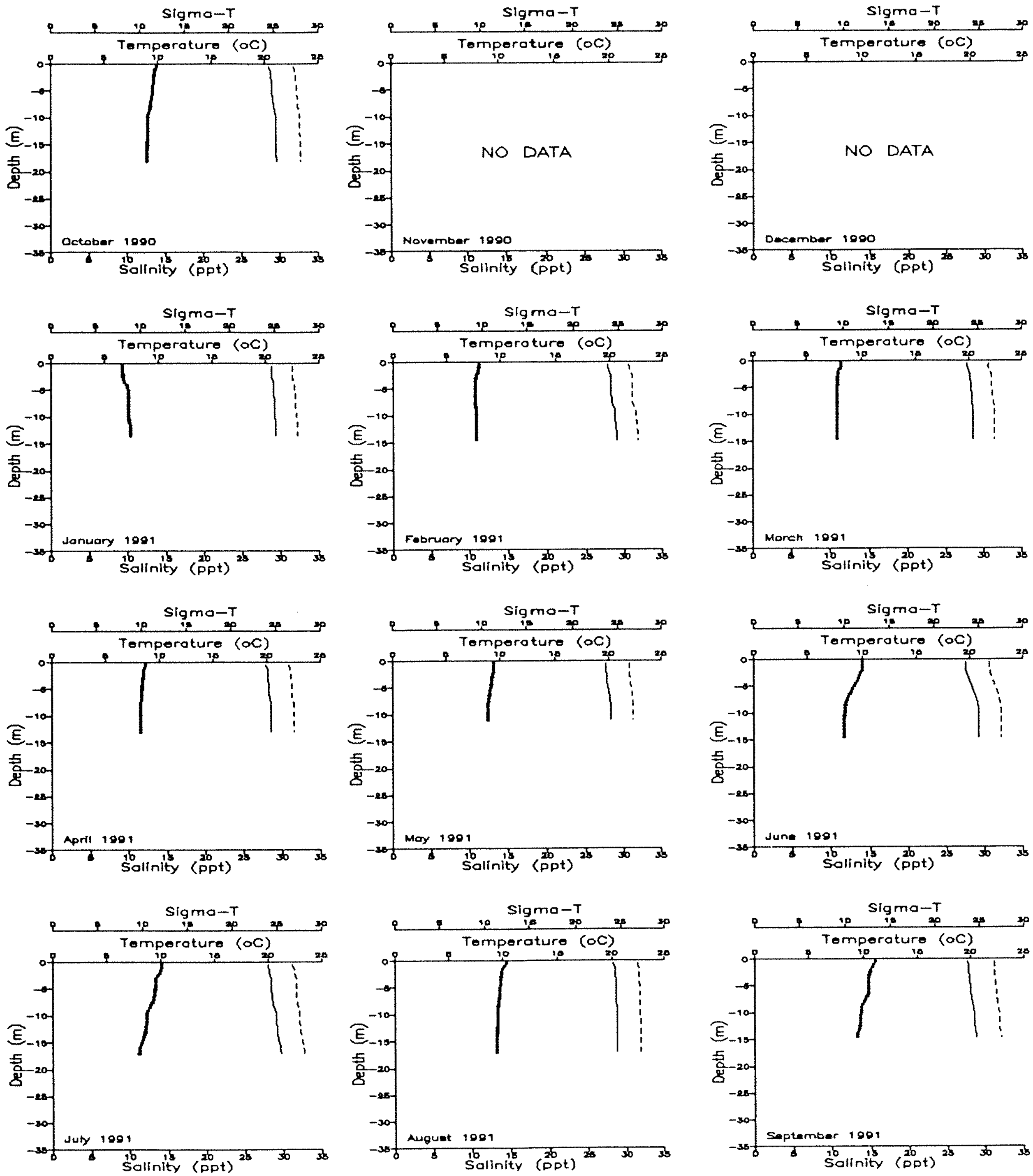
Salinity = Dashed line

Sigma-t = Solid line

Figure 23. Monthly temperature/salinity/density plots for Strait of Georgia Station GRG002 during WY 1991.

WATERYEAR 1991

Straits of Juan de Fuca Near Port Angeles (Station PAH008)

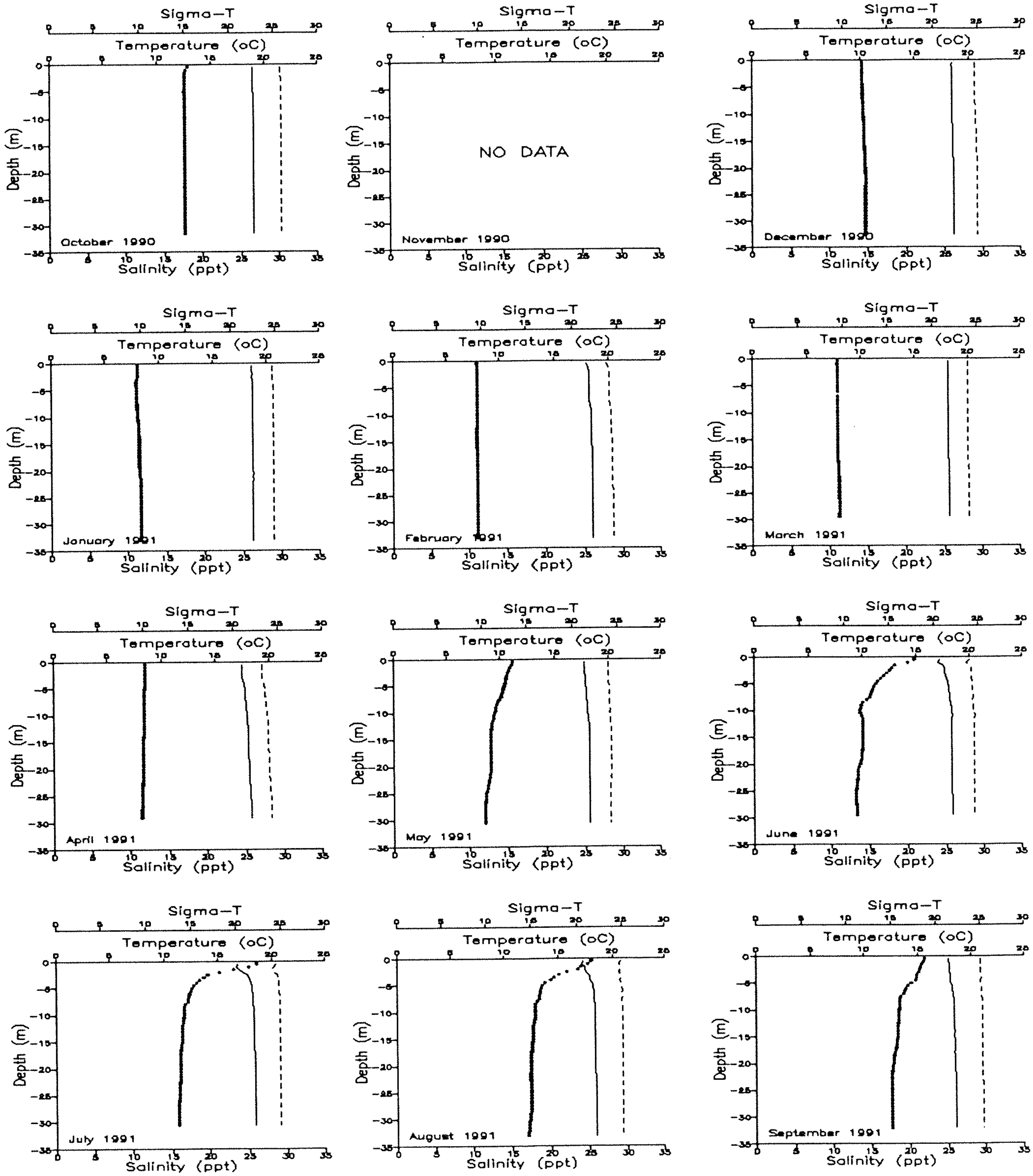


Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

Figure 24. Monthly temperature/salinity/density plots for Strait of Juan de Fuca Station PAH008 during WY 1991.

WATERYEAR 1991

Carr Inlet (Station CRR001)



Key:

Temperature = Dotted line

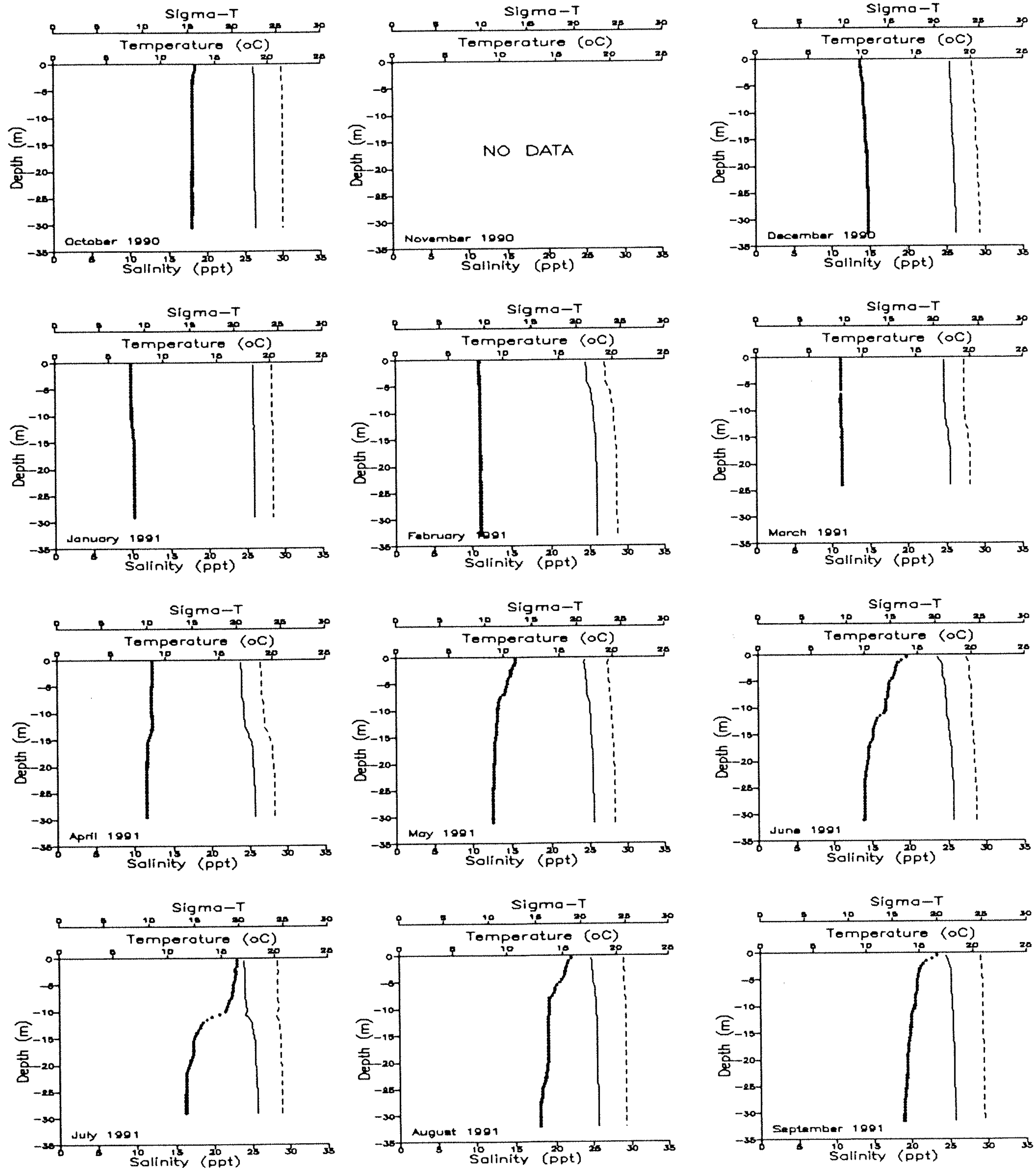
Salinity = Dashed line

Sigma-t = Solid line

Figure 25. Monthly temperature/salinity/density plots for Carr Inlet Station CRR001 during WY 1991.

WATERYEAR 1991

Outer Case Inlet (Station CSE001)



Key:

Temperature = Dotted line

Salinity = Dashed line

Sigma-t = Solid line

Figure 26. Monthly temperature/salinity/density plots for Case Inlet Station CSE001 during WY 1991.

Dissolved Oxygen Concentrations

Stratification and mixing regimes play a role in the marine water column's dissolved oxygen profile. Other factors include the following:

- freshwater input,
- biological activity (respiration, photosynthesis, decay),
- loading of wastes with high biological oxygen demand (BOD), and
- oceanic input.

In the marine environment, oxygen concentrations exhibit large ranges. Supersaturated concentrations tend to occur during periods of high algal activity. Typical coastal marine oxygen concentrations of 7.0-9.0 mg/L are generally seen during high seasonal freshwater discharge periods. Off-shore oceanic oxygen concentrations typically reside around 5.0-6.0 mg/L. In areas with large biological oxygen demand, oxygen concentrations can drop to levels that are deleterious for the animals inhabiting the water column and bottom sediments.

Oxygen concentrations less than 4.0-5.0 mg/L may stress marine organisms if concentrations remain low for extended periods of time. Concentrations less than 3.0 mg/L will cause motile species to seek more oxygenated water and can harm or kill intolerant sedentary species (PSEP, 1988). Hypoxic concentrations (less than 3.0 mg/L) and anoxic conditions (zero dissolved oxygen) are observed in areas where water is not well flushed and/or has a high organic decay burden, such as bottom waters behind sills in embayments and in organically loaded waters. Low oxygen concentrations also may be observed in areas with a high level of respiration by organisms in the water column (e.g., at depth during blooms of vertically migrating dinoflagellates; URS, 1986). During WY 1991 in Puget Sound, areas with hypoxic conditions generally occurred during the late summer and early fall months, though some sites experienced low oxygen concentrations year-round (Tables 4 and 5).

Marine Water Quality Standards for Dissolved Oxygen

Water quality standards were developed for dissolved oxygen concentrations in marine and fresh waters to help determine aquatic uses of various waterbodies and to assess existing conditions. The existing state standards for Class AA through C waters in Washington State are as follows (WAC 173-201, 1991):

Class AA	Extraordinary	>7.0 mg/L
Class A	Excellent	>6.0 mg/L
Class B	Good	>5.0 mg/L
Class C	Fair	>4.0 mg/L

Deviations from these standards can occur naturally. When natural conditions cause dissolved oxygen concentrations to be depressed near or below the standard values, no more than a 0.2 mg/L degradation from the natural concentration can be incurred due to anthropogenic causes.

The 305(b) Report (Ecology, 1992), produced on even years for the USEPA, further describes beneficial uses of marine waters and how dissolved oxygen concentration standards are applied.

Low Dissolved Oxygen Concentrations in Puget Sound

Dissolved oxygen concentrations during WY 1991 were typically within acceptable ranges for Puget Sound due to the fairly vigorous tidal mixing and large freshwater inputs. Several areas, however, have less vigorous mixing, such as protected embayments. Lack of sufficient mixing and flushing can affect oxygen concentrations, especially in the bottom waters of such areas. Most stations in such areas visited during WY 1991 did not experience severe oxygen deficiency in the upper 30-m, though during the course of the year, 23 of all 28 stations sampled in Puget Sound violated dissolved oxygen water quality standards one or more times (WAC 173-201, 1991).

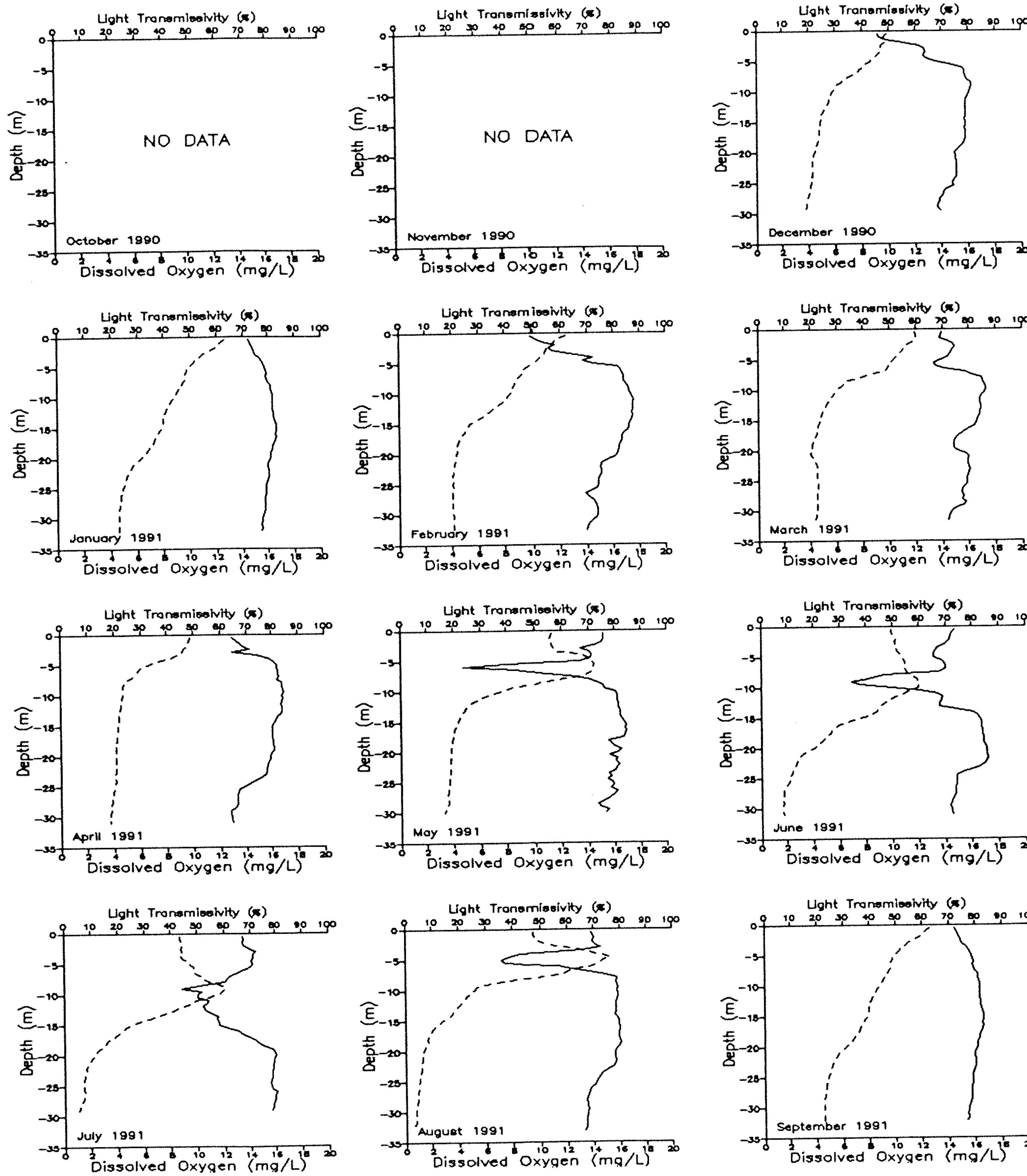
The stations that had dissolved oxygen concentrations below 5.0 mg/L included some of the Northern Puget Sound sites (ADM002, PAH008, PSS019, SAR003; Table 5). They experienced slightly depressed oxygen concentrations (4.5-5.0 mg/L) in the fall months (October 1990 and September 1991). Though these concentrations fell below water quality standards, they were likely naturally influenced by incoming oceanic waters. This may be especially true for North Puget Sound locations nearest the entrance to the Pacific Ocean (ADM002, PAH008). Though weak, summer upwelling along the coast of Washington forces lower oxygenated, deeper oceanic waters into Puget Sound. The lower oxygen concentration signal is most noticeable in Puget Sound during the late summer and fall months (Collias and Lincoln, 1977).

Extremely low oxygen concentrations were observed year-round in South Hood Canal (Figures 27 and 28). Oxygen concentrations were hypoxic below the surface at Station HCB004 for all twelve sampling events during WY 1991. This condition was likely a result of little vertical mixing and reduced circulation of deep water behind the sill near Sister's Point, as well as high algal productivity and subsequent decay processes. Nutrient sources to South Hood Canal likely promote excessive and ongoing algal productivity. Station HCB007 in Lynch Cove also showed low oxygen concentrations throughout most of the year, with the shallowest occurrence in April 1991 as with HCB004 (Figure 28). (Note: Tidal action can cause the depths of depressed dissolved oxygen concentrations to vary). Though further inland, HCB007 experienced slightly better oxygen quality during most of the year compared to its neighbor station, HCB004. This was probably due to the shallower depth at HCB007.

Historical data at HCB004 dating back to WY 1976 showed low oxygen concentrations (less than 5.0 mg/L) at the 10-m and 30-m depths, with most frequent lows observed during mid-

WATERYEAR 1991

South Hood Canal at Sister's Point (Station HCB004)

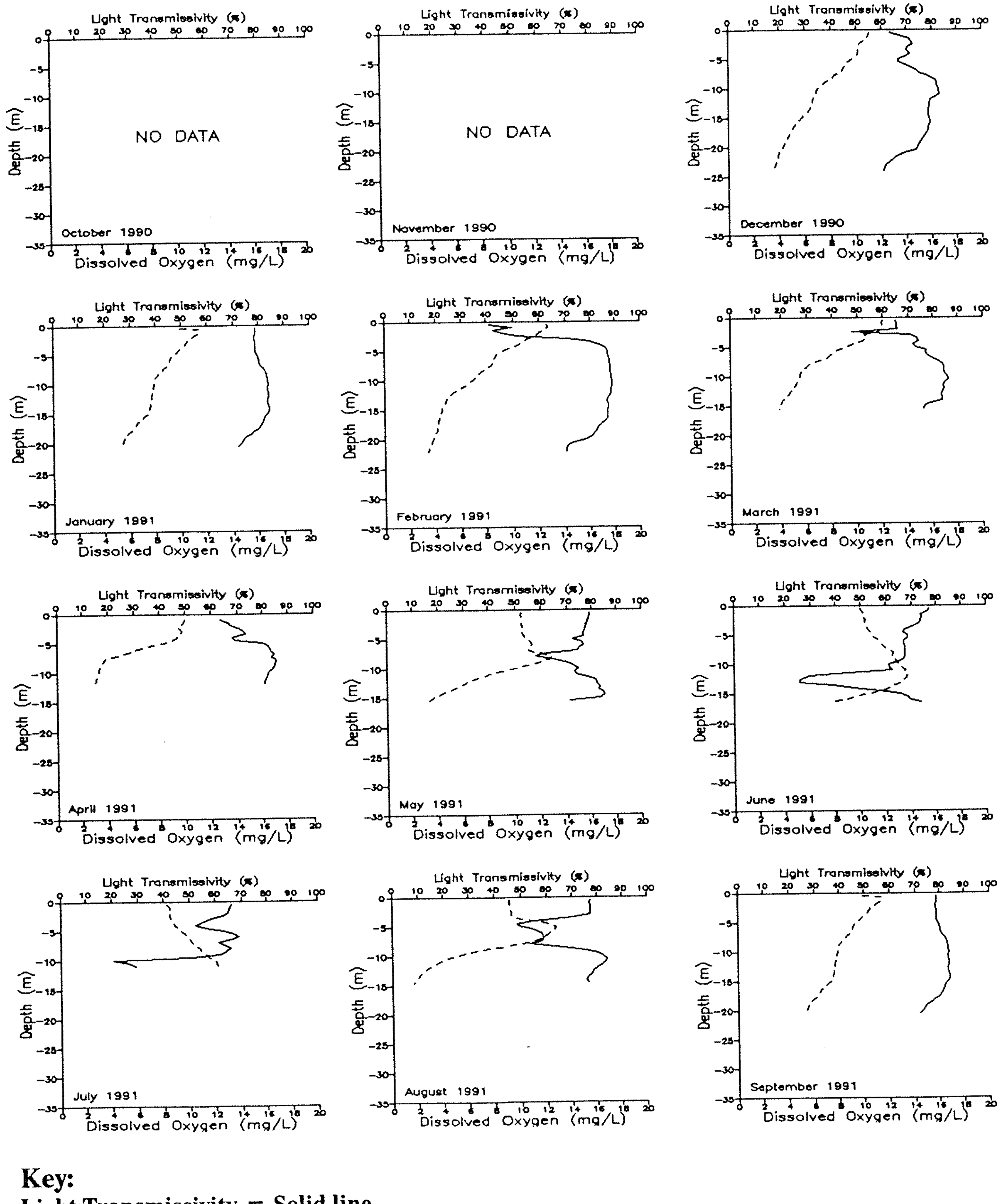


Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

Figure 27. Dissolved oxygen concentration profiles for Hood Canal Station HCB004 during WY 1991.

WATERYEAR 1991

Lynch Cove (Station HCB007)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

Figure 28. Dissolved oxygen concentration profiles for Hood Canal Station HCB007 during WY 1991.

summer and fall months. The months of July through October frequently showed oxygen concentrations below 3.0 mg/L, namely at depths of 30-m (66% of the readings below 3.0 mg/L were at 30-m). No winter results were available for comparison to fall and spring values prior to WY 1991. As observed in the WY 1991 oxygen results, historical oxygen concentrations were also below 5.0 mg/L year-round at depths of 10-m or greater.

The most northern Hood Canal station (HCB006) did not appear to experience depressed oxygen concentrations in the upper 30-m (Appendix D). In the summer and early fall months (July - September, 1991), the station near the Hamma Hamma River at Eldon in Central Hood Canal (HCB003) showed depressed oxygen concentrations at depths below 22-m in July 1991, 18-m in August 1991, and 14-m in September 1991 (Table 5; Appendix D). The layer of low-oxygenated water appeared to grow larger as the summer progressed.

The remaining stations that violated dissolved oxygen standards during WY 1991 (Table 4) did not display oxygen concentrations below 5.0 mg/L.

Fecal Coliform Bacteria

Fecal coliform bacteria, though not harmful themselves, are pathogen indicators used to assess effects on marine water quality. The fecal coliform bacteria criterion for Class A and AA marine waters states, the bacteria count shall not exceed a geometric mean value of 14 organisms/100 mL, with no more than 10 percent of samples exceeding 43 organisms/100 mL (WAC 173-201, 1991). This criterion takes into account the high variability encountered with fecal coliform bacteria samples. The criterion depends on calculating a geometric mean, therefore multiple samples should be collected for proper assessment. Fecal coliform bacteria levels at or exceeding this criterion may affect beneficial uses, such as shellfish harvesting and swimming.

Monthly ambient fecal coliform bacteria data cannot be directly applied using this criterion due to the requirement for multiple concurrent samples. However, the monthly data can assist in identifying areas that might be impacted due to frequent above detection limit fecal coliform bacteria counts. As mentioned in the Results Section of this report, fecal coliform bacteria counts measuring above 14 organisms/100 mL were considered significant during ambient data analysis.

Fecal Coliform Bacteria Counts in Puget Sound

The majority of Puget Sound stations sampled did not show high fecal counts (above 14 organisms/100 mL), and usually showed counts below detectable levels. This was likely due to the distance of the ambient stations from sources of bacteria. Counts that did exceed 14 organisms/100 mL occurred during the fall through spring months for Puget Sound, and year-round for the coastal stations (Table 6), likely a result of increased terrestrial run-off due to frequent rain events and subsequent increased river discharge.

Three North Sound stations (BLL009, PSS019, SKG003) had high fecal coliform bacteria counts in the fall months (October 1990 and September 1991). Fecal counts measured above 14 organisms/100 mL only once at Station BLL009, whereas counts measured above 14 organisms/100 mL twice at Station SKG003, and more than three times at Station PSS019. Fecal coliform counts from Station PSS019 have frequently surpassed 14 organisms/100 mL over the past several years (AMS Database; Janzen 1992a).

Fecal coliform bacteria counts at four Central Sound stations (ADM003, CMB003, NRR001, PSB003) measured above 14 organisms/100 mL one or more times in WY 1991. The highest counts occurred in December 1990 and February 1991. High counts also occurred in October 1990 and March 1991. Neither ADM003 (south of Whidbey Island) nor NRR001 (Tacoma Narrows) have shown ongoing historical fecal coliform bacteria counts above a detection limit value of 1 organism/100 mL (AMS Database). Station PSB003 (West Point-Main Basin) fecal coliform bacteria counts, on the other hand, have varied over time, possibly due to the proximity of the West Point METRO sewage out-fall. Fecal counts at Station CMB003 (Commencement Bay) have frequently exceeded 14 organisms/100 mL in the past (AMS Database). As seen in Table 6, the fecal coliform bacteria values at CMB003 in WY 1991 were considerably higher than those experienced at other stations.

Four South Sound embayment stations (BUD005, OAK004, CSE002, NSQ001) had counts above 14 organisms/100 mL. Two of these sites frequently experienced counts of 14 organisms/100 mL (BUD005 and OAK004), as was expected due to their proximity to major urban centers. Overall, the months that showed higher counts varied from site to site, but the highest counts observed were during high river discharge periods (late fall, winter and early spring; Appendix L). Inner Case Inlet Station CSE002 (a floating station) was sampled specifically for monthly fecal coliform bacteria. Counts were measured above 14 organisms/100 mL only once during WY 1991 (35 organisms/100 mL in February 1991). Station NSQ001 in the Nisqually Reach also had a measurement above 14 organisms/100 mL on April 8, 1991.

Fecal Coliform Bacteria Counts in the Coastal Estuaries

Several coastal stations, namely in Grays Harbor, showed high fecal coliform bacteria counts. These stations were close to urban centers or near river inputs, as noted in Table 6. As in Puget Sound, the coastal stations located further offshore (e.g., WPA004) experienced lower fecal counts.

Three sites in Grays Harbor (GYS004, GYS008, GYS009) had fecal counts above 14 organisms/100 mL during WY 1991. These stations are located near Aberdeen and Hoquiam, and are largely affected by the Chehalis River. The months of the highest counts varied for each station (Table 6).

Only one site in the Willapa Bay station network (WPA001) showed fecal coliform bacteria counts above 14 organisms/100 mL during WY 1991. Station WPA001 in the Willapa River near Raymond, Washington, has salt water influence from the salt wedge created by intruding waters from Willapa Bay. However, this site is still dominated by freshwater. The highest observed fecal coliform bacteria count at WPA001 was in June 1991.

Nutrient and Chlorophyll *a* Concentrations

Nutrient sensitive areas in the Puget Sound and coastal regions could face eutrophication and its associated problems if additional nutrient inputs occur (Tetra Tech, 1988). In order to determine the potential effect of increasing anthropogenic nutrient inputs on ambient water quality, it is important to document seasonal and annual changes in nutrient concentrations and biological activity.

Limiting Nutrients for Marine Coastal Waters

Dissolved inorganic nitrogen (a combination of dissolved ammonia, ammonium, nitrate, and nitrite) is typically the primary limiting nutrient in marine waters. Ambient ammonia (NH_3) concentrations are typically low in Puget Sound waters, as seen in Ecology's ambient data and historical studies conducted in Puget Sound (Collias and Lincoln, 1977; Chew and Stober, 1984; Campbell *et al.*, 1977). Wateryear 1991 data showed 34 percent of the results for NH_3 were below detectable levels (Eisner, 1992; Appendix H). Nitrite (NO_2) concentrations were also low in Puget Sound during WY 1991, with 94 percent of the results below detectable levels. Due to the low ammonium and nitrite concentrations, nitrate (NO_3) was most likely the significant source of nitrogen used in phytoplankton growth. In this analysis, nitrite-nitrate (NO_2-NO_3) concentrations, consisting mostly of NO_3, were used to determine the nutrient status (depletion) at WY 1991 stations.

During times following large decreases in surface NO_2-NO_3 concentrations, a sharp decrease in chlorophyll *a* concentrations was observed at many sites (e.g., EAS001 and BUD005). This decrease in chlorophyll *a* concentrations could have indicated that nitrogen was limiting to algal growth provided that other factors, such as light and water column stability, were optimal. Due to spatial and temporal frequency of the data, the lack of recycling rates of nitrogen, and the lack of algal growth rate data, the concentration of nitrogen that limits phytoplankton growth at each station could not be precisely determined. However, previous studies have computed limiting nitrogen concentrations, but for distinct locations only. For instance, the concentration at which nitrogen becomes limiting to phytoplankton growth in Budd Inlet was determined from primary production studies conducted by URS (1986). During these studies, URS determined the limiting concentration for nitrogen nutrients (including NO_2-NO_3 and NH_3) to be 0.04 mg/L (2.86 μmole/L) or less. For comparative purposes in this report, the limiting value of 0.04 mg/L derived by URS for Budd Inlet was used to define nutrient depletion at all of Ecology's WY 1991 marine stations.

The criterion used to determine O-PO_4 status assumed the minimum marine nitrogen versus phosphorus (N:P) molar ratio needed for algal growth ranges from 5:1 to 15:1. This range of ratios was determined for coastal waters by Ryther and Dunstan (1971) and McCarthy (1980). Ratios less than 15:1 are most common in coastal marine surface waters (McCarthy, 1980). The Redfield ratio of 15:1 (Redfield, 1958) is attained only when the maximum growth is approached, and applies more specifically to open oceanic environments. Coastal environments have complex interactions including physical transport, biological modification, and terrigenous inputs, therefore N:P ratios should be determined empirically for distinct areas of interest.

If nitrogen depletion is assumed to occur at 0.04 mg/L (2.86 μmole), then based on the N:P molar ratios, phosphate depletion by biological processes can be assumed to occur at concentrations ranging from 0.006 to 0.018 mg/L (0.191 to 0.572 μmole/L). This range of O-PO_4 concentration extends below the reporting limit (0.01 mg/L) met by Manchester Laboratory. For this reason, the term "near depletion" was used for O-PO_4 values below 0.01 mg/L (0.32 μmole/L). As a result, conclusive statements concerning O-PO_4 depletion could not be made. For discussion, stations that showed O-PO_4 values falling below 0.01 mg/L (near depleted) are examined in comparison to stations that showed the assumed nitrogen depletion (0.04 mg/L).

Nutrient Dynamics

Nitrite-Nitrate

Stations exhibiting NO_2-NO_3 depletion were likely affected by the following four processes:

- lack of continuous nutrient sources,
- optimal stratification conditions (little vertical mixing),
- sufficient light (day length and depth of mixed layer), and
- limited flushing of the area.

Table 7 (Results) depicts the WY 1991 stations that showed NO_2-NO_3 depletion.

At several locations, NO_2-NO_3 depletion occurred at both surface and 10-m depths. This occurred in Carr Inlet during the September 1991 site visit (CRR001) (Figure 29). Surface and 10-m depletion likely occurred as a result of a large bloom that encompassed both surface and 10-m depths, or as a result of initial surface depletion of nutrients which forced later phytoplankton blooms to occur in deeper waters where nutrients were still available.

Stations that did not exhibit NO2-NO3 depletion were likely affected by the following two major physical processes:

- replenishment of nutrients by upwelling caused by vigorous mixing; and
- lack of vertical density stratification and/or adequate flushing which prohibited significant occurrences of phytoplankton blooms.

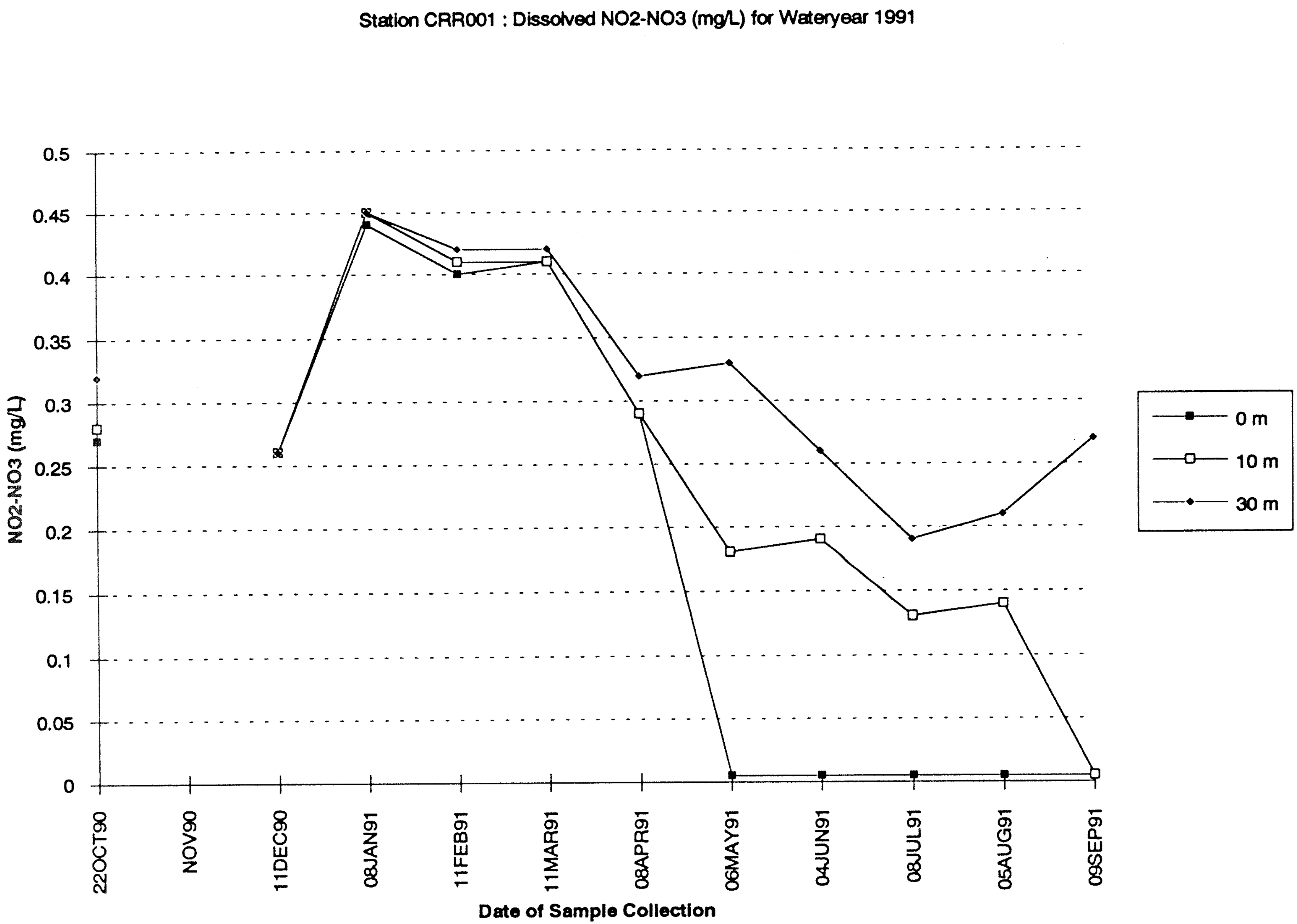


Figure 29. Nitrite-nitrate plots for Carr Inlet Station CRR001 at surface, 10-, and 30-m depths for WY 1991.

The lack of observed nutrient depletion in some areas could also have been due to the presence of a deep mixed layer. A mixed layer much deeper than the photic zone will result in light limitation of algal growth, since the algae spend too little time in the light for positive net growth to occur. Light limitation has been documented in the Main Basin of Puget Sound (Chew and Stober, 1984). A deep mixed layer, for instance, may explain the lack of nutrient depletion at well mixed stations like PSB003 near West Point in the Main Basin.

Some sites experienced low NO_2-NO_3 concentrations, but were never quite depleted. One example was Station NSQ001 in the Nisqually Reach. Near NO_2-NO_3 depletion (0.05 mg/L) occurred in May and June 1991 at NSQ001. However, NSQ001 surface NO_2-NO_3 concentrations rose to nearly 0.10 mg/L by July 1991 (Figure 30). Turbidity from river discharge, which could have reduced the amount of light penetration in the water column, may have inhibited phytoplankton production (Cloern, 1987; Alpine and Cloern, 1988; see Secchi depth discussion). In addition, the river likely provided a continual source of nutrients to the delta. Adequate flushing, turbidity, and a continual source of nutrients may have been factors that prevented complete and ongoing nutrient depletion at NSQ001.

Ammonia

As with NO_2-NO_3, many processes affect the presence or absence of NH_3 in marine waters. In WY 1991, NH_3 was typically found to be depleted before NO_2-NO_3 at most Puget Sound stations. One reason for this pattern of depletion is that many types of phytoplankton, such as diatoms which tend to dominate the spring blooms, assimilate NH_3 more rapidly as a nitrogen source than NO_2-NO_3 (Eppley and Harrison, 1975; URS, 1986). Another reason is that concentrations of NH_3 in Puget Sound are usually lower than ambient concentrations of NO_2-NO_3 (Table 13; AMS Database). Since NH_3 concentrations are typically low, the presence of NH_3 at marine stations may have indicated sources, as often found in urbanized areas. In WY 1991, there were a few locations that showed higher concentrations of NH_3.

Compared to all the WY 1991 stations, Budd Inlet showed the least amount of NH_3 depletion. This was likely due to continuous inputs of NH_3 from local point and nonpoint discharges as well as the Deschutes River. Other WY 1991 stations that did not show complete NH_3 depletion were also located near urban centers where sources of NH_3 tend to be higher.

It is possible to contrast urban versus rural bay NH_3 concentrations by using inner Budd Inlet as an example of an urban bay station and Central Budd, Eld, and Totten Inlets as examples of non-urban bay stations. The histogram in Figure 31 demonstrates a historical plot of these four South Sound stations. Historical Station BUD002 is located in the inner west bay of Budd Inlet, near the Olympia Port Dock, whereas Station BUD005 is further offshore and away from direct urban sources. Station ELD001 is offshore in the center of Eld Inlet, and Station TOT001 is offshore in the center of Totten Inlet. The NH_3 concentrations at these

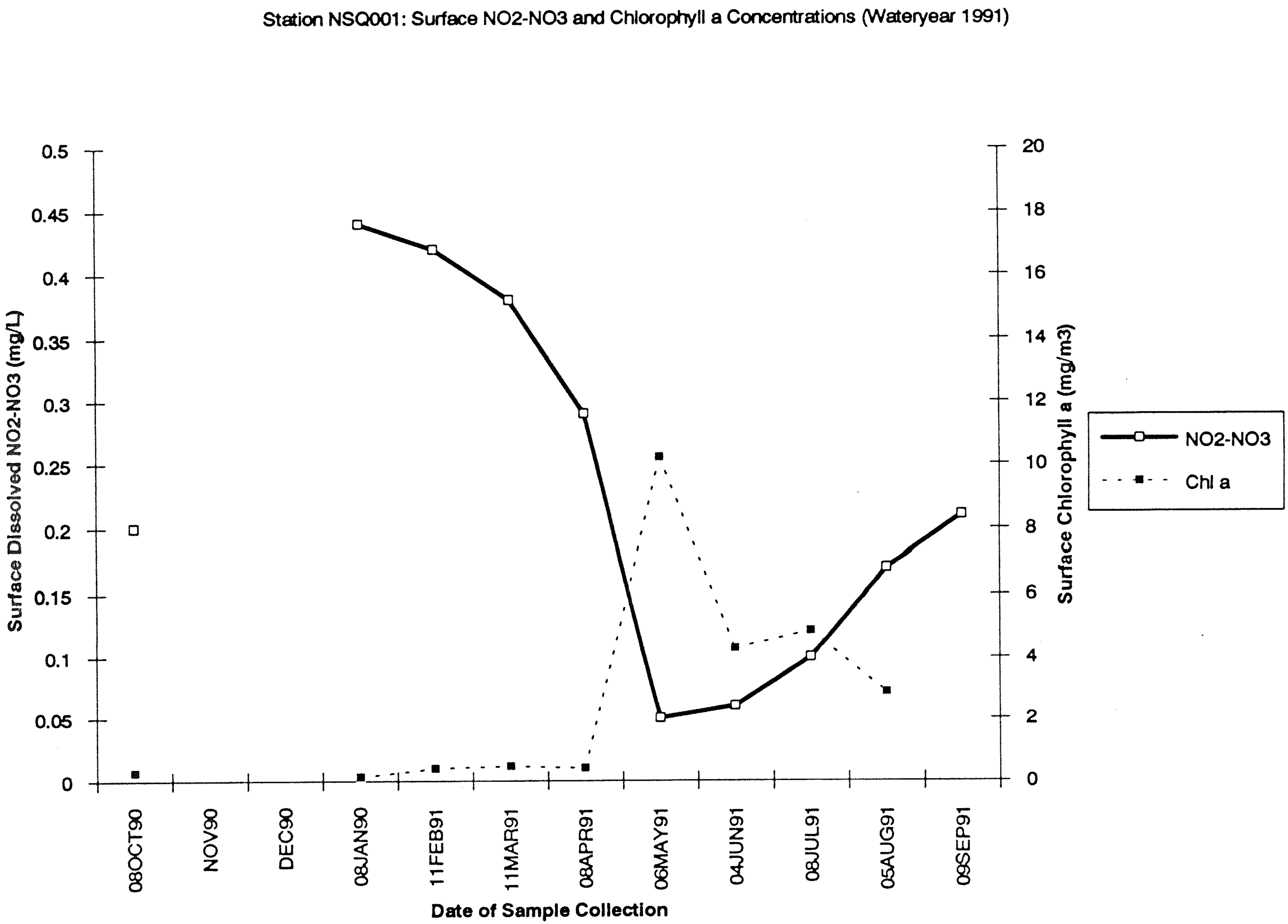


Figure 30. Nitrite-nitrate and chlorophyll *a* plots for WY 1991 at Nisqually Station NSQ001.

Table 13. Ninetieth percentile values of marine dissolved nutrients for WY 1991.

STATION	# Samples	NH3 (mg/L)	PO4 (mg/L)	NO2–NO3 (mg/L)
North Sound				
ADM002	24	0.020	0.074	0.410
GRG002	27	0.010	0.070	0.380
BLL009	20	0.058	0.080	0.389
SKG003	18	0.022	$\boxed{0.081}$	0.344
EAS001	20	$\boxed{0.113}$	0.070	0.378
LOP001	20	0.020	0.070	0.378
DIS001	22	0.050	0.070	0.327
JDF005	22	0.010	0.070	0.354
PAH008	20	0.029	0.070	0.390
PSS019	30	0.039	0.080	0.400
SAR003	30	0.039	0.080	0.389
Central Sound				
ADM003	24	0.030	0.080	0.410
EAP001	30	0.020	0.080	0.419
PSB003	30	0.039	0.080	0.419
CMB003	27	0.050	0.080	0.420
NRR001	30	0.020	0.080	0.419
South Sound				
BUD005	20	$\boxed{0.088}$	0.080	$\boxed{0.457}$
QAK004	22	$\boxed{0.071}$	$\boxed{0.088}$	0.404
CSE001	33	0.046	0.080	0.442
CRR001	33	0.042	0.080	0.432
NSQ001	20	0.039	0.080	$\boxed{0.438}$
DNA001	36	0.043	0.080	0.436
Hood Canal				
HCB003	30	0.019	$\boxed{0.097}$	$\boxed{0.466}$
HCB006	33	0.030	0.080	0.400
HCB004	20	0.010	$\boxed{0.093}$	0.399
HCB007	20	0.039	$\boxed{0.108}$	0.409
Coastal				
GYS004	20	$\boxed{0.099}$	0.030	$\boxed{0.604}$
GYS008	17	$\boxed{0.072}$	0.040	0.302
GYS009	20	0.070	0.040	0.431
WPA004	18	0.031	0.030	0.195
WPA003	18	0.060	0.040	0.328
WPA001	18	0.070	0.030	$\boxed{0.671}$
AVERAGE		0.043	0.072	0.408
WT AVG		0.041	0.074	0.410

indicates the five highest nutrient concentrations

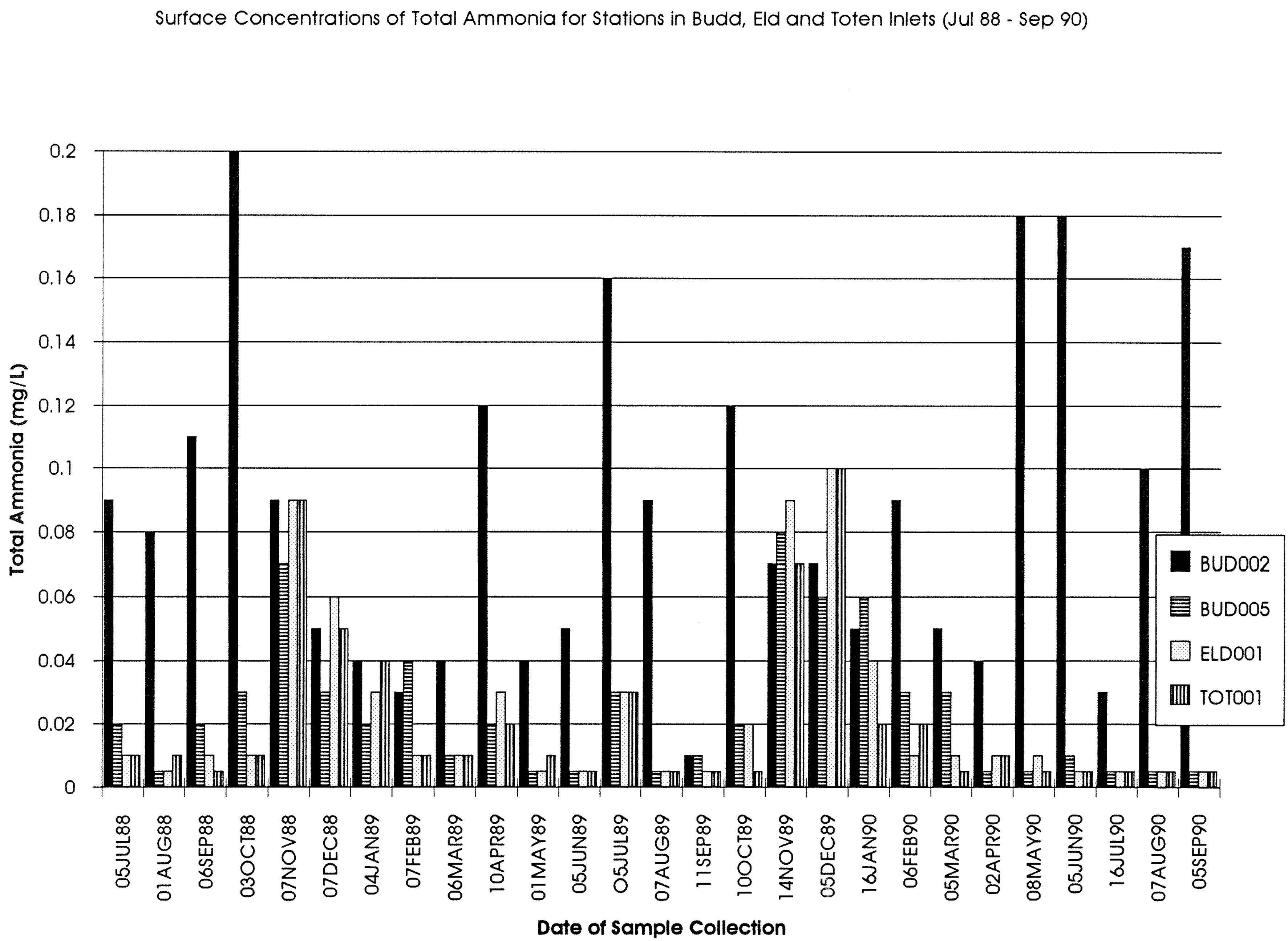


Figure 31. Ammonia concentration time series for three South Sound embayments -- Budd Inlet, Eld Inlet, and Totten Inlet, July 1988-September 1990.

stations showed a distinct seasonal pattern, with higher concentrations in the winter and lower concentrations during the growing season, as expected. During the winter months, all the stations had similar NH_3 concentrations. However, during the growing season, NH_3 concentrations dropped to near or below detection limit values for all stations except BUD002. The NH_3 concentrations were intermittent at BUD002, and did not seem to follow a direct seasonal pattern like that seen at the other stations. It is likely the NH_3 time series at BUD002 was a result of ongoing discharges from the Lacey, Olympia, Tumwater, Thurston County (LOTT) treatment facility. A less significant source of NH_3 may have been the Deschutes River, which inputs further in the head of the west bay.

Orthophosphate

It is rare to observe phosphate values near depletion when nitrogen is not depleted in marine waters. During WY 1991 when near depletion of O-PO_4 (<0.01 mg/L) occurred, it was usually during times of NO_2-NO_3 depletion as seen at ADM003 (May and September 1991), BLL009 (May and August 1991), and CRR001 (May and July 1991) (Appendix F). However, the duration of O-PO_4 near depletion was much shorter than the duration of NO_2-NO_3 depletion. Only a few events of near O-PO_4 depletion occurred, with only eight percent of the O-PO_4 data collected during WY 1991 recorded below the reporting limit of 0.01 mg/L.

Two stations which did show O-PO_4 near depletion, but did not show NO_2-NO_3 depletion, included SKG003 in Skagit Bay during March 1991, and OAK004 in Oakland Bay during April 1991 (Appendix F). The CTD data for these months showed surface salinities of only 2.09 ppt at SKG003, and 10.56 ppt at OAK004. Since phosphate is usually the limiting nutrient in freshwater systems, and nitrogen is usually limiting in marine systems, one can infer from the fresher surface waters that these samples may have been influenced by freshwater phytoplankton O-PO_4 uptake.

Similarities in Nutrient Dynamics at WY 1991 Stations

As mentioned earlier in the stratification discussion, a few stations showed similarities in their water quality characteristics. Stations that showed similar nutrient and stratification patterns in WY 1991 were:

- PSS019 and SAR003 in Possession Sound and Saratoga Passage, North Sound;
- CSE001 and CRR001 in Case Inlet and Carr Inlet, South Sound; and
- HCB004 and HCB007 at the Great Bend and Lynch Cove, South Hood Canal.

Surface NO_2-NO_3 depletion and O-PO_4 near depletion occurred during the same months at each set of these stations. The stations within each pair were located fairly close, and may have been influenced by similar intrinsic factors (inputs, weather patterns, hydrographic dynamics, size, and geographic orientation), as well as by the same water masses entering and exiting the areas. Each pair also had similar stratification regimes throughout the year (Appendix C and D). Knowing the similarities between bays may be useful when trying to select regionally representative embayments to conduct more intensive seasonal sampling.

Chlorophyll *a* and Nutrient Relationships

Surface Relationships

There was strong seasonality demonstrated in both the surface NO_2-NO_3 and chlorophyll *a* data for most of the Puget Sound stations, particularly those in semi-enclosed embayments. Examples of time series plots of station nutrient and chlorophyll *a* data that showed well defined seasonality include (Figure 32; Appendix I):

- BLL009 Bellingham Bay, North Sound;
- PSB003 Main Basin - West Point, Central Sound;
- CSE001 Case Inlet - Heron Island, South Sound; and
- HCB003 Central Hood Canal - Eldon.

Chlorophyll *a* maximum concentrations that were observed at the same time as minimum NO_2-NO_3 concentrations, and vise versa, was one such seasonal pattern. Stations that demonstrated this chlorophyll *a* maximum/NO_2-NO_3 minimum relationship included (Figure 33; Appendix I):

- DIS001 Discovery Bay, North Sound;
- PSB003 Main Basin - West Point, Central Sound;
- CRR001 Carr Inlet - Green Point, South Sound; and
- HCB006 Northern Hood Canal - Bangor.

This nutrient and algal biomass relationship was consistent with that found and modeled by O'Brien (O'Brien, 1974; Figure 34). The inverse relationship between chlorophyll *a* and NO_2-NO_3 is due to the utilization of NO_2-NO_3 and other nutrients (NO_2, NH_3 and O-PO_4) by phytoplankton during periods of exponential growth. As nutrients become limiting, phytoplankton growth decreases. At stations where nutrients did not appear to be limiting to algal growth, the decrease in chlorophyll *a* concentration may have been due to grazing of phytoplankton by zooplankton, a breakdown in stratification, flushing and/or light limitation (Chew and Stober, 1984).

Ten-meter Depth Relationships

Ten-meter depth NO_2-NO_3 decreases were correlated with increased 10-m chlorophyll *a* concentrations at a few stations including BLL009, DIS001, PSB003 (Appendix J). This inverse relationship at 10-m typically occurred when the same relationship was seen at the surface. Ten-meter nutrient/chlorophyll *a* changes also occurred later in the growing season.

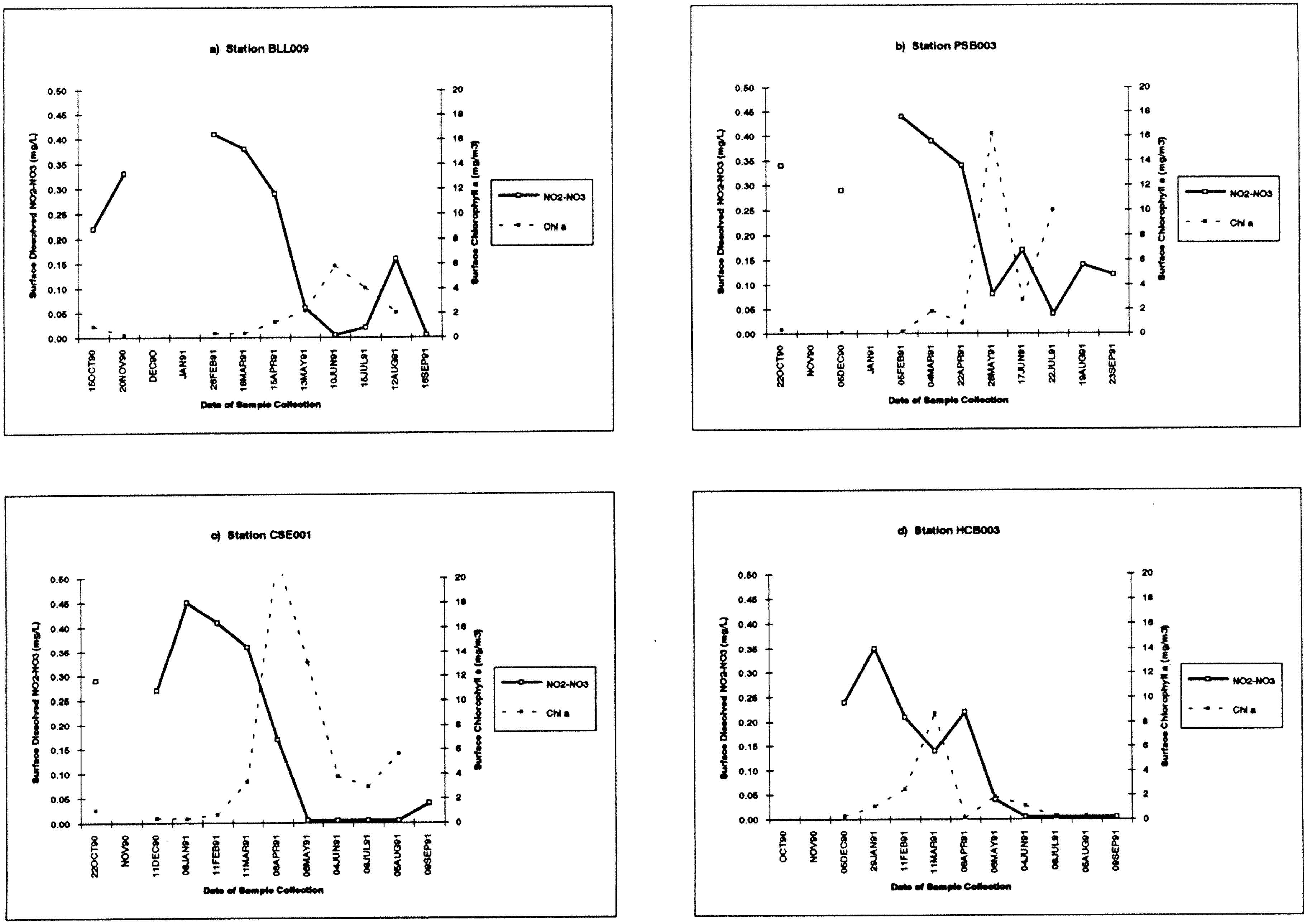


Figure 32. Nitrogen/chlorophyll *a* plots for stations a) BLL009, b) PSB003, c) CSE001, and d) HCB003 for WY 1991.

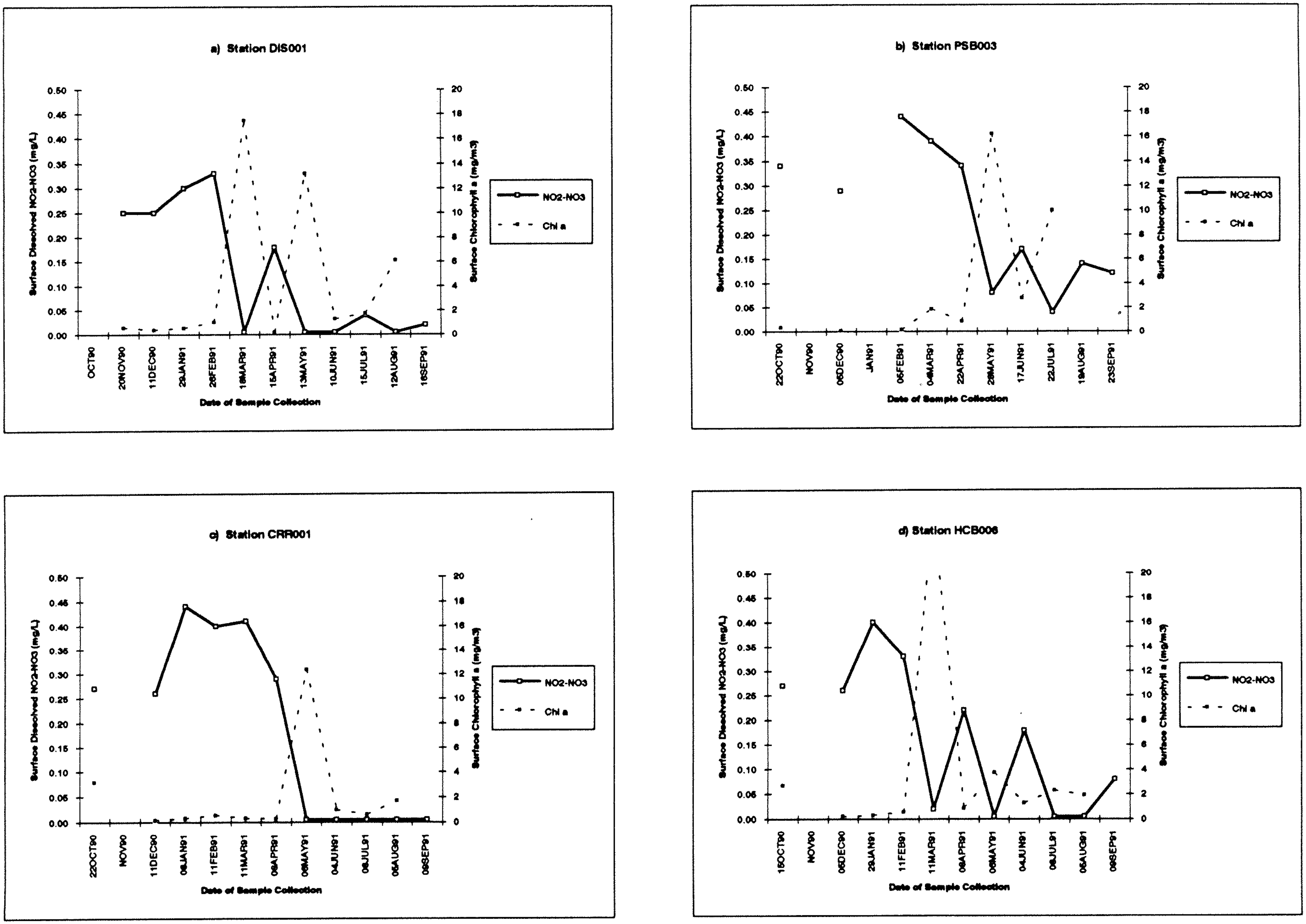
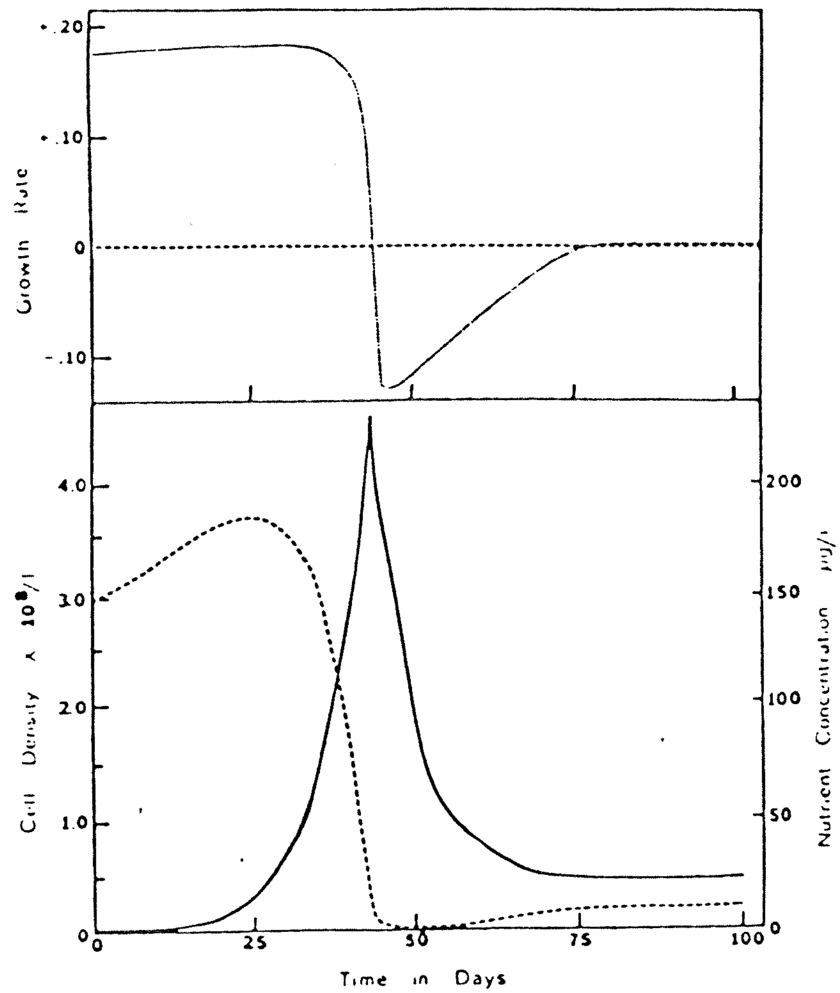


Figure 33. Nitrogen/chlorophyll *a* plots for stations a) DIS001, b) PSB003, c) CRR001, and d) HCB006 for WY 1991.

NUTRIENT LIMITATION OF PHYTOPLANKTON



Typical simulation run with a single population and nutrient. The initial population size was 500,000 cells/liter with a K_s of 10, g_m of a division every 2 days and a death rate of .15. The initial concentration of the nutrient was 150 $\mu g/l$ with the replacement rate of 2 $\mu g/l$. day and each cell took up 2.36×10^{-7} μg of nutrient. Dark line = population size. Dashed line in the lower panel shows the nutrient concentration; dashed line upper panel marks zero rate of population change. Dotted line upper panel shows the actual rate of population change as determined by equation (3).

Figure 34. Nutrient and algal biomass relationship for marine phytoplankton (From: O'Brien, 1974).

Surface nutrient depletion later followed by 10-m nutrient decreases may have been due to initial phytoplankton blooms exhausting surface nutrients, followed by a bloom occurrence deeper in the water column where nutrient supplies were still available. Examples of this pattern were seen at:

- CSE001 Case Inlet, May and June, 1991 (Figure 35);
- HCB004 South Hood Canal, March-May, and June 1991 (Figure 36); and
- EAS001 East Sound, April and June 1991 (Figure 37).

As seen in the chlorophyll *a* results, the blooms occurring later in the growing season were located deeper in the water column, presumably due to the concentrations of nutrients still available at these depths. The timing was such that a spring surface chlorophyll *a* maximum was followed by a sub-surface summer maximum. For example, both outer Case Inlet (CSE001) and East Sound near Orcas Island (EAS001) had a surface chlorophyll *a* maximum during April 1991 (Figures 35a and 37a, respectively) followed by a 10-m chlorophyll *a* maximum during June 1991 (Figures 35b and 37b, respectively). Note that the phytoplankton species that utilized the surface nutrients may have been different than those that utilized the 10-m nutrients.

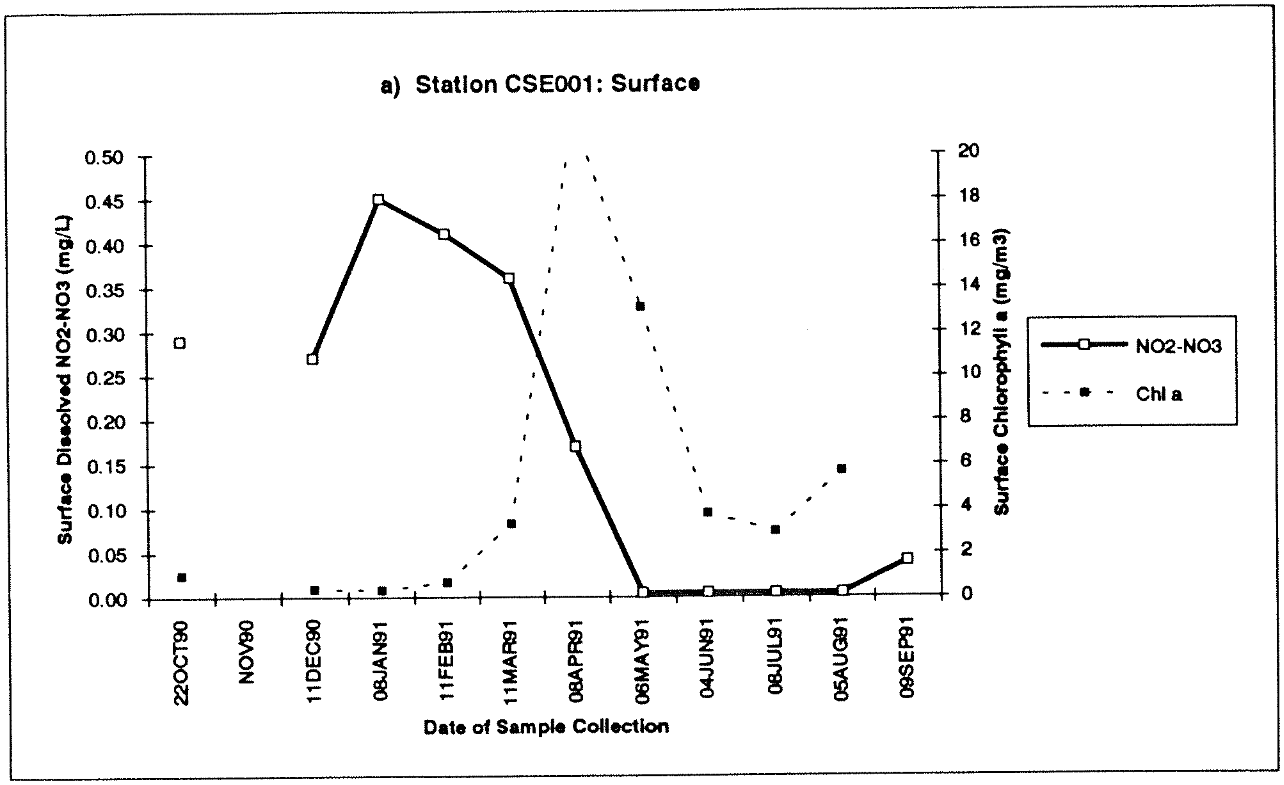
Chlorophyll *a* peaks were not always observed during periods of nutrient depletion. This was likely due to the patchiness of the phytoplankton and the nature of the long-term monitoring sample collection. During the long-term monitoring, chlorophyll samples were taken at discrete, pre-determined depths (surface, 10- , and 30-m). Therefore, samples may not have been collected from the depth of the chlorophyll maximum. Furthermore, monthly sampling did not always provide the temporal frequency needed to adequately assess changes in phytoplankton biomass. Phytoplankton blooms can have a time scale of much less than one month (Forbes, 1991). Therefore, it is possible for a phytoplankton population to begin growth, peak, and die-off without being observed during the monthly monitoring, despite observed nutrient depletion. It is possible too that grazing of phytoplankton by zooplankton caused lower chlorophyll *a* concentrations to be observed during some of the station visits.

Thirty-Meter Depth Relationships

Thirty-meter results showed low chlorophyll *a* and higher nutrient concentrations during WY 1991. Light limitation is most likely the reason the chlorophyll *a* concentrations were so low at these depths. Nutrient concentrations were never depleted at 30-m.

Nutrient Limited and Non-Limited Stations

Surface phytoplankton populations may be nutrient limited at many of the stations visited in Puget Sound during WY 1991, particularly those that showed stratification and had a shallow mixed layer. Examples of such stations include (Appendices C and I):



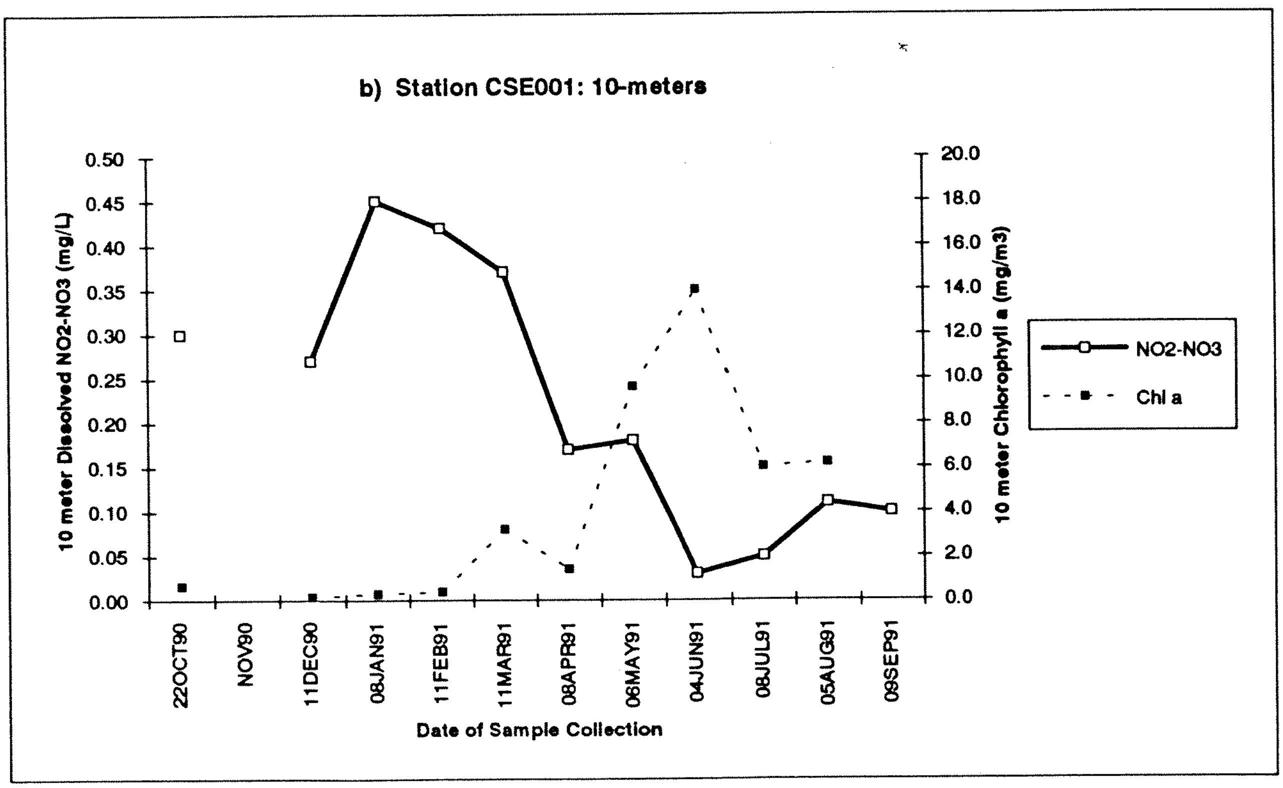
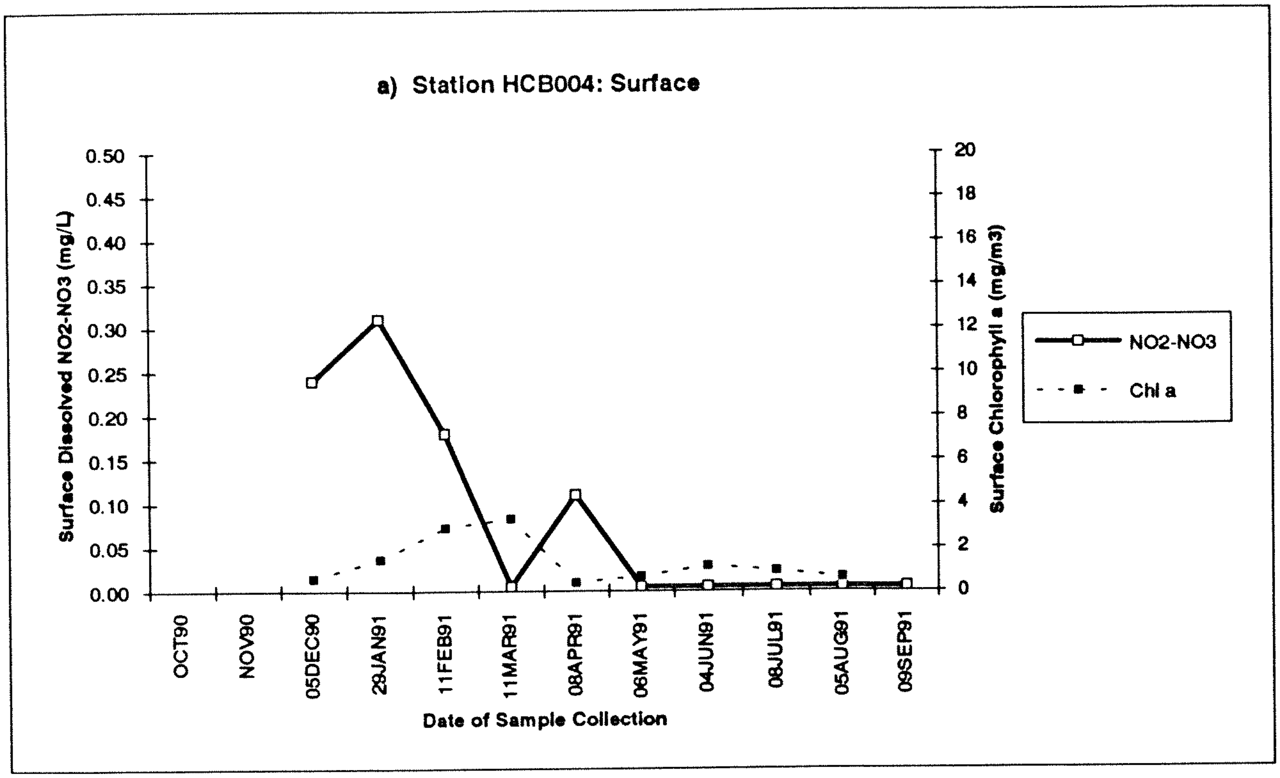


Figure 35. Nitrogen/chlorophyll *a* plot for Case Inlet Station CSE001 at the a) surface, and b) 10-m.



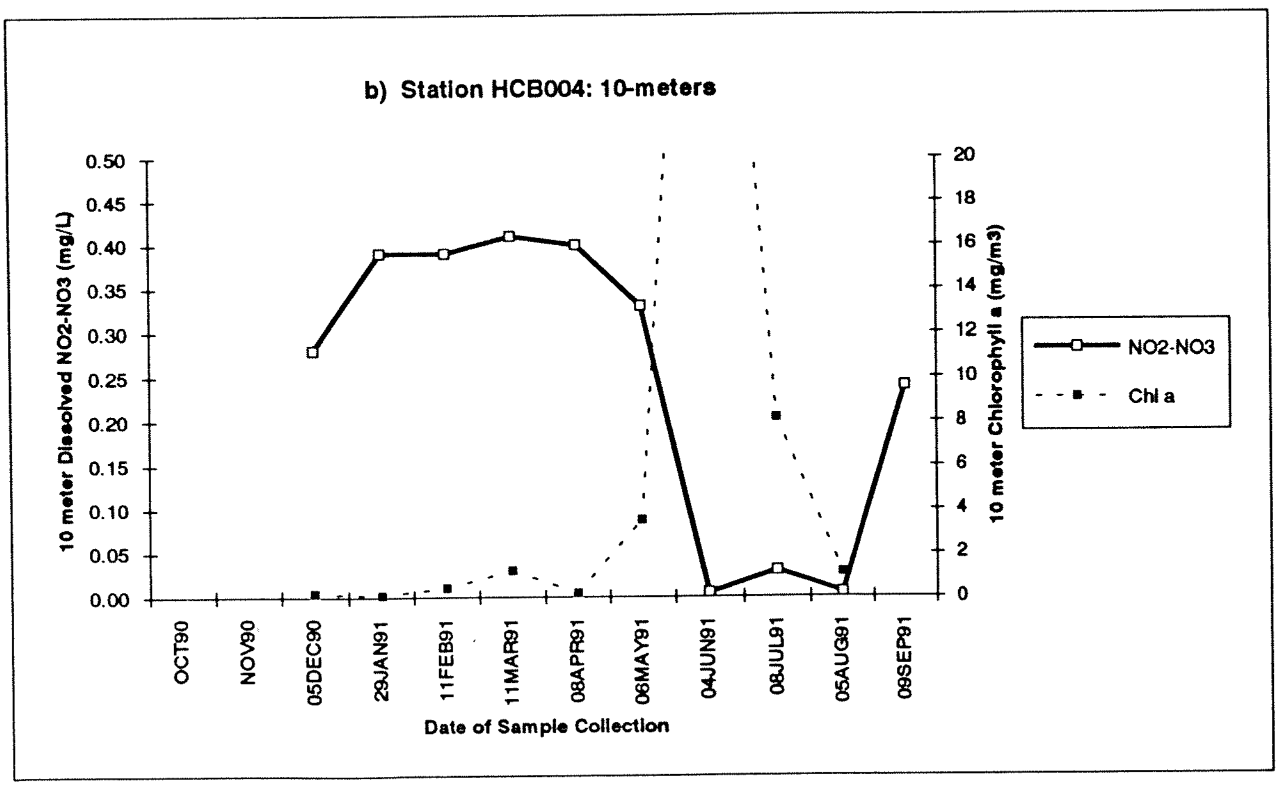
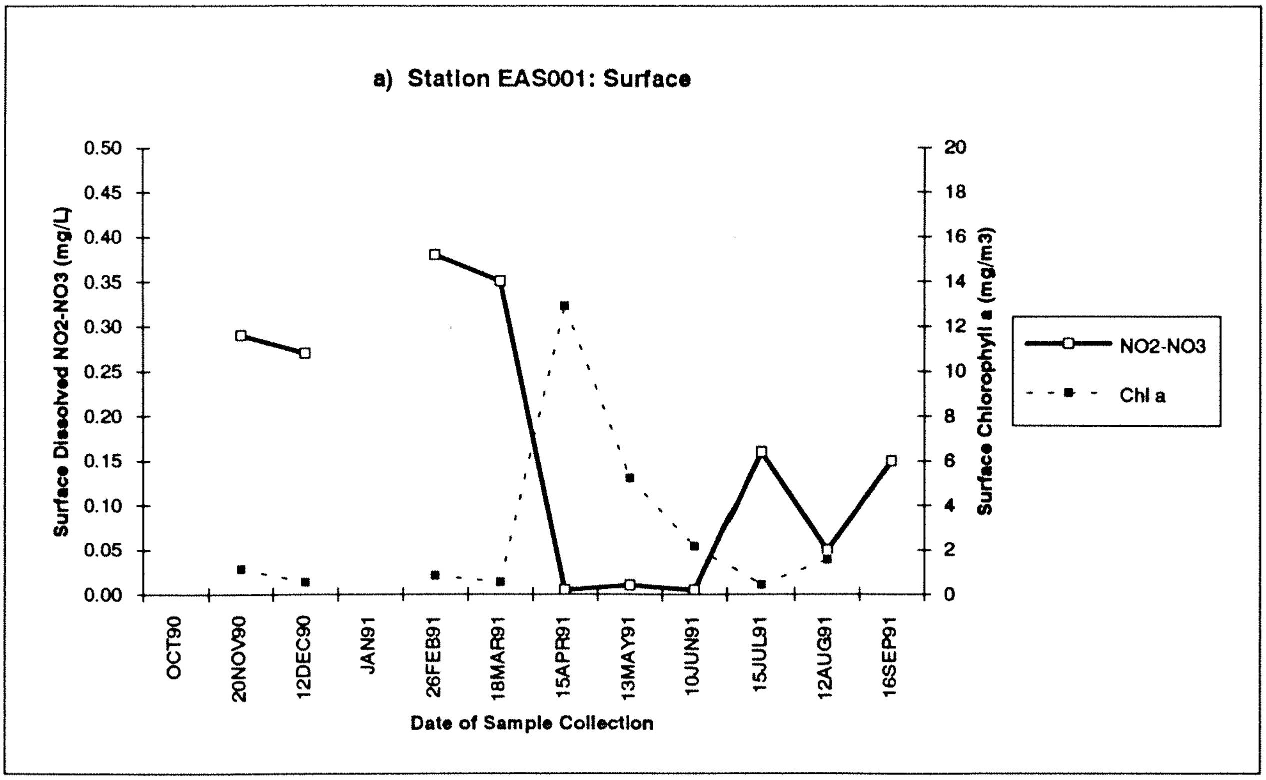


Figure 36. Nitrogen/chlorophyll *a* plot for South Hood Canal Station HCB004 at the a) surface, and b) 10-m.



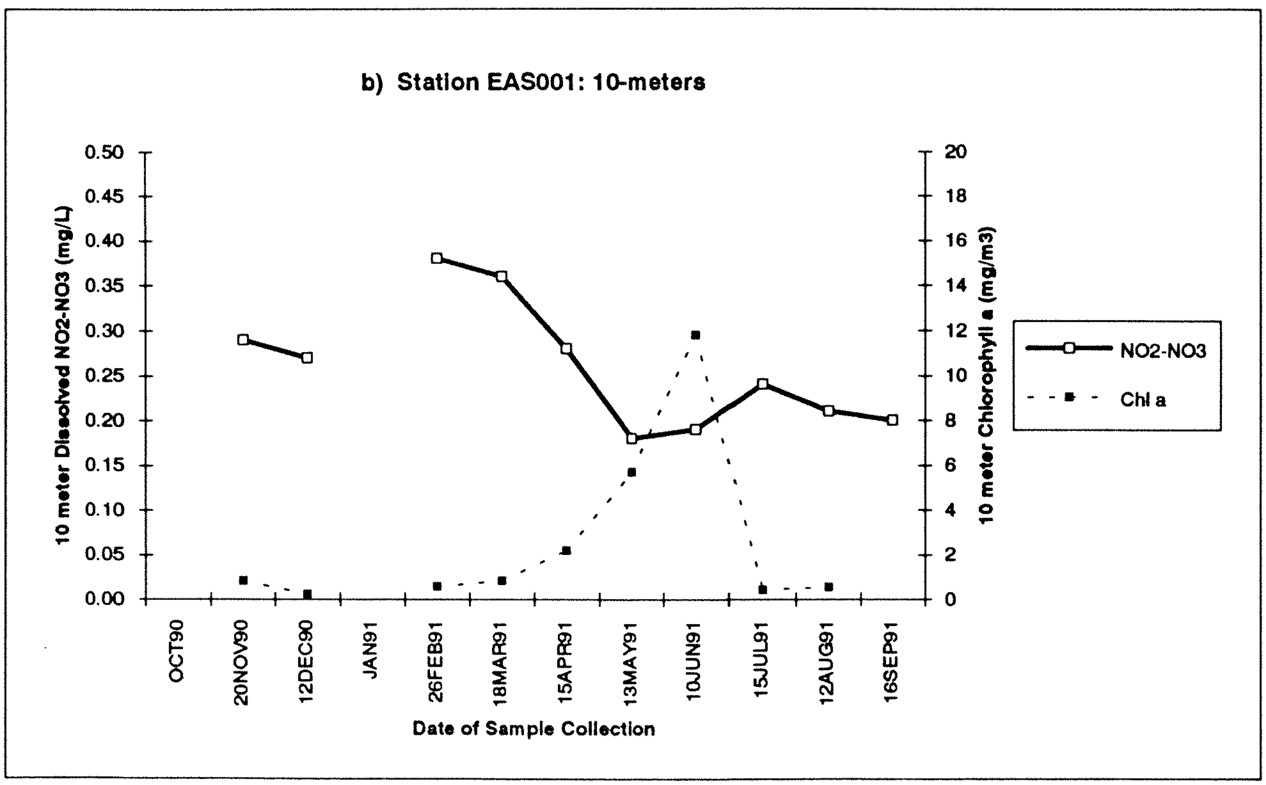


Figure 37. Nitrogen/chlorophyll *a* plot for East Sound Station EAS001 at the a) surface, and b) 10-m.

- SAR003 Saratoga Passage, North Sound;
- EAP001 East Passage, Central Sound;
- BUD005 Budd Inlet, South Sound; and
- HCB007 Lynch Cove, South Hood Canal.

At these stations, it appeared the phytoplankton blooms continued to occur until the nutrients in the surface mixed layer became depleted (or limiting). Generally, if phytoplankton cannot attain additional nutrients from upwelling, freshwater inputs, or by vertically migrating (which occurs in flagellated algae such as dinoflagellates), growth rates will decline, and the algae will die-off.

An issue of concern relative to nutrient limitation of algal growth, is eutrophication potential. In areas where excessive algal blooms are maintained by large and unlimited nutrient supplies, portions of the algae mass will continually die, sink, and decay. Ongoing algal decay in the water column (namely the bottom waters) can decrease dissolved oxygen concentrations to levels often associated with extreme eutrophication (excessive algal growth due to large nutrient inputs, abundant sunlight, a stable water column, and minimal grazing). Eutrophication has been documented in the inner portions of Budd Inlet (PSEP, 1988) and most of South Hood Canal (Curl and Paulson, 1991).

Several open basin stations in Puget Sound and all stations in Grays Harbor showed minimal nutrient depletion, low chlorophyll *a* concentrations, and had little if any density stratification. Examples of Puget Sound stations include (Figure 38; Appendix I):

- ADM002 Strait of Juan de Fuca, North Sound;
- PAH008 Strait of Juan de Fuca near Port Angeles, North Sound;
- GRG002 Strait of Georgia - Patos Island, North Sound; and
- NRR001 Tacoma Narrows, Central/South Sound.

At these stations, it is likely that algal cells were flushed out and diluted before significant growth could occur. As mentioned earlier, it is also possible that cell growth was light limited because the mixed layer extended below the photic zone. In Grays Harbor, continual riverine inputs, high turbidity, and rapid flushing likely reduced algal activity.

Secchi Depth Measurements

Secchi depth measurements were shallow when they were taken just prior to/or during the months when a station experienced nutrient depletion. Examples include:

- DIS001 Discovery Bay (Figure 39),
- PSS019 Possession Sound - Gedney Island (Figure 40),
- CRR001 Carr Inlet - Green Point (Figure 41), and
- WPA004 Willapa Bay - Toke Point (Figure 42).

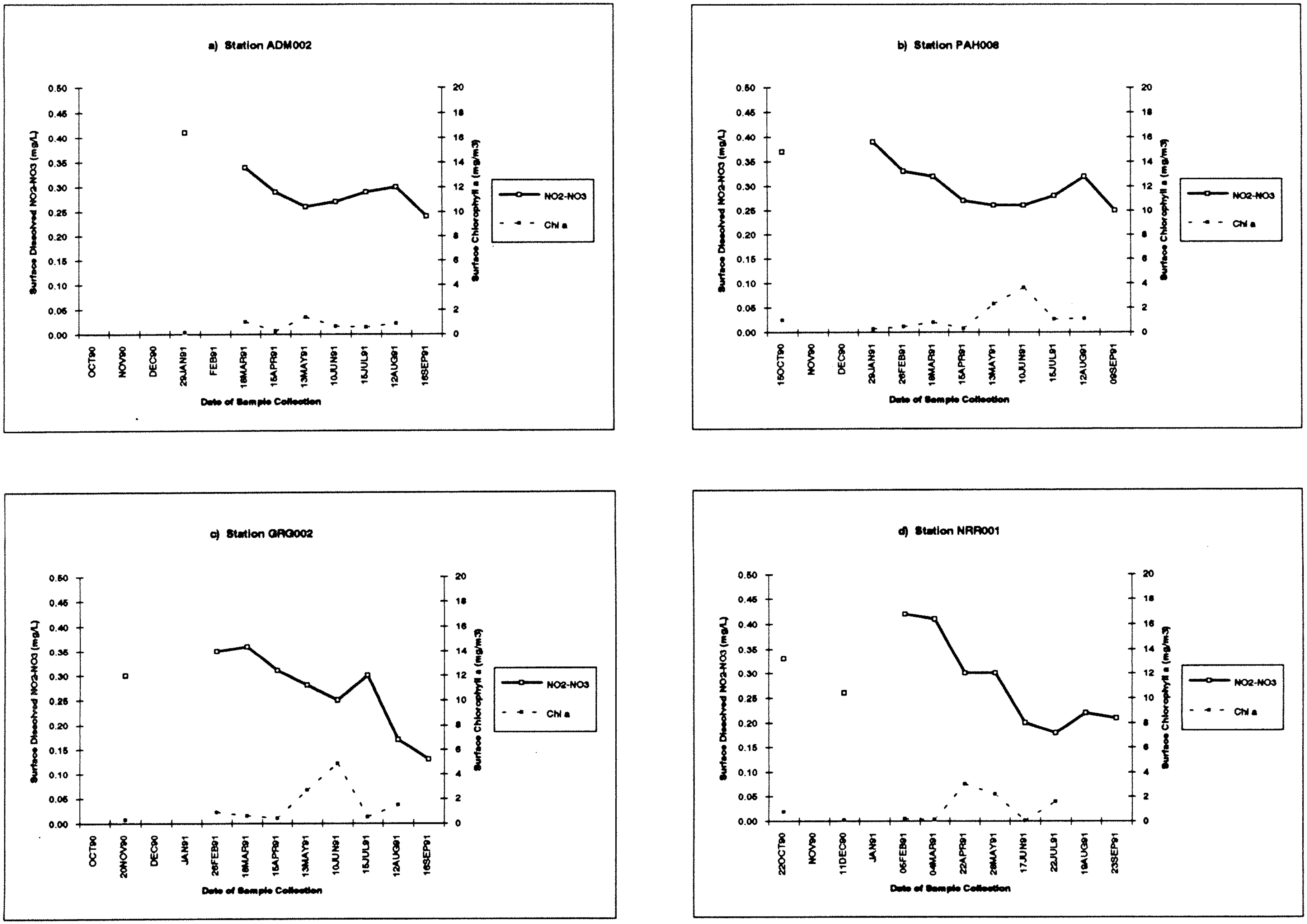
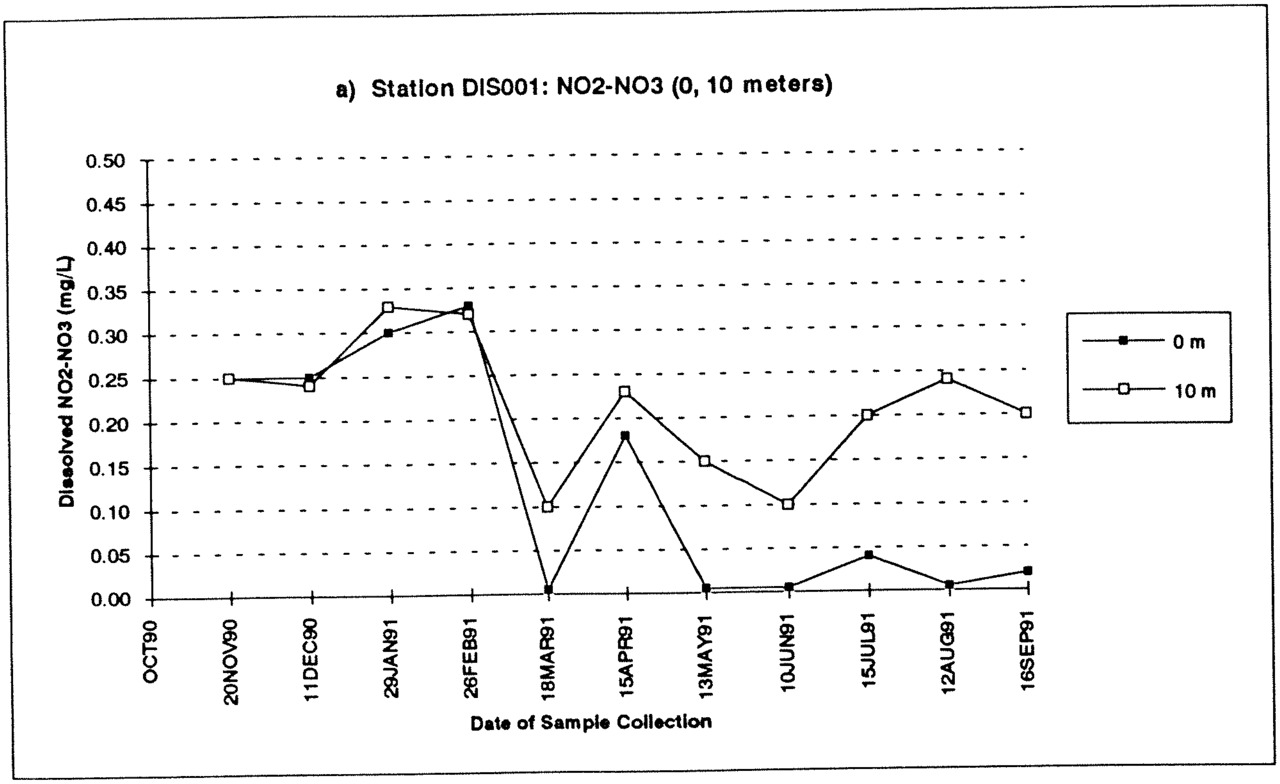


Figure 38. Nitrogen/chlorophyll *a* plots for stations a) ADM002, b) PAH008, c) GRG002, and d) NRR001 for WY 1991.



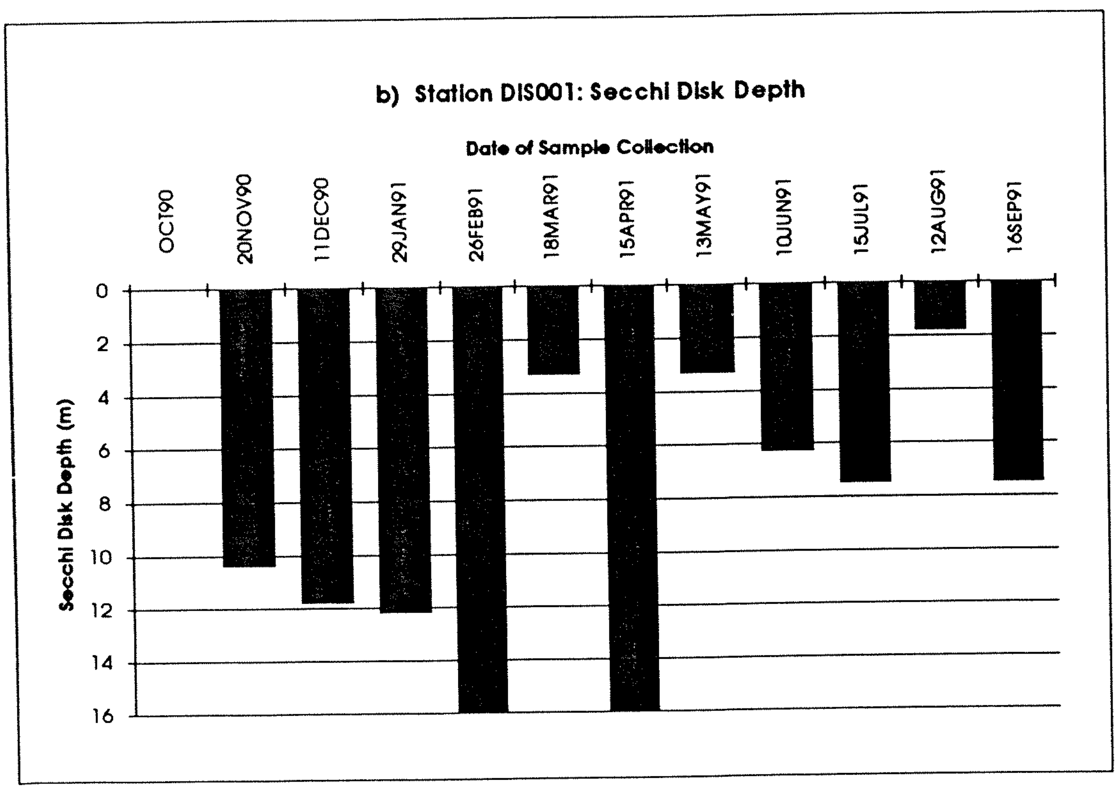
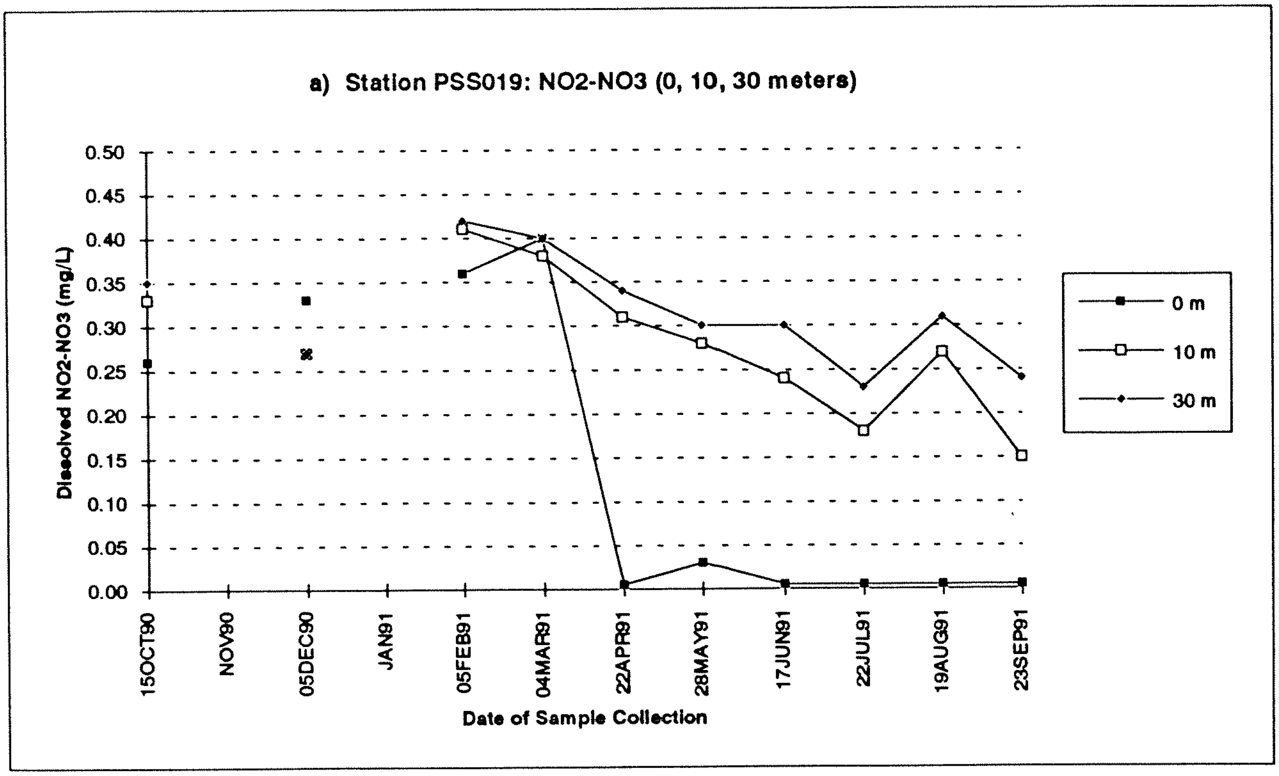


Figure 39. Discovery Bay Station DIS001 WY 1991 a) dissolved NO_2-NO_3 plots at all depths, and b) Secchi depth plots.



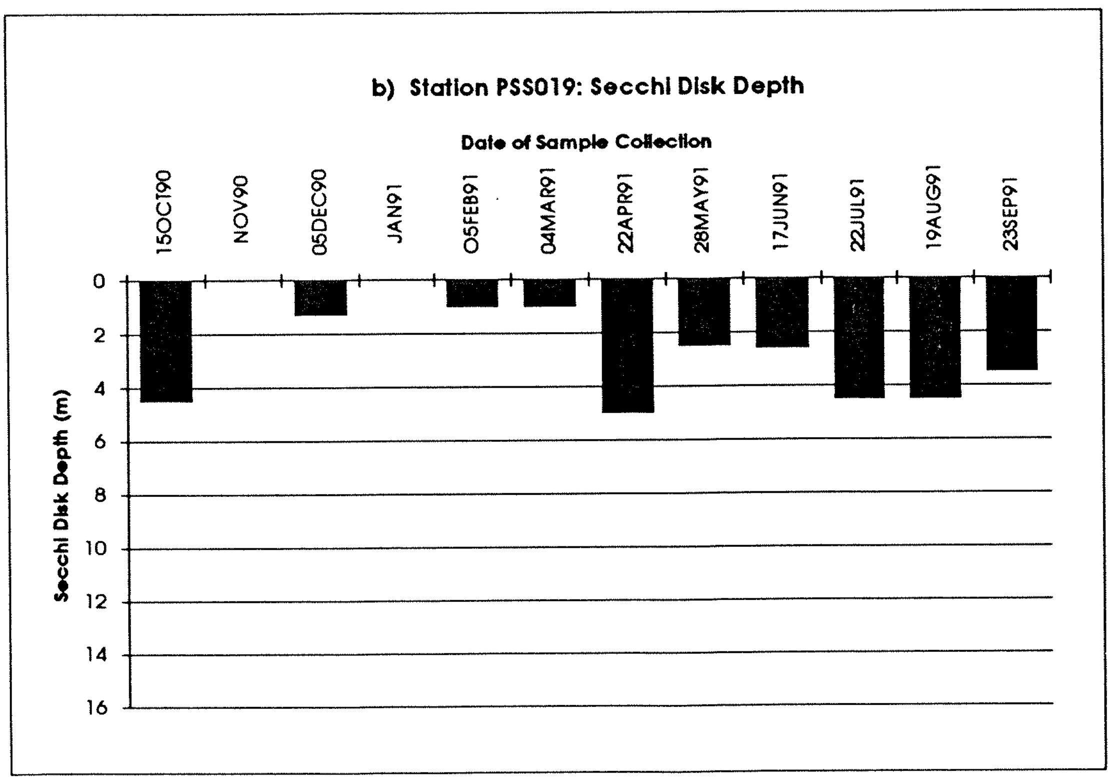
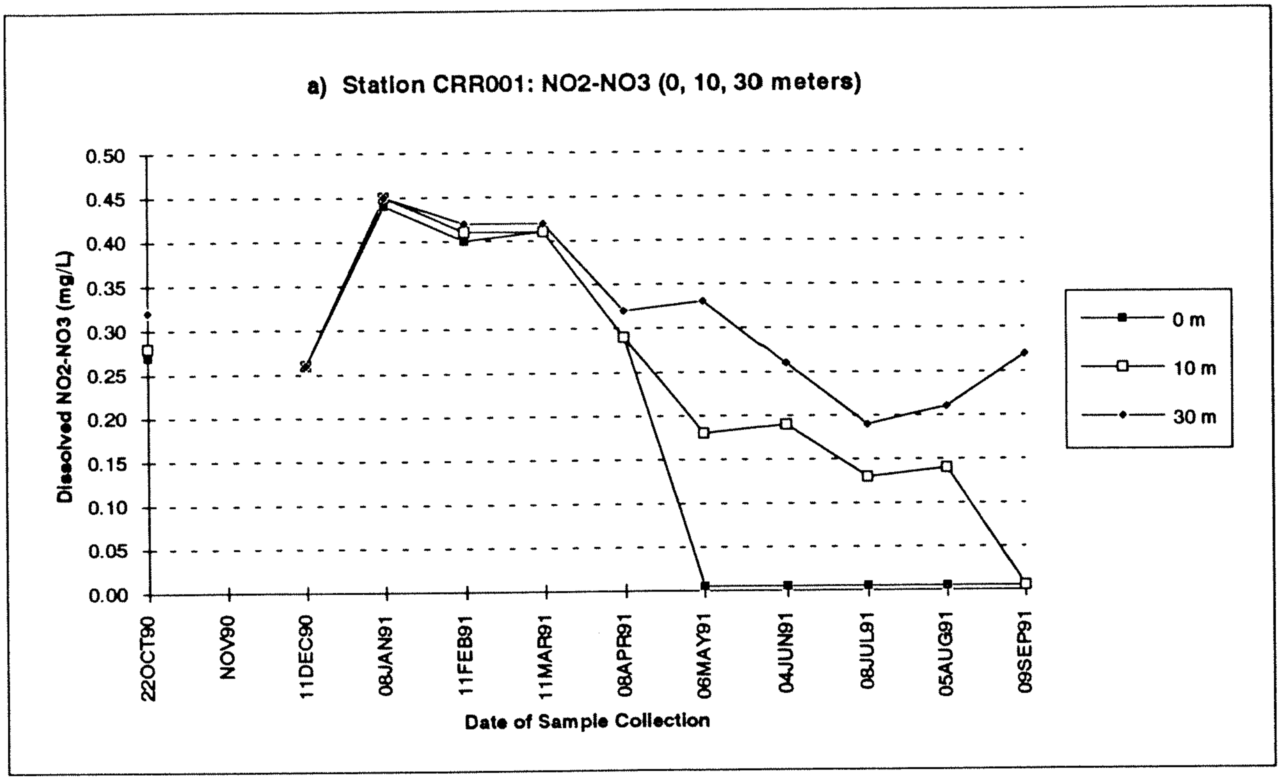


Figure 40. Possession Sound Station PSS019 WY 1991 a) dissolved NO_2-NO_3 plots at all depths, and b) Secchi depth plots.



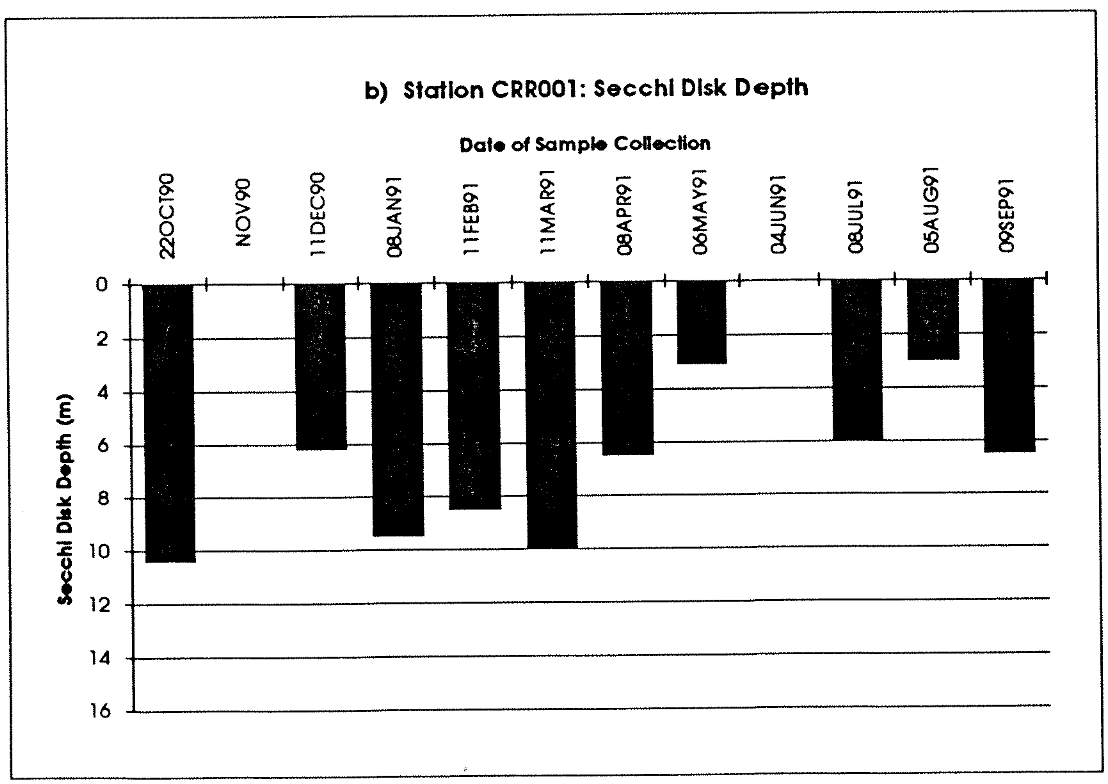
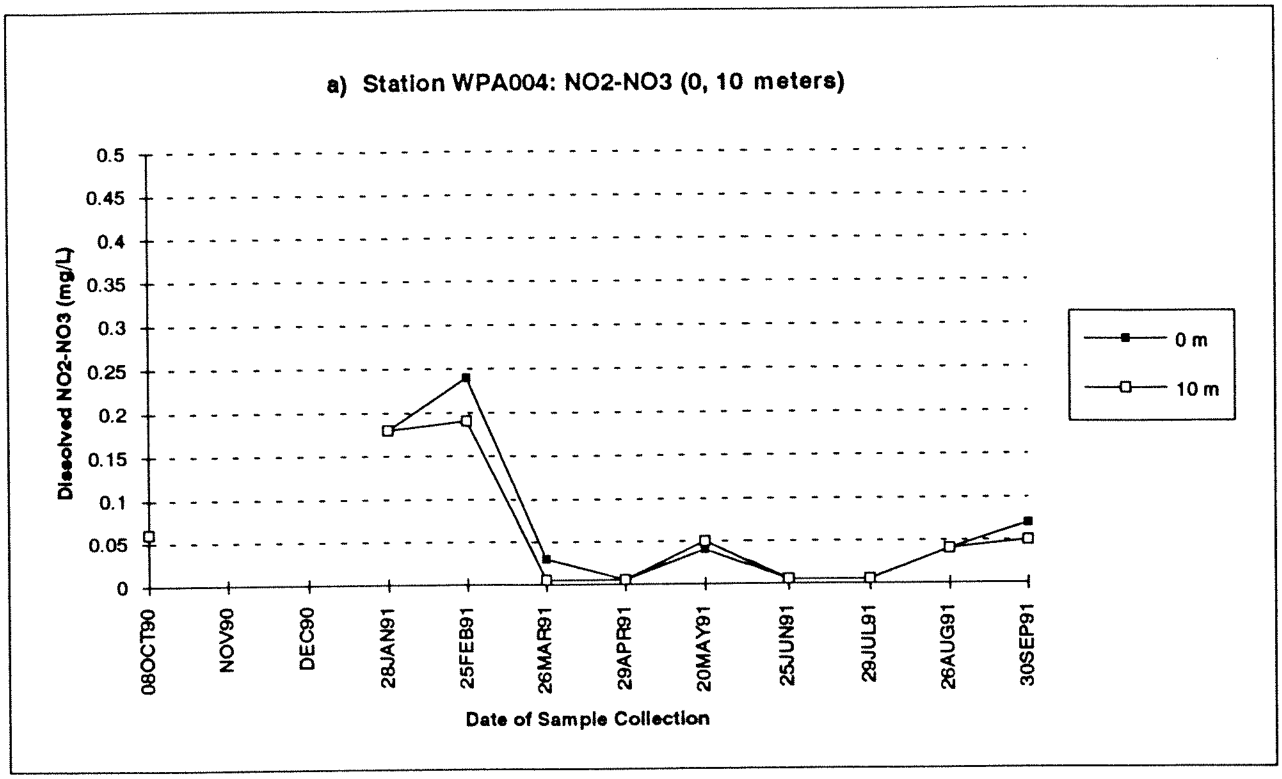


Figure 41. Carr Inlet Station CRR001 WY 1991 a) dissolved NO_2-NO_3 plots at all depths, and b) Secchi depth plots.



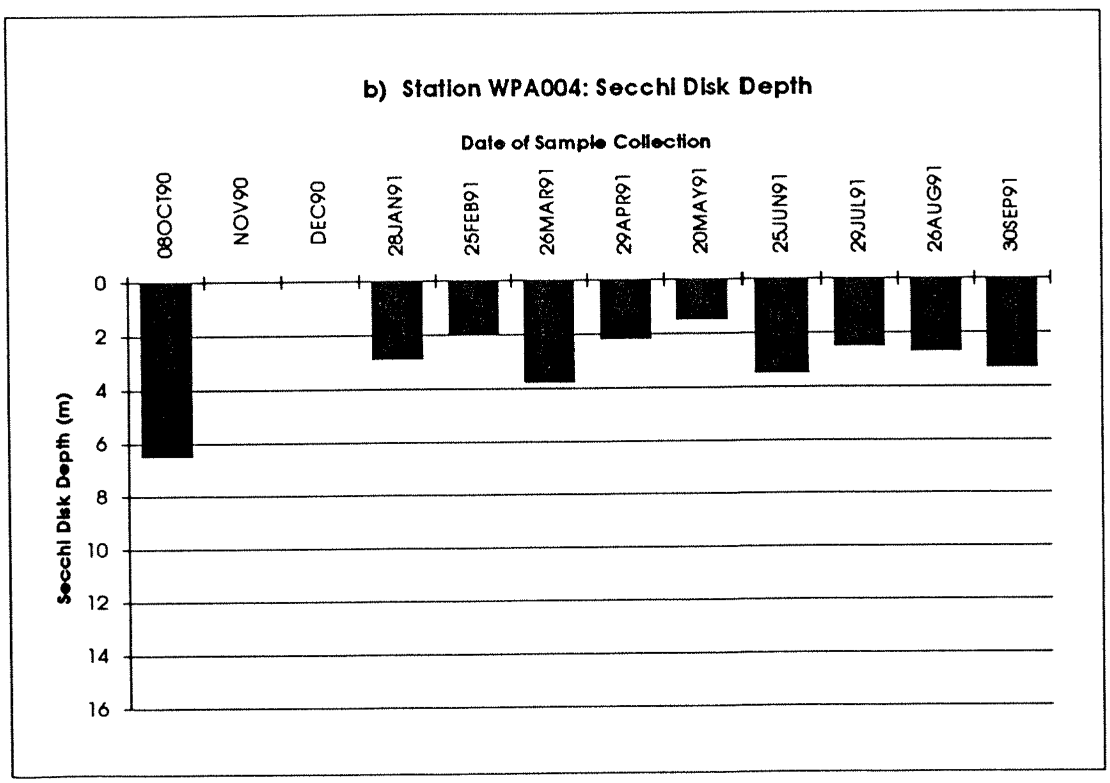


Figure 42. Willapa Bay Station WPA004 WY 1991 a) dissolved NO_2-NO_3 plots at all depths, and b) Secchi depth plots.

This pattern may have indicated that algae blooms were well underway before complete nutrient depletion could be documented.

In areas with little significant riverine inputs, Secchi depths taken two or more months prior to nutrient depletion were often deeper, as expected. Shallow Secchi depths that occurred prior to the growing season were likely a result of increased river discharge and land run-off from winter storm events and melting snow packs. As seen in the Results Section, most of the stations that had multiple readings at or below 2-m one or more times were located near river inputs (Table 11; Appendices K and L).

CONCLUSIONS

Overall, observations made during the Marine Water Column Monitoring Program in WY 1991 indicated good water quality in Puget Sound. Only a few water quality problems existed, such as areas where circulation is restricted and in embayments near urban centers. Areas such as South Hood Canal (HCB004 and HCB007) showed low oxygen concentrations year-round, possibly the result of excessive nutrient inputs and the lack of sufficient flushing. South Hood Canal has a fairly extensively developed shoreline, is highly stratified, and experiences minimal circulation and flushing, preventing adequate nutrient removal by processes other than excessive algal growth.

Coastal stations in Grays Harbor appeared to be mostly affected by fecal coliform bacteria inputs from the Chehalis River and local urban areas. Grays Harbor also had high turbidity values, most likely due to the river. Willapa Bay did not appear to have the water quality problems seen in Grays Harbor. The Willapa River station showed higher fecal coliform counts, but similar high counts were not always evident downstream.

Many Puget Sound embayments showed seasonal patterns of nutrient depletion similar to those in South Hood Canal. However, these areas did not appear to experience hypoxic conditions resulting from die-off of massive algal populations. Seasonal patterns of nutrient depletion without excessive algal growth may have been due to lower nutrient availability, continuous flushing, adequate mixing, and grazing of phytoplankton by zooplankton (preventing excessive algal growth). However, embayments that showed nutrient depletion (or near depletion) could become adversely affected by additional nutrient inputs. In future monitoring efforts, these embayments should be monitored more intensively to better understand the nutrient/phytoplankton dynamics as well as the circulation and mixing processes.

Fecal coliform bacteria data suggested that some areas may have been receiving ongoing fecal coliform bacteria inputs (Table 6). Many of the areas with higher counts were adjacent to urban centers like Commencement Bay near Tacoma (CMB003) and Possession Sound near Everett (PSS019). Higher fecal coliform bacteria counts were also seen in areas receiving large riverine inputs such as Grays Harbor (all stations), Willapa Bay (northern stations), Skagit Bay (SKG003), Budd Inlet (BUD005), and those sites mentioned above in Commencement Bay and Possession Sound (CMB003 and PSS019, respectively). It is possible that the salinity stratification near riverine discharges allowed fresher surface water to transport fecal coliform bacteria offshore, resulting in high counts at these offshore ambient sites. Fecal coliform bacteria also tend to survive longer in fresh water (Thomann and Mueller, 1987).

In WY 1991, occasional fecal coliform counts measured above 14 organisms/100 mL at a few stations offshore that are not affected directly by rivers and sources (e.g., ADM003). These observations were difficult to interpret since the locations at which they occurred do not typically experience fecal coliform counts above detection limits (1 organism/100 mL). These values were therefore considered anomalous for the time being.

Fecal coliform bacteria contamination is known to occur in inner Case Inlet. This condition is of concern to local shellfish growers, the local and State health departments, and Ecology. WY 1991 ambient results did not indicate a bacterial problem at the offshore sampling site CSE002 (inner Case Inlet), but this site may not best represent the nearshore resource areas. Future fecal coliform bacteria monitoring in Case Inlet should be focused closer to shore where higher counts are more likely to occur and where the shellfish resources are located.

Recommendations

Site Selection for Seasonal Monitoring

In 1992, the seasonal monitoring component of the marine water column monitoring program will be initiated. This type of monitoring is designed to improve spatial and temporal coverage in embayments and will help with the interpretation of nutrient/phytoplankton dynamics and physical transport processes in Puget Sound. Recommended study areas for seasonal monitoring should include embayments that showed nutrient depletion (or near depletion), since these areas may be the most sensitive to additional nutrient inputs. Study area selection should also include regions that demonstrated lower dissolved oxygen concentrations and restricted circulation and mixing, such as in highly stratified and semi-enclosed embayments. Sites that showed both nutrient depletion and lower dissolved oxygen concentrations might represent areas where algal processes could be detrimentally enhanced by additional nutrient inputs.

Fecal Coliform Bacteria

Interpretation of the fecal coliform bacteria results is limited by the variability in the data (Appendix H). Future monitoring of this parameter may be improved by increasing the number of samples collected at stations where detectable counts have been measured in the past. Fecal coliform bacteria data may also provide better information if sampling is focused on nearshore stations.

Fecal coliform bacteria at many stations did not show frequent (more than three times a year) counts above detection limits (1 organism/100 mL). As a result, continuing to sample at all of these sites may not be necessary; however, if fecal coliform data collection is discontinued at multiple sites, a limited number of "background" stations should be maintained, one in each Puget Sound region (north, central, and south), and one in each coastal estuary.

Nitrite

Dissolved nitrite results were frequently below detectable levels (94 percent of the nitrite values for WY 1991 were below detection limits). Below detection limit concentrations yield little information regarding nutrient dynamics. To adequately assess nitrite concentrations, detection levels of 0.005 mg/L must be achieved (MMC, 1988). Nitrite analysis should be discontinued until lower reporting limits can be achieved. In June 1992, the PSAMP Steering Committee approved to discontinue nitrite analysis at all but three stations. Ecology continues to sample nitrite in three urban bays where concentrations are most likely to change (BLL009 - Bellingham Bay; CMB003 - Commencement Bay; BUD005 - Budd Inlet).

Chlorophyll *a*

For Puget Sound stations, the depth where most algal growth occurs is generally well above 30-m. However, due to the patchiness of the blooms in the water column, it is difficult to predict where in the water column the maximum phytoplankton mass will occur. Monthly chlorophyll *a* samples should be discontinued at the 30-m depths since the majority of the results from this depth are at or below detectable levels. Sampling should be continued in the surface and 10-m samples where the blooms predominate. Increased sampling of chlorophyll *a* throughout the water column should be reserved for seasonal monitoring, where a real-time profiling fluorometer can be deployed to provide depths of chlorophyll *a* concentration peaks. In June 1992, the PSAMP Steering Committee approved to discontinue 30-m chlorophyll *a* sample collection at long-term monitoring stations.

To reduce sample degradation for chlorophyll *a* filters (prepared from water samples), the centrifuge tubes used to store the chlorophyll *a* filters should be filled with 10 mL of acetone before adding the processed filter. The acetone will extract cell pigments and slow down degradation during storage.

CTD Profiles and Water Sample Collection

Further changes to the monthly monitoring should include sampling of nutrients near the bottom of the deep open basin stations (core stations). CTD casts should also be conducted to the bottom, though this may prove to be problematic with time and logistical constraints while using a floatplane. Deep water sampling may best be reserved for seasonal monitoring when a boat is employed, offering a more suitable and stable platform from which to work. Beginning in the spring of 1992, CTD casts are being conducted to a maximum depth of 130-m. This depth allows the bottom of most stations to be reached.

Phytoplankton sample collection should be added to a select number of long-term core monitoring stations in order to develop information on species composition of algal blooms occurring in both Puget Sound and the coastal estuaries. Phytoplankton sample collection and analysis is necessary in order to increase understanding of the interacting biological parameters that affect water quality. By collecting samples throughout the year, phytoplankton species dominance during bloom periods (e.g., spring versus summer) can be estimated. Collection of phytoplankton samples during seasonal monitoring efforts will improve the capability of identifying dominant species during individual bloom events of the growing season. Phytoplankton samples are currently being collected at four long-term monitoring stations (WPA004, BUD005, PSB003, and GRG002) as part of an in-kind service agreement with the University of Washington School of Oceanography. Sample collection commenced in the spring of 1992.

Sample Handling

Filtering of the chlorophyll *a* samples should be completed as soon after sample collection as possible (at least by the end of each day). Filters should be stored in centrifuge vials containing 10 mL of acetone, and ideally analyzed as soon after filtering as possible. Filters should be frozen immediately after filtration if same day analysis is not possible. Furthermore, consistency with analysts conducting the fluorometry has been shown to improve quality of the results (Appendix H).

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APPENDIX A

CTD FACTORY CALIBRATION RESULTS

SBE SEA-BIRD ELECTRONICS, INC TELEPHONE 206 643-9866 FAX 206 643-9954
1808-136th Place Northeast, Bellevue, Washington 98005 USA Telex 292915 SBEI UR

Temperature Calibration Report

Customer: Washington Department of Ecology

SBE Job Number: 5291

Date of report: 03 Sept 91

SBE Model Number: 19

Serial Number: 165

Unless instructed otherwise and if received intact (not broken) and functional, temperature sensors are calibrated 'as received', i.e, without repairs or adjustments that would prevent determination of the sensor's drift history. If calibration uncovers problems with the sensor, a second calibration will be required after the necessary work is finished.

An 'as received' calibration certificate listing the coefficients used to convert sensor frequency to temperature will be provided. Users may judge whether the 'as received' or previously determined coefficients are more likely to represent the condition of the sensor at the time of deployment (those using SEASOFT should enter the chosen coefficients using SEACON). Calibration coefficients obtained after a repair should only be used with data collected subsequent to the calibration.

'AS RECEIVED CALIBRATION' (x) Performed ( ) Not Performed

Date: 29 August 91 Drift since last cal: .005 °Celsius/year

Comments:

'POST REPAIR CALIBRATION' ( ) Performed (x) Not Performed

Comments:

S E A - B I R D   E L E C T R O N I C S ,   I N C .
1808 136th Place N.E., Bellevue, Washington 98005
Telephone: (206) 643-9866 Telex: 292915 SBEI UR

TEMPERATURE CALIBRATION DATA
CALIBRATION DATE: 29-Aug-91

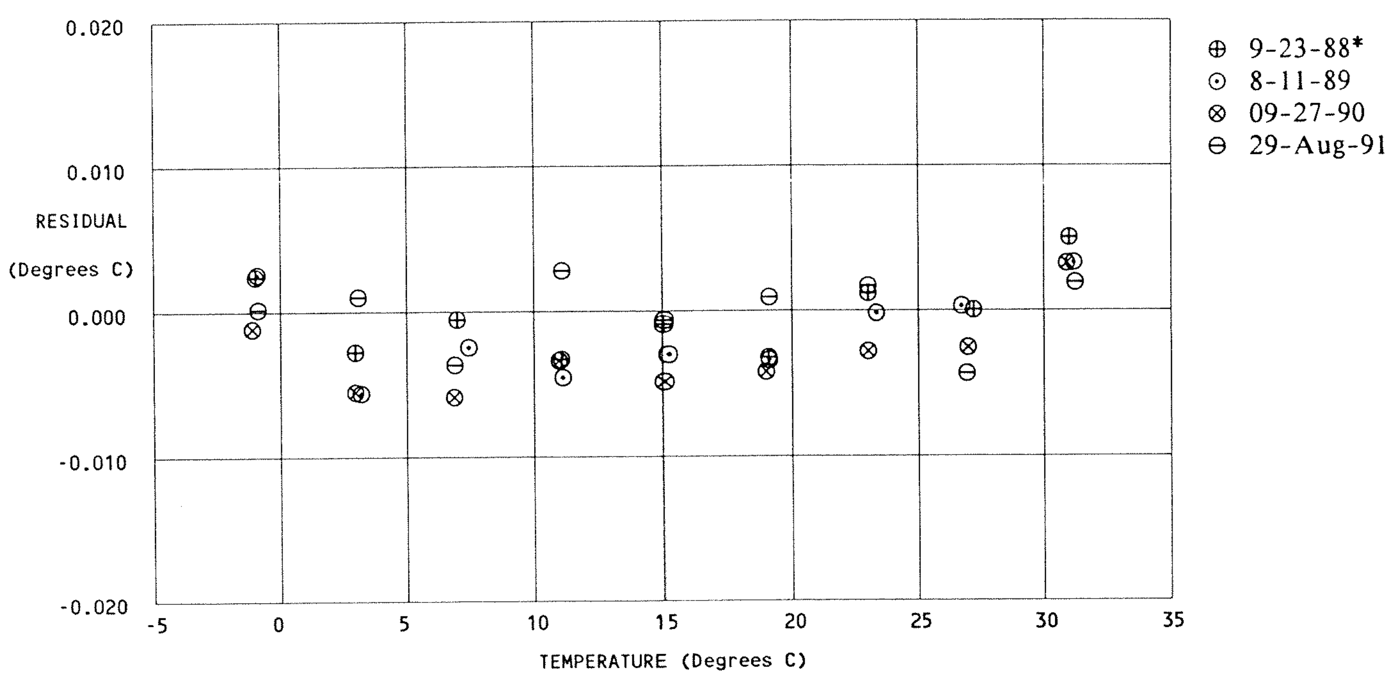
SENSOR SERIAL NUMBER = 165

a = 3.67306119e-03 b = 5.73609617e-04
c = 5.05857501e-06 d = -2.96760202e-06
f_0 = 2462.20

BATH TEMP (°C)	INSTRUMENT FREQ (Hz)	INST TEMP (°C)	RESIDUAL (°C)
31.2364	4868.74	31.2383	0.00189
22.9900	4140.08	22.9917	0.00171
15.0254	3512.06	15.0248	-0.00061
6.9115	2944.19	6.9079	-0.00364
-0.8977	2462.20	-0.8975	0.00018
26.9187	4476.41	26.9144	-0.00432
19.0997	3824.32	19.1006	0.00094
11.0962	3228.63	11.0990	0.00282
3.0753	2700.01	3.0763	0.00104

Temperature = $1/\{a + b[\ln(f_0/f)] + c[\ln^2(f_0/f)] + d[\ln^3(f_0/f)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



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Telephone: (206) 643-9866 Telex: 292915 SBEI UR

TEMPERATURE CALIBRATION DATA
CALIBRATION DATE: 09-27-90

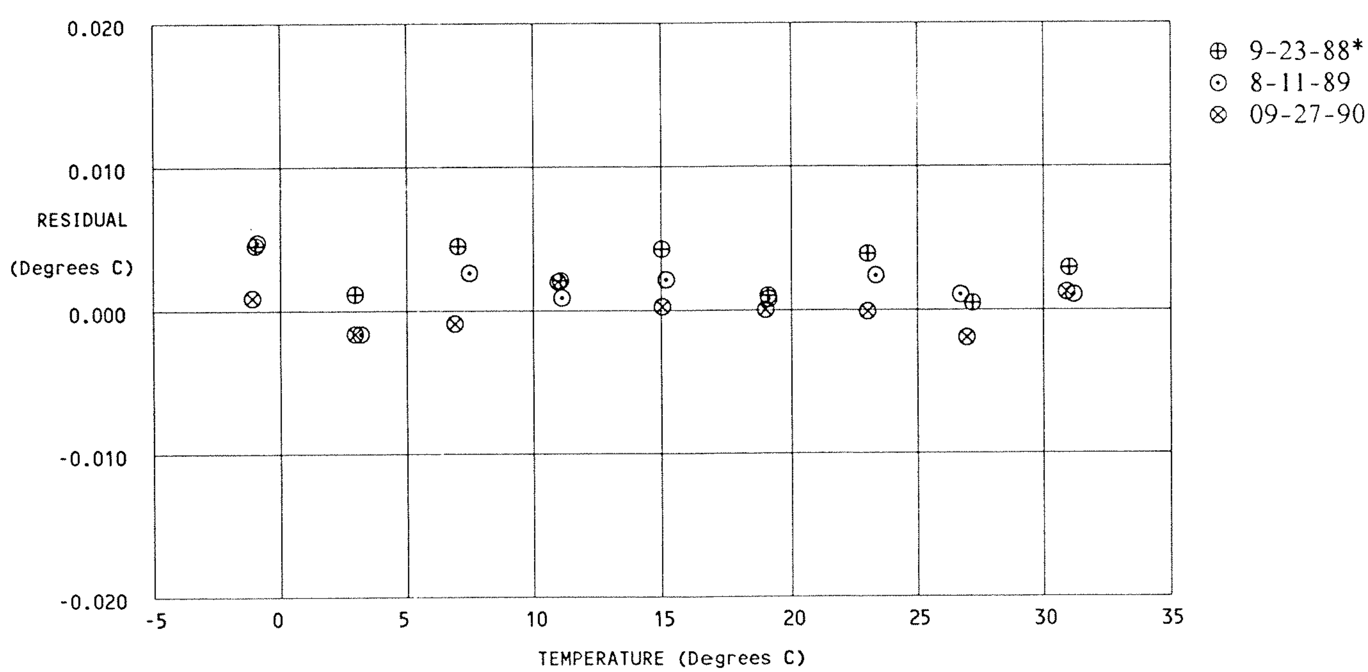
SENSOR SERIAL NUMBER = 165

a = 3.67600445e-03　　b = 5.73967365e-04
c = 5.63515369e-06　　d = -2.86969994e-06
f_o = 2449.48

BATH TEMP (°C)	INSTRUMENT FREQ (Hz)	INST TEMP (°C)	RESIDUAL (°C)
30.8905	4836.63	30.8917	0.00124
22.9933	4139.98	22.9932	-0.00008
15.0260	3511.79	15.0263	0.00029
6.8819	2942.10	6.8810	-0.00089
-1.1164	2449.48	-1.1155	0.00089
26.9842	4482.34	26.9823	-0.00193
18.9710	3813.77	18.9711	0.00005
10.9707	3219.41	10.9727	0.00202
2.9529	2692.05	2.9513	-0.00159

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

Residual = instrument temperature - bath temperature



S E A - B I R D E L E C T R O N I C S , I N C .
1808 136th Place N.E., Bellevue, Washington 98005
Telephone: (206) 643-9866 Telex: 292915 SBEI UR

TEMPERATURE CALIBRATION DATA
CALIBRATION DATE: 8-11-89

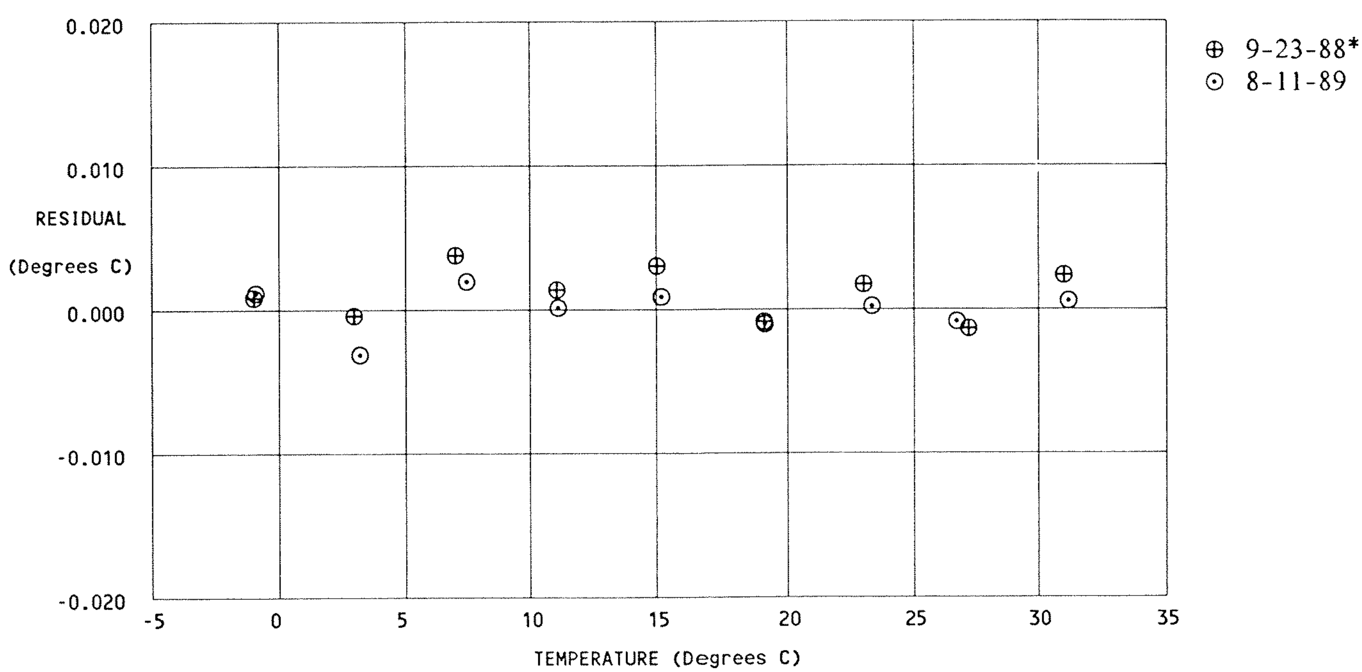
SENSOR SERIAL NUMBER = 165

a = 3.67340699e-03   b = 5.74346062e-04
c = 7.05830456e-06   d = -1.62987168e-06
f_o = 2460.80

BATH TEMP (°C)	INSTRUMENT FREQ (Hz)	INST TEMP (°C)	RESIDUAL (°C)
31.1684	4862.52	31.1690	0.00057
23.3171	4167.27	23.3173	0.00023
15.1667	3522.40	15.1676	0.00089
7.4455	2979.49	7.4475	0.00198
-0.9243	2460.80	-0.9232	0.00115
26.7189	4459.24	26.7181	-0.00084
19.1034	3824.27	19.1024	-0.00104
11.1248	3230.12	11.1249	0.00015
3.1699	2705.45	3.1668	-0.00309

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

Residual = instrument temperature - bath temperature



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8-17

SEA-BIRD ELECTRONICS, INC.
1808 136th Place N.E., Bellevue, Washington 98005
Telephone: (206) 643-9866 Telex: 292915 SBEI UR

TEMPERATURE CALIBRATION DATA
CALIBRATION DATE: 9-23-88*

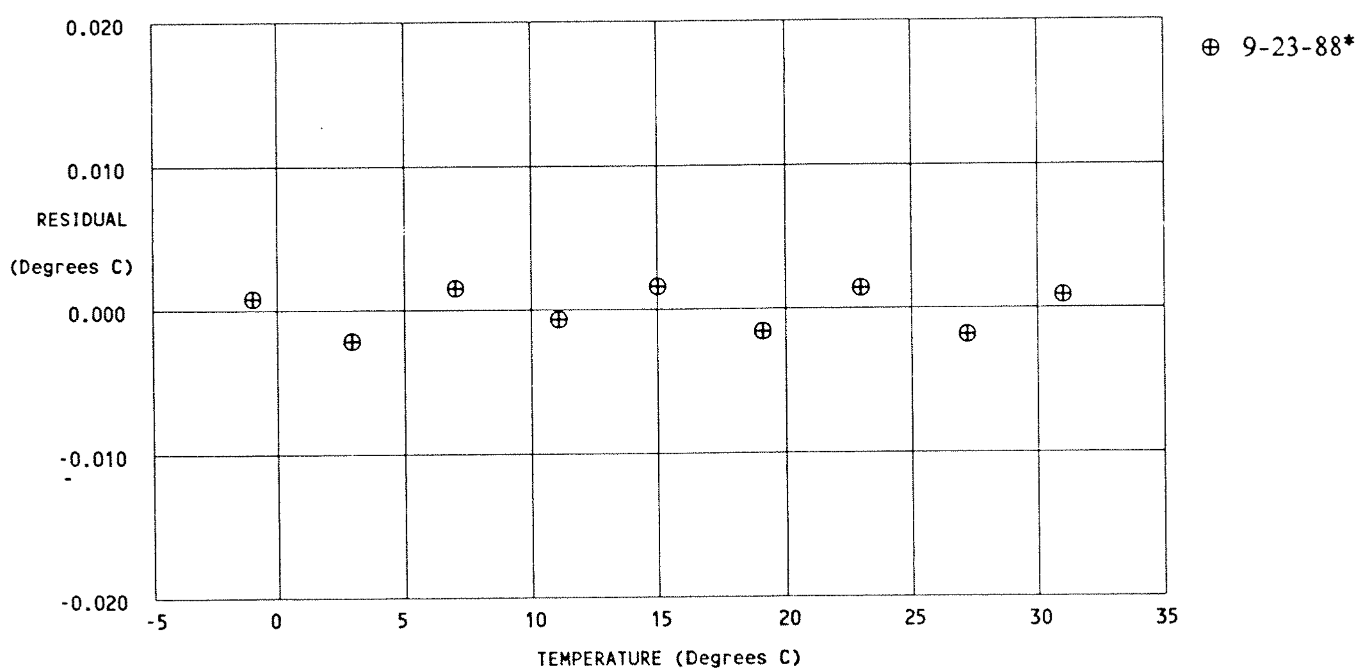
SENSOR SERIAL NUMBER = 165

a = 3.67449414e-03 b = 5.74034419e-04
c = 5.84172365e-06 d = -2.72226164e-06
f_o = 2456.15

BATH TEMP (°C)	INSTRUMENT FREQ (Hz)	INST TEMP (°C)	RESIDUAL (°C)
31.0051	4847.46	31.0060	0.00088
23.0067	4141.43	23.0081	0.00141
15.0071	3510.68	15.0087	0.00158
6.9980	2950.08	6.9995	0.00151
-1.0045	2456.15	-1.0037	0.00080
27.2002	4501.64	27.1984	-0.00181
19.0705	3821.69	19.0689	-0.00158
11.0722	3226.52	11.0715	-0.00068
2.9448	2691.72	2.9427	-0.00212

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

Residual = instrument temperature - bath temperature



* The conversion from HEX data to temperature frequency was performed incorrectly on the initial calibration. This calibration sheet has been corrected.

SBE SEA-BIRD ELECTRONICS, INC TELEPHONE 206 643-9866 FAX 206 643-9954
1808-136th Place Northeast, Bellevue, Washington 98005 USA Telex 292915 SBEI UR

Conductivity Calibration Report

Customer: Washington Department of Ecology

SBE Job Number: 5291 Date of report: 03 Sept 91

SBE Model Number: 19 Serial Number: 165

Unless instructed otherwise and if received intact (not broken) and functional, conductivity sensors are calibrated 'as received', i.e, without cleaning or other processing that would prevent determination of the sensor's drift history. If calibration uncovers problems with the sensor or demonstrates the need to clean the conductivity cell and replatinize the cell electrodes, a second calibration will be performed after the necessary work is finished.

An 'as received' calibration certificate listing the coefficients used to convert sensor frequency to conductivity will be provided. Users may judge whether the 'as received' or previously determined coefficients are more likely to represent the condition of the sensor at the time of deployment (those using SEASOFT should enter the chosen coefficients using SEACON). Calibration coefficients obtained after a repair or after cleaning and replatinizing the cell should only be used with data collected subsequent to the calibration.

'AS RECEIVED CALIBRATION' (x) Performed ( ) Not Performed

Date: 29 August 91 Drift since last cal: .000091 S/m/month[1]

Comments:

'POST CLEANING/REPLATINIZING CALIBRATION' ( ) Performed (x) Not Performed

Date: ______ Drift since initial cal:[2] ______ S/m/month[2]

Comments:

[1]Measured at 3.0 S/m

[2]Cleaning and replatinizing tend to 'reset' the conductivity sensor to its original condition. Therefore, lack of drift in post cleaning/replatinizing calibration is an indicator of geometric stability of the cell and the electrical stability of the sensor interface circuits. 'Drift since initial cal' is the total drift from date of the sensor's initial calibration (at time of manufacture) except where the cell has been replaced in which case the drift is referenced to the 1st calibration using the replacement cell.1

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1808 136th Place N.E., Bellevue, Washington 98005
Telephone: (206) 643-9866   Telex: 292915 SBEI UR

CONDUCTIVITY CALIBRATION DATA
CALIBRATION DATE: 29-Aug-91

PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

SENSOR SERIAL NUMBER = 165

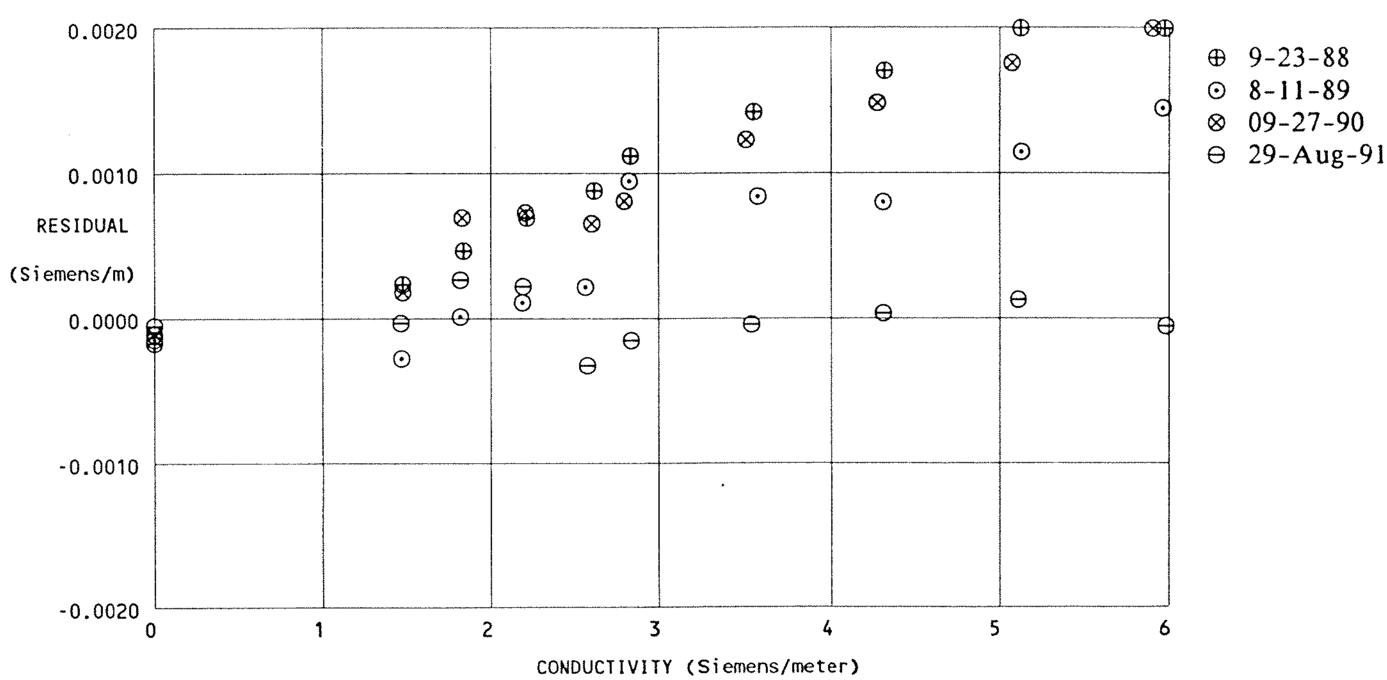
a = 6.10211274e-04   b = 4.68727404e-01
c = -3.91758160e+00   d = 4.23749587e-04
m = 3.0

BATH TEMP (°C)	BATH SAL (°/oo)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
31.2364	35.0706	5.97810	11.56942	5.97805	-0.00005
22.9900	35.0939	5.10984	10.75798	5.10997	0.00013
15.0254	35.0935	4.30414	9.94439	4.30417	0.00003
6.9115	35.0931	3.52855	9.09131	3.52851	-0.00004
-0.8977	35.0927	2.83350	8.25077	2.83335	-0.00015
26.9187	15.0319	2.56932	7.90558	2.56899	-0.00033
19.0997	15.0379	2.18790	7.38235	2.18812	0.00022
11.0962	15.0375	1.81554	6.83168	1.81581	0.00027
3.0753	15.0375	1.46572	6.26928	1.46569	-0.00003
0.0000	0.0000	0.00000	2.88541	-0.00005	-0.00005

Conductivity = $(af^m + bf^2 + c + dt) / [10(1 - 9.57(10^{-8})p)]$ Siemens/meter, where p = pressure in dbars

Residual = instrument conductivity - bath conductivity

NOTE: Multiply Siemens/meter by 10 to obtain mmho/cm



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Clean/calib re-plat

S E A - B I R D   E L E C T R O N I C S ,   I N C .
1808 136th Place N.E., Bellevue, Washington 98005
Telephone: (206) 643-9866   Telex: 292915 SBEI UR

CONDUCTIVITY CALIBRATION DATA
CALIBRATION DATE: 09-27-90

PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

SENSOR SERIAL NUMBER = 165

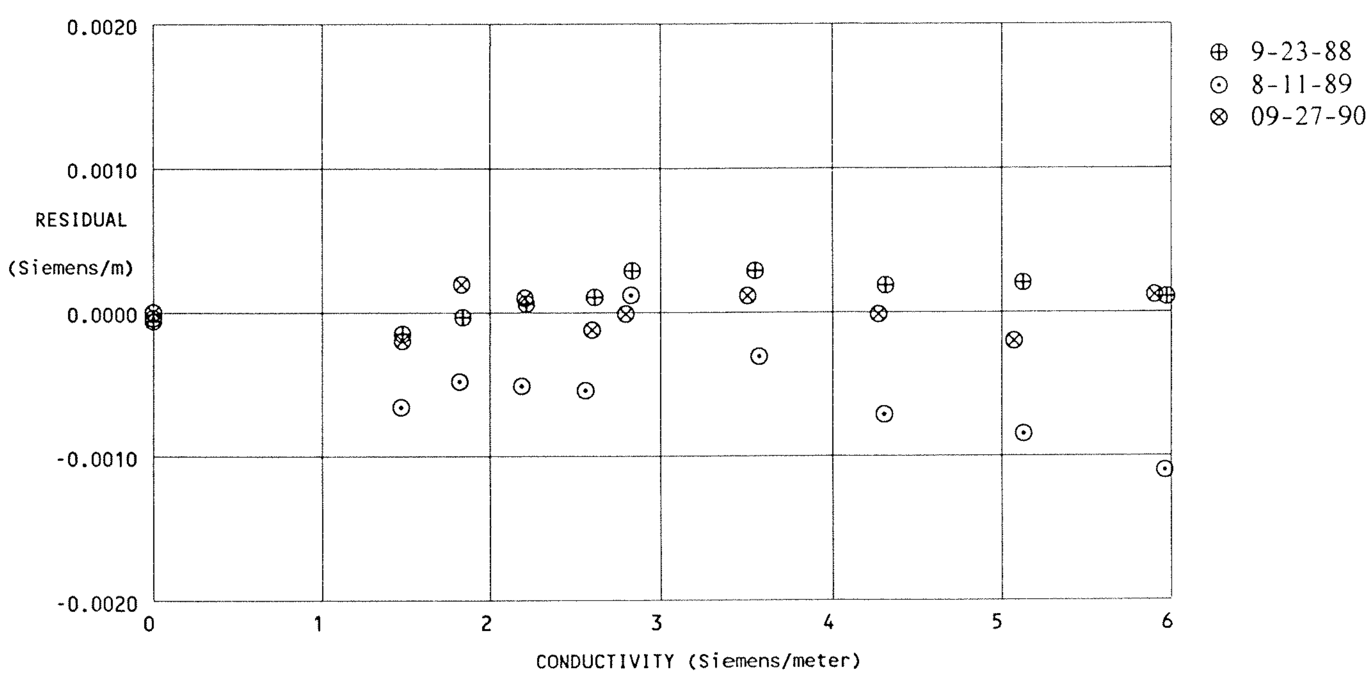
a = 8.35598821e-04   b = 4.68002028e-01
c = -3.91383273e+00   d = 4.13743958e-04
m = 2.9

BATH TEMP (°C)	BATH SAL (°/oo)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
30.8905	34.7940	5.89933	11.50062	5.89945	0.00012
22.9933	34.7951	5.07146	10.72223	5.07126	-0.00020
15.0260	34.7948	4.27144	9.91145	4.27143	-0.00001
6.8819	34.7944	3.49881	9.05843	3.49892	0.00011
-1.1164	34.7936	2.79309	8.20043	2.79308	-0.00001
26.9842	15.1945	2.59798	7.94486	2.59786	-0.00012
18.9710	15.1934	2.20240	7.40370	2.20250	0.00010
10.9707	15.1924	1.82698	6.84995	1.82718	0.00020
2.9529	15.1929	1.47450	6.28439	1.47430	-0.00020
0.0000	0.0000	0.00000	2.88520	0.00000	0.00000

Conductivity = $(af^{m} + bf^{2} + c + dt) / [10(1 - 9.57(10^{-8})p)]$ Siemens/meter, where p = pressure in dbars

Residual = instrument conductivity - bath conductivity

NOTE: Multiply Siemens/meter by 10 to obtain mmho/cm



S E A - B I R D E L E C T R O N I C S , I N C .
1808 136th Place N.E., Bellevue, Washington 98005
Telephone: (206) 643-9866 Telex: 292915 SBEI UR

CONDUCTIVITY CALIBRATION DATA
CALIBRATION DATE: 8-11-89

PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

SENSOR SERIAL NUMBER = 165

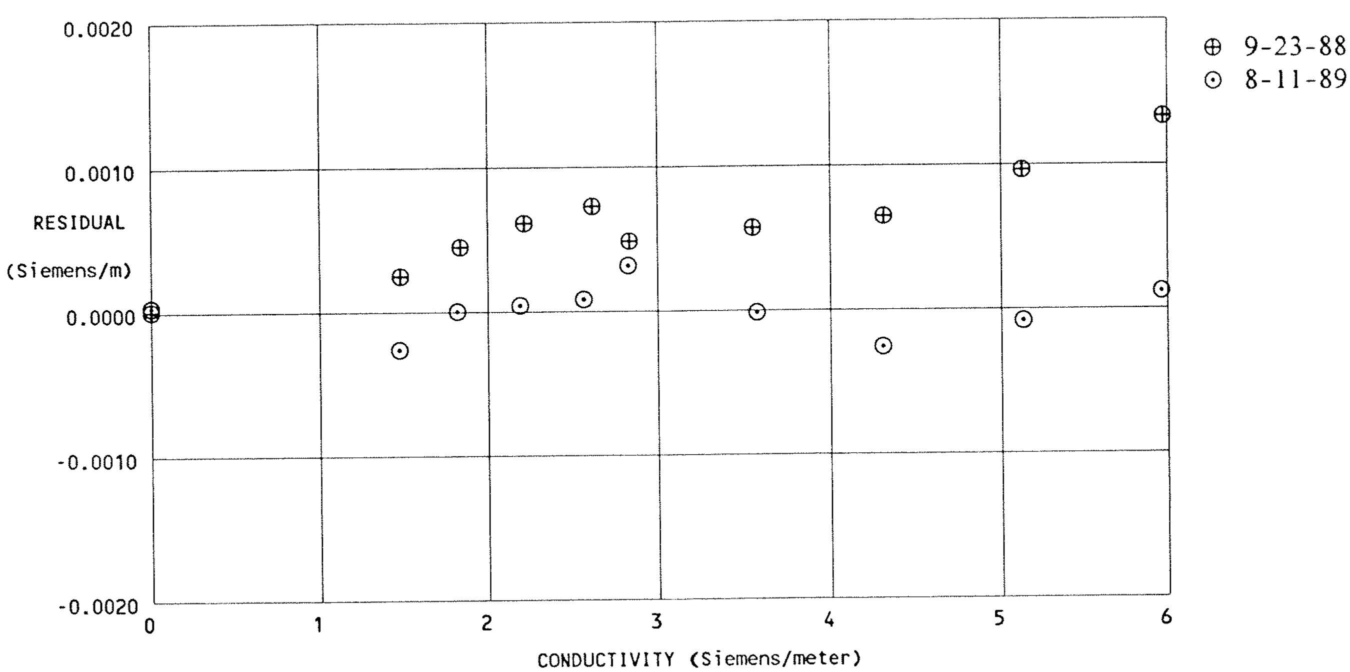
a = 3.13920415e-04 b = 4.69739191e-01
c = -3.91887053e+00 d = 5.59822388e-04
m = 3.2

BATH TEMP (°C)	BATH SAL (°/oo)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
31.1684	34.9790	5.95696	11.55170	5.95708	0.00012
23.3171	34.9799	5.12889	10.77744	5.12881	-0.00008
15.1667	34.9805	4.30566	9.94679	4.30541	-0.00025
7.4455	34.9793	3.56759	9.13719	3.56757	-0.00002
-0.9243	34.9782	2.82286	8.23862	2.82317	0.00031
26.7189	15.0265	2.55852	7.89195	2.55860	0.00008
19.1034	15.0281	2.18677	7.38058	2.18681	0.00004
11.1248	15.0270	1.81567	6.83149	1.81567	0.00000
3.1699	15.0272	1.46876	6.27397	1.46850	-0.00026
0.0000	0.0000	0.00000	2.88506	0.00004	0.00004

Conductivity = $(af^m + bf^2 + c + dt) / [10(1 - 9.57(10^{-8})p)]$ Siemens/meter, where p = pressure in dbars

Residual = instrument conductivity - bath conductivity

NOTE: Multiply Siemens/meter by 10 to obtain mmho/cm



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SEA-BIRD ELECTRONICS, INC.
1808 136th Place N.E., Bellevue, Washington 98005
Telephone: (206) 643-9866 Telex: 292915 SBEI UR

CONDUCTIVITY CALIBRATION DATA
CALIBRATION DATE: 9-23-88

PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

SENSOR SERIAL NUMBER = 165

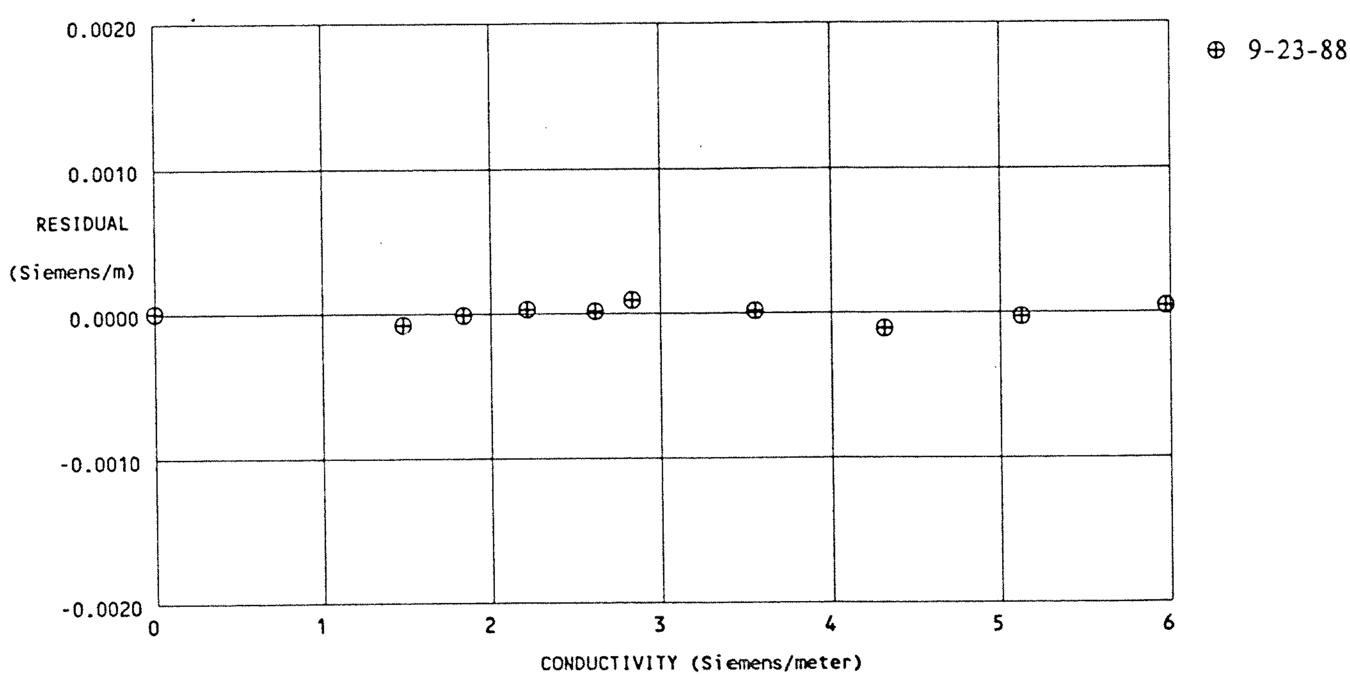
a = 4.32157949e-04 b = 4.69193423e-01
c = -3.91657598e+00 d = 4.38231702e-04
m = 3.1

BATH TEMP (°C)	BATH SAL (°/oo)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
31.0051	35.1861	5.97059	11.56511	5.97064	0.00005
23.0067	35.1861	5.12351	10.77325	5.12348	-0.00003
15.0071	35.1861	4.31249	9.95493	4.31239	-0.00010
6.9980	35.1861	3.54497	9.11190	3.54499	0.00002
-1.0045	35.1861	2.83121	8.24948	2.83131	0.00010
27.2002	15.2203	2.61292	7.96488	2.61294	0.00002
19.0705	15.2203	2.21077	7.41552	2.21080	0.00003
11.0722	15.2203	1.83470	6.86145	1.83469	-0.00001
2.9448	15.2203	1.47660	6.28800	1.47653	-0.00007
0.0000	0.0000	0.00000	2.88497	0.00001	0.00001

Conductivity = $(af^m + bf^2 + c + dt) / 10$ Siemens/meter

Residual = instrument conductivity - bath conductivity

NOTE: Multiply Siemens/meter by 10 to obtain mmho/cm



SBE SEA-BIRD ELECTRONICS, INC.
1808 - 136th Place Northeast, Bellevue, Washington 98005
Telephone: (206) 643-9866 Fax: (206) 643-9954 Telex: 292915 SBEI UR

SBE 193686-165

28 SEPTEMBER 1990

Pressure calibration: Senso-Metrics SP91-PFS-500A 500 psia S/N 7H083

Straight Line Fit:

Pressure(psia) = M * N + B (N = Binary output)

M = -0.14521 B = 546.45

Quadratic Fit:

Pressure(psia) = A0 + A1 * N + A2 * N * N (N = binary output)

A0 = 547.45236 A1 = -1.467134e-01 A2 = 3.765083e-07

Pressure (psi)	Output (N)	Straight Line Fit error, psi	Straight Line Fit error, %FS	Quadratic Fit error, psi	Quadratic Fit error, %FS
14.75	3666.34	-0.683	-0.14	-0.137	-0.03
100.06	3070.00	0.599	0.12	0.531	0.11
200.12	2382.90	0.312	0.06	-0.133	-0.03
300.18	1693.10	0.416	0.08	-0.049	-0.01
400.24	1005.70	0.172	0.03	0.043	0.01
500.30	321.35	-0.515	-0.10	0.045	0.01
400.24	1006.07	0.118	0.02	-0.011	-0.00
300.18	1693.97	0.290	0.06	-0.175	-0.04
200.12	2384.18	0.126	0.03	-0.319	-0.06
100.06	3070.00	0.599	0.12	0.531	0.11
14.75	3667.99	-0.920	-0.18	-0.371	-0.07

Output binary values are averages of 101 samples taken at 2 Hz.

SEASOFT Versions 3.3M and higher will prompt for A0, A1, and A2

SEASOFT Versions 3.3L and lower will prompt for M and B

SBE **SEA-BIRD ELECTRONICS, INC.**
1808 - 136th Place Northeast, Bellevue, Washington 98005
Telephone: (206) 643-9866 Fax: (206) 643-9954 Telex: 292915 SBEI UR

SBE 191843-165

Pressure calibration: Senso-Metrics SP91PFS-500A S/N 7H083 23 September 1988

Pressure(psia) = M(Binary) + B where **M = -0.14518** and **B = 545.88**

Input pressure (psi)	Output (binary)	error, psi	error, % FS
14.66	3661.79	-0.389	-0.08
100.06	3068.01	0.415	0.08
200.12	2377.80	0.559	0.11
300.17	1687.00	0.798	0.16
400.23	1000.10	0.461	0.09
500.29	319.01	-0.719	-0.14
400.23	1002.29	0.143	0.03
300.17	1690.49	0.292	0.06
200.12	2381.64	0.002	0.00
100.06	3069.99	0.128	0.03
14.66	3665.81	-0.972	-0.19

Output binary values are averages of 101 samples taken at 2 Hz.

SBE SEA-BIRD ELECTRONICS, INC.
1808 - 136th Place Northeast, Bellevue, Washington 98005
Telephone: (206) 643-9866 Fax: (206) 643-9954 Telex: 292915 SBEI UR

pH SENSOR CALIBRATION: S/N 22172 27 August 1991

The value of b as measured at electrical test was 2.4902 volts.

The following values of Vout were measured at a temperature of 22.748 deg C using +/-0.02 pH buffer solutions:

pH	Vout	Residual (pH units)
4	1.819	-0.013
7	2.625	-0.007
10	3.433	-0.009

Using phfit, the calibration coefficients for this sensors are: phvref = 0.3820
m = 4.5854

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1808 - 136th Place Northeast, Bellevue, Washington 98005
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pH SENSOR CALIBRATION: S/N 220172 1 November 1990

The value of b as measured at electrical test was 2.4902 volts.

The following values of Vout were measured at a temperature of 21.82 deg C using +/-0.02 pH buffer solutions:

pH	Vout	Residual (pH units)
4	1.704	-0.021
7	2.507	-0.001
10	3.321	-0.021

Using phfit, the calibration coefficients for this sensors are: phvref = 0.4061
m = 4.6055

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1808 - 136th Place Northeast, Bellevue, Washington 98005
Telephone: (206) 643-9866 Fax: (206) 643-9954 Telex: 292915 SBEI UR

pH SENSOR CALIBRATION: S/N 22172 16 August 1989

The value of b as measured at electrical test was 2.4902 volts.

The following values of Vout were measured at a temperature of 22.73 deg C using +/-0.02 pH buffer solutions:

pH	Vout	Residual (pH units)
4	1.761	+0.038
7	2.575	-0.007
10	3.367	+0.031

Using phfit, the calibration coefficients for this sensors are: phvref = 0.3927
m = 4.5545

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8-17

SBE SEA-BIRD ELECTRONICS, INC.
1808 - 136th Place Northeast, Bellevue, Washington 98005
Telephone: (206) 643-9866 Fax: (206) 643-9954 Telex: 292915 SBEI UR

pH SENSOR CALIBRATION: S/N 22172 8 September 1988

The value of b as measured at electrical test was 2.4902 volts.

The following values of Vout were measured at a temperature of 20.94 deg C using +/-0.02 pH buffer solutions:

pH	Vout	Residual (pH units)
4	1.740	-0.003
7	2.544	-0.003
10	3.348	-0.002

Using phfit, the calibration coefficients for this sensors are: phvref = 0.3969
m = 4.5932

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DISSOLVED OXYGEN SENSOR CALIBRATION: S/N 22172 29 August 1991

Sensor Current

m = 3.1892 E-7
b = -7.2394 E-9

The use of these constants in a linear equation of the form

$$I = mV + b$$

will yield DO sensor membrane current as a function of sensor output voltage.

Sensor Compensation Temperature

k = 8.8918
c = -4.9203

The use of these constants in a linear equation of the form

$$T = kV + c$$

will yield membrane temperature as a function of temperature channel voltage with a maximum error of about 0.5 deg C. The correction to dissolved oxygen resulting from the use of this calibration should be sufficient to achieve the precision of which the sensor is capable.

SEASOFT Coefficients based on Oxfit Calibration Results

Soc	2.4652	
Boc	-0.0567	
tcor	-0.033	(nominal)
pcor	1.50e-4	(nominal)
tau	2.0	(nominal)
wt	0.67	(nominal)

barometer	=	1005.889	mB
Twater	=	22.55	deg C
Tcomp	=	23.14	deg C
Isat	=	0.870	uA
Iair	=	0.899	uA
Izero	=	0.023	uA

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DISSOLVED OXYGEN SENSOR CALIBRATION: S/N 22172 16 August 1989

Sensor Current

m	=	3.1892 E-7
b	=	-7.2394 E-9

The use of these constants in a linear equation of the form

$$I = mV + b$$

will yield DO sensor membrane current as a function of sensor output voltage.

Sensor Compensation Temperature

k	=	8.8918
c	=	-4.9203

The use of these constants in a linear equation of the form

$$T = kV + c$$

will yield membrane temperature as a function of temperature channel voltage with a maximum error of about 0.5 deg C. The correction to dissolved oxygen resulting from the use of this calibration should be sufficient to achieve the precision of which the sensor is capable.

SEASOFT Coefficients based on Oxfit Calibration Results

Soc	2.4643	
Boc	-0.0254	
tcor	-0.033	(nominal)
pcor	1.50e-4	(nominal)
tau	2.0	(nominal)
wt	0.67	(nominal)

pcor [illegible] due to [illegible]
[illegible]

barometer	=	1015.92	mB
Twater	=	22.75	deg C
Tcomp	=	23.33	deg C
Isat	=	0.872	uA
Iair	=	0.891	uA
Izero	=	0.010	uA

Logged in 3-17

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DISSOLVED OXYGEN SENSOR CALIBRATION: S/N 22172 8 September 1988

Sensor Current

m	=	3.1892 E-7
b	=	-7.2394 E-9

The use of these constants in a linear equation of the form

$$I = mV + b$$

will yield DO sensor membrane current as a function of sensor output voltage.

Sensor Compensation Temperature

k	=	8.8918
c	=	-4.9203

The use of these constants in a linear equation of the form

$$T = kV + c$$

will yield membrane temperature as a function of temperature channel voltage with a maximum error of about 0.5 deg C. The correction to dissolved oxygen resulting from the use of this calibration should be sufficient to achieve the precision of which the sensor is capable.

SEASOFT Coefficients based on Oxfit Calibration Results

Soc	2.2195	
Boc	-0.0089	
tcor	-0.033	(nominal)
pcor	2.38e-4	(nominal)
tau	2.0	(nominal)
wt	0.67	(nominal)

barometer	=	1018.7	mB
Twater	=	21.40	deg C
Tcomp	=	21.85	deg C
Isat	=	0.922	uA
Iair	=	0.958	uA
Izero	=	0.004	uA

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TRANSMISSOMETER CALIBRATION: S/N 292 28 September 1988

A = 4.750 (air calibration from SEA TECH)
Y = 0.002 (blocked path voltage from SEA TECH)

B = 4.727 (current air voltage)
Z = 0.006 (current blocked path voltage)

M = 20 * (4.750 - 0.002) / (4.727 - 0.006) = 20.114

B = -M * Z = -0.1206

APPENDIX B

WY 1991 MARINE WATER COLUMN DATA REPORTS

STORET REMARK CODES

Observations in STORET are stored as numerical values usually representing the result of a laboratory or field analysis to quantify the concentration of a chemical in a water sample. In some cases, the numerical value stored represents something other than a normal outcome, and a "Remark Code" is associated with the value as it is entered. Remark codes which are permitted are listed below, with their definitions.

Remark	Definition
(blank)	Data not remarked. Number should be interpreted exactly as reported.
A	Value reported is the mean of two or more determinations.
B	Results based upon colony counts outside the acceptable range.
C	Calculated. Value stored was not measured directly, but was calculated from other data available.
D	Field measurement. Some parameter codes (e.g. 401, "Field pH") imply this condition without this remark.
E	Extra sample taken in compositing process.
F	In the case of species, F indicates Female sex.
G	Value reported is the maximum of two or more determinations.
H	Value based on field kit determination; results may not be accurate.
J	Estimated. Value shown is not a result of analytical measurement.
K	Off-scale low. Actual value not known, but known to be less than value shown. Usually, used to indicate a failure to detect the substance.
L	Off-scale high. Actual value not known, but known to be greater than value shown.
M	Presence of material verified, but not quantified. Indicates a positive detection, at a level too low to permit accurate quantification. In the case of temperature or oxygen reduction potential, M indicates a negative value. In the case of species, M indicates Male sex.
N	Presumptive evidence of presence of material.
O	Sampled for, but analysis lost. Accompanying value is not meaningful for analysis.
P	Too numerous to count.
Q	Sample held beyond normal holding time.
R	Significant rain in the past 48 hours.
S	Laboratory test.
T	Value reported is less than the criteria of detection.
U	Material was analyzed for, but not detected. Value stored is the limit of detection for the process in use. In the case of species, Undetermined sex.
V	Indicates the analyte was detected in both the sample and associated method blank.
W	Value observed is less than the lowest value reportable under remark "T".
X	Value is quasi vertically-integrated sample.
Y	Laboratory analysis from unpreserved sample. Data may not be accurate.
Z	Too many colonies were present to count (TNTC), the numeric value represents the filtration volume.
$	Calculated by retrieval software. Numerical value was neither measured nor reported to the database, but was calculated from other data available during generation of the retrieval report.

ADM002
ADMIRALTY INLET NEAR PROTECTION ISLAND
48 11 15.0 122 50 30.0 2F000 Elev= 0 ft
53031 Washington Jefferson Co. PACIFIC NORTHWEST
PUGET SOUND (Quilcene/Snow-17) 131117
21540000 Reach=17110019 0.000 Drg= 0 sqmi
AMBNT/OCEAN/RMP

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
91/01/29	1500	000	6.9	8.6	85.8	8.1	77.0	1K	6.0	30.15	0.410	0.010K
	1510	010	7.0	8.3	83.0	8.1	78.2			30.23	0.410	0.010K
	1520	030	7.2	7.5	75.8	8.1	78.1			30.87	0.410	0.010K
91/03/18	1210	000	7.9	8.2	84.0	8.1	80.3	1K	8.5	30.40	0.340	0.010K
	1215	010	7.8	8.0	81.8	8.1	80.1			30.63	0.340	0.010K
	1225	029	7.7	8.0	81.4	8.1	80.8			30.90	0.340	0.010K
91/04/15	1310	000	9.2	8.6	90.6	8.0	82.2	1K	9.2	30.22	0.290	0.010K
	1320	010	8.4	8.4	86.8	8.0	79.0			30.25	0.300	0.010K
	1330	030	8.3	8.3	85.2	8.0	79.2			30.37	0.300	0.010K
91/05/13	1215	000	9.2	8.5	88.9	8.2	76.8	1K	6.5	30.21	0.260	0.010K
	1225	010	9.2	8.3	87.5	8.2	76.5			30.28	0.260	0.010K
	1235	030	9.1	8.1	85.1	8.2	78.2			30.51	0.280	0.010K
91/06/10	1150	000	9.4	7.3	77.3	8.1	80.9	1K	7.0	30.75	0.270	0.010K
	1200	010	9.3	7.2	76.0	8.1	81.1			30.75	0.290	0.010K
	1210	030	8.5	6.1	63.7	8.1	76.9			31.67	0.350	0.010K
91/07/15	1220	000	9.9	5.9	63.5	8.0	76.6	1K	6.0	30.68	0.290	0.010K
	1230	010	9.9	6.0	64.4	8.0	76.5			30.68	0.290	0.010K
	1240	030	9.9	6.0	64.1	8.0	76.7			30.68	0.290	0.010K
91/08/12	1210	000	10.5	6.4	69.1	8.1	80.4	1K	7.0	30.87	0.300	0.010K
	1220	010	10.4	6.4	69.7	8.1	79.7			30.88	0.270	0.010K
	1230	030	10.4	6.2	67.0	8.0	79.1			30.87	0.300	0.010K
91/09/16	1220	000	11.5	6.3	69.6	8.0	70.3	1K	10.0	30.08	0.240	0.010K
	1230	010	11.1	6.4	70.2	8.0	83.9			30.42	0.220	0.010K
	1240	030	9.1	4.9	51.6	8.0	84.5			32.05	0.290	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
91/01/29	1500	000	0.010K	0.070	56286	0.16	0.23
	1510	010	0.010K	0.070	56287	0.13	0.19
	1520	030	0.010K	0.070	56288	0.10	0.21
91/03/18	1210	000	0.010	0.060	126286	1.02	0.97
	1215	010	0.010K	0.070	126287	1.03	0.90
	1225	029	0.010	0.060	126288	0.73	0.77
91/04/15	1310	000	0.020	0.058	166286	0.24	0.39
	1320	010	0.020	0.059	166287	0.25	0.47
	1330	030	0.020	0.059	166288	0.21	0.64
91/05/13	1215	000	0.020	0.052	206286	1.40	3.20

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
91/05/13	1225	010	0.010	0.054	206287	1.60	2.10
	1235	030	0.020	0.055	206288	1.20	1.90
91/06/10	1150	000	0.020	0.055	246286	0.63	1.29
	1200	010	0.010	0.058	246287	0.39	1.25
	1210	030	0.010	0.065	246288	0.80	2.11
91/07/15	1220	000	0.020	0.078	296286	0.56	1.15
	1230	010	0.020	0.062	296287	0.48	1.40
	1240	030	0.020	0.061	296288	0.81	1.23
91/08/12	1210	000	0.020	0.060	336286	0.85	1.29
	1220	010	0.020	0.079	336287	1.12	1.06
	1230	030	0.020	0.060	336288	1.09	1.77
91/09/16	1220	000	0.020	0.061	386286		
	1230	010	0.020	0.060	386287		
	1240	030	0.010	0.070	386288		

ADM003
ADMIRALTY INLET NEAR POINT NO POINT
47 52 45.0 122 28 55.0 2F000 Elev= 0 ft
53035 Washington Kitsap Co. PACIFIC NORTHWEST
PUGET SOUND (Kitsap-15) 131115
21540000 Reach=17110019 0.000 Drg= 0 sqmi
AMBNT/OCEAN/RMP

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/22	1025	000	10.1	9.2	92.3		62.4	14	4.5	20.63	0.330	0.010K
	1030	010	11.6	6.7	73.6		83.0			29.47	0.340	0.010K
	1035	027	11.8	6.1	67.5		84.5			30.07	0.340	0.010K
91/02/05	1225	000	7.9	10.2	98.9	8.1	37.7	84	3.4	23.15	0.400	0.010K
	1235	010	8.0	8.5	86.1	8.0	83.0			29.05	0.420	0.010K
	1245	018	7.9	8.2	79.5	8.0	82.6			22.83	0.420	0.010K
91/04/22	1230	000	10.7	12.5	131.4	8.4	65.6	1K	4.7	25.79	0.090	0.010K
	1240	010	9.7	10.5	110.0	8.2	75.8			27.72	0.230	0.010K
	1250	018	8.9	9.2	94.7	8.1	80.8			28.35	0.320	0.010K
91/05/28	1225	000	12.4	13.7	144.7	8.8	38.4	1K	2.6	21.47	0.010K	0.010K
	1235	010	9.6	11.0	116.0	8.3	80.6			28.97	0.150	0.010K
	1245	024	9.3	8.9	92.6	8.2	84.0			29.22	0.290	0.010K
91/06/17	1315	000	11.3	9.2	99.5	8.3	82.8	1K	10.8	28.13	0.170	0.010
	1320	010	10.4	9.0	96.3	8.2	85.8			29.32	0.220	0.010
	1325	029	10.1	8.0	85.2	8.2	84.6			29.53	0.240	0.010
91/07/22	1210	000	13.6	10.4	117.0	8.3	68.8	1K	5.5	27.48	0.040	0.010K
	1220	010	12.9	9.8	110.0	8.2	71.5			28.12	0.070	0.010K
	1230	030	11.6	8.2	90.2	8.1	81.0			29.32	0.180	0.010K
91/08/19	1340	000	16.2	9.6	114.2	8.4	61.9	1K	7.5	27.24	0.080	0.010K
	1350	010	11.8	7.4	82.0	8.1	82.9			29.91	0.200	0.010K
	1400	024	11.8	7.0	77.3	8.1	83.6			29.95	0.240	0.010K
91/09/23	1150	000	14.3	12.0	137.4	8.6	55.3	1K	3.5	27.18	0.010K	0.010K
	1200	010	12.6	8.6	97.0	8.2	82.5			29.97	0.150	0.010K
	1210	027	11.8	6.2	68.4	8.1	84.6			30.26	0.240	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/22	1025	000	0.010	0.060	436300	1.21	0.93
	1030	010	0.010	0.080	436301	0.29	0.43
	1035	027	0.010	0.080	436302	0.28	0.34
91/02/05	1225	000	0.030	0.060	66257	0.71	0.57
	1235	010	0.010K	0.080	66258	0.20	0.19
	1245	018	0.020	0.080	66259	0.19	0.24
91/04/22	1230	000	0.010K	0.020	176257	16.20	8.16
	1240	010	0.010K	0.042	176258	5.96	4.47
	1250	018	0.010	0.064	176259	1.35	0.92
91/05/28	1225	000	0.010K	0.010K	226257	1.80	3.90

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
91/05/28	1235	010	0.020	0.033	226258	12.90	7.10
	1245	024	0.030	0.055	226259	0.80	1.70
91/06/17	1315	000	0.020	0.041	256257	0.05K	0.05K
	1320	010	0.040	0.050	256258	0.05K	0.05K
	1325	029	0.030	0.052	256259	0.05K	0.05K
91/07/22	1210	000	0.010K	0.021	306257	4.65	5.45
	1220	010	0.010K	0.026	306258	5.36	5.09
	1230	030	0.030	0.053	306259	1.53	3.01
91/08/19	1340	000	0.010K	0.028	346257		
	1350	010	0.020	0.053	346258		
	1400	024	0.020	0.059	346259		
91/09/23	1150	000	0.010K	0.010K	396257		
	1200	010	0.010	0.047	396258		
	1210	027	0.010K	0.062	396259		

BLL009
BELLINGHAM BAY NR POINT FRANCES
48 41 10.0 122 35 54.0 1F 0 Elev= 0 ft
53073 Washington Whatcom Co. PACIFIC NORTHWEST
PUGET SOUND (Nooksack-01) 131101
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/15	1405	000	10.7	9.4	95.6		41.3	18	2.0	20.76	0.220	0.010
	1410	010	10.9	6.1	66.4		72.6			30.33	0.300	0.010
90/11/20	1500	000	8.9	8.7	88.8	8.1	51.7		2.5	27.00	0.330	0.010K
	1510	010	9.4	7.7	80.8	8.1	62.7			29.56	0.320	0.010K
91/02/26	1515	000	7.9	9.9	97.5	8.1	52.2	1U	2.0	25.34	0.410	0.010K
	1525	010	7.5	8.8	88.4	8.1	68.0			29.18	0.390	0.010K
91/03/18	1535	000	7.9	9.2	92.5	8.1	70.7	1K	3.9	28.32	0.380	0.010K
	1545	010	7.4	8.8	88.1	8.1	68.2			29.23	0.370	0.010K
91/04/15	1715	000	11.6	10.2	109.5	8.1	67.9	1K	5.5	26.37	0.290	0.010K
	1725	010	8.6	9.4	97.1	8.0	71.5			29.10	0.310	0.010K
91/05/13	1640	000	12.1	9.7	106.0	8.4	76.6	1K	5.5	26.48	0.060	0.010K
	1650	009	10.2	10.4	110.2	8.4	78.0			29.10	0.140	0.010K
91/06/10	1525	000	13.6	12.6	138.6	8.7	63.0	1K	4.5	23.52	0.010K	0.010K
	1535	007	11.6	13.1	141.1	8.6	51.8			26.63	0.050	0.010K
91/07/15	1555	000	15.9	9.2	105.0	8.3	53.7	1K	3.0	23.12	0.020	0.010K
	1605	010	10.8	6.9	74.4	8.1	73.3			29.36	0.260	0.010K
91/08/12	1525	000	13.0	7.5	83.4	8.2	70.6	1	5.5	27.45	0.160	0.010K
	1535	010	11.5	6.5	71.4	8.1	73.7			29.27	0.230	0.010K
91/09/16	1615	000	15.2	11.0	127.5	8.5	65.2	1K	3.0	26.74	0.010K	0.010K
	1625	010	11.4	6.6	72.3	8.1	80.3			29.17	0.210	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/15	1405	000	0.090	0.040	426261	0.92	3.80
	1410	010	0.060	0.080	426262	0.06	0.12
90/11/20	1500	000	0.040	0.070	476271	0.20	0.24
	1510	010	0.030	0.080	476272	0.17	0.29
91/02/26	1515	000	0.020	0.050	96271	0.34	0.24
	1525	010	0.010K	0.070	96272	0.27	0.33
91/03/18	1535	000	0.010	0.070	126271	0.34	0.45
	1545	010	0.010	0.070	126272	0.35	0.48
91/04/15	1715	000	0.010	0.048	166271	1.26	2.34
	1725	010	0.020	0.060	166272	0.50	0.61
91/05/13	1640	000	0.010	0.016	206271	2.20	1.40

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
91/05/13	1650	009	0.020	0.030	206272	3.10	2.80
91/06/10	1525	000	0.010K	0.010K	246271	5.82	5.16
	1535	007	0.020	0.024	246272	13.70	16.20
91/07/15	1555	000	0.010K	0.017	296271	4.04	2.96
	1605	010	0.020	0.057	296272	0.35	0.58
91/08/12	1525	000	0.010K	0.038	336271	2.02	1.40
	1535	010	0.020	0.080	336272	0.49	0.48
91/09/16	1615	000	0.010K	0.015	386271		
	1625	010	0.030	0.060	386272		

BUD005
BUDD INLET-OLYMPIA SHOAL AT HORN
47 05 32.0 122 55 01.0 2F 0 Elev= 0 ft
53067 Washington Thurston Co. PACIFIC NORTHWEST
PUGET SOUND (Deschutes-13) 131113
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/08	1055	000	13.7	8.7	99.3		76.3	8	5.5	28.99	0.130	0.010
	1100	010	13.9	6.5	74.9		68.5			29.78	0.170	0.010
90/11/12	0935	000	11.6	5.4	58.5	7.9	64.9	32	5.0	27.56	0.280	0.010
	0940	010	11.9	6.8	75.3	7.9	77.0			29.75	0.270	0.010
91/01/08	1110	000	6.6	9.6	92.5	8.0	70.2	14	6.0	26.27	0.470	0.010K
	1120	010	7.2	8.9	86.1	8.0	77.7			28.28	0.460	0.010K
91/02/11	1535	000	8.4	9.8	97.4	8.0	74.4	1	5.5	24.88	0.430	0.010K
	1540	010	7.8	8.9	89.3	8.0	74.9			27.87	0.420	0.010K
91/04/08	1525	000	8.8	10.0	101.5	8.1	78.1	6	8.0	26.23	0.220	0.010K
	1535	010	8.5	9.5	96.9	8.1	80.0			27.66	0.240	0.010K
91/05/06	1440	000	12.6	16.0	175.8	8.7	56.5	1K	2.7	26.48	0.010K	0.010K
	1445	010	9.6	11.9	123.5	8.3	60.5			27.77	0.180	0.010K
91/06/04	1550	000	14.3	13.9	159.1	8.5	63.9	1K	5.5	27.54	0.010K	0.010K
	1555	010	10.7	10.4	111.2	8.2	44.0			28.26	0.130	0.010K
91/07/08	1520	000	21.1	10.7	137.5	8.4	62.1	1K	8.5	25.75	0.010K	0.010K
	1525	010	13.0	10.3	115.7	8.2	75.1			28.67	0.110	0.010K
91/08/05	1040	000	18.2	15.7	194.4	8.8	64.4	1K	3.4	28.12	0.010K	0.010K
	1045	010	14.0	8.4	96.0	8.0	61.1			29.06	0.010K	0.010K
91/09/09	1630	000	17.1	15.4	187.2	8.6	79.9	1K	2.0	28.96	0.010K	0.010K
	1635	010	14.5	8.9	103.7	8.1	57.1			29.34	0.010K	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/08	1055	000	0.060	0.080	416202	1.12	0.87
	1100	010	0.060	0.080	416203	2.14	1.53
90/11/12	0935	000	0.050	0.080	466200	1.06	0.83
	0940	010	0.030	0.090	466201	0.74	0.57
91/01/08	1110	000	0.050	0.080	26200	0.91	0.59
	1120	010	0.020	0.080	26201	0.31	0.34
91/02/11	1535	000	0.050	0.080	76200	0.61	0.79
	1540	010	0.010	0.080	76201	0.49	0.45
91/04/08	1525	000	0.050	0.047	156200	0.15	0.44
	1535	010	0.050	0.054	156201	0.59	0.95
91/05/06	1440	000	0.010	0.010K	196200	6.94	8.33

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
91/05/06	1445	010	0.090	0.050	196201	14.60	14.60
91/06/04	1550	000	0.010K	0.024	236200	3.10	2.47
	1555	010	0.120	0.075	236201	13.00	17.40
91/07/08	1520	000	0.010K	0.015	286200	0.65	0.72
	1525	010	0.070	0.065	286201	4.38	4.97
91/08/05	1040	000	0.010K	0.011	326200	0.90	0.80
	1045	010	0.010K	0.065	326201	12.40	6.71
91/09/09	1630	000	0.010K	0.048	376200		
	1635	010	0.010	0.061	376201		

CMB003
COMMENCEMENT BAY
47 17 26.0 122 26 56.0 2F 0 Elev= 0 ft
53053 Washington Pierce Co. PACIFIC NORTHWEST
PUGET SOUND (Puyallup/White-10) 131110
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/22	1240	000	10.8	8.2	83.1		0.1	48	0.1	19.92	0.310	0.010K
	1245	010	12.1	5.8	64.8		81.7			30.40	0.340	0.010K
	1250	030	12.1	5.7	63.7		80.7			30.52	0.340	0.010K
90/12/05	1505	000	9.0	9.5	92.1	7.9	18.1	100S	0.8	19.01		
	1510	010	10.6	7.4	79.5	7.9	75.4			29.33		
	1515	029	10.8	7.1	76.8	7.9	78.8			29.74		
91/02/05	1430	000	7.7	10.8	100.4	8.0	5.5	220J	1.0	17.03	0.400	0.010K
	1440	010	8.0	8.7	88.5	8.0	83.7			29.00	0.420	0.010K
	1450	030	8.1	8.2	84.0	8.0	82.4			29.23	0.420	0.010K
91/03/04	1540	000	7.7	10.5	98.2	8.0	52.4	96	4.5	18.30	0.420	0.010K
	1550	010	8.0	8.7	88.2	8.1	86.8			28.22	0.410	0.010K
	1600	030	7.9	8.4	84.6	8.1	84.9			28.52	0.410	0.010K
91/04/22	1505	000	10.6	10.0	99.3	7.9	62.7	4	4.5	16.81	0.320	0.010K
	1515	010	8.5	8.7	88.8	8.0	83.1			28.49	0.340	0.010K
	1525	030	8.2	8.4	85.2	8.0	84.6			28.72	0.360	0.010K
91/05/28	1345	000	11.1	16.2	171.4	8.7	48.4	1K	2.7	25.64	0.010K	0.010K
	1355	010	9.6	10.7	112.3	8.3	79.7			28.88	0.250	0.010K
	1400	030	9.4	9.2	95.9	8.2	83.1			29.06	0.270	0.010K
91/06/17	1435	000	11.8	9.0	94.7	8.1	61.3	2	5.3	22.43	0.150	0.010
	1440	010	10.1	9.4	99.8	8.2	86.5			29.00	0.210	0.010
	1445	030	9.9	8.6	91.0	8.2	88.8			29.18	0.240	0.010
91/07/22	1450	000	14.1	11.4	129.0	8.3	54.0	3	3.5	27.13	0.060	0.010K
	1515	010	11.4	9.4	102.0	8.1	79.9			29.26	0.140	0.010K
	1525	030	11.2	7.6	83.1	8.1	86.9			29.47	0.180	0.010K
91/08/19	1605	000	15.9	9.6	113.6	8.2	62.7	1K	5.0	27.10	0.130	0.010K
	1615	010	12.2	8.8	97.5	8.2	82.0			29.51	0.190	0.010K
	1625	030	11.7	7.1	78.4	8.1	86.3			29.76	0.260	0.010K
91/09/23	1405	000	13.5	10.0	113.5	8.3	57.2	2	3.2	28.95	0.100	0.010K
	1415	010	12.6	7.5	84.1	8.2	80.6			29.94	0.110	0.010K
	1425	030	12.4	7.5	84.0	8.2	83.2			30.04	0.160	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/22	1240	000	0.030	0.060	436309	0.57	0.55
	1245	010	0.020	0.080	436310	0.45	0.38
	1250	030	0.010K	0.080	436311	0.40	0.32
90/12/05	1505	000			496324		
	1510	010			496325		
	1515	029			496326		
91/02/05	1430	000	0.050	0.060	66324	0.25	0.43
	1440	010	0.010	0.080	66325	0.05K	0.29
	1450	030	0.010K	0.080	66326	0.16	0.13
91/03/04	1540	000	0.050	0.060	106324	0.62	0.55
	1550	010	0.020	0.080	106325	0.90	0.40
	1600	030	0.010K	0.080	106326	0.71	0.30
91/04/22	1505	000	0.030	0.039	176324	1.32	1.09
	1515	010	0.020	0.073	176325	0.62	0.73
	1525	030	0.020	0.075	176326	0.13	0.17
91/05/28	1345	000	0.010K	0.010K	226324	4.50	2.70
	1355	010	0.020	0.047	226325	1.70	2.30
	1400	030	0.020	0.052	226326	0.90	3.50
91/06/17	1435	000	0.030	0.033	256324	0.88	1.26
	1440	010	0.050	0.052	256325	0.56	0.69
	1445	030	0.030	0.053	256326	0.16	0.87
91/07/22	1450	000	0.020	0.024	306324	7.51	5.20
	1515	010	0.030	0.042	306325	3.60	4.23
	1525	030	0.040	0.053	306326	0.65	2.15
91/08/19	1605	000	0.020	0.030	346324		
	1615	010	0.030	0.046	346325		
	1625	030	0.020	0.059	346326		
91/09/23	1405	000	0.010	0.041	306324		
	1415	010	0.010K	0.043	396325		
	1425	030	0.010	0.051	396326		

CRR001
CARR INLET OFF GREEN POINT
47 16 36.0 122 42 30.0 2F 0 Elev= 0 ft
53053 Washington Pierce Co. PACIFIC NORTHWEST
PUGET SOUND (Kitsap-15) 131115
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/22	1420	000	12.8	7.0	79.1		83.7	1K	10.4	30.12	0.270	0.010
	1425	010	12.6	6.5	73.2		83.8			30.21	0.280	0.010
	1430	030	12.6	5.7	64.2		84.3			30.26	0.320	0.010
90/12/11	1230	000	10.1	8.1	85.9	8.0	76.0	1K	6.2	28.82	0.260	0.010K
	1240	010	10.3	7.8	83.1	8.0	76.3			28.93	0.260	0.010K
	1250	030	10.5	7.3	78.3	7.9	80.3			29.25	0.260	0.010K
91/01/08	1300	000	8.0	9.2	93.2	8.0	84.2	1K	9.5	28.83	0.440	0.010K
	1310	010	8.1	9.0	91.4	8.0	84.5			28.92	0.450	0.010K
	1315	030	8.4	8.8	90.0	8.0	83.2			28.99	0.450	0.010K
91/02/11	1500	000	7.9	9.9	99.7	8.2	81.7	1K	8.5	27.72	0.400	0.010K
	1505	010	7.9	9.4	94.9	8.1	81.3			28.41	0.410	0.010K
	1510	030	8.0	8.6	86.5	8.1	82.6			28.65	0.420	0.010K
91/03/11	1340	000	7.8	9.4	94.4	8.1	86.8	1K	10.0	28.02	0.410	0.010K
	1355	010	7.9	9.1	91.1	8.1	88.8			28.03	0.410	0.010K
	1410	030	8.0	8.7	87.3	8.1	88.4			28.16	0.420	0.010K
91/04/08	1310	000	8.6	9.9	100.1	8.1	77.5	1K	6.5	27.10	0.290	0.010K
	1320	010	8.4	9.5	96.9	8.0	84.8			27.83	0.290	0.010K
	1330	029	8.2	8.8	89.6	8.0	86.1			28.33	0.320	0.010K
91/05/06	1300	000	11.2	15.7	169.6	8.7	54.5	1K	3.1	28.08	0.010K	0.010K
	1305	010	9.6	12.8	133.8	8.4	67.5			28.22	0.180	0.010K
	1310	030	8.6	8.9	90.7	8.1	79.0			28.33	0.330	0.010K
91/06/04	1430	000	14.9	11.5	133.6	8.5	75.3	1		28.07	0.010K	0.010K
	1440	010	9.8	11.6	122.0	8.4	74.5			28.65	0.190	0.010K
	1450	030	9.5	8.8	92.0	8.2	87.9			28.69	0.260	0.010K
91/07/08	1305	000	18.7	9.9	124.2	8.3	80.4	1K	6.0	28.55	0.010K	0.010K
	1310	010	11.8	10.9	120.2	8.2	75.4			29.06	0.130	0.010K
	1320	030	11.3	8.4	91.2	8.1	85.1			29.12	0.190	0.010K
91/08/05	1215	000	18.1	11.4	141.7	8.4	73.8	1K	3.0	29.13	0.010K	0.010K
	1220	010	12.8	9.9	111.4	8.3	79.2			29.31	0.140	0.010K
	1230	030	12.3	7.9	88.5	8.1	88.2			29.36	0.210	0.010K
91/09/09	1510	000	15.7	12.2	145.1	8.5	78.0	1K	6.5	29.30	0.010K	0.010K
	1515	010	13.3	9.5	107.5	8.2	55.7			29.58	0.010K	0.010K
	1520	030	12.6	6.3	70.7	8.1	80.2			29.73	0.270	0.020

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/22	1420	000	0.020	0.070	436317	3.15	1.07
	1425	010	0.020	0.070	436318	3.61	1.91
	1430	030	0.020	0.080	436319	0.90	0.62
90/12/11	1230	000	0.010	0.080	506280	0.16	0.24
	1240	010	0.010	0.080	506281	0.07	0.27
	1250	030	0.010	0.080	506282	0.15	0.20
91/01/08	1300	000	0.020	0.080	26280	0.31	0.28
	1310	010	0.010K	0.080	26281	0.19	0.21
	1315	030	0.010K	0.080	26282	0.17	0.18
91/02/11	1500	000	0.010	0.080	76280	0.52	0.52
	1505	010	0.010K	0.080	76281	0.43	0.45
	1510	030	0.010K	0.080	76282	0.05K	0.38
91/03/11	1340	000	0.010	0.080	116280	0.30	0.31
	1355	010	0.010	0.080	116281	0.35	0.41
	1410	030	0.010K	0.080	116282	0.16	0.20
91/04/08	1310	000	0.010	0.055	156280	0.24	0.68
	1320	010	0.010	0.056	156281	0.39	0.44
	1330	029	0.010K	0.062	156282	0.33	0.52
91/05/06	1300	000	0.010K	0.010K	196280	12.40	9.27
	1305	010	0.020	0.037	196281	15.30	12.00
	1310	030	0.020	0.062	196282	2.16	4.39
91/06/04	1430	000	0.010K	0.010K	236280	0.98	1.13
	1440	010	0.020	0.043	236281	8.13	6.48
	1450	030	0.050	0.061	236282	0.52	1.21
91/07/08	1305	000	0.010K	0.010K	286280	0.59	1.11
	1310	010	0.030	0.038	286281	4.51	5.86
	1320	030	0.050	0.050	286282	0.86	1.97
91/08/05	1215	000	0.010K	0.013	326280	1.69	1.86
	1220	010	0.030	0.044	326281	5.02	6.75
	1230	030	0.050	0.053	326282	0.45	0.88
91/09/09	1510	000	0.010K	0.029	376280		
	1515	010	0.010K	0.049	376281		
	1520	030	0.030	0.080	376282		

CSE001
CASE INLET OFF SOUTHERN HERON IS
47 15 53.0 122 50 35.0 2F 0 Elev= 0 ft
53053 Washington Pierce Co. PACIFIC NORTHWEST
PUGET SOUND (Kitsap-15) 131115
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/22	1455	000	13.2	6.8	77.3		80.6	1K	7.5	29.87	0.290	0.020
	1500	010	12.9	6.6	74.6		79.6			29.93	0.300	0.020
	1505	030	12.8	6.3	71.1		79.2			29.98	0.300	0.020
90/12/11	1400	000	9.8	8.1	84.9	8.0	78.4	1		28.18	0.270	0.010K
	1405	010	10.2	7.7	81.7	8.0	77.5			28.66	0.270	0.010K
	1410	030	10.5	7.1	76.1	7.9	75.6			29.20	0.270	0.010K
91/01/08	1400	000	7.1	9.4	93.0	8.0	81.4	1K	8.0	28.29	0.450	0.010K
	1410	010	7.1	9.3	92.0	8.0	81.3			28.34	0.450	0.010K
	1420	029	7.3	9.0	89.6	8.0	81.3			28.47	0.460	0.010K
91/02/11	1305	000	7.8	9.5	94.2	8.1	80.2	2	7.5	26.95	0.410	0.010K
	1310	010	7.9	8.9	89.1	8.0	80.0			28.16	0.420	0.010K
	1315	030	7.9	8.3	83.8	8.0	75.8			28.62	0.420	0.010K
91/03/11	1250	000	7.9	9.8	97.8	8.2	80.5	1K	7.0	27.20	0.360	0.010K
	1305	010	8.0	9.6	96.0	8.2	81.7			27.27	0.370	0.010K
	1320	024	8.0	8.1	82.0	8.1	79.6			28.09	0.430	0.010K
91/04/08	1245	000	8.8	10.9	110.3	8.2	79.0	1K		26.50	0.170	0.010K
	1255	010	8.7	10.7	108.2	8.2	77.8			26.89	0.170	0.010K
	1305	030	8.2	8.8	89.7	8.0	77.4			28.33	0.310	0.010K
91/05/06	1230	000	11.2	15.1	162.0	8.7	52.3	1K	2.4	27.48	0.010K	0.010K
	1240	010	9.5	11.5	120.0	8.3	66.1			27.91	0.180	0.010K
	1250	030	9.0	9.3	95.6	8.2	76.3			28.30	0.270	0.010K
91/06/04	1405	000	14.0	13.0	147.7	8.5	53.6	1K	2.8	27.34	0.010K	0.010K
	1410	010	12.0	15.4	168.9	8.7	36.0			28.09	0.030	0.010K
	1420	030	10.0	9.1	96.1	8.2	79.3			28.66	0.220	
91/07/08	1240	000	16.5	12.4	149.4	8.4	60.8	1K	4.0	28.47	0.010K	0.010K
	1250	010	15.4	12.8	150.7	8.4	63.1			28.47	0.050	0.010K
	1300	029	11.6	8.6	94.2	8.1	78.6			28.97	0.170	0.010K
91/08/05	1250	000	15.8	11.0	131.3	8.4	71.3	1K	5.0	28.97	0.010K	0.010K
	1255	010	13.7	9.5	108.1	8.2	79.2			29.18	0.110	0.010K
	1300	030	12.8	7.9	89.1	8.1	82.9			29.26	0.170	0.010K
91/09/09	1440	000	16.7	10.4	126.0	8.4	79.7	1K	6.0	29.12	0.040	0.010K
	1445	010	14.6	9.4	110.0	8.3	75.9			29.31	0.110	0.010K
	1450	030	13.6	7.7	88.4	8.2	80.1			29.52	0.180	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/22	1455	000	0.030	0.080	436320	1.01	0.82
	1500	010	0.030	0.090	436321	0.66	0.57
	1505	030	0.020	0.080	436322	0.68	0.64
90/12/11	1400	000	0.010	0.080	506283	0.37	0.43
	1405	010	0.010	0.090	506284	0.15	0.26
	1410	030	0.010	0.080	506285	0.15	0.28
91/01/08	1400	000	0.010K	0.080	26283	0.34	0.39
	1410	010	0.010	0.080	26284	0.31	0.36
	1420	029	0.010K	0.080	26285	0.42	0.43
91/02/11	1305	000	0.010	0.080	76283	0.67	0.54
	1310	010	0.010K	0.080	76284	0.38	0.44
	1315	030	0.010K	0.080	76285	0.12	0.28
91/03/11	1250	000	0.010	0.070	116283	3.31	2.27
	1305	010	0.010	0.070	116284	3.20	3.19
	1320	024	0.010K	0.080	116285	0.28	0.50
91/04/08	1245	000	0.010K	0.036	156283	21.70	16.60
	1255	010	0.010K	0.034	156284	1.40	5.37
	1305	030	0.020	0.064	156285	0.29	0.80
91/05/06	1230	000	0.010K	0.010K	196283	13.10	14.40
	1240	010	0.040	0.042	196284	9.66	11.70
	1250	030	0.040	0.057	196285	1.82	3.73
91/06/04	1405	000	0.010K	0.010K	236283	3.75	2.85
	1410	010	0.010K	0.023	236284	14.00	14.60
	1420	030	0.050	0.055	236285	0.61	1.37
91/07/08	1240	000	0.010K	0.010K	286283	2.95	2.99
	1250	010	0.010	0.027	286284	6.03	5.61
	1300	029	0.080	0.058	286285	0.98	2.03
91/08/05	1250	000	0.010	0.024	326283	5.66	4.26
	1255	010	0.040	0.045	326284	6.19	4.85
	1300	030	0.070	0.057	326285	1.79	1.54
91/09/09	1440	000	0.010K	0.056	376283		
	1445	010	0.020	0.075	376284		
	1450	030	0.040	0.075	376285		

CSE002
CASE INLET OFF ROCKY POINT
47 21 12.0 122 48 48.0 2F000 Elev= 0 ft
53045 Washington Mason Co. PACIFIC NORTHWEST
PUGET SOUND (Kitsap-15) 131115
21540000 Reach=17110019000 0.000 Drg= 0 sqmi
AMBNT/OCEAN

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/11/12	1135	000	11.9	8.2	89.0	8.0	71.4	4	7.5	26.78	0.270	0.010
	1140	010	12.0	7.0	77.6	7.9	80.5			29.63	0.260	0.010K
90/12/11	1325	000	9.1	9.0	91.1	8.0	70.0	5		25.26	0.260	0.010K
	1335	010	9.9	8.1	84.9	8.0	81.6			27.89	0.270	0.010K
91/01/08	1440	000	6.3	9.9	95.8	8.1	79.6	1K	7.0	27.82	0.450	0.010K
	1450	010	6.5	9.5	92.6	8.0	82.1			28.17		
91/02/11	1220	000	7.9	10.0	99.0	8.2	65.4	35	9.2	25.50		
	1225	010	7.8	8.9	89.6	8.0	81.9			28.06		
91/03/11	1230	000	7.6	10.9	106.6	8.3	76.9	1	5.5	24.97		
	1240	010	8.2	10.1	101.1	8.2	82.1			26.58		
91/04/08	1230	000	9.2	11.1	107.4	8.3	66.3	1	8.0	18.62		
	1240	010	8.6	10.5	106.6	8.2	78.7			27.54		
91/05/06	1215	000	12.4	14.6	160.5	8.7	56.9	1K	2.2	26.92		
	1225	010	9.3	12.4	127.9	8.4	51.0			27.76		
91/06/04	1350	000	14.4	11.9	135.9	8.4	58.1	1	3.5	26.95		
	1400	010	10.1	9.3	98.2	8.1	73.6			28.24		
91/07/08	1220	000	19.7	9.9	125.5	8.2	76.5	1K	7.3	27.68		
	1230	010	11.9	10.3	112.7	8.2	74.4			28.64		
91/08/05	1315	000	19.9	8.7	111.3	8.1	83.0	1K		28.00		
	1320	010	13.2	7.7	86.8	8.1	78.3			29.00		
91/09/09	1420	000	16.0	10.0	119.3	8.4	67.8	1K	5.5	29.02		
	1425	010	14.3	7.9	90.8	8.2	84.2			29.23		

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/11/12	1135	000	0.050	0.080	466208	1.36	1.24
	1140	010	0.030	0.090	466209	0.91	0.67
90/12/11	1325	000	0.020	0.080	506208	0.51	0.50
	1335	010	0.020	0.080	506209	0.33	0.42
91/01/08	1440	000	0.010	0.080	26208	0.45	0.57
91/02/11	1220	000			76208		
91/03/11	1230	000			116208		
91/04/08	1230	000			156208		
91/05/06	1215	000			196208		
91/06/04	1350	000			236208		
91/07/08	1220	000			286208		
91/08/05	1315	000			326208		

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
91/09/09	1420	000			376208		

DIS001
DISCOVERY BAY AT MILL POINT
48 01 06.0 122 50 48.0 2F000 Elev= 0 ft
53031 Washington Jefferson Co. PACIFIC NORTHWEST
PUGET SOUND (Quilcene/Snow-17) 131117
21540000 Reach=17110020000 0.000 Drg= 0 sqmi
AMBNT/OCEAN

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/11/20	1000	000	9.6	7.7	82.0	8.1	84.6		10.4	30.95	0.250	0.010
	1010	010	9.6	7.7	82.0	8.2	85.0			30.95	0.250	0.010K
90/12/11	1010	000	8.5	8.6	89.2	8.0	84.2	1	11.8	30.55	0.250	0.010K
	1015	010	8.5	8.6	89.2	8.0	84.0			30.58	0.240	0.010K
91/01/29	1255	000	6.4	9.0	88.9	8.2	85.1	1K	12.2	30.34	0.300	0.010K
	1305	010	7.1	8.3	83.5	8.1	84.1			30.66	0.330	0.010K
91/02/26	1025	000	7.9	11.6	118.0	8.1	86.2	1U	16.0	30.08	0.330	0.010K
	1035	010	7.7	8.4	85.4	8.1	87.2			30.38	0.320	0.010K
91/03/18	1030	000	8.3	16.2	167.2	8.7	59.7	1K	3.3	30.51	0.010K	0.010K
	1040	010	7.9	14.0	143.1	8.5	59.6			30.80	0.100	0.010K
91/04/15	1020	000	9.7	10.2	108.5	8.1	88.0	1K	16.0	30.18	0.180	0.010K
	1030	010	8.8	9.8	102.0	8.1	86.2			30.63	0.230	0.010K
91/05/13	1030	000	11.0	14.0	152.6	8.6	52.4	1K	3.3	30.36	0.010K	0.010K
	1040	010	10.0	11.1	119.0	8.4	76.5			30.50	0.150	0.010K
91/06/10	1010	000	13.7	10.8	124.3	8.5	80.9	1K	6.3	30.23	0.010K	0.010K
	1020	010	10.3	11.5	124.2	8.4	81.1			30.94	0.100	0.010K
91/07/15	1030	000	14.4	8.0	94.2	8.3	75.6	1K	7.5	30.59	0.040	0.010K
	1040	010	10.8	8.0	87.9	8.1	87.6			30.95	0.200	0.010K
91/08/12	1020	000	15.3	17.3	205.9	8.8	59.4	1	1.8	30.60	0.010K	0.010K
	1025	010	11.1	8.8	96.8	8.2	85.6			31.27	0.240	0.010K
91/09/16	1040	000	14.3	10.5	123.2	8.4	76.3	1K	7.5	31.36	0.020	0.010K
	1050	010	10.8	7.3	80.0	8.1	86.0			31.46	0.200	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/11/20	1000	000	0.020	0.070	476250	0.58	0.58
	1010	010	0.010	0.060	476251	0.78	0.70
90/12/11	1010	000	0.020	0.070	506250	0.38	0.43
	1015	010	0.010	0.070	506251	0.15	0.18
91/01/29	1255	000	0.010K	0.050	56250	0.54	0.57
	1305	010	0.010K	0.060	56251	0.39	0.34
91/02/26	1025	000	0.010	0.040	96250	1.02	0.45
	1035	010	0.010	0.050	96251	0.78	0.44
91/03/18	1030	000	0.010	0.010K	126250	17.50	10.30
	1040	010	0.010K	0.020	126251	18.20	10.60
91/04/15	1020	000	0.030	0.045	166250	0.19	0.16
	1030	010	0.010	0.049	166251	1.09	0.87

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
91/05/13	1030	000	0.020	0.012	206250	13.20	12.80
	1040	010	0.040	0.041	206251	5.30	4.60
91/06/10	1010	000	0.010K	0.010K	246250	1.29	1.28
	1020	010	0.010K	0.024	246251	5.05	4.46
91/07/15	1030	000	0.020	0.022	296250	1.73	1.93
	1040	010	0.050	0.057	296251	0.58	0.78
91/08/12	1020	000	0.010K	0.013	336250	6.15	3.72
	1025	010	0.050	0.061	336251	0.50	0.21
91/09/16	1040	000	0.010	0.025	386250		
	1050	010	0.060	0.075	386251		

DNA001
DANA PASSAGE NEAR BRISCO POINT
47 09 42.0 122 52 14.0 1F 0 Elev= 0 ft
53067 Washington Thurston Co. PACIFIC NORTHWEST
PUGET SOUND (Deschutes-13) 131113
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/08	1150	000	13.8	6.4	73.6		76.1	1	6.1	29.87	0.180	0.013
	1155	010	13.8	6.5	74.8		76.1			29.87	0.180	0.010
	1200	029	13.8	6.4	73.6		76.1			29.84	0.190	0.010
90/11/12	1000	000	11.8	7.1	78.4	7.9	77.4	1	6.5	29.60	0.270	0.010K
	1005	010	11.9	6.9	76.4	7.9	79.6			29.76	0.270	0.010K
	1010	030	11.8	6.5	71.9	7.9	78.7			29.98	0.280	0.010K
90/12/11	1500	000	10.1	7.5	79.2	8.0	72.8	1K	5.1	28.26	0.270	0.010K
	1510	010	10.2	7.4	78.4	8.0	72.6			28.41	0.270	0.010K
	1520	026	10.4	7.2	76.8	7.9	71.9			28.76	0.270	0.010K
91/01/08	1140	000	6.8	9.4	92.0	8.0	75.7	4	6.7	27.77	0.450	0.010K
	1150	010	7.6	9.0	90.1	8.0	77.9			28.42	0.450	0.010K
	1200	030	8.0	8.6	87.0	7.9	78.4			28.64	0.450	0.010K
91/02/11	1400	000	8.0	9.2	92.2	8.1	77.3	1K	6.5	27.35	0.420	0.010K
	1405	010	7.9	8.8	87.9	8.0	76.9			28.05	0.420	0.010K
	1410	030	8.0	8.4	84.6	8.0	74.3			28.64	0.420	0.010K
91/03/11	1455	000	7.8	9.2	90.8	8.1	79.9	1K	6.5	26.53	0.410	0.010K
	1505	010	7.9	8.6	86.5	8.1	80.9			27.30	0.420	0.010K
	1510	030	8.0	8.3	83.6	8.1	80.8			28.09	0.430	0.010K
91/04/08	1415	000	8.7	10.0	99.5	8.1	67.1	1	4.5	23.96	0.230	0.010K
	1425	010	8.5	9.6	96.8	8.1	81.2			27.34	0.260	0.010K
	1435	030	8.3	8.9	90.5	8.0	81.7			28.17	0.310	0.010K
91/05/06	1350	000	10.5	12.2	129.0	8.6	64.6	1K	4.0	27.40	0.090	0.010K
	1355	010	9.9	11.3	118.0	8.4	68.4			27.70	0.080	0.010K
	1400	030	9.4	9.9	102.7	8.2	69.3			28.04	0.190	0.010K
91/06/04	1525	000	11.2	10.6	114.5	8.3	67.3	1K	4.0	28.20	0.120	0.010K
	1535	010	10.8	9.9	106.1	8.3	70.9			28.34	0.140	0.010K
	1545	030	10.7	10.1	108.1	8.3	73.4			28.38	0.160	0.010K
91/07/08	1450	000	13.7	9.8	112.0	8.2	76.6	1K	7.2	28.33	0.110	0.010K
	1500	010	12.8	9.3	104.6	8.1	76.2			28.88	0.140	0.010K
	1510	030	12.0	8.7	95.7	8.1	76.0			28.97	0.160	0.010K
91/08/05	1110	000	15.3	9.8	115.0	8.3	75.6	1K	6.5	29.01	0.060	0.010K
	1120	010	14.2	9.6	111.0	8.2	74.8			29.11	0.050	0.010K
	1135	029	13.0	8.0	90.7	8.1	79.0			29.26	0.190	0.010K
91/09/09	1605	000	14.8	9.6	112.0	8.3	78.3	1K	7.0	29.35	0.120	0.010K
	1610	010	14.1	8.6	99.0	8.2	78.5			29.44	0.150	0.010K
	1615	030	13.7	7.8	89.3	8.2	76.0			29.53	0.170	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/08	1150	000	0.040	0.080	416206	0.53	0.81
	1155	010	0.050	0.080	416207	1.07	0.89
	1200	029	0.040	0.080	416208	1.03	0.74
90/11/12	1000	000	0.020	0.080	466202	0.74	0.51
	1005	010	0.020	0.080	466203	0.81	0.53
	1010	030	0.010	0.080	466204	0.59	0.52
90/12/11	1500	000	0.020	0.090	506202	0.20	0.31
	1510	010	0.020	0.080	506203	0.21	0.39
	1520	026	0.020	0.090	506204	0.20	0.31
91/01/08	1140	000	0.020	0.080	26202	0.63	0.58
	1150	010	0.020	0.080	26203	0.29	0.37
	1200	030	0.010	0.080	26204	0.21	0.32
91/02/11	1400	000	0.010	0.080	76202	0.63	0.57
	1405	010	0.010	0.080	76203	0.38	0.39
	1410	030	0.010K	0.080	76204	0.13	0.52
91/03/11	1455	000	0.020	0.080	116202	0.84	0.67
	1505	010	0.010	0.080	116203	0.71	0.65
	1510	030	0.010	0.080	116204	0.36	0.56
91/04/08	1415	000	0.040	0.047	156202	0.63	0.72
	1425	010	0.030	0.053	156203	1.10	1.23
	1435	030	0.020	0.065	156204	0.41	1.20
91/05/06	1350	000	0.020	0.027	196202	5.50	17.00
	1355	010	0.010	0.024	196203	9.99	11.50
	1400	030	0.030	0.044	196204	5.84	9.68
91/06/04	1525	000	0.030	0.040	236202	2.87	7.18
	1535	010	0.030	0.040	236203	3.77	3.94
	1545	030	0.040	0.048	236204	2.38	3.03
91/07/08	1450	000	0.030	0.042	286202	2.59	2.98
	1500	010	0.040	0.047	286203	2.19	2.96
	1510	030	0.060	0.051	286204	1.14	2.02
91/08/05	1110	000	0.020	0.041	326202	3.33	3.45
	1120	010	0.020	0.035	326203	8.38	6.83
	1135	029	0.060	0.058	326204	1.45	1.73
91/09/09	1605	000	0.010	0.060	376202		
	1610	010	0.020	0.063	376203		
	1615	030	0.030	0.066	376204		

EAP001
EAST PASSAGE NEAR THREE TREE POINT
47 25 02.0 122 22 45.0 2F000 Elev= 0 ft
53033 Washington King Co. PACIFIC NORTHWEST
PUGET SOUND (Duwamish/Green-09) 131109
21540000 Reach=17110019 0.000 Drg= 0 sqmi
AMBNT/OCEAN/RMP

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/22	1145	000	12.1	7.2	80.2		84.5	1	12.0	30.12	0.300	0.010K
	1155	010	12.1	6.8	75.8		84.7			30.22	0.310	0.010K
	1205	030	12.0	6.7	74.6		85.2			30.26	0.310	0.010K
90/12/05	1445	000	10.2	8.1	86.0	8.0	74.2	5	5.0	28.70	0.280	0.010K
	1450	010	10.2	7.9	84.0	8.0	79.1			28.99	0.280	0.010K
	1455	026	10.4	7.5	80.3	8.0	82.2			29.40	0.280	0.010K
91/02/05	1340	000	8.2	9.1	91.6	8.0	79.6	3	8.2	27.82	0.420	0.010K
	1350	010	8.0	8.8	89.1	8.0	82.6			28.35	0.420	0.010K
	1400	030	8.0	8.6	87.7	8.0	85.0			28.86	0.420	0.010K
91/03/04	1445	000	8.0	10.1	101.4	8.2	85.0	1	12.0	27.57	0.380	0.010K
	1455	010	8.0	9.4	95.0	8.1	87.2			27.91	0.400	0.010K
	1500	030	8.0	8.6	87.1	8.1	87.0			28.48	0.410	0.010K
91/04/22	1445	000	9.6	9.6	100.6	8.0	77.5	1K	7.0	28.24	0.330	0.010K
	1455	010	9.1	9.5	98.2	8.0	80.5			28.51	0.340	0.010K
	1500	030	8.6	8.8	90.7	8.0	83.7			28.60	0.340	0.010K
91/05/28	1315	000	12.2	16.4	180.2	8.7	54.0	1K	3.0	27.39	0.010K	0.010K
	1325	010	9.8	11.7	123.5	8.4	76.4			28.89	0.150	0.010K
	1335	030	9.6	9.8	102.8	8.2	81.4			29.00	0.250	0.010K
91/06/17	1400	000	13.0	12.7	141.7	8.6	64.6	1K	3.4	27.60	0.010K	0.010K
	1405	010	11.0	11.4	123.1	8.5	73.8			28.75	0.060	0.010K
	1410	028	10.4	9.6	102.6	8.3	84.8			29.14	0.190	0.010
91/07/22	1420	000	13.9	13.1	150.0	8.5	56.0	1K	3.0	29.20	0.010K	0.010K
	1430	010	11.9	10.2	112.0	8.2	76.6			29.45	0.100	0.010K
	1445	022	11.3	7.9	86.3	8.1	86.4			29.55	0.180	0.010K
91/08/19	1530	000	15.2	14.1	166.6	8.6	51.8	1K	3.5	29.58	0.010K	0.010K
	1540	010	12.8	10.8	122.0	8.3	74.4			29.69	0.120	0.010K
	1550	030	11.9	7.2	79.7	8.1	87.6			29.83	0.250	0.010K
91/09/23	1335	000	13.3	10.5	119.3	8.4	75.9	1K	5.5	29.97	0.080	0.010K
	1345	010	12.7	9.0	100.9	8.3	79.1			30.00	0.110	0.010K
	1355	029	12.4	7.2	81.0	8.1	85.9			30.08	0.180	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/22	1145	000	0.010	0.070	436306	2.81	1.60
	1155	010	0.010	0.070	436307	1.86	1.03
	1205	030	0.010	0.070	436308	1.81	1.10
90/12/05	1445	000	0.010K	0.080	496321	0.21	0.15
	1450	010	0.010K	0.080	496322	0.17	0.11
	1455	026	0.010K	0.080	496323	0.11	0.17
91/02/05	1340	000	0.020	0.080	66321	0.26	0.28
	1350	010	0.010	0.080	66322	0.27	0.21
	1400	030	0.010K	0.080	66323	0.34	0.26
91/03/04	1445	000	0.010K	0.070	106321	5.94	2.53
	1455	010	0.010	0.070	106322	1.36	0.45
	1500	030	0.010K	0.080	106323	0.96	0.37
91/04/22	1445	000	0.010K	0.071	176321	1.22	0.98
	1455	010	0.010K	0.074	176322	1.05	0.89
	1500	030	0.010K	0.074	176323	0.46	0.55
91/05/28	1315	000	0.010K	0.010K	226321	14.20	7.20
	1325	010	0.010K	0.032	226322	2.70	3.10
	1335	030	0.020	0.049	226323	24.50	6.80
91/06/17	1400	000	0.010K	0.010K	256321	7.01	6.35
	1405	010	0.010K	0.024	256322	8.85	8.30
	1410	028	0.020	0.042	256323	2.22	2.19
91/07/22	1420	000	0.010K	0.011	306321	9.66	12.10
	1430	010	0.020	0.033	306322	6.93	5.78
	1445	022	0.030	0.051	306323	1.67	2.56
91/08/19	1530	000	0.010K	0.010K	346321		
	1540	010	0.010	0.031	346322		
	1550	030	0.020	0.054	346323		
91/09/23	1335	000	0.010K	0.038	396321		
	1345	010	0.010K	0.042	396322		
	1355	029	0.010K	0.054	396323		

EAS001
EAST SOUND AT ROSARIO POINT
48 38 35.0 122 52 56.0 2F000 Elev= 0 ft
53055 Washington San Juan Co. PACIFIC NORTHWEST
PUGET SOUND (San Juan-02) 131102
21540000 Reach=17110003000 0.000 Drg= 0 sqmi
AMBNT/OCEAN

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/11/20	1305	000	9.3	8.3	87.3	8.2	82.8		11.5	30.17	0.290	0.010K
	1315	010	9.4	7.9	83.3	8.1	83.4			30.26	0.290	0.010K
90/12/12	1145	000	8.0	9.3	94.6	8.1	81.6	1K	7.0	29.42	0.270	0.010K
	1155	010	8.6	8.7	89.9	8.0	81.3			29.75	0.270	0.010K
91/02/26	1410	000	7.6	9.7	98.4	8.1	74.7	1U	6.5	29.66	0.380	0.010K
	1420	010	7.4	9.6	96.1	8.1	76.1			29.68	0.380	0.010K
91/03/18	1435	000	7.7	9.6	96.8	8.1	79.4	1K	7.3	29.65	0.350	0.010K
	1445	010	7.3	9.5	94.9	8.1	78.5			29.71	0.360	0.010K
91/04/15	1525	000	10.6	16.0	172.4	8.5	61.8	1K	6.2	29.66	0.010K	0.010K
	1535	010	8.4	10.7	110.1	8.1	74.2			29.96	0.280	0.010K
91/05/13	1500	000	11.3	13.4	146.9	8.6	56.9	1K	3.5	29.91	0.010	0.010K
	1510	010	9.6	10.2	108.1	8.4	76.5			30.05	0.180	0.010K
91/06/10	1410	000	13.0	12.7	140.5	8.6	80.2	1K	5.5	26.31	0.010K	0.010K
	1420	010	10.8	10.0	107.3	8.3	73.3			28.43	0.190	0.010K
91/07/15	1450	000	12.4	7.6	84.6	8.1	87.3	1K	10.5	29.06	0.160	0.010K
	1500	010	10.7	6.2	67.2	8.0	82.8			29.66	0.240	0.010K
91/08/12	1600	000	14.0	9.9	114.4	8.4	77.2	1K	8.5	29.47	0.050	0.010K
	1610	010	11.1	6.3	69.2	8.0	82.4			29.90	0.210	0.010K
91/09/16	1450	000	12.5	8.2	91.6	8.2	82.0	1K	8.5	29.58	0.150	0.010K
	1500	010	11.8	7.5	82.8	8.1	82.7			29.45	0.200	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/11/20	1305	000	0.030	0.070	476262	1.13	0.95
	1315	010	0.020	0.070	476263	0.83	0.62
90/12/12	1145	000	0.020	0.070	506262	0.55	0.71
	1155	010	0.020	0.070	506263	0.24	0.35
91/02/26	1410	000	0.010	0.060	96262	0.85	0.46
	1420	010	0.120	0.060	96263	0.59	0.52
91/03/18	1435	000	0.010	0.070	126262	0.56	0.73
	1445	010	0.010	0.070	126263	0.85	0.89
91/04/15	1525	000	0.010K	0.010K	166262	12.90	6.26
	1535	010	0.010K	0.051	166263	2.19	7.00
91/05/13	1500	000	0.010K	0.012	206262	5.20	4.80
	1510	010	0.040	0.044	206263	5.70	4.60
91/06/10	1410	000	0.010K	0.010K	246262	2.15	2.59
	1420	010	0.020	0.041	246263	11.80	7.73

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
91/07/15	1450	000	0.040	0.046	296262	0.45	0.35
	1500	010	0.050	0.061	296263	0.43	0.95
91/08/12	1600	000	0.010K	0.022	336262	1.55	1.74
	1610	010	0.150	0.081	336263	0.56	1.24
91/09/16	1450	000	0.020	0.046	386262		
	1500	010	0.020	0.056	386263		

GRG002
STRAIT OF GEORGIA NEAR PATOS ISLAND
48 48 30.0 122 57 10.0 2F000 Elev= 0 ft
53055 Washington San Juan Co. PACIFIC NORTHWEST
PUGET SOUND (San Juan-02) 131102
21540000 Reach=17110003 0.000 Drg= 0 sqmi
AMBNT/OCEAN/RMP

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/11/20	1400	000	8.9	8.5	86.9	8.2	72.1		6.1	27.36	0.300	0.010K
	1410	010	9.7	6.5	68.7	8.0	85.7			29.68	0.300	0.010K
	1420	030	9.6	6.4	67.7	8.1	82.9			30.10	0.310	0.010K
91/02/26	1440	000	7.3	11.0	105.4	8.1	63.5	1U	6.3	22.93	0.350	0.010K
	1450	010	7.5	8.7	86.6	8.1	79.1			28.77	0.380	0.010K
	1505	028	7.5	8.4	83.9	8.1	78.9			29.20	0.380	0.010K
91/03/18	1505	000	8.2	9.3	94.0	8.1	80.7	1K	9.6	27.35	0.360	0.010K
	1515	010	7.7	8.8	88.3	8.1	84.3			28.90	0.380	0.010K
	1525	030	7.6	8.5	85.4	8.1	83.5			29.20	0.370	0.010K
91/04/15	1620	000	8.1	8.4	85.5	8.0	78.7	1K	6.4	29.73	0.310	0.010K
	1625	010	8.1	8.3	84.7	8.0	78.8			29.74	0.310	0.010K
	1630	030	8.1	8.4	85.6	8.0	78.5			29.75	0.320	0.010K
91/05/13	1530	000	9.5	8.9	92.4	8.3	66.5	1K	6.5	28.43	0.280	0.010K
	1540	010	8.7	7.7	79.8	8.1	78.3			29.87	0.270	0.010K
	1550	030	8.7	7.5	77.7	8.1	77.9			29.94	0.310	0.010K
91/06/10	1435	000	10.1	8.9	94.4	8.2	72.7	1	6.5	28.89	0.250	0.010K
	1445	010	9.8	9.1	96.1	8.2	75.2			29.25	0.290	0.010K
	1455	025	9.6	7.9	83.2	8.2	76.7			29.45	0.290	0.010K
91/07/15	1520	000	10.3	6.1	65.8	8.0	80.7	1K	8.0	29.84	0.300	0.010K
	1530	010	10.2	6.1	65.7	8.0	81.1			29.87	0.290	0.010K
	1540	030	10.0	5.8	61.8	8.0	81.0			29.99	0.300	0.010K
91/08/12	1430	000	14.0	8.3	92.7	8.2	71.2	1K		24.74	0.170	0.010K
	1440	010	11.2	7.0	76.0	8.1	83.5			28.88	0.260	0.010K
	1450	030	10.6	5.9	64.0	8.0	82.1			29.75	0.320	0.010K
91/09/16	1510	000	12.8	8.8	98.1	8.3	65.7	1K	7.0	27.38	0.130	0.010K
	1520	010	11.0	6.7	72.2	8.1	83.0			29.38	0.200	0.010K
	1530	030	10.8	6.3	67.6	8.1	83.6			29.55	0.230	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/11/20	1400	000	0.010	0.070	476264	0.30	0.40
	1410	010	0.010K	0.070	476265	0.14	0.17
	1420	030	0.010K	0.070	476266	0.14	0.20
91/02/26	1440	000	0.010	0.050	96264	0.89	0.63
	1450	010	0.010	0.060	96265	0.25	0.24
	1505	028	0.010	0.060	96266	0.27	0.20
91/03/18	1505	000	0.010K	0.070	126264	0.59	0.56
	1515	010	0.010K	0.070	126265	0.38	0.45
	1525	030	0.010K	0.070	126266	0.42	0.42
91/04/15	1620	000	0.010	0.062	166264	0.42	0.70
	1625	010	0.020	0.062	166265	0.31	0.99
	1630	030	0.010	0.062	166266	0.45	0.79
91/05/13	1530	000	0.010	0.055	206264	2.70	2.50
	1540	010	0.010K	0.054	206265	2.90	2.70
	1550	030	0.010K	0.061	206266	0.90	1.10
91/06/10	1435	000	0.010K	0.048	246264	4.85	4.15
	1445	010	0.010K	0.054	246265	1.67	2.16
	1455	025	0.010K	0.053	246266	2.56	3.58
91/07/15	1520	000	0.010	0.059	296264	0.52	0.68
	1530	010	0.010K	0.058	296265	1.32	1.02
	1540	030	0.010	0.060	296266	0.47	0.69
91/08/12	1430	000	0.010K	0.034	336264	1.49	0.89
	1440	010	0.010K	0.052	336265	1.43	1.18
	1450	030	0.010K	0.060	336266	0.41	0.67
91/09/16	1510	000	0.010K	0.040	386264		
	1520	010	0.010	0.052	386265		
	1530	030	0.010	0.059	386266		

GYS004
GRAYS HBR-CHEHALIS R AT STRD OIL
46 58 41.0 123 47 00.0 2F 0 Elev= 0 ft
53027 Washington Grays Harbor Co. PACIFIC NORTHWEST
COASTAL (Lower Chehalis-22) 131222
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/STREAM

INDEX 1312099
MILES 0001.40 . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/08	1405	000	14.6	8.0	82.8		16.1	39	0.9	10.21	0.270	0.010K
	1410	010	14.1	7.5	82.3		0.3			21.62	0.190	0.010K
90/11/12	1245	000	10.4	7.9	70.6	7.3	0.8	73S	0.2	0.58	0.550	0.010K
	1250	010	10.4	8.1	72.4	7.2	0.8			0.61	0.520	0.010K
91/01/28	0930	000	4.9	12.5	101.6	7.5	27.3	140	1.0	6.84	0.610	0.010K
	0935	010	6.1	10.7	97.4	7.9	0.9			19.68	0.320	0.010K
91/02/25	1025	000	7.3	11.6	96.6	7.1	23.2	43	1.0	0.37	0.660	0.010K
	1035	010	8.6	9.4	91.5	8.1	7.0			21.11	0.230	0.010K
91/03/26	0945	000	8.3	11.5	99.9	7.5	33.4	31	1.0	4.28	0.440	0.010K
	0955	010	9.0	9.6	93.9	8.1	0.2			19.91	0.160	0.010K
91/04/29	1150	000	10.3	9.3	83.0	7.1	1.7	37S	0.5	0.22	0.430	0.010K
	1155	010	10.2	10.4	92.3	7.0	0.6			0.29	0.410	0.010K
91/05/20	1015	000	12.6	9.6	92.8	7.4	33.7	40S	1.3	5.71	0.230	0.010K
	1025	010	12.1	8.6	87.8	7.7	0.4			16.55	0.210	0.010K
91/06/25	1120	000	15.2	8.5	88.3	7.6	32.2	120S	1.4	8.78	0.230	0.010K
	1130	010	14.8	7.9	83.8	7.6	11.0			13.64	0.190	0.010K
91/07/29	0950	000	19.4	7.4	81.7	7.2	5.0	9	0.6	4.78	0.240	0.010K
	1000	010	19.3	7.0	78.4	7.2	3.9			7.65	0.230	0.010K
91/08/26	1005	000						39	1.1		0.210	0.010K
	1015	010									0.200	0.010
91/09/30	1050	000	15.6	7.5	80.5	7.5	27.5	58X	1.7	11.88	0.250	0.010K
	1100	010	15.0	6.9	77.0	7.6	13.2			20.97	0.220	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/08	1405	000	0.090	0.020	416215	2.14	2.61
	1410	010	0.110	0.040	416216	3.45	10.90
90/11/12	1245	000	0.020	0.010K	466210	0.65	1.33
	1250	010	0.030	0.010K	466211	1.41	2.63
91/01/28	0930	000	0.070	0.020	56210	0.25	0.47
	0935	010	0.100	0.030	56211	1.93	3.81
91/02/25	1025	000	0.030	0.010	96210	0.75	0.73
	1035	010	0.080	0.030	96211	0.98	1.27
91/03/26	0945	000	0.030	0.010K	136210	0.25	0.49

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
91/03/26	0955	010	0.050	0.020	136211	1.79	3.11
91/04/29	1150	000	0.020	0.010K	186210	0.99	3.69
	1155	010	0.030	0.014	186211	1.96	4.68
91/05/20	1015	000	0.040	0.026	216210	0.50	2.40
	1025	010	0.050	0.023	216211	0.80	2.70
91/06/25	1120	000	0.050	0.014	266210	0.12	0.16
	1130	010	0.060	0.025	266211	0.06	0.45
91/07/29	0950	000	0.010	0.012	316210	15.60	14.50
	1000	010	0.020	0.020	316211	13.10	12.10
91/08/26	1005	000	0.060	0.018	356210		
	1015	010	0.080	0.027	356211		
91/09/30	1050	000	0.060	0.019	406210		
	1100	010	0.120	0.039	406211		

GYS008
GRAYS HARBOR AT MID SOUTH CHAN
46 56 15.0 123 54 43.0   2F 0   Elev=   0 ft
53027 Washington   Grays Harbor Co.   PACIFIC NORTHWEST
COASTAL (Lower Chehalis-22)   131222
21540000   Reach=   0.000   Drg=   0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/08	1425	000	13.7	7.6	84.7		11.1	4	0.8	25.27	0.140	0.010K
	1430	006	13.6	7.5	83.5		2.0			25.47	0.140	0.010K
91/01/28	1025	000	6.0	10.7	98.2	8.1	5.9	3	0.6	21.21	0.270	0.010K
	1035	007	6.1	10.5	98.0	8.2	7.9			23.25	0.240	0.010K
91/02/25	1050	000	7.9	10.5	93.7	7.8	15.5	5	0.8	10.74	0.430	0.010K
	1100	007	8.6	9.7	96.2	8.2	22.6			24.29	0.210	0.010K
91/03/26	1010	000	8.4	9.7	91.4	8.1	9.8	5	0.8	16.32	0.200	0.010K
	1020	007	8.8	9.4	92.3	8.3	29.5			21.61	0.110	0.010K
91/04/29	1225	000	11.4	10.1	99.0	7.7	1.4	2	0.5	12.60	0.260	0.010K
	1230	003	11.3	10.1	98.9	7.7	0.2			12.74	0.260	0.010K
91/05/20	1050	000	12.5	8.8	88.9	7.7	19.1	3X	0.6	14.41	0.130	0.010K
	1100	004	12.1	8.5	87.6	7.7	1.3			17.21	0.130	0.010K
91/06/25	1145	000	15.4	8.1	90.4	8.0	8.7	14	0.7	20.18	0.100	0.010K
	1155	006	15.4	8.2	91.9	8.0	2.3			20.79	0.090	0.010K
91/07/29	1015	000	18.6	6.4	76.4	7.6	10.1	6	1.0	21.06	0.100	0.010K
	1025	003	18.4	6.4	76.0	7.6	4.5			21.23		
91/08/26	1030	000	16.8	7.0	82.7	7.9	6.2	110X	0.6	25.32	0.050	0.010K
	1040	004	16.8	6.9	81.3	7.9	3.2			25.35	0.050	0.010K
91/09/30	1115	000	15.0	7.4	82.4	7.7	17.5	250X	1.1	21.65	0.220	0.010K
	1125	005	14.9	7.0	80.6	7.8	20.5			26.21	0.180	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/08	1425	000	0.070	0.040	416217	3.24	5.38
	1430	006	0.080	0.040	416218	3.00	5.70
91/01/28	1025	000	0.050	0.030	56214	1.05	2.10
	1035	007	0.050	0.030	56215	1.08	1.65
91/02/25	1050	000	0.050	0.020	96214	0.44	0.79
	1100	007	0.030	0.030	96215	0.75	0.92
91/03/26	1010	000	0.030	0.013	136214	1.20	1.67
	1020	007	0.020	0.013	136215	1.51	1.93
91/04/29	1225	000	0.060	0.017	186214	3.25	4.60
	1230	003	0.060	0.019	186215	4.19	6.91
91/05/20	1050	000	0.060	0.026	216214	2.10	2.80

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
91/05/20	1100	004	0.060	0.031	216215	3.30	6.60
91/06/25	1145	000	0.020	0.018	266214	0.36	0.54
	1155	006	0.010	0.018	266215	0.28	0.69
91/07/29	1015	000	0.050	0.034	316214	3.20	4.23
91/08/26	1030	000	0.050	0.022	356214		
	1040	004	0.040	0.035	356215		
91/09/30	1115	000	0.090	0.040	406214		
	1125	005	0.080	0.043	406215		

GYS009
GRAYS HARBOR AT MOON IS REACH
46 57 53.0 123 56 54.0 2F 0 Elev= 0 ft
53027 Washington Grays Harbor Co. PACIFIC NORTHWEST
COASTAL (Lower Chehalis-22) 131222
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/08	1440	000	14.3	7.9	89.2		19.8	3	1.0	25.52	0.110	0.010K
	1445	010	13.6	7.9	90.0		6.8			28.93	0.090	0.010K
90/11/12	1305	000	10.9	10.4	95.7	7.4	1.0	92S	0.2	3.73	0.470	0.010K
	1310	008	11.8	9.2	93.7	8.0	0.9			17.70	0.170	0.010K
91/01/28	1050	000	6.0	10.1	93.4	8.2	18.9	2	0.9	22.32	0.260	0.010K
	1100	010	6.4	10.1	96.8	8.3	5.2			26.10	0.190	0.010K
91/02/25	1110	000	7.9	11.1	99.6	8.0	29.7	9	1.0	10.66	0.450	0.010K
	1120	008	8.7	9.4	95.7	8.3	30.6			27.98	0.160	0.010K
91/03/26	1030	000	8.5	10.0	96.4	8.3	47.0	1	1.5	19.65	0.140	0.010K
	1050	010	8.9	9.4	95.1	8.4	42.5			25.13	0.050	0.010K
91/04/29	1250	000	11.7	8.2	83.6	8.0	6.5	2	0.6	17.12	0.170	0.010K
	1255	004	11.1	8.7	87.8	8.1	0.5			18.34	0.160	0.010K
91/05/20	1110	000	12.4	8.6	88.0	7.9	24.0	16S	1.0	15.99	0.140	0.010K
	1120	010	10.8	8.1	85.7	8.0	2.5			27.06	0.110	0.010K
91/06/25	1205	000	15.0	8.6	97.4	8.2	36.2	1U	1.5	23.75	0.080	0.010K
	1215	010	14.9	8.5	96.2	8.2	27.2			23.96	0.080	0.010K
91/07/29	1030	000	19.0	6.5	77.4	7.6	18.2	73X	1.0	19.15	0.120	0.010K
	1040	010	18.0	6.4	78.0	7.8	2.1			25.57	0.070	0.010K
91/08/26	1055	000	16.7	7.0	83.6	8.0	27.4	3J	1.5	26.92	0.080	0.010K
	1105	010	16.1	6.9	82.6	8.0	13.0			27.98	0.080	0.010K
91/09/30	1130	000	15.1	7.2	81.7	7.8	29.1	67X	1.4	23.91	0.210	0.010K
	1140	010	14.0	7.4	85.1	8.0	38.3			29.28	0.180	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/08	1440	000	0.070	0.040	416219	2.05	2.14
	1445	010	0.070	0.040	416220	1.36	2.78
90/11/12	1305	000	0.050	0.010K	466212	0.56	0.85
	1310	008	0.060	0.030	466213	2.04	2.97
91/01/28	1050	000	0.060	0.030	56212	1.17	1.05
	1100	010	0.020	0.030	56213	0.93	1.11
91/02/25	1110	000	0.050	0.020	96212	0.41	0.64
	1120	008	0.020	0.030	96213	0.98	1.14
91/03/26	1030	000	0.030	0.015	136212	1.13	0.98

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
91/03/26	1050	010	0.020	0.010	136213	2.25	1.68
91/04/29	1250	000	0.050	0.017	186212	3.50	4.42
	1255	004	0.040	0.016	186213	3.57	7.24
91/05/20	1110	000	0.080	0.029	216212	0.80	2.40
	1120	010	0.040	0.029	216213	2.20	4.60
91/06/25	1205	000	0.020	0.017	266212	0.24	0.24
	1215	010	0.020	0.016	266213	0.15	0.44
91/07/29	1030	000	0.070	0.035	316212	2.75	3.31
	1040	010	0.050	0.034	316213	2.93	6.42
91/08/26	1055	000	0.060	0.037	356212		
	1105	010	0.050	0.036	356213		
91/09/30	1130	000	0.150	0.048	406212		
	1140	010	0.070	0.031	406213		

GYS016
GRAYS HARBOR NEAR DAMON POINT
46 57 13.0 124 05 30.0 1F 0 Elev= 0 ft
53027 Washington Grays Harbor Co. PACIFIC NORTHWEST
Columbia River below Yakima River 131022
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/ESTURY

INDEX
MILES . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
91/01/28	1110	000	6.7	10.5	102.0	8.3	57.6		0.5	27.09		
	1120	009	6.8	10.2	99.4	8.3	56.8			27.13		
91/02/25	1135	000	8.5	10.3	100.8	8.2	38.2		1.5	21.66		
	1140	004	8.6	9.8	99.2	8.2	13.3			26.44		
91/03/26	1055	000	9.0	9.6	96.8	8.4	55.3		3.5	24.93		
	1105	008	8.8	9.6	98.0	8.4	50.8			27.19		
91/04/29	1325	000	11.4	7.7	82.5	8.3	30.3		1.6	26.51		
	1330	004	10.4	8.7	92.8	8.3	28.7			28.27		
91/05/20	1130	000	12.0	8.3	88.5	8.0	42.1		1.5	23.30		
	1140	006	11.8	8.1	87.3	8.0	29.5			25.72		
91/06/25	1225	000	13.6	9.2	103.9	8.4	56.8		2.5	27.64		
	1235	004	12.9	9.0	100.8	8.4	50.7			28.57		
91/07/29	1100	000	17.4	7.1	87.5	8.0	39.3		1.8	29.04		
	1110	002	17.4	7.1	86.8	8.0	39.0			29.12		
91/08/26	1125	000	14.3	7.2	84.0	8.1	37.6		1.7	30.78		
	1135	003	14.3	7.1	82.5	8.1	30.1			30.75		
91/09/30	1155	000	14.6	7.4	86.5	8.0	47.3		2.3	30.30		
	1205	005	13.5	7.7	88.7	8.1	55.1			30.91		

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L

HCB003
HOOD CANAL AT ELDON
47 32 17.0 123 00 30.0   2F 0   Elev=   0 ft
53045 Washington   Mason Co.   PACIFIC NORTHWEST
PUGET SOUND (Skokomisk/Dosewallips-16)   131116
21540000   Reach=   0.000   Drg=   0 sqmi
AMBNT/OCEAN

INDEX
MILES

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/12/05	1055	000	8.4	9.5	90.7	8.0	60.0	2	2.1	18.86	0.240	0.010K
	1110	010	9.6	8.1	84.4	7.9	79.8			27.80	0.270	0.010K
	1115	029	10.4	6.4	68.7	7.8	83.4			29.78	0.280	0.010K
91/01/29	1125	000	6.8	9.9	95.9	8.1	83.6	1K	11.5	26.34	0.350	0.010K
	1135	010	7.7	8.1	80.9	8.0	85.8			27.77	0.400	0.010K
	1145	030	9.3	6.5	68.1	7.9	86.6			29.63	0.430	0.010K
91/02/11	1105	000	7.9	11.7	107.1	8.2	65.6	1K	6.0	14.50	0.210	0.010K
	1110	010	8.0	8.9	90.3	8.0	85.0			28.55	0.380	0.010K
	1115	028	9.8	5.5	59.0	7.8	86.7			30.02	0.410	0.010K
91/03/11	1045	000	7.5	11.4	110.3	8.5	70.9	1K	5.0	24.01	0.140	0.010K
	1055	010	8.2	8.9	89.7	8.2	79.8			28.05	0.340	0.010K
	1105	030	8.3	7.1	72.9	8.0	82.9			29.38	0.410	0.010K
91/04/08	1100	000	8.6	10.0	97.7	7.9	71.3	1K	6.0	21.29	0.220	0.010K
	1110	010	8.6	8.7	88.6	8.0	85.3			28.30	0.250	0.010K
	1120	030	8.4	6.3	64.2	7.7	87.0			29.50	0.400	0.010K
91/05/06	1035	000	10.8	11.0	117.3	8.5	74.1	1K	5.4	26.94	0.040	0.010K
	1045	010	9.0	8.7	90.6	8.2	76.4			28.98	0.100	0.010K
	1055	022	8.5	7.0	71.6	8.0	86.3			29.24	0.390	0.010K
91/06/04	1055	000	13.3	10.6	118.3	8.4	78.6	1K	7.5	26.69	0.010K	0.010K
	1105	010	9.9	9.1	96.1	8.3	79.4			28.93	0.250	0.010K
	1110	024	8.8	6.0	62.1	7.9	86.1			29.36	0.430	0.010K
91/07/08	1100	000	19.1	8.6	106.7	8.2	74.7	1K	8.3	26.15	0.010K	0.010K
	1110	010	11.9	12.8	140.5	8.4	59.9			28.69	0.010K	0.010K
	1120	026	9.4	4.8	50.4	7.7	75.5			29.50	0.470	0.010K
91/08/05	1545	000	20.7	8.6	110.5	8.3	79.3	1K	8.5	25.76	0.010K	0.010K
	1555	010	11.8	12.3	135.5	8.4	73.1			29.16	0.120	0.010K
	1605	030	9.4	3.2	33.9	7.7	85.5			29.60	0.490	0.010K
91/09/09	1200	000	17.0	9.8	112.1	8.4	69.8	1K	5.5	19.12	0.010K	0.010K
	1205	010	12.0	7.4	82.2	8.1	83.1			29.21	0.290	0.010K
	1210	030	9.5	2.5	26.7	7.7	84.8			29.78	0.510	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/12/05	1055	000	0.010K	0.060	496304	0.28	0.22
	1110	010	0.010K	0.080	496305	0.15	0.21
	1115	029	0.010K	0.080	496306	0.07	0.07
91/01/29	1125	000	0.010K	0.070	56304	1.05	0.84
	1135	010	0.010K	0.080	56305	0.31	0.61
	1145	030	0.010K	0.090	56306	0.08	0.13
91/02/11	1105	000	0.010K	0.040	76304	2.45	2.36
	1110	010	0.010	0.080	76305	0.31	0.35
	1115	028	0.010K	0.090	76306	0.06	0.10
91/03/11	1045	000	0.010K	0.030	116304	8.73	5.39
	1055	010	0.010	0.070	116305	4.16	2.89
	1105	030	0.010K	0.080	116306	0.37	0.73
91/04/08	1100	000	0.020	0.051	156304	0.12	0.20
	1110	010	0.020	0.061	156305	0.73	0.98
	1120	030	0.010K	0.080	156306	0.10	0.11
91/05/06	1035	000	0.010K	0.019	196304	1.86	3.84
	1045	010	0.020	0.031	196305	7.99	10.10
	1055	022	0.010K	0.080	196306	0.35	1.56
91/06/04	1055	000	0.010K	0.014	236304	1.12	1.29
	1105	010	0.010K	0.056	236305	2.79	2.54
	1110	024	0.010K	0.088	236306	0.88	1.15
91/07/08	1100	000	0.010K	0.010K	286304	0.15	0.60
	1110	010	0.010K	0.010K	286305	0.74	1.37
	1120	026	0.010K	0.098	286306	0.08	0.85
91/08/05	1545	000	0.010K	0.015	326304	0.31	0.57
	1555	010	0.010K	0.038	326305	1.75	2.18
	1605	030	0.010K	0.101	326306	0.07	1.94
91/09/09	1200	000	0.010K	0.011	376304		
	1205	010	0.010K	0.068	376305		
	1210	030	0.010K	0.115	376306		

HCB004
HOOD CANAL AT SISTERS POINT
47 21 23.0 123 01 25.0 2F 0 Elev= 0 ft
53045 Washington Mason Co. PACIFIC NORTHWEST
PUGET SOUND (Kitsap-15) 131115
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/12/05	1030	000	8.3	9.9	96.1	7.9	45.8	4	1.7	21.58	0.240	0.010K
	1035	010	10.6	5.8	62.3	7.7	80.5			29.15	0.280	0.010K
	1040	030	10.9	3.8	41.3	7.7	69.7			30.05		
91/01/29	1105	000	5.6	12.6	115.5	8.2	72.4	1K	6.3	22.39	0.310	0.010K
	1115	010	8.8	8.8	89.6	7.9	81.8			27.03	0.390	0.010K
	1120	030	10.4	4.6	49.4	7.7	77.7			29.83		
91/02/11	1140	000	7.4	12.5	108.0	8.2	49.7	4	2.5	6.75	0.180	0.010K
	1145	010	8.7	8.4	86.3	7.9	86.5			28.26	0.390	0.010K
	1150	030	10.5	4.1	44.4	7.7	73.9			30.05		
91/03/11	1120	000	7.5	11.9	111.4	8.7	69.7	1K	5.0	18.39	0.010K	0.010K
	1130	010	9.6	6.1	63.9	7.9	86.1			29.05	0.410	0.010K
	1135	030	10.0	4.5	48.1	7.8	73.4			29.73		
91/04/08	1140	000	9.3	9.8	96.1	8.0	64.7	1K	5.0	20.34	0.110	0.010K
	1150	010	9.5	4.7	49.2	7.6	84.2			29.41	0.400	0.010K
	1200	030	9.8	3.7	39.4	7.5	64.0			29.68		
91/05/06	1115	000	12.9	11.3	122.7	8.6	75.8	1K	6.0	23.91	0.010K	0.010K
	1125	010	9.8	7.6	80.6	8.1	80.3			29.30	0.330	0.010K
	1135	030	9.7	3.3	35.0	7.7	76.4			29.65		
91/06/04	1130	000	15.0	9.9	112.7	8.4	73.7	1K	5.0	24.63	0.010K	0.010K
	1140	010	10.7	12.0	128.6	8.4	49.8			28.62	0.010K	0.010K
	1145	030	9.6	1.7	17.9	7.6	72.5			29.55		
91/07/08	1130	000	20.3	8.7	109.8	8.1	67.3	1K	5.5	24.97	0.010K	0.010K
	1140	010	11.8	11.7	127.8	8.2	50.3			28.73	0.030	0.010K
	1145	029	9.7	1.1	11.6	7.5	78.5			29.59		
91/08/05	1505	000	21.5	9.5	123.4	8.3	69.2	1K	4.5	25.53	0.010K	0.010K
	1515	010	10.6	5.2	55.5	7.9	79.0			29.34	0.010K	0.010K
	1520	030	9.6	0.8	8.0	7.5	67.8			29.69		
91/09/09	1230	000	18.2	9.2	107.4	8.4	62.2	1	4.8	18.68	0.010K	0.010K
	1235	010	11.8	5.8	63.8	8.1	81.7			28.78	0.240	0.010K
	1240	030	9.6	0.2	1.7	7.5	80.5			29.76		

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/12/05	1030	000	0.010	0.070	496302	0.60	0.58
	1035	010	0.010K	0.100	496303	0.19	0.16
91/01/29	1105	000	0.010K	0.060	56302	1.48	1.31
	1115	010	0.010K	0.080	56303	0.08	1.59
91/02/11	1140	000	0.010	0.020	76302	2.91	2.15
	1145	010	0.010	0.080	76303	0.40	1.09
91/03/11	1120	000	0.010K	0.010K	116302	3.31	2.73
	1130	010	0.010	0.090	116303	1.22	1.25
91/04/08	1140	000	0.010K	0.022	156302	0.39	0.45
	1150	010	0.010K	0.093	156303	0.19	0.24
91/05/06	1115	000	0.010K	0.010K	196302	0.68	0.74
	1125	010	0.030	0.088	196303	3.52	3.10
91/06/04	1130	000	0.010K	0.015	236302	1.15	1.13
	1140	010	0.010K	0.028	236303	46.70	43.80
91/07/08	1130	000	0.010K	0.020	286302	0.90	1.04
	1140	010	0.010K	0.036	286303	8.17	10.30
91/08/05	1505	000	0.010K	0.014	326302	0.61	0.63
	1515	010	0.010K	0.014	326303	1.11	0.69
91/09/09	1230	000	0.010K	0.030	376302		
	1235	010	0.010	0.090	376303		

HCB006
HOOD CANAL NEAR KING SPIT
47 44 52.0 122 43 49.0   2F 0   Elev=   0 ft
53035 Washington   Kitsap Co.   PACIFIC NORTHWEST
PUGET SOUND (Kitsap-15)   131115
21540000 Reach=   0.000   Drg=   0 sqmi
AMBNT/STREAM

INDEX
MILES . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/15	1610	000	11.4	6.9	75.7		77.6	1K	7.0	29.96	0.270	0.010K
	1615	010	11.5	6.2	68.3		78.4			30.15	0.300	0.010K
	1620	030	11.4	5.5	60.6		80.3			30.49	0.320	0.020
90/12/05	1130	000	8.9	9.2	92.9	8.0	66.8	1K	3.6	25.54	0.260	0.010K
	1135	010	9.3	8.4	86.7	8.0	72.1			27.38	0.270	0.010K
	1140	027	9.7	7.3	77.0	7.9	71.8			29.29	0.280	0.010K
91/01/29	1200	000	7.1	7.2	71.3	8.1	83.9	1K	8.5	28.51	0.400	0.010K
	1210	010	7.5	7.4	74.2	8.0	82.0			28.92	0.410	0.010K
	1220	030	8.0	8.1	82.4	8.0	75.8			29.40	0.420	0.010K
91/02/11	1020	000	8.0	10.6	101.6	8.1	75.8	1	5.5	21.42	0.330	0.010K
	1025	010	8.1	8.2	82.9	8.0	81.3			28.91	0.390	0.010K
	1030	028	8.2	7.4	76.0	8.0	82.3			29.55	0.400	0.010K
91/03/11	1005	000	7.8	12.7	124.4	8.6	59.2	1K	3.0	25.11	0.020	0.010K
	1015	010	8.0	9.5	96.4	8.2	78.8			28.70	0.280	0.010K
	1025	030	8.1	7.4	75.6	8.0	77.0			29.43	0.390	0.010K
91/04/08	1005	000	8.5	11.5	115.4	8.0	79.4	1K	8.0	26.37	0.220	0.010K
	1015	010	8.4	8.2	83.8	8.0	83.2			28.46	0.260	0.010K
	1025	026	8.2	7.9	80.3	8.0	80.6			29.50	0.290	0.010K
91/05/06	1005	000	11.9	11.8	128.0	8.6	67.1	1K	4.0	26.52	0.010K	0.010K
	1015	010	10.3	10.4	110.2	8.4	68.1			28.43	0.080	0.010K
	1025	018	9.2	9.0	94.0	8.2	70.1			29.48	0.250	0.010K
91/06/04	1020	000	11.6	9.3	101.6	8.2	81.7	1K	8.3	28.71	0.180	0.010K
	1030	010	10.3	8.4	89.7	8.2	79.8			29.31	0.220	0.010K
	1040	030	9.5	7.0	73.7	8.0	80.1			29.69	0.310	0.010K
91/07/08	1020	000	15.3	10.8	126.6	8.3	68.6	1K	5.3	28.32	0.010K	0.010K
	1030	010	11.2	9.5	103.6	8.2	71.8			29.29	0.180	0.010K
	1040	030	9.6	5.8	61.5	7.9	79.9			29.85	0.350	0.010K
91/08/05	1630	000	18.3	10.3	128.3	8.4	65.9	1K	4.0	28.23	0.010K	0.010K
	1640	010	14.2	10.9	125.4	8.4	56.7			29.17	0.020	0.010K
	1650	030	11.1	6.3	68.9	8.0	78.2			29.90	0.340	0.010K
91/09/09	1130	000	14.7	8.9	102.8	8.3	67.9	1K	6.5	27.83	0.080	0.010K
	1135	010	12.1	6.8	75.5	8.1	78.3			29.59	0.260	0.010K
	1140	030	11.1	5.3	57.8	8.0	77.0			30.07	0.370	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/15	1610	000	0.020	0.070	426253	2.67	1.89
	1615	010	0.030	0.080	426254	1.60	1.35
	1620	030	0.030	0.080	426255	0.95	0.95
90/12/05	1130	000	0.010K	0.080	496307	0.22	0.19
	1135	010	0.010	0.080	496308	0.28	0.30
	1140	027	0.010K	0.080	496309	0.16	0.30
91/01/29	1200	000	0.010K	0.080	56307	0.30	0.32
	1210	010	0.010K	0.080	56308	0.26	0.30
	1220	030	0.010K	0.080	56309	0.19	0.23
91/02/11	1020	000	0.010K	0.060	76307	0.58	0.47
	1025	010	0.010K	0.080	76308	0.36	0.35
	1030	028	0.010K	0.080	76309	0.15	0.24
91/03/11	1005	000	0.010K	0.010	116307	24.70	15.00
	1015	010	0.010	0.060	116308	4.31	4.88
	1025	030	0.010K	0.080	116309	0.45	0.48
91/04/08	1005	000	0.020	0.049	156307	0.85	1.03
	1015	010	0.020	0.055	156308	0.68	0.91
	1025	026	0.020	0.062	156309	0.08	0.19
91/05/06	1005	000	0.020	0.010K	196307	3.74	3.11
	1015	010	0.020	0.025	196308	4.27	5.58
	1025	018	0.040	0.054	196309	1.19	2.46
91/06/04	1020	000	0.010K	0.042	236307	1.28	1.40
	1030	010	0.010	0.049	236308	1.39	1.97
	1040	030	0.030	0.068	236309	0.18	0.82
91/07/08	1020	000	0.010K	0.010K	286307	2.29	3.10
	1030	010	0.010K	0.041	286308	7.12	11.60
	1040	030	0.020	0.075	286309	0.33	0.71
91/08/05	1630	000	0.010K	0.010	326307	1.92	4.11
	1640	010	0.010K	0.019	326308	10.80	7.00
	1650	030	0.020	0.070	326309	0.53	0.71
91/09/09	1130	000	0.010K	0.042	376307		
	1135	010	0.010K	0.059	376308		
	1140	030	0.010	0.078	376309		

HCB007
HOOD CANAL AT INNER LYNCH COVE
47 23 54.0 122 55 42.0 2F000 Elev= 0 ft
53045 Washington Mason Co. PACIFIC NORTHWEST
PUGET SOUND (Kitsap-15) 131115
21540000 Reach=17110018000 0.000 Drg= 0 sqmi
AMBNT/OCEAN

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/12/05	0945	000	6.8	11.1	100.8	8.0	63.4	2	4.2	16.81	0.230	0.010K
	1010	010	10.6	7.1	76.2	7.7	82.5			29.10	0.270	0.010K
91/01/29	1030	000	6.5	9.9	94.5	8.1	78.9	4	8.0	25.22	0.340	0.010K
	1040	010	9.5	7.9	82.3	7.8	83.8			28.16	0.400	0.010K
91/02/11	1205	000	8.0	12.6	112.7	8.3	41.5	4	0.2	9.87	0.150	0.010K
	1210	010	9.8	6.9	72.7	7.8	88.7			29.11	0.400	0.010K
91/03/11	1155	000	7.4	12.0	110.5	8.8	65.4	1K	4.4	16.73	0.010K	0.010K
	1205	010	9.7	5.5	57.5	7.8	85.8			28.96	0.410	0.010
91/04/08	1210	000	9.8	10.0	99.7	8.1	63.8	2	3.5	20.78	0.110	0.010K
	1220	010	9.9	3.3	34.8	7.5	82.6			29.49	0.410	0.010K
91/05/06	1155	000	13.7	10.6	116.3	8.6	79.1	1K	7.3	23.50	0.010K	0.010K
	1205	010	10.1	10.2	108.0	8.2	74.5			28.95	0.230	0.010K
91/06/04	1325	000	15.0	10.0	113.5	8.4	77.2	1K	5.5	24.09	0.010K	0.010K
	1335	010	12.1	13.0	142.6	8.5	61.3			27.82	0.010K	0.010K
91/07/08	1200	000	21.1	8.3	105.8	8.1	66.2	1K	4.2	24.76	0.010K	0.010K
	1210	010	11.8	12.0	131.8	8.4	20.7			28.78	0.010K	0.010K
91/08/05	1440	000	21.9	9.2	119.8	8.3	77.3	1K	5.0	25.75	0.010K	0.010K
	1445	010	10.6	5.1	54.7	7.7	82.7			29.38	0.310	0.010K
91/09/09	1355	000	18.5	9.4	110.3	8.3	62.5	1K	4.5	18.99	0.010K	0.010K
	1400	010	11.7	6.5	71.3	8.0	70.5			29.10	0.090	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/12/05	0945	000	0.060	0.060	496300	1.13	1.11
	1010	010	0.010K	0.100	496301	0.19	0.28
91/01/29	1030	000	0.010K	0.070	56300	1.69	1.09
	1040	010	0.010K	0.090	56301	0.73	0.63
91/02/11	1205	000	0.010K	0.020	76300	8.84	5.23
	1210	010	0.010	0.100	76301	0.25	0.35
91/03/11	1155	000	0.010K	0.010K	116300	2.47	1.99
	1205	010	0.020	0.090	116301	1.57	1.43
91/04/08	1210	000	0.010K	0.019	156300	0.73	0.70
	1220	010	0.010K	0.101	156301	0.15	0.25
91/05/06	1155	000	0.010K	0.010K	196300	0.68	1.10
	1205	010	0.030	0.074	196301	5.14	7.55
91/06/04	1325	000	0.010K	0.021	236300	0.40	0.60
	1335	010	0.010K	0.022	236301	13.90	19.40

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
91/07/08	1200	000	0.010K	0.029	286300	0.72	1.01
	1210	010	0.010K	0.043	286301	24.30	18.30
91/08/05	1440	000	0.010K	0.016	326300	0.56	0.47
	1445	010	0.040	0.124	326301	0.33	0.85
91/09/09	1355	000	0.010K	0.034	376300		
	1400	010	0.020	0.109	376301		

JDF005
ST OF JUAN DE FUCA IN SEQUIM BAY
48 03 40.0 123 01 47.0 1F 0 Elev= 0 ft
53009 Washington Clallam Co. PACIFIC NORTHWEST
PUGET SOUND (Quilcene/Snow-17) 131117
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/11/20	1050	000	9.4	7.3	77.4	8.2	85.4		13.5	30.95	0.230	0.010K
	1055	010	9.5	7.2	76.5	8.2	85.6			31.06	0.230	0.010K
	1100	030	9.7	5.7	61.0	8.0	82.6			31.46		
90/12/11	1045	000	7.9	8.5	86.2	8.0	72.9	1	6.3	29.36	0.240	0.010K
	1055	010	8.6	7.6	79.0	8.0	80.6			30.61	0.240	0.010K
	1100	030	8.7	7.4	77.1	8.0	78.0			30.65		
91/01/29	1330	000	6.6	8.4	83.6	8.1	81.5	1K	8.8	30.70	0.360	0.010K
	1340	010	6.6	8.2	81.6	8.1	81.5			30.70	0.360	0.010K
	1350	026	6.6	8.0	79.6	8.1	80.6			30.73		
91/02/26	1055	000	7.6	8.4	77.0	8.1	79.5	1U	8.0	15.33	0.340	0.010K
	1105	010	7.6	7.9	80.2	8.1	79.7			30.45	0.340	0.010K
	1110	029	7.6	7.6	77.5	8.1	76.6			30.68		
91/03/18	1055	000	8.4	11.7	121.0	8.4	69.4	1K	5.4	30.61	0.120	0.010K
	1105	010	7.8	10.0	102.0	8.3	77.0			30.75	0.250	0.010K
	1110	029	7.8	8.6	88.0	8.2	79.0			30.87		
91/04/15	1200	000	10.6	14.0	151.3	8.5	56.8	1K	3.4	30.49	0.010K	0.010K
	1210	010	8.8	11.1	116.0	8.2	73.0			30.81	0.130	0.010K
	1215	030	8.4	8.5	88.1	8.1	77.5			30.99		
91/05/13	1105	000	11.5	12.0	132.8	8.5	69.7	1K	7.2	30.55	0.050	0.010K
	1115	010	10.1	9.9	106.5	8.3	80.2			30.77	0.180	0.010K
	1120	024	9.8	7.4	79.2	8.2	83.1			31.07		
91/06/10	1040	000	13.9	12.4	143.7	8.6	71.7	1K	5.0	30.64	0.010K	0.010K
	1050	010	10.8	11.4	124.4	8.4	77.8			30.91	0.160	0.010K
	1055	023	10.3	8.4	90.8	8.2	61.2			30.98		
91/07/15	1100	000	14.0	11.7	136.0	8.4	67.4	1K	5.0	30.54	0.010K	0.010K
	1110	010	11.4	8.2	90.3	8.1	82.5			30.88	0.160	0.010K
	1115	027	11.1	7.1	78.3	8.1	78.4			30.94		
91/08/12	1050	000	14.5	13.2	155.3	8.6	75.9	1	5.5	31.02	0.020	0.010K
	1100	010	11.5	8.2	91.0	8.2	84.1			31.23	0.190	0.010K
	1110	028	10.9	7.3	79.8	8.2	79.6			31.30		
91/09/16	1120	000	13.7	12.5	145.0	8.5	33.8	1K	2.5	31.40	0.010K	0.010K
	1130	010	11.3	8.7	96.8	8.2	68.3			31.46	0.160	0.010K
	1135	030	10.8	6.0	65.7	8.0	80.1			31.52		

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/11/20	1050	000	0.020	0.060	476252	0.69	0.48
	1055	010	0.040	0.060	476253	0.45	0.29
90/12/11	1045	000	0.030	0.070	506252	0.39	0.55
	1055	010	0.040	0.070	506253	0.11	0.25
91/01/29	1330	000	0.020	0.070	56252	0.60	0.48
	1340	010	0.010	0.070	56253	0.54	0.56
91/02/26	1055	000	0.010	0.050	96252	0.85	0.53
	1105	010	0.020	0.050	96253	1.05	0.65
91/03/18	1055	000	0.010	0.030	126252	7.41	5.48
	1105	010	0.010	0.050	126253	5.23	5.18
91/04/15	1200	000	0.010K	0.010K	166252	6.16	3.81
	1210	010	0.010	0.032	166253	8.02	5.63
91/05/13	1105	000	0.010K	0.025	206252	3.00	2.10
	1115	010	0.040	0.051	206253	3.00	3.10
91/06/10	1040	000	0.010K	0.011	246252	4.50	3.44
	1050	010	0.010	0.042	246253	5.59	6.05
91/07/15	1100	000	0.010K	0.011	296252	1.42	1.47
	1110	010	0.060	0.053	296253	1.51	1.94
91/08/12	1050	000	0.010K	0.017	336252	2.87	2.85
	1100	010	0.060	0.057	336253	0.74	0.49
91/09/16	1120	000	0.010	0.026	386252		
	1130	010	0.010	0.053	386253		

JDF007
SEQUIM BAY OFF GOOSE POINT
48 02 55.0 123 00 30.0 2F000 Elev= 0 ft
53009 Washington Clallam Co. PACIFIC NORTHWEST
PUGET SOUND (Quilcene/Snow-17) 131117
21540000 Reach=17110020000 0.000 Drg= 0 sqmi
AMBNT/OCEAN

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/11/20	1035	000	9.1	7.6	80.0	8.2	84.4			30.93		
	1045	010	9.2	7.4	78.1	8.2	85.1			31.01		
90/12/11	1110	000	8.1	8.0	81.7	8.0	73.0			29.71		
	1115	010	8.6	7.7	80.0	8.0	82.0			30.57		
91/01/29	1400	000	6.0	9.3	91.1	8.2	82.0		9.5	30.44		
	1410	010	6.5	8.7	86.3	8.1	82.0			30.60		
91/02/26	1135	000	7.8	9.4	95.2	8.1	76.6		8.5	29.77		
	1145	010	7.7	8.4	85.6	8.1	80.6			30.48		
91/03/18	1120	000	8.9	16.1	168.3	8.7	48.9		2.5	30.44		
	1130	010	7.7	10.1	102.7	8.2	78.6			30.68		
91/04/15	1220	000	11.1	14.4	157.5	8.5	65.7		3.3	30.40		
	1225	010	8.8	11.5	120.4	8.2	66.4			30.80		
91/05/13	1125	000	12.2	10.9	121.5	8.4	73.0		6.5	30.54		
	1135	010	10.2	9.8	105.1	8.3	85.1			30.79		
91/06/10	1100	000	14.3	11.7	136.5	8.5	60.6			30.52		
	1110	010	10.7	10.5	114.2	8.3	66.3			30.80		
91/07/15	1125	000	13.2	9.6	109.0	8.2	68.9		3.0	30.60		
	1135	010	11.3	7.7	84.3	8.1	82.9			30.91		
91/08/12	1115	000	14.6	11.8	139.2	8.5	76.1		4.0	30.97		
	1120	010	11.5	7.7	85.1	8.2	86.9			31.25		
91/09/16	1140	000	14.7	14.1	167.1	8.6	33.0		2.0	31.24		
	1150	010	11.0	7.9	86.3	8.1	81.5			31.51		

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L

LOP001
LOPEZ ISLAND AT DECATUR ISLAND
48 38 35.0 122 52 56.0 2F000 Elev= 0 ft
53055 Washington San Juan Co. PACIFIC NORTHWEST
PUGET SOUND (San Juan-02) 131102
21540000 Reach=17110003000 0.000 Drg= 0 sqmi
AMBNT/OCEAN

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/11/20	1240	000	9.5	7.3	77.2	8.1	72.5		5.0	30.29	0.300	0.010K
	1250	010	9.5	7.2	76.1	8.1	70.3			30.29	0.300	0.010K
90/12/12	1110	000	8.7	8.0	82.8	8.0	74.3	1K	5.5	29.68	0.260	0.010K
	1120	010	8.8	7.9	82.0	8.0	72.3			29.74	0.260	0.010K
91/02/26	1235	000	8.1	8.8	89.6	8.1	73.5	1U	5.5	29.50	0.380	0.010K
	1245	010	7.5	8.7	87.3	8.1	71.3			29.63	0.380	0.010K
91/03/18	1415	000	8.9	8.9	93.0	8.1	82.0	1K	6.5	29.60	0.360	0.010K
	1425	010	7.6	9.0	91.2	8.1	73.7			29.86	0.360	0.010K
91/04/15	1500	000	10.2	8.9	95.1	8.0	79.5	1K	6.5	29.54	0.300	0.010K
	1510	010	8.4	9.0	92.9	8.0	68.5			29.88	0.300	0.010K
91/05/13	1425	000	10.0	8.9	94.7	8.2	75.1	1K	5.5	30.08	0.270	0.010K
	1435	010	9.3	8.8	93.0	8.2	71.1			30.12	0.270	0.010K
91/06/10	1225	000	12.1	11.5	126.2	8.5	68.0	1J	4.7	27.87	0.020	0.010K
	1235	010	10.3	9.7	103.3	8.3	64.5			28.95	0.220	0.010K
91/07/15	1425	000	11.1	7.5	81.8	8.1	75.2	1K	6.5	29.71	0.250	0.010K
	1435	010	10.5	6.4	69.1	8.0	63.5			29.91	0.280	0.010K
91/08/12	1400	000	11.4	7.1	77.7	8.1	78.2	1K	7.0	29.97	0.280	0.010K
	1410	010	10.7	6.3	68.3	8.1	68.1			30.15	0.300	0.010K
91/09/16	1430	000	12.5	8.7	97.0	8.2	76.0	1K	6.2	29.62	0.170	0.010K
	1440	010	11.5	8.0	87.5	8.2	78.2			29.67	0.200	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/11/20	1240	000	0.010	0.070	476260	0.26	0.51
	1250	010	0.010K	0.070	476261	0.29	0.52
90/12/12	1110	000	0.020	0.070	506260	0.14	0.34
	1120	010	0.010	0.070	506261	0.10	0.34
91/02/26	1235	000	0.010K	0.060	96260	0.29	0.18
	1245	010	0.010	0.060	96261	0.32	0.35
91/03/18	1415	000	0.010	0.070	126260	0.27	0.35
	1425	010	0.010K	0.070	126261	0.37	0.42
91/04/15	1500	000	0.010	0.058	166260	0.35	0.42
	1510	010	0.020	0.058	166261	1.14	1.01
91/05/13	1425	000	0.010K	0.053	206260	1.00	1.00
	1435	010	0.020	0.057	206261	1.10	1.20
91/06/10	1225	000	0.010K	0.016	246260	8.52	8.80
	1235	010	0.010	0.043	246261	5.08	6.31

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
91/07/15	1425	000	0.010	0.051	296260	1.70	2.17
	1435	010	0.020	0.059	296261	1.04	1.27
91/08/12	1400	000	0.020	0.055	336260	0.63	0.81
	1410	010	0.020	0.060	336261	1.25	1.41
91/09/16	1430	000	0.010K	0.049	386260		
	1440	010	0.010	0.055	386261		

NRR001
TACOMA NARROWS NR POINT DEFIANCE
47 19 00.0 122 32 55.0 2F 0 Elev= 0 ft
53053 Washington Pierce Co. PACIFIC NORTHWEST
PUGET SOUND (Chambers/Clover-12) 131112
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/22	1320	000	12.2	5.7	63.8		82.3	1	10.4	30.44	0.330	0.010K
	1325	010	12.3	5.7	63.9		82.1			30.44	0.330	0.010K
	1330	030	12.1	5.7	63.6		82.5			30.43	0.330	0.010K
90/12/11	1200	000	10.6	7.1	76.5	7.9	79.4	1K	7.5	29.62	0.260	0.010K
	1205	010	10.6	7.0	75.4	7.9	78.7			29.64	0.260	0.010K
	1210	030	10.7	6.7	72.4	7.9	77.5			29.76	0.260	0.010K
91/02/05	1500	000	8.0	8.7	87.9	8.0	78.4	14	6.5	28.50	0.420	0.010K
	1510	010	8.0	8.6	86.9	8.0	79.0			28.67	0.420	0.010K
	1520	025	8.0	8.5	85.6	8.0	79.0			28.68	0.420	0.010K
91/03/04	1615	000	7.9	8.2	83.1	8.1	78.1	1	8.5	29.13	0.410	0.010K
	1625	010	7.9	8.2	82.9	8.1	79.7			29.12	0.410	0.010K
	1635	029	7.9	8.1	81.5	8.1	79.5			29.19	0.410	0.010K
91/04/22	1555	000	8.9	9.7	99.7	8.1	77.1	1K	6.5	28.00	0.300	0.010K
	1605	010	8.9	9.6	98.2	8.1	77.6			28.06	0.300	0.010K
	1615	030	8.8	9.3	96.0	8.1	77.7			28.10	0.300	0.010K
91/05/28	1410	000	9.2	9.1	95.1	8.1	79.6	1K	8.0	29.22	0.300	0.010K
	1420	010	9.2	9.1	95.3	8.1	79.6			29.20	0.290	0.010K
	1430	030	9.2	8.8	92.3	8.1	79.6			29.21	0.310	0.010K
91/06/17	1520	000	10.4	8.7	92.9	8.2	83.4	2	9.1	29.03	0.200	0.010
	1525	010	10.4	8.6	91.9	8.2	83.3			29.03	0.210	0.010
	1530	030	10.3	8.6	91.7	8.2	83.4			29.09	0.180	0.010
91/07/22	1530	000	10.5	6.6	70.7	8.0	82.6	1	9.0	29.91	0.180	0.010K
	1540	010	10.4	6.5	70.2	8.0	83.1			29.90	0.200	0.010K
	1600	030	10.4	6.4	68.5	8.0	83.1			29.90	0.220	0.010K
91/08/19	1645	000	12.7	8.0	89.3	8.1	78.9	1K	10.0	29.66	0.220	0.010K
	1655	010	12.2	7.5	83.4	8.1	83.4			29.76	0.240	0.010K
	1705	030	11.4	6.7	73.1	8.1	85.4			29.98	0.300	0.010K
91/09/23	1435	000	12.1	6.9	76.8	8.1	77.4	1K	5.5	30.20	0.210	0.010K
	1440	010	12.1	6.8	75.9	8.1	77.4			30.21	0.230	0.010K
	1450	030	12.0	6.7	74.8	8.1	77.6			30.24	0.220	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/22	1320	000	0.010	0.080	436312	0.76	0.59
	1325	010	0.010	0.080	436313	0.76	0.61
	1330	030	0.020	0.080	436314	0.80	0.60
90/12/11	1200	000	0.020	0.080	506254	0.09	0.15
	1205	010	0.010	0.080	506255	0.07	0.17
	1210	030	0.010	0.080	506256	0.06	0.21
91/02/05	1500	000	0.010	0.080	66254	0.20	0.29
	1510	010	0.010K	0.080	66255	0.22	0.23
	1520	025	0.010	0.080	66256	0.15	0.20
91/03/04	1615	000	0.010K	0.080	106254	0.12	0.11
	1625	010	0.010K	0.180	106255	0.25	0.19
	1635	029	0.010K	0.080	106256	0.22	0.13
91/04/22	1555	000	0.010K	0.063	176254	3.01	2.04
	1605	010	0.010	0.066	176255	1.05	3.95
	1615	030	0.010	0.064	176256	2.73	2.07
91/05/28	1410	000	0.020	0.057	226254	2.20	2.90
	1420	010	0.020	0.055	226255	2.60	2.40
	1430	030	0.020	0.056	226256	1.70	2.50
91/06/17	1520	000	0.030	0.047	256254	0.05K	0.05K
	1525	010	0.030	0.055	256255	0.05K	0.05K
	1530	030	0.020	0.043	256256	0.05K	0.05K
91/07/22	1530	000	0.020	0.050	306254	1.58	3.37
	1540	010	0.020	0.057	306255	2.02	2.03
	1600	030	0.020	0.059	306256	1.25	1.46
91/08/19	1645	000	0.010	0.066	346254		
	1655	010	0.010	0.063	346255		
	1705	030	0.010K	0.067	346256		
91/09/23	1435	000	0.010	0.058	396254		
	1440	010	0.010	0.066	396255		
	1450	030	0.010	0.061	396256		

NSQ001
NISQUALLY REACH AT NISQUALLY R
47 06 45.0 122 41 50.0 2F 0 Elev= 0 ft
53067 Washington Thurston Co. PACIFIC NORTHWEST
PUGET SOUND (Nisqually-11) 131111
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/08	1125	000	13.1	6.7	75.0		21.8	3	1.2	27.73	0.200	0.010K
	1130	010	13.0	6.1	69.2		80.1			30.13	0.230	0.010
91/01/08	1220	000	8.0	9.1	89.7	8.0	62.4	11		24.95	0.440	0.010K
	1230	010	8.7	8.2	84.5	7.9	80.7			28.99	0.450	0.010K
91/02/11	1430	000	7.9	8.8	88.9	8.0	78.5	1	6.5	27.96	0.420	0.010K
	1435	010	8.0	8.4	85.3	8.0	80.1			26.63	0.420	0.010K
91/03/11	1430	000	7.4	10.5	102.8	8.3	66.5	8	3.5	25.74	0.380	0.010K
	1440	010	7.9	8.6	86.8	8.1	82.6			27.91	0.420	0.010K
91/04/08	1350	000	8.1	11.0	103.2	8.1	22.5	23S	1.2	17.63	0.290	0.010K
	1400	010	8.3	9.3	93.8	8.0	84.1			28.01	0.310	0.010K
91/05/06	1325	000	10.7	13.1	138.3	8.5	57.6	1K	3.2	25.92	0.050	0.010K
	1330	010	9.8	12.3	128.5	8.4	68.0			27.94	0.140	0.010K
	1335	030	9.3	10.1	104.8	8.3	75.5			28.26	0.215	0.010K
91/06/04	1500	000	12.6	12.6	136.1	8.5	31.9	1	3.5	23.89	0.060	0.010K
	1510	010	10.6	11.2	119.7	8.4	74.3			28.46	0.120	0.010K
91/07/08	1430	000	14.4	10.2	117.4	8.2	76.3	1K	7.8	28.80	0.100	0.010K
	1440	010	11.3	8.7	94.9	8.1	82.1			29.19	0.130	0.010K
91/08/05	1155	000	13.2	8.8	99.6	8.2	82.8	1K	10.5	29.28	0.170	0.010K
	1200	010	12.8	8.3	93.3	8.1	84.1			29.35	0.190	0.010K
91/09/09	1540	000	13.7	7.9	90.0	8.2	60.3	1K	8.5	29.58	0.210	0.010K
	1545	010	12.7	7.3	82.7	8.2	81.5			29.80	0.240	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/08	1125	000	0.030	0.060	416204	0.26	0.51
	1130	010	0.020	0.070	416205	0.28	0.54
91/01/08	1220	000	0.010	0.070	26205	0.12	0.32
	1230	010	0.010	0.080	26206	0.19	0.26
91/02/11	1430	000	0.010	0.080	76205	0.38	0.39
	1435	010	0.010	0.080	76206	0.20	0.23
91/03/11	1430	000	0.020	0.060	116205	0.45	0.60
	1440	010	0.010K	0.080	116206	0.42	0.47
91/04/08	1350	000	0.020	0.028	156205	0.39	0.66
	1400	010	0.020	0.058	156206	0.27	0.46

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
91/05/06	1325	000	0.010K	0.023	196205	10.20	11.60
	1330	010	0.010	0.032	196206	12.20	11.60
	1335	030	0.020	0.046	196207	6.20	10.60
91/06/04	1500	000	0.010	0.023	236205	4.28	3.65
	1510	010	0.040	0.032	236206	7.89	7.00
91/07/08	1430	000	0.020	0.035	286205	4.85	3.55
	1440	010	0.030	0.040	286206	2.93	3.40
91/08/05	1155	000	0.030	0.050	326205	2.86	3.23
	1200	010	0.050	0.053	326206	1.81	1.85
91/09/09	1540	000	0.020	0.064	376205		
	1545	010	0.020	0.065	376206		

OAK004
OAKLAND BAY NEAR EAGLE POINT
47 12 49.0 123 04 35.0 2F 0 Elev= 0 ft
53045 Washington Mason Co. PACIFIC NORTHWEST
PUGET SOUND (Kennedy/Goldsboro-14) 131114
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/08	1305	000	14.7	6.6	76.6		67.2	4	3.6	28.52	0.160	0.010
	1310	010	14.4	6.6	76.3		65.4			28.83	0.160	0.010
90/12/11	1425	000	8.1	9.8	91.6	7.9	53.8	73	2.5	16.57	0.260	0.010K
	1435	010	9.0	8.6	85.3	7.9	65.2			22.57	0.280	0.010K
91/01/08	1035	000	4.7	11.3	100.3	8.0	53.7	79	3.0	20.90	0.390	0.010K
	1045	010	5.4	10.2	95.0	8.0	66.6			25.34	0.450	0.010K
91/02/11	1340	000	7.7	10.0	95.0	8.0	71.6	3	4.5	19.75	0.370	0.010K
	1345	010	7.7	9.4	91.1	8.0	70.0			24.21	0.410	0.010K
91/03/11	1525	000	7.1	10.7	96.7	8.1	70.5	1	4.0	15.06	0.290	0.010K
	1535	008	7.9	9.3	89.9	8.0	75.9			22.99	0.390	0.010K
91/04/08	1500	000	8.9	11.3	103.3	8.1	42.1	6	2.1	10.56	0.120	0.010K
	1510	007	9.2	10.5	102.8	8.2	58.9			20.35	0.140	0.010K
91/05/06	1420	000	13.4	11.9	128.3	8.5	63.1	21	3.5	20.95	0.010K	0.010K
	1425	008	12.3	12.3	133.2	8.5	62.1			24.72	0.010K	0.010K
91/06/04	0945	000	14.1	9.7	108.4	8.2	55.6	7	2.5	24.46	0.040	0.010K
	0955	010	13.3	10.0	111.1	8.2	67.5			26.12	0.050	0.010K
91/07/08	0940	000	19.1	6.5	80.7	8.0	52.9	1	2.5	25.88	0.010K	0.010K
	0950	003	17.9	8.0	98.1	8.0	43.1			26.92	0.030	0.010K
91/08/05	1730	000	19.1	9.7	122.1	8.2	64.0	1K	4.5	27.59	0.010K	0.010K
	1740	007	18.1	9.7	119.6	8.2	74.4			28.08	0.030	0.010K
91/09/09	1040	000	16.8	7.0	84.6	8.0	54.2	17	3.5	27.71	0.120	0.010K
	1050	010	16.6	7.1	85.4	8.0	66.3			28.05	0.110	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/08	1305	000	0.080	0.090	416213	1.09	1.03
	1310	010	0.080	0.090	416214	1.10	1.85
90/12/11	1425	000	0.040	0.050	506269	0.21	0.48
	1435	010	0.040	0.070	506270	0.20	0.49
91/01/08	1035	000	0.040	0.060	26269	0.49	0.55
	1045	010	0.030	0.080	26270	0.33	0.57
91/02/11	1340	000	0.040	0.060	76269	0.13	1.67
	1345	010	0.030	0.080	76270	0.37	0.85
91/03/11	1525	000	0.030	0.050	116269	1.86	1.74

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
91/03/11	1535	008	0.030	0.070	116270	0.63	0.77
91/04/08	1500	000	0.010K	0.010K	156269	0.87	3.96
	1510	007	0.030	0.023	156270	3.68	3.15
91/05/06	1420	000	0.010K	0.015	196269	3.11	5.54
	1425	008	0.010	0.013	196270	8.09	11.30
91/06/04	0945	000	0.010	0.039	236269	2.30	2.76
	0955	010	0.020	0.037	236270	3.48	3.72
91/07/08	0940	000	0.010K	0.031	286269	2.49	2.98
	0950	003	0.020	0.042	286270	4.38	6.07
91/08/05	1730	000	0.010K	0.049	326269	6.06	6.30
	1740	007	0.020	0.052	326270	3.50	4.66
91/09/09	1040	000	0.050	0.080	376269		
	1050	010	0.050	0.084	376270		

PAH008
PORT ANGLES HBR AT MORSE CREEK
47 07 18.0 123 21 00.0 1F 0 Elev= 0 ft
53009 Washington Clallam Co. PACIFIC NORTHWEST
PUGET SOUND (Elwha/Dungeness-18) 131118
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/15	1530	000	9.9	6.4	69.0		78.5	3	12.6	31.83	0.370	0.010
	1535	010	9.1	4.8	51.1		85.5			32.58	0.390	0.010
91/01/29	1425	000	6.7	8.0	80.3	8.1	82.4	1K	8.9	31.52	0.390	0.010K
	1435	010	7.3	6.8	69.4	8.1	81.5			32.03	0.400	0.010K
91/02/26	1200	000	8.0	8.7	89.3	8.1	76.7	1K	6.5	30.52	0.330	0.010K
	1210	010	7.8	7.9	80.7	8.1	75.1			31.53	0.340	0.010K
91/03/18	1145	000	8.1	8.5	86.9	8.1	73.2	1K	5.0	30.60	0.320	0.010K
	1155	010	7.8	7.8	79.8	8.1	81.9			31.40	0.340	0.010K
91/04/15	1235	000	8.7	8.6	89.7	8.0	83.8	1K	9.5	30.91	0.270	0.010K
	1245	010	8.2	7.9	81.7	8.0	80.6			31.52	0.300	0.010K
91/05/13	1145	000	9.5	8.9	93.9	8.2	78.4	2	6.5	30.74	0.260	0.010K
	1155	010	8.9	7.7	81.3	8.2	79.1			31.33	0.290	0.010K
91/06/10	1120	000	10.0	8.7	93.2	8.2	76.4	1K	7.0	30.65	0.260	0.010K
	1130	010	8.4	6.7	70.1	8.1	81.0			32.16	0.390	0.010K
91/07/15	1150	000	10.1	7.1	77.0	8.0	82.1	1K	9.5	31.21	0.280	0.010K
	1200	010	8.7	6.0	63.2	8.0	85.2			32.10	0.340	0.010K
91/08/12	1135	000	10.3	7.2	78.4	8.1	84.3	1K	13.0	31.56	0.320	0.010K
	1145	010	9.5	6.6	70.0	8.1	85.7			31.86	0.340	0.010K
91/09/16	1200	000	11.1	6.4	70.3	8.0	85.1	1K	13.0	31.11	0.250	0.010K
	1210	010	9.8	5.7	61.8	8.0	83.6			31.73	0.280	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/15	1530	000	0.020	0.070	426256	0.98	0.60
	1535	010	0.020	0.080	426257	0.16	0.21
91/01/29	1425	000	0.010K	0.070	56267	0.29	0.21
	1435	010	0.030	0.070	56268	0.13	0.18
91/02/26	1200	000	0.040	0.040	96267	0.46	0.32
	1210	010	0.020	0.060	96268	0.27	0.33
91/03/18	1145	000	0.010	0.060	126267	0.80	0.56
	1155	010	0.010K	0.060	126268	0.42	0.58
91/04/15	1235	000	0.020	0.054	166267	0.30	0.34
	1245	010	0.010	0.057	166268	0.28	0.54
91/05/13	1145	000	0.010	0.053	206267	2.30	3.00

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
91/05/13	1155	010	0.020	0.057	206268	1.40	2.20
91/06/10	1120	000	0.010K	0.048	246267	3.64	4.26
	1130	010	0.010K	0.066	246268	1.12	1.81
91/07/15	1150	000	0.020	0.054	296267	1.08	2.05
	1200	010	0.010	0.065	296268	0.63	1.02
91/08/12	1135	000	0.010	0.058	336267	1.09	1.36
	1145	010	0.010K	0.062	336268	0.80J	0.58J
91/09/16	1200	000	0.010	0.066	386267		
	1210	010	0.010K	0.069	386268		

PSB003
PUGET SOUND AT WEST POINT
47 39 36.0 122 26 30.0 2F 0 Elev= 0 ft
53033 Washington King Co. PACIFIC NORTHWEST
Puget Sound 131191
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/22	1105	000	11.6	7.2	78.3		80.0	44	8.5	28.03	0.340	0.010K
	1110	010	12.1	6.1	68.1		84.8			30.38	0.320	0.010K
	1115	029	12.1	6.0	67.0		84.5			30.47	0.330	0.010K
90/12/05	1355	000	9.7	8.5	88.2	8.0	68.2	200	3.2	26.98	0.290	0.010K
	1400	010	10.3	7.7	82.1	8.0	82.9			29.16	0.280	0.010K
	1405	025	10.3	7.3	78.0	7.9	85.6			29.35	0.280	0.010K
91/02/05	1310	000	8.4	9.2	91.7	8.0	62.4	190S	7.0	26.13	0.440	0.010K
	1320	010	8.1	8.7	88.4	8.0	83.0			28.93	0.420	0.010K
	1330	030	8.1	8.5	86.0	8.0	83.4			29.03	0.420	0.010K
91/03/04	1250	000	8.0	9.4	94.6	8.1	85.3	10	12.0	27.65	0.390	0.010K
	1300	010	8.0	9.0	90.3	8.1	87.2			28.17	0.400	0.010K
	1310	024	8.0	8.5	86.0	8.0	86.5			28.44	0.410	0.010K
91/04/22	1305	000	9.9	9.4	97.1	8.0	75.9	1K	7.0	25.95	0.340	0.010K
	1315	010	8.9	9.1	93.9	8.0	81.5			28.38	0.340	0.010K
	1325	030	8.5	8.7	88.7	8.0	83.5			28.58	0.340	0.010K
91/05/28	1250	000	10.3	12.4	131.3	8.4	68.3	1K	5.0	28.66	0.080	0.010K
	1300	010	9.8	10.7	112.9	8.3	74.4			28.91	0.120	0.010K
	1305	030	9.7	10.3	108.9	8.3	75.6			28.94	0.240	0.010K
91/06/17	1330	000	11.2	9.4	101.9	8.3	83.0	1K	8.5	28.79	0.170	0.010
	1335	010	10.5	9.2	98.5	8.3	84.0			29.11	0.200	0.010
	1340	030	10.3	8.6	91.7	8.2	79.0			29.03	0.220	0.020
91/07/22	1240	000	13.2	10.5	118.0	8.3	64.0	1K	3.7	28.31	0.040	0.010K
	1250	010	12.3	10.0	111.0	8.2	68.4			29.26	0.140	0.010K
	1300	030	11.3	7.8	85.4	8.1	84.0			29.55	0.170	0.010K
91/08/19	1410	000	13.4	9.7	110.6	8.2	64.8	1K	6.0	29.35	0.140	0.010K
	1420	010	12.4	7.9	88.7	8.2	83.4			29.75	0.200	0.010K
	1430	030	12.2	7.7	85.6	8.1	85.8			29.76	0.250	0.010K
91/09/23	1220	000	13.1	9.1	102.7	8.3	75.9	3		29.35	0.120	0.010K
	1230	010	12.7	8.3	93.3	8.2	78.4			29.93	0.150	0.010K
	1240	027	12.1	6.5	72.3	8.1	80.8			30.12	0.200	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/22	1105	000	0.020	0.080	436303	0.35	0.38
	1110	010	0.020	0.070	436304	0.72	0.48
	1115	029	0.010K	0.080	436305	0.89	0.64
90/12/05	1355	000	0.010K	0.070	496318	0.06	0.92
	1400	010	0.010K	0.080	496319	0.12	0.15
	1405	025	0.010K	0.080	496320	0.09	0.15
91/02/05	1310	000	0.030	0.080	66318	0.15	0.28
	1320	010	0.010	0.080	66319	0.19	0.25
	1330	030	0.010K	0.080	66320	0.13	0.18
91/03/04	1250	000	0.010K	0.070	106318	1.86	0.67
	1300	010	0.010K	0.070	106319	1.94	0.66
	1310	024	0.010K	0.080	106320	1.15	0.41
91/04/22	1305	000	0.010K	0.065	176318	0.82	0.62
	1315	010	0.010K	0.065	176319	0.68	0.63
	1325	030	0.010	0.074	176320	0.35	0.40
91/05/28	1250	000	0.010K	0.025	226318	16.20	6.70
	1300	010	0.010K	0.030	226319	17.60	7.60
	1305	030	0.030	0.049	226320	1.80	8.10
91/06/17	1330	000	0.010	0.040	256318	2.76	1.90
	1335	010	0.070	0.056	256319	2.00	2.40
	1340	030	0.020	0.050	256320	0.15J	0.99J
91/07/22	1240	000	0.010K	0.022	306318	10.00	6.73
	1250	010	0.020	0.042	306319	5.32	6.15
	1300	030	0.040	0.051	306320	2.79	3.48
91/08/19	1410	000	0.070	0.045	346318		
	1420	010	0.020	0.047	346319		
	1430	030	0.020	0.054	346320		
91/09/23	1220	000	0.010	0.045	396318		
	1230	010	0.010K	0.050	396319		
	1240	027	0.010K	0.056	396320		

PSS019
POSSESSION SOUND OFF EAST GEDNEY ISLAND
48 00 40.0 122 18 00.0   2F 0   Elev=   0 ft
53061 Washington   Snohomish Co.   PACIFIC NORTHWEST
PUGET SOUND (Snohomish-07)   131107
21540000   Reach=   0.000   Drg=   0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/15	1245	000	10.2	10.1	98.3		53.6	200L	4.5	15.62	0.260	0.010
	1250	010	11.7	6.0	65.8		84.6			28.91	0.330	0.010
	1255	029	11.9	5.0	55.5		86.3			30.25	0.350	0.010K
90/12/05	1245	000	6.8	12.2	105.8	8.0	34.2	38S	1.3	9.69	0.330	0.010K
	1250	010	9.3	8.8	88.9	7.9	77.5			24.36	0.270	0.010K
	1255	030	10.6	7.0	75.2	7.9	81.8			29.20	0.270	0.010K
91/02/05	1140	000	7.6	11.4	104.7	8.1	18.3	32	1.0	15.51	0.360	0.010K
	1150	010	8.3	9.4	94.8	8.0	73.2			26.63	0.410	0.010K
	1200	030	8.5	8.0	82.3	8.0	83.4			29.02	0.420	0.010K
91/03/04	1205	000	7.1	11.3	102.3	8.1	24.0	88S	1.0	14.91	0.400	0.010K
	1215	010	8.0	9.9	97.4	8.1	78.2			25.10	0.380	0.010K
	1225	026	8.0	8.8	88.2	8.1	86.2			27.88	0.400	0.010K
91/04/22	1200	000	11.7	13.6	144.0	8.6	73.8	1K	5.0	23.71	0.010K	0.010K
	1210	010	8.5	9.7	98.6	8.1	82.7			28.14	0.310	0.010K
	1220	030	8.3	8.3	85.1	8.0	83.4			28.75	0.340	0.010K
91/05/28	1150	000	12.7	12.4	127.2	8.6	42.8	4	2.5	16.06	0.030	0.010K
	1200	010	9.7	11.0	115.1	8.4	70.0			27.92	0.280	0.010K
	1210	029	9.1	8.6	88.8	8.1	85.6			28.99	0.330	0.010K
91/06/17	1220	000	13.6	11.7	124.6	8.6	43.4	2	2.6	18.38	0.010K	0.010K
	1225	010	10.3	9.2	97.4	8.2	86.6			28.03	0.240	0.010
	1230	030	9.6	8.1	85.1	8.2	85.3			29.08	0.300	0.010K
91/07/22	1135	000	16.3	10.0	114.0	8.4	66.6	1K	4.5	21.06	0.010K	0.010K
	1145	010	11.3	7.9	86.5	8.1	86.4			29.27	0.180	0.010K
	1200	029	10.8	6.8	73.1	8.0	85.6			29.46	0.230	0.010K
91/08/19	1305	000	19.1	8.2	100.4	8.3	75.4	1K	4.5	24.48	0.010K	0.010K
	1315	010	11.8	7.9	86.6	8.2	83.8			29.29	0.270	0.010K
	1325	030	11.2	6.5	70.9	8.0	87.4			29.64	0.310	0.010K
91/09/23	1120	000	14.3	11.2	127.7	8.5	58.3	1K	3.5	26.96	0.010K	0.010K
	1125	010	12.7	9.1	102.1	8.3	79.7			29.02	0.150	0.010K
	1130	030	11.7	5.9	65.7	8.0	87.9			29.95	0.240	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/15	1245	000	0.040	0.040	426269	2.13	1.48
	1250	010	0.020	0.080	426270	0.19	0.21
	1255	029	0.010	0.080	426271	0.07	0.15
90/12/05	1245	000	0.040	0.030	496313	1.20	0.60
	1250	010	0.020	0.060	496314	0.17	0.11
	1255	030	0.010K	0.080	496315	0.07	0.08
91/02/05	1140	000	0.020	0.040	66313	1.14	0.80
	1150	010	0.010	0.070	66314	0.35	0.30
	1200	030	0.010K	0.080	66315	0.06	0.20
91/03/04	1205	000	0.050	0.040	106313	1.51	1.04
	1215	010	0.010K	0.070	106314	1.09	0.59
	1225	026	0.010K	0.070	106315	0.29	0.17
91/04/22	1200	000	0.010K	0.010K	176313	6.80	3.52
	1210	010	0.010	0.060	176314	3.49	2.56
	1220	030	0.020	0.072	176315	0.13	0.36
91/05/28	1150	000	0.010K	0.010K	226313		
	1200	010	0.020	0.057	226314	7.40	5.60
	1210	029	0.030	0.064	226315	0.40	1.30
91/06/17	1220	000	0.010K	0.010K	256313	3.77	4.96
	1225	010	0.020	0.046	256314	0.25	0.79
	1230	030	0.010K	0.058	256315	0.88J	0.86J
91/07/22	1135	000	0.010K	0.010K	306313	0.90	1.01
	1145	010	0.020	0.049	306314	0.22	0.71
	1200	029	0.020	0.057	306315	0.10	1.21
91/08/19	1305	000	0.010K	0.013	346313		
	1315	010	0.010K	0.061	346314		
	1325	030	0.010K	0.061	346315		
91/09/23	1120	000	0.010K	0.010K	396313		
	1125	010	0.010K	0.043	396314		
	1130	030	0.010K	0.061	396315		

SAR003
SARATOGA PASSAGE OFF EAST POINT
48 06 28.0 122 29 25.0 2F 0 Elev= 0 ft
53029 Washington Island Co. PACIFIC NORTHWEST
PUGET SOUND (Island-06) 131106
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/STREAM

INDEX
MILES . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/15	1320	000	11.2	8.1	86.3		85.3	1K	16.0	26.17	0.260	0.010
	1325	010	11.4	7.2	77.7		86.2			27.57	0.290	0.020
	1330	030	11.8	4.6	51.1		83.6			30.44	0.360	0.010
90/12/05	1220	000	7.6	10.6	97.0	8.0	67.3	1K	3.3	15.06	0.240	0.010K
	1225	010	9.2	9.2	91.4	7.9	80.1			22.05	0.260	0.010K
	1230	029	10.8	6.4	69.1	7.9	83.2			29.32	0.270	0.010K
91/02/05	1110	000	8.1	10.2	101.1	8.1	74.0	1		24.82	0.380	0.010K
	1120	010	8.2	9.8	97.4	8.0	75.8			25.56	0.390	0.010K
	1130	030	9.1	7.1	73.4	7.9	80.6			29.03	0.410	0.010K
91/03/04	1135	000	8.0	9.8	94.9	8.0	68.7	1	4.0	22.91	0.350	0.010K
	1145	010	8.2	9.2	92.0	8.0	78.3			25.84	0.350	0.010K
	1155	029	8.2	8.2	82.8	8.0	83.1			28.55	0.400	0.010K
91/04/22	1110	000	11.4	12.8	133.8	8.6	81.6	1K	6.0	23.10	0.010K	0.010K
	1120	010	8.7	10.0	102.3	8.1	79.2			27.55	0.270	0.010K
	1130	030	8.2	7.8	79.9	7.9	86.4			28.78	0.350	0.010K
91/05/28	1100	000	12.3	15.5	162.4	8.9	28.8	1K	2.0	20.43	0.010K	0.010K
	1110	010	8.9	9.6	99.1	8.2	83.4			28.55	0.370	0.010K
	1120	030	8.7	7.1	72.7	8.0	84.8			28.94	0.380	0.010K
91/06/17	1155	000	13.3	11.9	128.3	8.6	49.0	1K	3.5	21.42	0.010K	0.010K
	1200	010	10.6	9.8	103.4	8.3	84.7			26.67	0.190	0.010K
	1205	027	9.1	7.3	75.8	8.1	88.2			28.90	0.370	0.010K
91/07/22	1055	000	14.8	12.5	138.0	8.5	42.4	1K	3.0	21.08	0.010K	0.010K
	1110	010	10.6	7.9	84.8	8.0	85.8			28.68	0.220	0.010K
	1125	024	9.6	6.0	63.2	7.8	87.9			29.20	0.270	0.010K
91/08/19	1215	000	16.4	12.1	140.8	8.5	55.0	1K	4.5	23.71	0.010K	0.010K
	1225	010	11.1	7.8	84.3	8.1	77.8			28.91	0.270	0.010K
	1235	030	10.6	5.8	62.8	7.9	87.0			29.51	0.320	0.010K
91/09/23	1050	000	13.9	13.2	147.7	8.7	57.6	1K	3.6	25.62	0.010K	0.010K
	1100	010	11.4	7.8	85.1	8.1	80.2			29.50	0.250	0.010K
	1110	030	11.3	5.3	57.7	8.0	87.0			29.86	0.270	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/15	1320	000	0.040	0.070	426266	0.25	0.22
	1325	010	0.030	0.080	426267	0.21	0.37
	1330	030	0.010	0.080	426268	0.06	0.20
90/12/05	1220	000	0.030	0.050	496310	0.33	0.27
	1225	010	0.020	0.060	496311	0.06	0.12
	1230	029	0.010K	0.080	496312	0.06	0.05K
91/02/05	1110	000	0.010	0.070	66310	1.11	0.72
	1120	010	0.010K	0.070	66311	0.79	0.50
	1130	030	0.010	0.080	66312	0.11	0.14
91/03/04	1135	000	0.010K	0.060	106310	1.51	0.87
	1145	010	0.010K	0.070	106311	1.22	0.74
	1155	029	0.010K	0.080	106312	0.17	0.09
91/04/22	1110	000	0.010	0.010K	176310	0.81	3.12
	1120	010	0.010	0.055	176311	2.76	3.21
	1130	030	0.020	0.072	176312	0.33	0.53
91/05/28	1100	000	0.010K	0.010K	226310		
	1110	010	0.020	0.072	226311	0.70	3.00
	1120	030	0.020	0.072	226312	0.60	1.90
91/06/17	1155	000	0.010K	0.010K	256310	2.53	4.05
	1200	010	0.010K	0.037	256311	1.19	1.78
	1205	027	0.010K	0.069	256312	0.05K	0.19
91/07/22	1055	000	0.010K	0.010K	306310	1.63	2.02
	1110	010	0.010	0.055	306311	0.71	0.59
	1125	024	0.010K	0.064	306312	0.06	1.30
91/08/19	1215	000	0.010K	0.013	346310		
	1225	010	0.010K	0.066	346311		
	1235	030	0.010K	0.066	346312		
91/09/23	1050	000	0.010K	0.010K	396310		
	1100	010	0.010K	0.065	396311		
	1110	030	0.010K	0.069	396312		

SKG003
SKAGIT BAY OFF STRAWBERRY POINT
48 17 48.0 122 29 18.0 2F000 Elev= 0 ft
53029 Washington Island Co. PACIFIC NORTHWEST
PUGET SOUND (Island-06) 131106
21540000 Reach=17110019000 0.000 Drg= 0 sqmi
AMBNT/OCEAN

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/12/12	1415	000	7.2	11.1	99.6	8.0	34.1	8	1.5	13.54	0.230	0.010K
	1425	010	10.5	6.2	65.9	7.8	36.6			27.90	0.260	0.010K
91/02/05	1040	000	8.0	10.5	100.2	8.0	43.8	1K	1.5	20.17	0.330	0.010K
	1050	010	8.1	9.7	96.3	8.0	71.4			25.14	0.380	0.010K
91/03/04	1055	000	5.4	13.3	106.2	7.6	3.2	16	0.5	2.09	0.140	0.010K
	1105	010	7.8	9.8	94.3	7.9	56.7			22.25	0.340	0.010K
91/04/22	1033	000	11.0	10.8	108.8	8.2	62.0	1K	3.0	18.90	0.130	0.010K
	1045	010	8.6	8.0	81.4	7.9	63.4			27.99	0.340	0.010K
91/05/28	1030	000	12.7	10.9	105.0	8.0	54.7	4J	1.5	4.09	0.090	0.010K
	1040	010	10.1	10.0	102.2	8.1	53.1			23.03	0.160	0.010K
91/06/17	1115	000	11.8	11.0	115.2	8.5	44.6	1K	2.6	21.61	0.040	0.010K
	1120	010	10.0	9.0	93.5	8.1	58.8			26.13	0.260	0.010K
91/07/22	1030	000	13.9	10.2	106.0	8.2	45.9	1K	2.2	12.69	0.040	0.010K
	1040	010	10.6	7.6	80.3	7.9	60.4			26.95	0.190	0.010K
91/08/19	1135	000	15.6	10.5	117.2	8.3	51.3	5	3.5	19.30	0.034	0.010K
	1145	010	10.5	6.1	65.9	7.9	67.2			29.15	0.308	0.010K
91/09/23	1025	000	13.0	8.0	86.0	8.0	58.0	20	2.5	21.19	0.120	0.010K
	1035	010	11.6	6.2	67.5	7.9	67.8			27.33	0.200	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/12/12	1415	000	0.040	0.050	506273	0.37	0.36
	1425	010	0.020	0.080	506274	0.06	0.18
91/02/05	1040	000	0.020	0.090	66273	0.71	0.64
	1050	010	0.020	0.070	66274	0.74	0.64
91/03/04	1055	000	0.010	0.010K	106273	0.19	0.20
	1105	010	0.010	0.060	106274	0.89	0.61
91/04/22	1033	000	0.010K	0.026	176273	5.66	3.32
	1045	010	0.020	0.071	176274	1.25	0.99
91/05/28	1030	000	0.010K	0.010	226273	2.80	3.50
	1040	010	0.010K	0.028	226274	4.90	3.80
91/06/17	1115	000	0.010K	0.010K	256273	3.13	5.27
	1120	010	0.010K	0.044	256274	1.71	2.41
91/07/22	1030	000	0.010K	0.010K	306273	1.27	1.01
	1040	010	0.010K	0.044	306274	2.46	2.50
91/08/19	1135	000	0.010K	0.017	346273		
	1145	010	0.015	0.073	346274		

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
91/09/23	1025	000	0.010K	0.033	396273		
	1035	010	0.010K	0.056	396274		

WPA001
WILLAPA RIVER AT RAYMOND
46 41 15.0 123 44 55.0 2F 0 Elev= 0 ft
53049 Washington Pacific Co. PACIFIC NORTHWEST
COASTAL (Willapa-24) 131224
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/STREAM

INDEX 1312137
MILES 0006.40

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/08	1655	000	15.6	8.2	91.7		10.9	31	0.8	19.90	0.130	0.010K
	1700	010	14.6	6.9	77.7		2.8			24.14	0.080	0.010K
91/01/28	1415	000	5.7	11.4	98.6	7.9	2.3	2	0.6	13.33	0.460	0.010K
	1425	009	5.7	11.2	97.1	7.9	0.0			13.82	0.480	0.010K
91/02/25	1445	000	8.0	11.7	101.0	7.6	5.4	19	0.6	3.46	0.860	0.010K
	1450	008	8.2	11.6	100.6	7.5	5.0			4.15	0.650	0.010K
91/03/26	1420	000	8.3	10.9	95.3	7.7	34.7	46	1.4	5.73	0.090	0.010K
	1425	008	8.6	10.3	95.3	7.8	19.6			12.81	0.320	0.010K
91/04/29	1540	000	13.0	10.1	97.9	7.7	25.7	18	1.2	4.37	0.360	0.010K
	1545	010	11.5	9.7	94.4	7.6	7.5			10.46	0.250	0.010K
91/05/20	1450	000	13.2	9.3	90.3	7.6	30.2	35	1.4	4.28	0.240	0.010K
	1500	008	12.9	8.3	85.1	7.5	1.9			14.69	0.110	0.010K
91/06/25	1525	000	16.5	12.0	130.5	8.7	29.0	100	1.5	12.16	0.010K	0.010K
	1535	009	16.1	8.2	90.7	7.9	25.8			16.34	0.010K	0.010K
91/07/29	1410	000	21.7	6.5	81.1	7.5	12.3	12	1.0	18.46	0.040	0.010K
	1420	009	20.9	6.1	76.0	7.5	1.9			19.79	0.040	0.010K
91/08/26	1410	000	20.1	7.1	88.3	7.8	12.4	10	1.1	23.05	0.020	0.010K
	1420	010	19.6	6.9	84.8	7.8	3.0			23.69	0.020	0.010K
91/09/30	1455	000	17.8	6.5	76.8	7.6	27.3	19	1.2	22.84	0.110	0.010K
	1505	009	16.8	6.3	75.4	7.7	6.9			26.42	0.080	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/08	1655	000	0.070	0.030	416225	36.60	27.00
	1700	010	0.070	0.030	416226	3.60	4.07
91/01/28	1415	000	0.030	0.010	56222	1.44	2.62
	1425	009	0.030	0.010	56223	1.19	4.87
91/02/25	1445	000	0.040	0.010	96222	0.86	2.02
	1450	008	0.040	0.010	96223	1.58	4.14
91/03/26	1420	000	0.020	0.010K	136222	0.54	1.79
	1425	008	0.030	0.010K	136223	1.24	2.25
91/04/29	1540	000	0.040	0.010K	186222	0.90	1.35
	1545	010	0.050	0.010K	186223	2.33	3.69
91/05/20	1450	000	0.040	0.016	216222	0.90	2.90

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
91/05/20	1500	008	0.060	0.011	216223	1.80	5.90
91/06/25	1525	000	0.010K	0.021	266222	1.78	1.59
	1535	009	0.010K	0.010K	266223	0.28	0.44
91/07/29	1410	000	0.030	0.013	316222	5.40	4.25
	1420	009	0.040	0.015	316223	5.67	7.23
91/08/26	1410	000	0.020	0.011	356222		
	1420	010	0.020	0.011	356223		
91/09/30	1455	000	0.130	0.020	406222		
	1505	009	0.120	0.022	406223		

WPA003
WILLAPA RIVER AT JOHNSON SLOUGH
46 42 15.0 123 50 10.0 2F 0 Elev= 0 ft
53049 Washington Pacific Co. PACIFIC NORTHWEST
Washington Coast 131291
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/STREAM

INDEX 1312137
MILES 0000.40 . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/08	1630	000	14.1	7.8	89.6		16.3	7	1.0	28.72	0.060	0.010K
	1635	008	14.0	8.0	92.1		44.2			29.35	0.060	0.010K
91/01/28	1345	000	6.0	13.0	118.1	8.2	11.1	1K	0.9	19.68	0.310	0.010K
	1355	008	5.8	10.4	95.8	8.3	0.1			22.46	0.230	0.010K
91/02/25	1425	000	9.0	11.1	103.2	8.1	20.5	2	1.0	11.92	0.490	0.010K
	1435	007	8.8	10.5	102.1	8.2	1.5			20.30	0.270	0.010K
91/03/26	1355	000	9.2	10.6	99.2	8.2	39.3	9	1.5	12.95	0.270	0.010K
	1415	008	8.6	9.9	96.3	8.3	12.9			20.58	0.090	0.010K
91/04/29	1520	000	12.4	9.5	98.9	8.1	12.8	5	1.0	18.61	0.060	0.010K
	1525	008	11.3	9.4	96.1	8.1	13.4			19.74	0.070	0.010K
91/05/20	1425	000	13.7	8.9	92.8	7.9	31.8	6	1.5	14.68	0.090	0.010K
	1435	006	12.3	8.3	88.7	8.0	10.4			22.50	0.040	0.010K
91/06/25	1510	000	16.3	8.2	93.9	8.2	31.5	1	1.3	21.42	0.010K	0.010K
	1520	006	16.2	8.0	91.6	8.2	29.3			21.77	0.010K	0.010K
91/07/29	1330	000	20.9	7.2	91.6	7.9	23.4	1	1.0	24.32	0.010K	0.010K
	1340	005	20.5	7.0	89.2	7.9	11.0			24.75	0.010K	0.010K
91/08/26	1350	000	18.1	7.0	87.5	8.1	33.7	1K	2.2	28.82	0.010K	0.010K
	1400	007	17.9	7.0	87.1	8.1	20.7			28.83	0.010K	0.010K
91/09/30	1430	000	17.8	7.2	88.0	7.9	26.1	2	1.4	27.25	0.070	0.010K
	1440	007	16.0	7.2	85.8	8.0	19.4			29.63	0.060	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/08	1630	000	0.060	0.040	416223	1.53	1.85
	1635	008	0.060	0.040	416224	1.32	1.83
91/01/28	1345	000	0.030	0.020	56218	1.26	1.71
	1355	008	0.020	0.020	56219	1.97	5.87
91/02/25	1425	000	0.040	0.020	96218	0.87	0.96
	1435	007	0.030	0.030	96219		
91/03/26	1355	000	0.020	0.010K	136218	1.07	1.33
	1415	008	0.010	0.010K	136219	2.01	3.06
91/04/29	1520	000	0.020	0.010K	186218	2.97	3.21
	1525	008	0.020	0.010K	186219	2.90	3.32
91/05/20	1425	000	0.030	0.010	216218	2.80	3.50

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
91/05/20	1435	006	0.040	0.017	216219	2.80	4.10
91/06/25	1510	000	0.010K	0.010K	266218	0.28	0.30
	1520	006	0.010K	0.010K	266219	0.18	0.26
91/07/29	1330	000	0.010	0.021	316218	3.48	3.78
	1340	005	0.010K	0.023	316219	4.08	4.87
91/08/26	1350	000	0.010K	0.023	356218		
	1400	007	0.010K	0.023	356219		
91/09/30	1430	000	0.070	0.023	406218		
	1440	007	0.070	0.030	406219		

WPA004
WILLAPA BAY AT TOKE POINT
46 41 13.0 123 58 20.0 2F 0 Elev= 0 ft
53049 Washington Pacific Co. PACIFIC NORTHWEST
COASTAL (Willapa-24) 131224
21540000 Reach= 0.000 Drg= 0 sqmi
AMBNT/OCEAN

INDEX
MILES . . . .

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
90/10/08	1610	000	13.2	9.3	107.3		78.5	1	6.5	31.99	0.060	0.010K
	1615	008	13.2	9.0	103.8		78.0			31.99	0.060	0.010K
91/01/28	1255	000	6.4	11.4	108.6	8.3	63.4	1K	2.9	25.18	0.180	0.010K
	1305	007	6.4	11.1	105.7	8.3	56.6			25.19	0.180	0.010K
91/02/25	1325	000	8.9	10.9	108.3	8.3	49.5	1K	2.0	22.57	0.240	0.010K
	1335	005	8.8	10.7	106.9	8.3	46.6			24.04	0.190	0.010K
91/03/26	1250	000	9.0	10.3	102.9	8.4	50.2	1K	3.8	23.51	0.030	0.010K
	1310	008	8.7	10.1	101.6	8.5	58.8			25.00	0.010K	0.010K
91/04/29	1355	000	11.1	9.9	103.9	8.3	29.9	1K	2.2	24.84	0.010K	0.010K
	1400	005	10.9	9.8	102.9	8.3	40.9			25.06	0.010K	0.010K
91/05/20	1320	000	13.2	9.0	96.7	8.0	36.8	2	1.5	21.15	0.040	0.010K
	1330	010	12.0	8.9	95.8	8.1	44.8			25.53	0.050	0.010K
91/06/25	1355	000	14.2	10.5	118.3	8.5	58.7	1U	3.5	25.39	0.010K	0.010K
	1405	010	13.7	10.2	114.0	8.5	55.5			25.80	0.010K	0.010K
91/07/29	1225	000	18.5	7.3	90.8	8.1	53.9	1K	2.5	27.88	0.010K	0.010K
	1235	010	18.3	7.3	90.5	8.1	50.6			28.06	0.010K	0.010K
91/08/26	1255	000	15.6	8.0	95.9	8.2	57.3	2J	2.7	30.88	0.040	0.010K
	1305	010	15.6	8.0	96.0	8.2	52.0			30.89	0.040	0.010K
91/09/30	1330	000	15.4	7.8	93.1	8.1	65.4	1K	3.3	30.60	0.070	0.010K
	1340	008	14.5	8.4	98.5	8.2	60.2			30.75	0.050	0.010K

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
90/10/08	1610	000	0.040	0.030	416221	1.14	1.04
	1615	008	0.030	0.030	416222	1.50	0.99
91/01/28	1255	000	0.020	0.030	56216	0.98	0.99
	1305	007	0.010	0.030	56217	1.14	1.18
91/02/25	1325	000	0.030	0.030	96216	0.88	0.60
	1335	005	0.020	0.030	96217	1.55	1.18
91/03/26	1250	000	0.010K	0.010K	136216	1.17	1.08
	1310	008	0.010K	0.010K	136217	2.32	2.59
91/04/29	1355	000	0.010K	0.010K	186216	2.93	3.37
	1400	005	0.010K	0.010K	186217	3.01	3.70
91/05/20	1320	000	0.020	0.016	216216	1.60	2.20

MORE DATES NEXT PAGE

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L
91/05/20	1330	010	0.020	0.021	216217	1.30	3.50
91/06/25	1355	000	0.010K	0.010K	266216	0.40	0.35
	1405	010	0.010K	0.010K	266217	0.69	0.73
91/07/29	1225	000	0.010K	0.028	316216	2.16	3.23
	1235	010	0.010K	0.027	316217	2.34	3.63
91/08/26	1255	000	0.010K	0.026	356216		
	1305	010	0.010K	0.026	356217		
91/09/30	1330	000	0.030	0.029	406216		
	1340	008	0.030	0.029	406217		

WPA006
WILLAPA BAY AT NAHCOTTA CHANNEL
46 32 44.0 123 58 44.0 2F000 Elev= 0 ft
53049 Washington Pacific Co. PACIFIC NORTHWEST
COASTAL (Willapa-24) 131224
21540000 Reach=17100106000 0.000 Drg= 0 sqmi
AMBNT/OCEAN

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
91/01/28	1330	000	6.2	11.4	106.6	8.3	56.5		2.5	23.20		
	1340	010	6.2	11.3	103.7	8.3	60.1			23.33		
91/02/25	1405	000	9.2	11.0	106.3	8.3	54.0		2.0	18.41		
	1410	010	9.1	10.9	105.9	8.3	42.9			19.14		
91/03/26	1315	000	9.0	10.5	104.3	8.5	68.2		4.0	22.23		
	1325	010	8.8	10.4	103.4	8.5	66.0			23.05		
91/04/29	1435	000	11.5	10.2	105.9	8.3	45.1		1.8	21.64		
	1440	010	11.4	10.0	103.8	8.3	42.1			21.77		
91/05/20	1345	000	13.5	8.7	93.3	8.0	38.0		2.0	20.55		
	1355	010	12.7	8.7	93.5	8.1	46.6			23.15		
91/06/25	1415	000	15.2	9.4	107.3	8.4	67.4		4.0	24.42		
	1425	010	15.2	9.1	104.0	8.3	66.5			24.52		
91/07/29	1250	000	19.7	7.4	93.0	8.1	66.0		3.5	26.71		
	1300	008	19.2	7.5	93.9	8.1	65.3			27.04		
91/08/26	1320	000	18.0	8.0	99.7	8.2	70.6		5.1	29.07		
	1330	010	17.8	8.0	99.4	8.2	70.3			29.25		
91/09/30	1355	000	16.4	7.8	94.0	8.1	53.5		2.4	29.44		
	1405	010	16.2	7.7	92.3	8.1	53.8			29.55		

DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L

WPA007
WILLAPA BAY NEAR LONG ISLAND
46 27 12.0 124 00 30.0 2F000 Elev= 0 ft
53049 Washington Pacific Co. PACIFIC NORTHWEST
COASTAL (Willapa-24) 131224
21540000 Reach=17100106000 0.000 Drg= 0 sqmi
AMBNT/OCEAN

DATE FROM TO	TIME	DEPTH METER	10 WATER TEMP CENT	300 DO MG/L	301 DO SATUR PERCENT	400 PH SU	74 TURB TRANS %	31616 FEC COLI MFM-FCBR /100ML	78 TRANSP SECCHI METERS	480 SALINITY PPTH	631 NO2&NO3 N-DISS MG/L	613 NO2-N DISS MG/L
91/03/26	1330	000	9.3	10.8	105.9	8.4	56.8		3.0	20.11		
	1340	007	8.9	10.5	103.1	8.4	60.7			20.64		
91/04/29	1450	000	11.8	9.6	100.2	8.2	43.8		1.8	20.54		
	1455	010	11.7	9.6	99.3	8.2	47.3			20.54		
91/05/20	1405	000	13.5	9.0	97.1	8.1	43.7		2.0	20.24		
	1415	004	13.3	9.1	97.4	8.1	43.6			20.47		
91/06/25	1430	000	16.0	8.0	92.8	8.2	43.3		2.7	24.46		
	1440	009	16.0	8.2	95.1	8.2	60.7			24.46		
91/07/29	1305	000	20.1	6.9	86.8	8.0	41.1		2.0	26.01		
	1315	004	20.0	6.8	86.2	8.0	37.9			26.01		
91/08/26	1335	000	18.5	7.6	94.7	8.2	66.2		3.8	28.35		
	1340	010	18.4	7.7	95.8	8.2	57.9			28.35		
91/09/30	1410	000	17.2	7.7	94.1	8.1	39.1		2.0	28.59		
	1420	010	17.0	7.7	93.1	8.1	37.3			28.63		

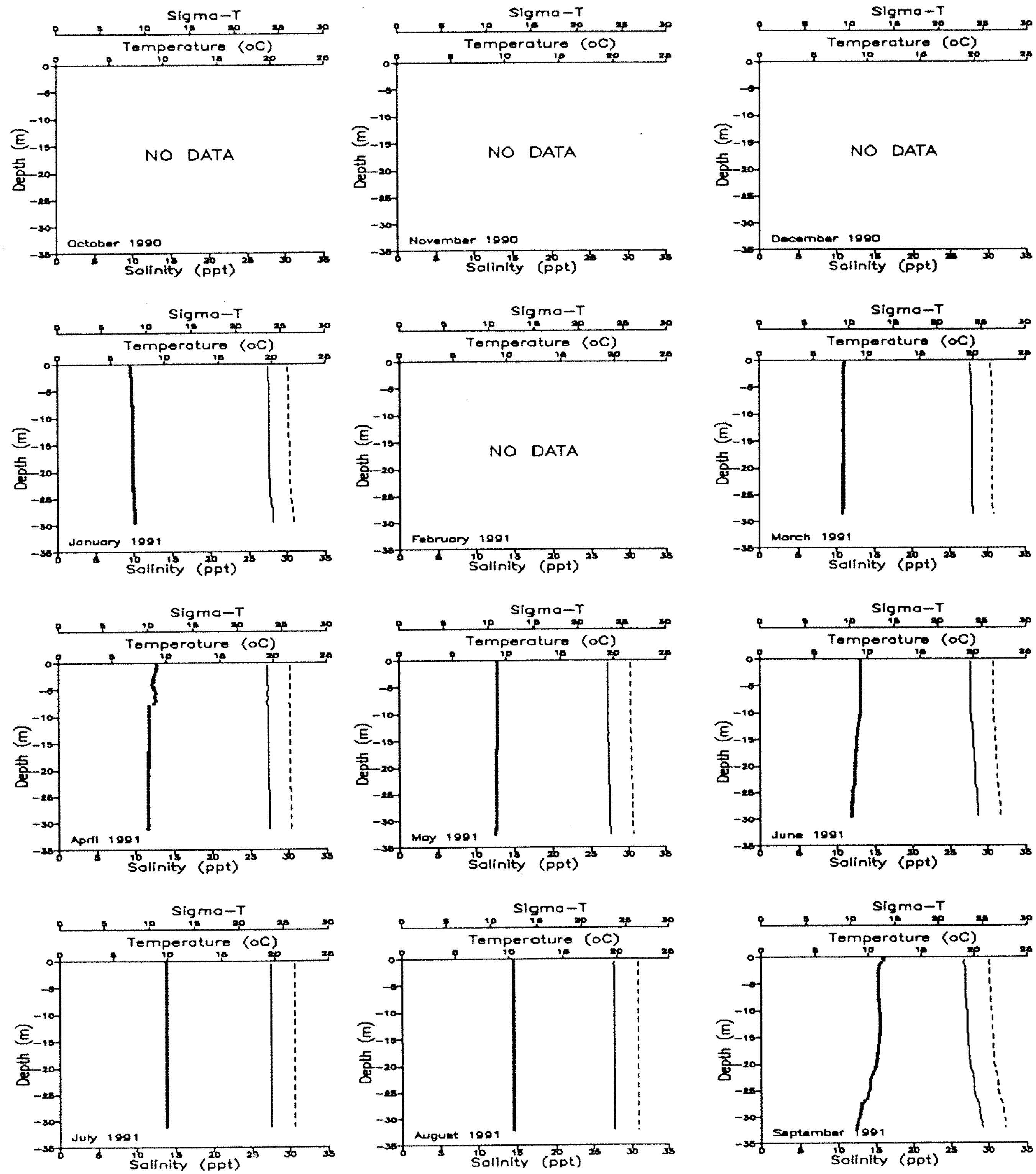
DATE FROM TO	TIME	DEPTH METER	608 NH3+NH4- N DISS MG/L	671 PHOS-DIS ORTHO MG/L P	8 LAB IDENT. NUMBER	32211 CHLRPHYL A UG/L CORRECTD	32218 PHEOPHTN A UG/L

APPENDIX C

T/S/D PLOTS FOR ALL WY 1991 LONG-TERM MONITORING STATIONS

WATERYEAR 1991

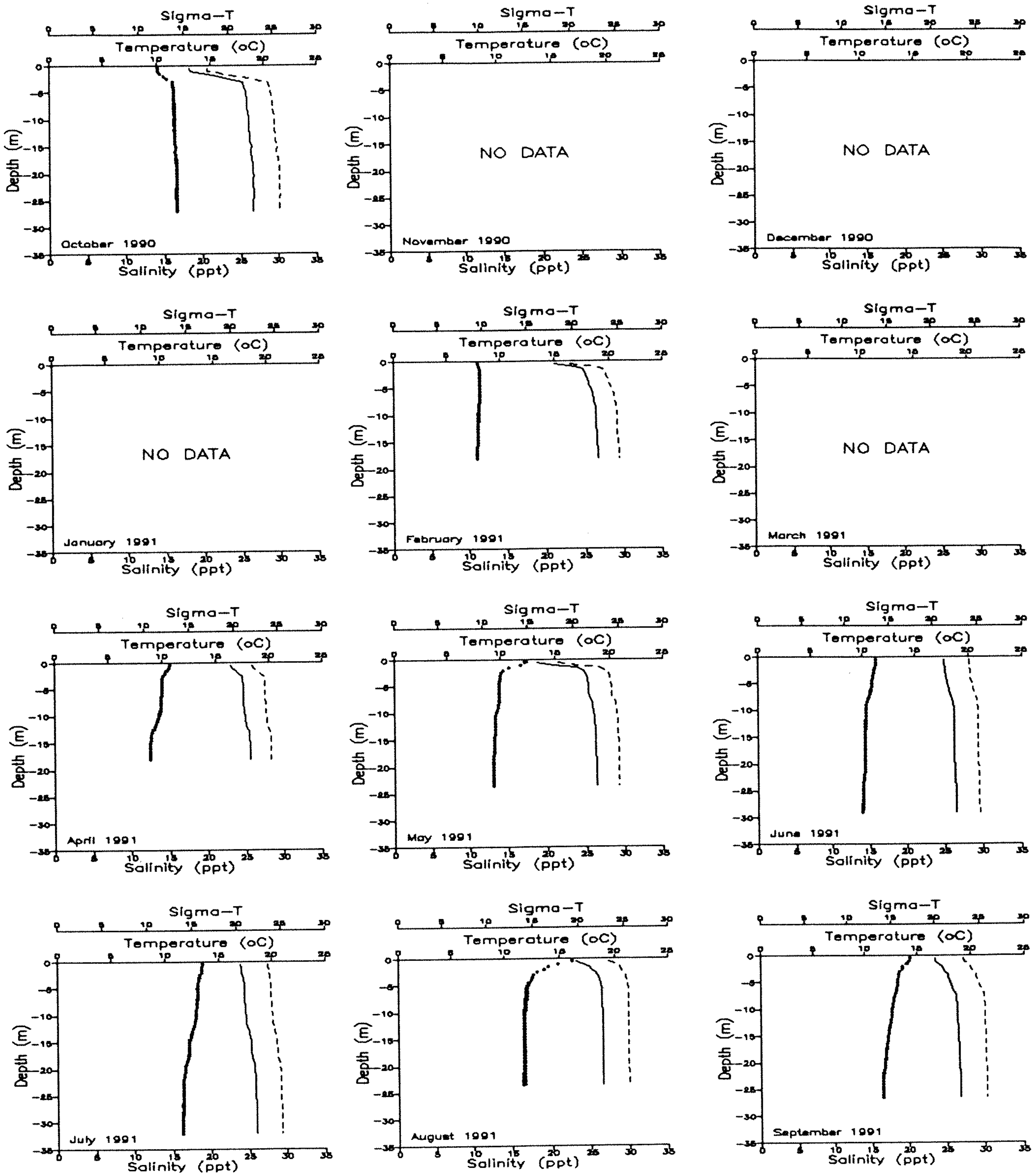
Straits of Juan de Fuca (Station ADM002)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

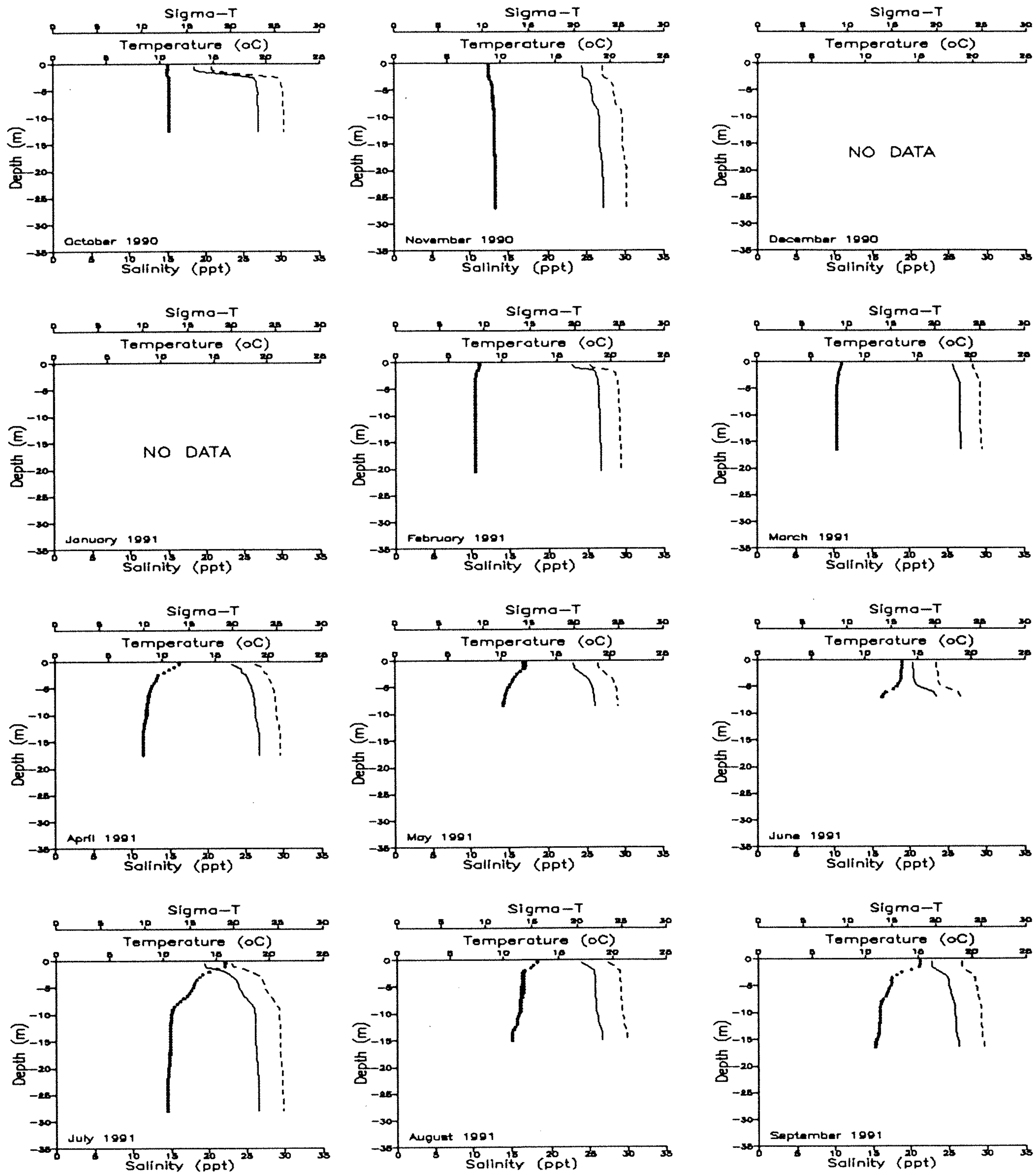
Central Puget Sound (Station ADM003)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

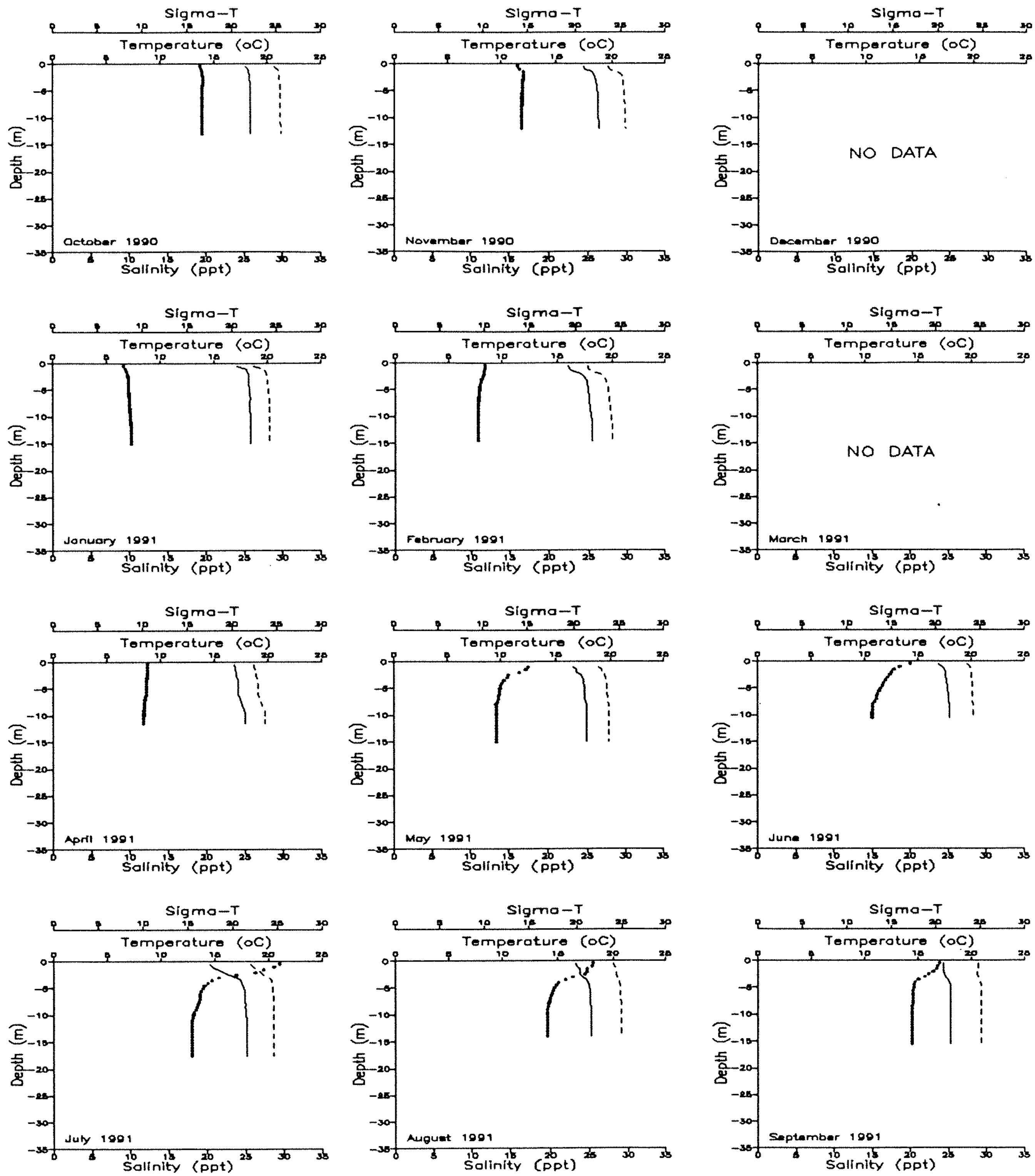
Bellingham Bay (Station BLL009)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

Budd Inlet (Station BUD005)



Key:

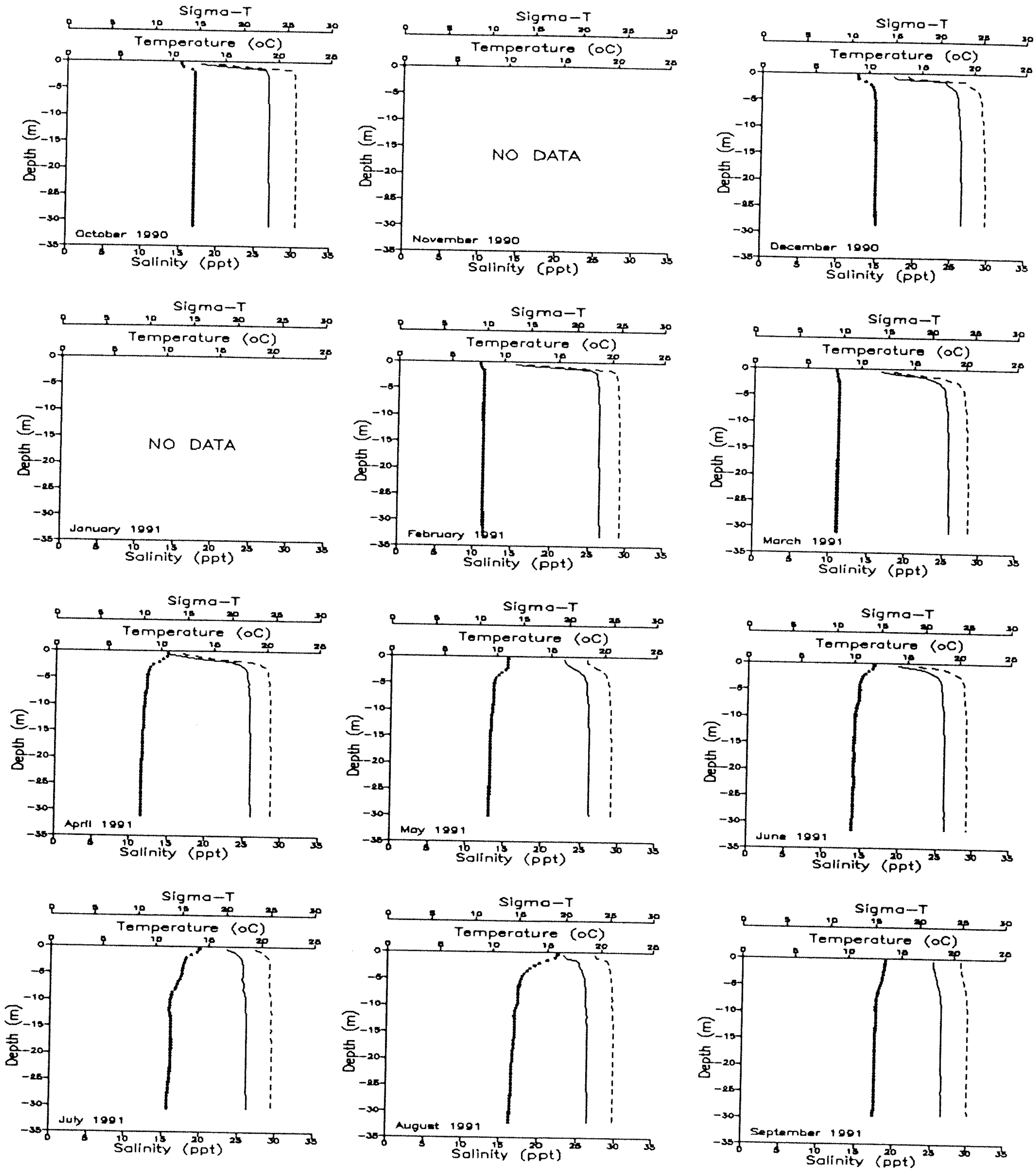
Temperature = Dotted line

Salinity = Dashed line

Sigma-t = Solid line

WATERYEAR 1991

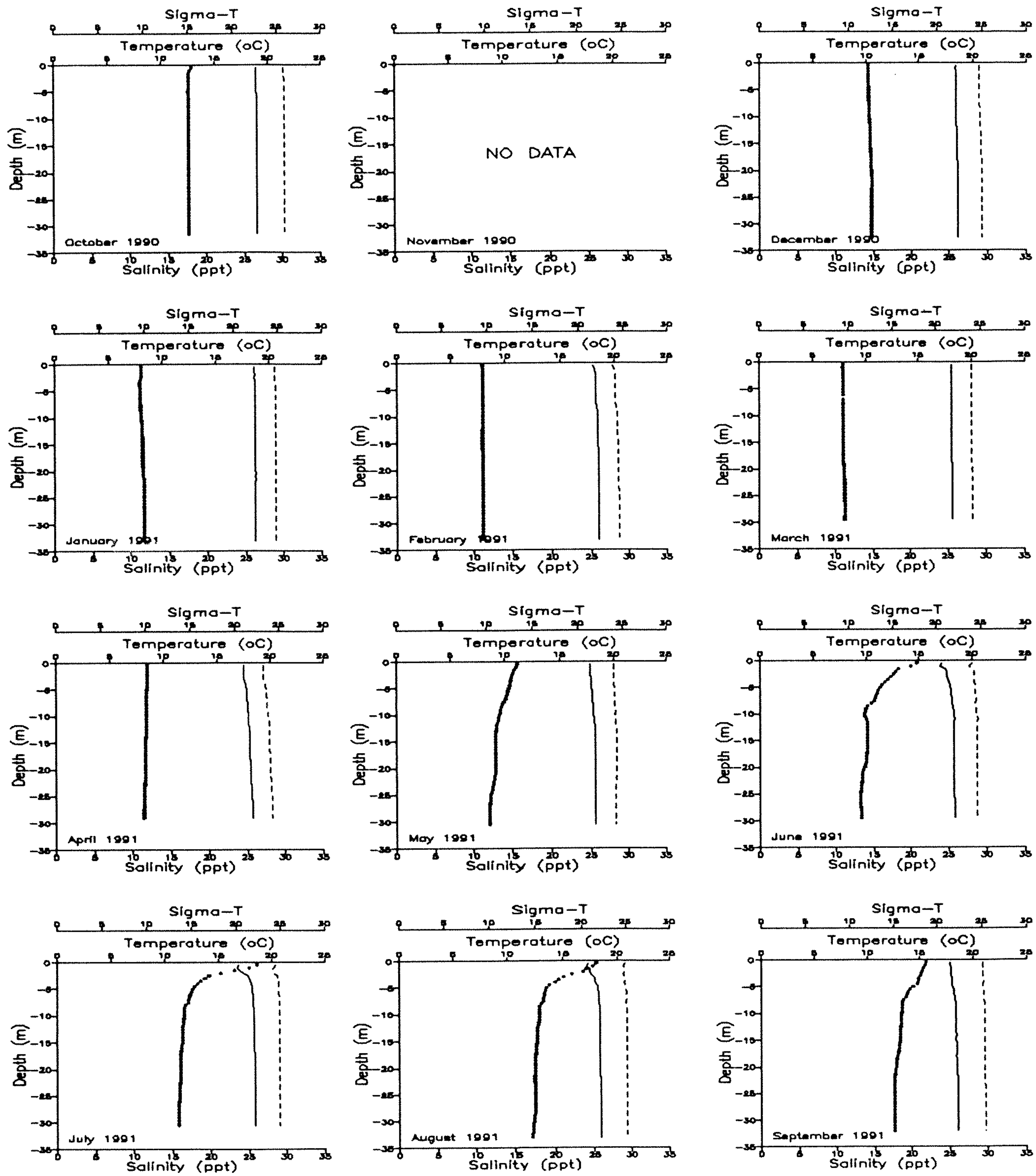
Commencement Bay - Brown Point (Station CMB003)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

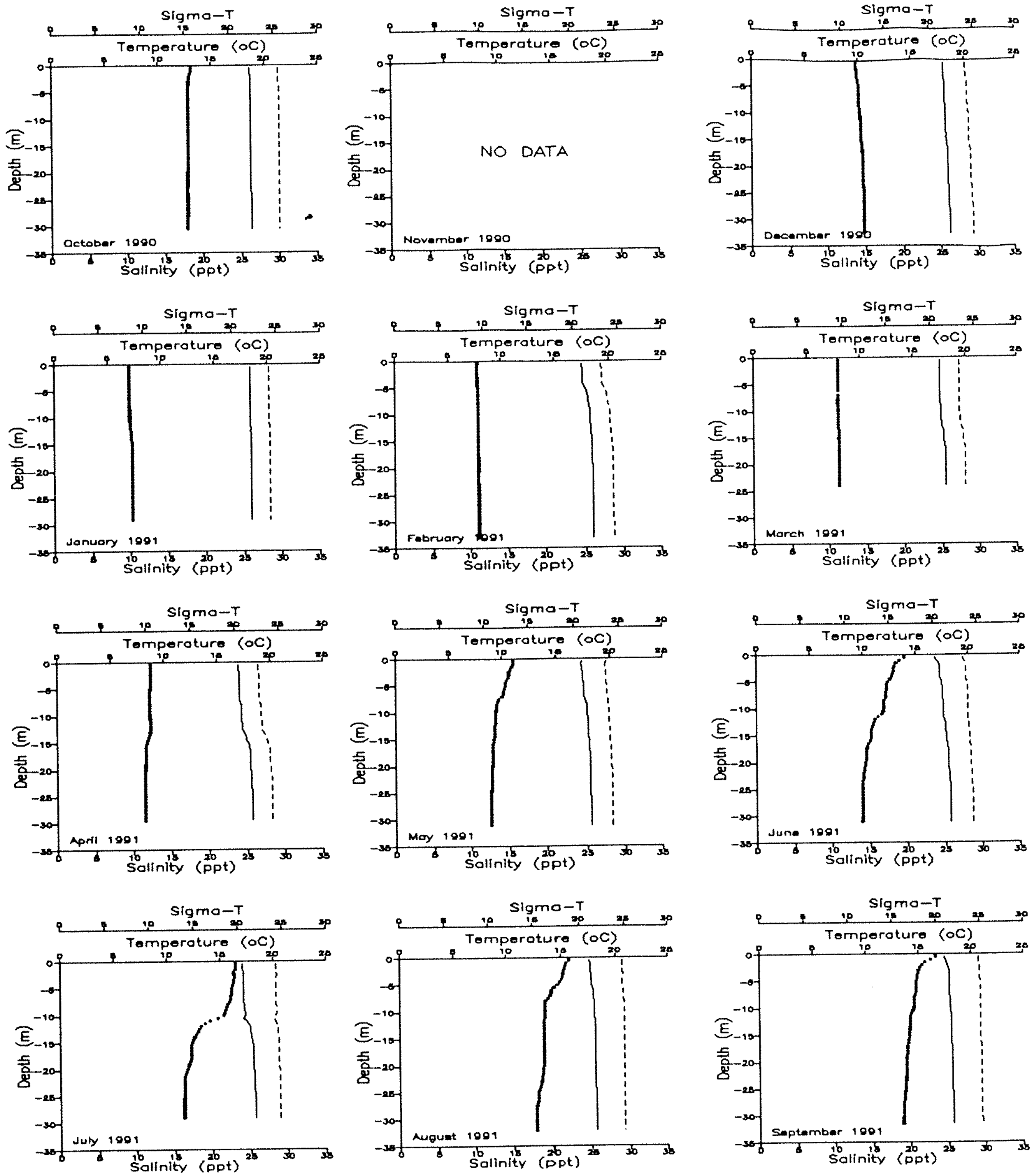
Carr Inlet (Station CRR001)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

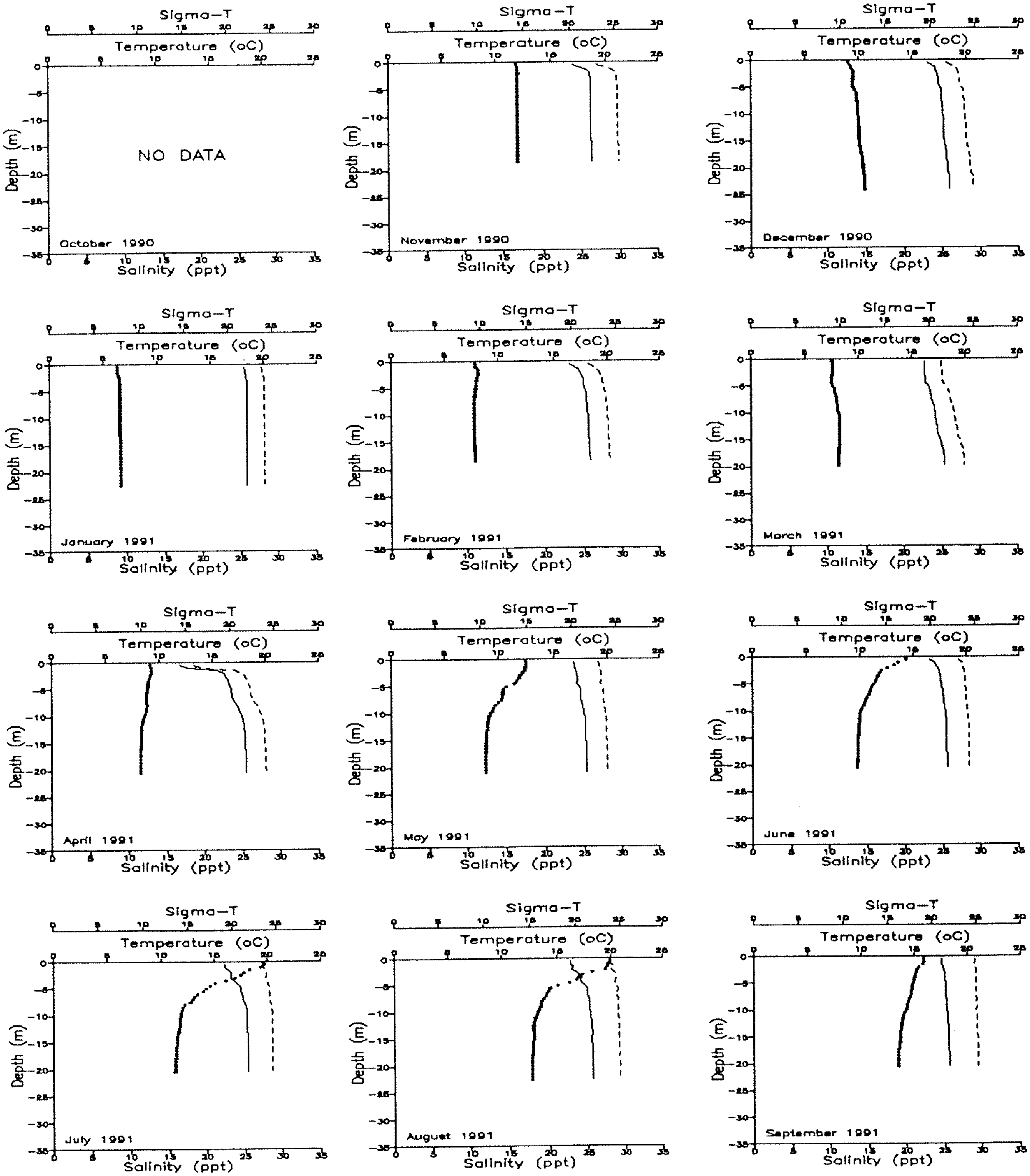
Outer Case Inlet (Station CSE001)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

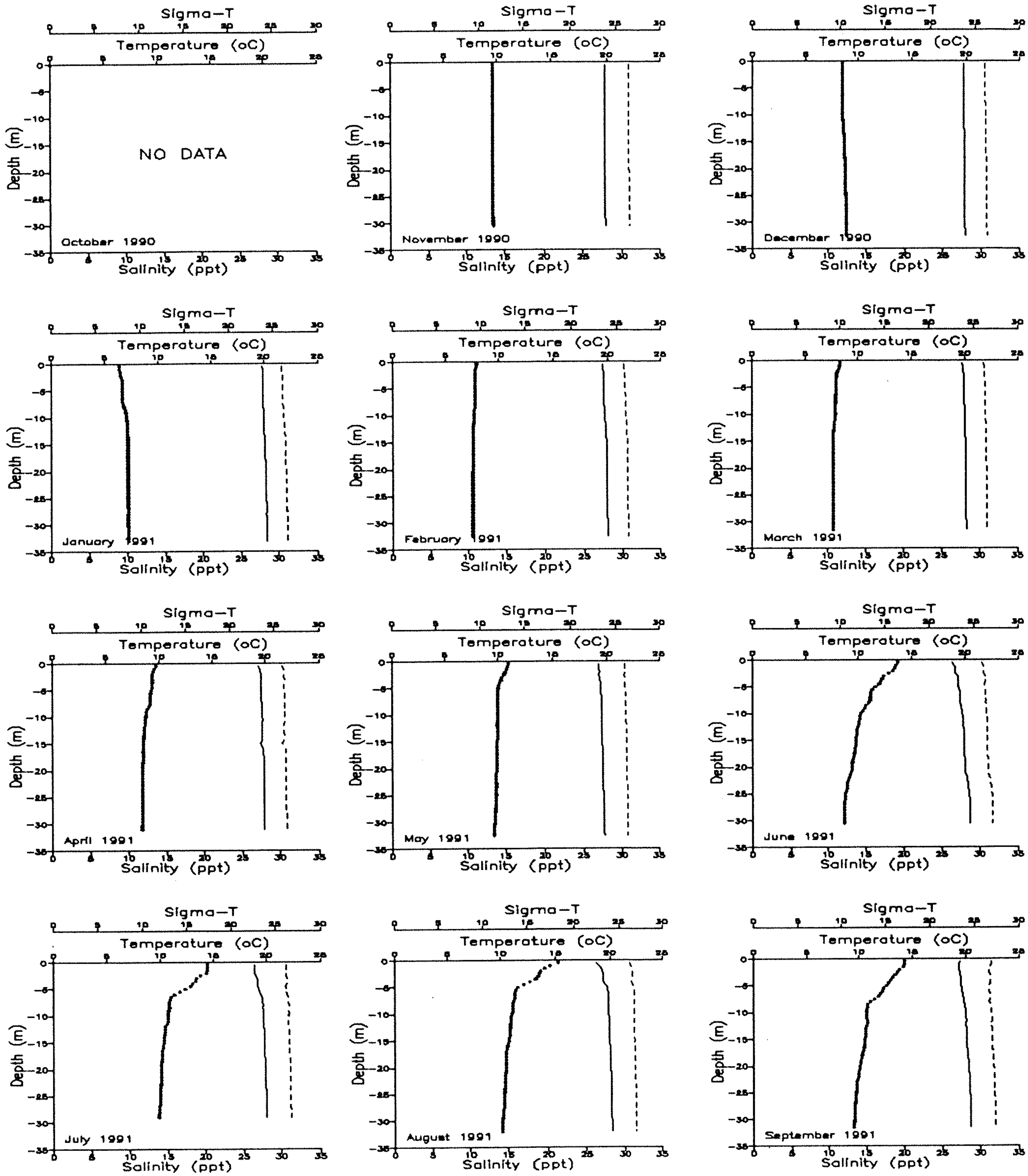
Inner Case Inlet (Station CSE002)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

Discovery Bay (Station DIS001)



Key:

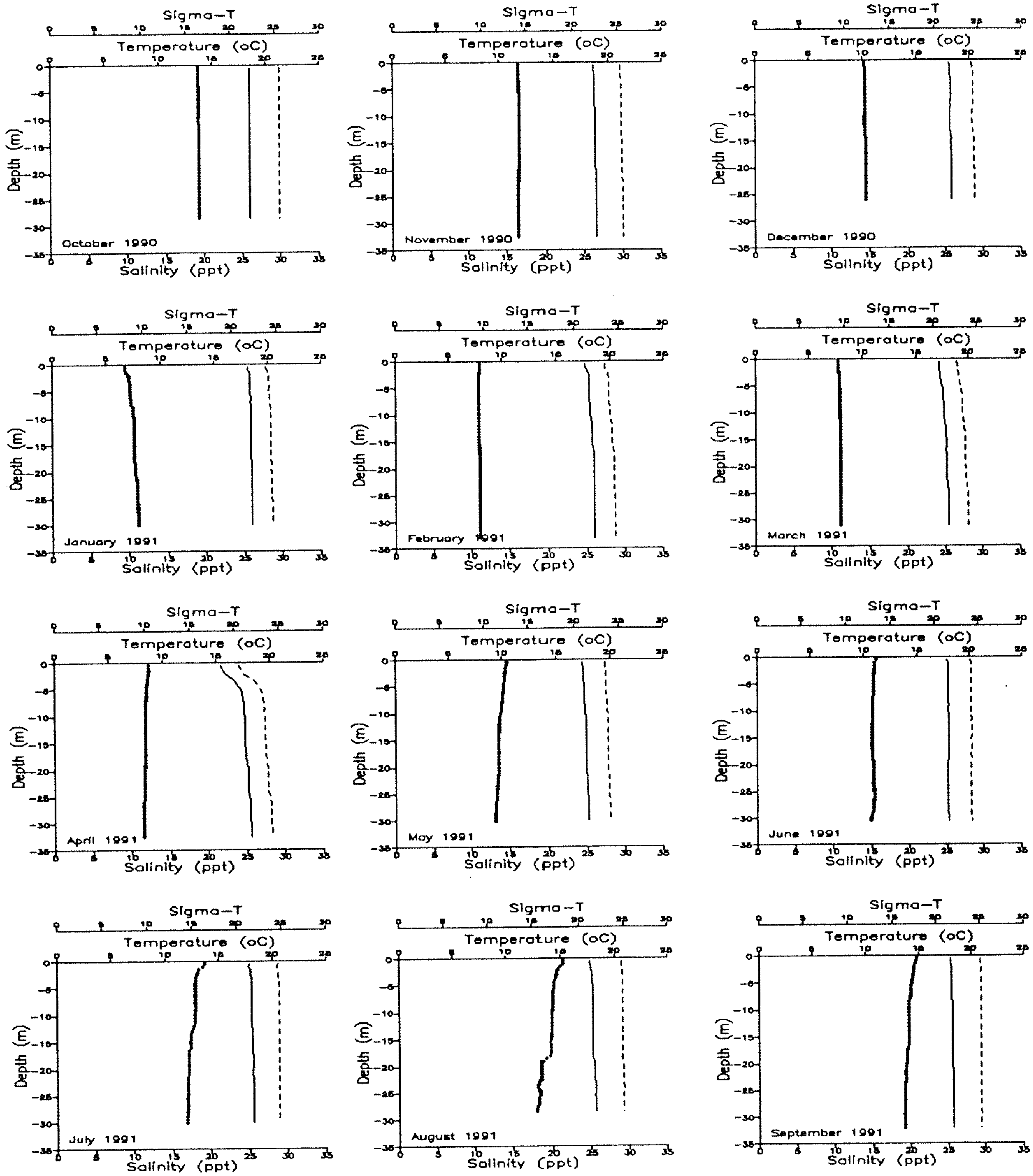
Temperature = Dotted line

Salinity = Dashed line

Sigma-t = Solid line

WATERYEAR 1991

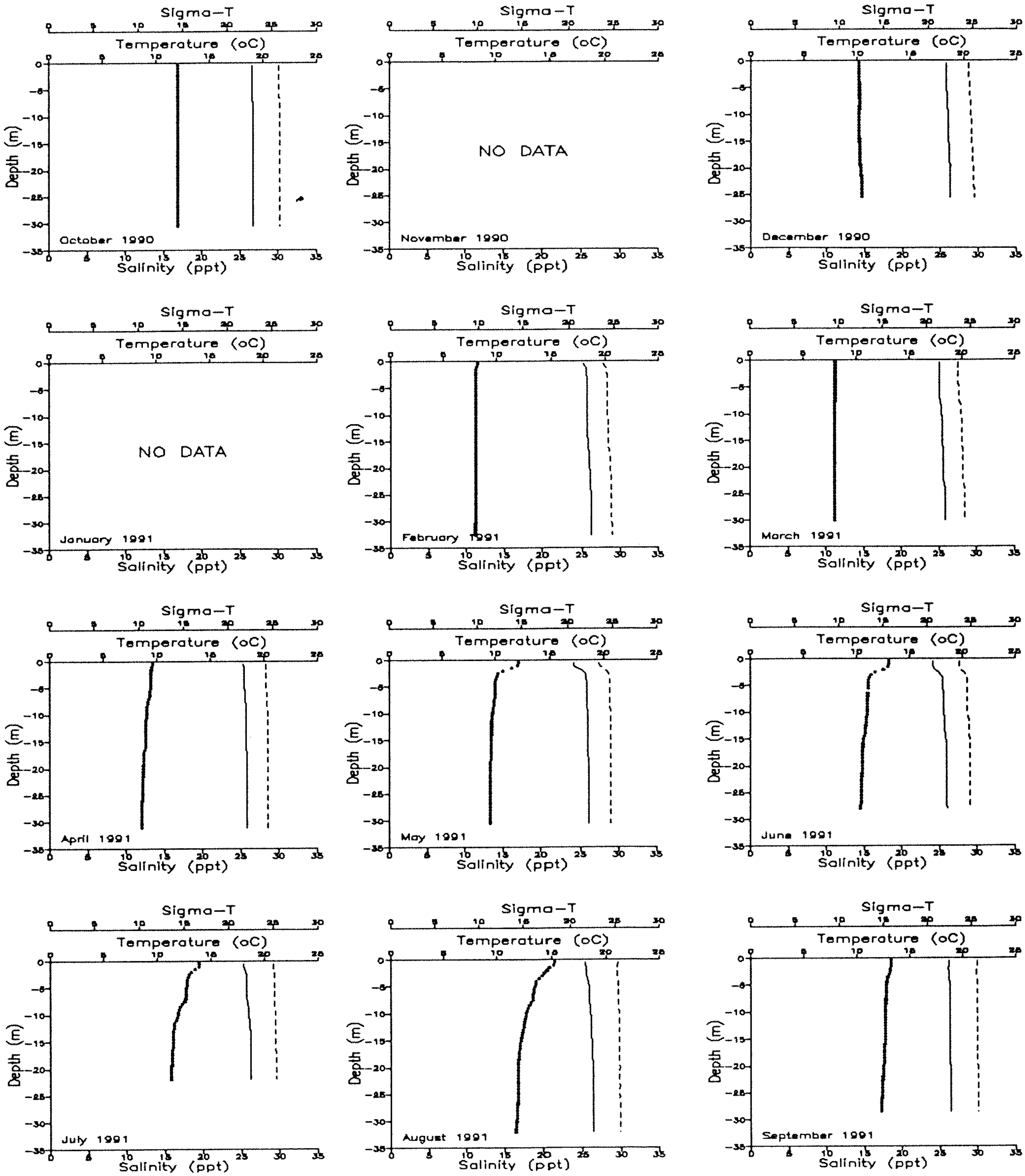
Dana Passage (Station DNA001)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

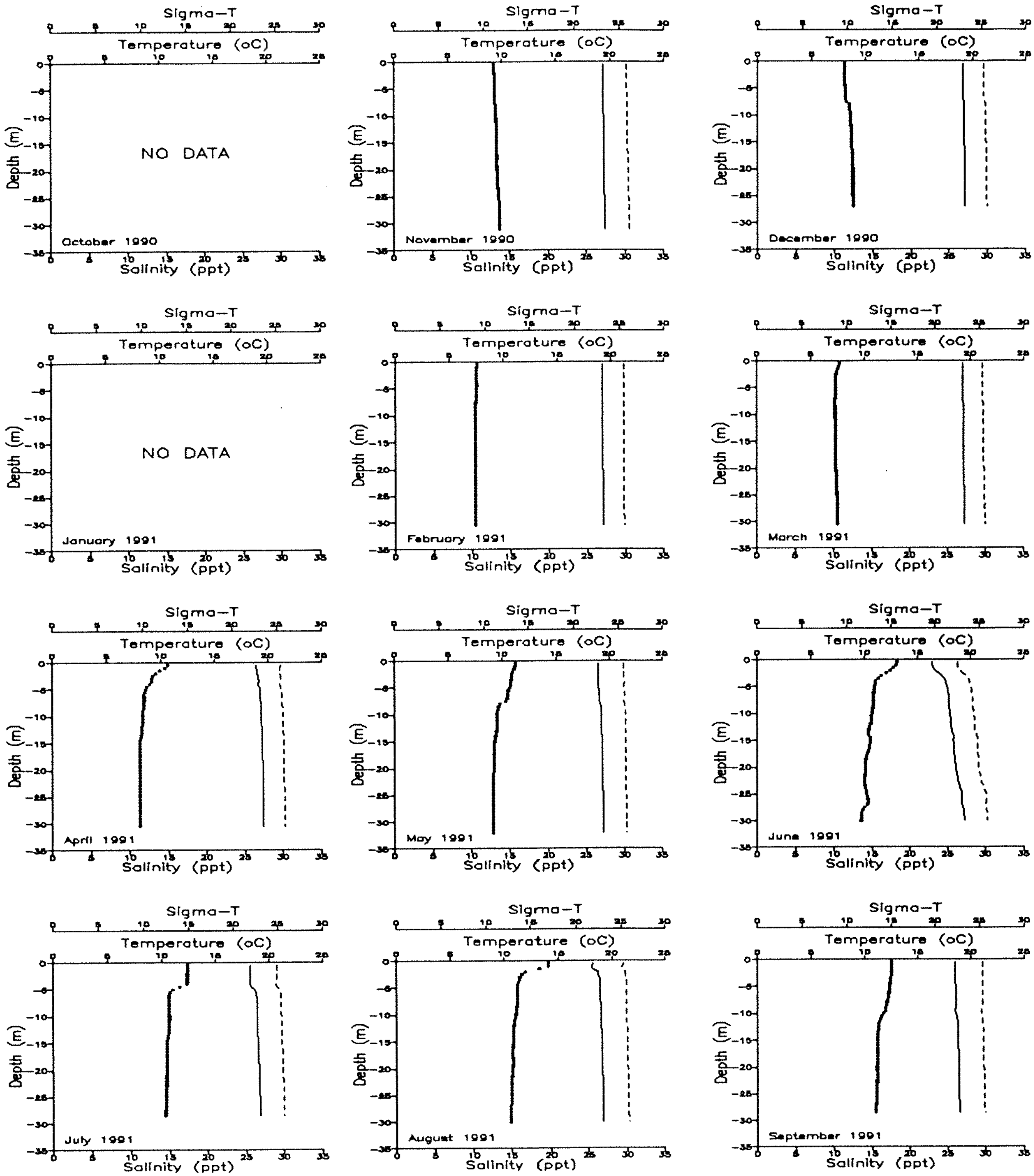
East Passage (Station EAP001)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

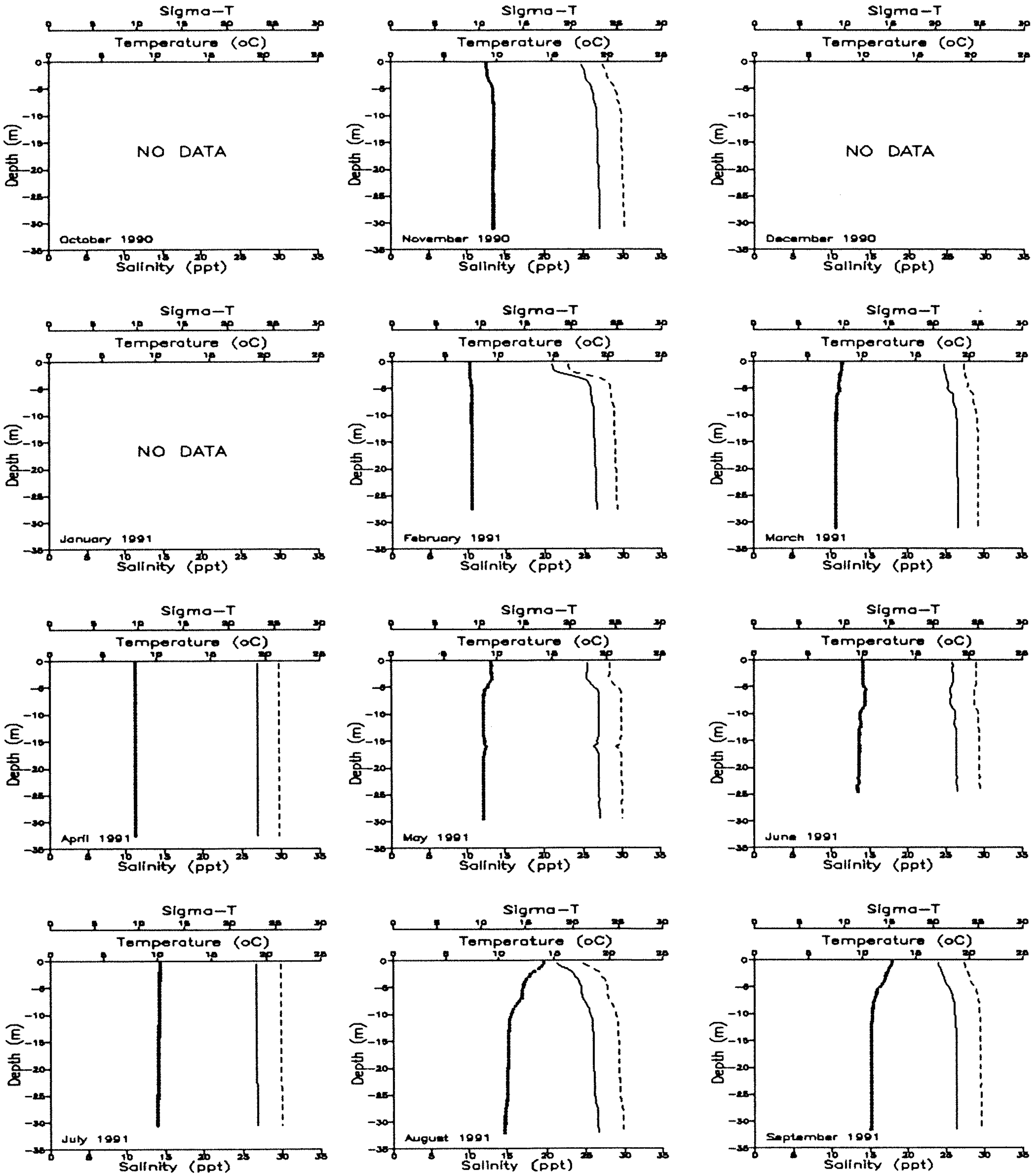
East Sound - Orcas Island (Station EAS001)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

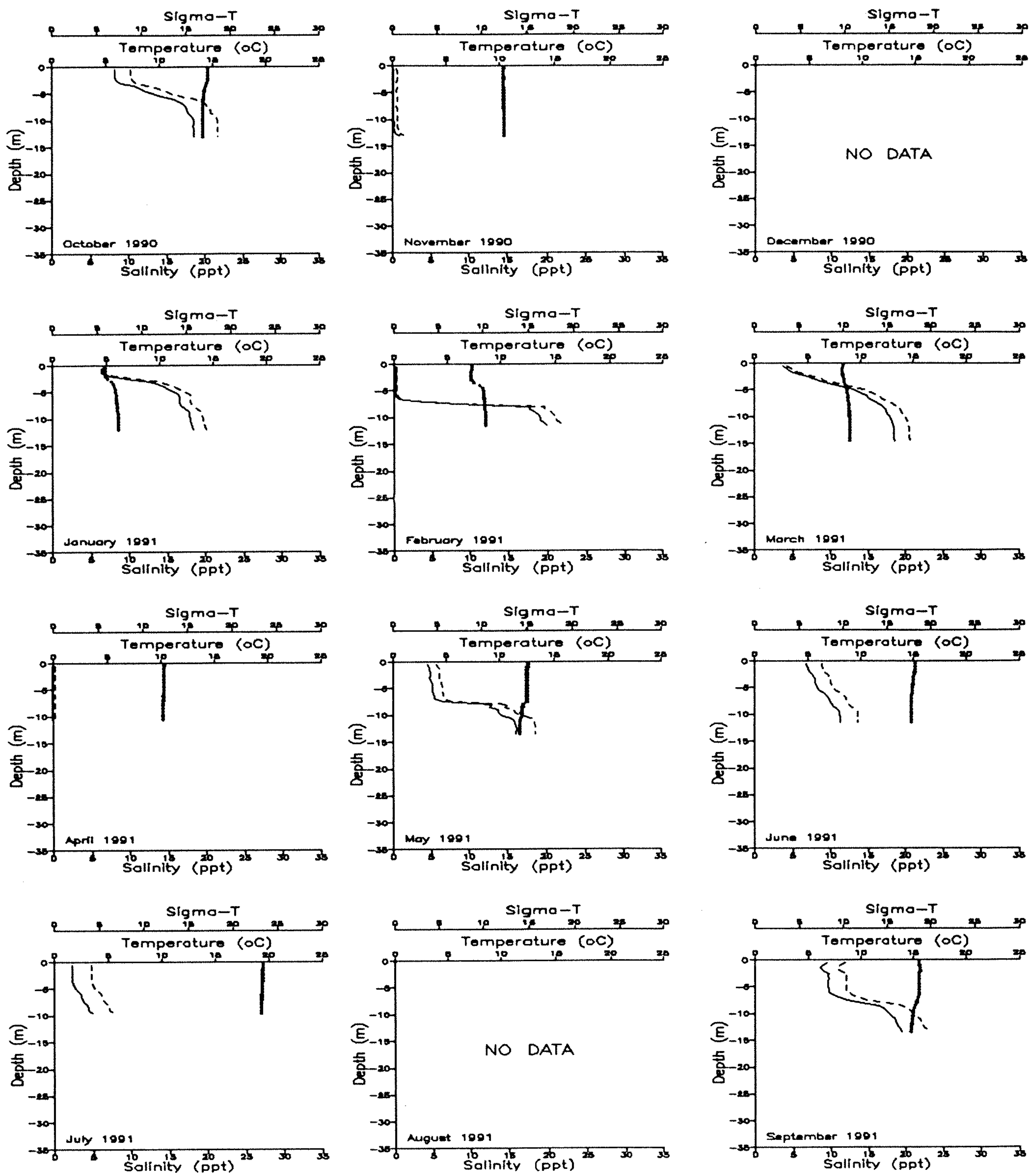
Strait of Georgia (Station GRG002)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

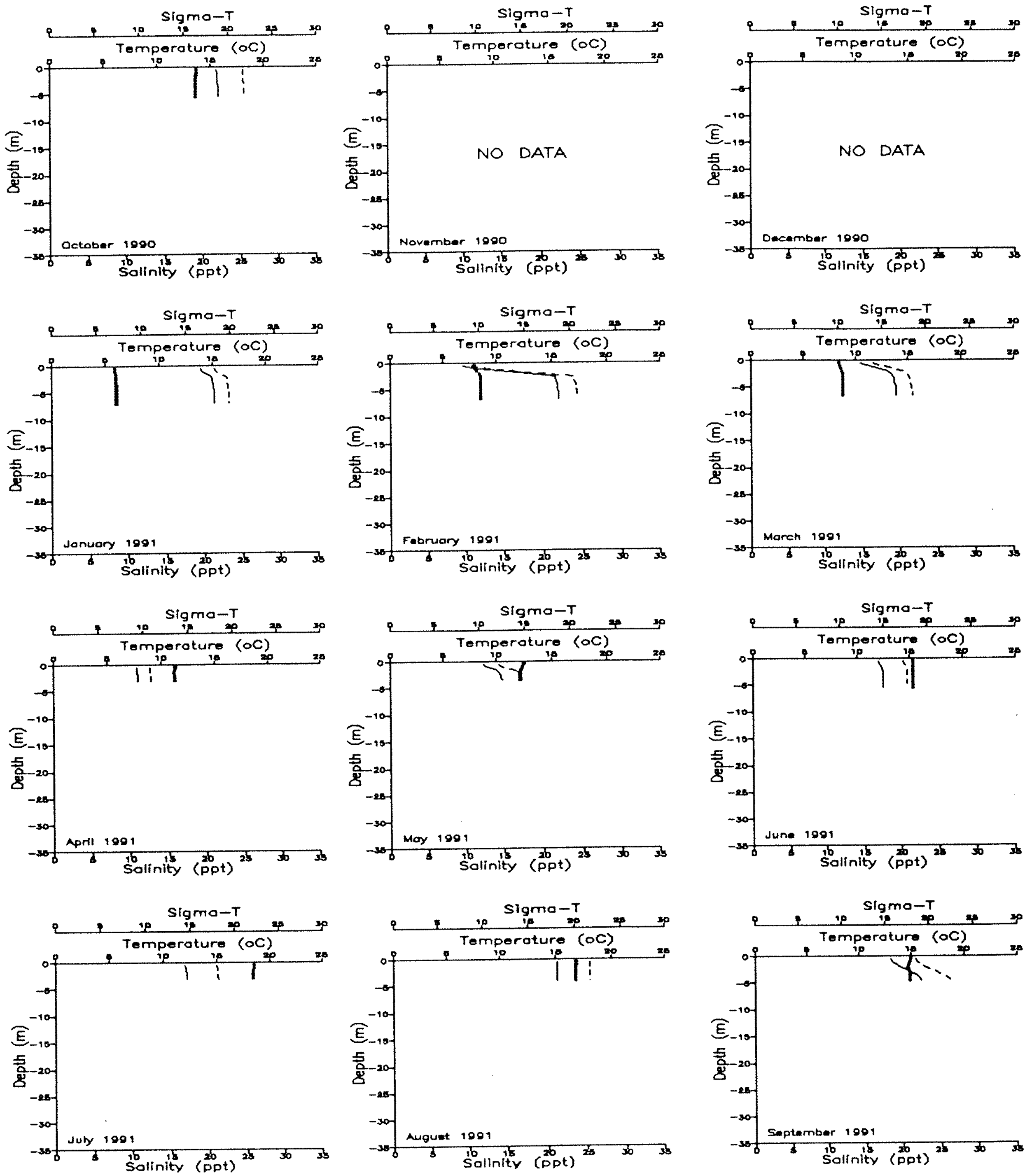
Gray's Harbor - Chehalis (Station GYS004)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

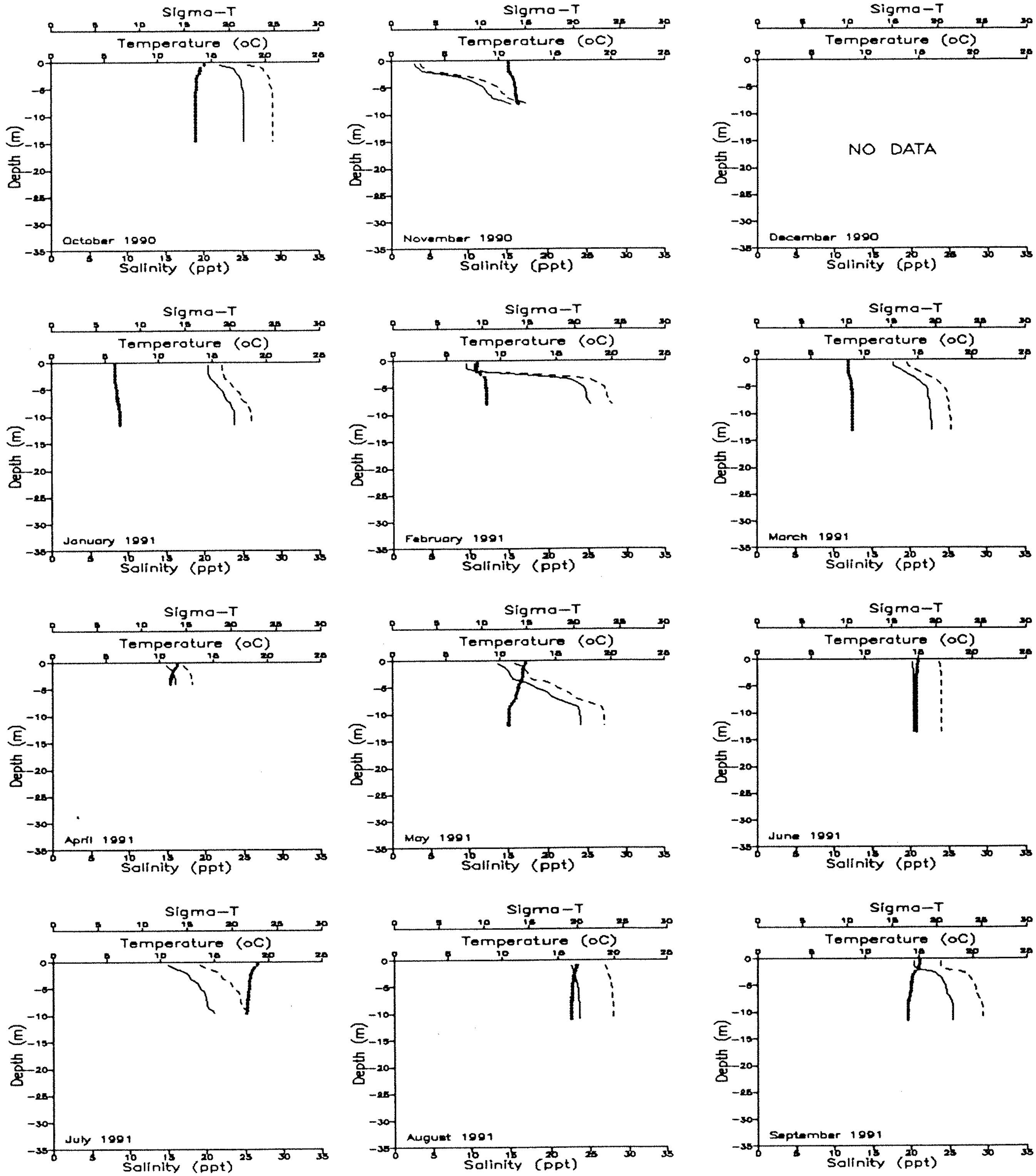
Gray's Harbor - South Channel (Station GYS008)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

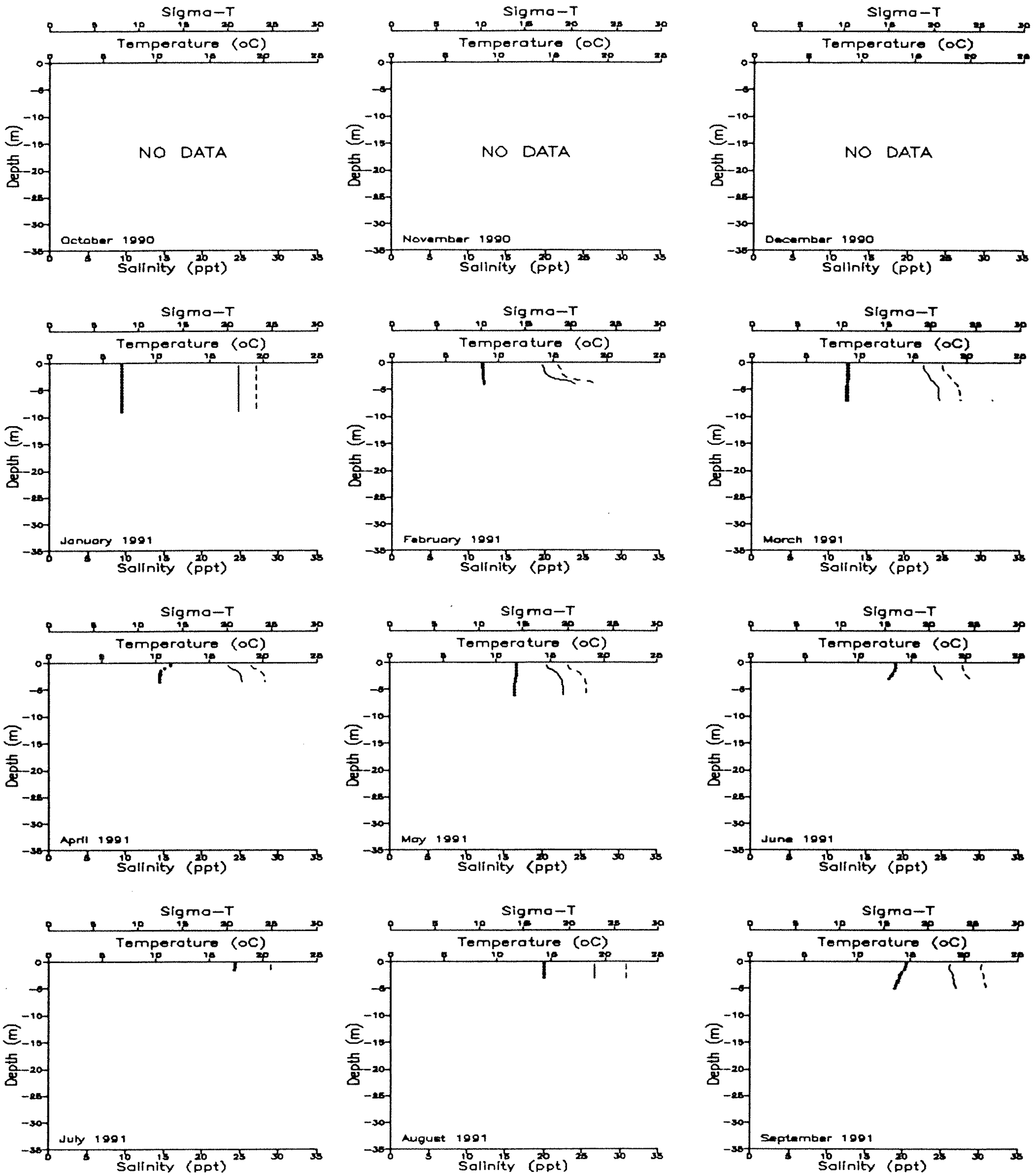
Gray's Harbor - North Channel (Station GYS009)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

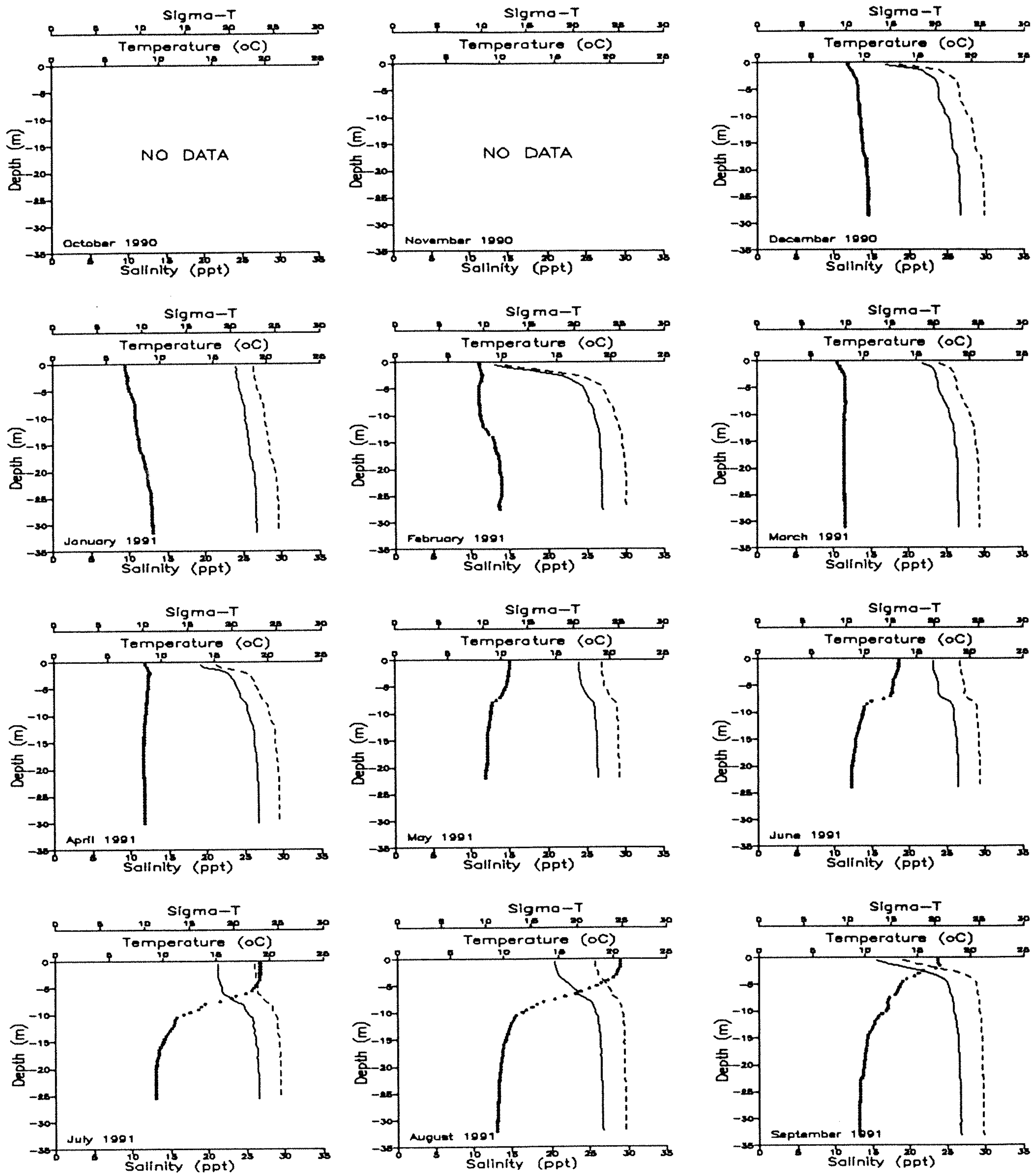
Gray's Harbor - Damon Point (Station GYS016)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

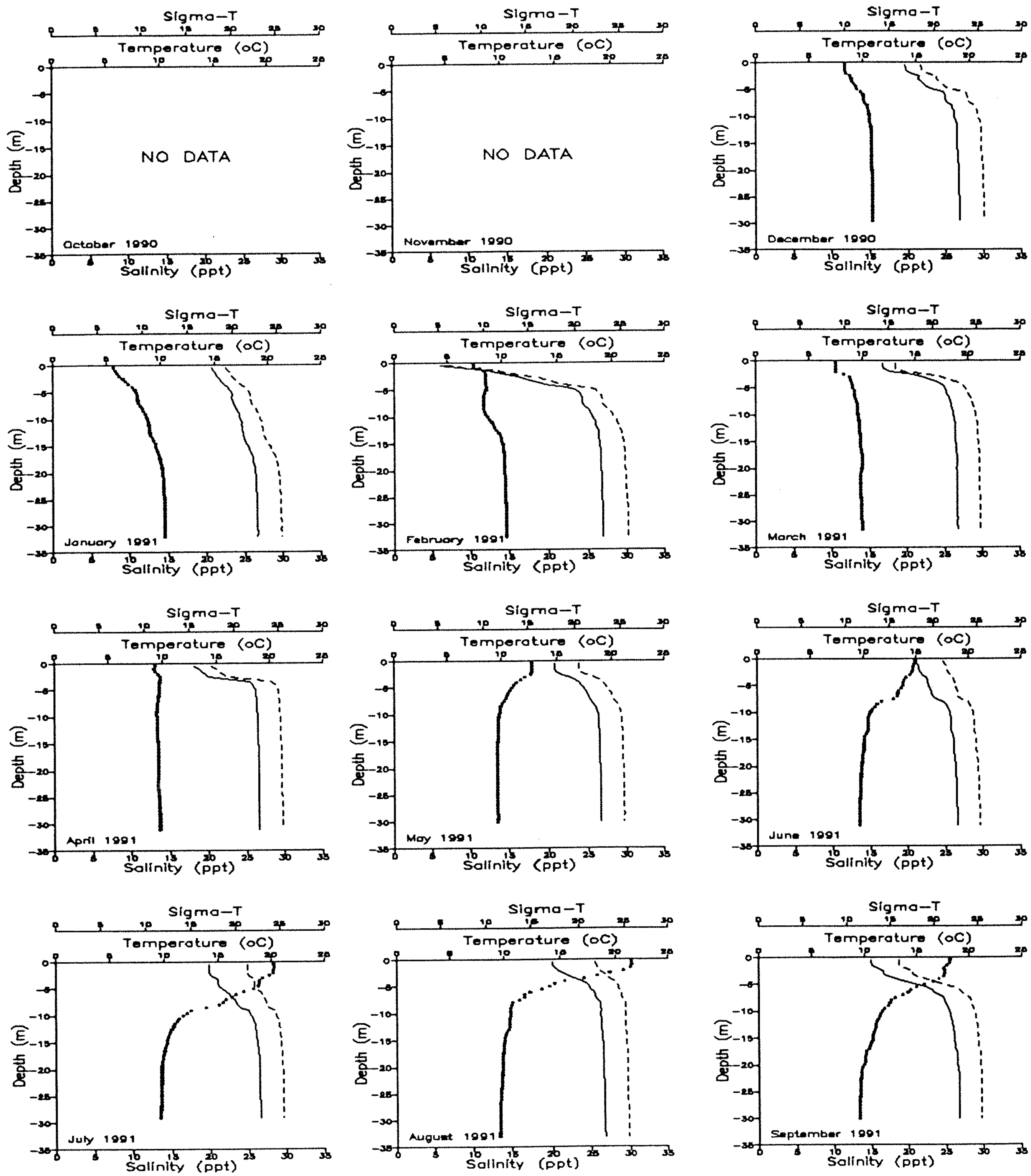
Central Hood Canal - Eldon (Station HCB003)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

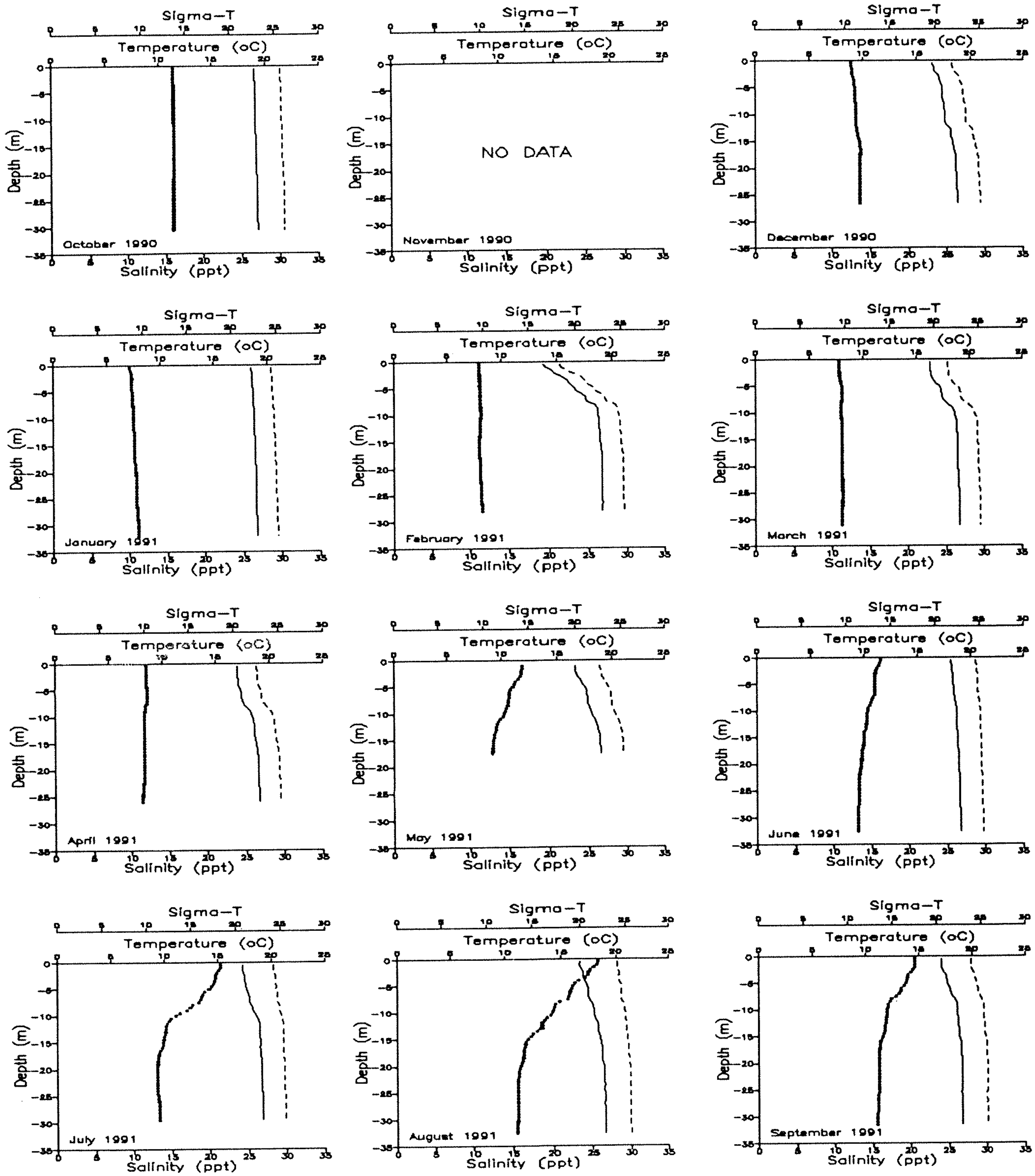
South Hood Canal at Sister's Point (Station HCB004)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

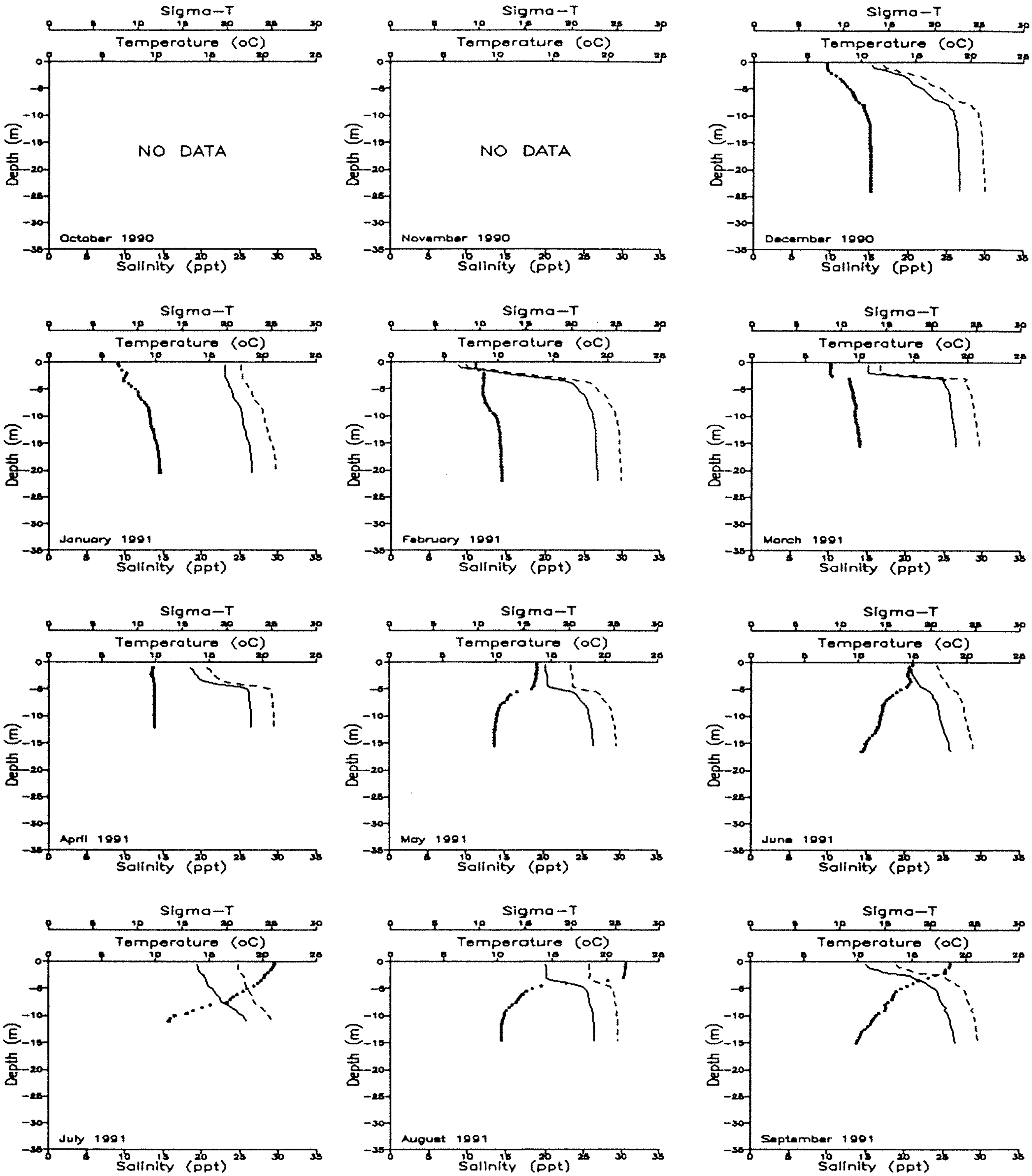
North Hood Canal - Bangor (Station HCB006)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

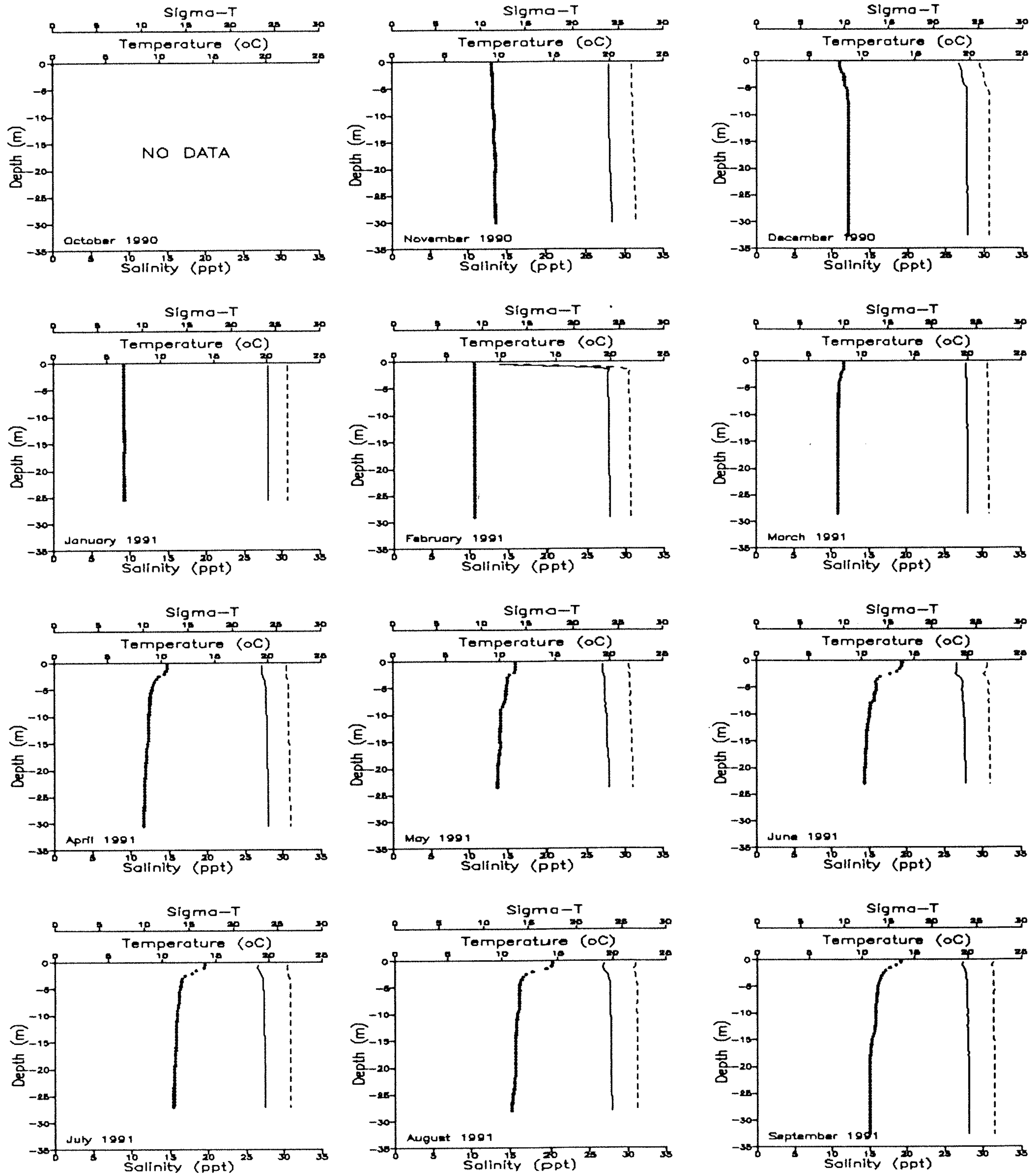
Lynch Cove (Station HCB007)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

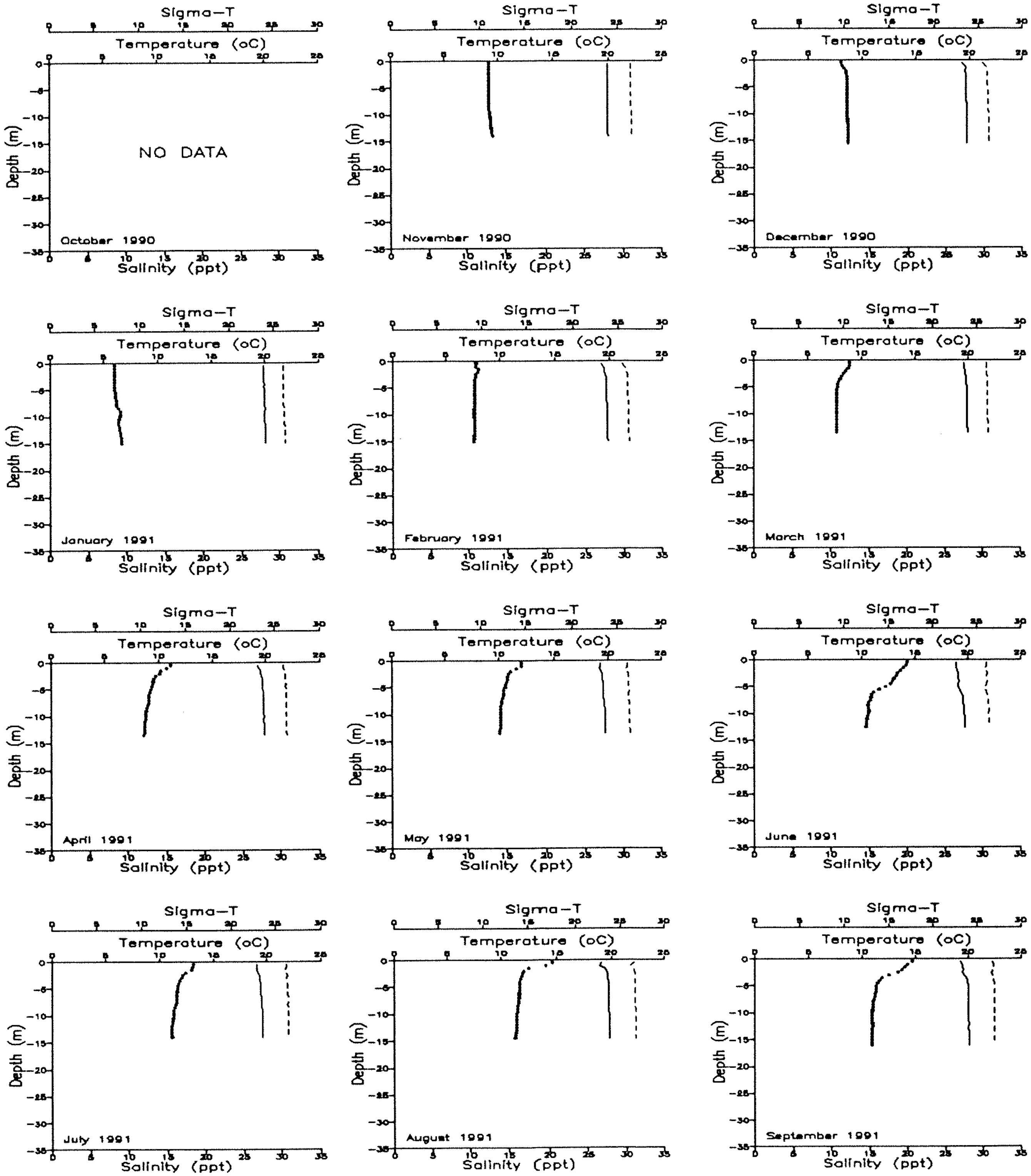
Sequim Bay (Station JDF005)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

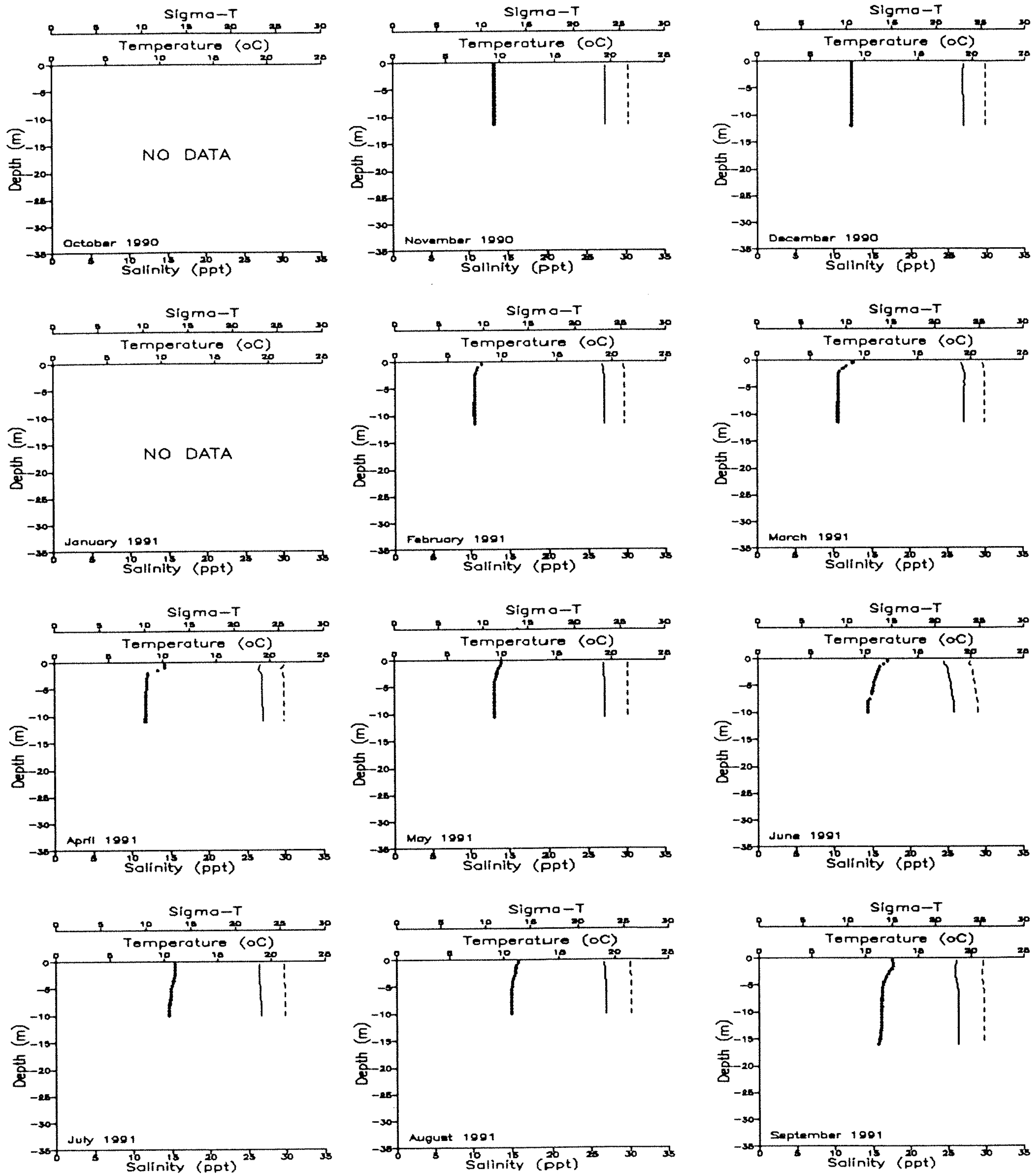
Sequim Bay - Goose Point (Station JDF007)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

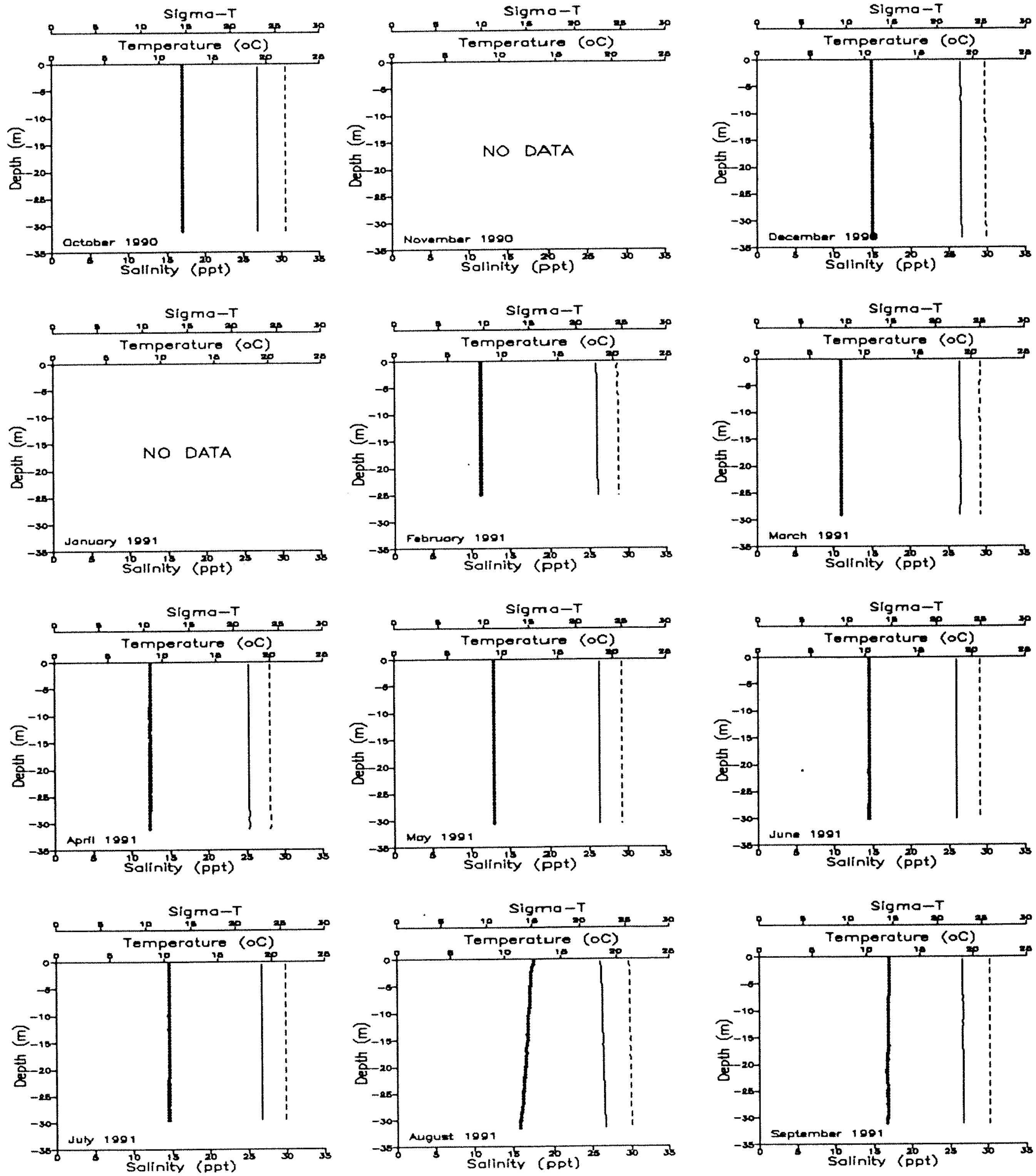
Lopez Sound - Lopez Island (Station LOP001)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

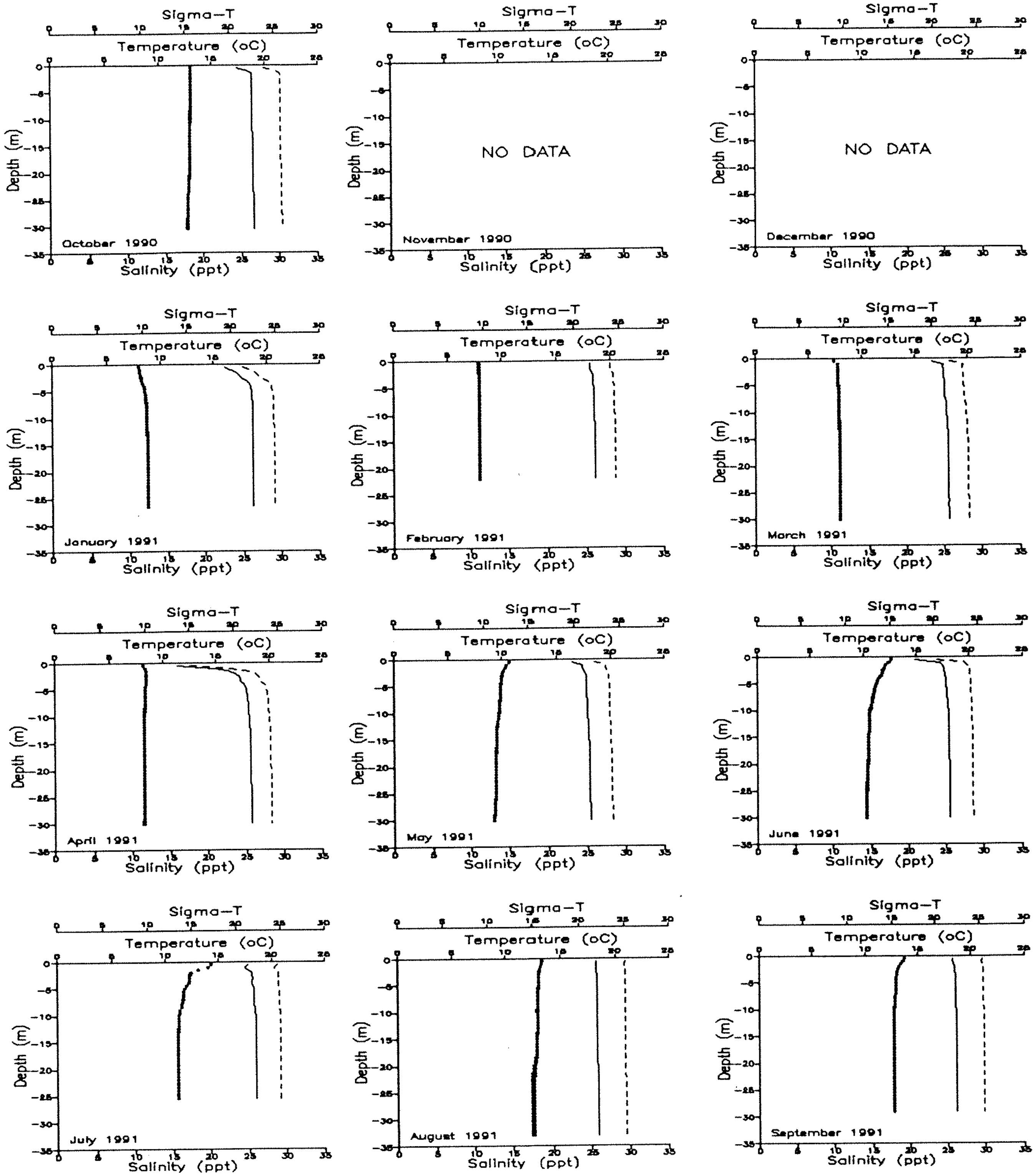
Tacoma Narrows (Station NRR001)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

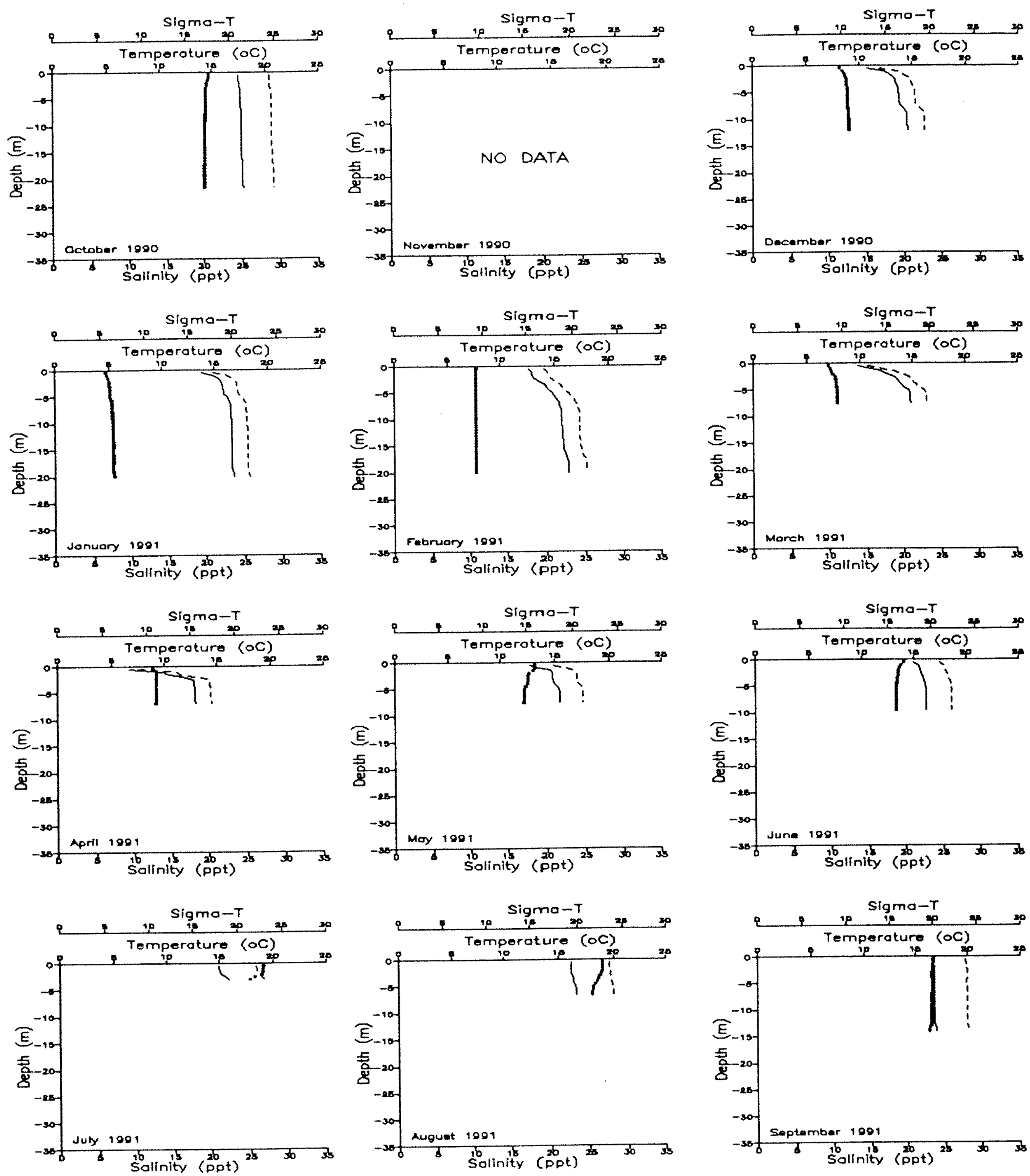
Nisqually Reach (Station NSQ001)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

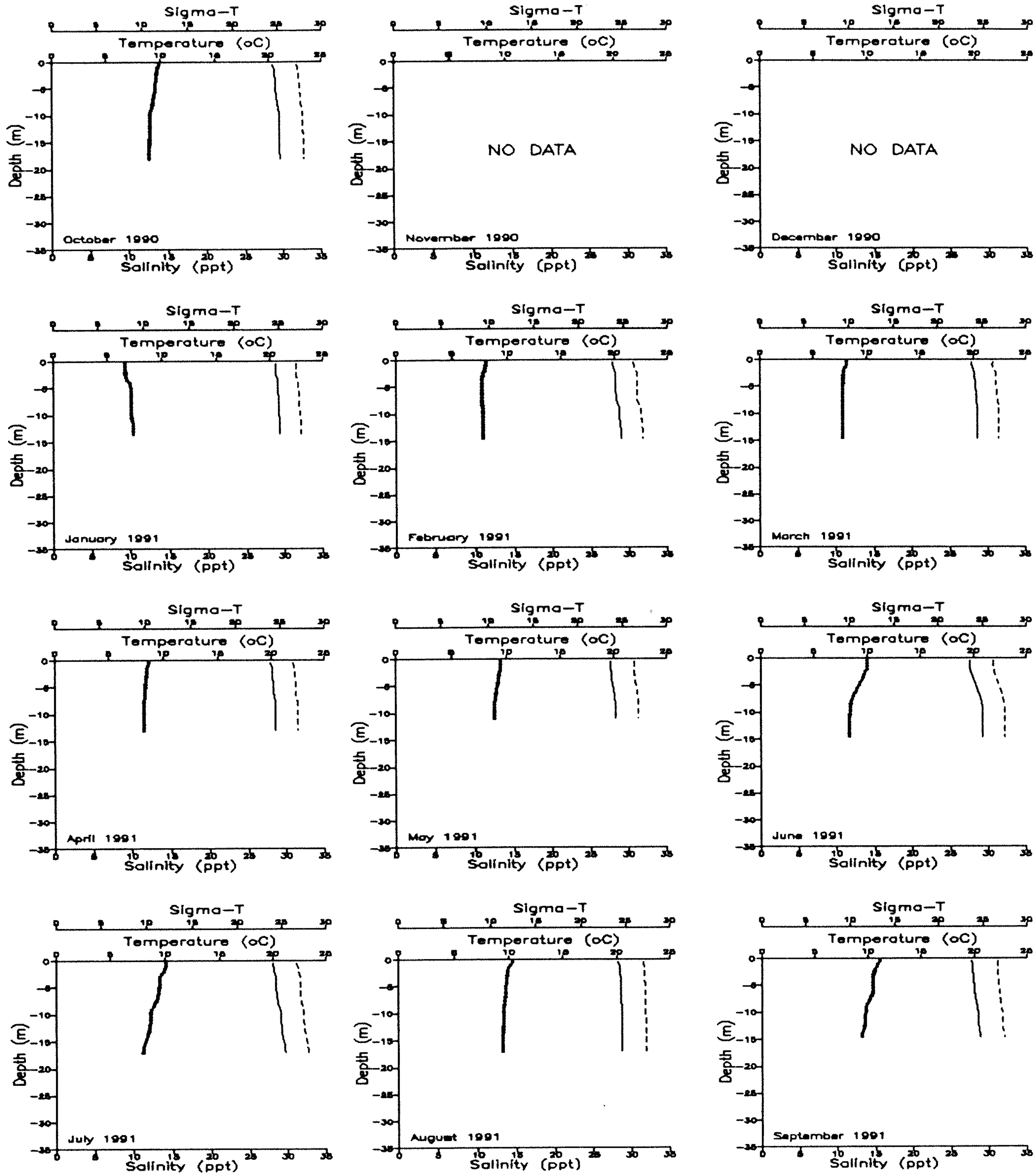
Oakland Bay (Station OAK004)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

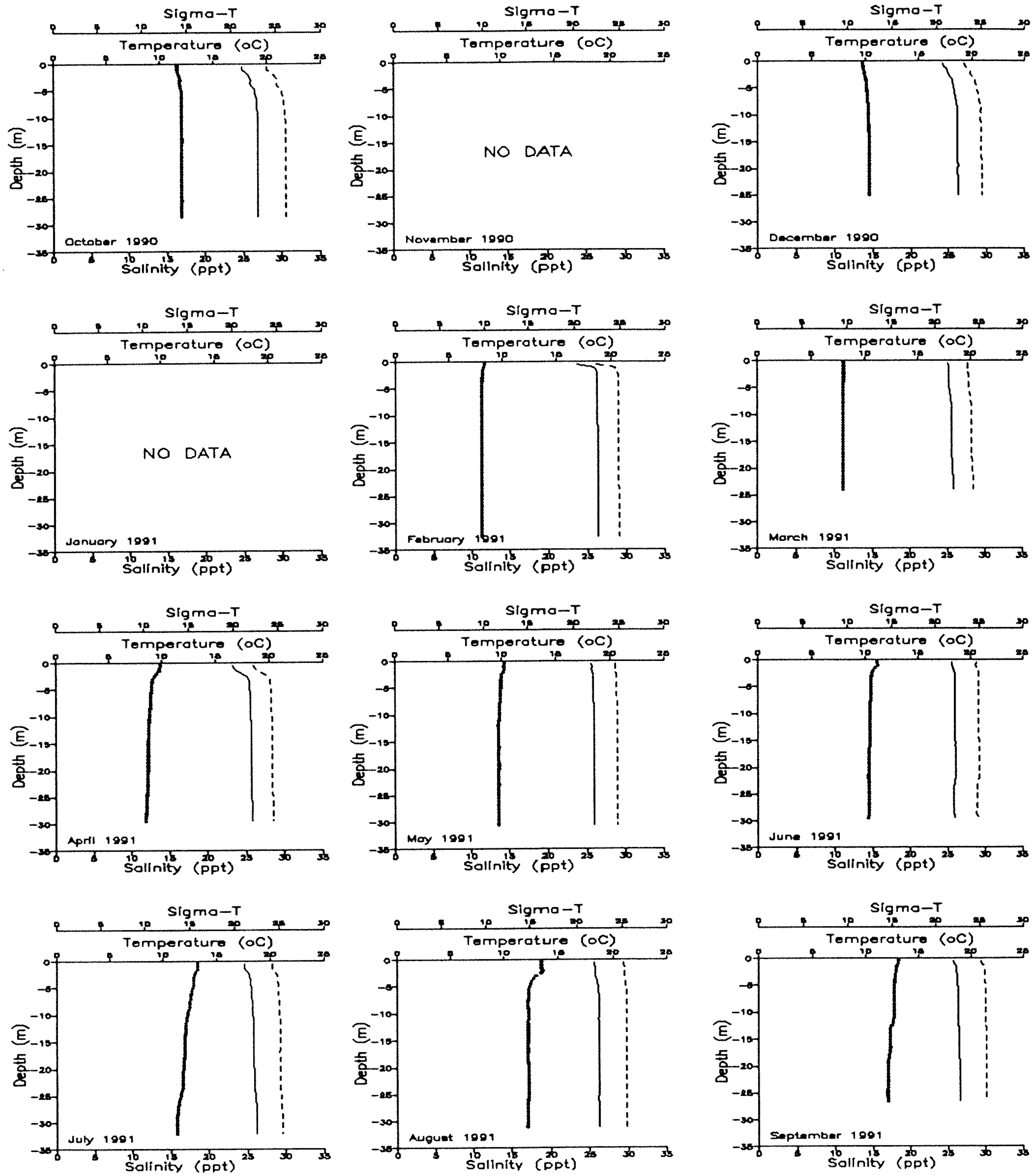
Straits of Juan de Fuca Near Port Angeles (Station PAH008)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

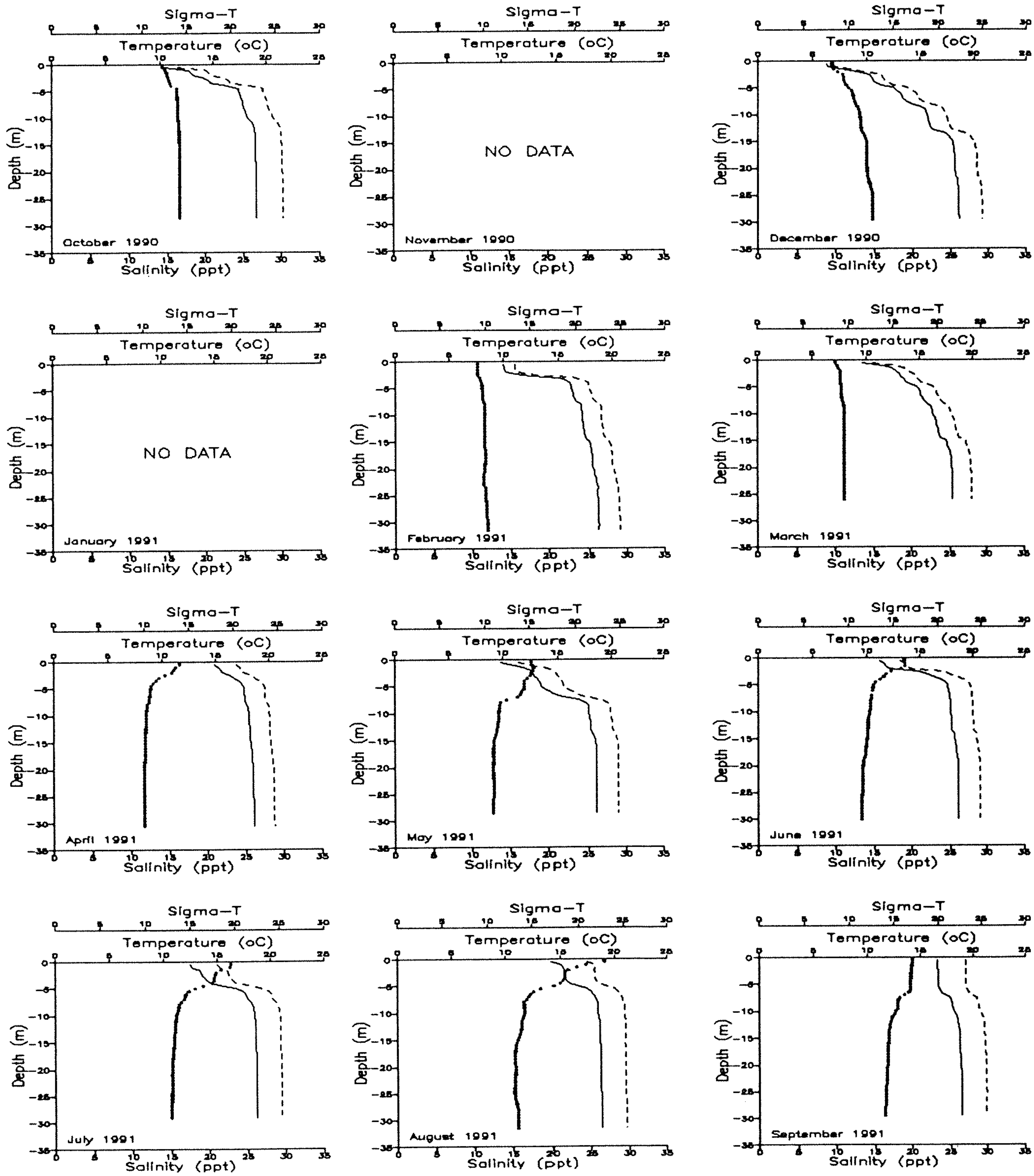
Puget Sound - Main Basin (Station PSB003)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

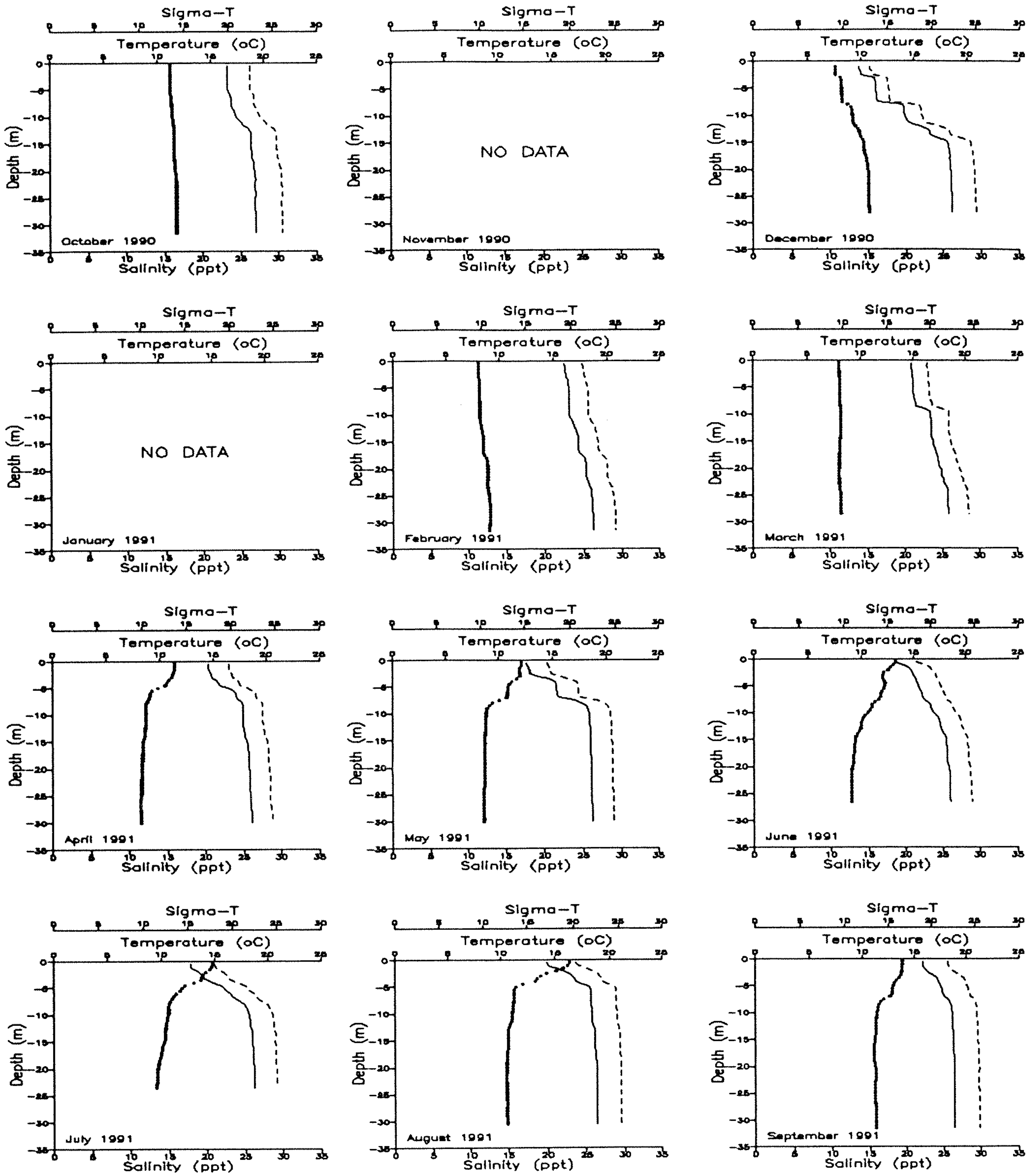
Possession Sound - Gedney Island (Station PSS019)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

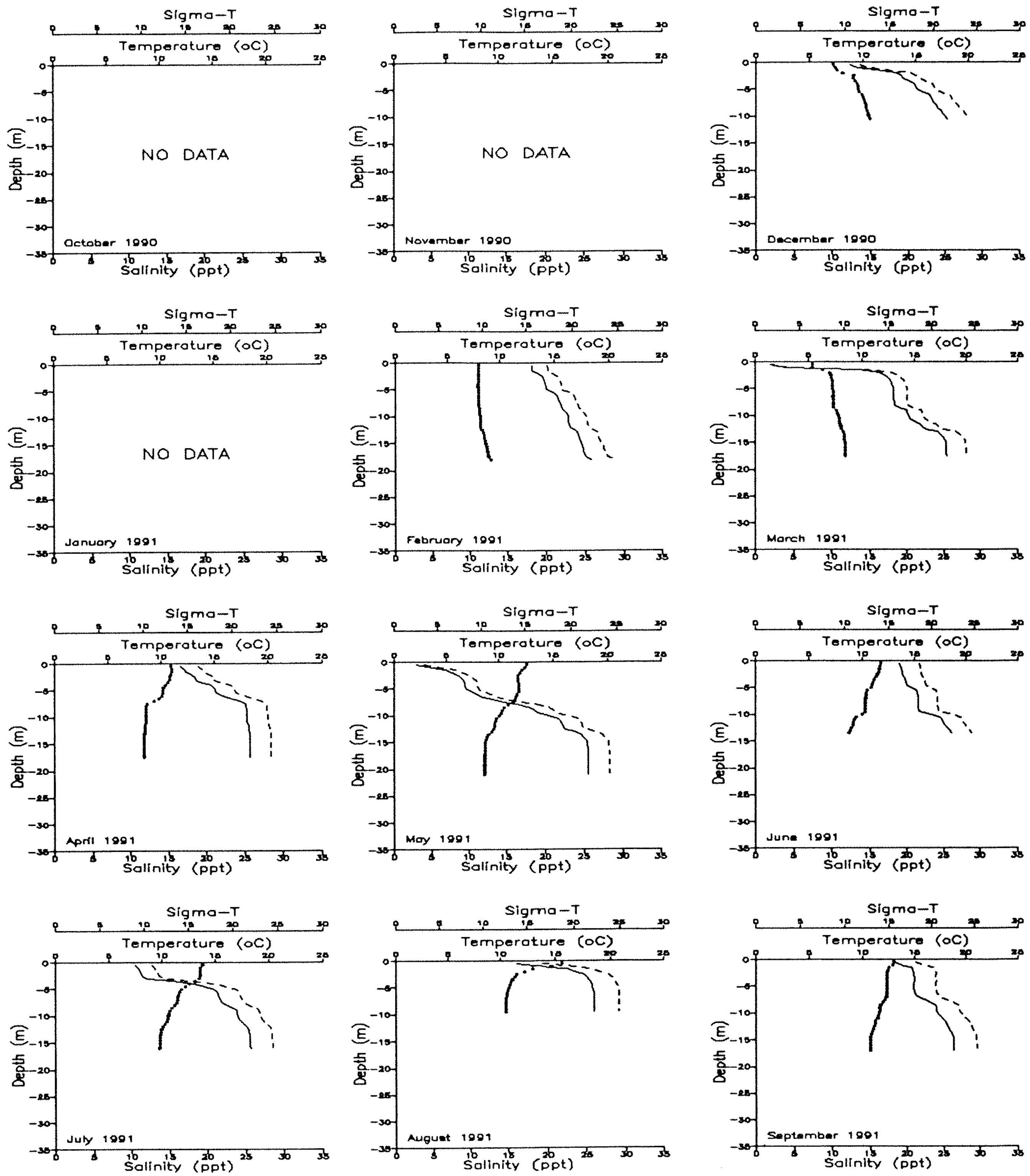
Saratoga Passage (Station SAR003)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

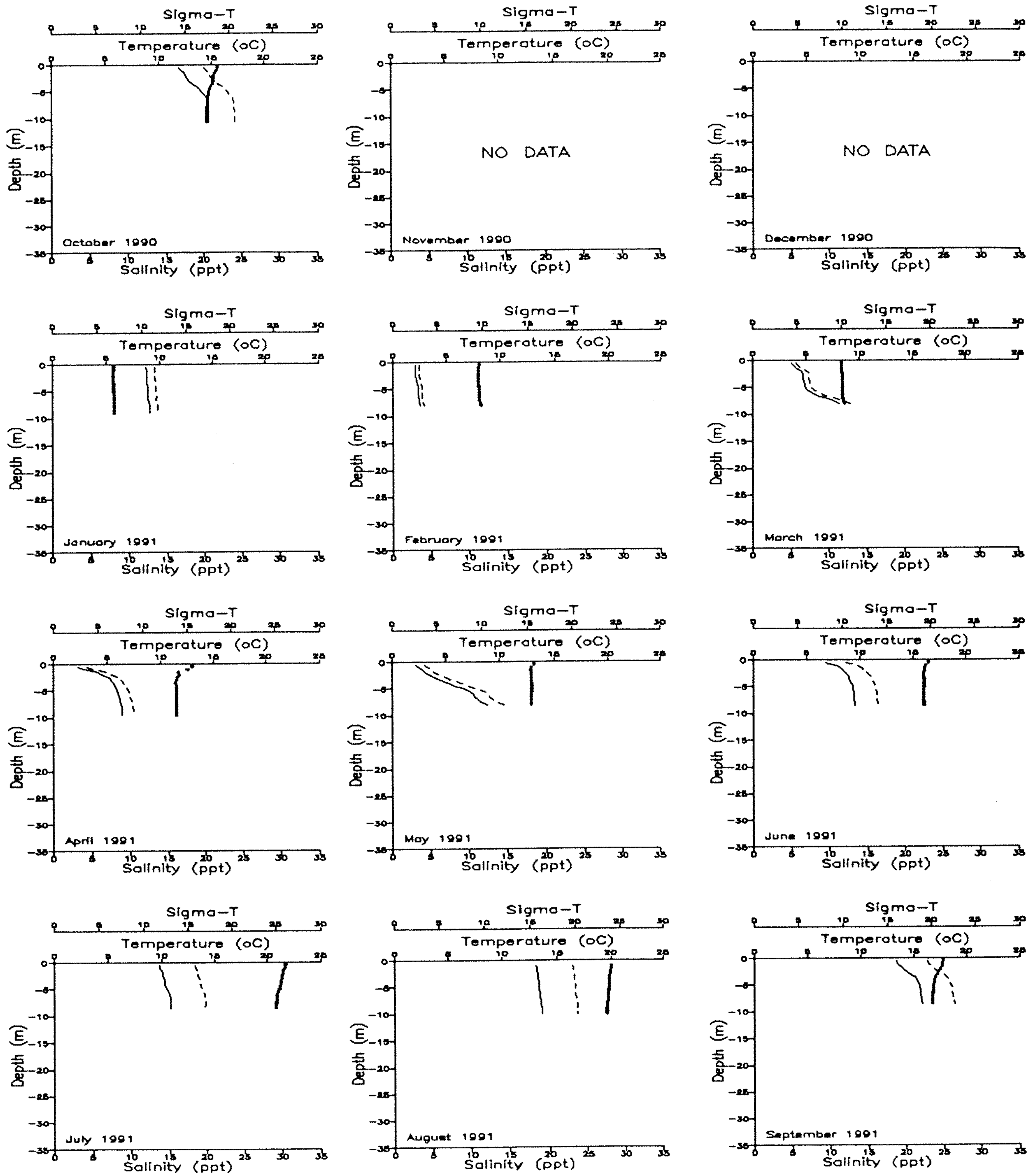
Skagit Bay (Station SKG003)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

Willapa Bay - Willapa River (Station WPA001)



Key:

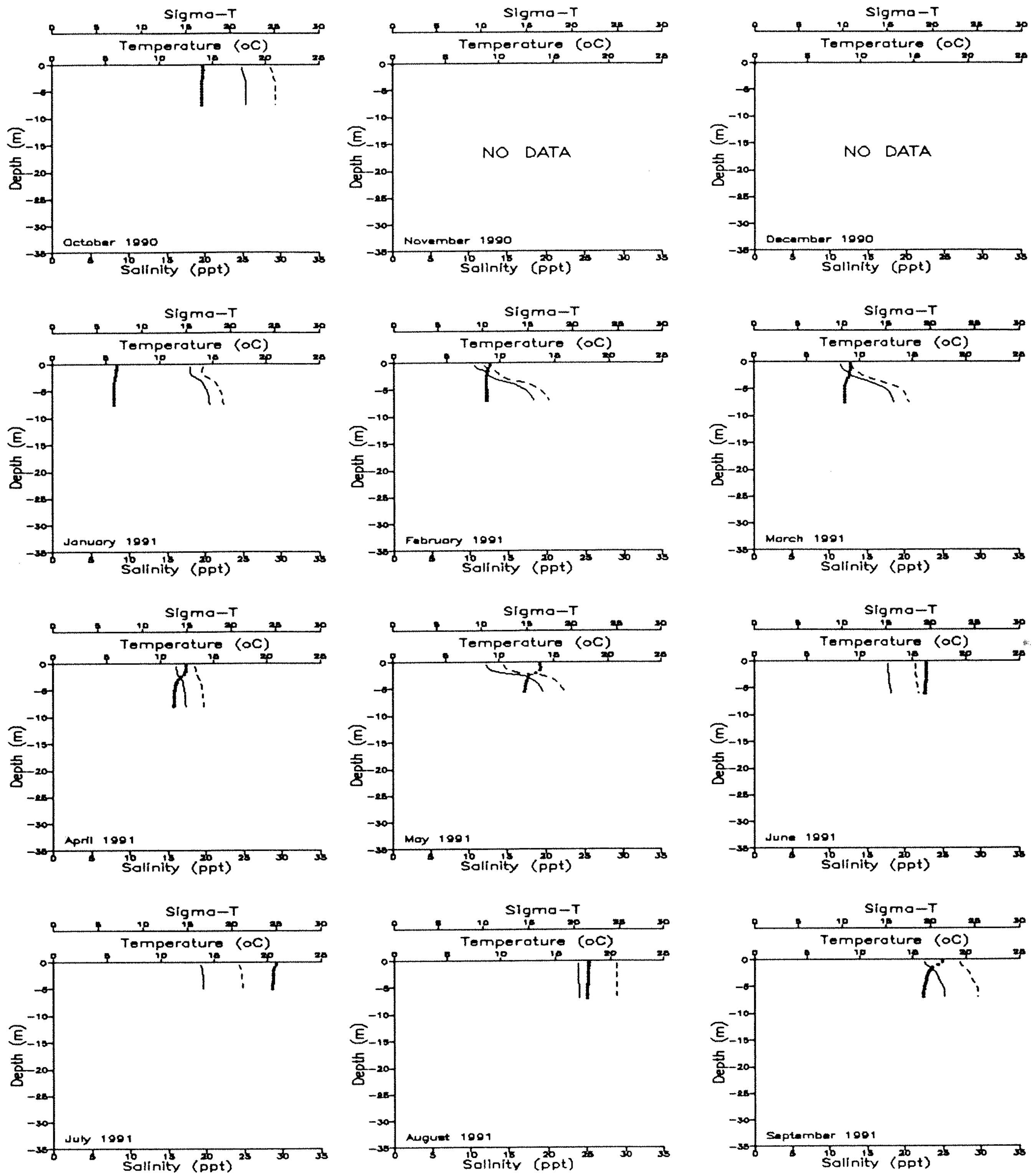
Temperature = Dotted line

Salinity = Dashed line

Sigma-t = Solid line

WATERYEAR 1991

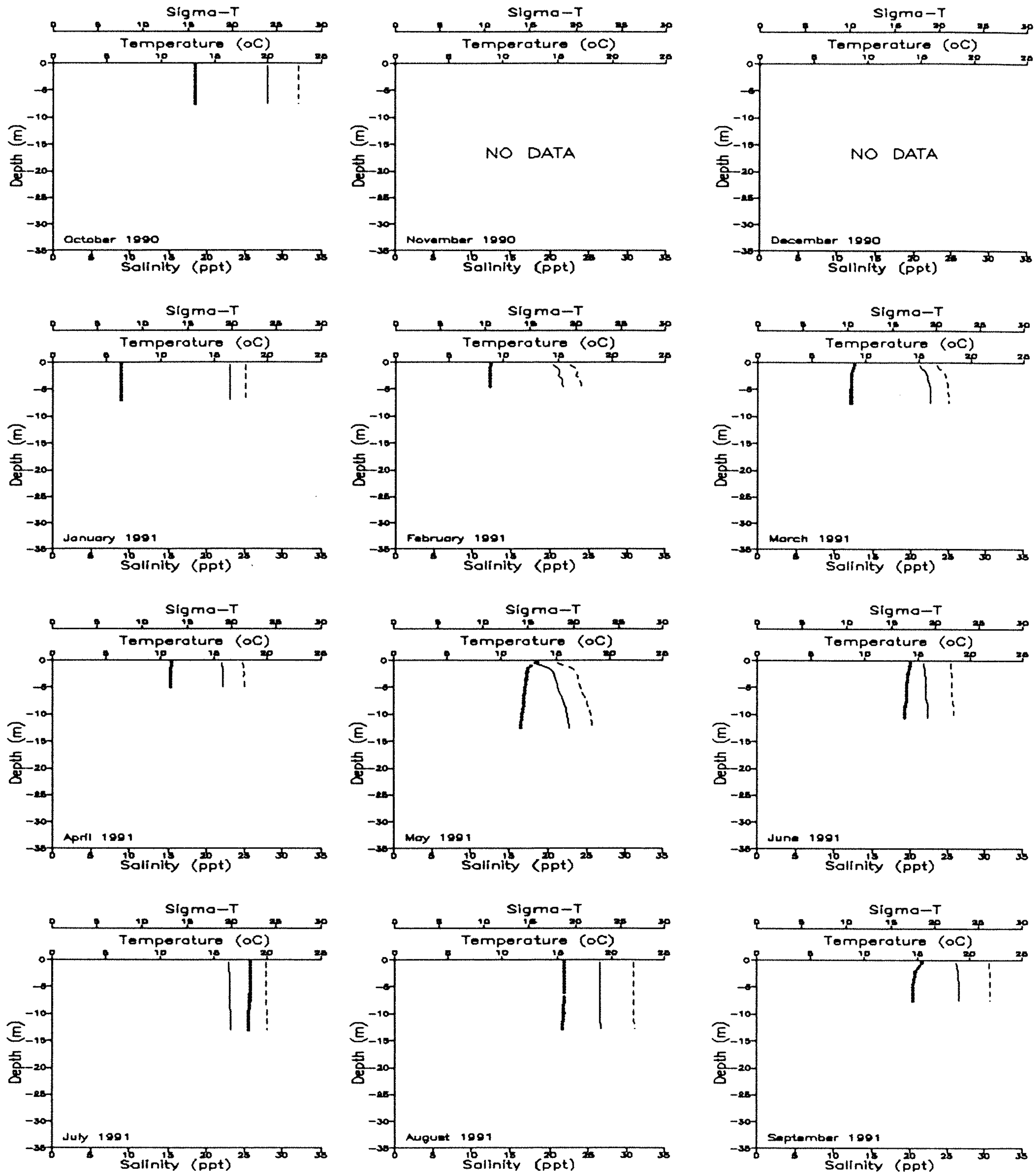
Willapa Bay - Johnson Slough (Station WPA003)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

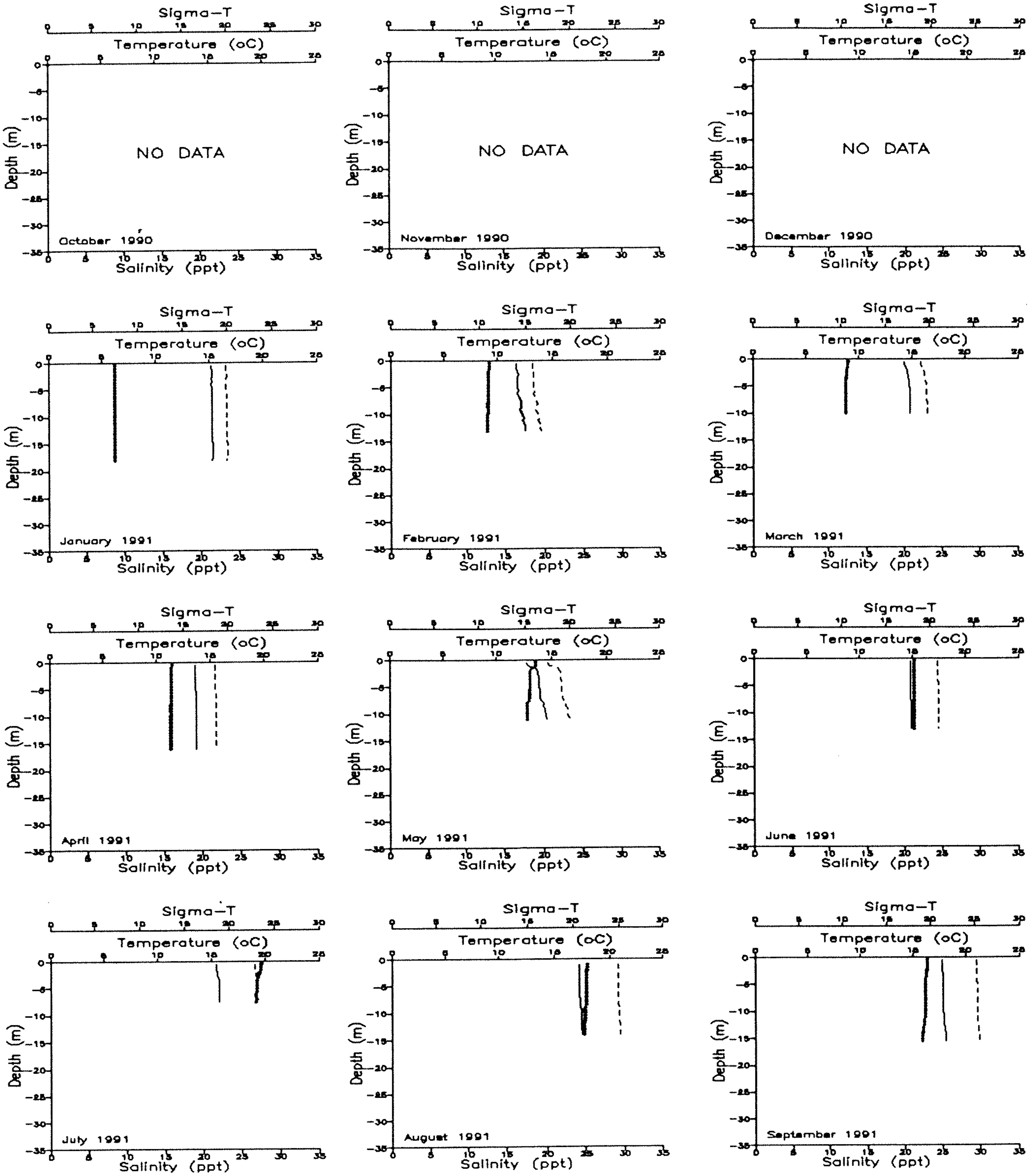
North Willapa Bay (Station WPA004)



Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

WATERYEAR 1991

Willapa Bay - Nahcotta Channel (Station WPA006)



Key:

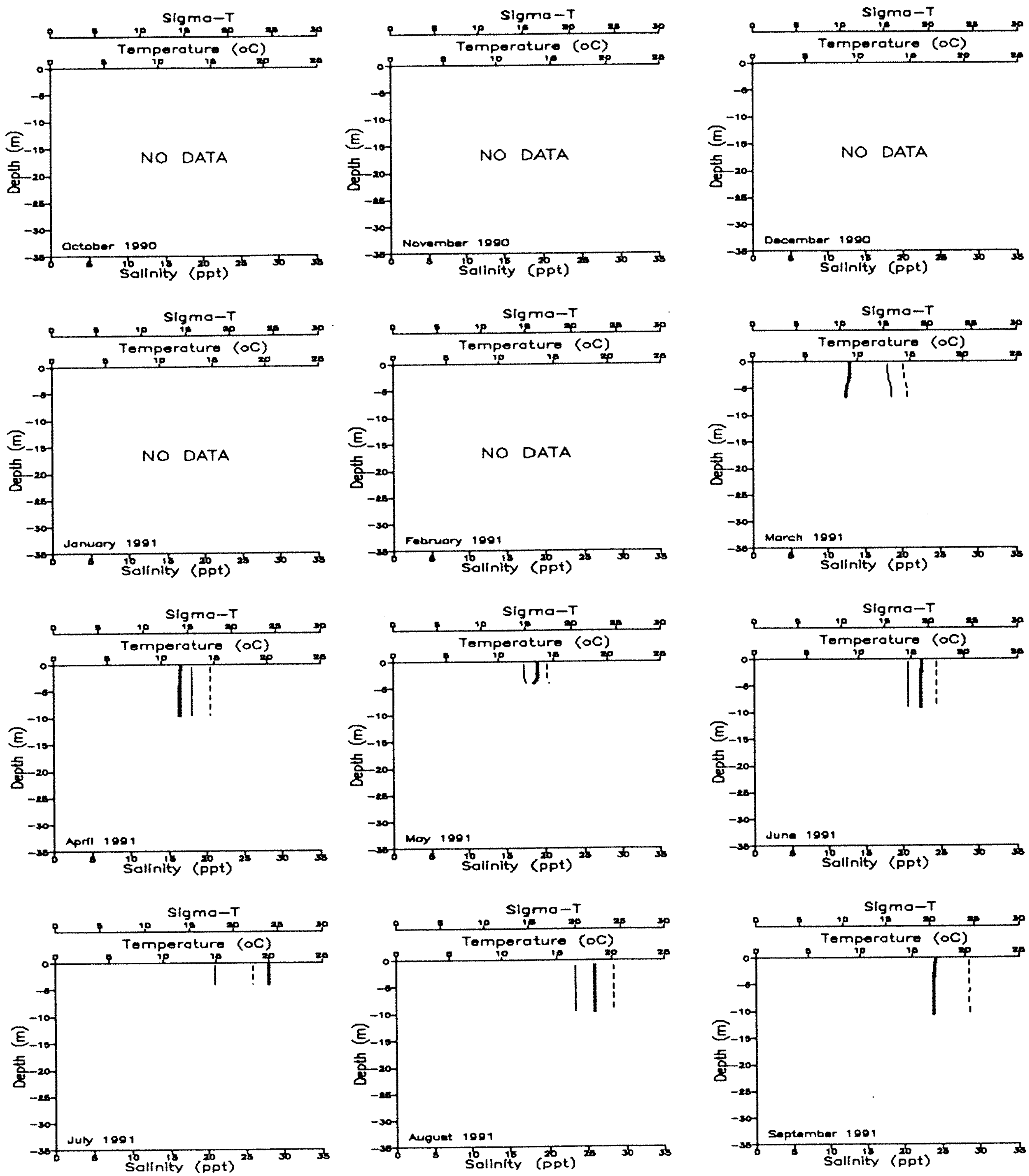
Temperature = Dotted line

Salinity = Dashed line

Sigma-t = Solid line

WATERYEAR 1991

Willapa Bay - Jensen Point (Station WPA007)



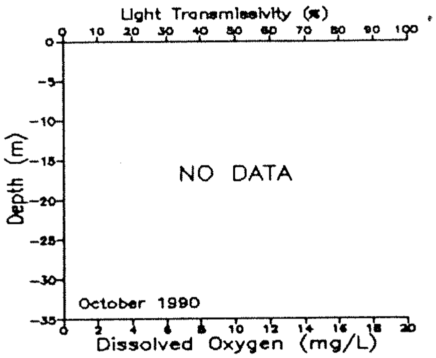
Key:
Temperature = Dotted line
Salinity = Dashed line
Sigma-t = Solid line

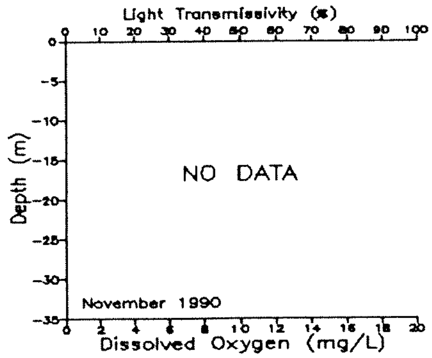
APPENDIX D

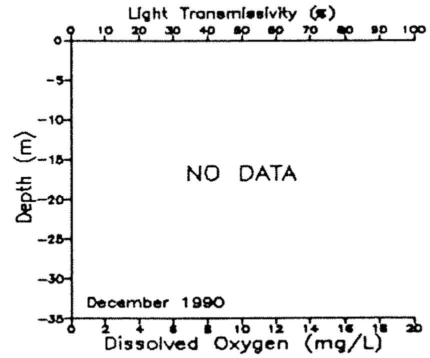
DISSOLVED OXYGEN AND LIGHT TRANSMISSIVITY PROFILES FOR ALL WY 1991 LONG-TERM MONITORING STATIONS

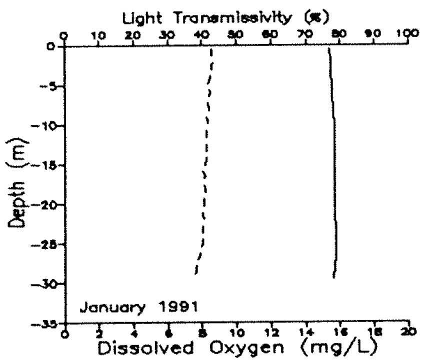
WATERYEAR 1991

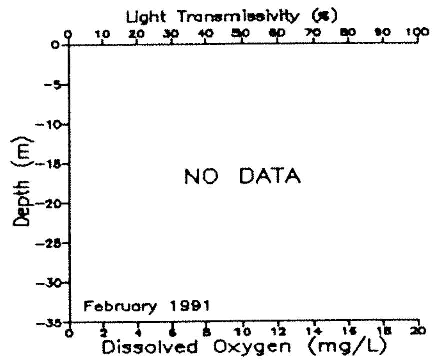
Straits of Juan de Fuca (Station ADM002)

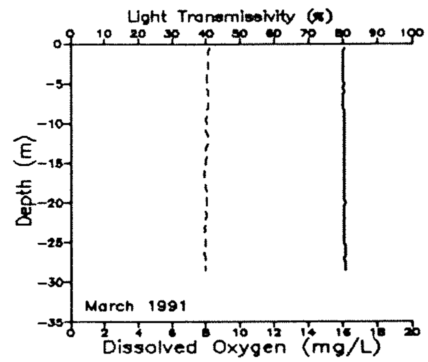


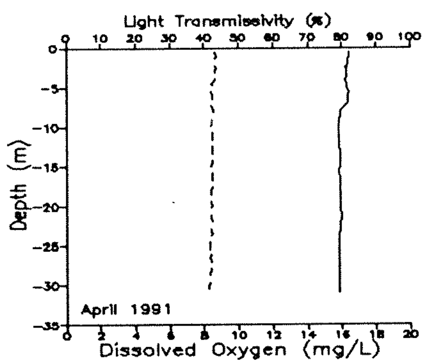


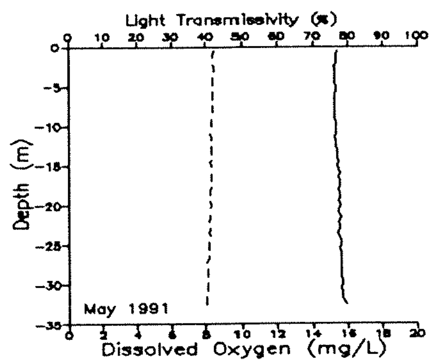


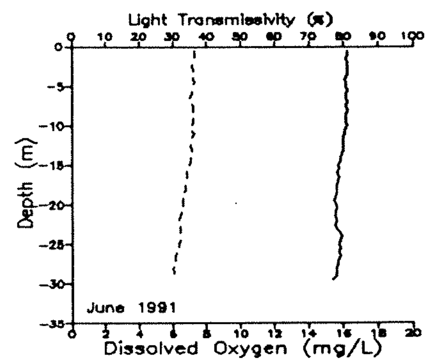


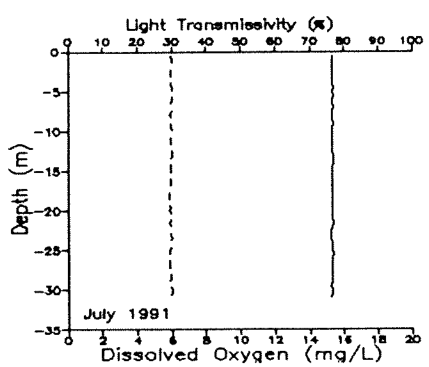


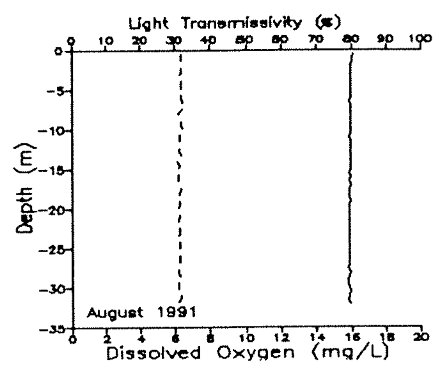


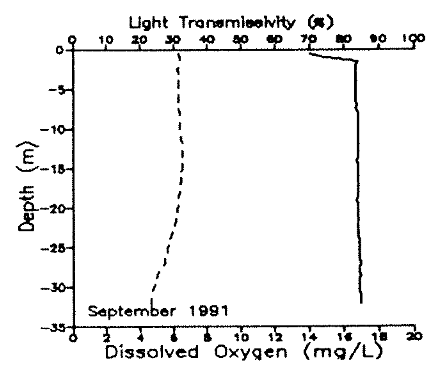








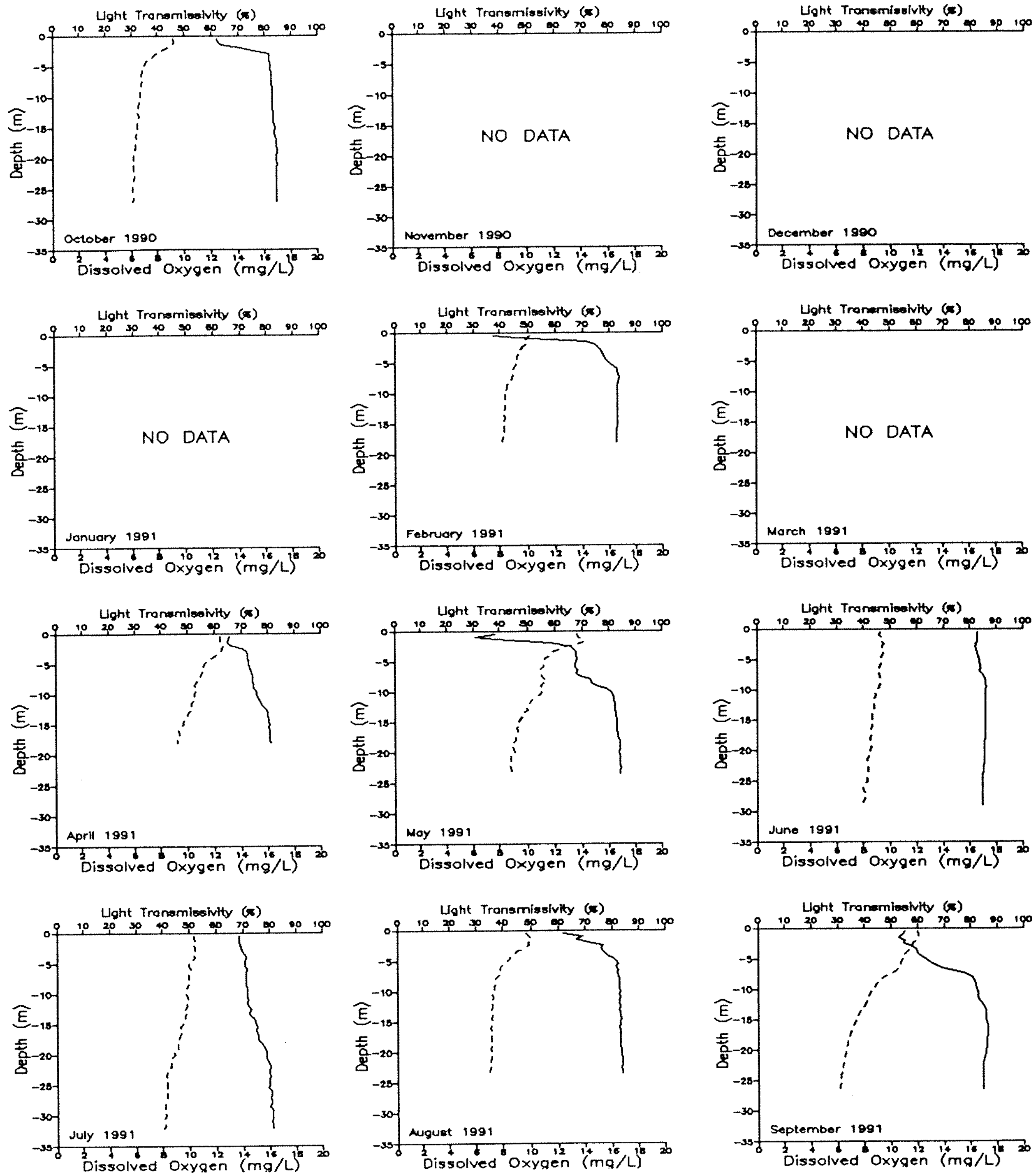




Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

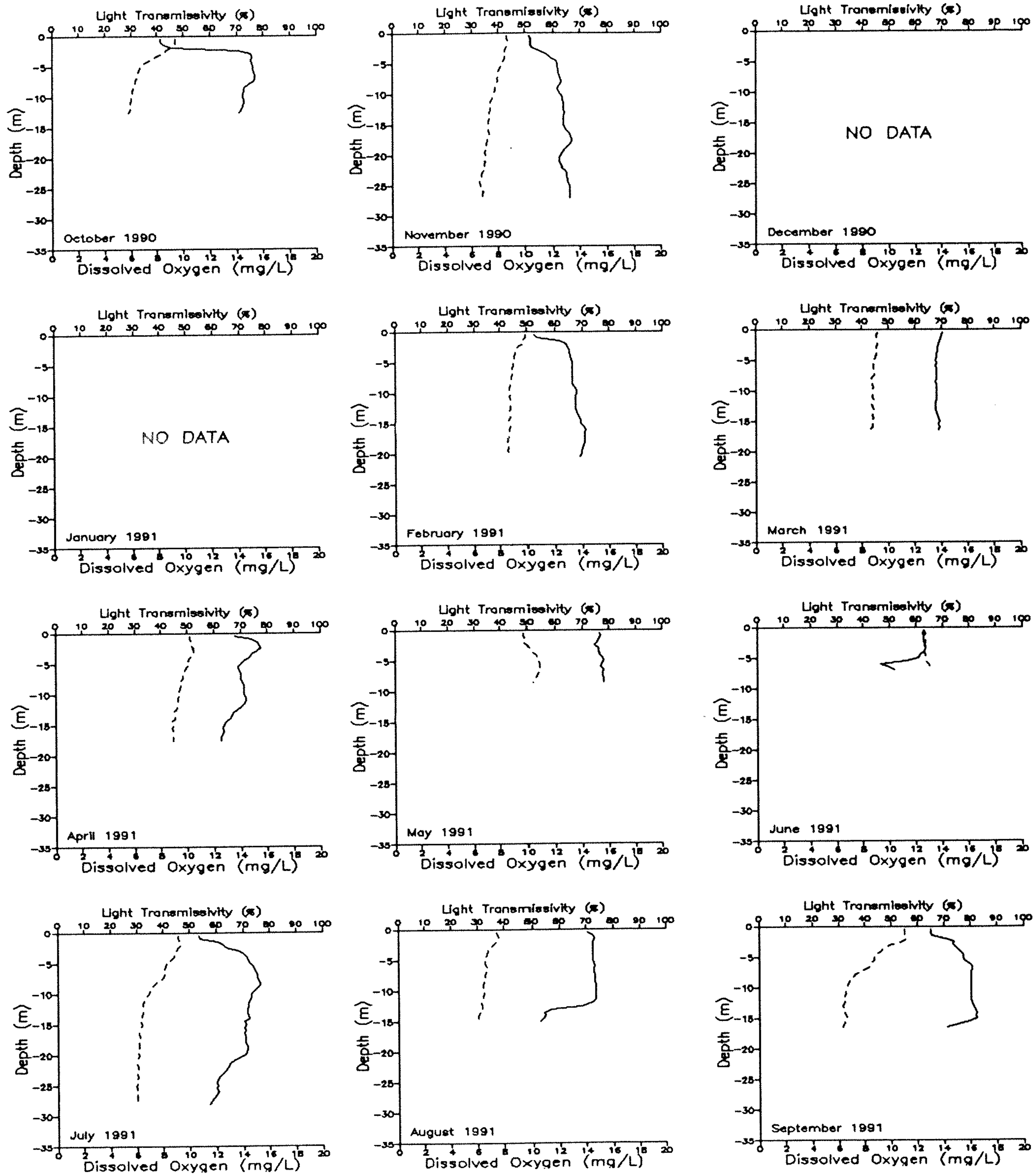
Central Puget Sound (Station ADM003)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

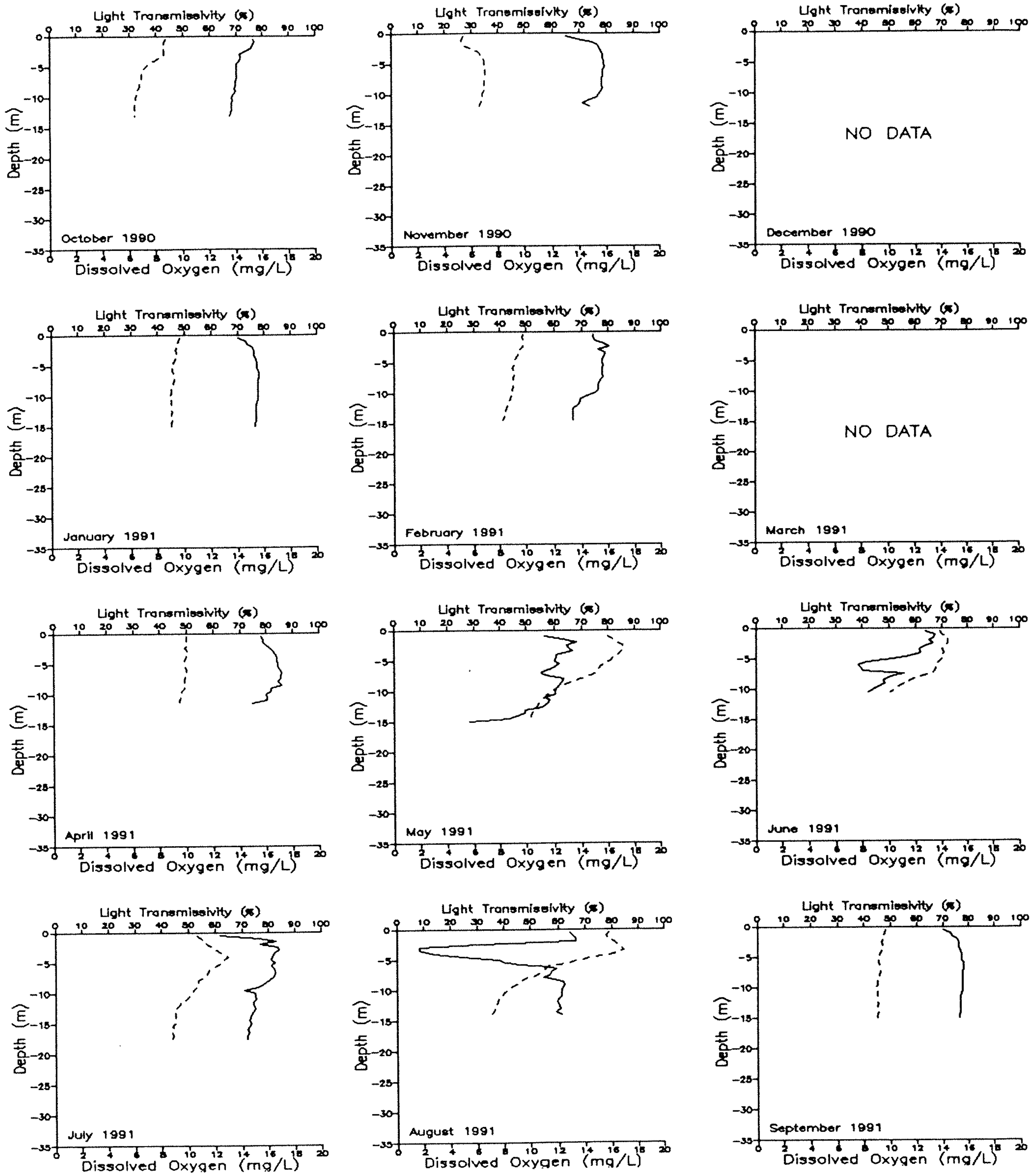
Bellingham Bay (Station BLL009)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

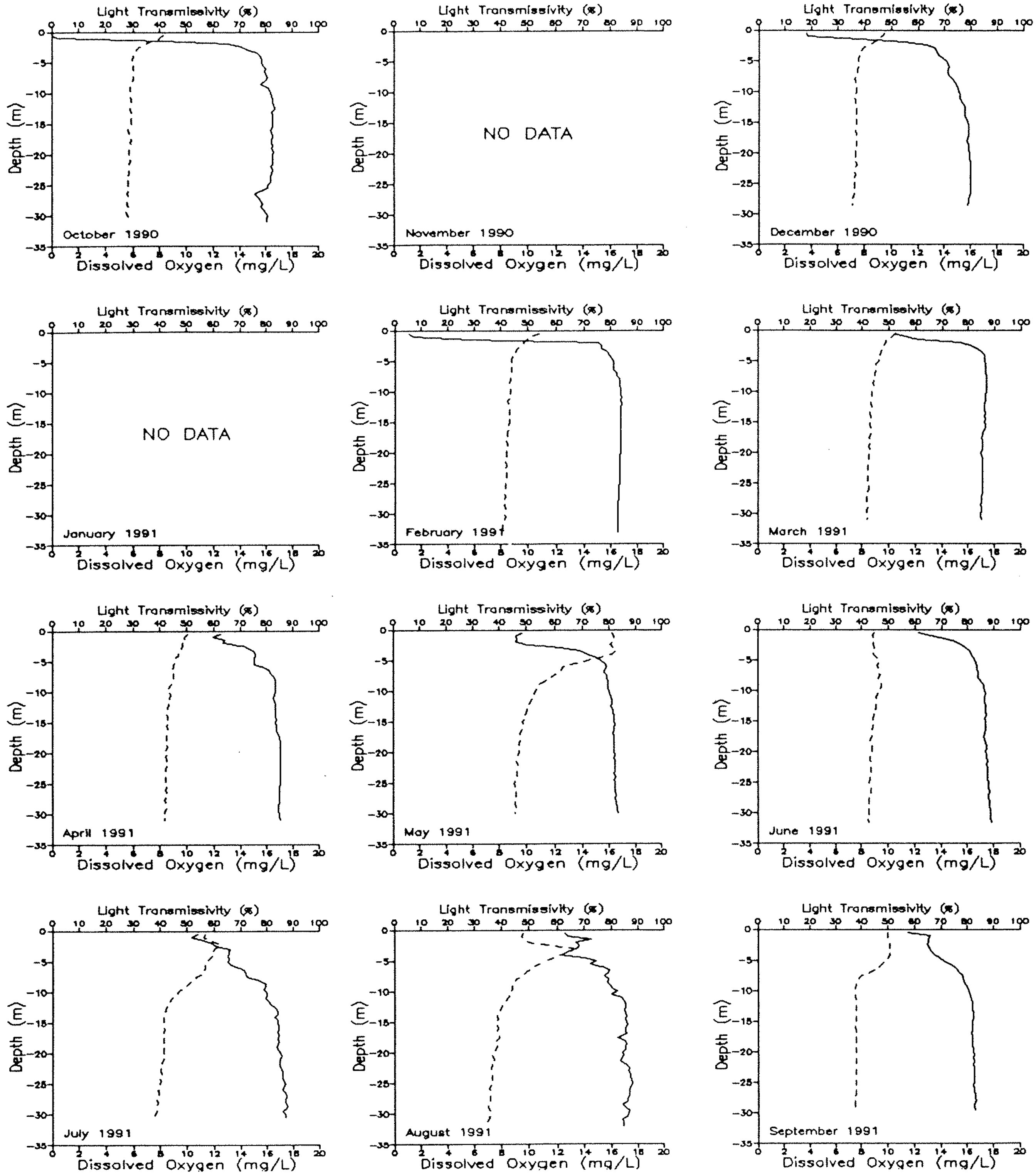
Budd Inlet (Station BUD005)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

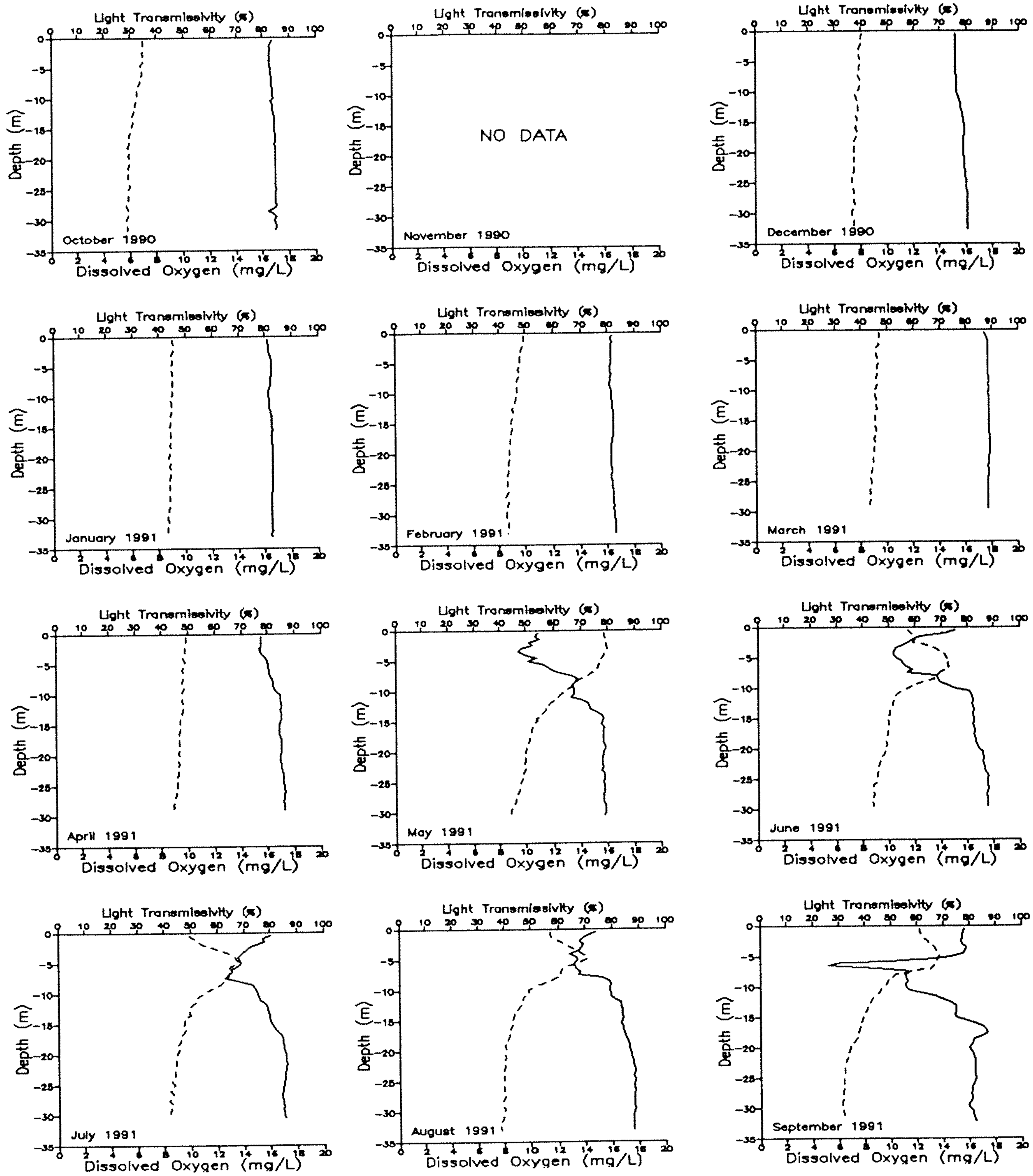
Commencement Bay - Brown Point (Station CMB003)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

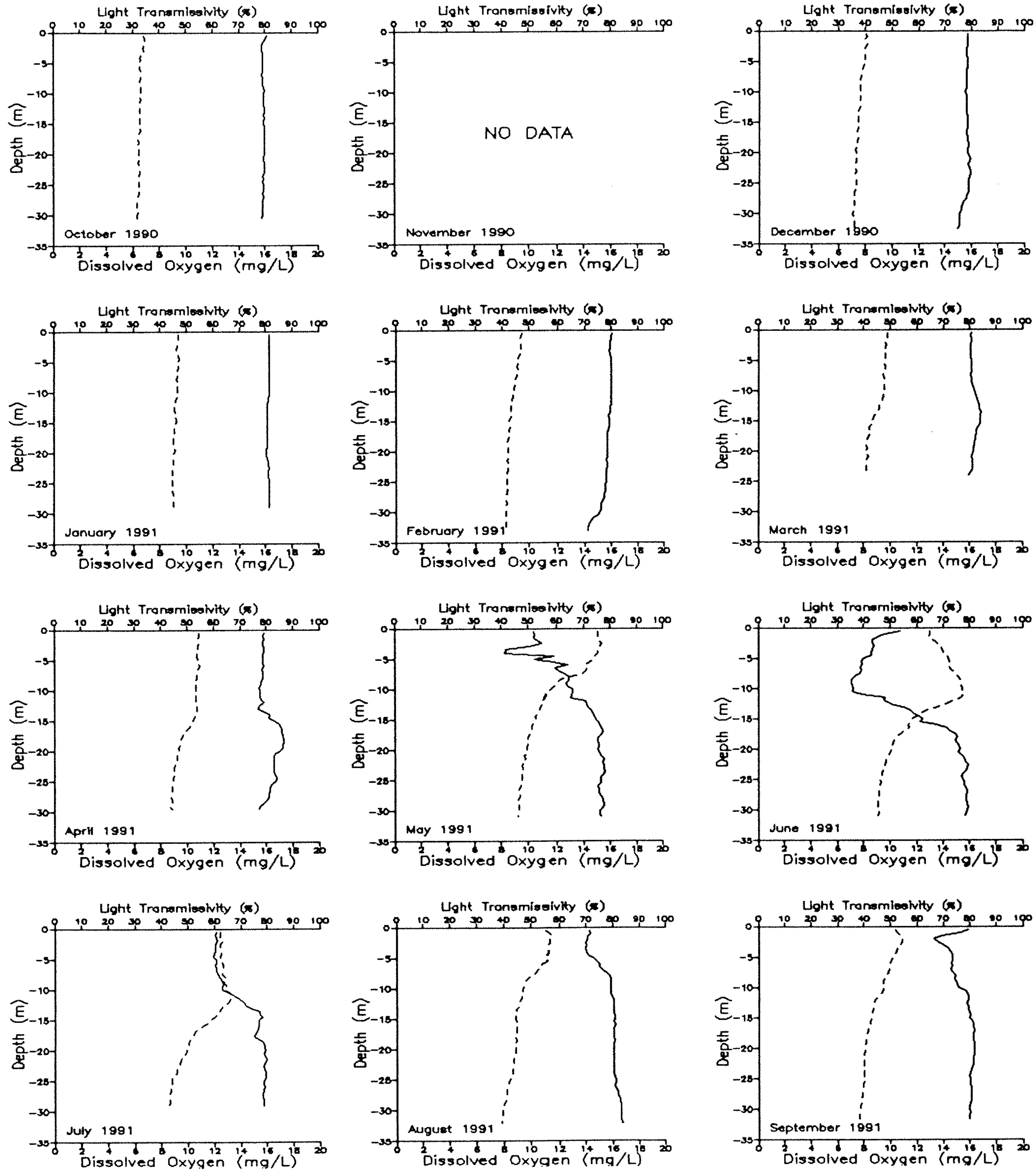
Carr Inlet (Station CRR001)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

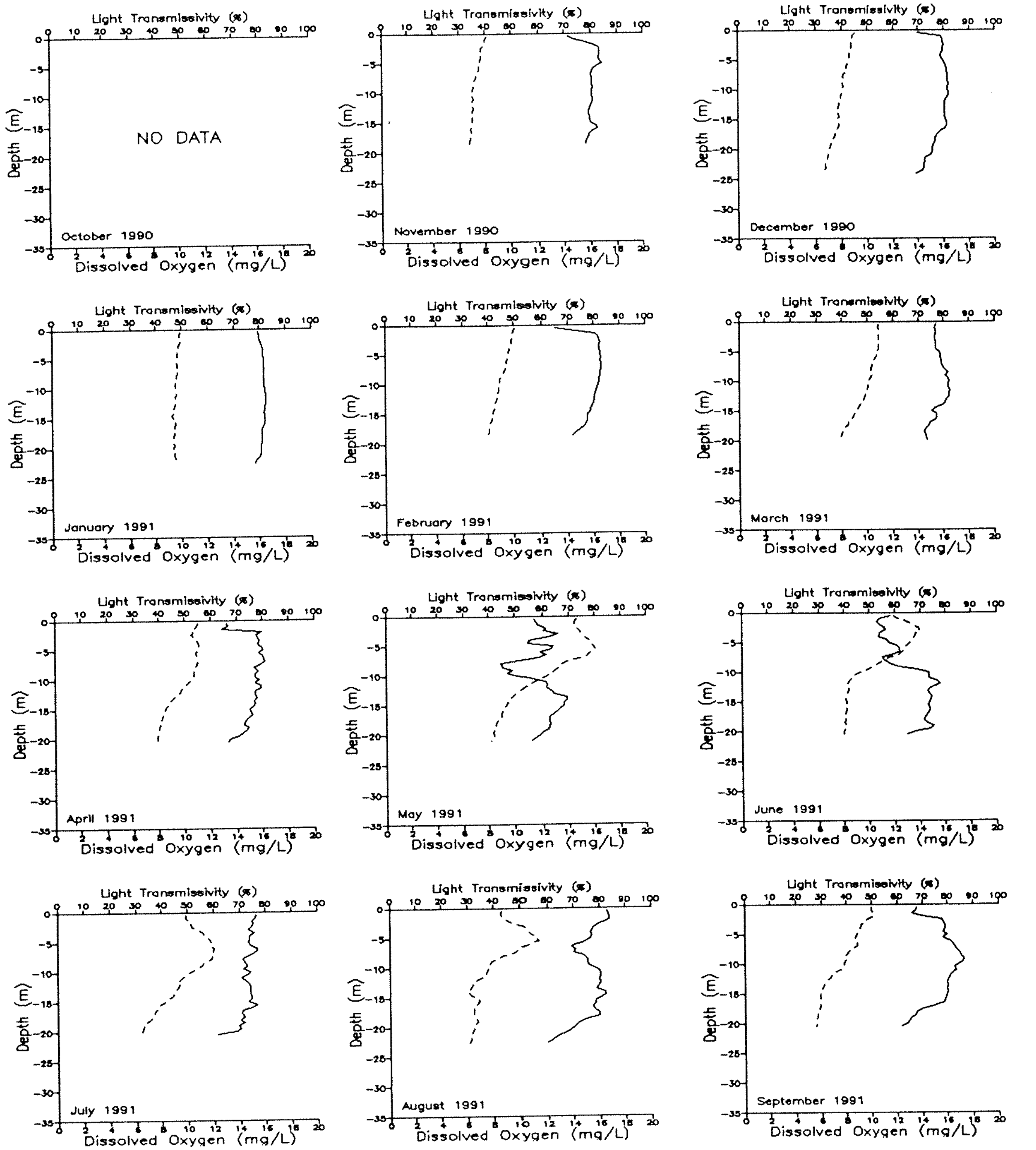
Outer Case Inlet (Station CSE001)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

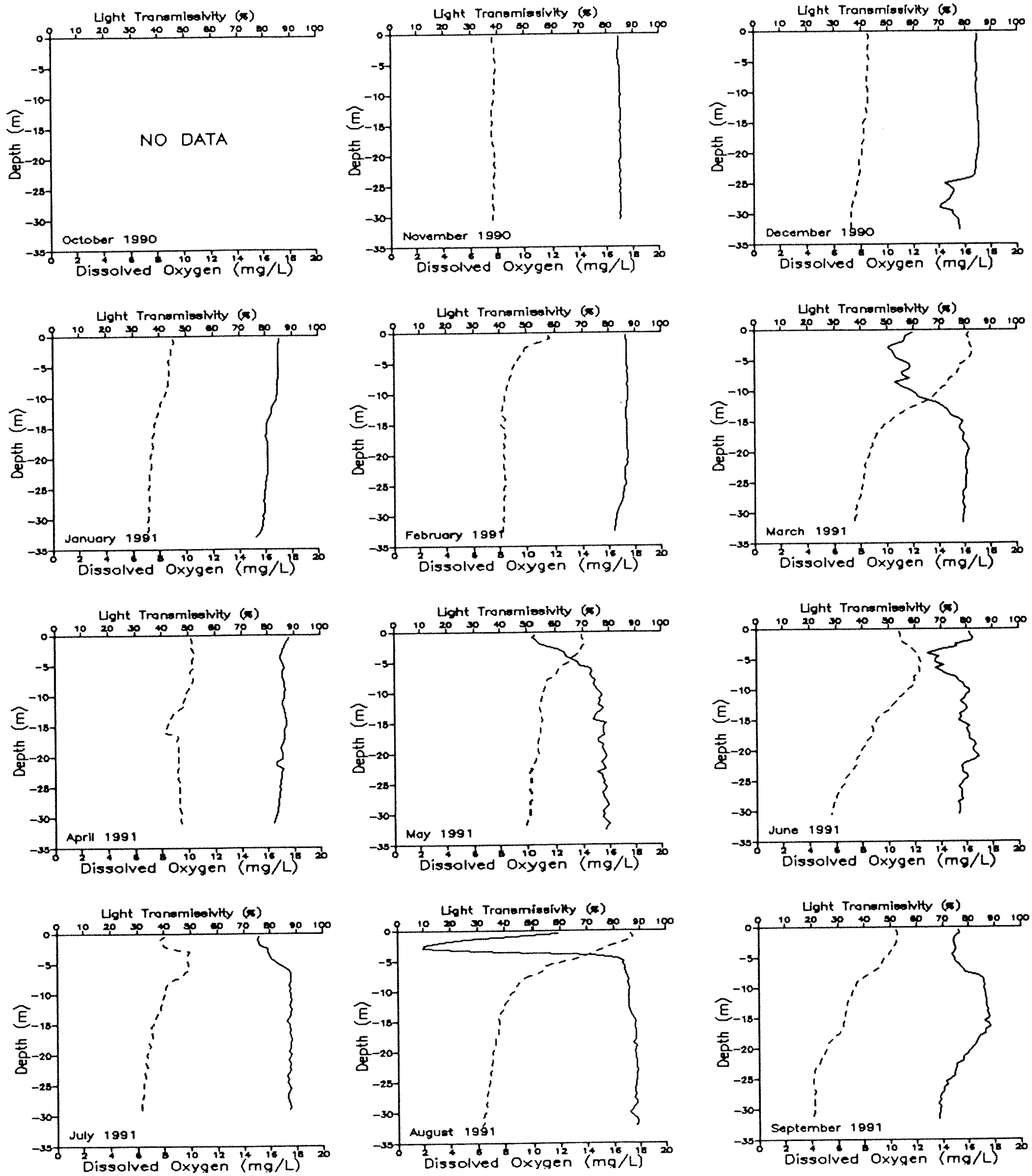
Inner Case Inlet (Station CSE002)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

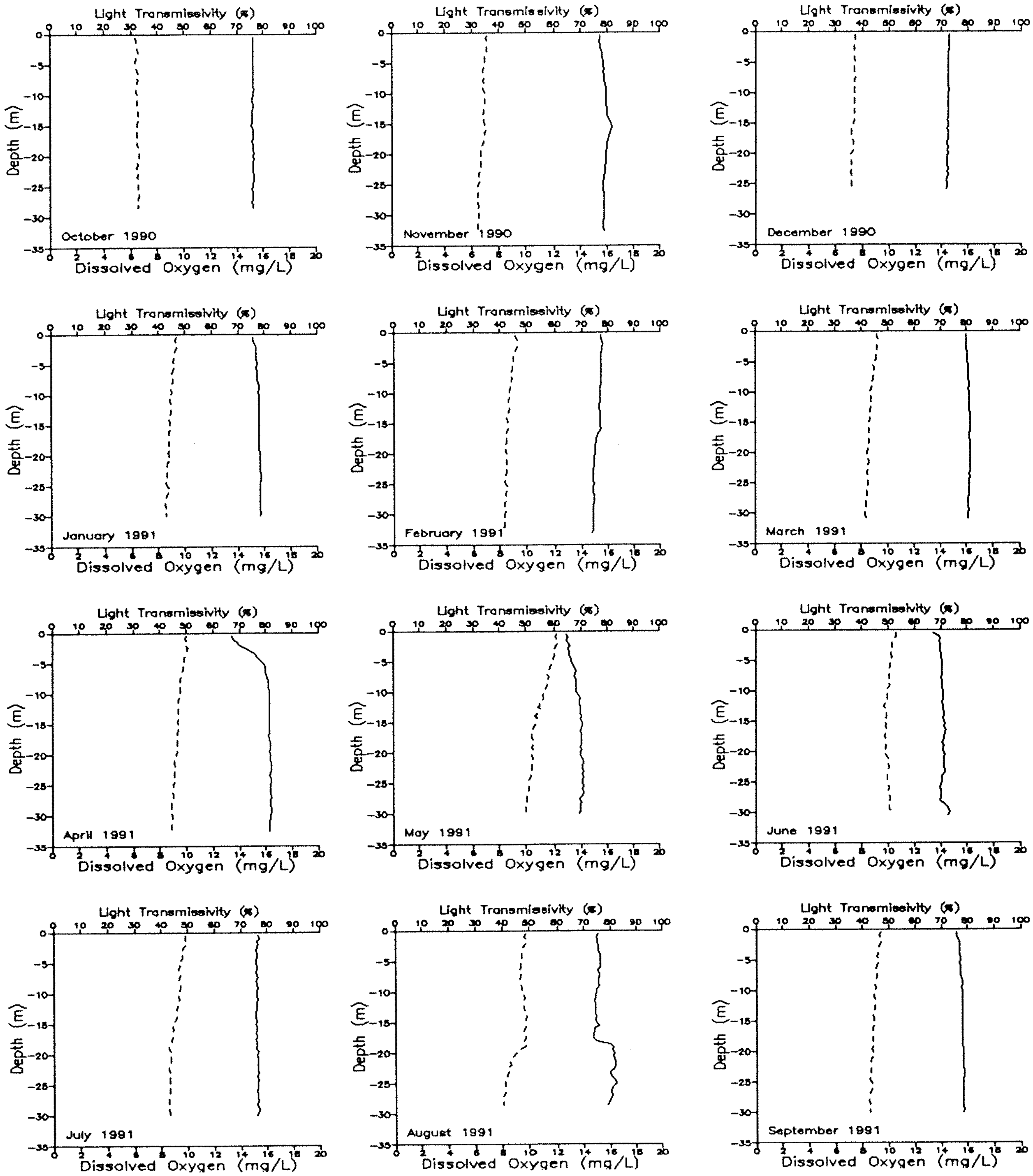
Discovery Bay (Station DIS001)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

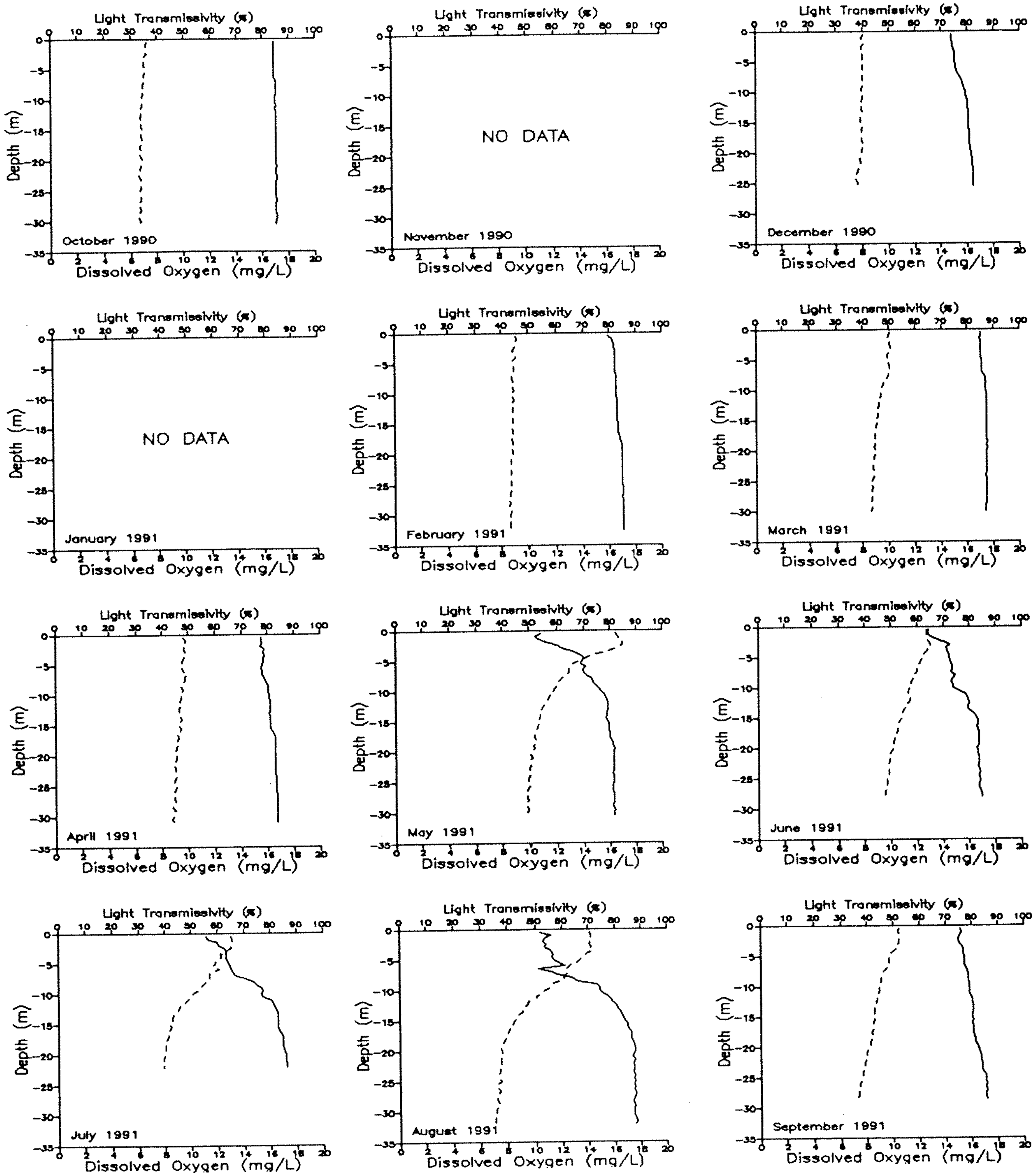
Dana Passage (Station DNA001)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

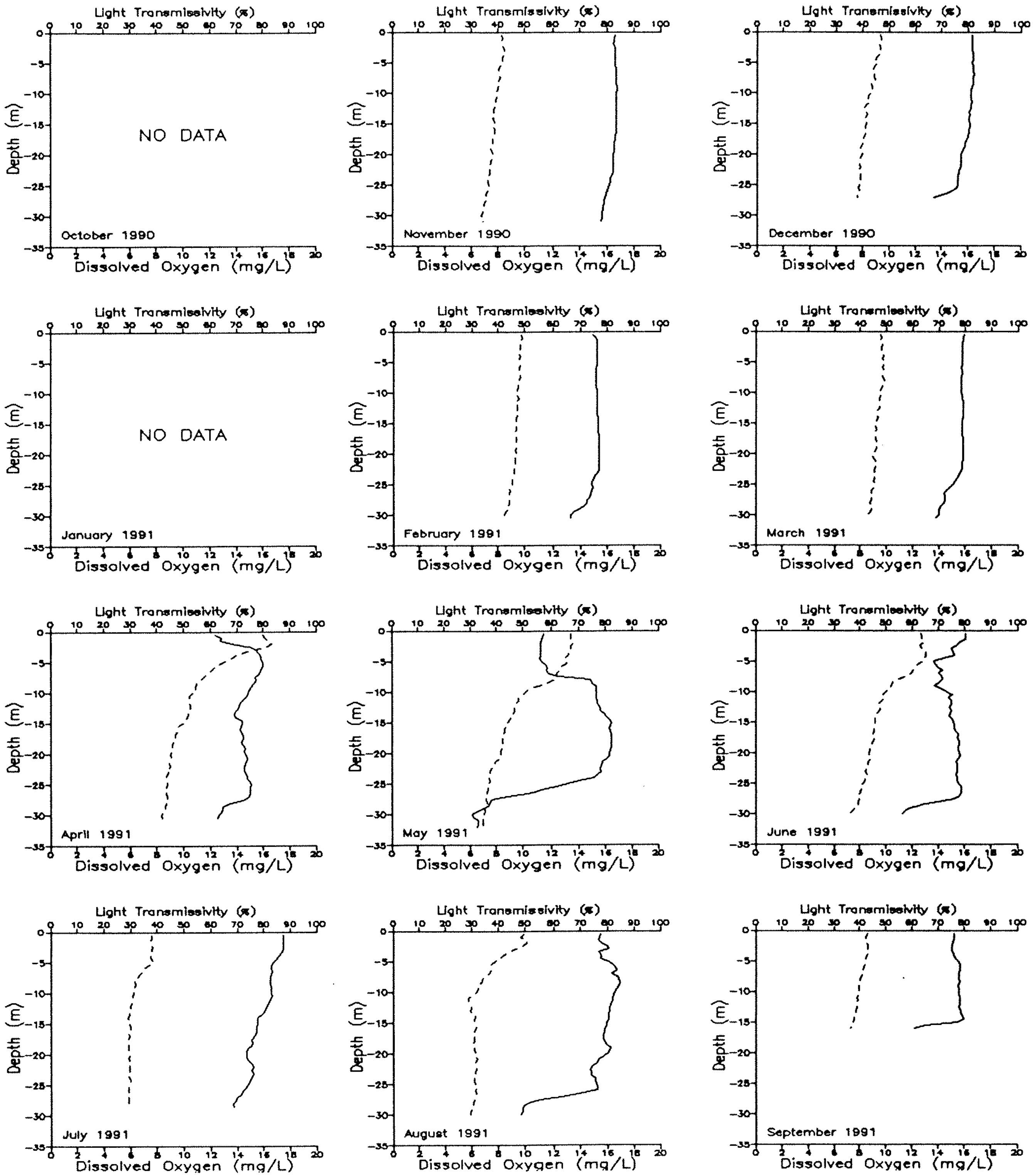
East Passage (Station EAP001)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

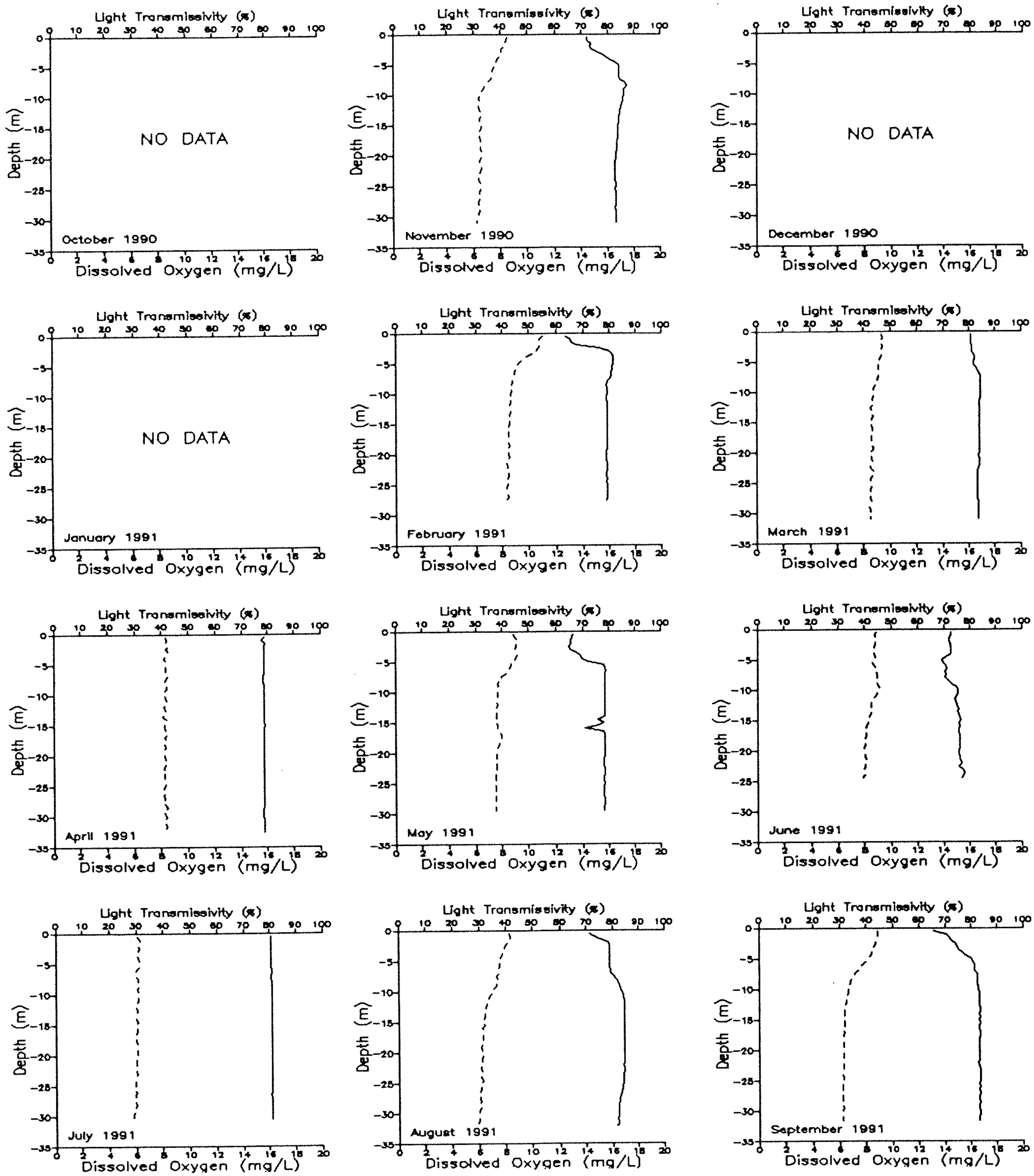
East Sound - Orcas Island (Station EAS001)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

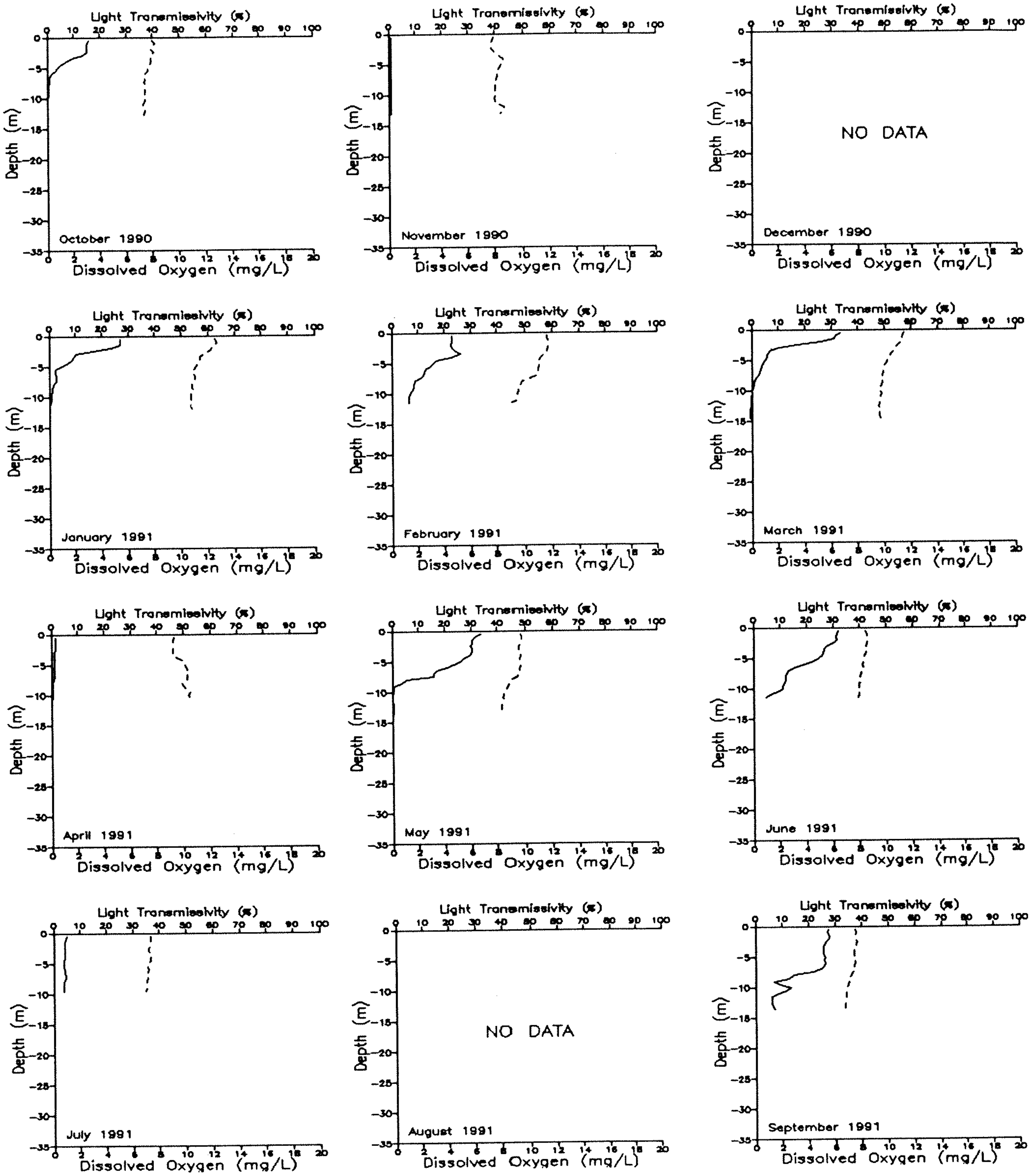
Strait of Georgia (Station GRG002)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

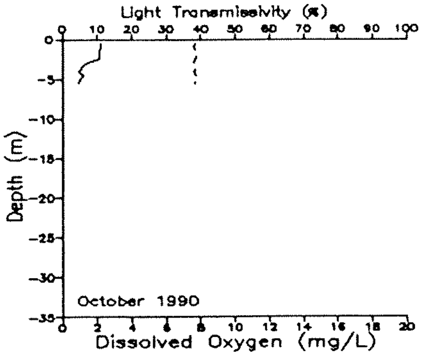
Gray's Harbor - Chehalis (Station GYS004)

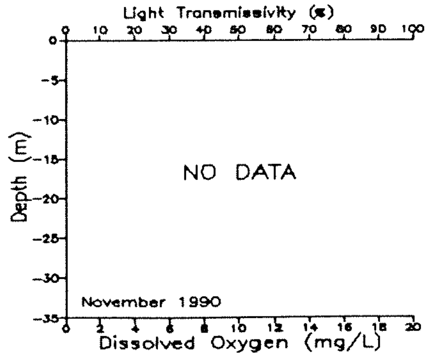


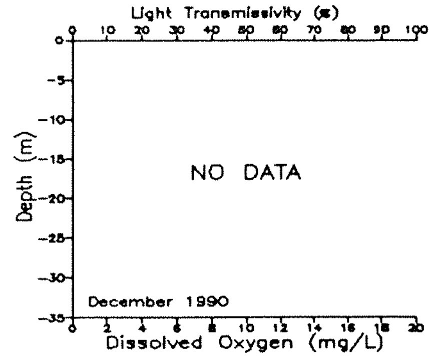
Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

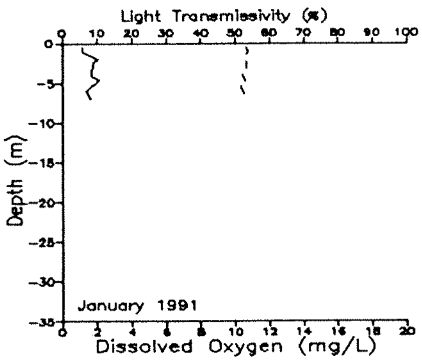
WATERYEAR 1991

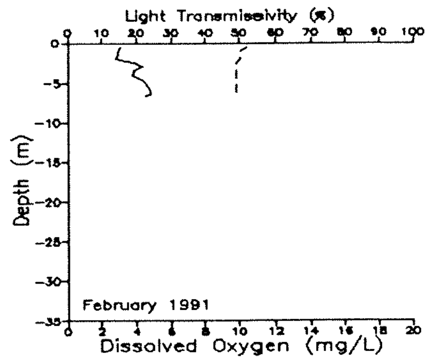
Gray's Harbor - South Channel (Station GYS008)

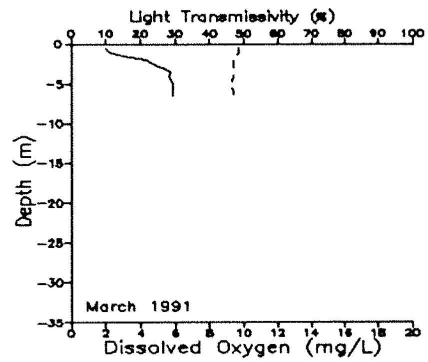


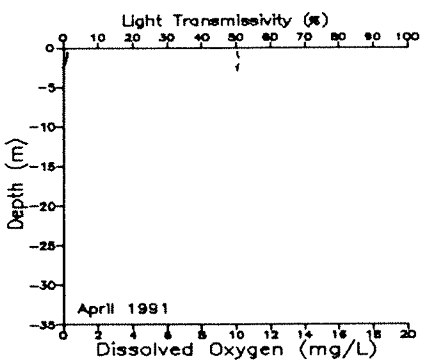


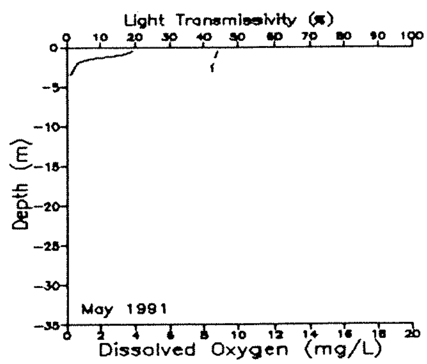


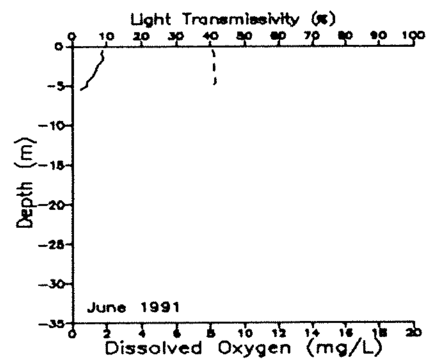


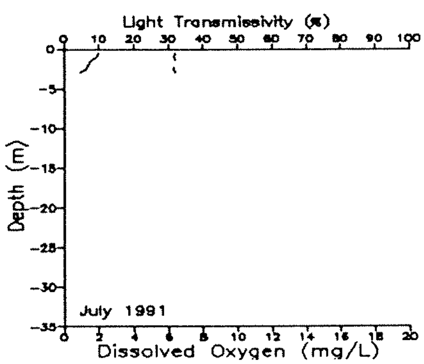


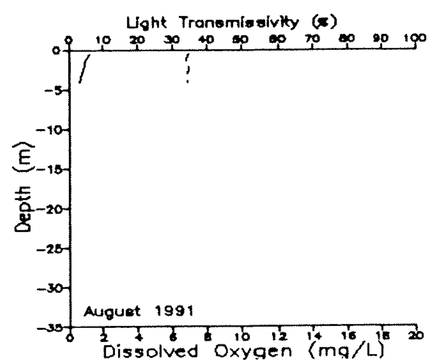


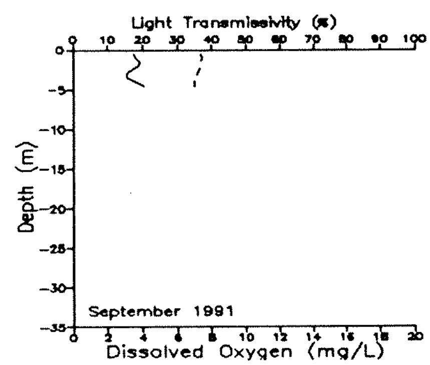












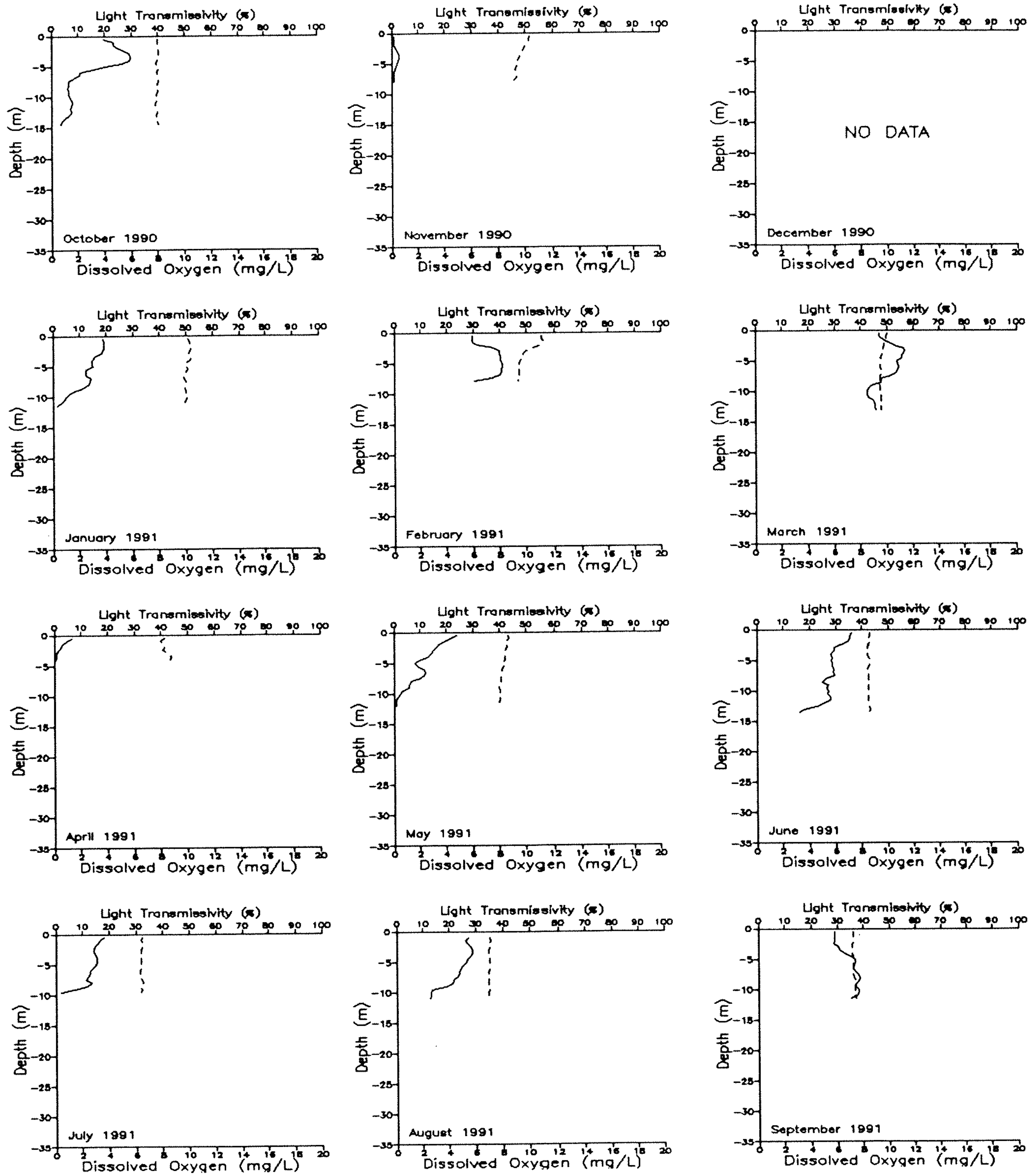
Key:

Light Transmissivity = Solid line

Dissolved Oxygen = Dashed line

WATERYEAR 1991

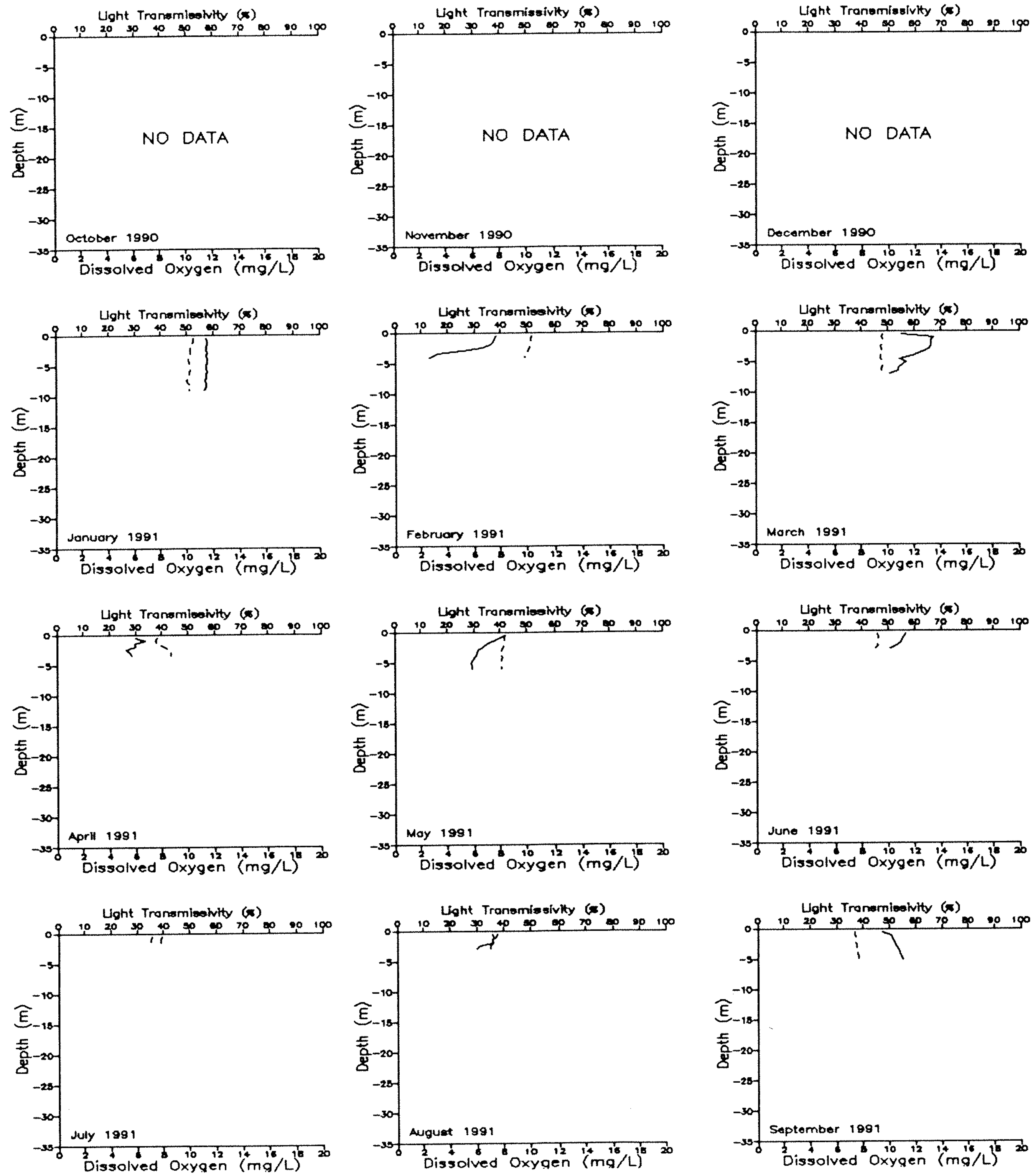
Gray's Harbor - North Channel (Station GYS009)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

Gray's Harbor - Damon Point (Station GYS016)



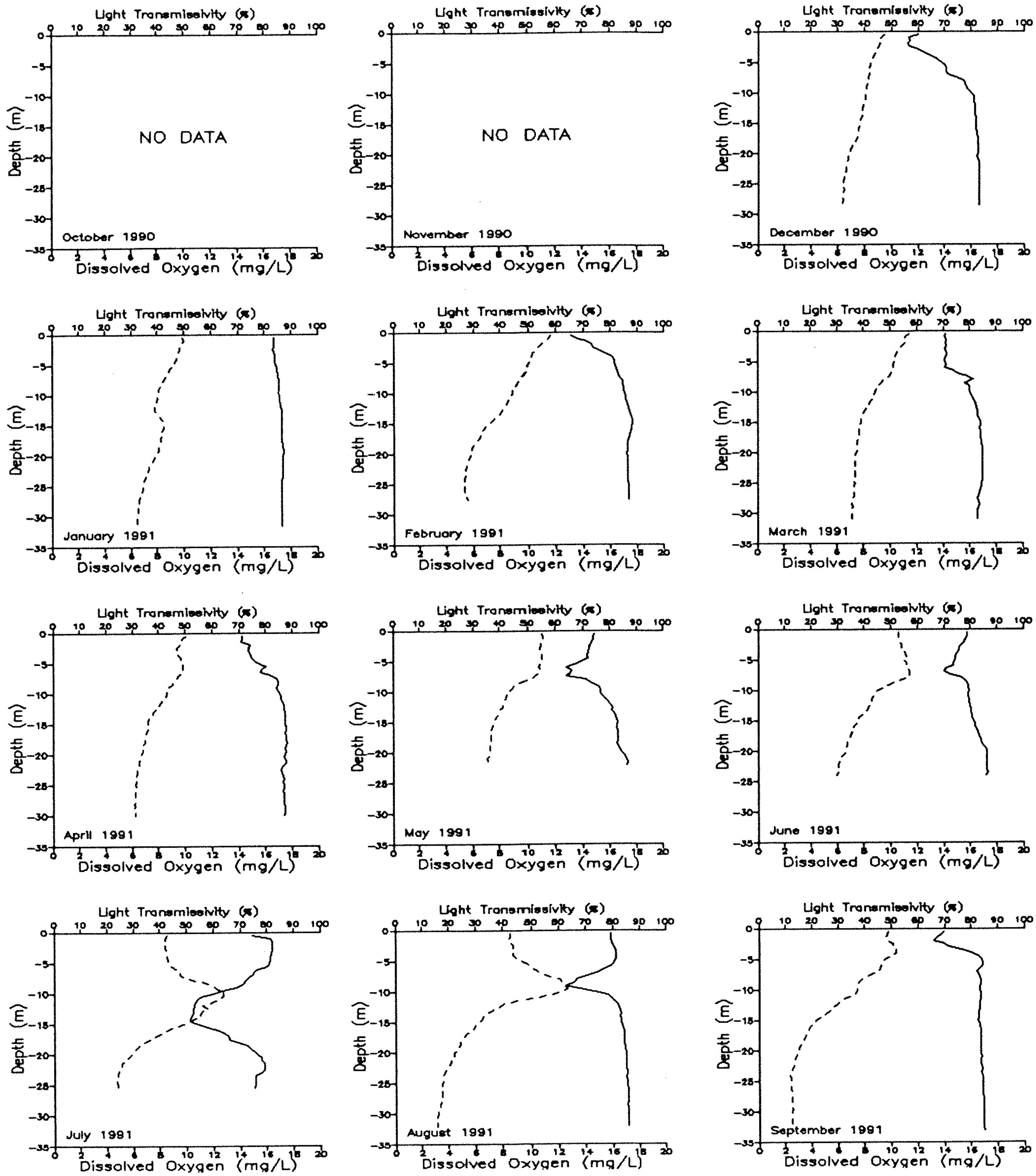
Key:

Light Transmissivity = Solid line

Dissolved Oxygen = Dashed line

WATERYEAR 1991

Central Hood Canal - Eldon (Station HCB003)



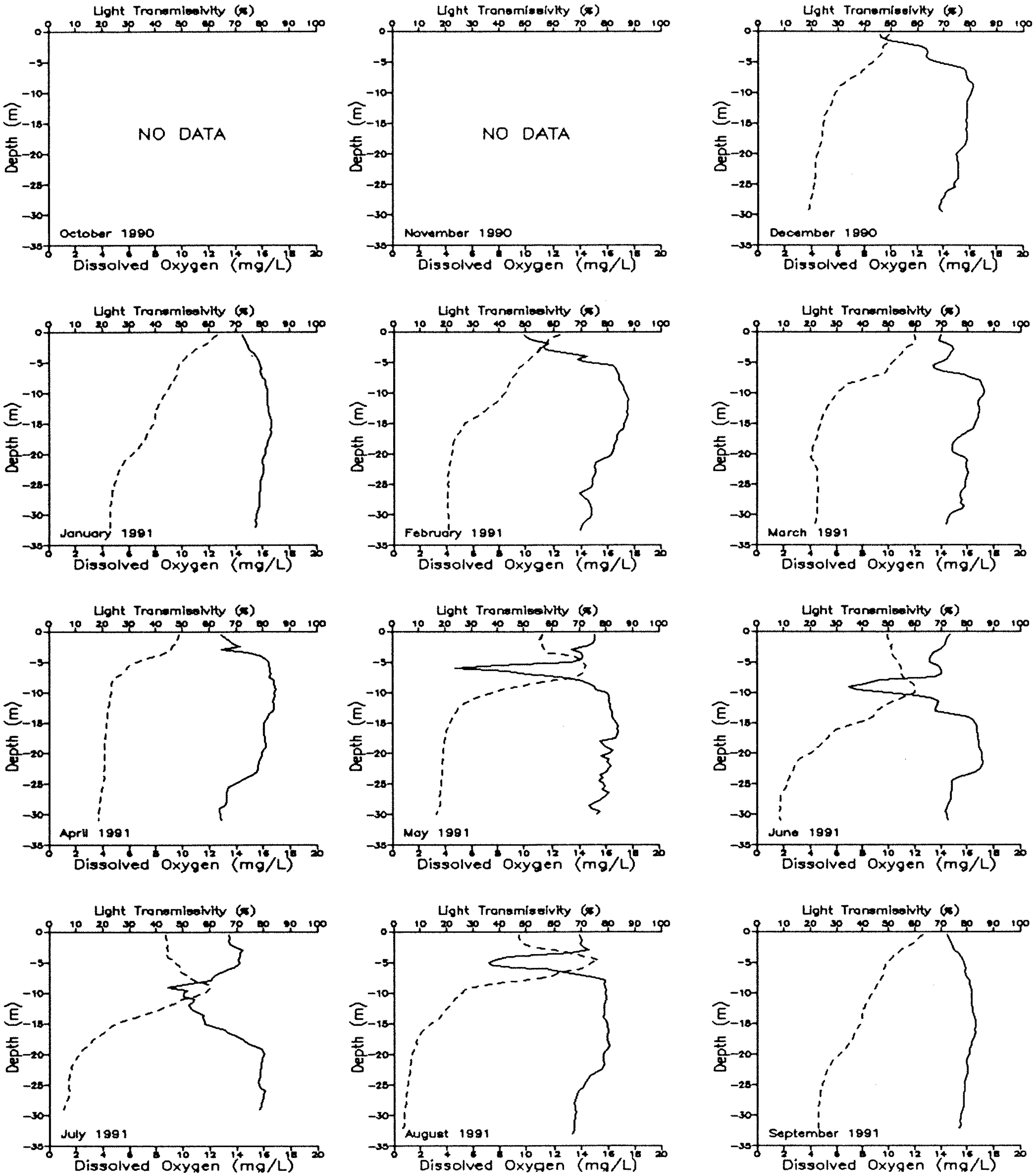
Key:

Light Transmissivity = Solid line

Dissolved Oxygen = Dashed line

WATERYEAR 1991

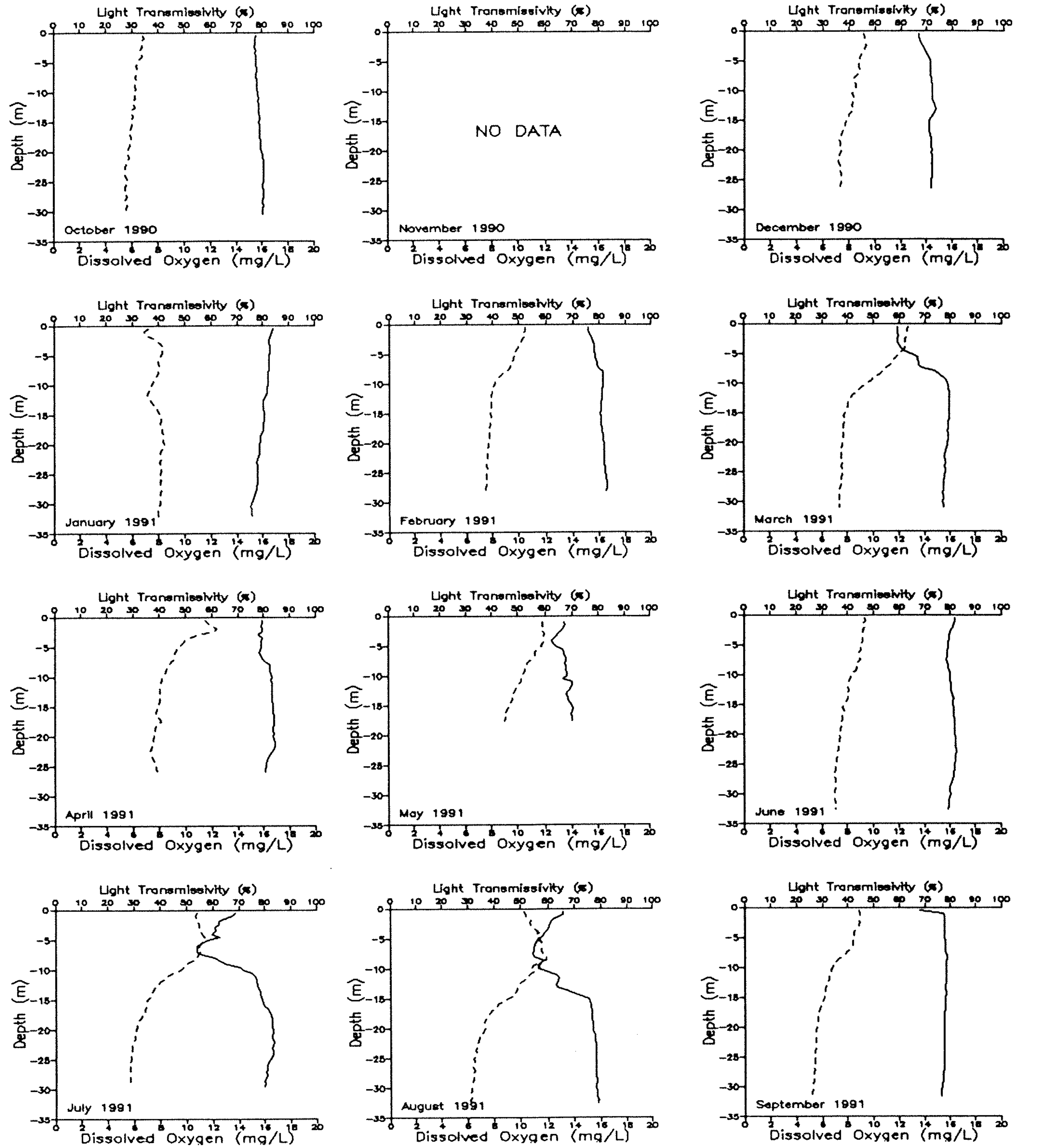
South Hood Canal at Sister's Point (Station HCB004)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

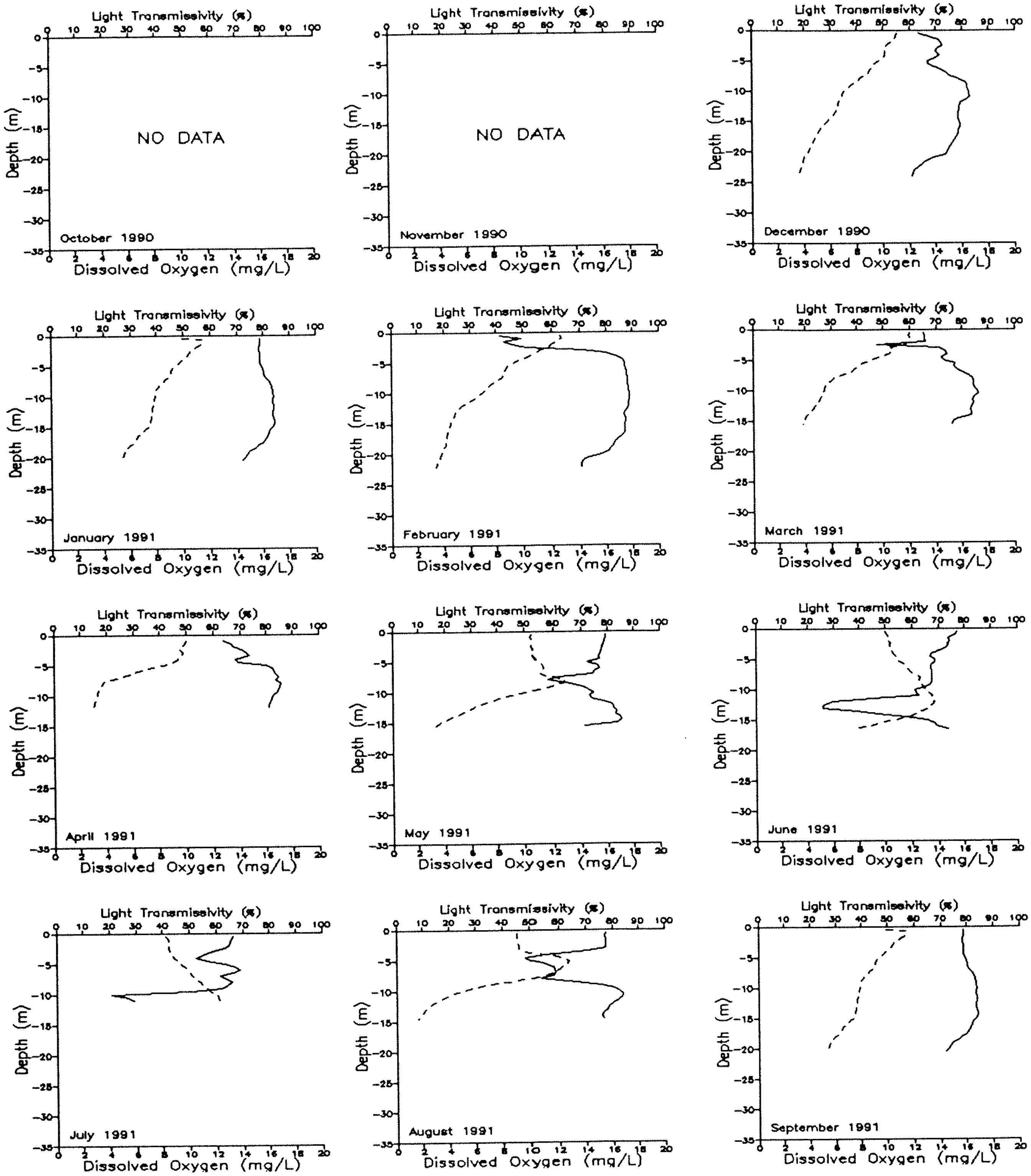
North Hood Canal - Bangor (Station HCB006)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

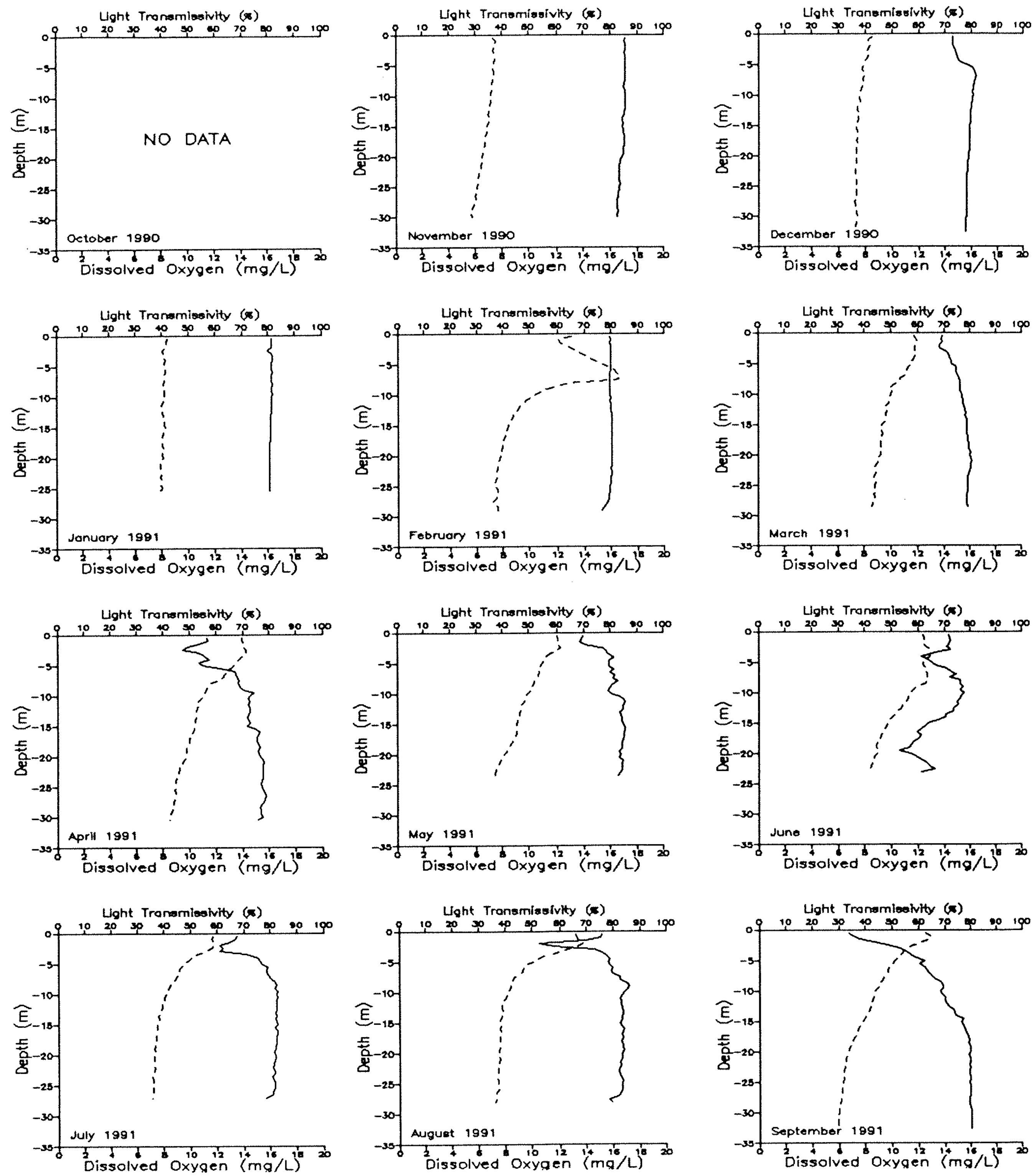
Lynch Cove (Station HCB007)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

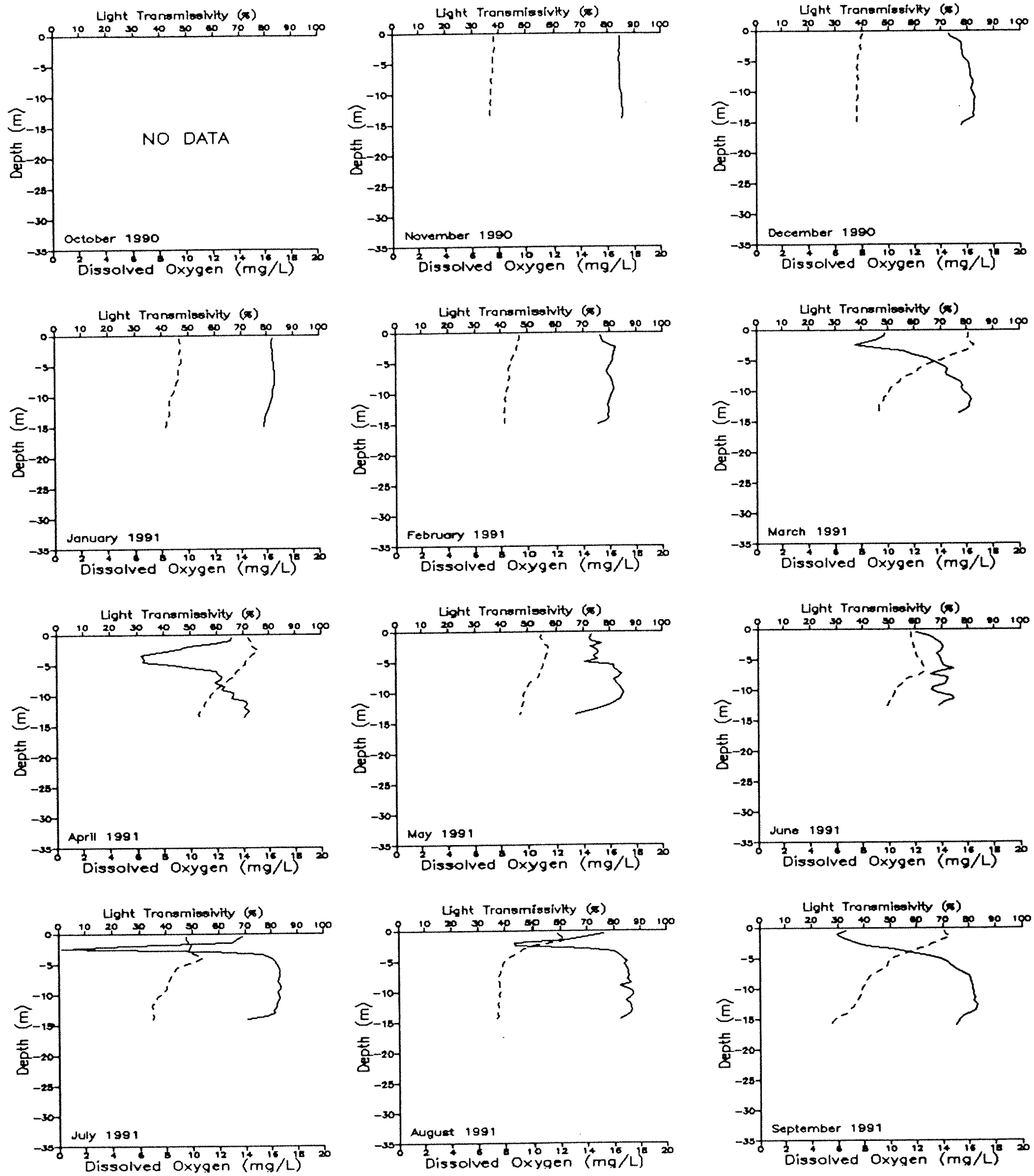
Sequim Bay (Station JDF005)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

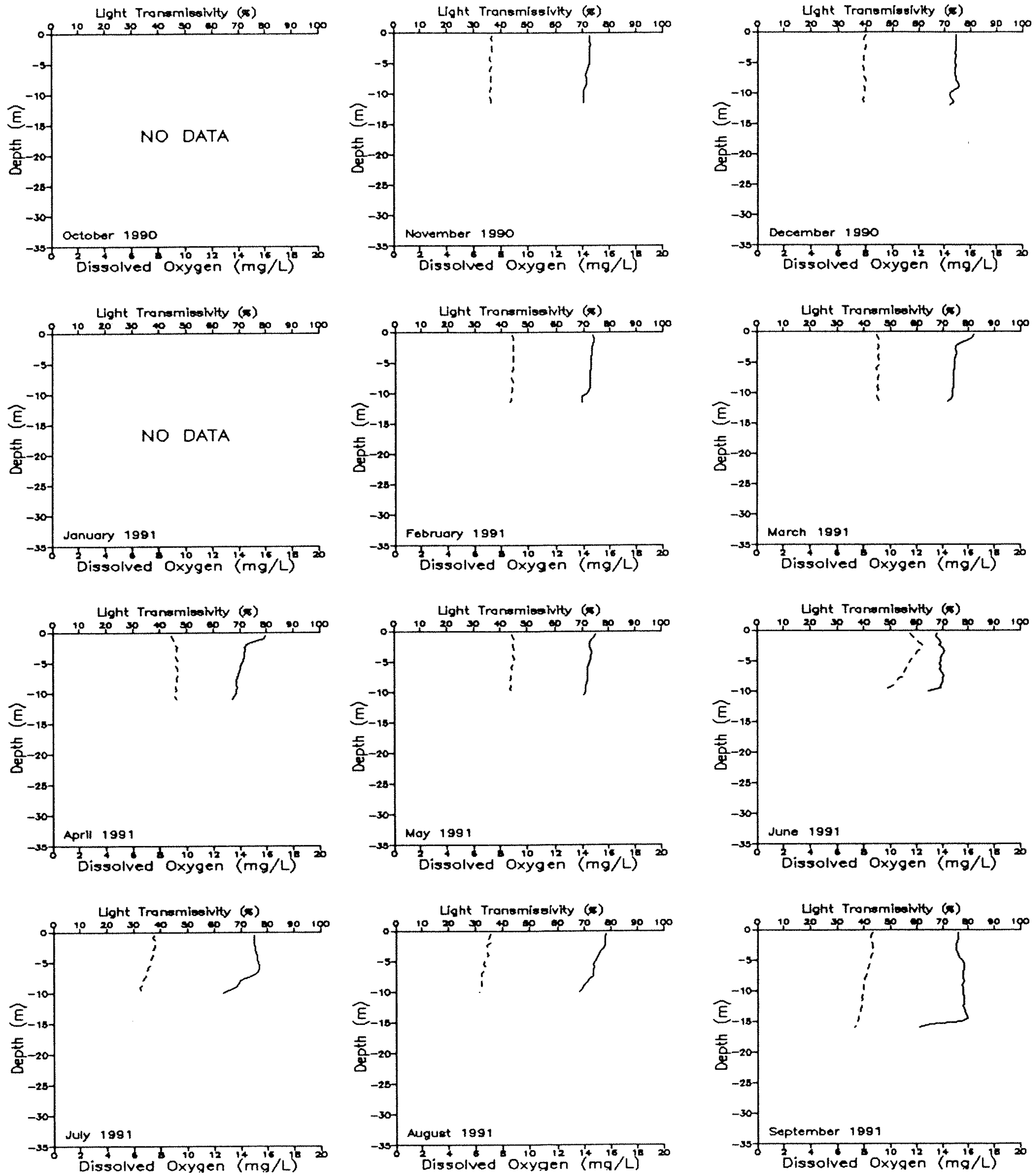
Sequim Bay - Goose Point (Station JDF007)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

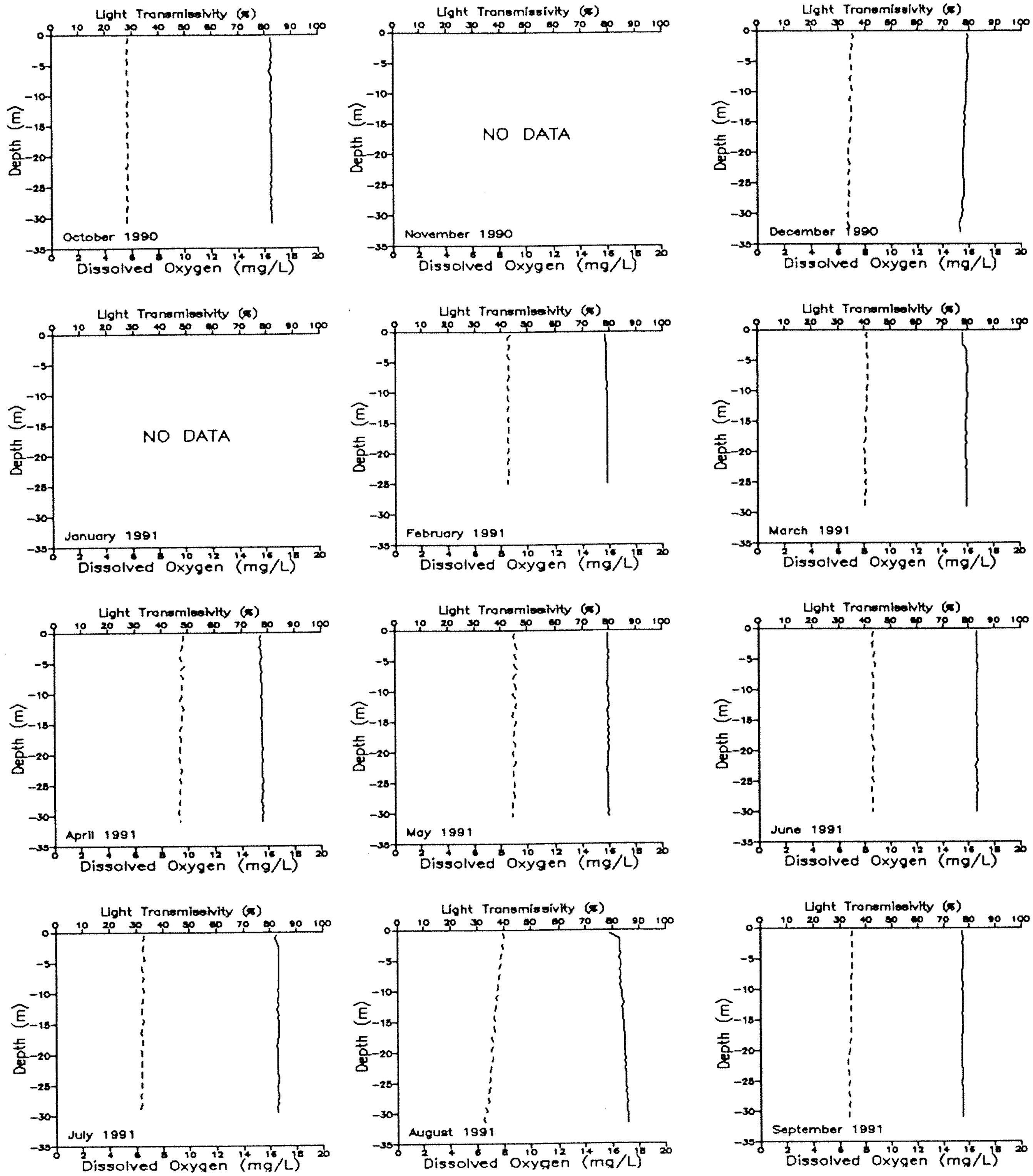
Lopez Sound - Lopez Island (Station LOP001)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

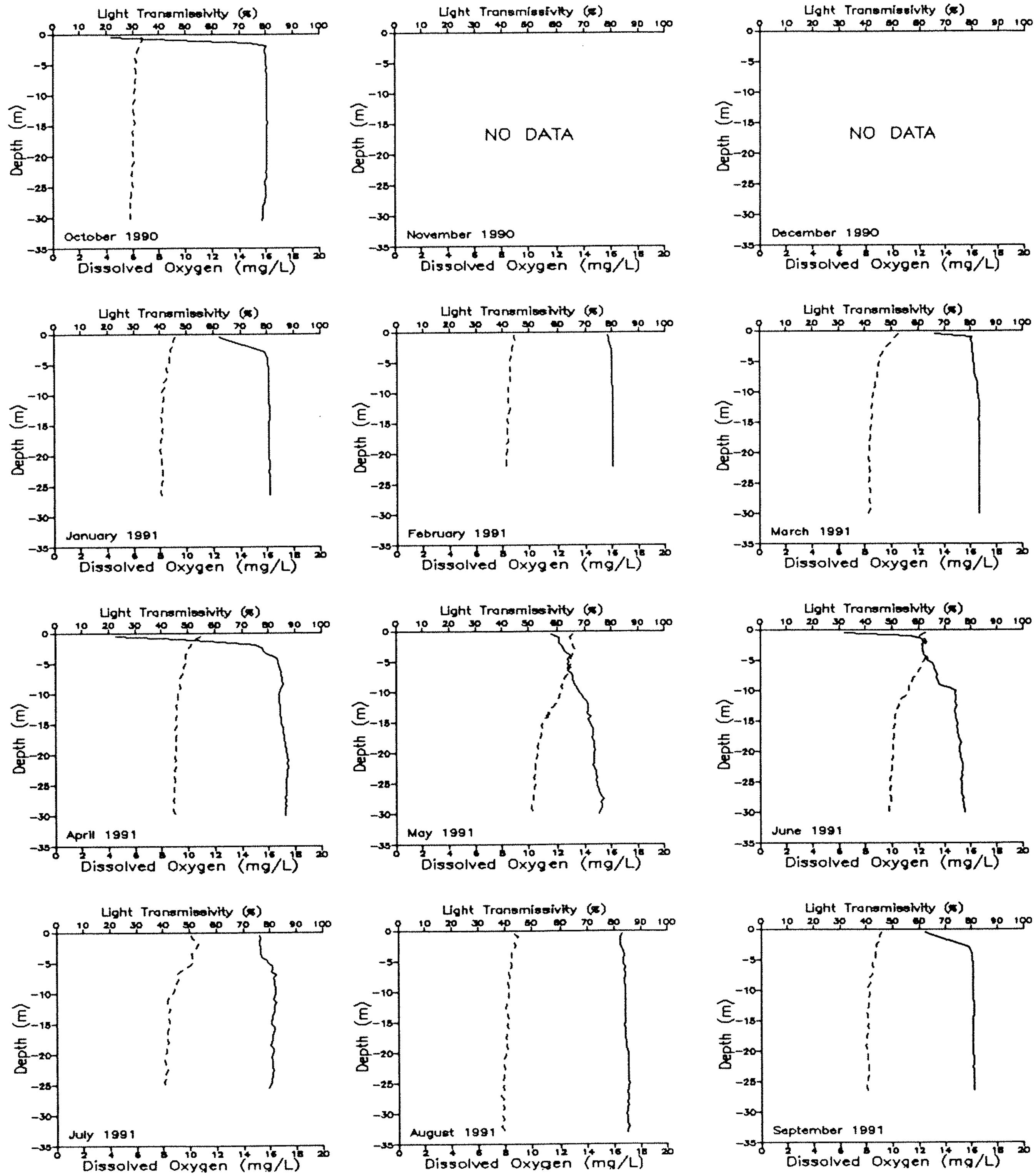
Tacoma Narrows (Station NRR001)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

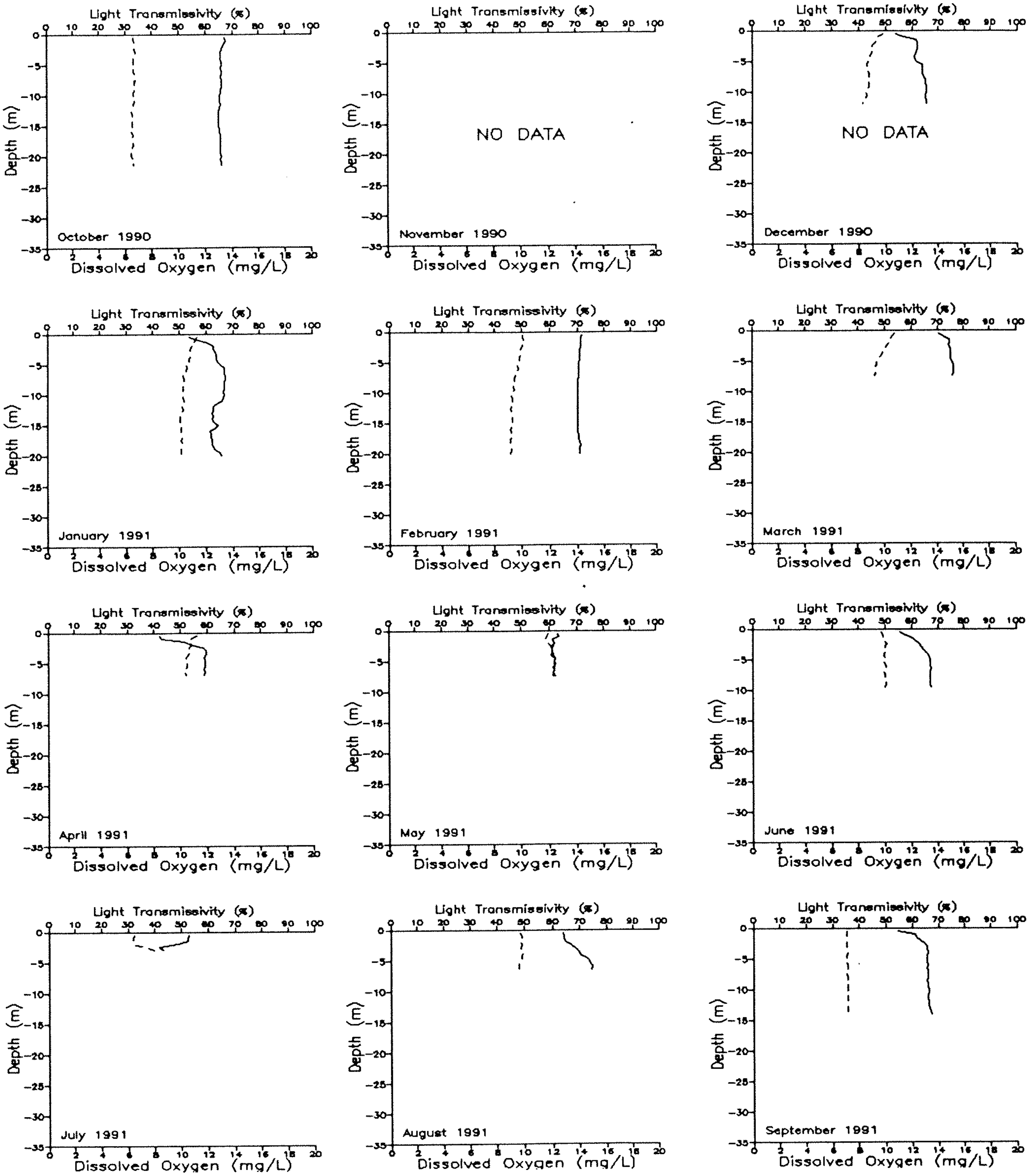
Nisqually Reach (Station NSQ001)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

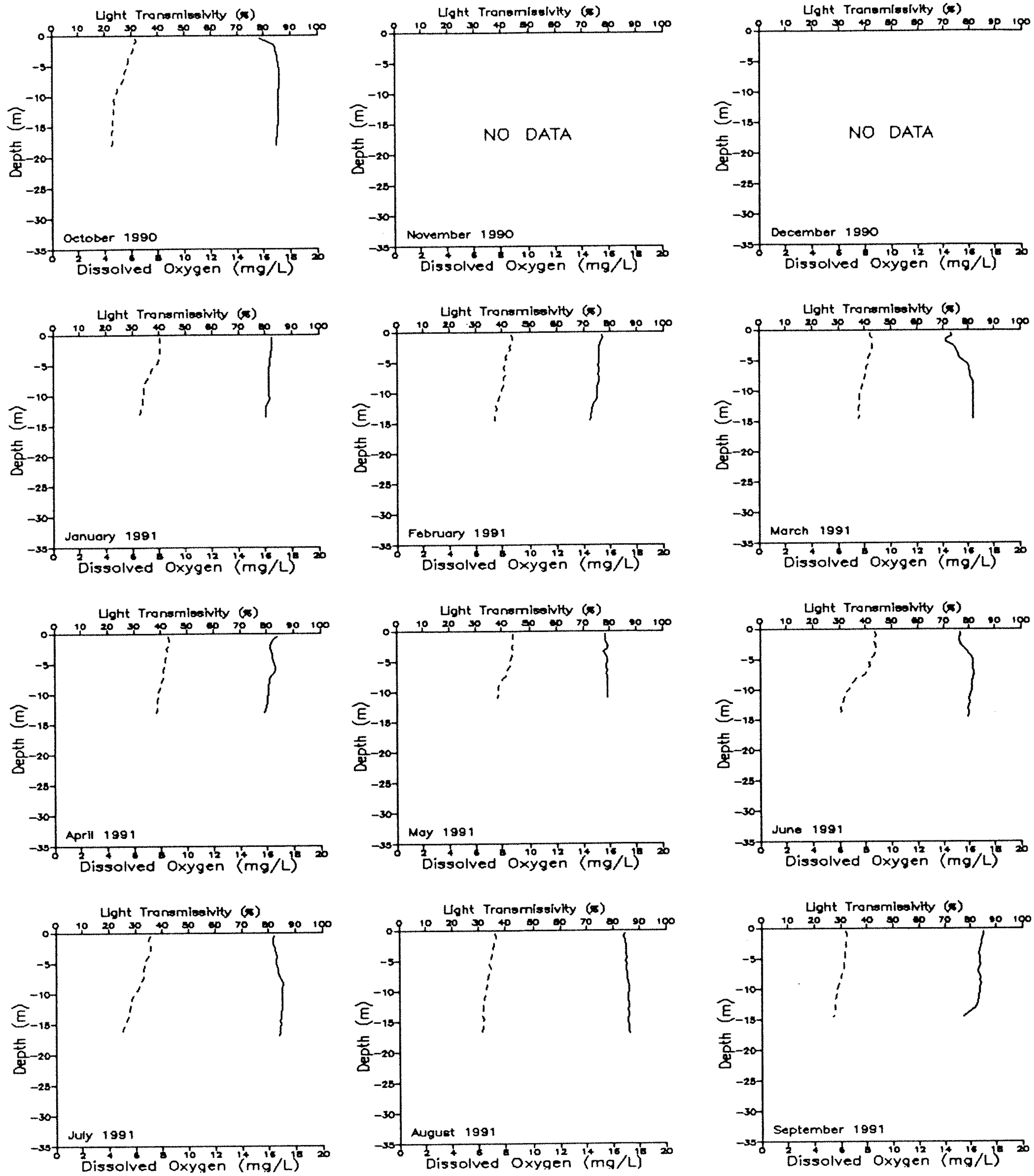
Oakland Bay (Station OAK004)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

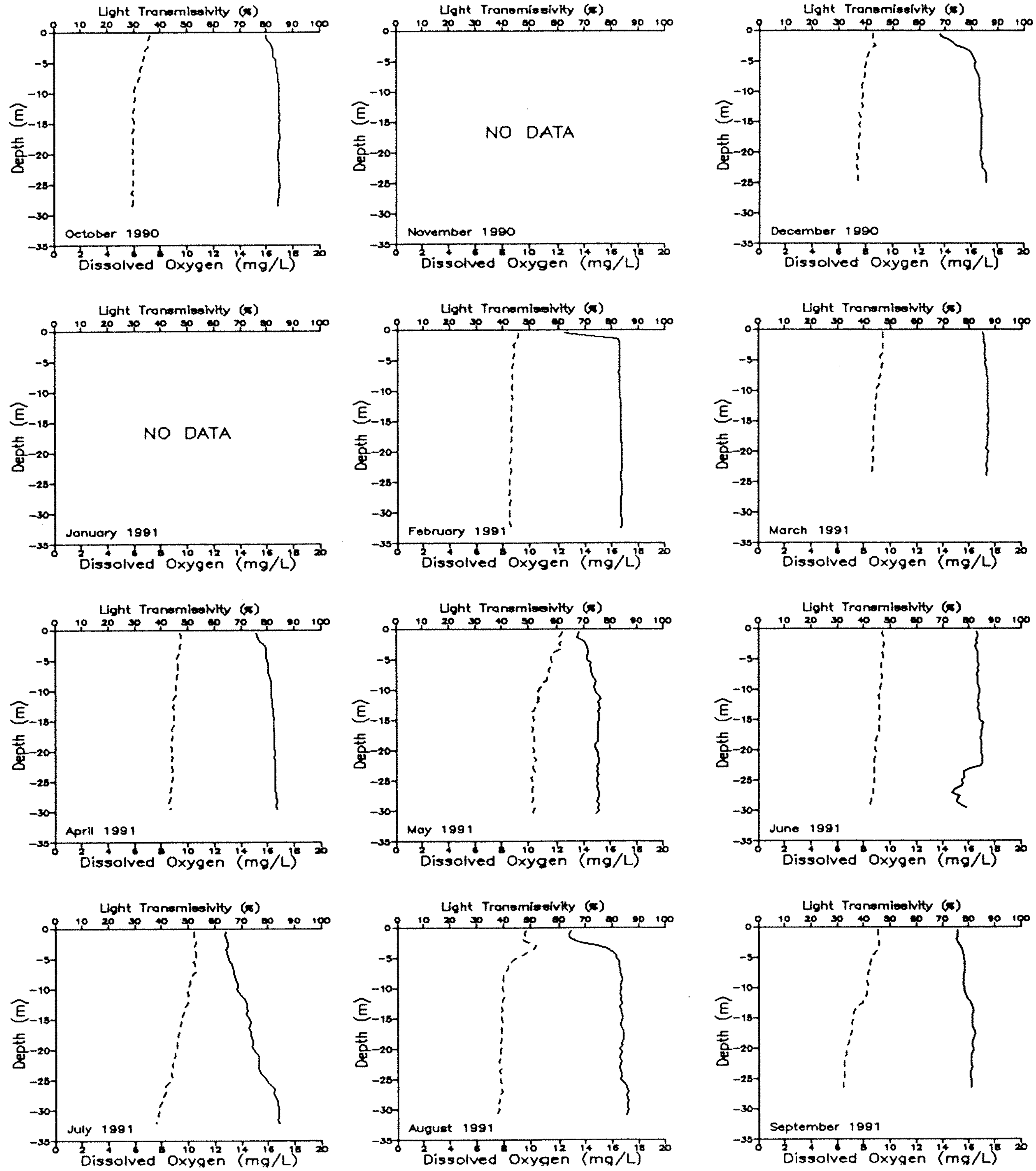
Straits of Juan de Fuca Near Port Angeles (Station PAH008)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

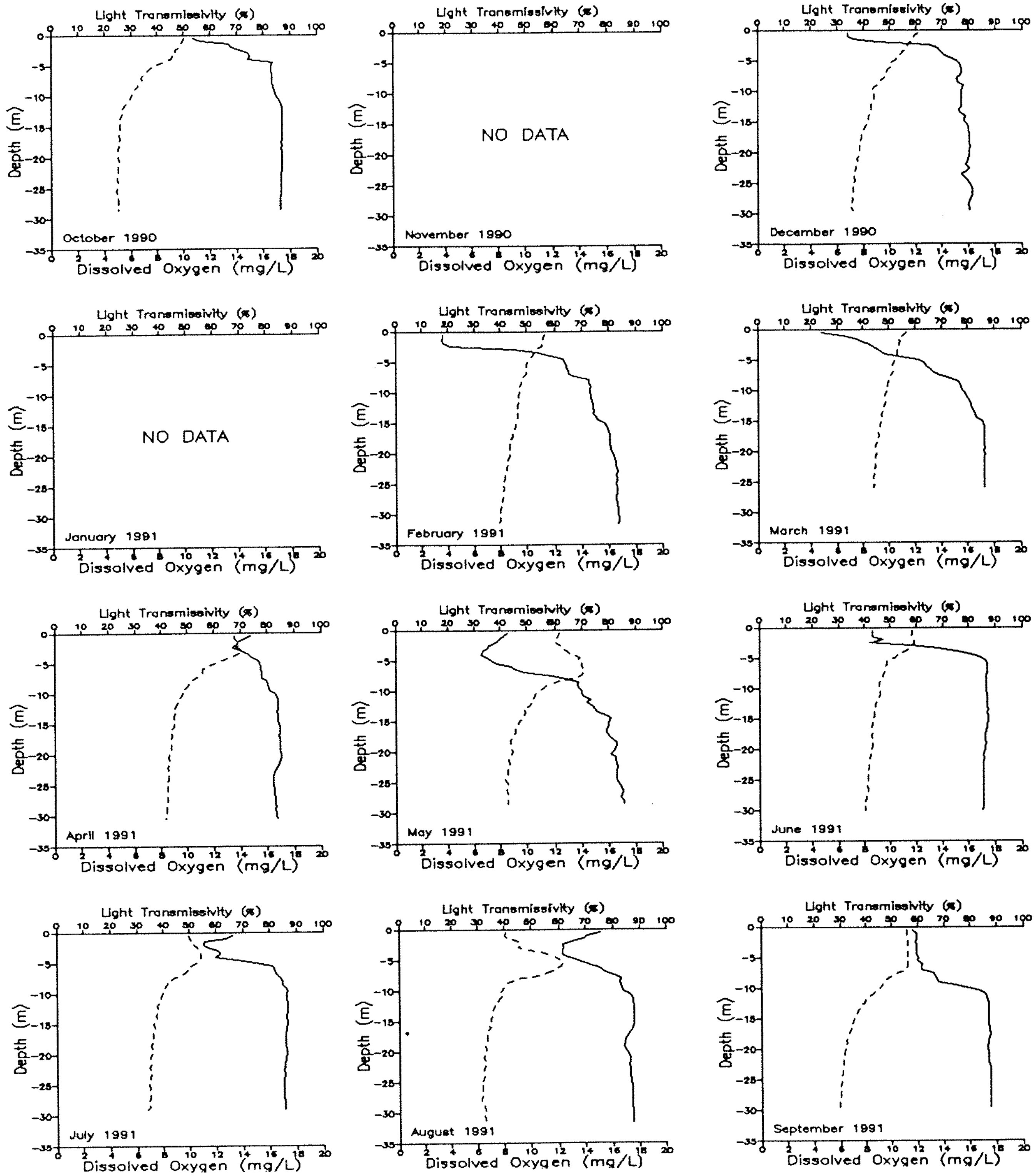
Puget Sound - Main Basin (Station PSB003)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

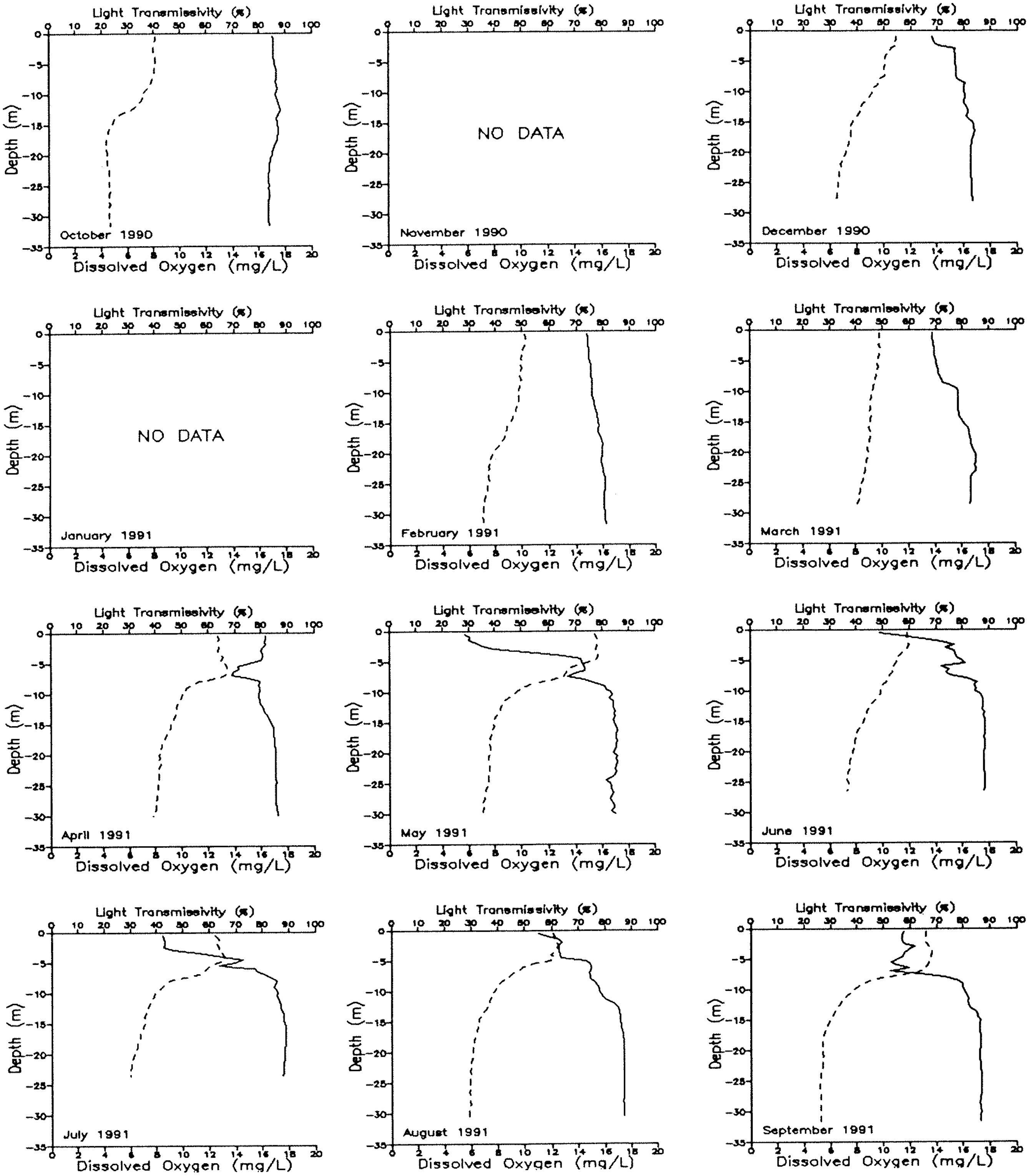
Possession Sound - Gedney Island (Station PSS019)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

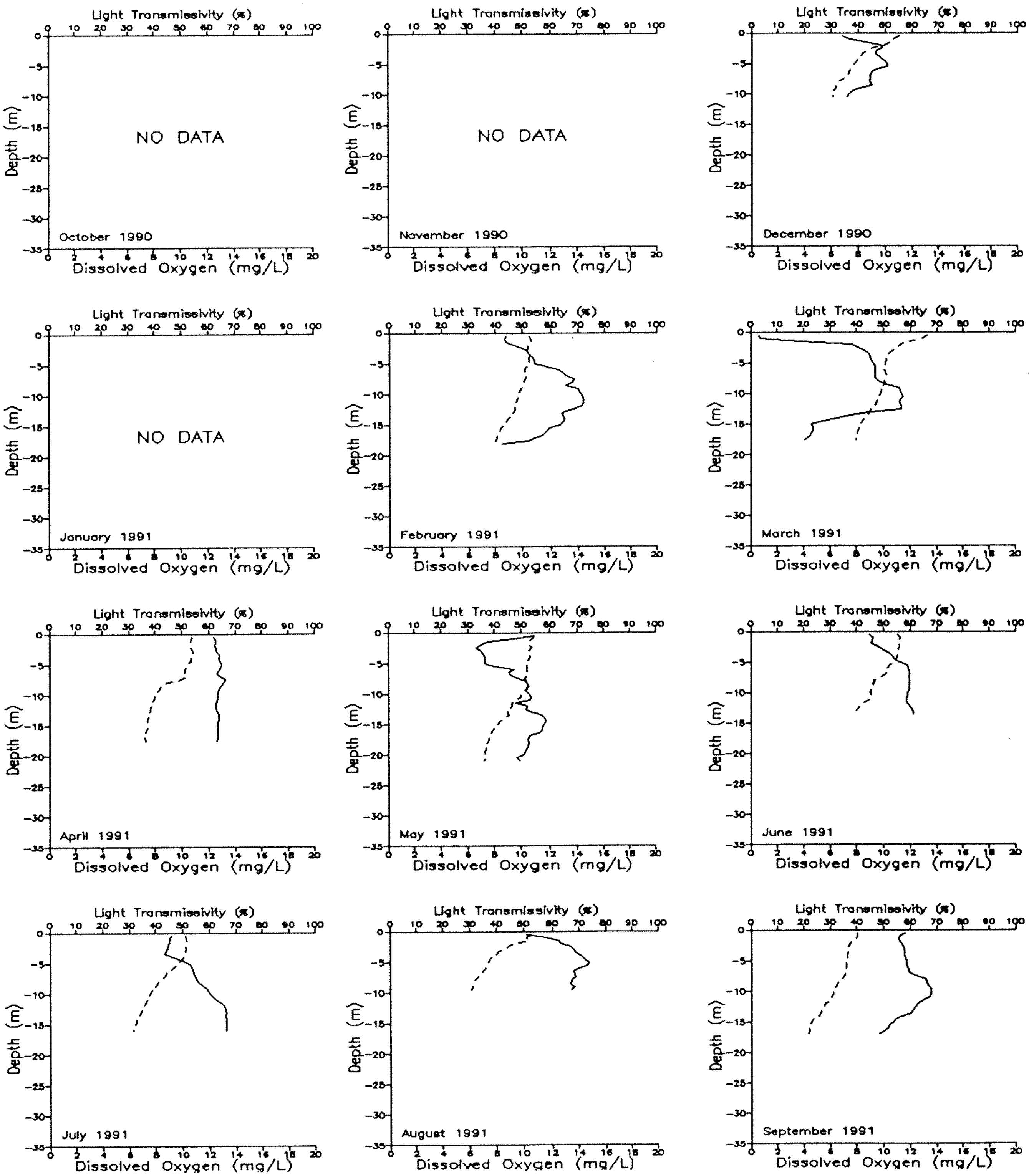
Saratoga Passage (Station SAR003)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

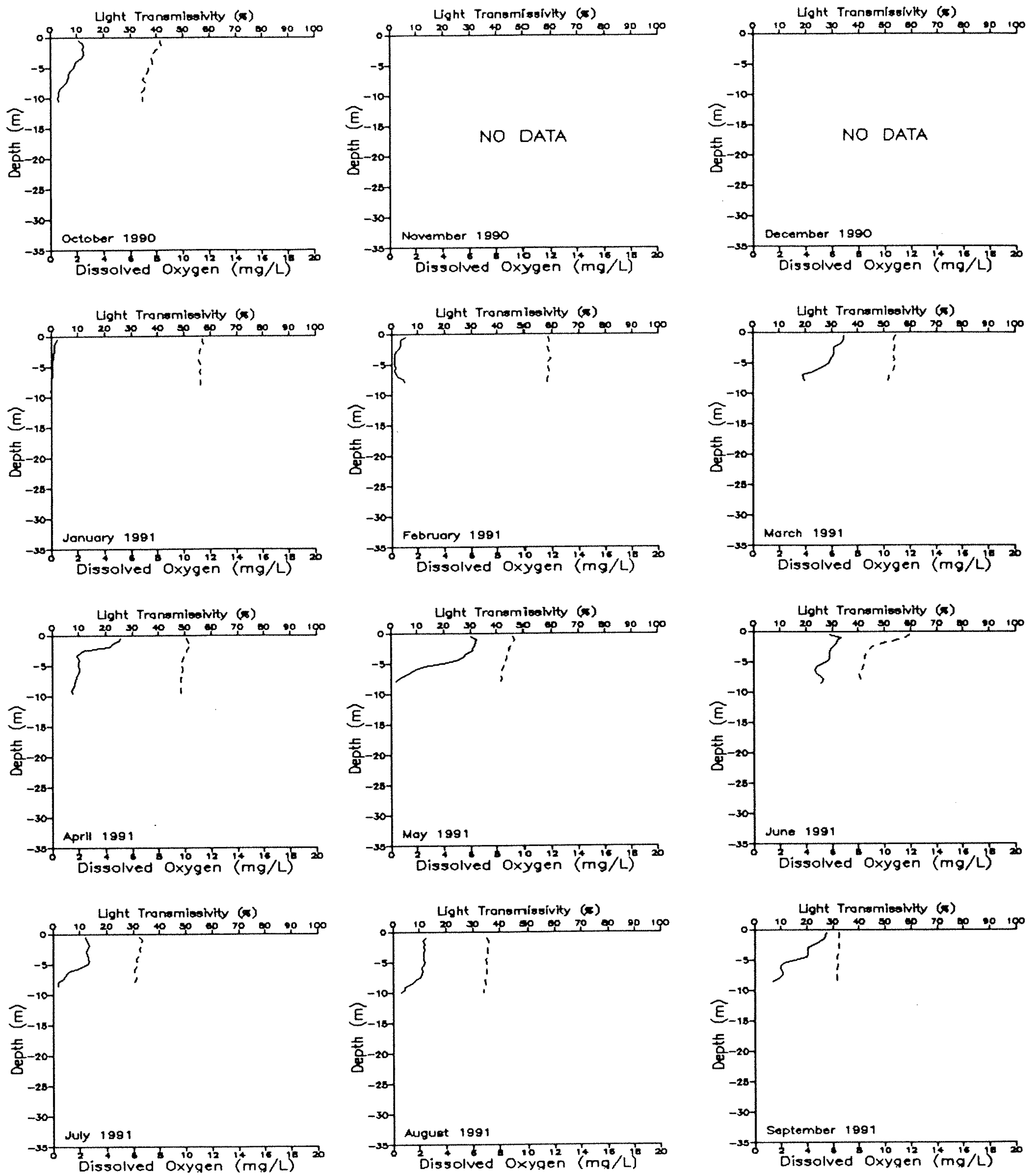
Skagit Bay (Station SKG003)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

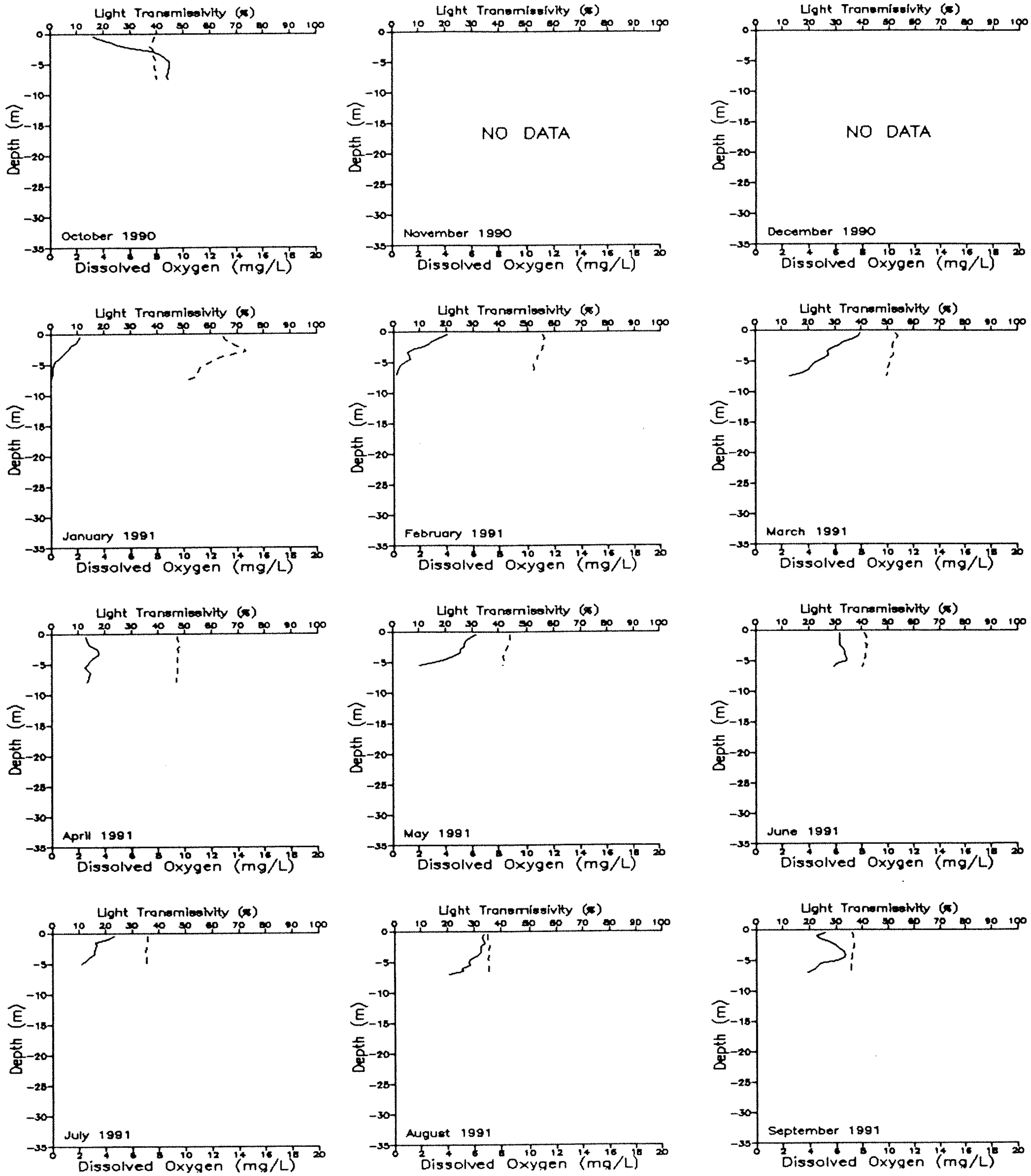
Willapa Bay - Willapa River (Station WPA001)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

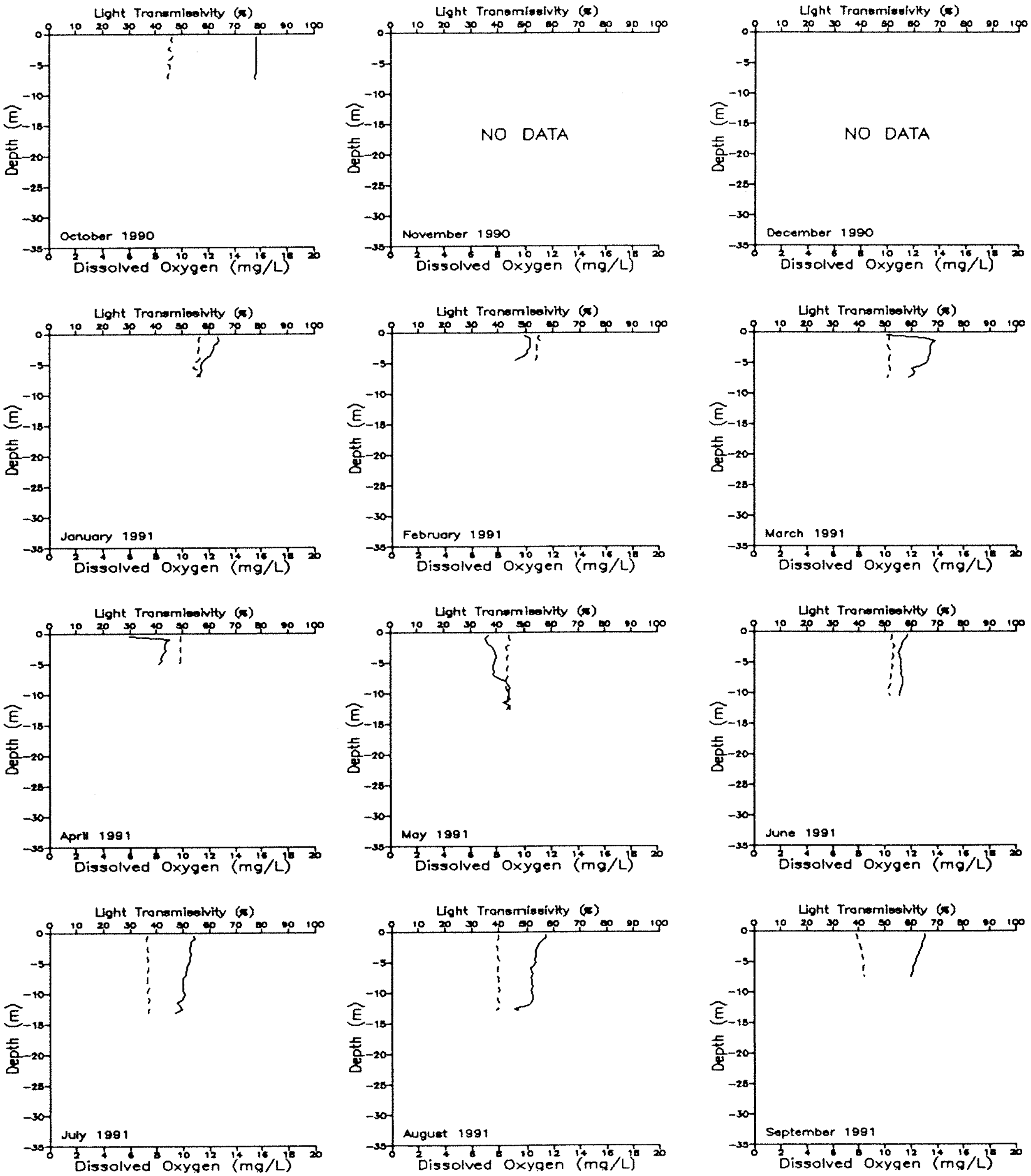
Willapa Bay - Johnson Slough (Station WPA003)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

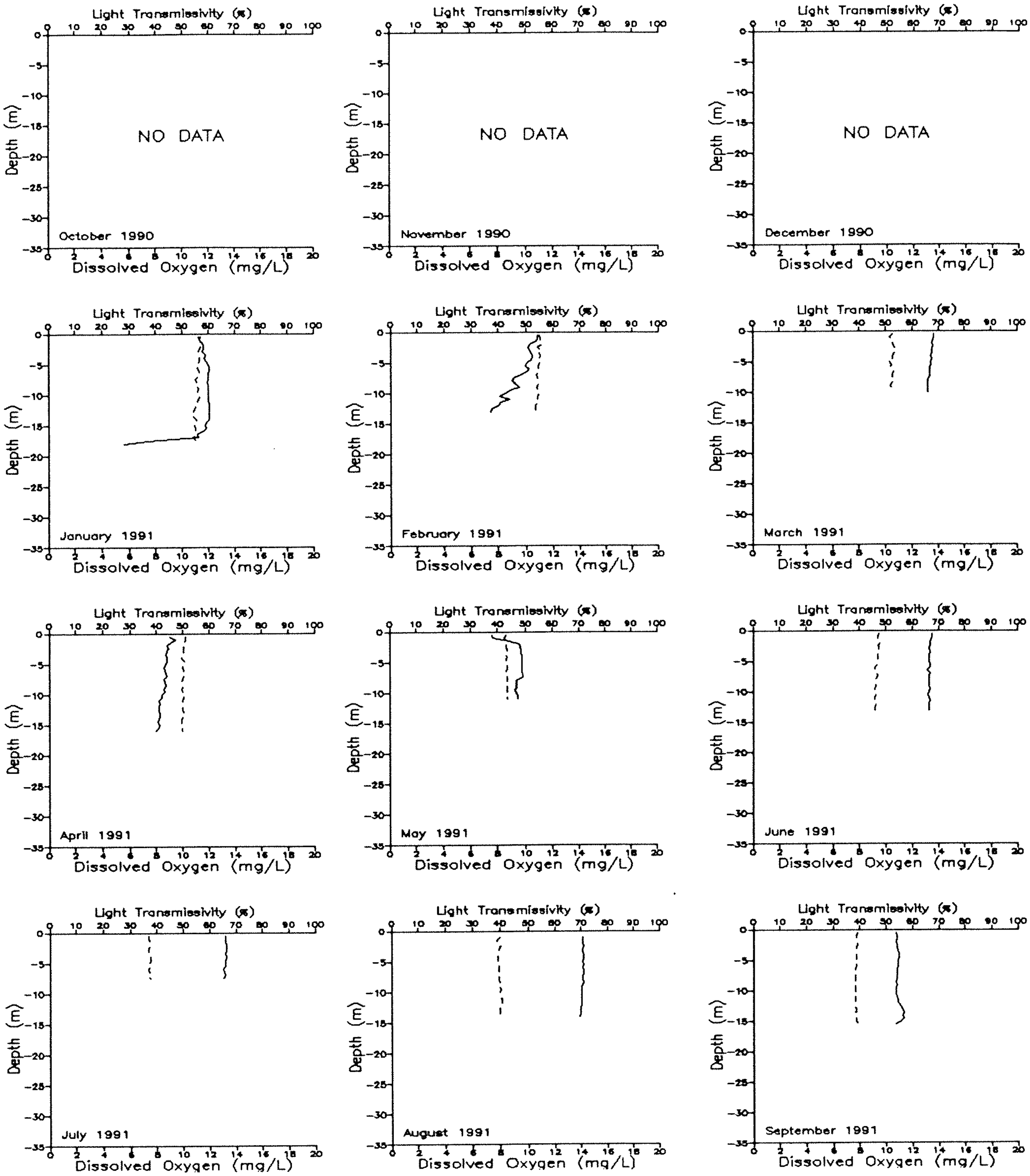
North Willapa Bay (Station WPA004)



Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

WATERYEAR 1991

Willapa Bay - Nahcotta Channel (Station WPA006)



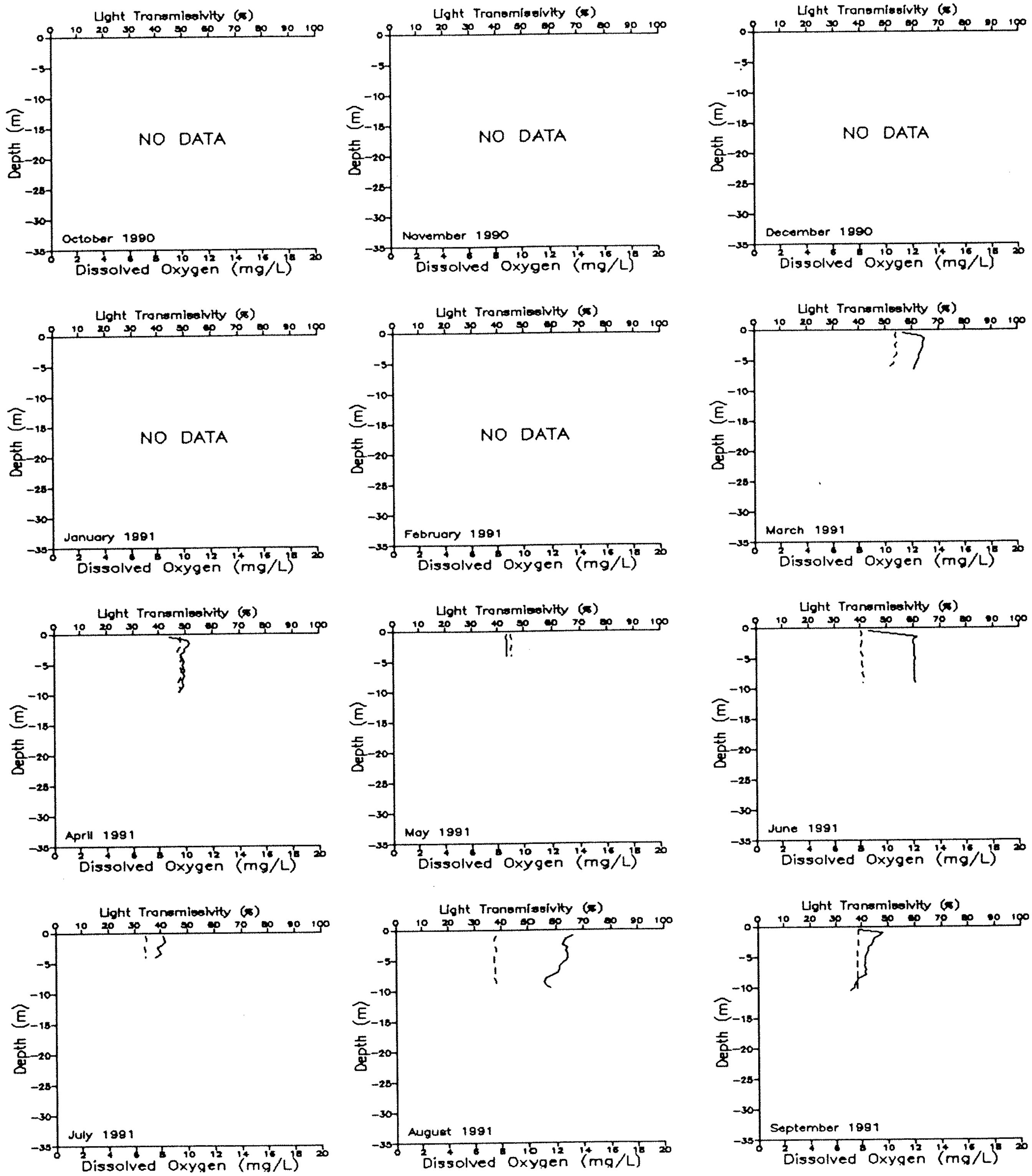
Key:

Light Transmissivity = Solid line

Dissolved Oxygen = Dashed line

WATERYEAR 1991

Willapa Bay - Jensen Point (Station WPA007)

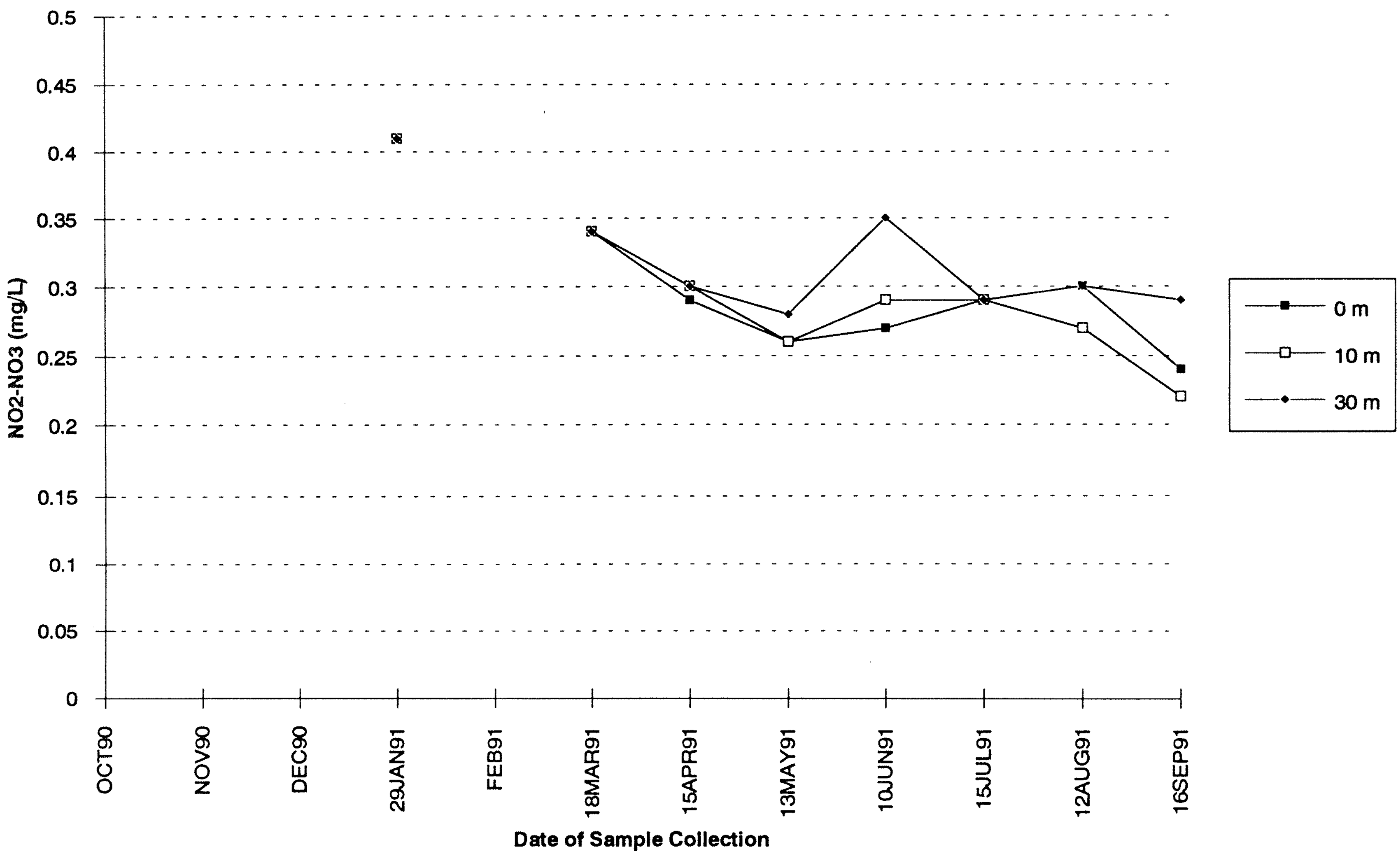


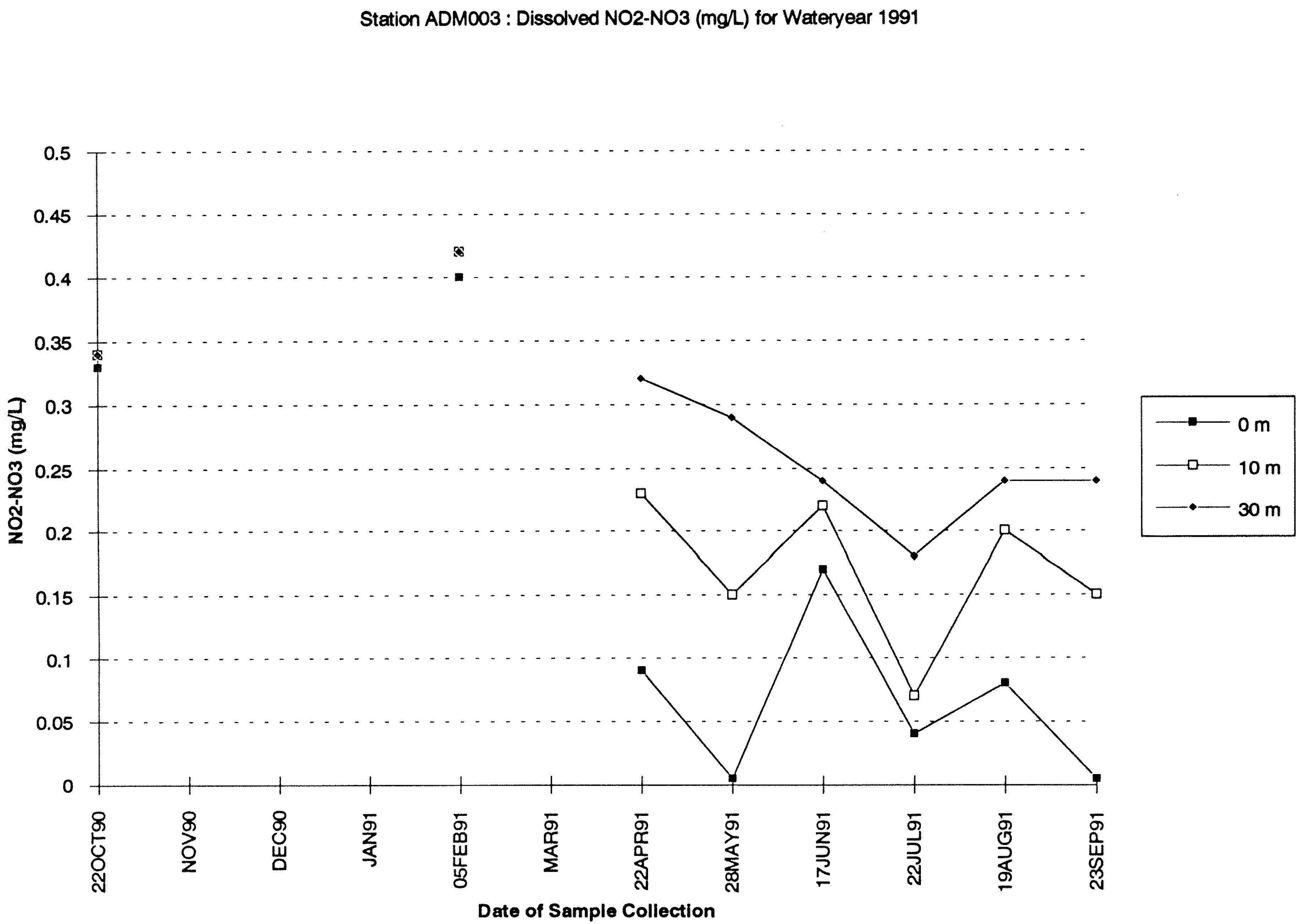
Key:
Light Transmissivity = Solid line
Dissolved Oxygen = Dashed line

APPENDIX E

PLOTS OF NITRITE-NITRATE CONCENTRATIONS FOR EACH WY 1991 STATION AT ALL DEPTHS

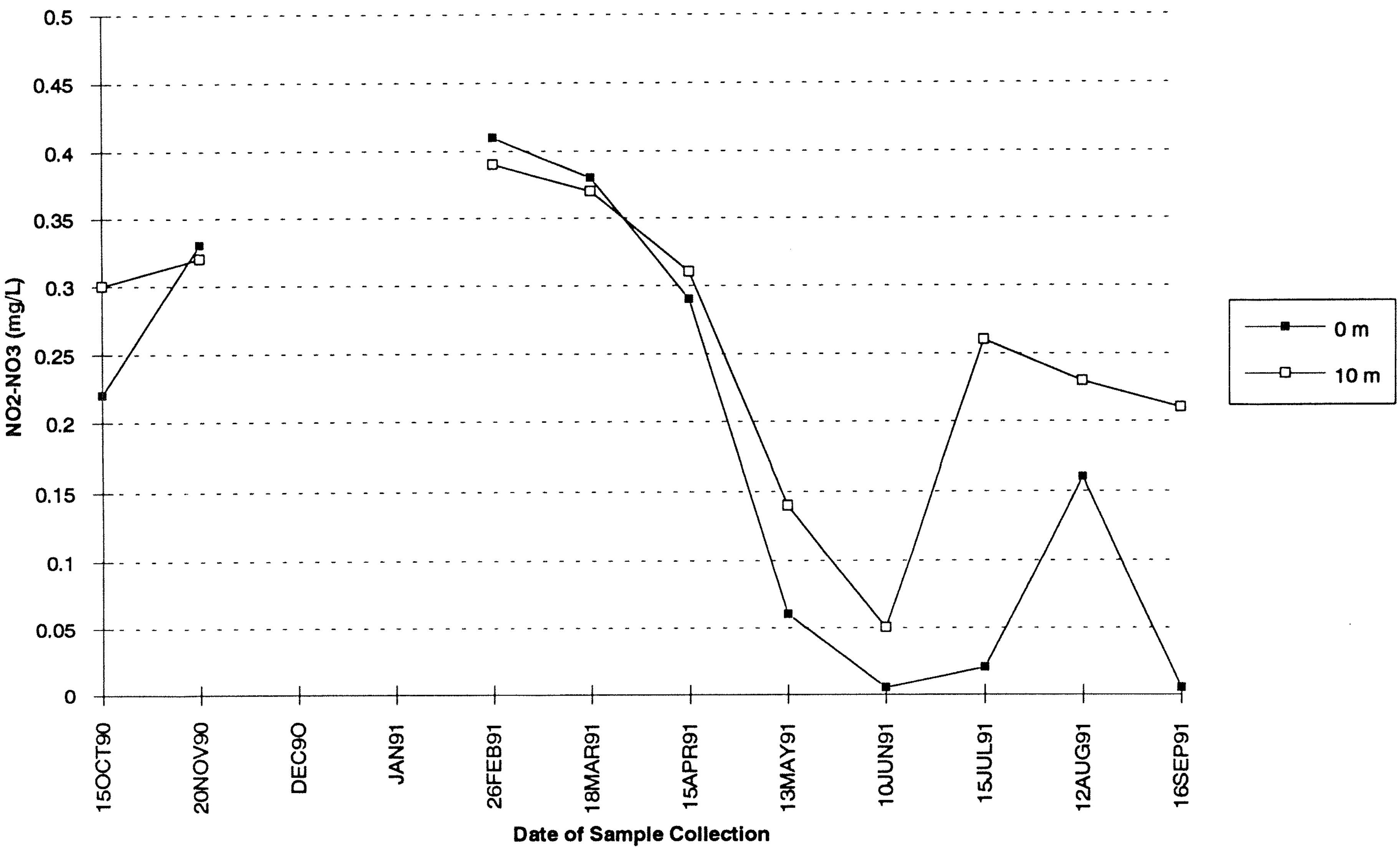
Station ADM002 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991



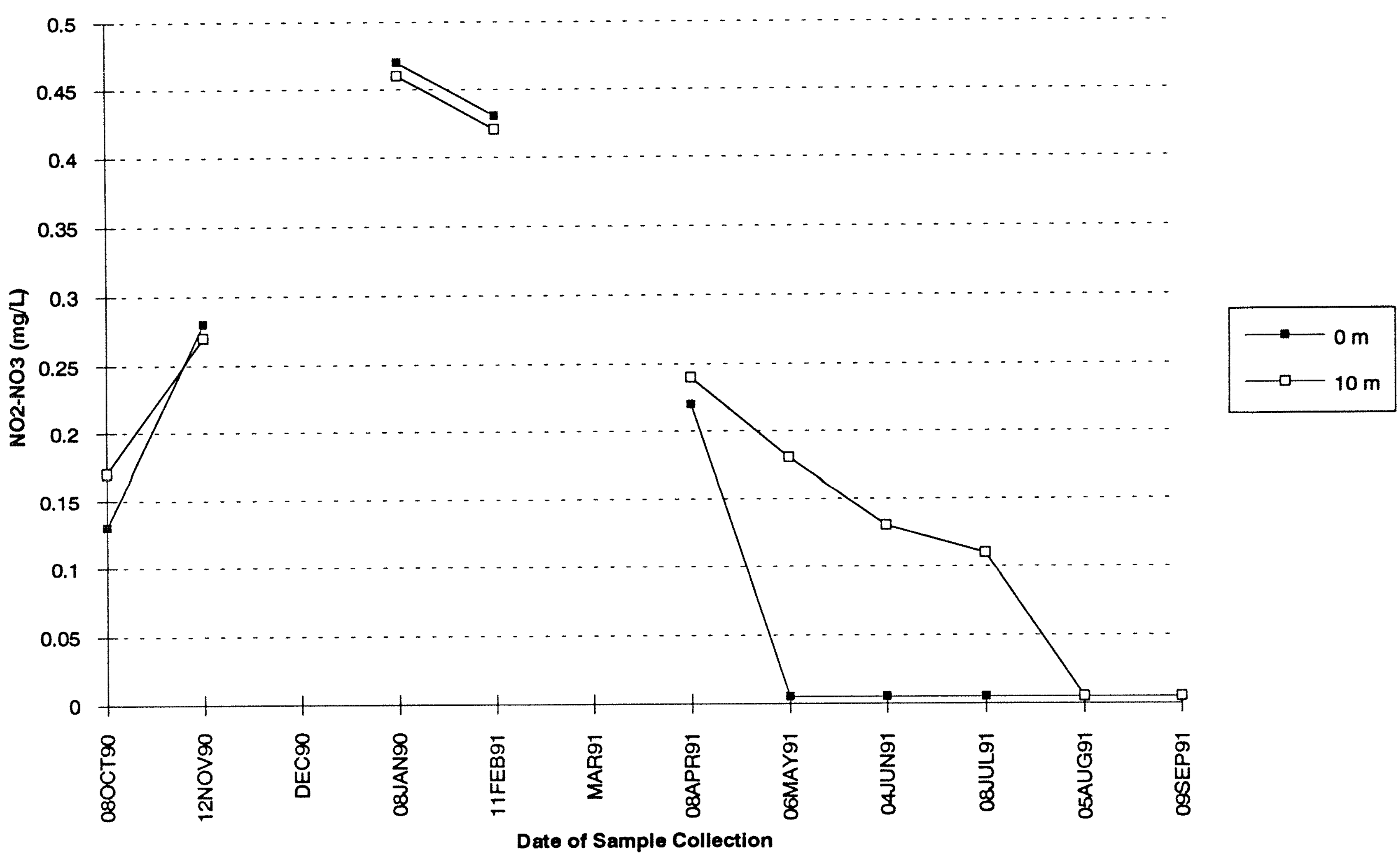


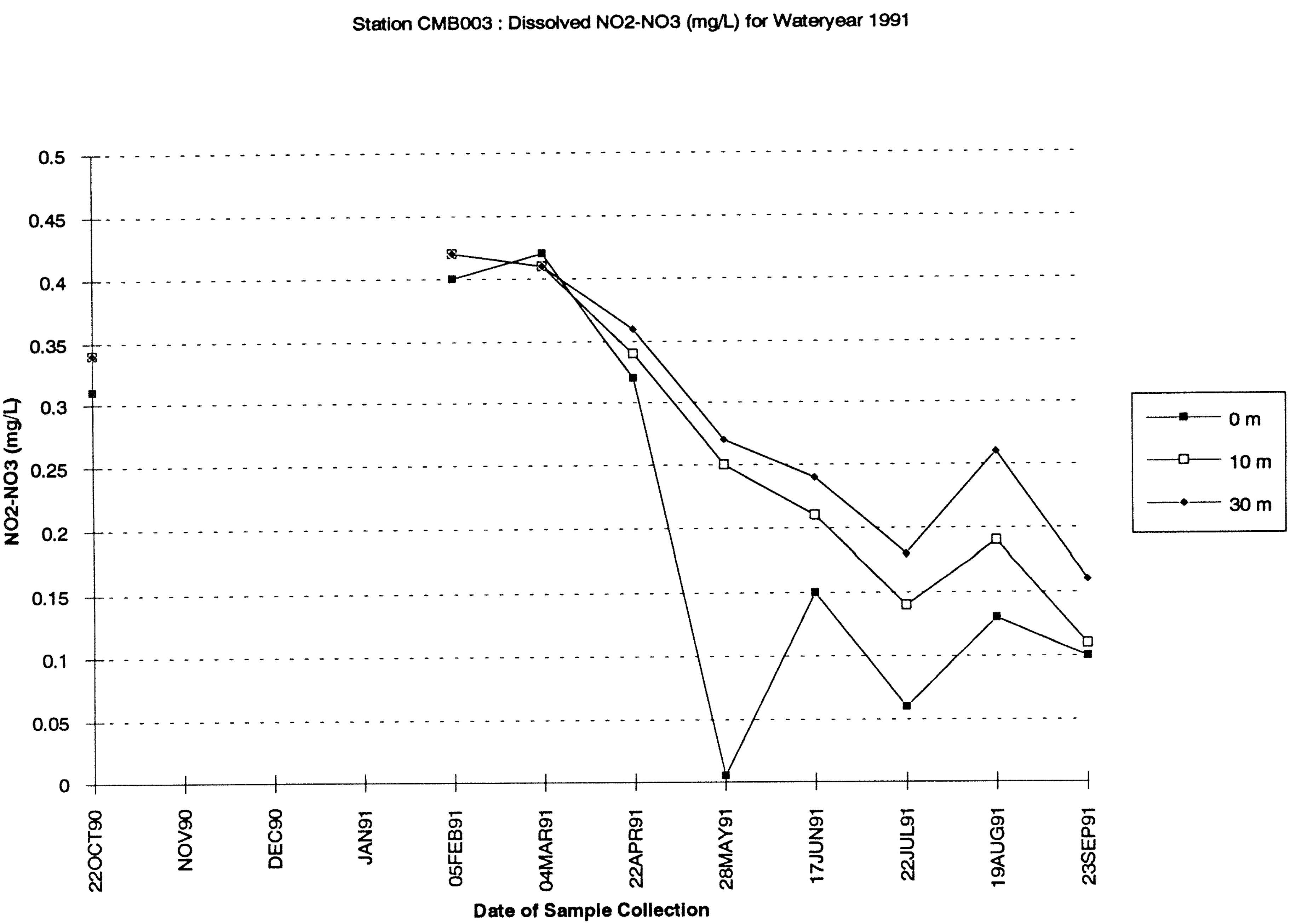
Station ADM003 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
NO2-NO3 (mg/L)
22OCT90
NOV90
DEC90
JAN91
05FEB91
MAR91
22APR91
28MAY91
17JUN91
22JUL91
19AUG91
23SEP91
Date of Sample Collection
0 m
10 m
30 m

Station BLL009 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991



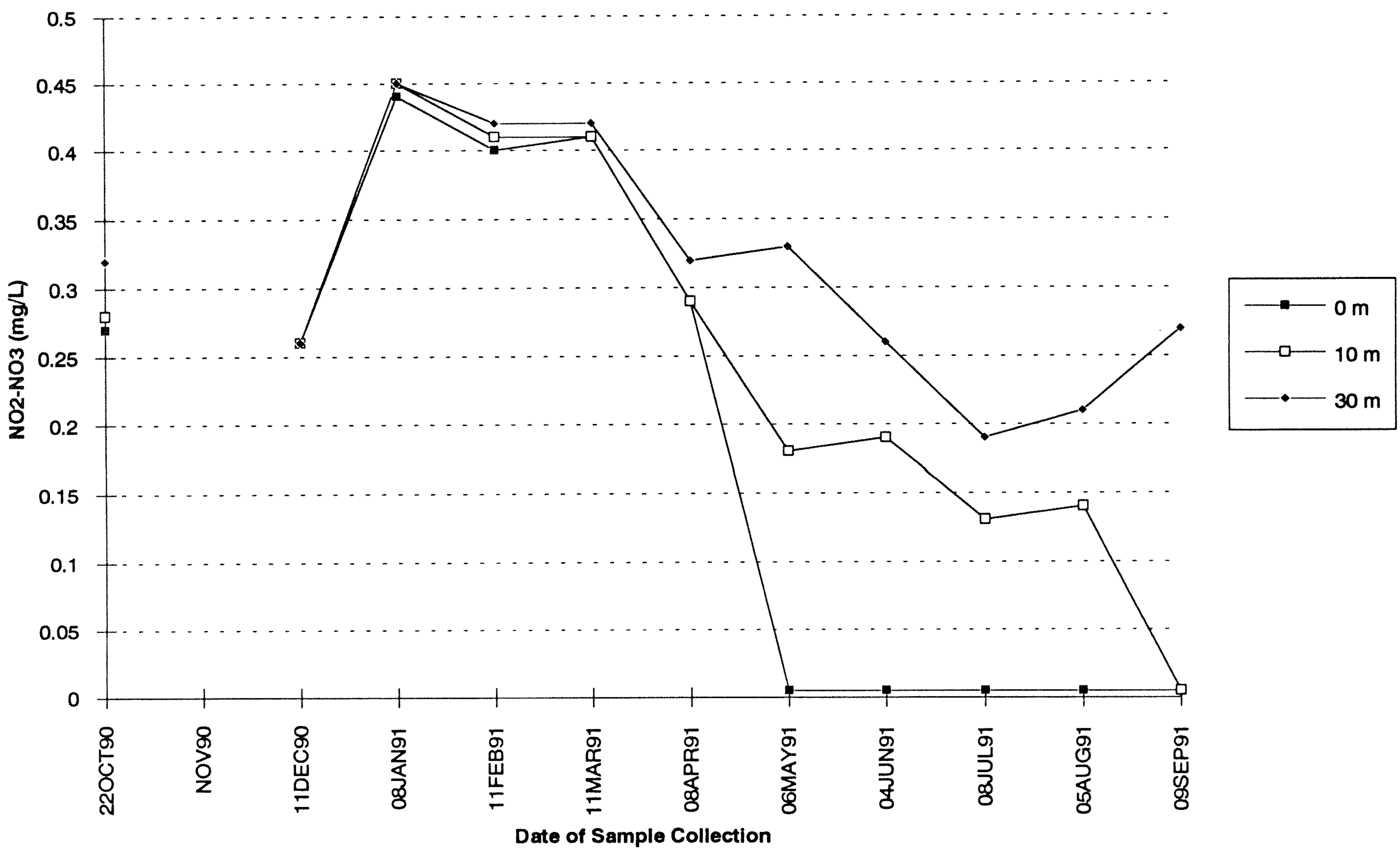
Station BUD005 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991

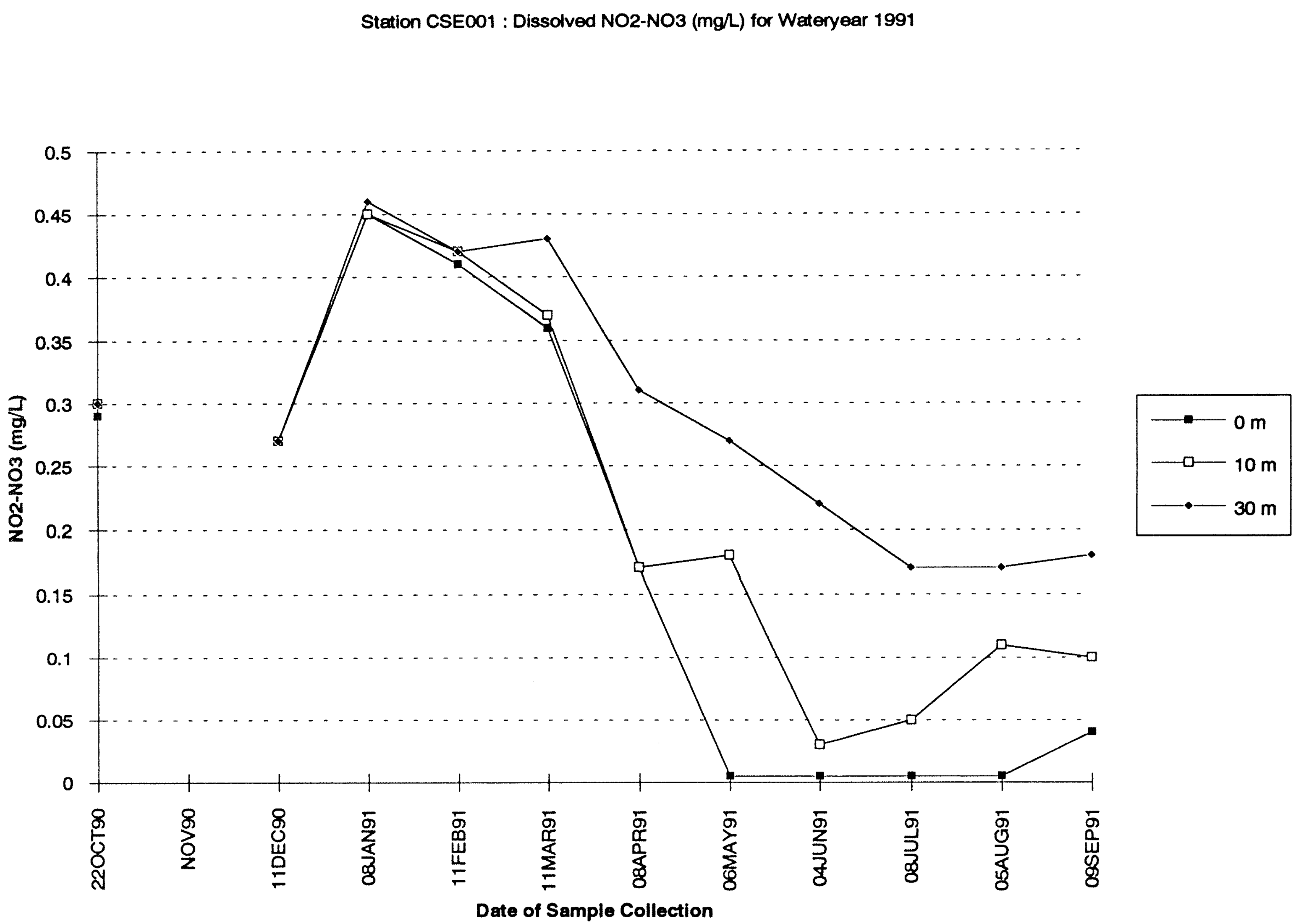




Station CMB003 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991
NO2-NO3 (mg/L)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
22OCT90
NOV90
DEC90
JAN91
05FEB91
04MAR91
22APR91
28MAY91
17JUN91
22JUL91
19AUG91
23SEP91
Date of Sample Collection
0 m
10 m
30 m

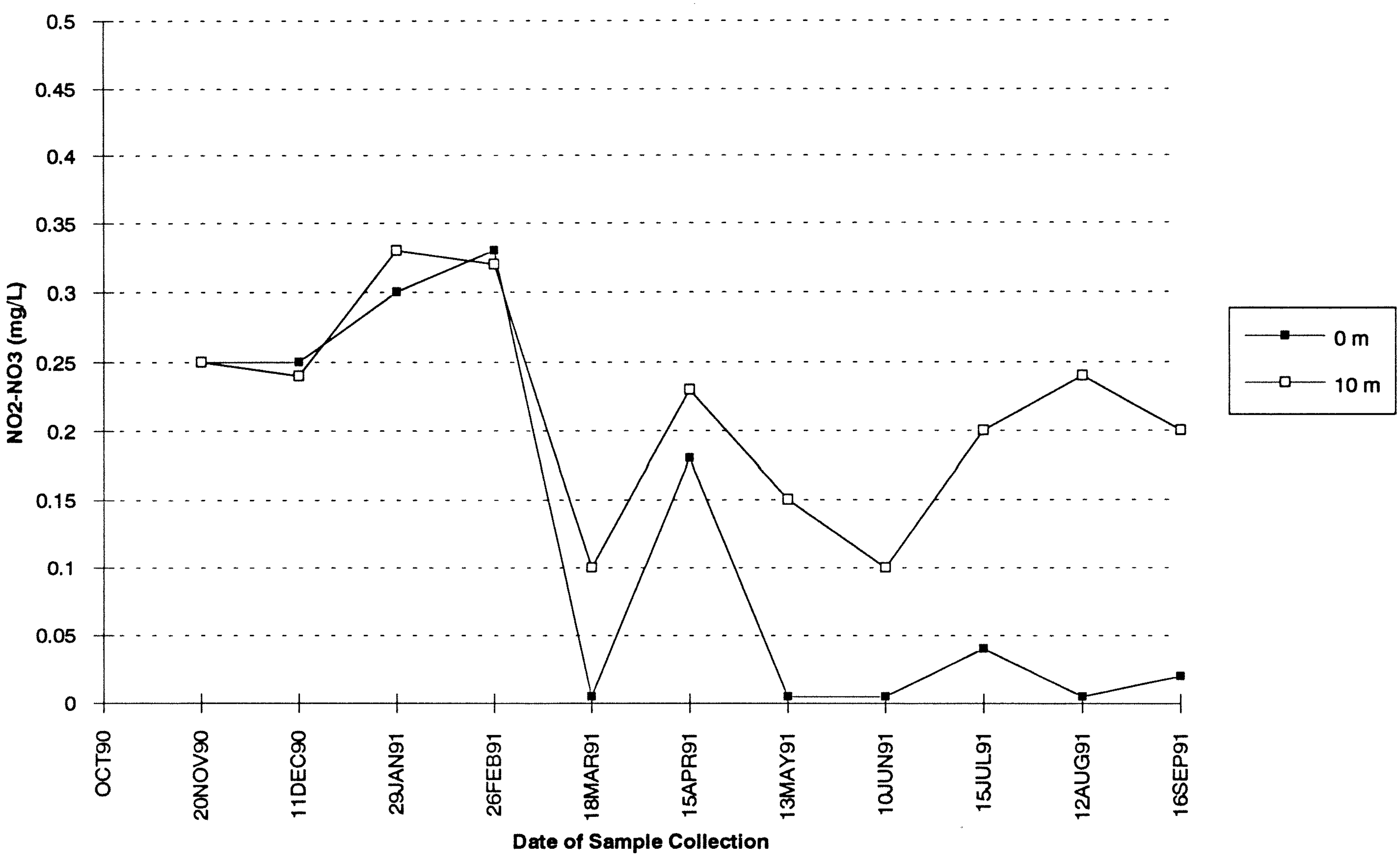
Station CRR001 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991



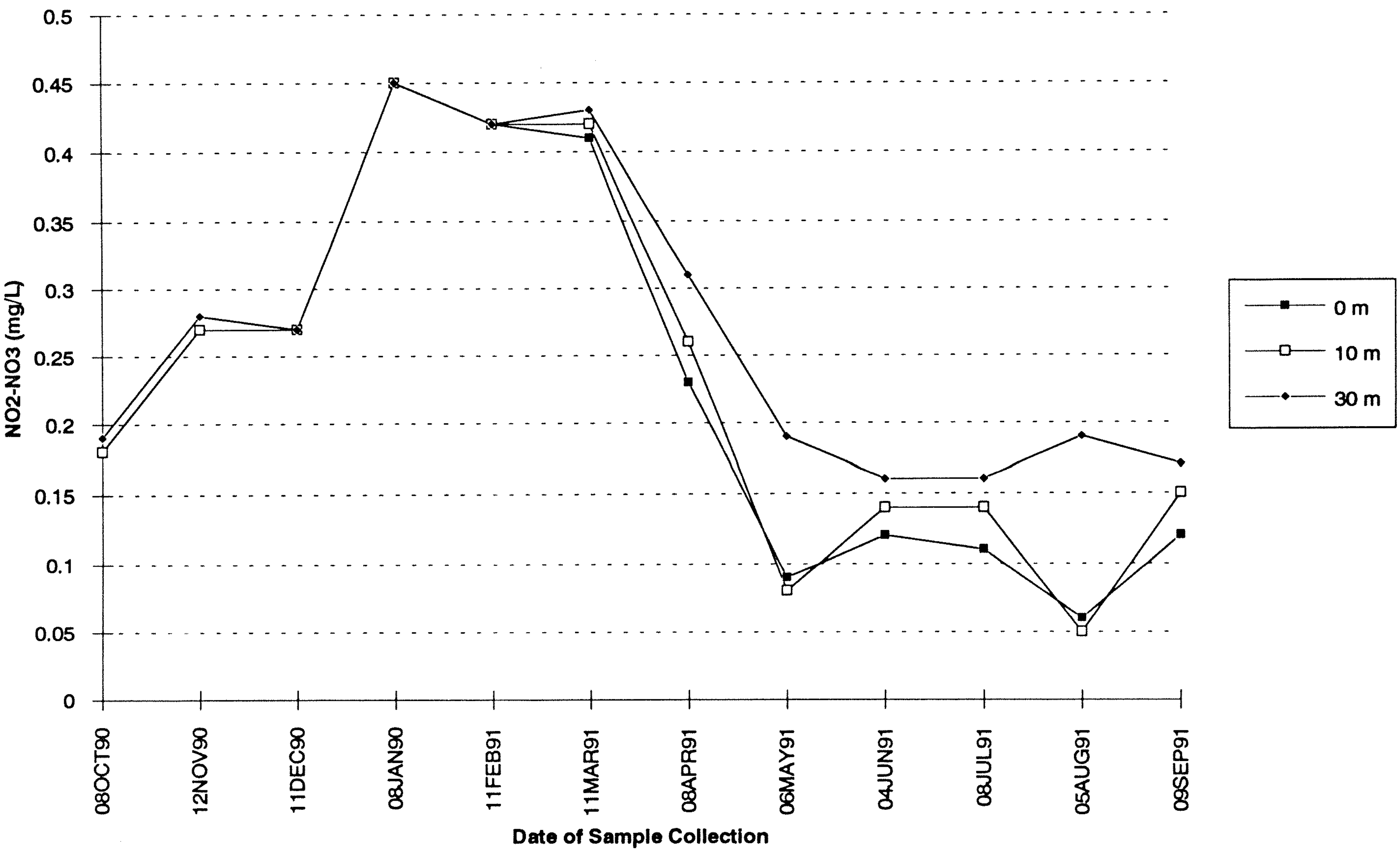


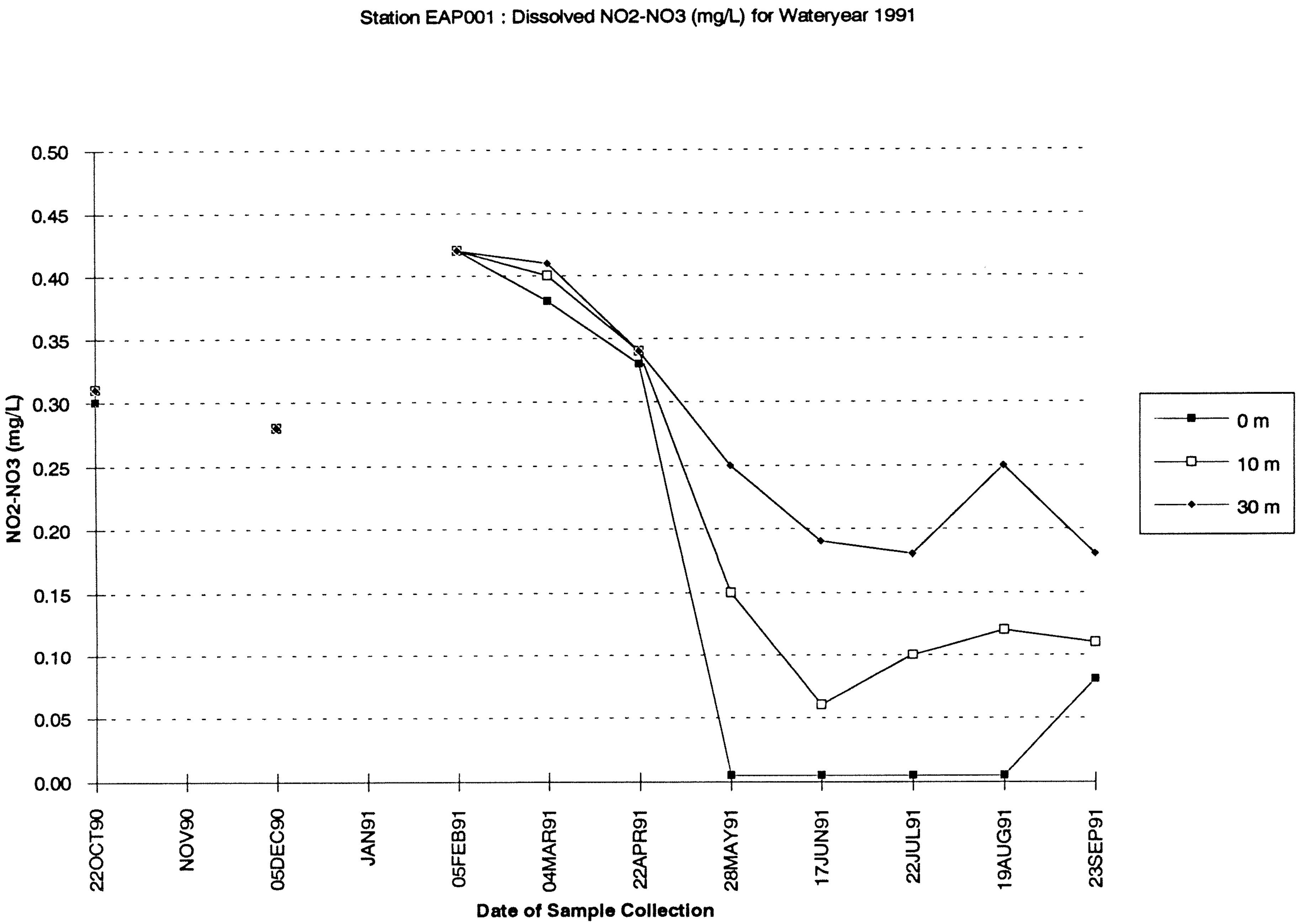
Station CSE001 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991
NO2-NO3 (mg/L)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
22OCT90
NOV90
11DEC90
08JAN91
11FEB91
11MAR91
08APR91
06MAY91
04JUN91
08JUL91
05AUG91
09SEP91
Date of Sample Collection
0 m
10 m
30 m

Station DIS001 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991



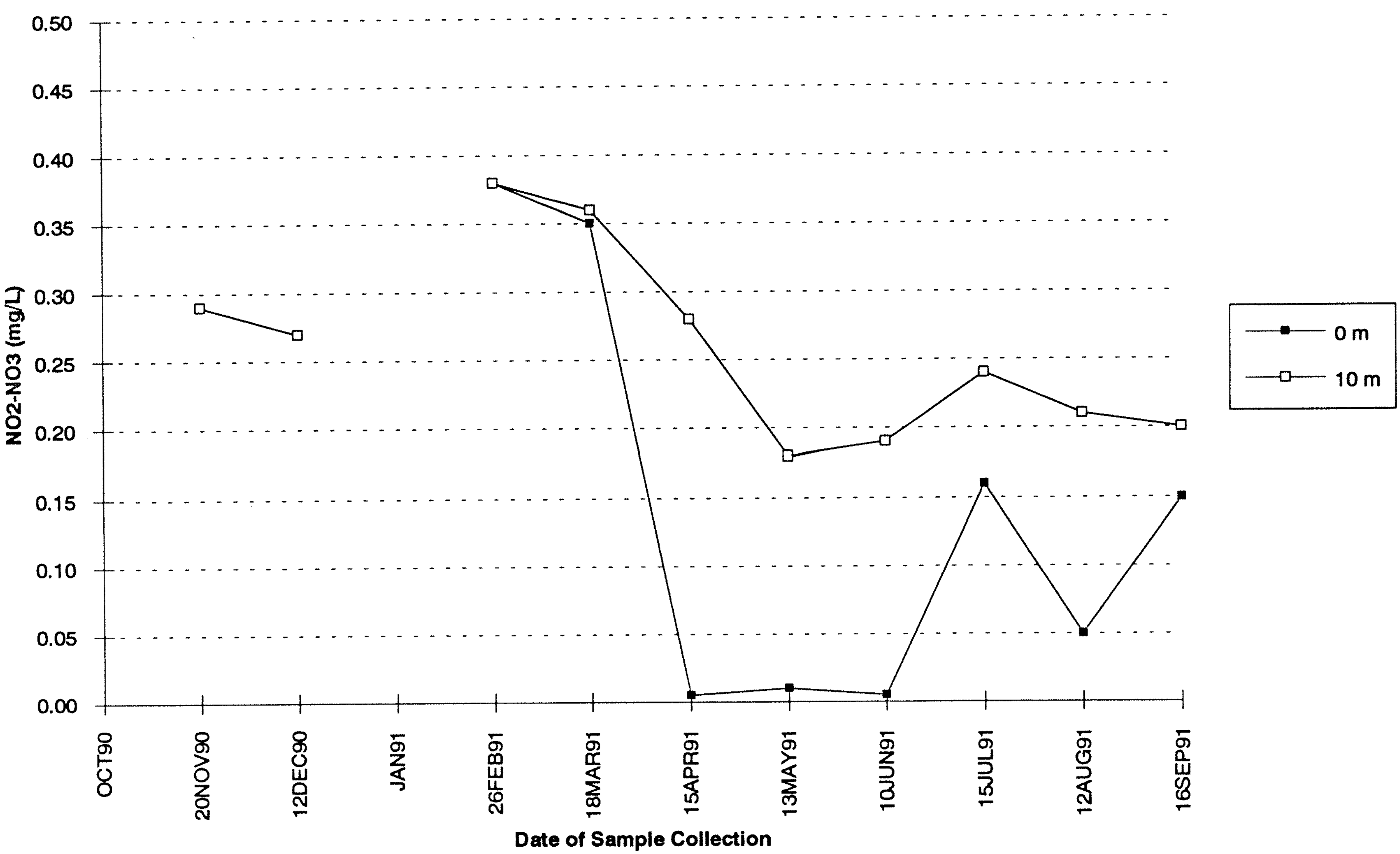
Station DNA001 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991



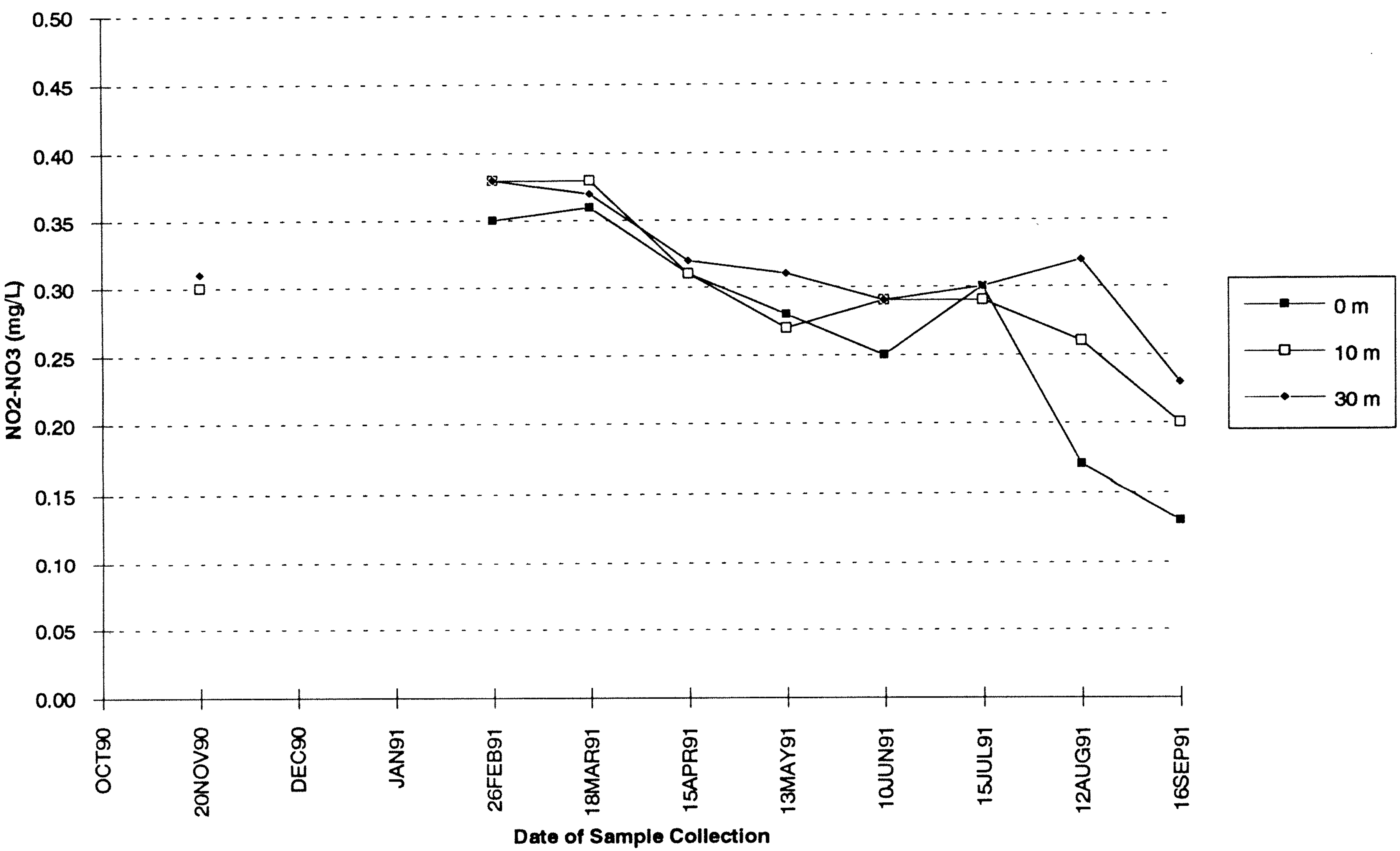


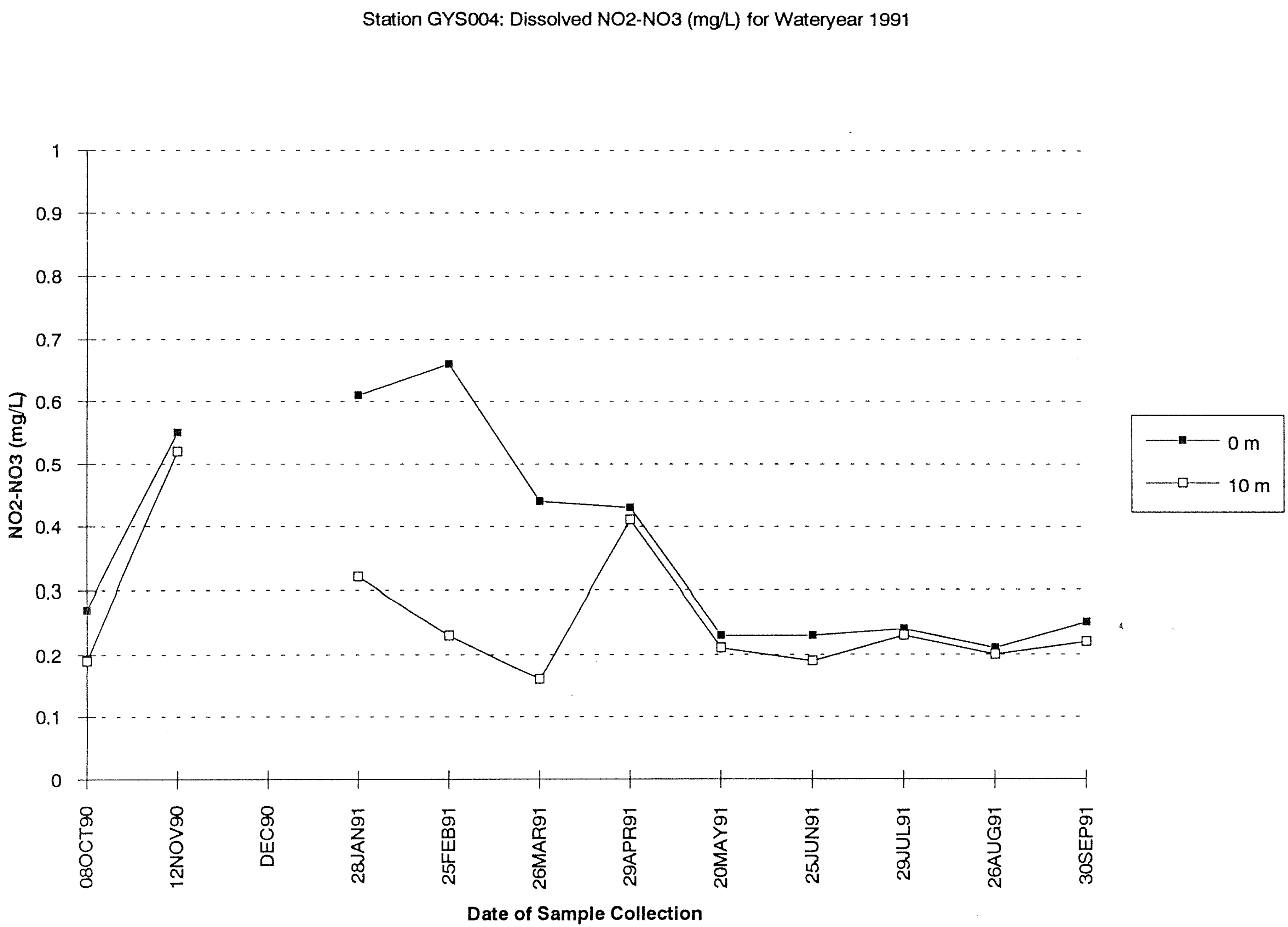
Station EAP001 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991
NO2-NO3 (mg/L)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
22OCT90
NOV90
05DEC90
JAN91
05FEB91
04MAR91
22APR91
28MAY91
17JUN91
22JUL91
19AUG91
23SEP91
Date of Sample Collection
0 m
10 m
30 m

Station EAS001 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991



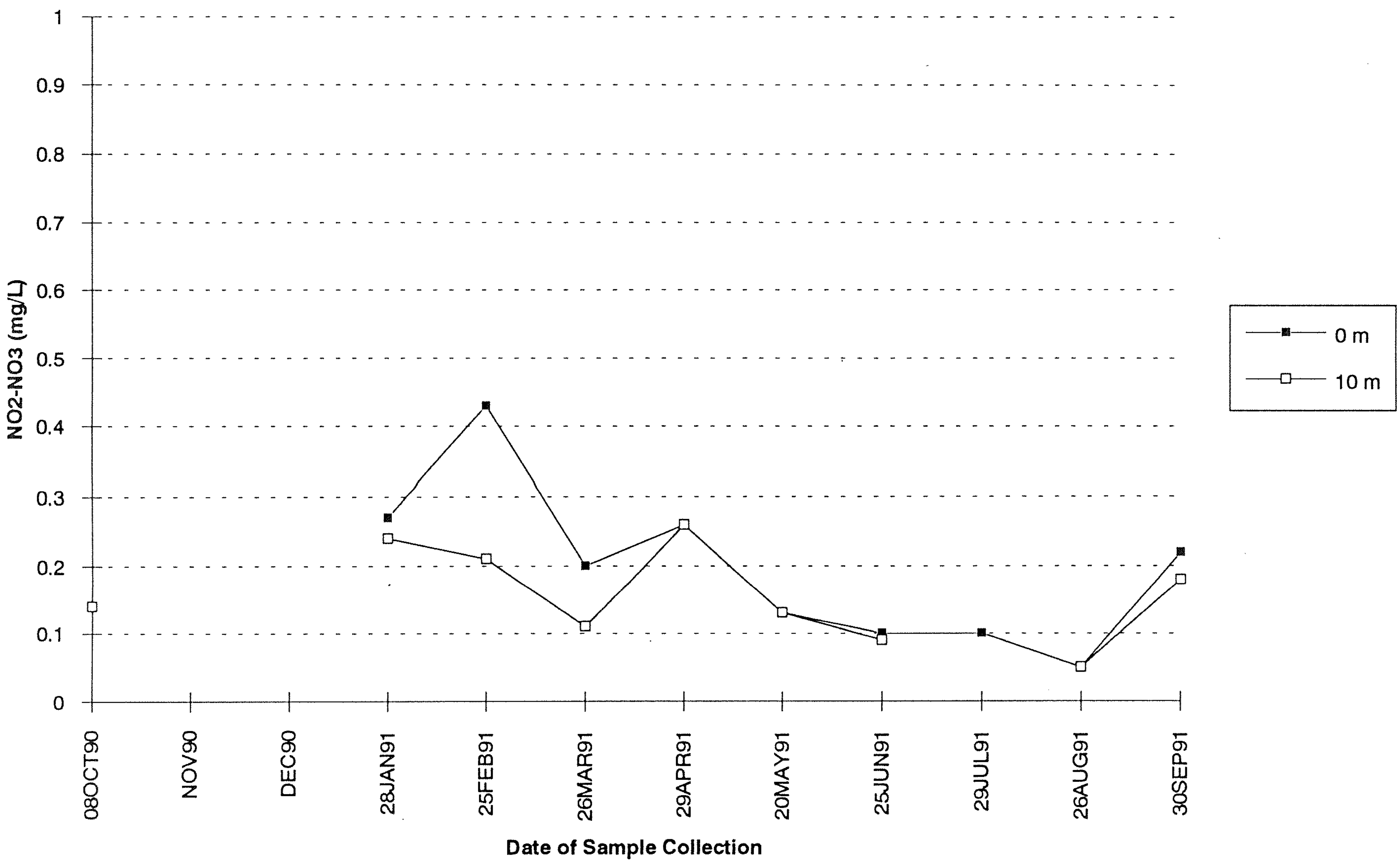
Station GRG002 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991



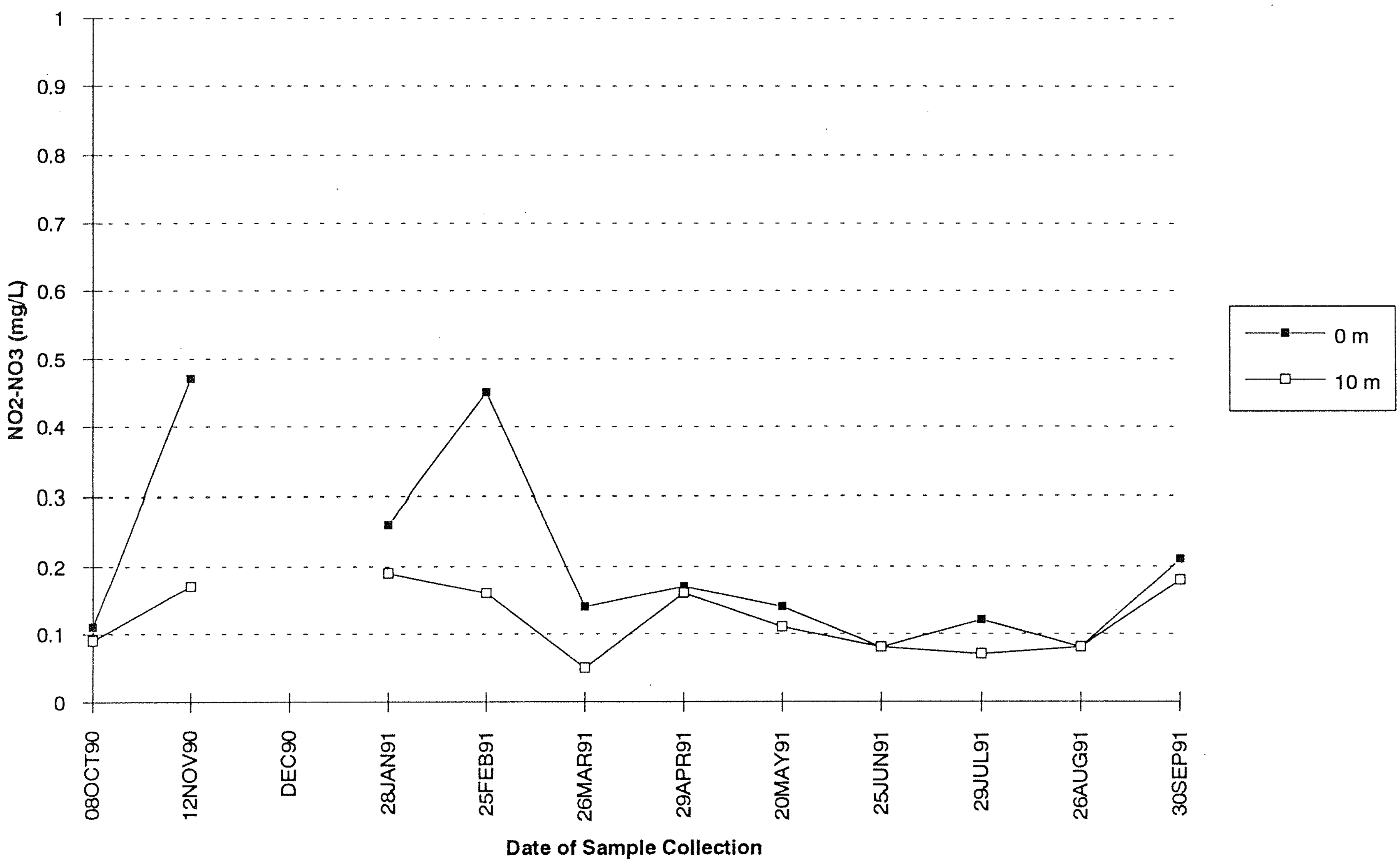


Station GYS004: Dissolved NO2-NO3 (mg/L) for Wateryear 1991
NO2-NO3 (mg/L)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
08OCT90
12NOV90
DEC90
28JAN91
25FEB91
26MAR91
29APR91
20MAY91
25JUN91
29JUL91
26AUG91
30SEP91
Date of Sample Collection
0 m
10 m

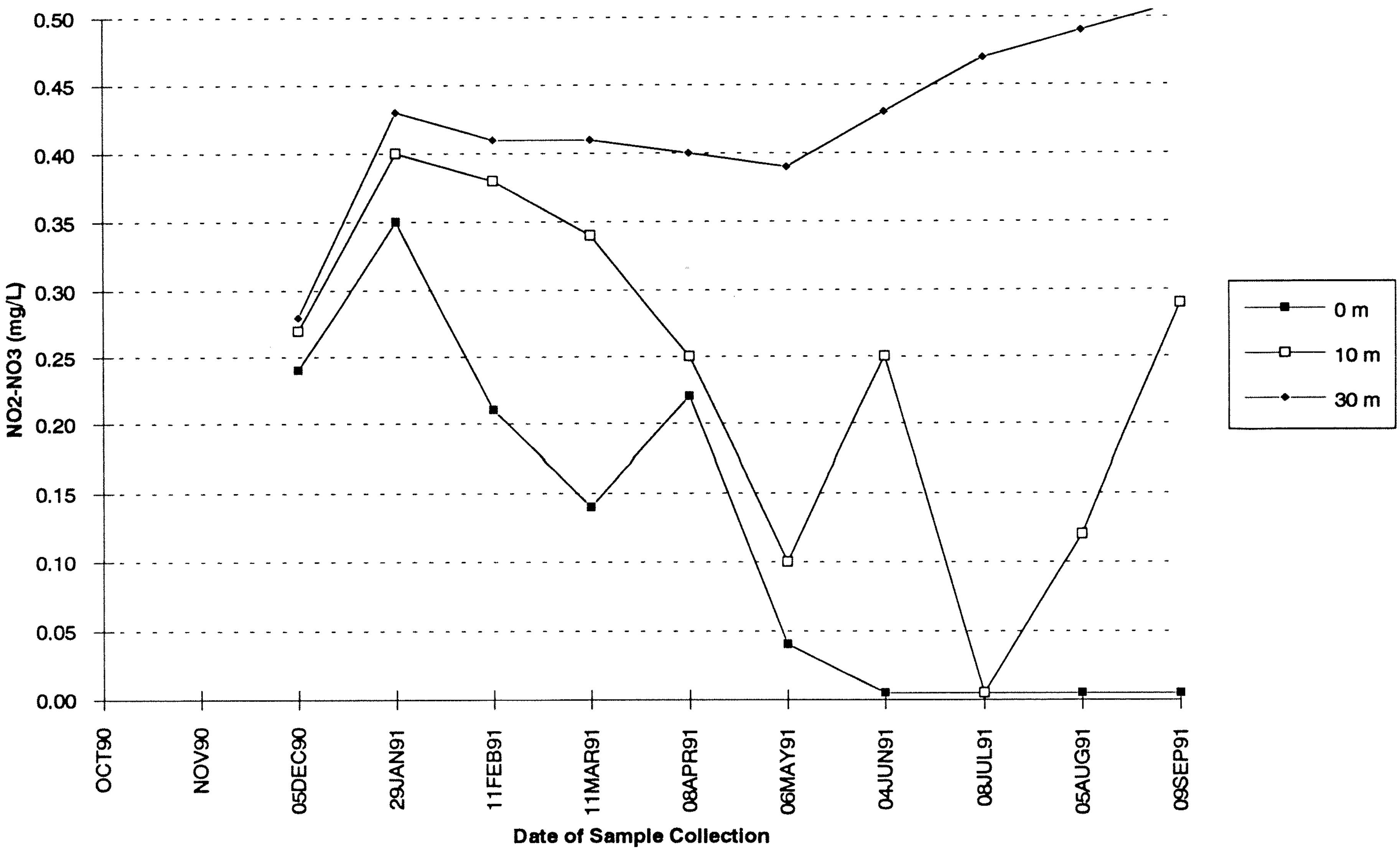
Station GYS008: Dissolved NO2-NO3 (mg/L) for Wateryear 1991



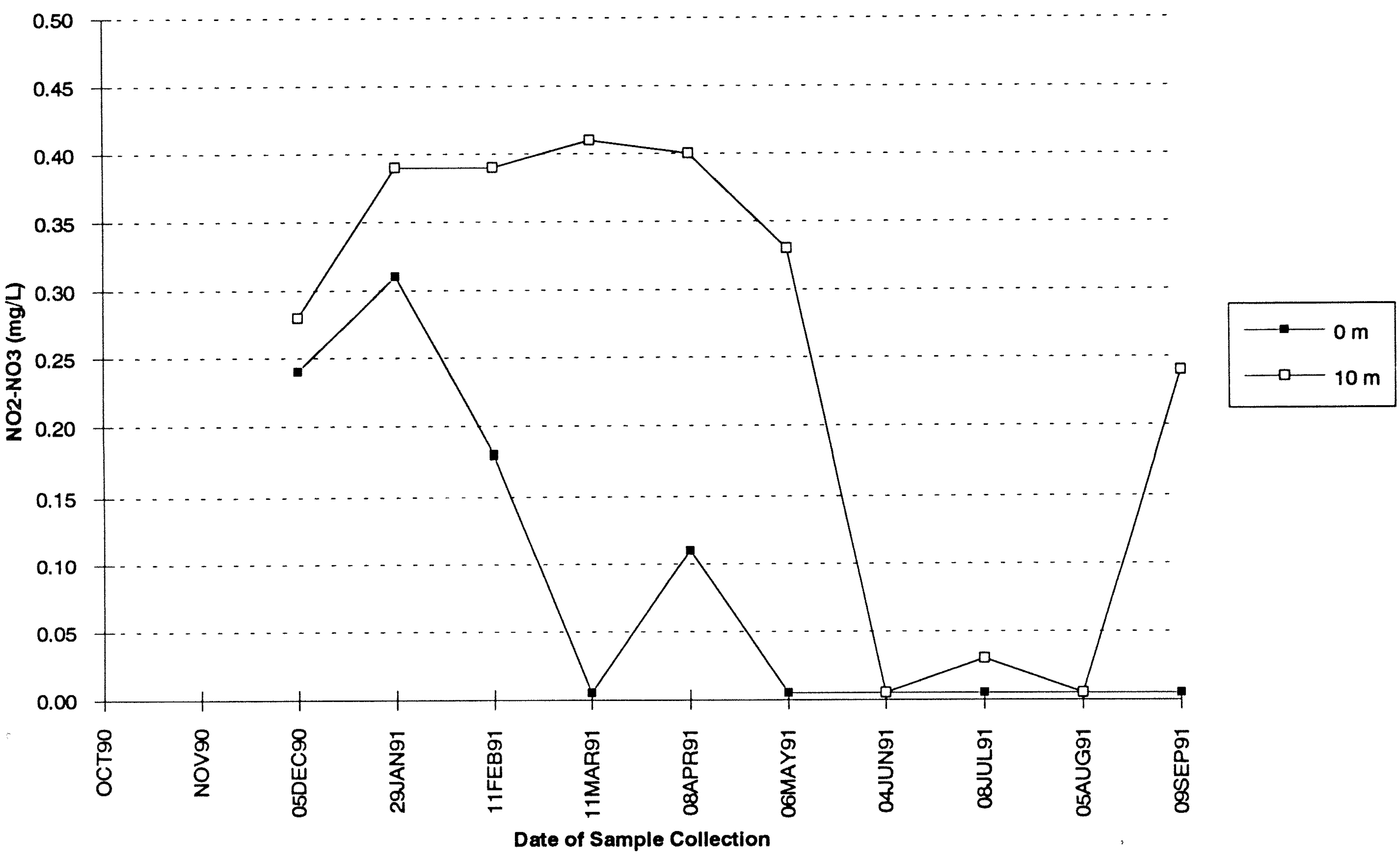
Station GYS009: Dissolved NO2-NO3 (mg/L) for Wateryear 1991



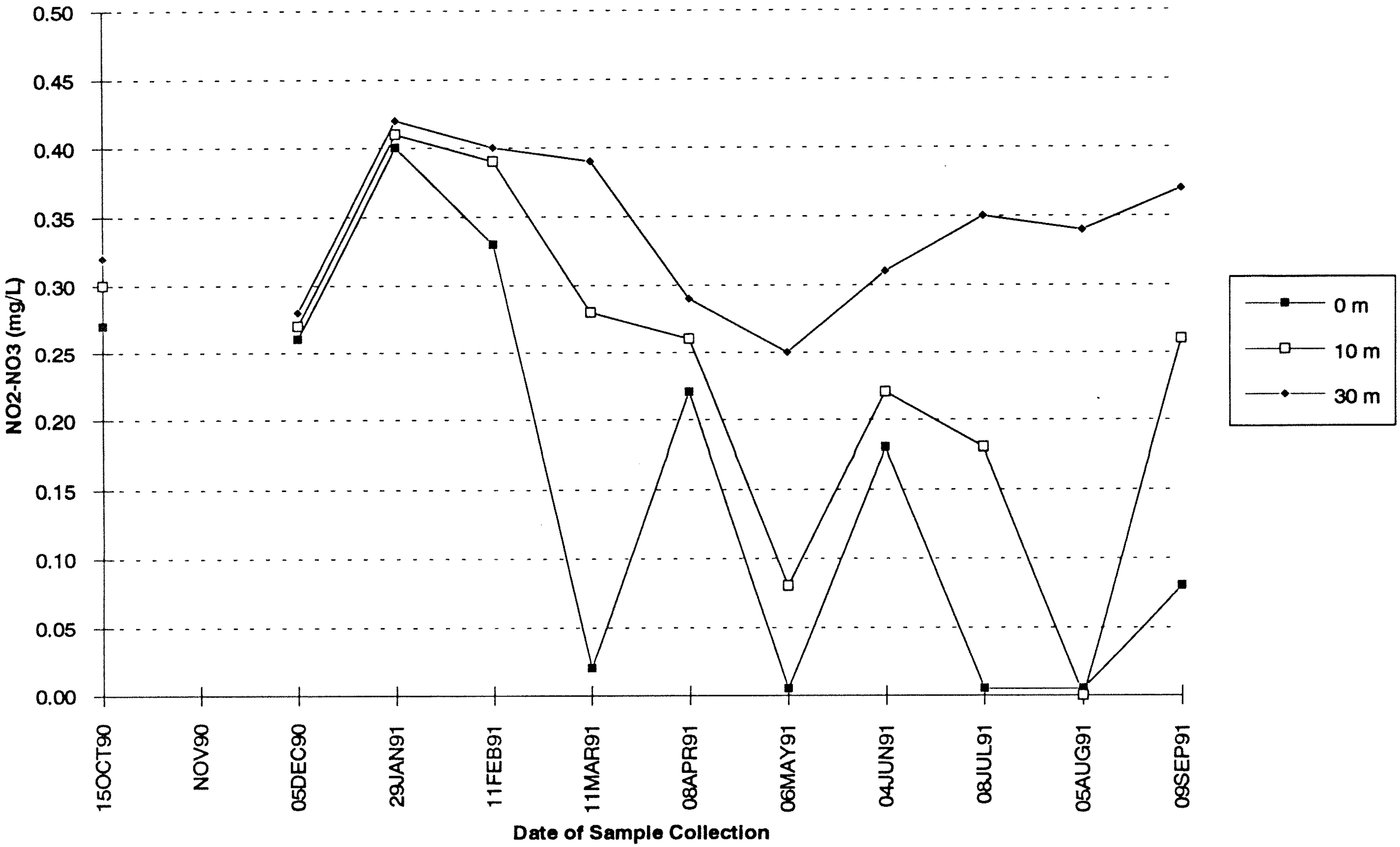
Station HCB003 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991



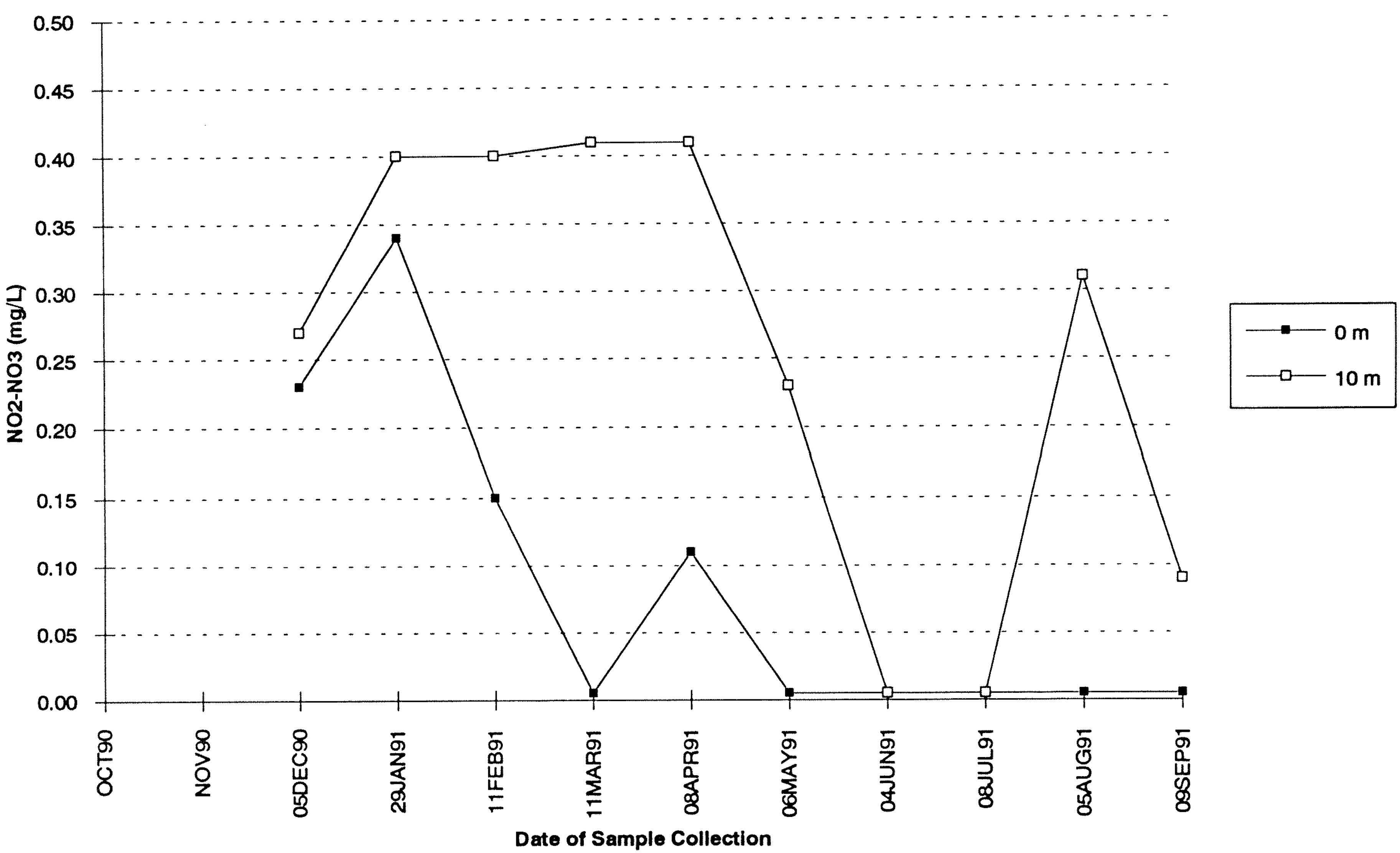
Station HCB004 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991



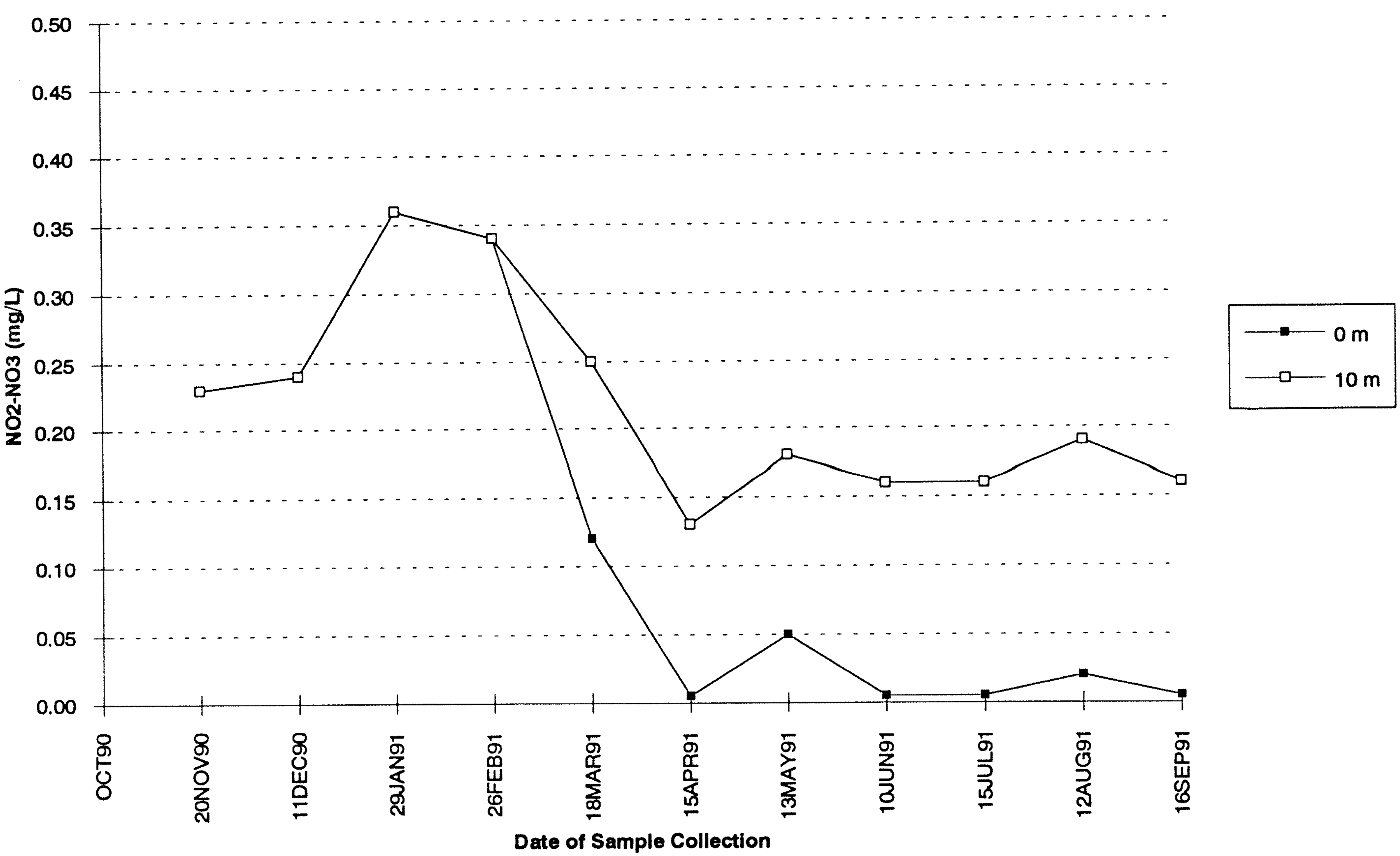
Station HCB006 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991



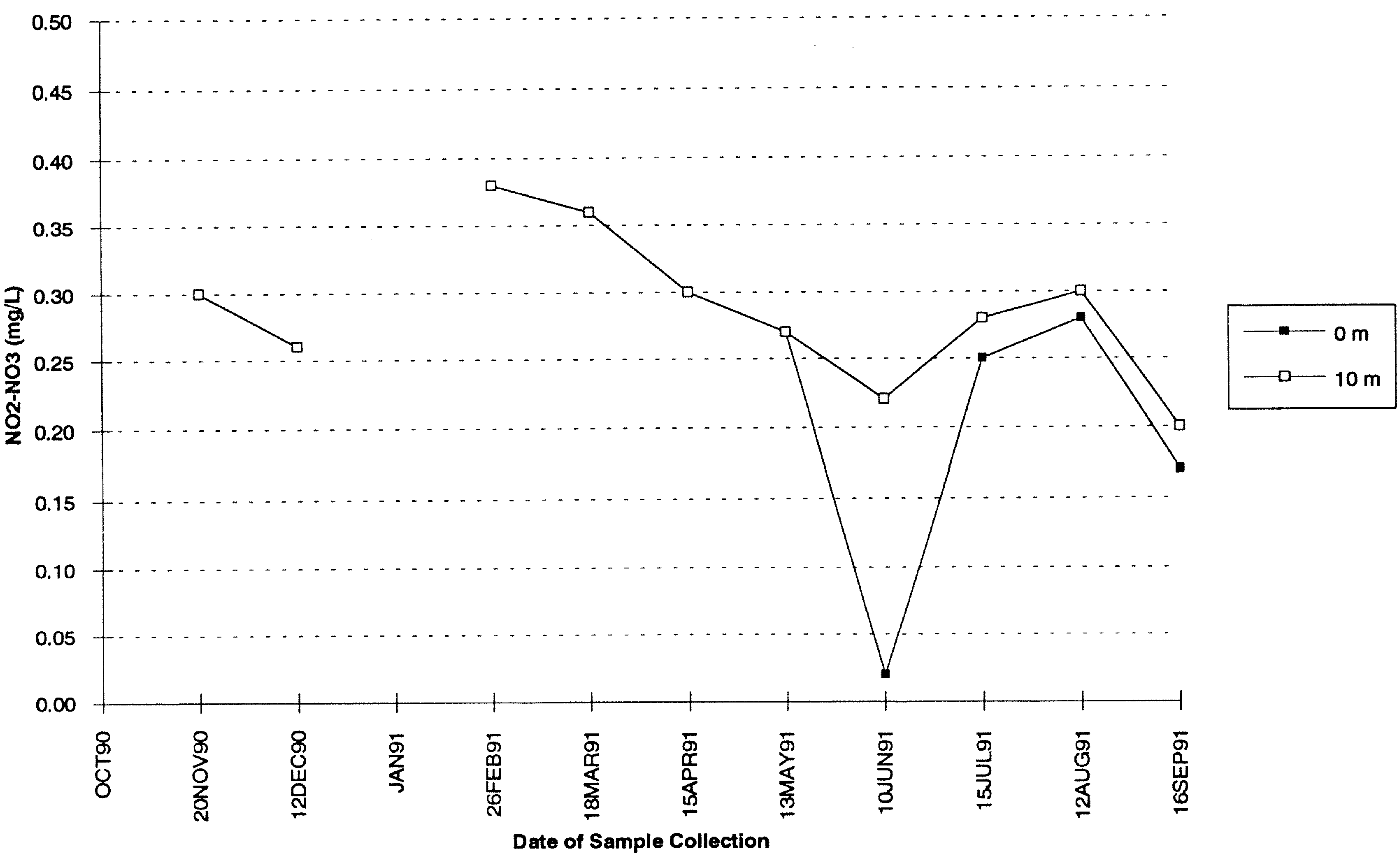
Station HCB007 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991



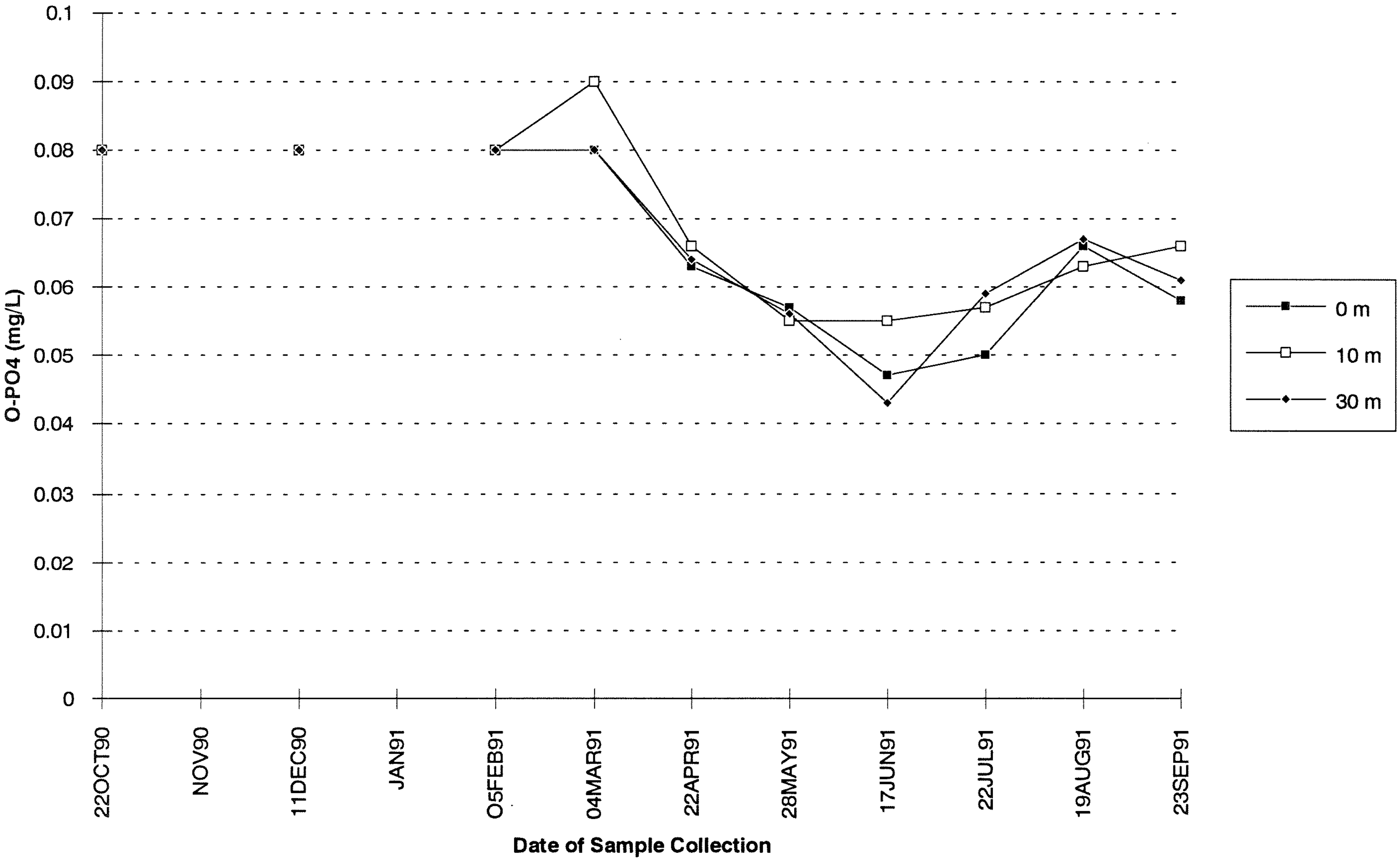
Station JDF005 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991



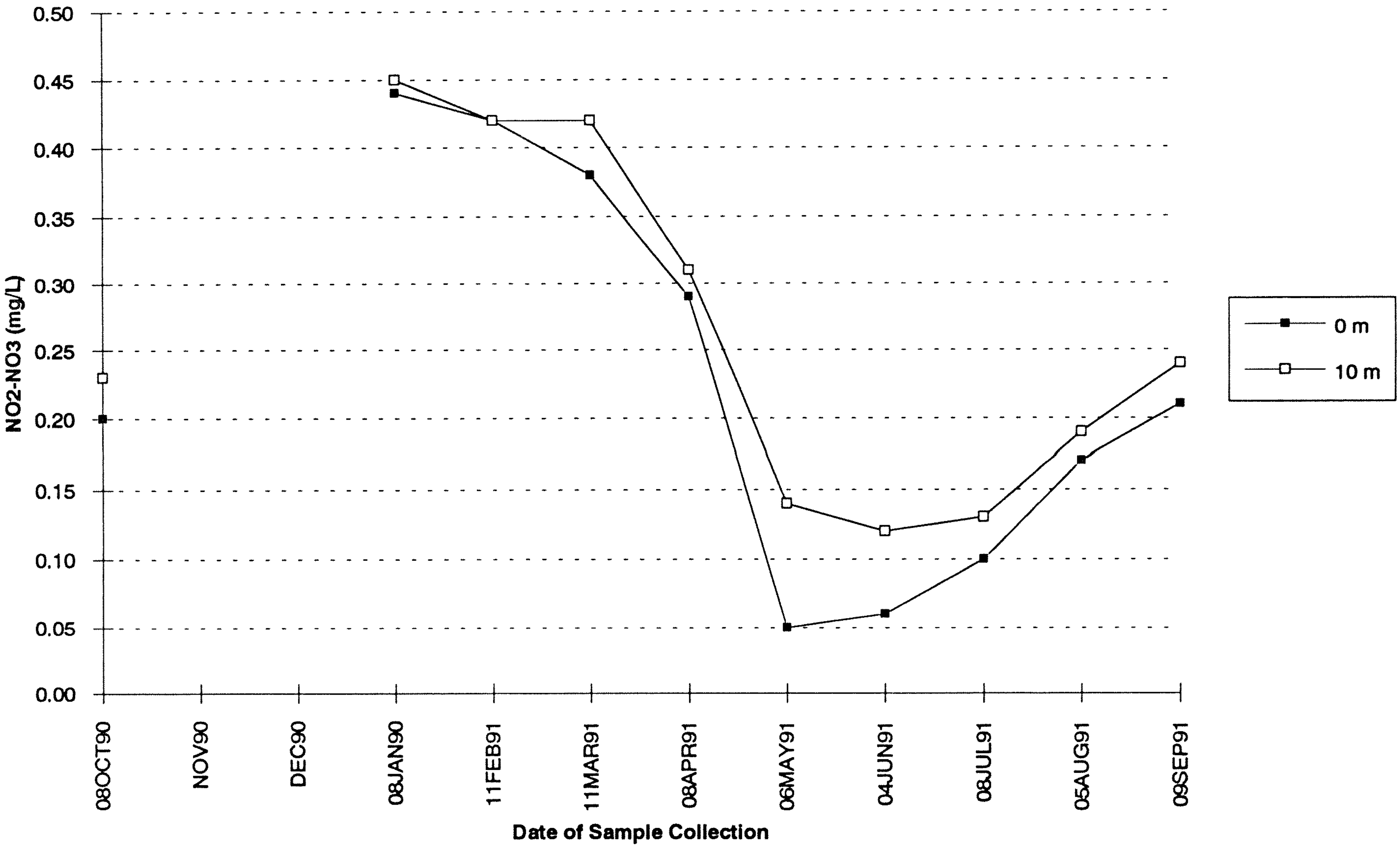
Station LOP001 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991

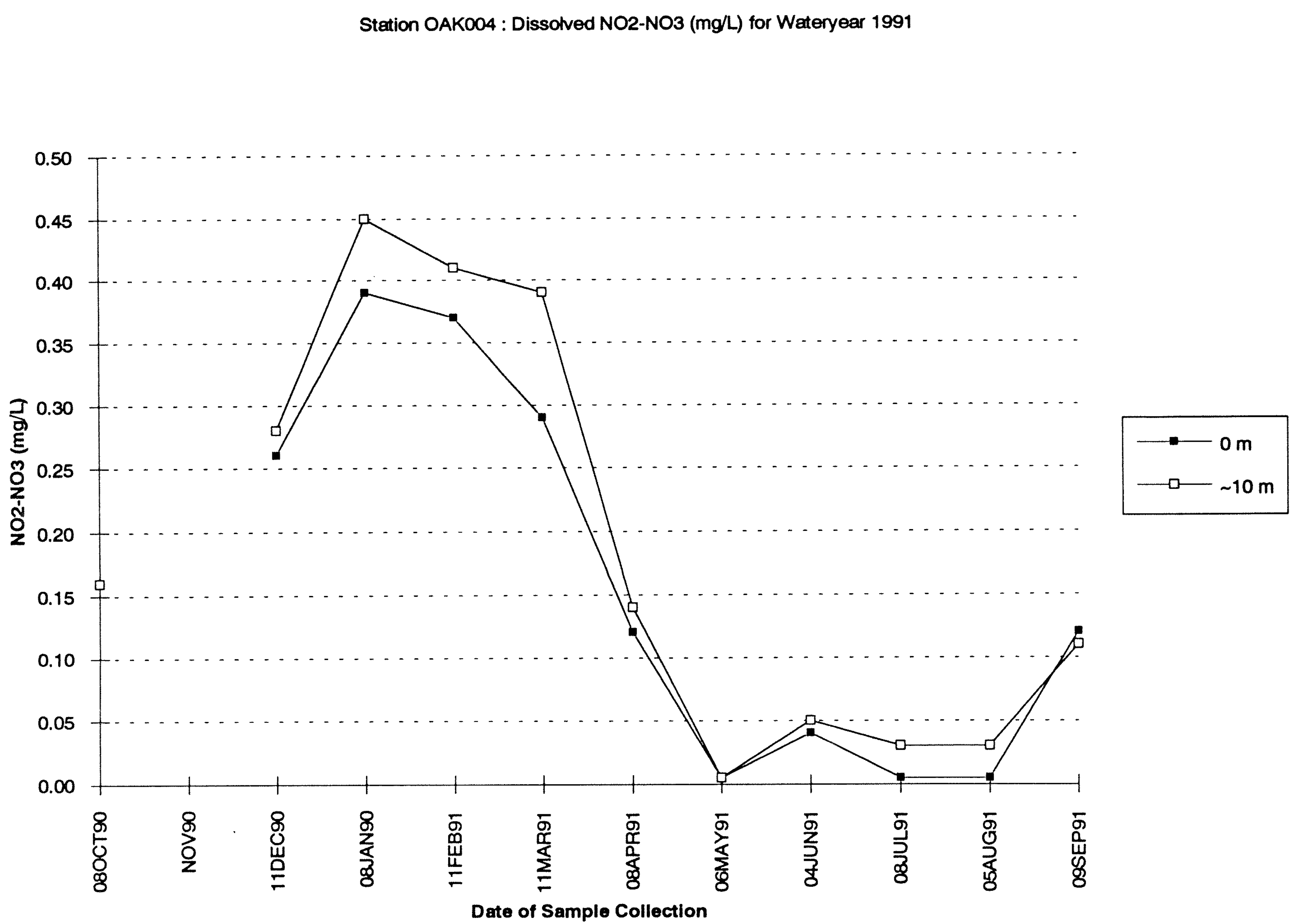


Station NRR001: Dissolved O-PO4 (mg/L) for Wateryear 1991

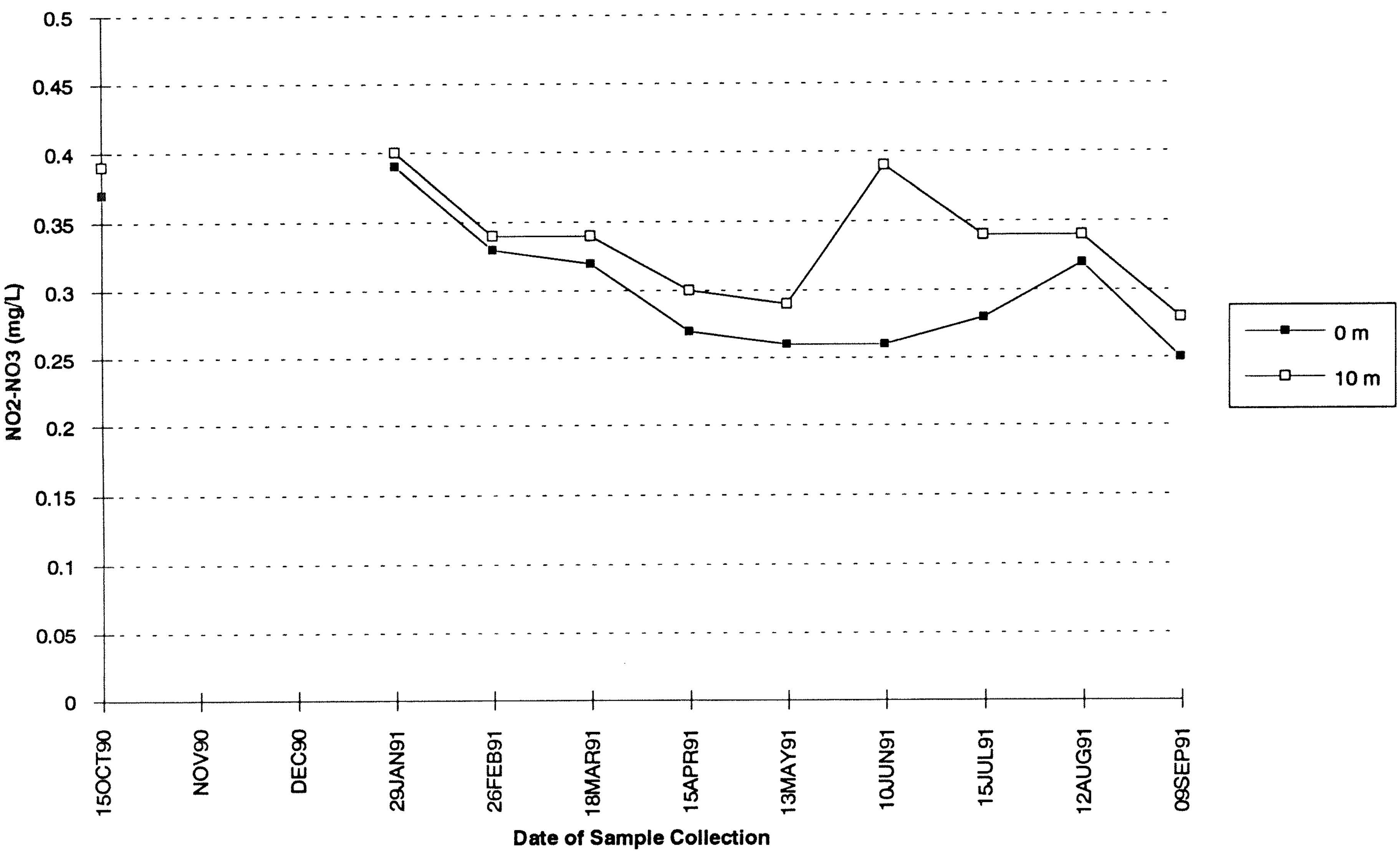


Station NSQ001 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991

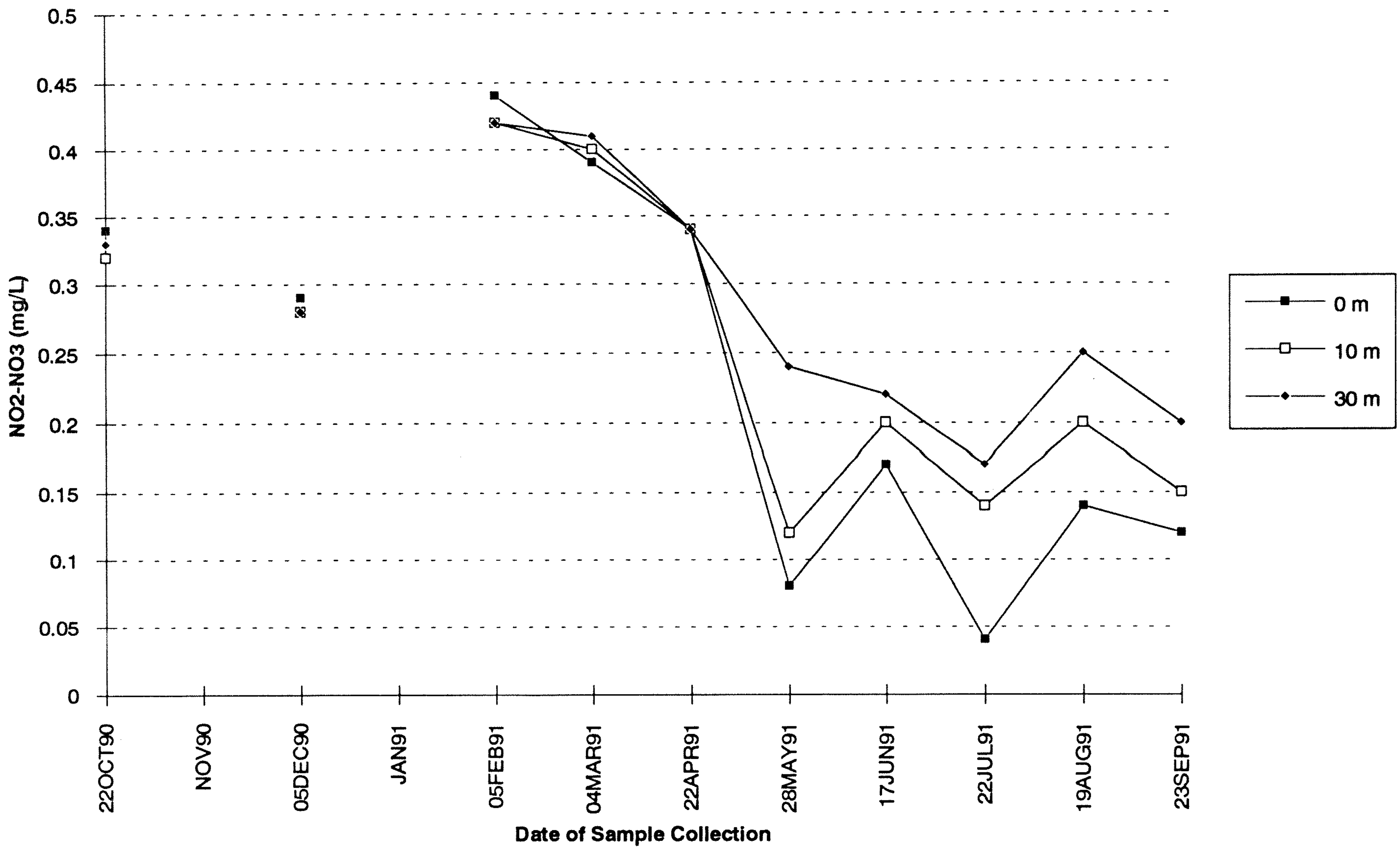



Station OAK004 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
NO2-NO3 (mg/L)
08OCT90
NOV90
11DEC90
08JAN90
11FEB91
11MAR91
08APR91
06MAY91
04JUN91
08JUL91
05AUG91
09SEP91
Date of Sample Collection
0 m
~10 m

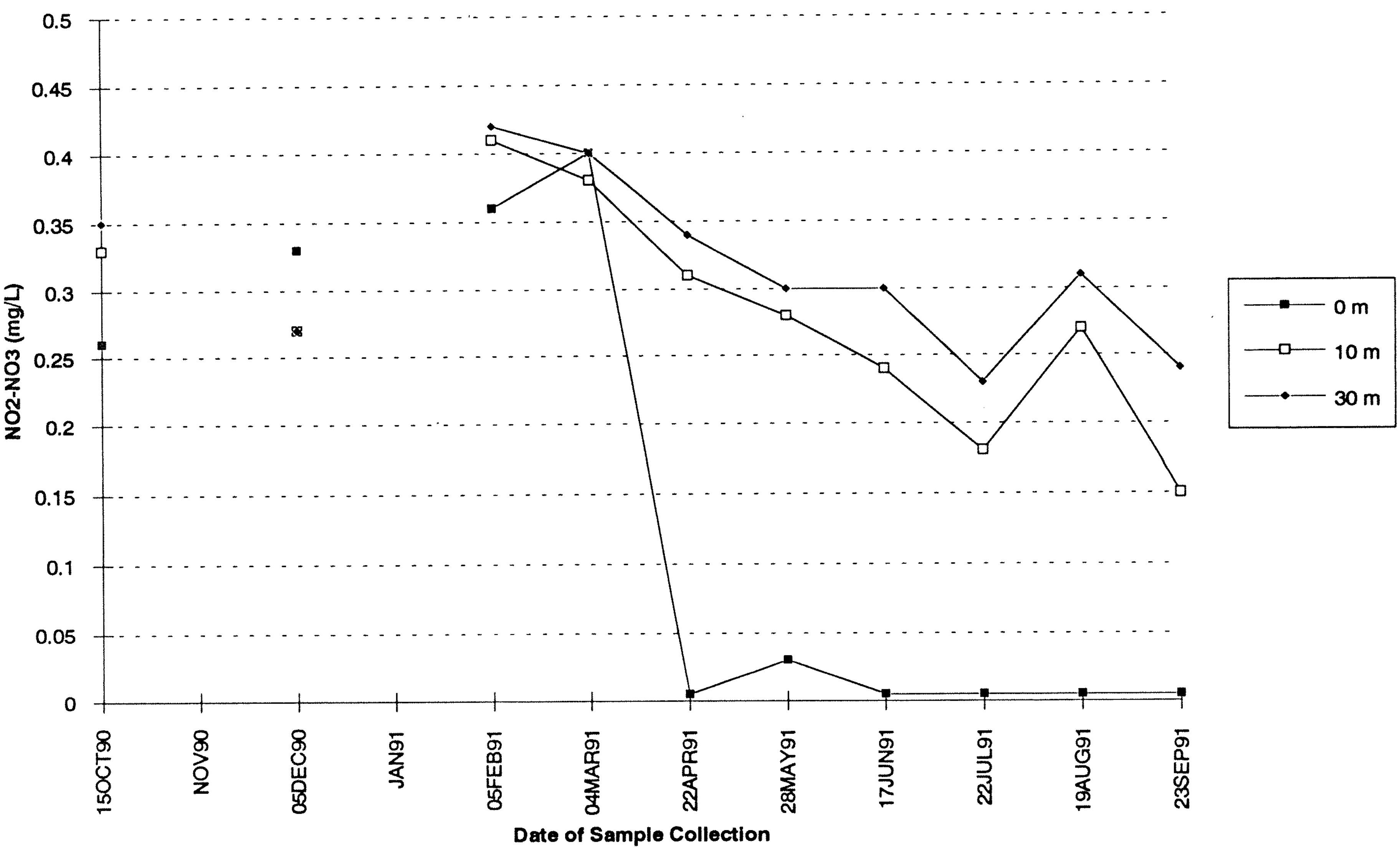
Station PAH008 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991



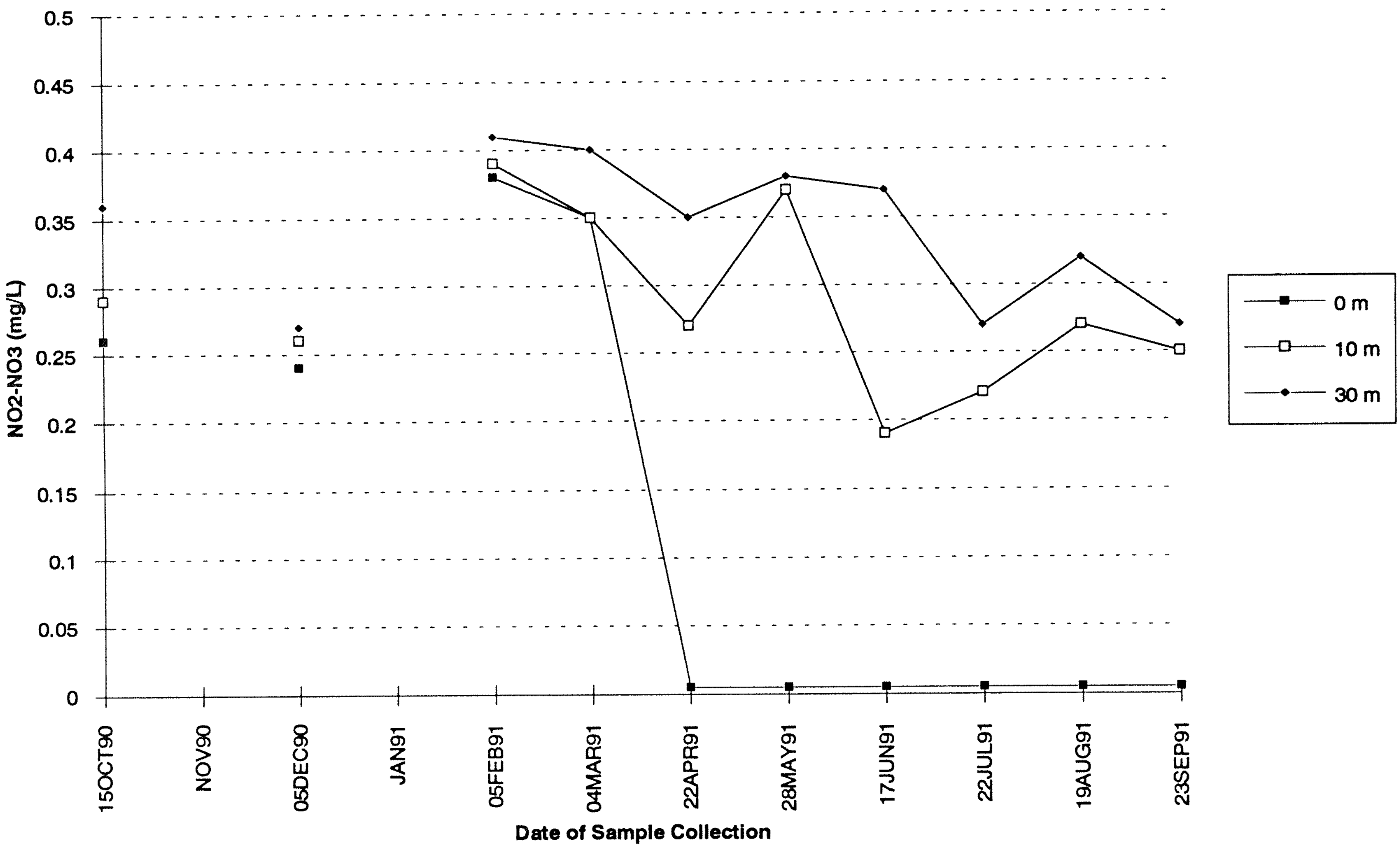
Station PSB003 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991

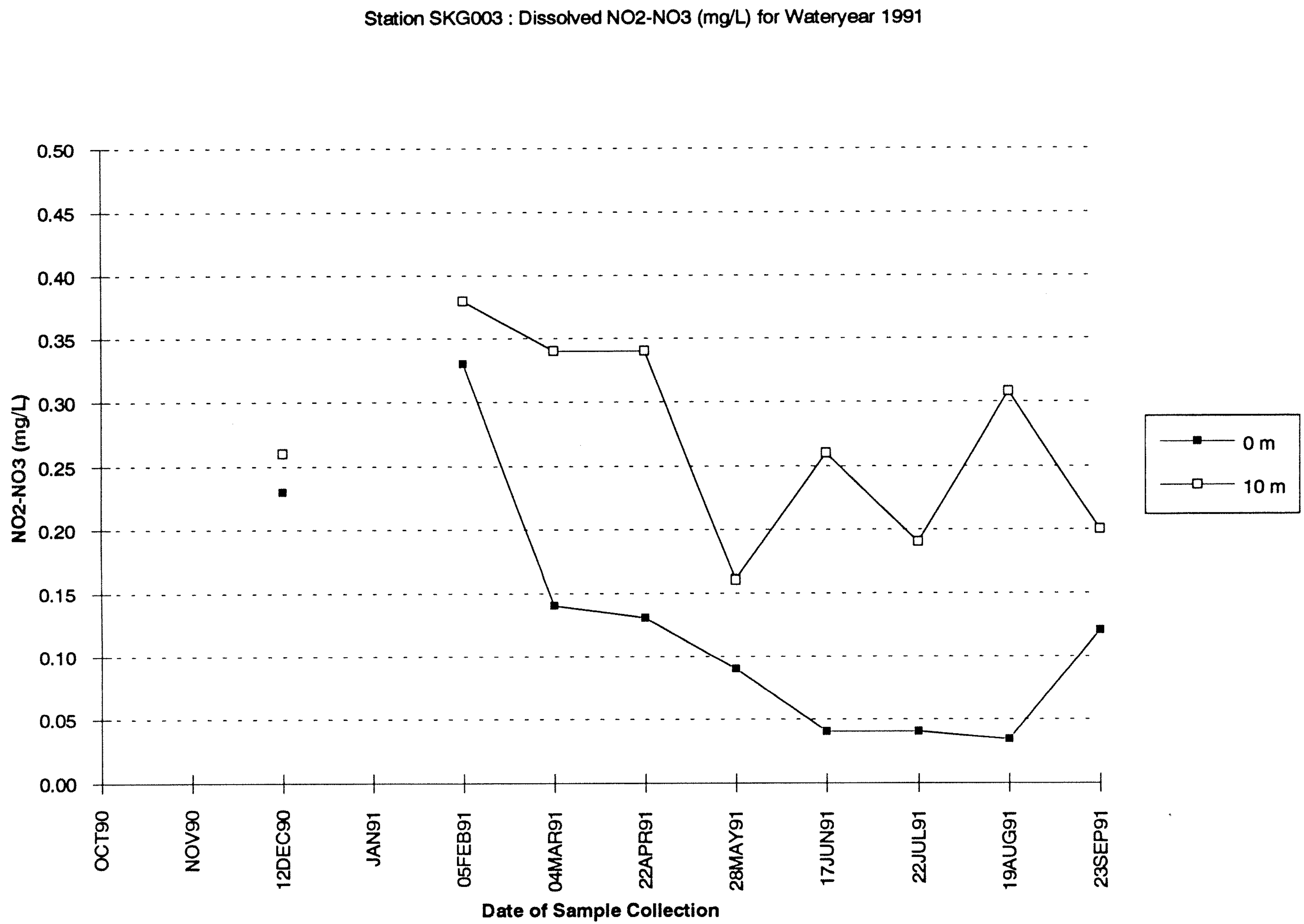


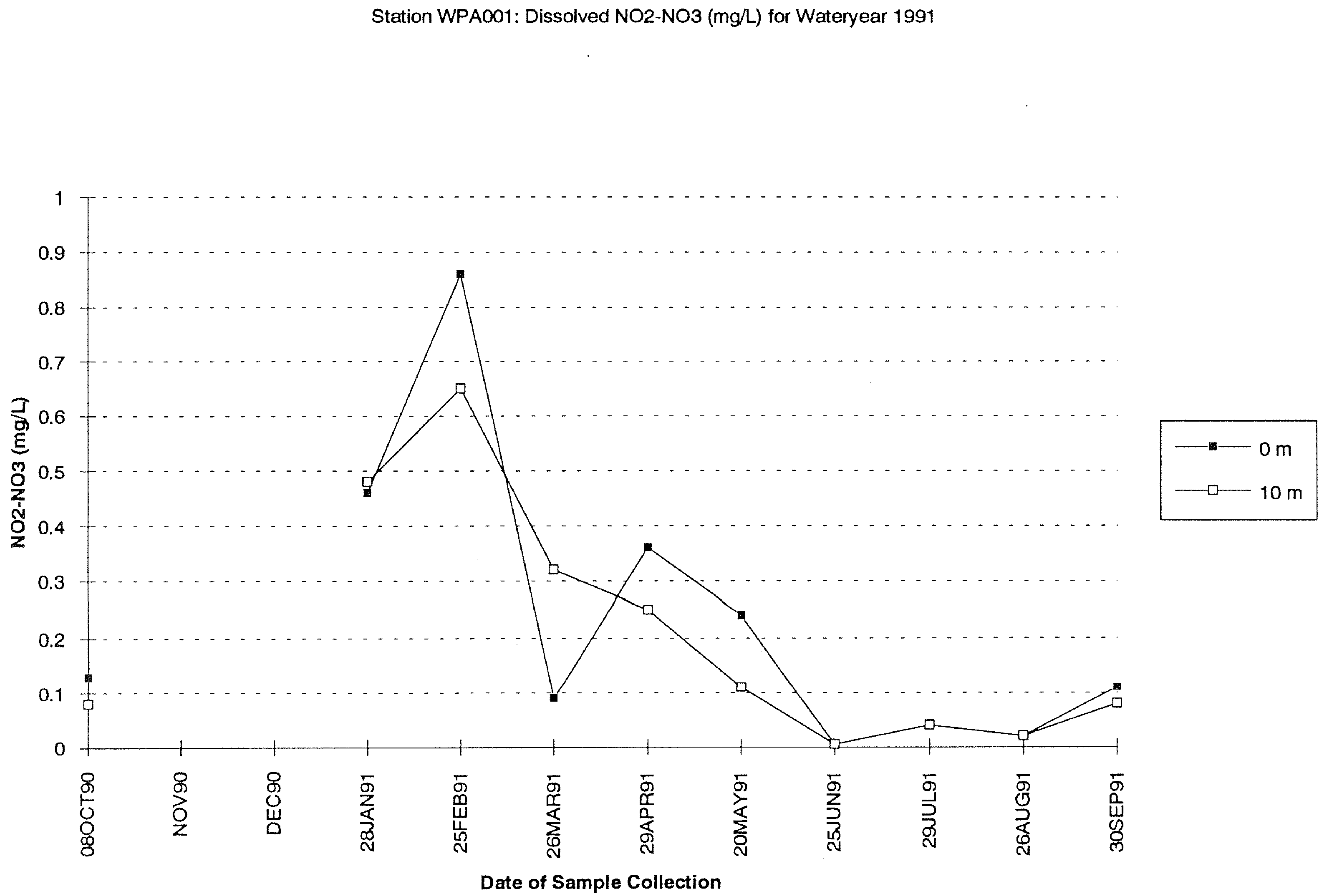
Station PSS019 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991



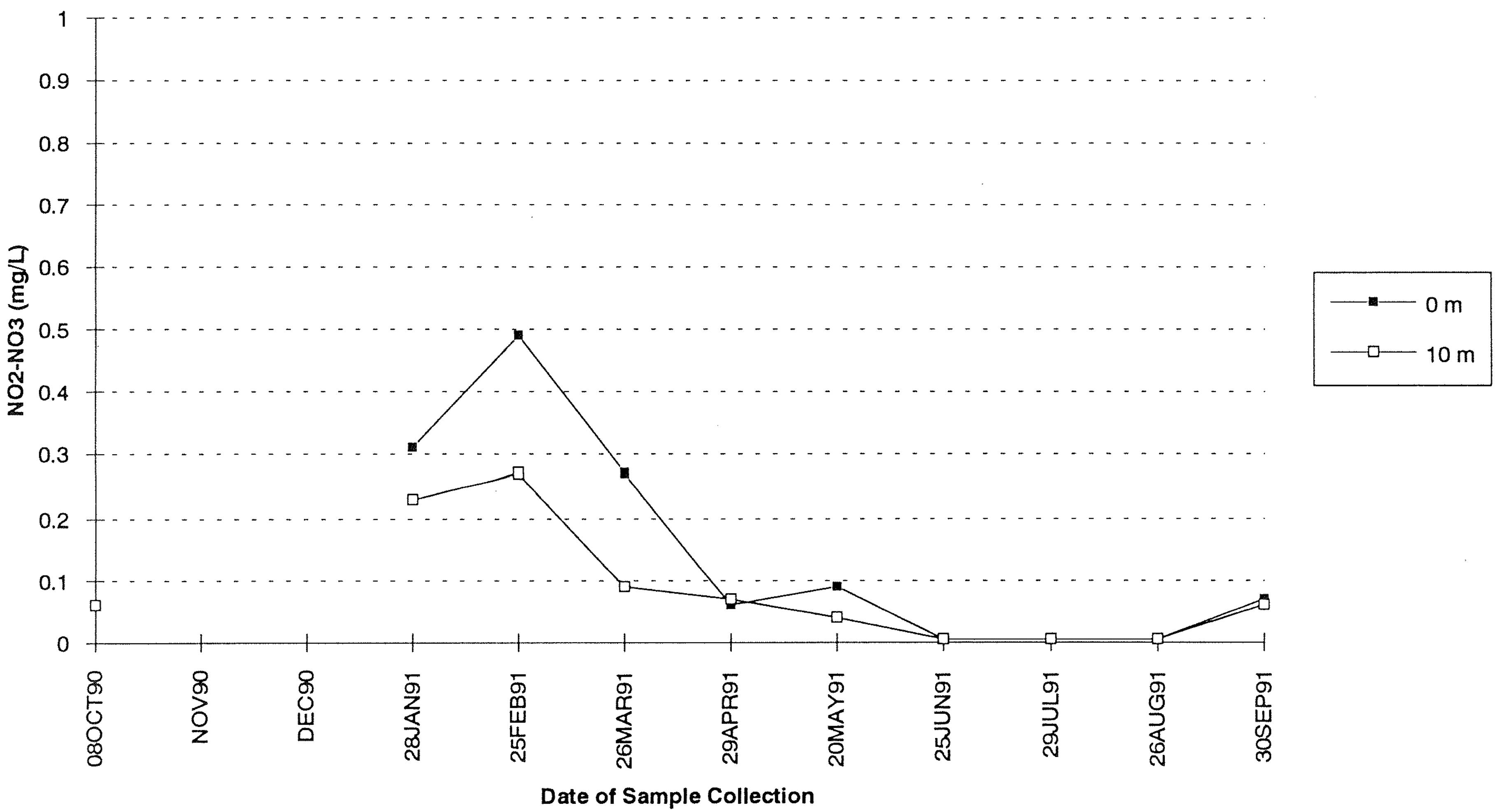
Station SAR003 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991



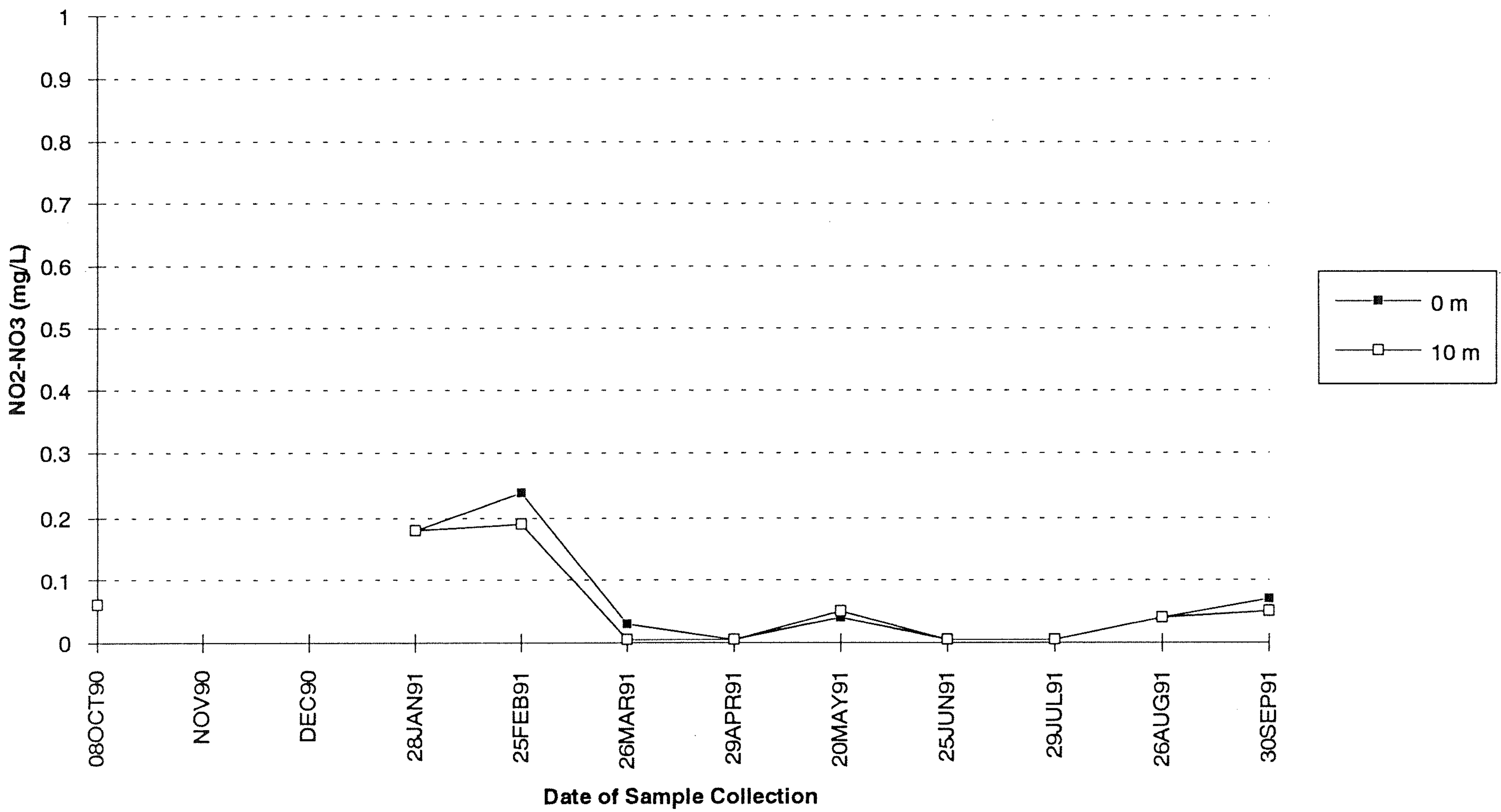

Station SKG003 : Dissolved NO2-NO3 (mg/L) for Wateryear 1991
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
NO2-NO3 (mg/L)
OCT90
NOV90
12DEC90
JAN91
05FEB91
04MAR91
22APR91
28MAY91
17JUN91
22JUL91
19AUG91
23SEP91
Date of Sample Collection
0 m
10 m


Station WPA001: Dissolved NO2-NO3 (mg/L) for Wateryear 1991
NO2-NO3 (mg/L)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
08OCT90
NOV90
DEC90
28JAN91
25FEB91
26MAR91
29APR91
20MAY91
25JUN91
29JUL91
26AUG91
30SEP91
Date of Sample Collection
0 m
10 m

Station WPA003: Dissolved NO2-NO3 (mg/L) for Wateryear 1991



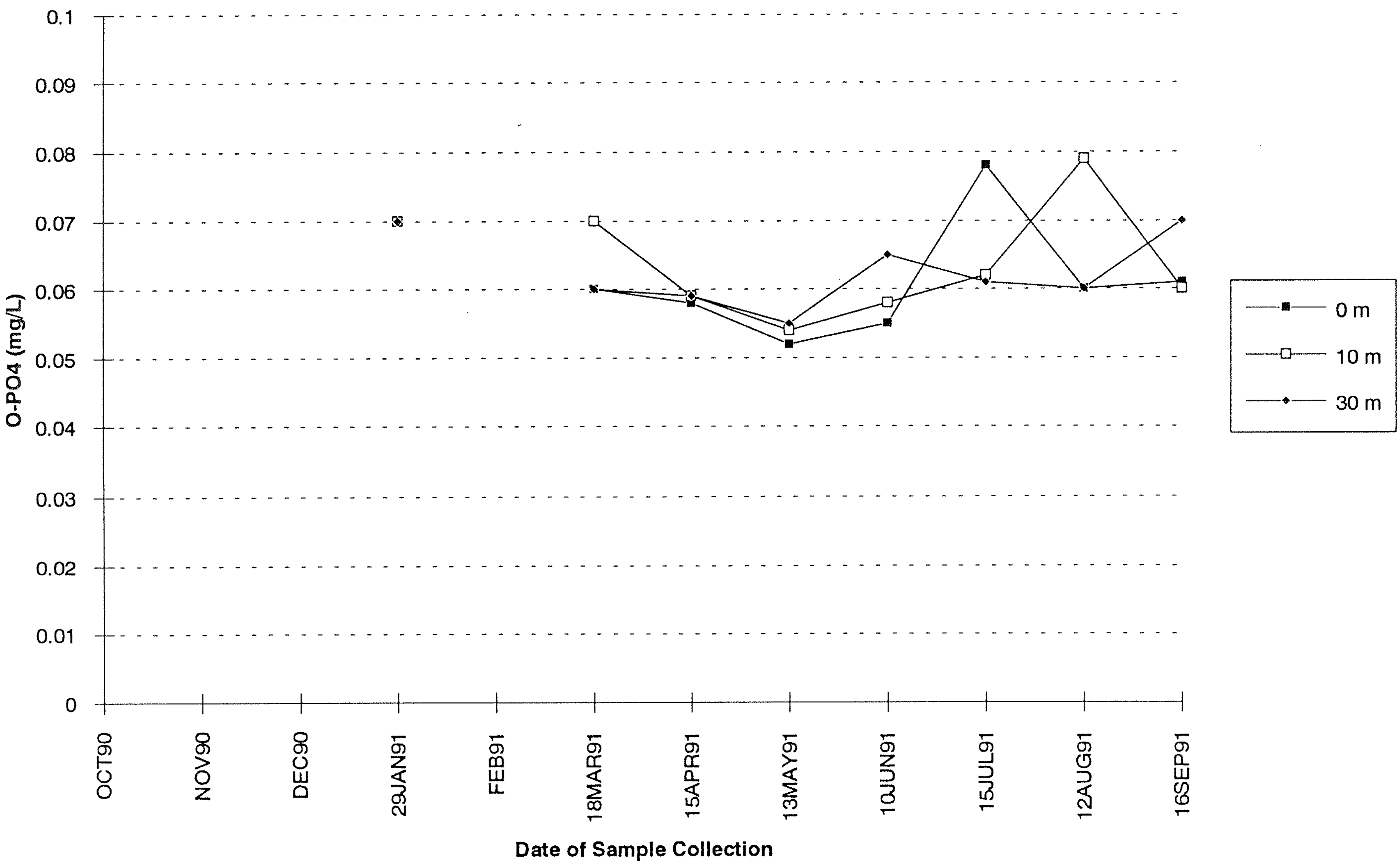
Station WPA004: Dissolved NO2-NO3 (mg/L) for Wateryear 1991



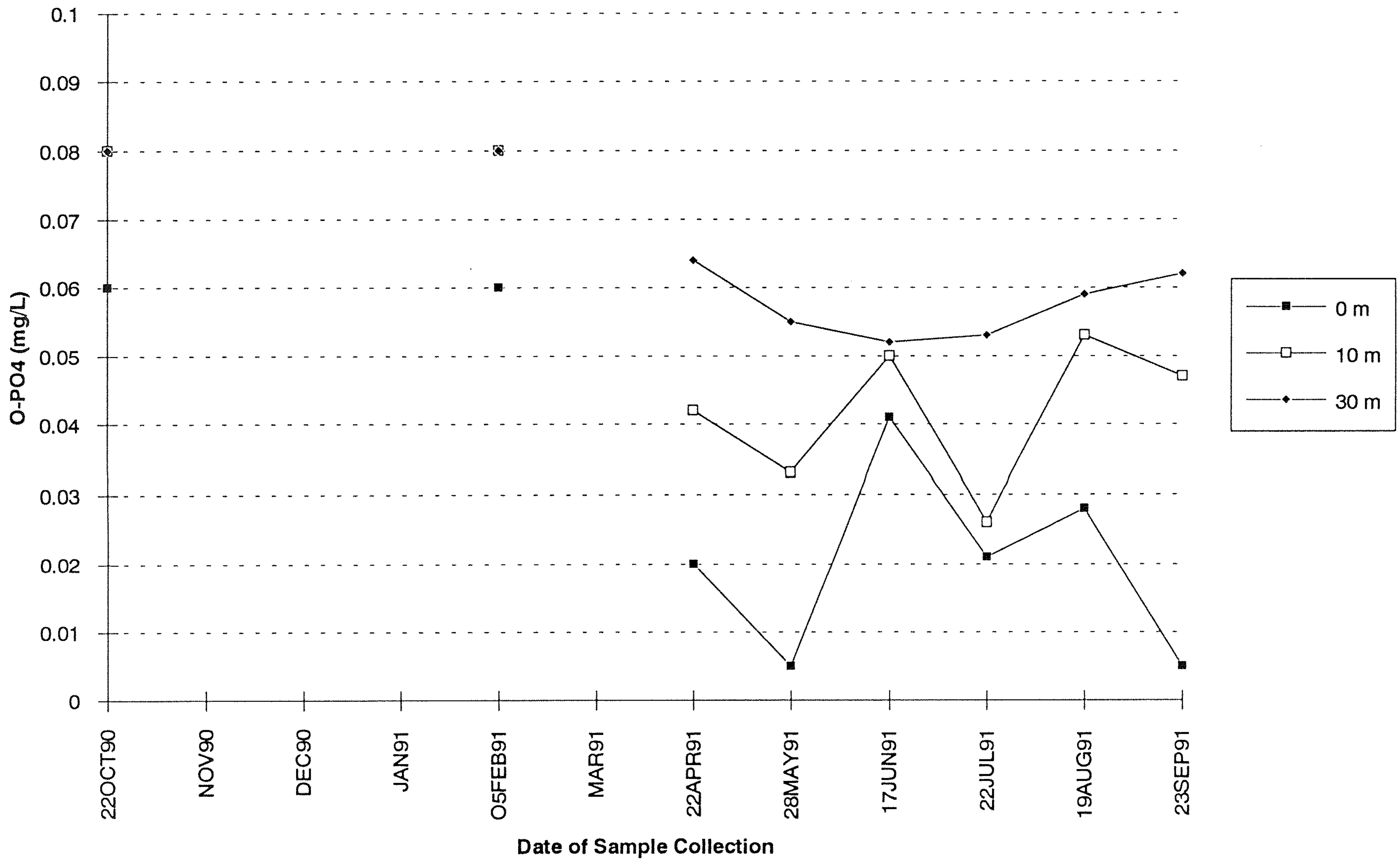
APPENDIX F

PLOTS OF ORTHOPHOSPHORUS CONCENTRATIONS FOR EACH WY 1991 STATION AT ALL DEPTHS

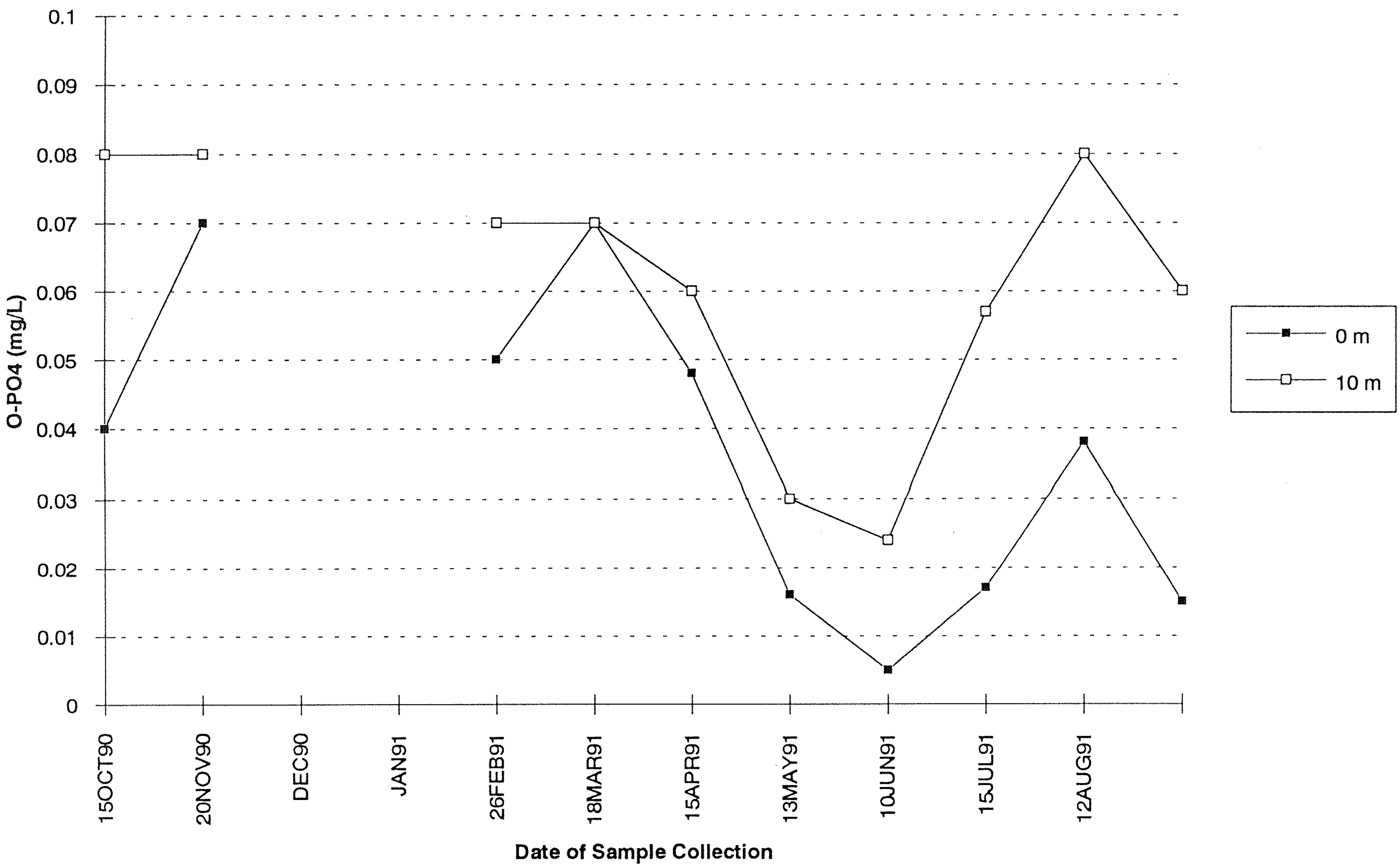
Station ADM002: Dissolved O-PO4 (mg/L) for Wateryear 1991

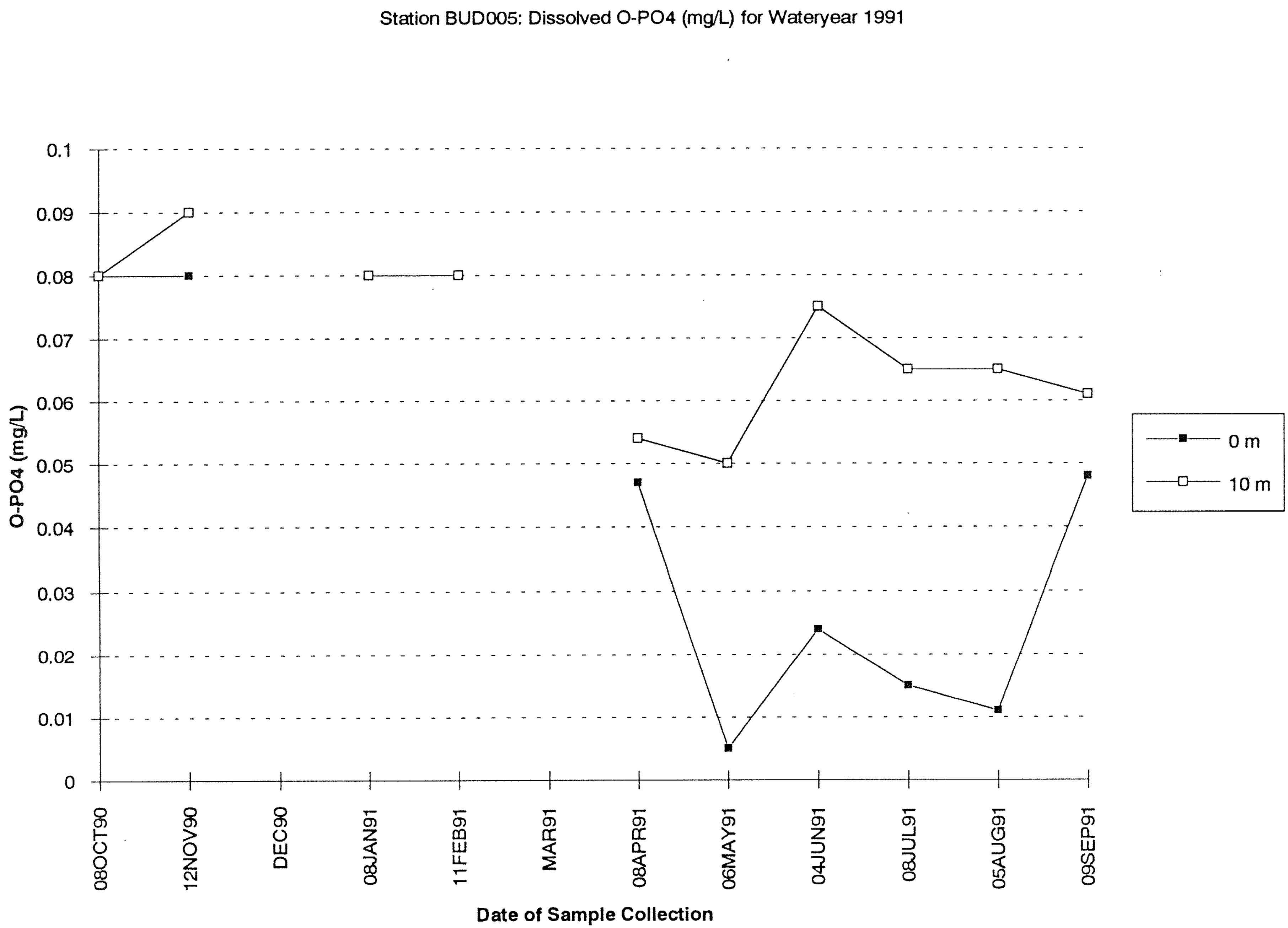


Station ADM003: Dissolved O-PO4 (mg/L) for Wateryear 1991

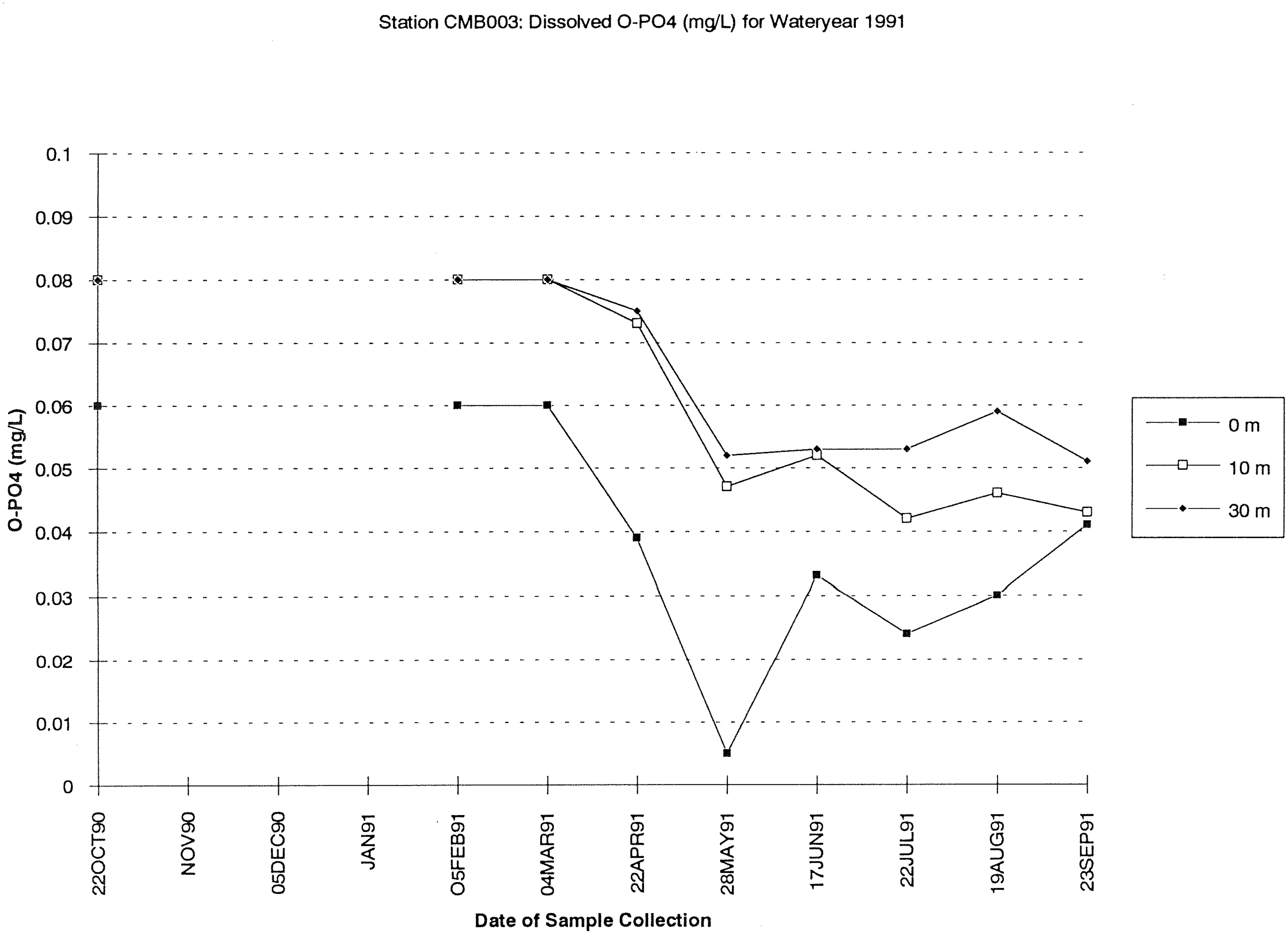


Station BLL009: Dissolved O-PO4 (mg/L) for Wateryear 1991



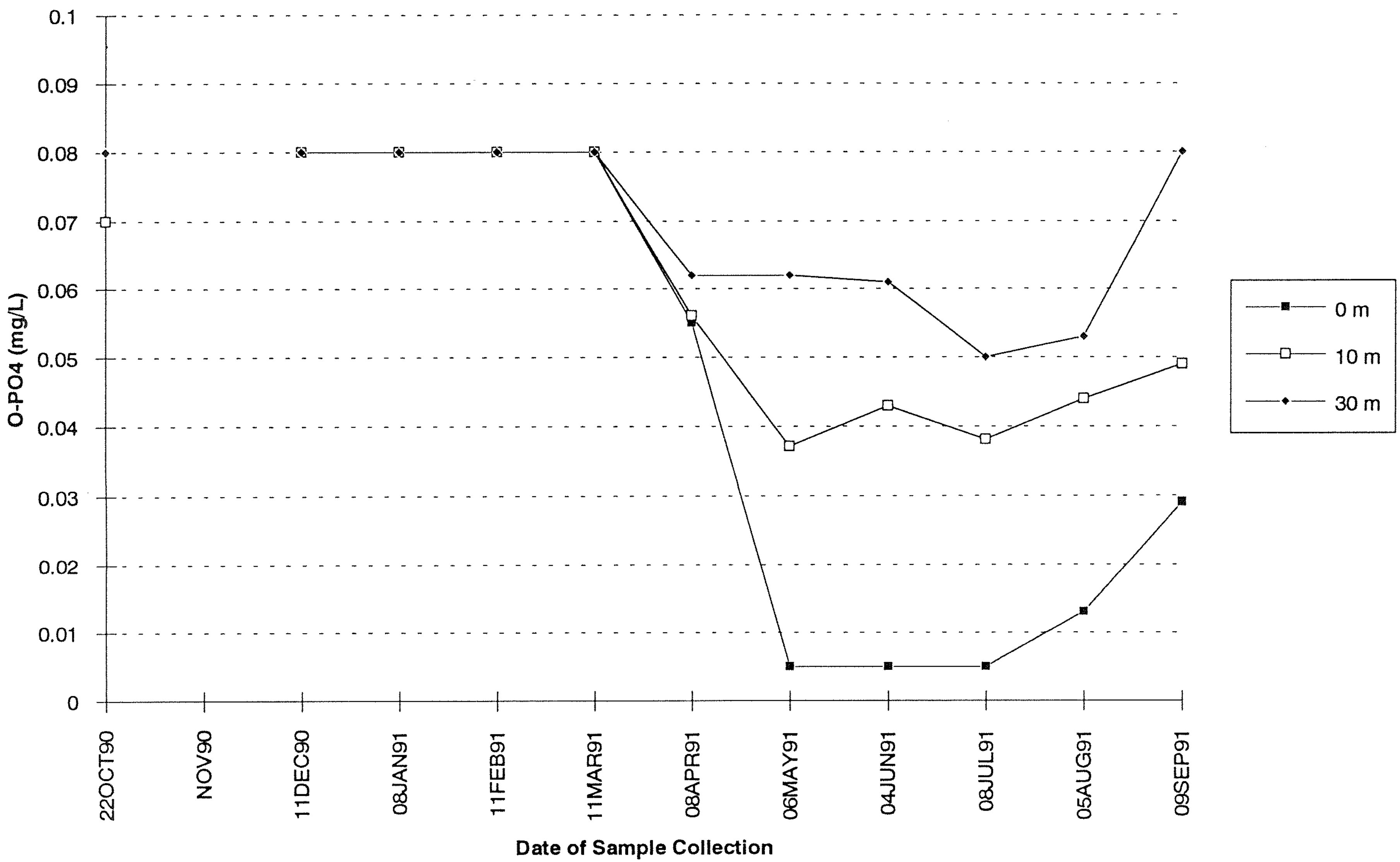


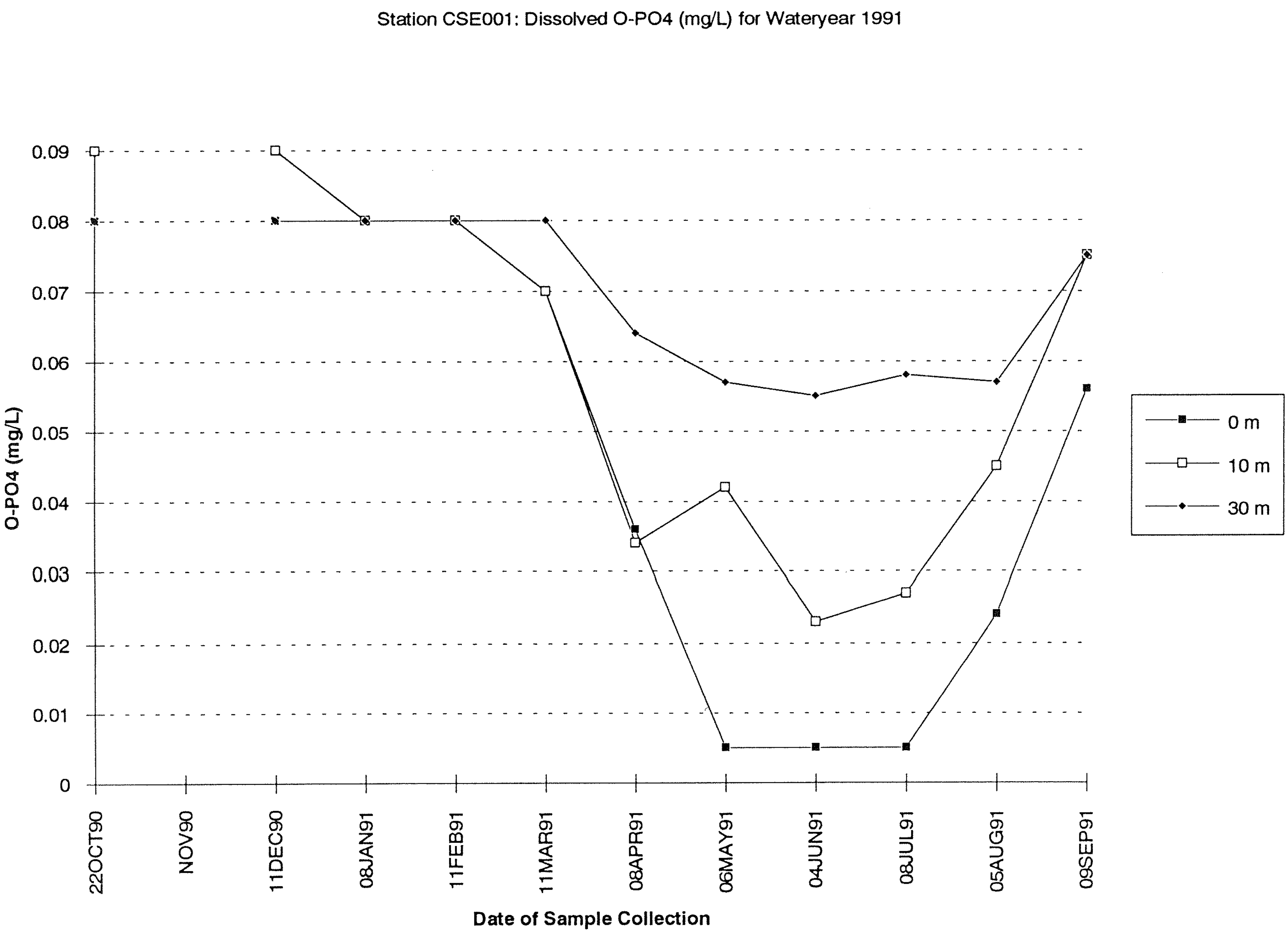
Station BUD005: Dissolved O-PO4 (mg/L) for Wateryear 1991
O-PO4 (mg/L)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
08OCT90
12NOV90
DEC90
08JAN91
11FEB91
MAR91
08APR91
06MAY91
04JUN91
08JUL91
05AUG91
09SEP91
Date of Sample Collection
0 m
10 m



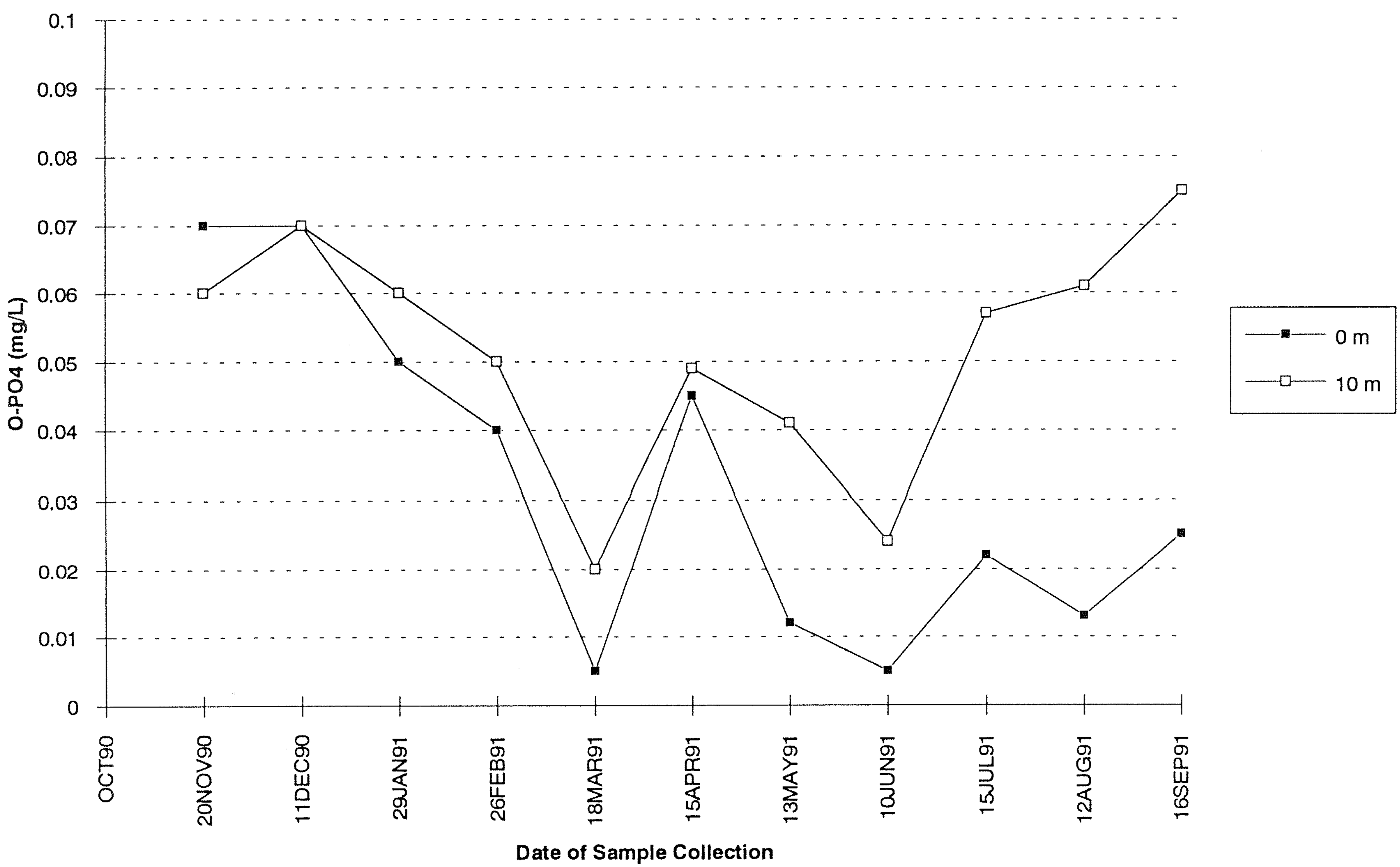
Station CMB003: Dissolved O-PO4 (mg/L) for Wateryear 1991
O-PO4 (mg/L)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
22OCT90
NOV90
05DEC90
JAN91
O5FEB91
04MAR91
22APR91
28MAY91
17JUN91
22JUL91
19AUG91
23SEP91
Date of Sample Collection
0 m
10 m
30 m

Station CRR001: Dissolved O-PO4 (mg/L) for Wateryear 1991

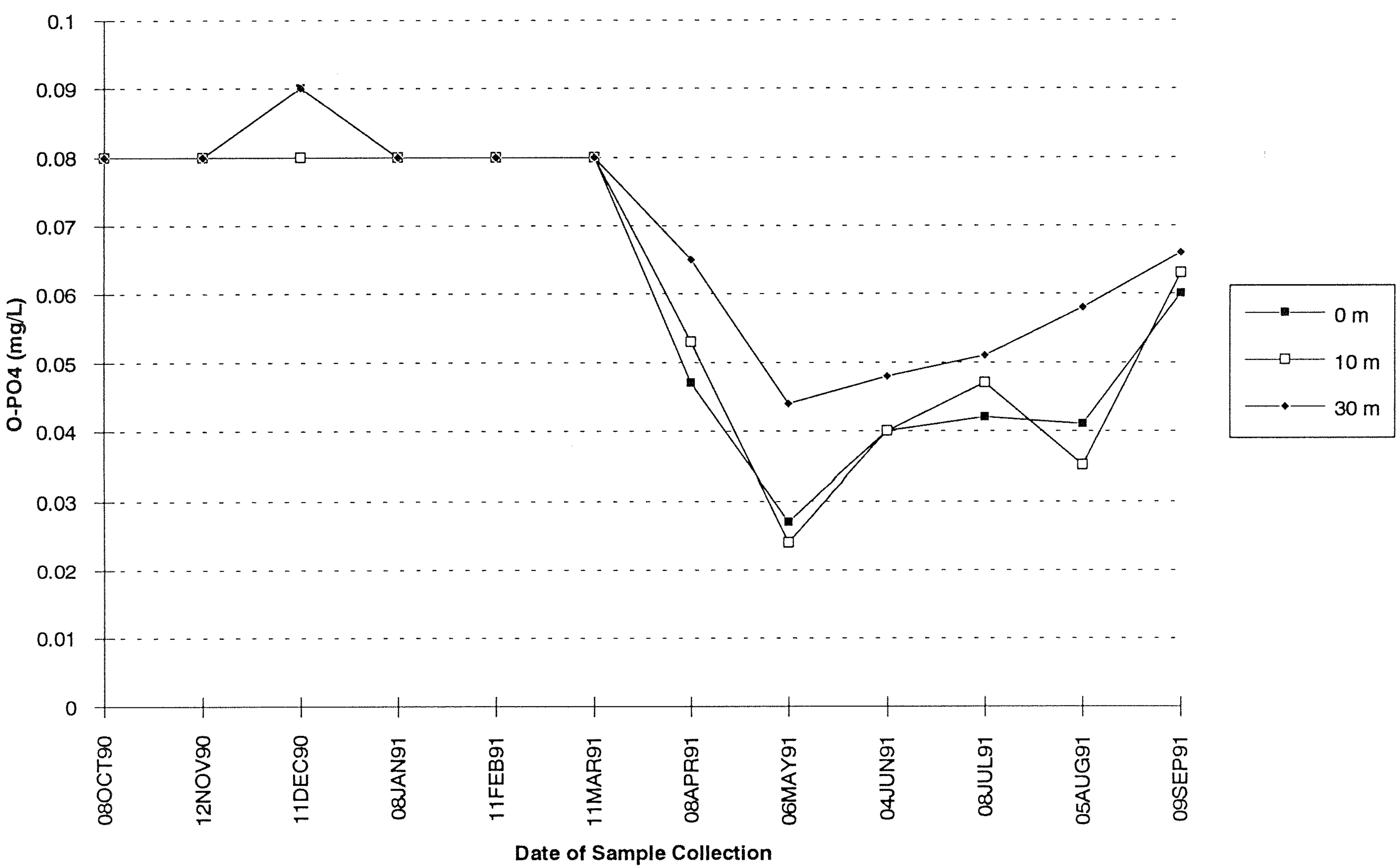


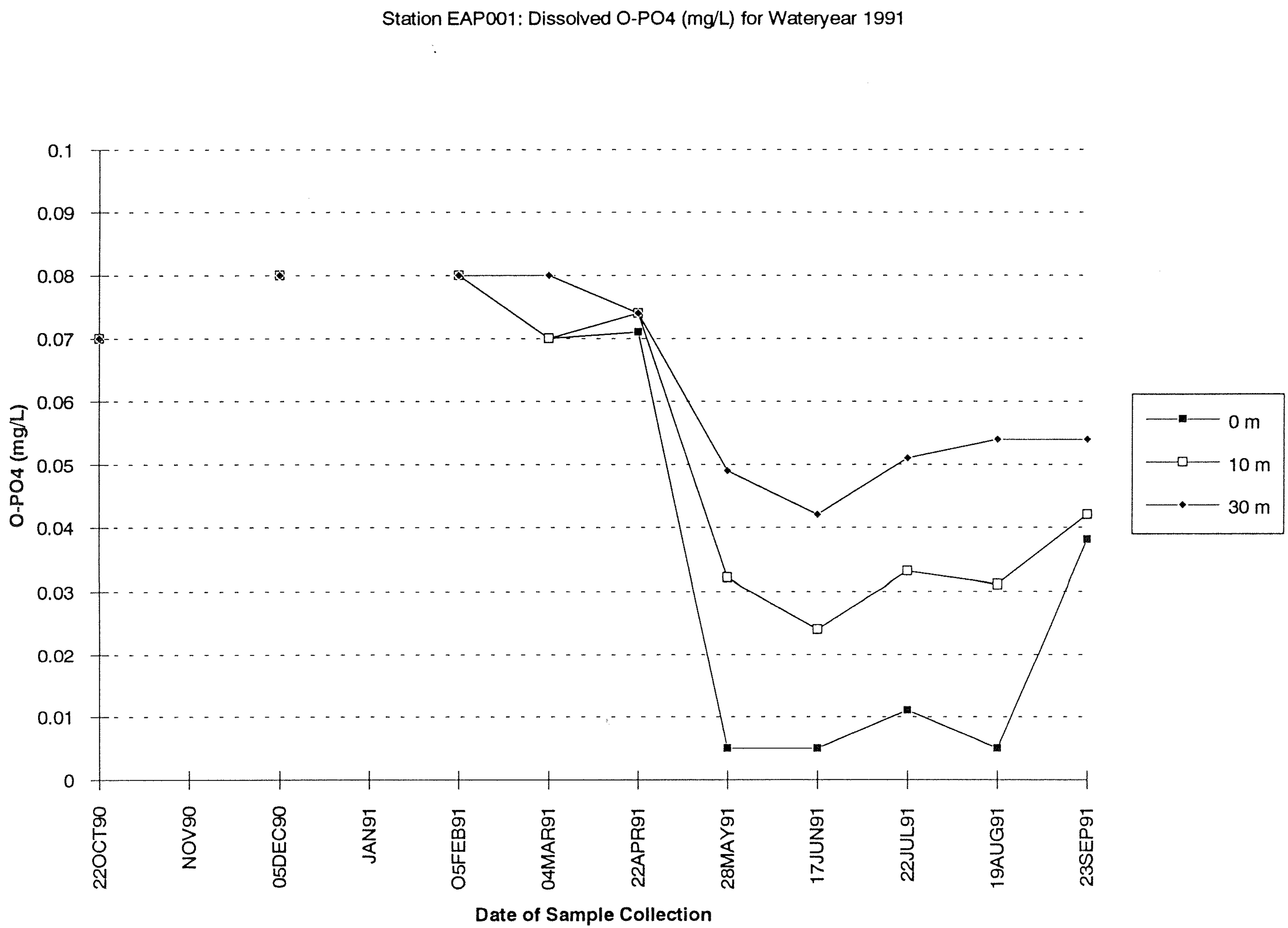

Station CSE001: Dissolved O-PO4 (mg/L) for Wateryear 1991
O-PO4 (mg/L)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
22OCT90
NOV90
11DEC90
08JAN91
11FEB91
11MAR91
08APR91
06MAY91
04JUN91
08JUL91
05AUG91
09SEP91
Date of Sample Collection
0 m
10 m
30 m

Station DIS001: Dissolved O-PO4 (mg/L) for Wateryear 1991



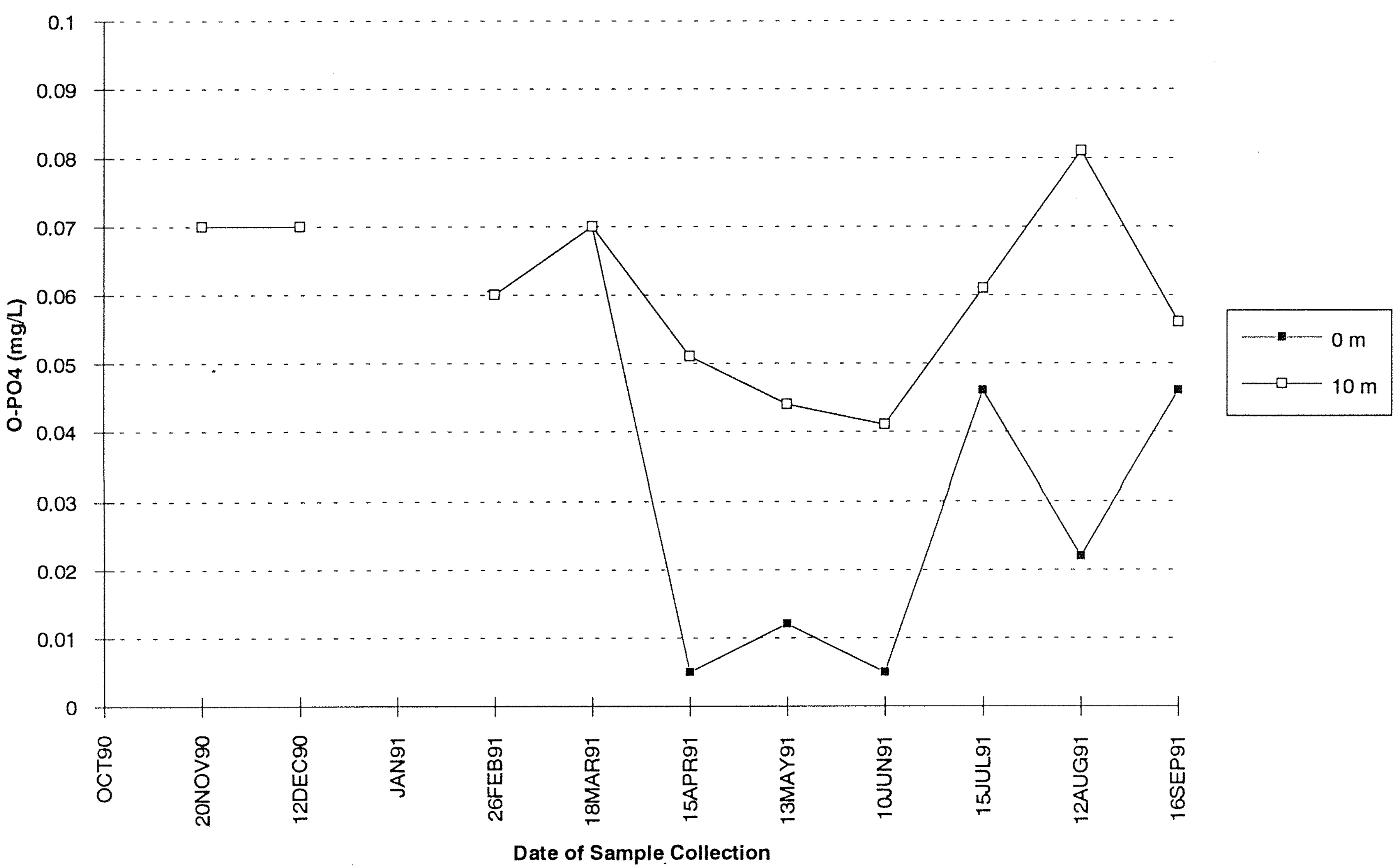
Station DNA001: Dissolved O-PO4 (mg/L) for Wateryear 1991



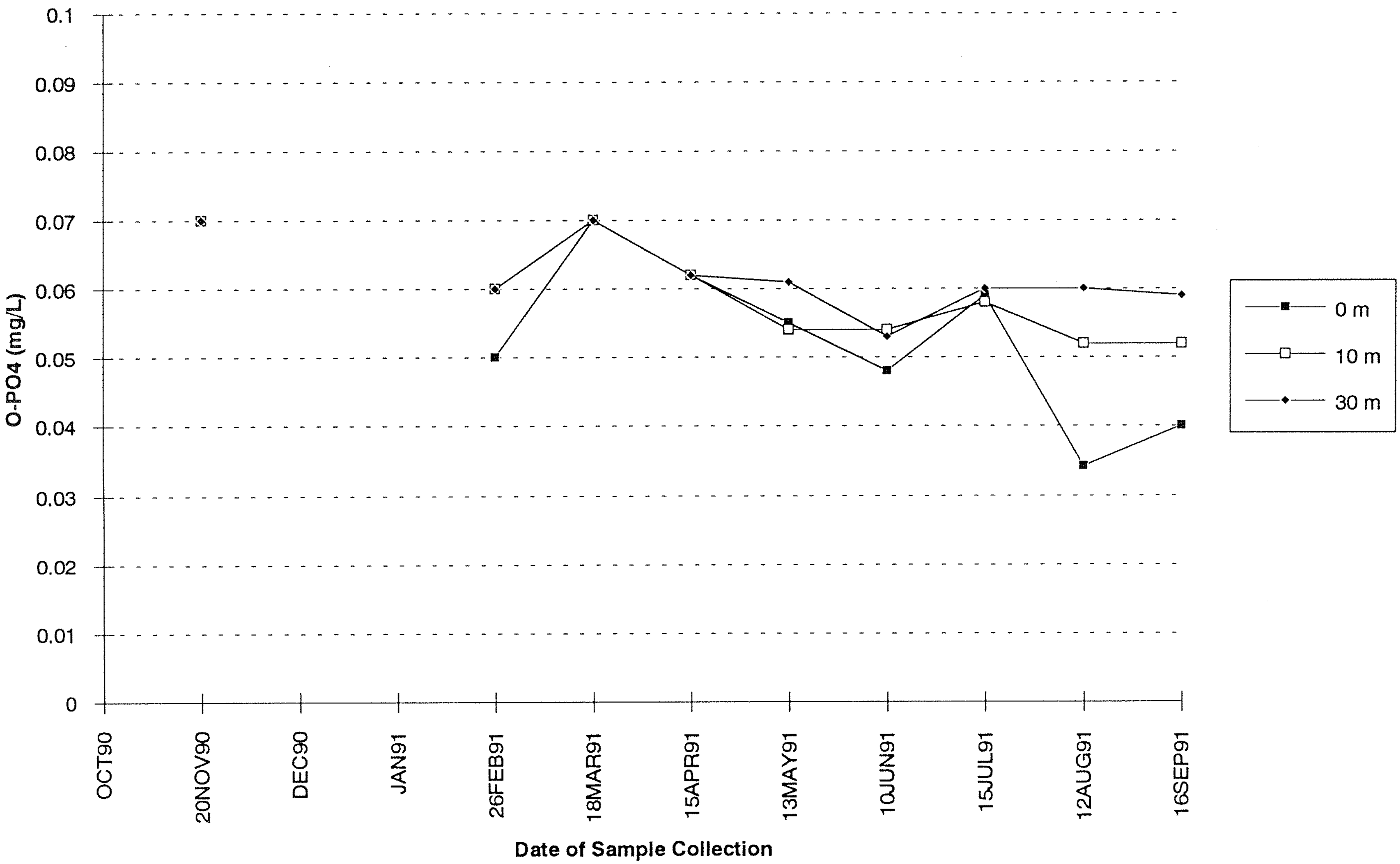


Station EAP001: Dissolved O-PO4 (mg/L) for Wateryear 1991
O-PO4 (mg/L)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
22OCT90
NOV90
05DEC90
JAN91
O5FEB91
04MAR91
22APR91
28MAY91
17JUN91
22JUL91
19AUG91
23SEP91
Date of Sample Collection
0 m
10 m
30 m

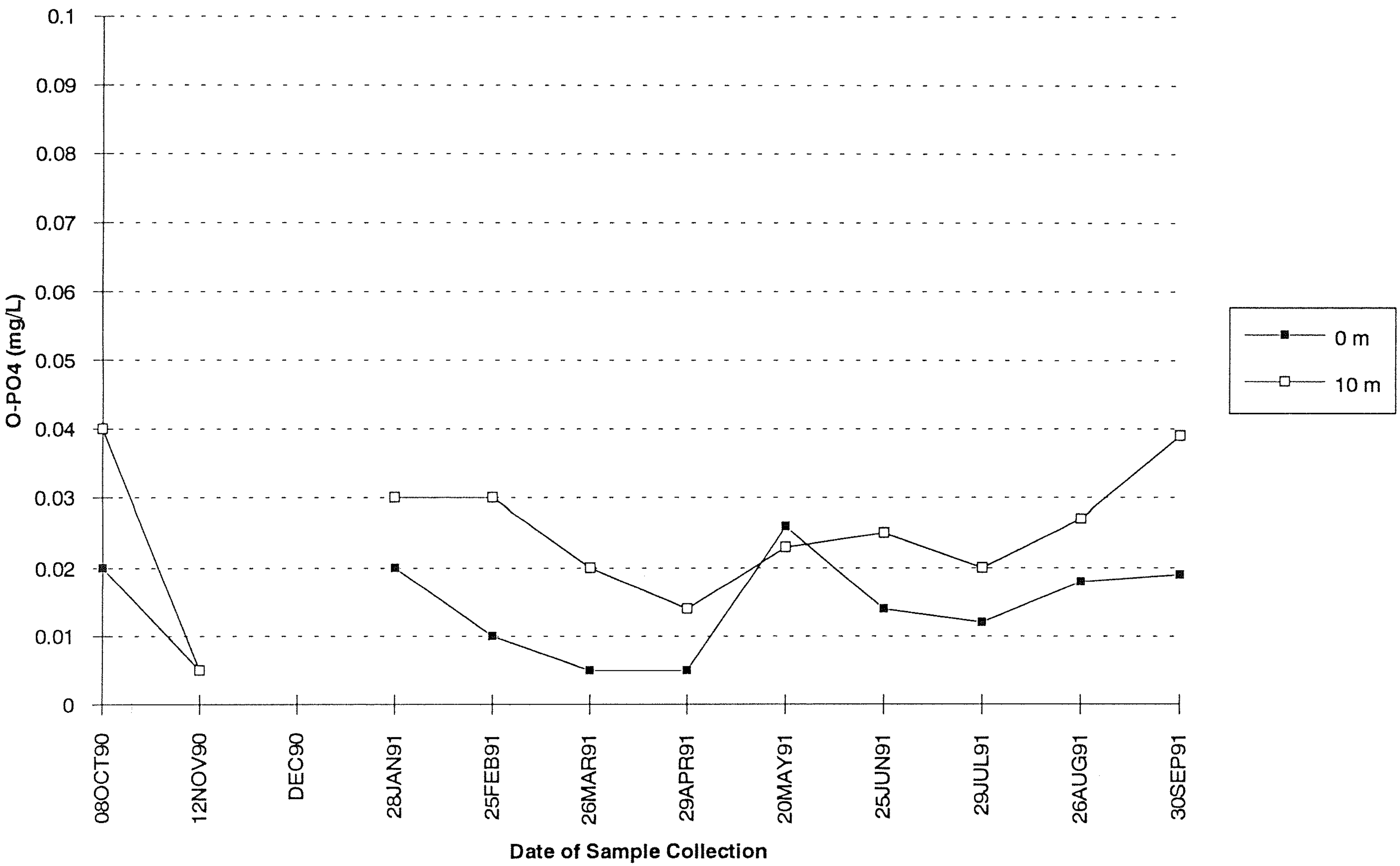
Station EAS001: Dissolved O-PO4 (mg/L) for Wateryear 1991

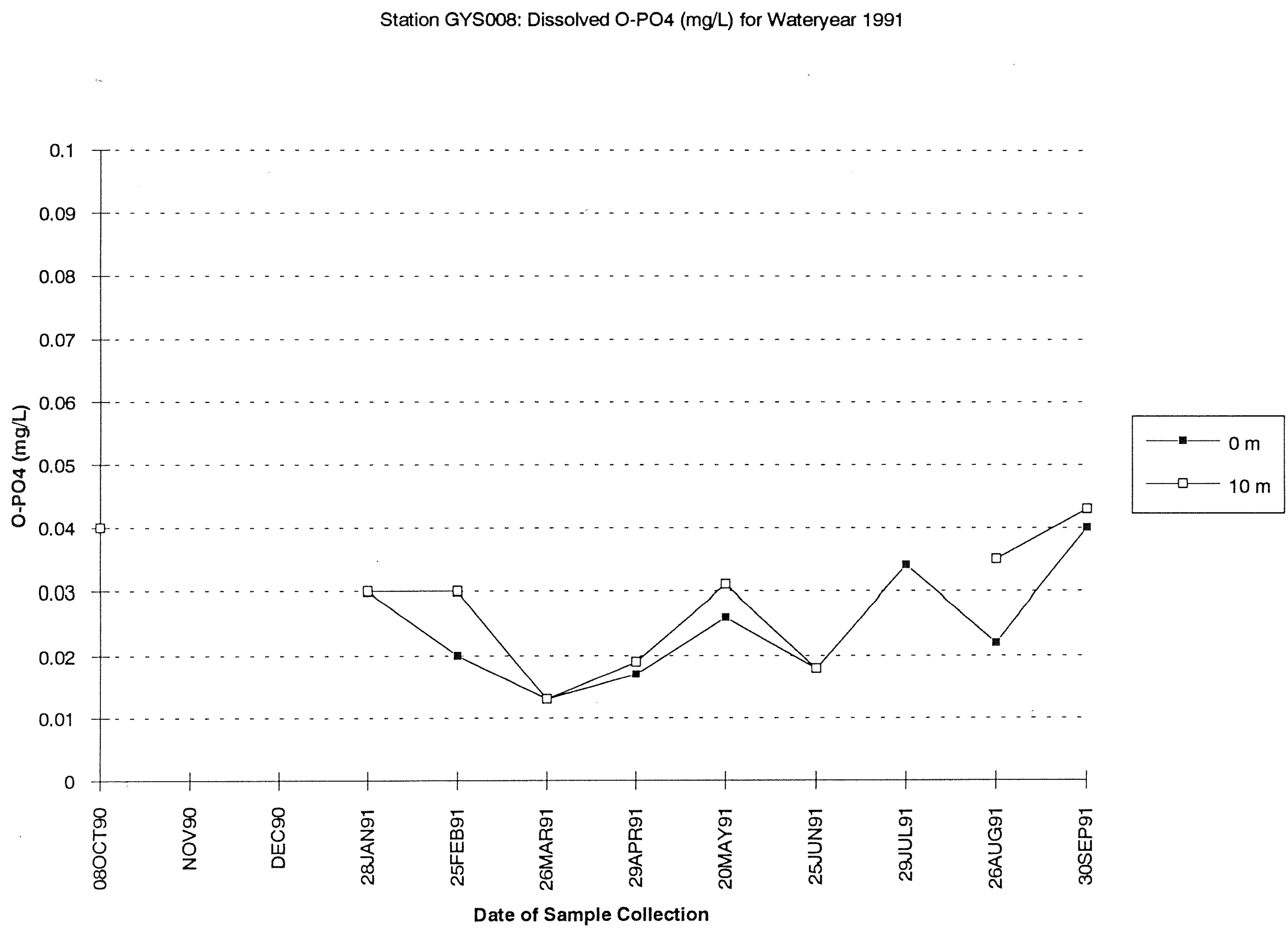


Station GRG002: Dissolved O-PO4 (mg/L) for Wateryear 1991

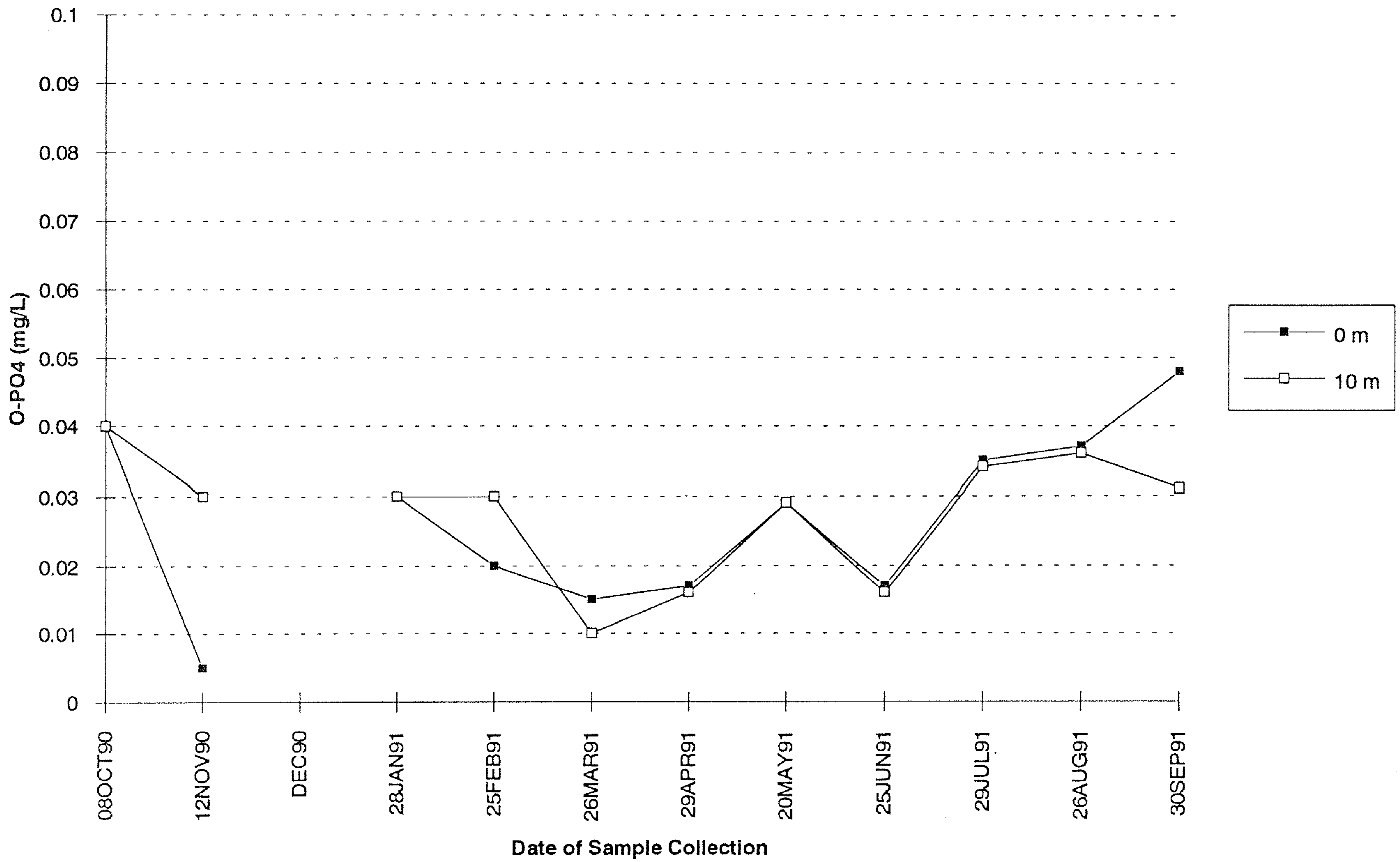


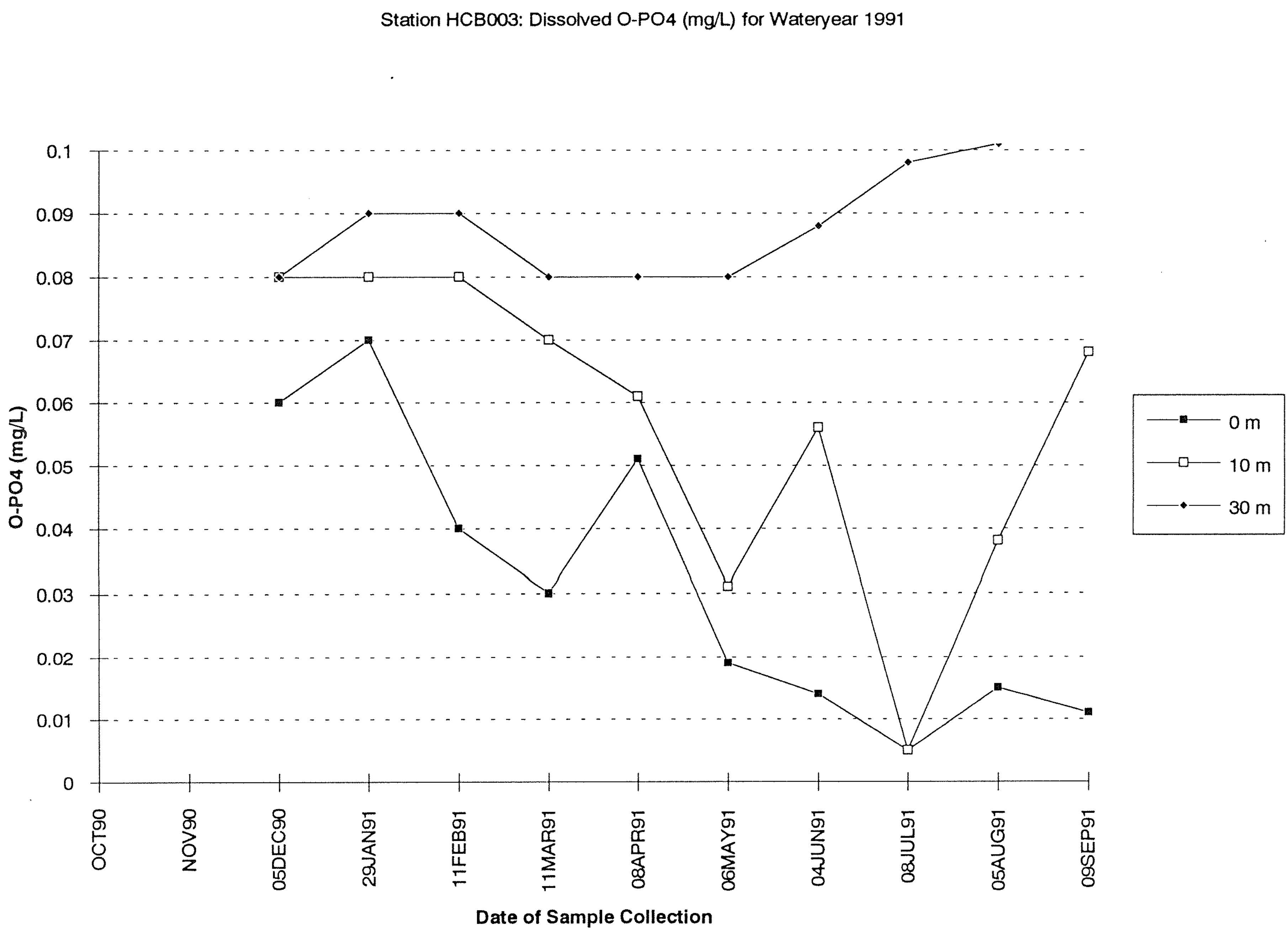
Station GYS004: Dissolved O-PO4 (mg/L) for Wateryear 1991




Station GYS008: Dissolved O-PO4 (mg/L) for Wateryear 1991
O-PO4 (mg/L)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
08OCT90
NOV90
DEC90
28JAN91
25FEB91
26MAR91
29APR91
20MAY91
25JUN91
29JUL91
26AUG91
30SEP91
Date of Sample Collection
0 m
10 m

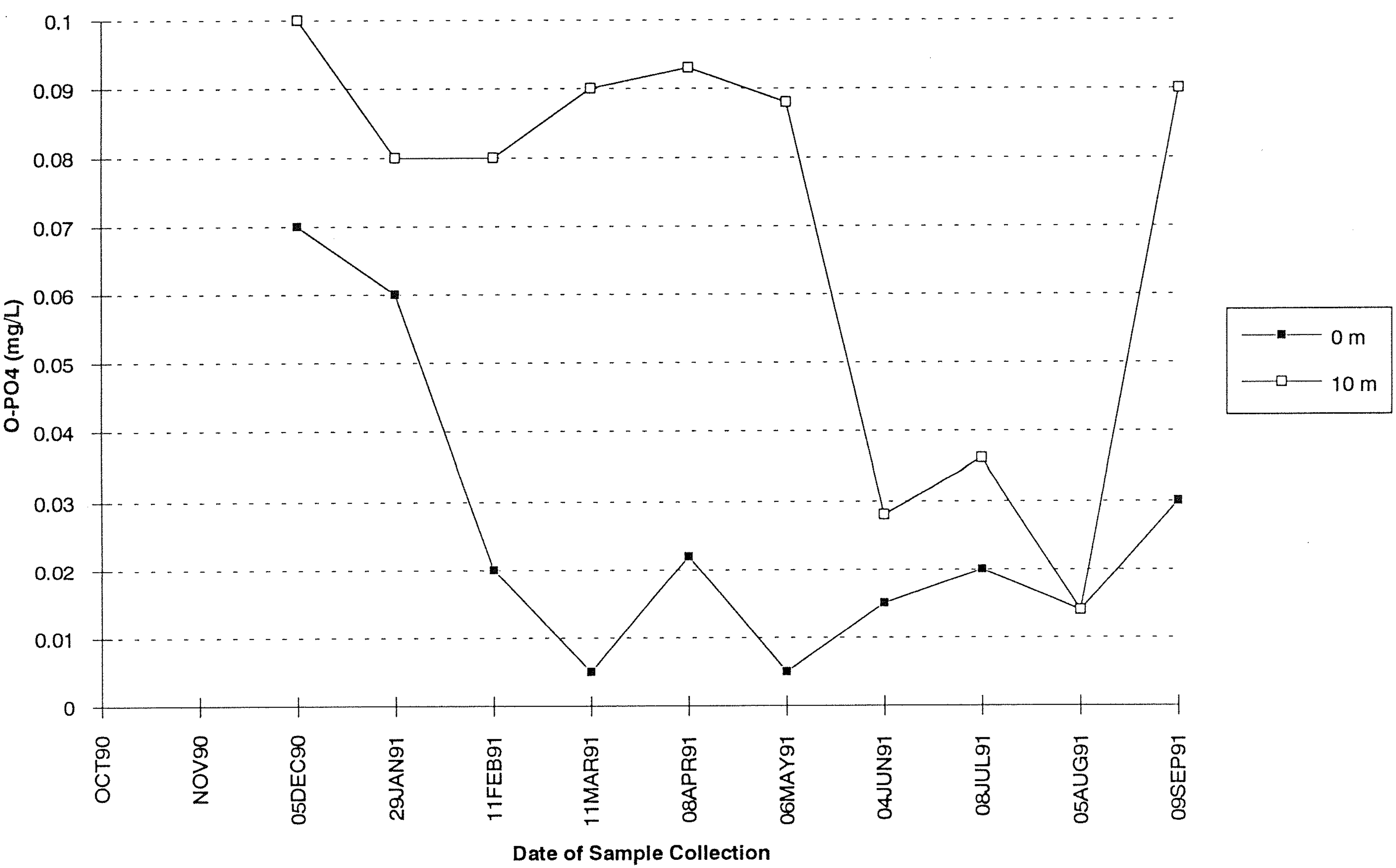
Station GYS009: Dissolved O-PO4 (mg/L) for Wateryear 1991



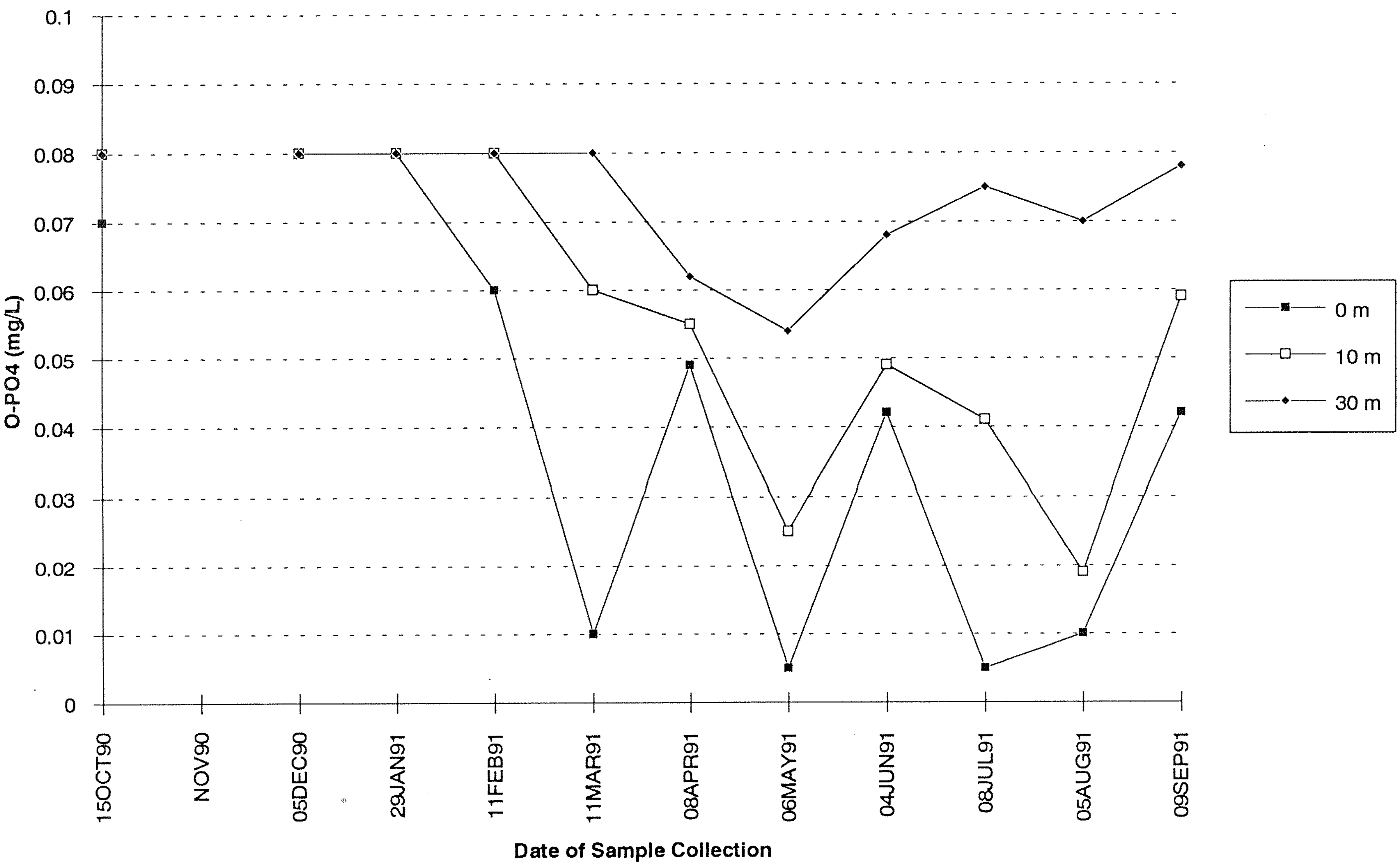


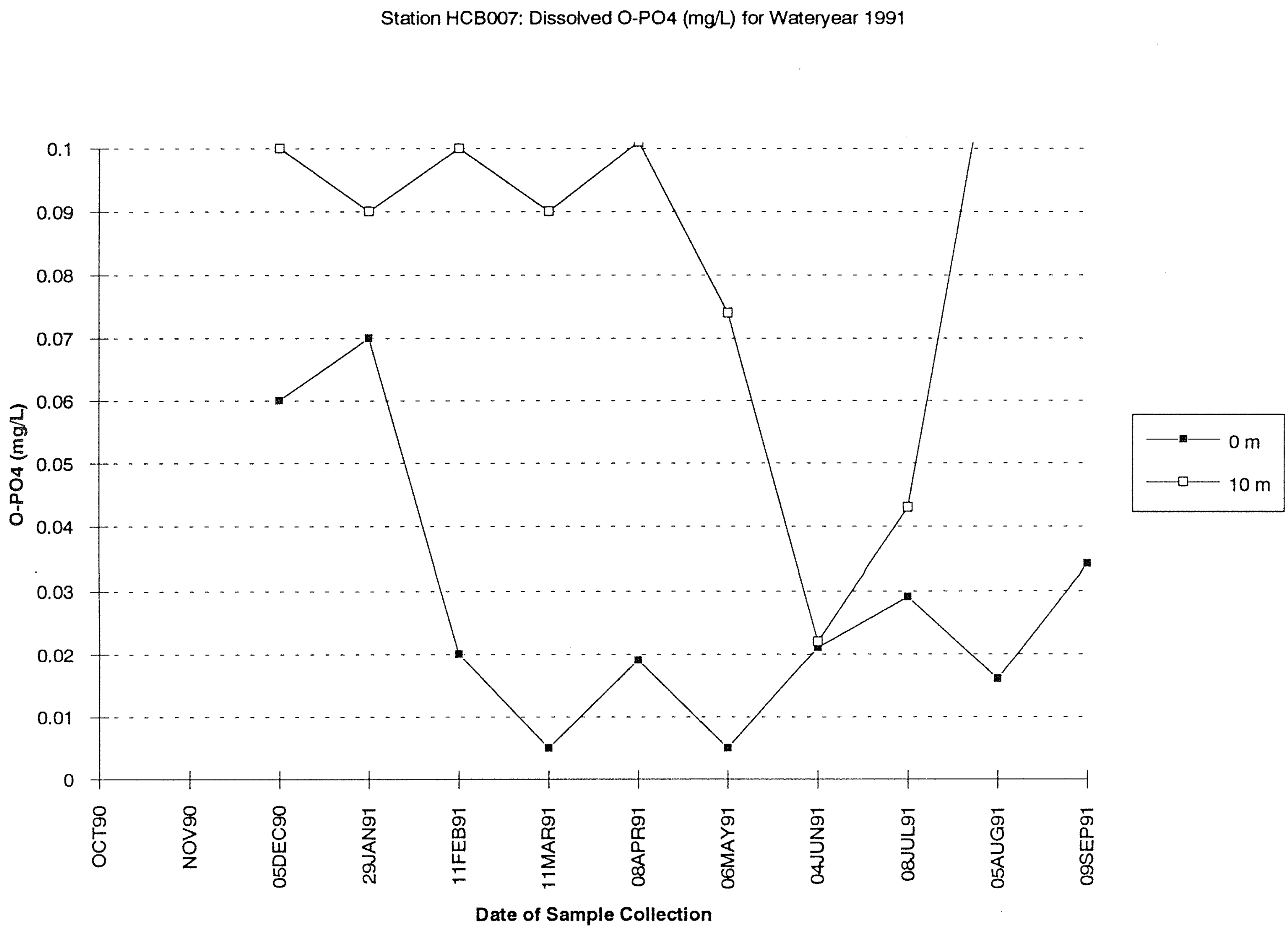
Station HCB003: Dissolved O-PO4 (mg/L) for Wateryear 1991
O-PO4 (mg/L)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
OCT90
NOV90
05DEC90
29JAN91
11FEB91
11MAR91
08APR91
06MAY91
04JUN91
08JUL91
05AUG91
09SEP91
Date of Sample Collection
0 m
10 m
30 m

Station HCB004: Dissolved O-PO4 (mg/L) for Wateryear 1991

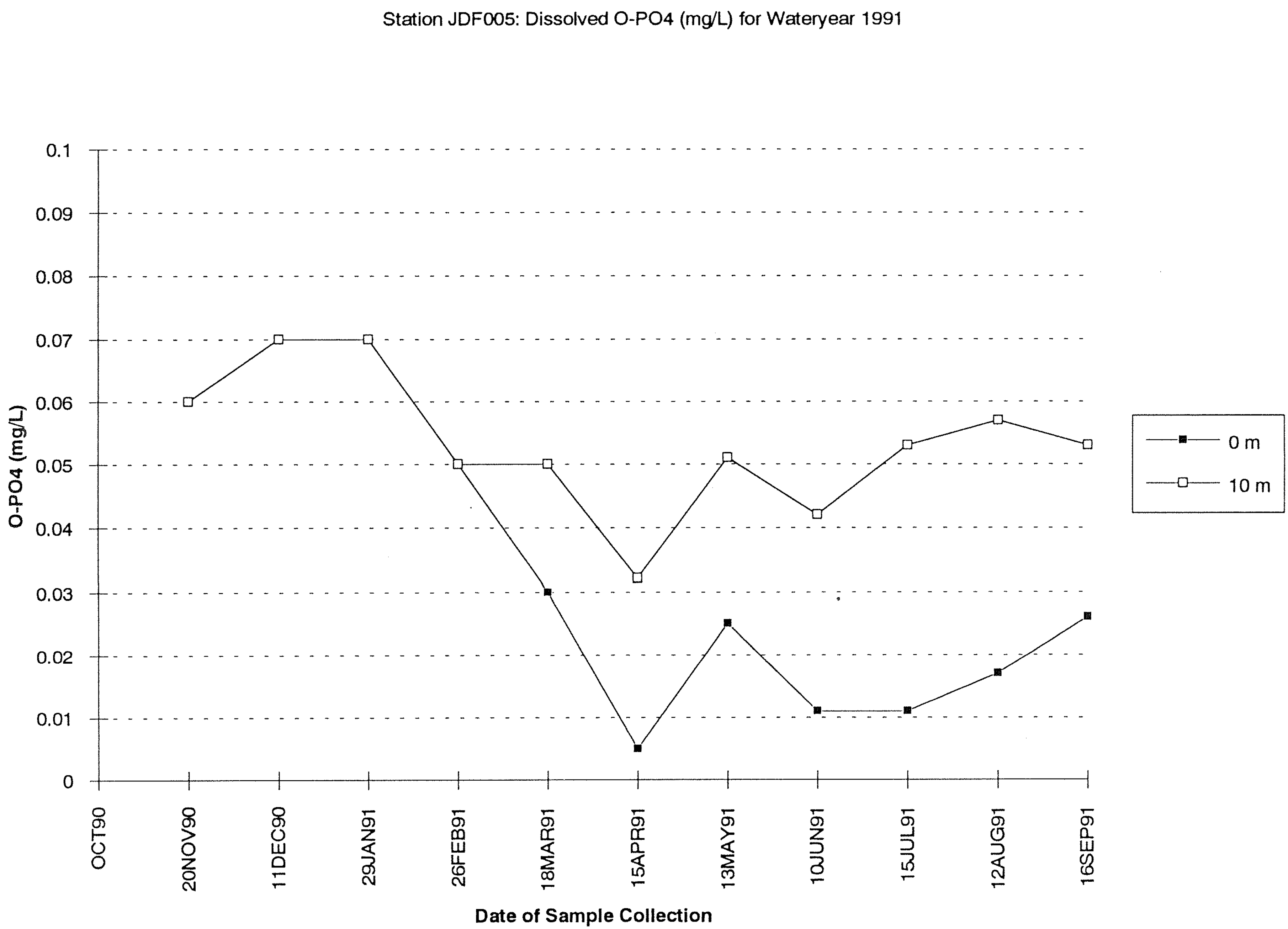


Station HCB006: Dissolved O-PO4 (mg/L) for Wateryear 1991

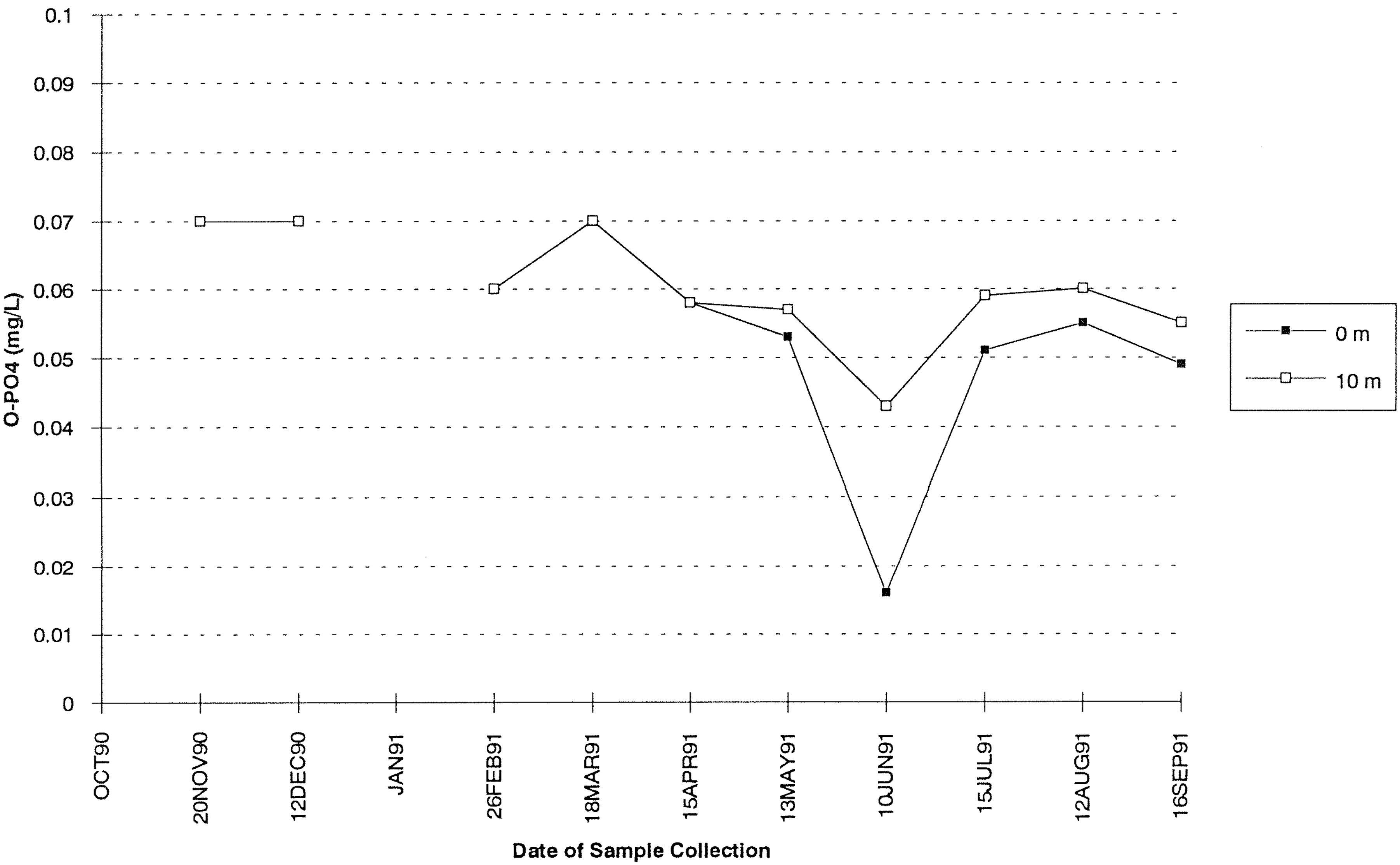


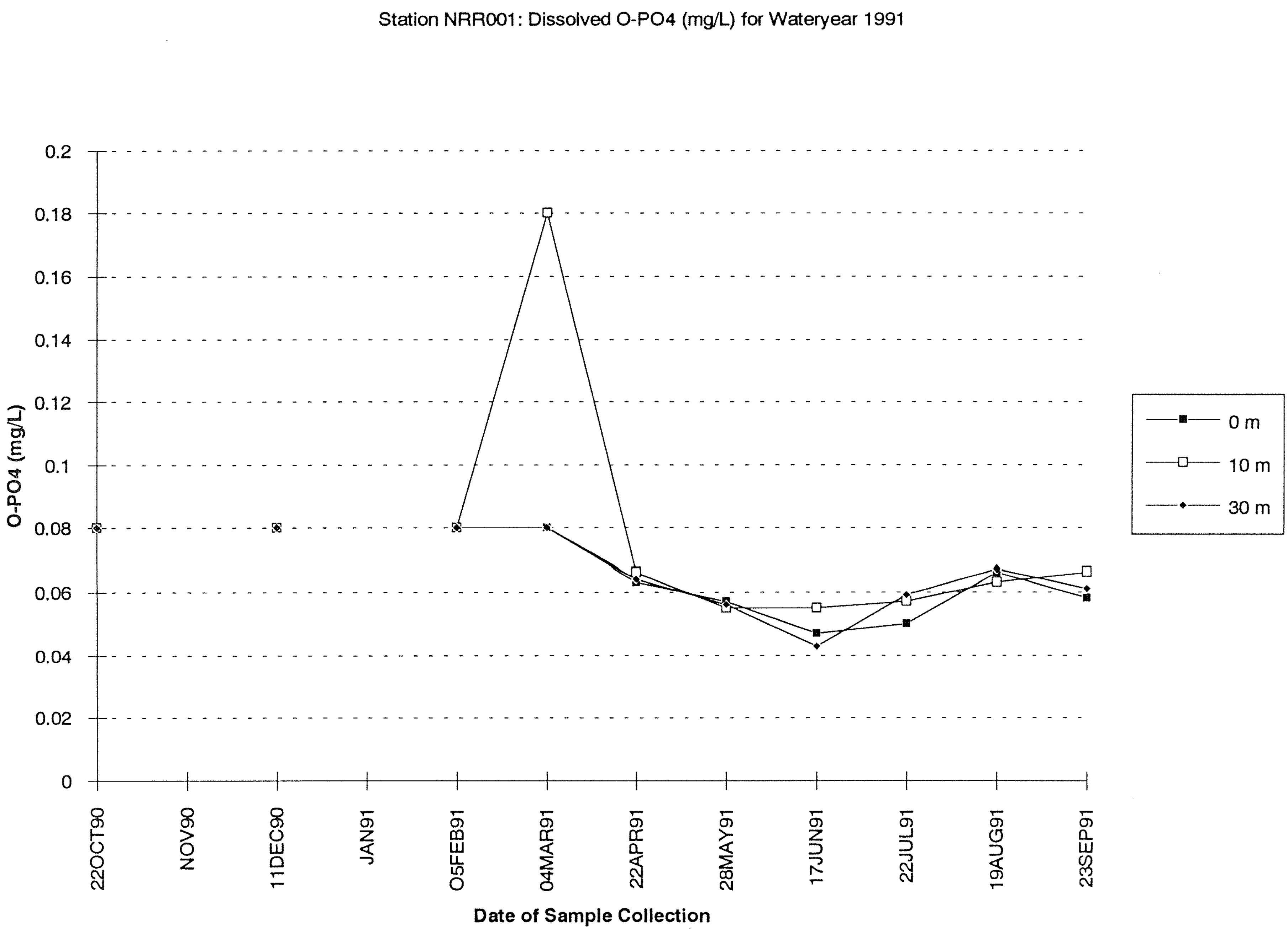


Station HCB007: Dissolved O-PO4 (mg/L) for Wateryear 1991
O-PO4 (mg/L)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
OCT90
NOV90
05DEC90
29JAN91
11FEB91
11MAR91
08APR91
06MAY91
04JUN91
08JUL91
05AUG91
09SEP91
Date of Sample Collection
0 m
10 m


Station JDF005: Dissolved O-PO4 (mg/L) for Wateryear 1991
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
O-PO4 (mg/L)
0 m
10 m
OCT90
20NOV90
11DEC90
29JAN91
26FEB91
18MAR91
15APR91
13MAY91
10JUN91
15JUL91
12AUG91
16SEP91
Date of Sample Collection

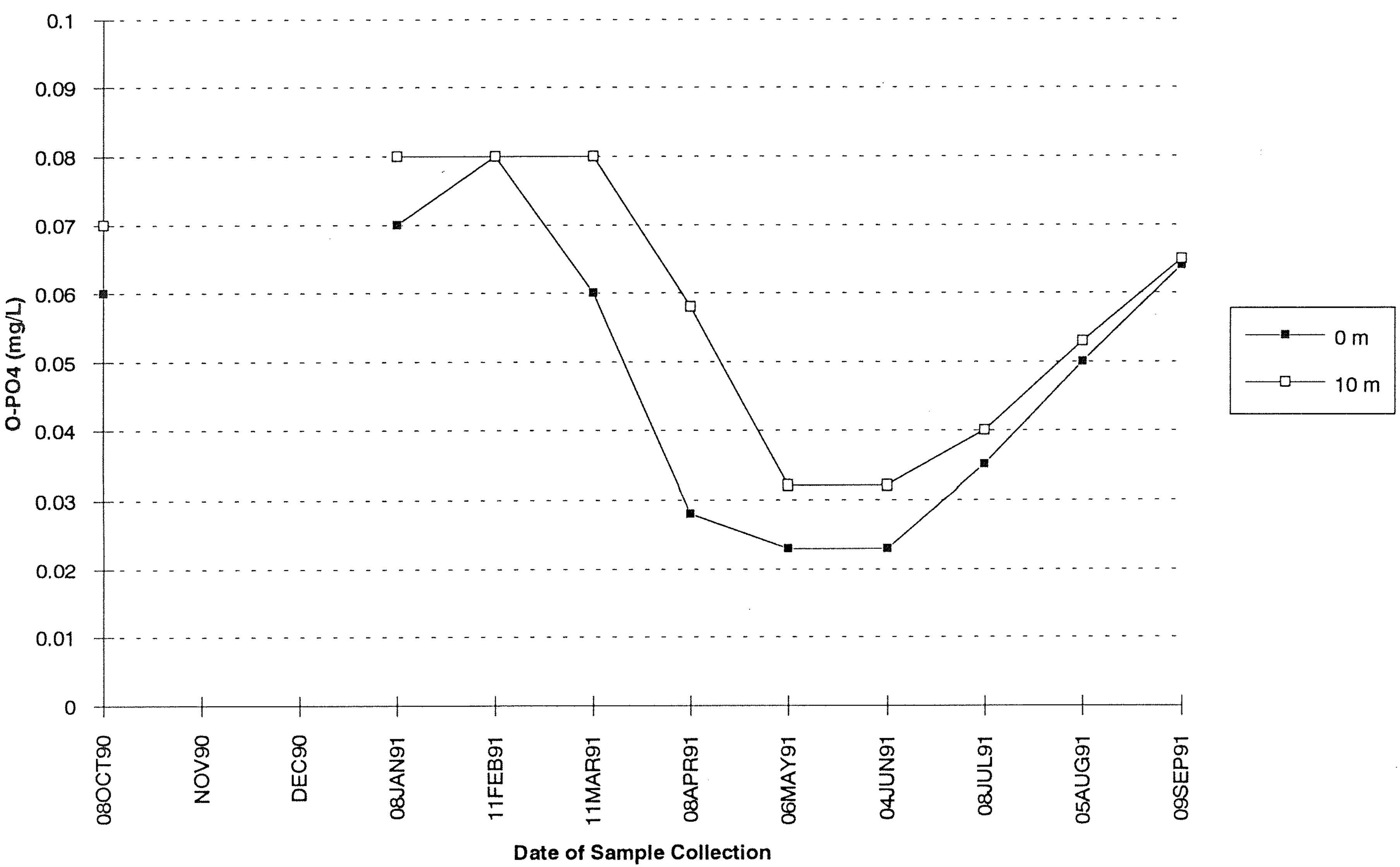
Station LOP001: Dissolved O-PO4 (mg/L) for Wateryear 1991



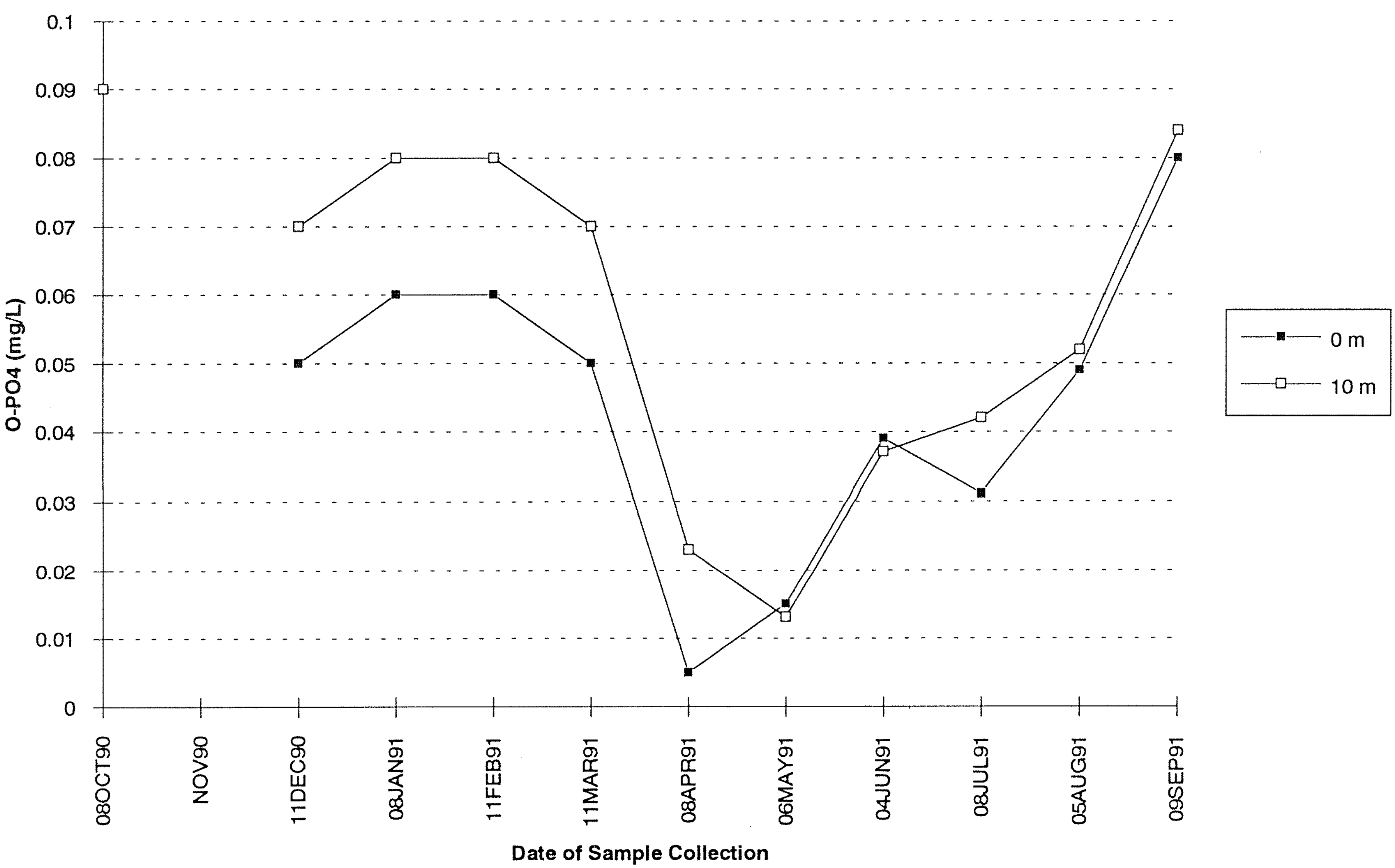


Station NRR001: Dissolved O-PO4 (mg/L) for Wateryear 1991
O-PO4 (mg/L)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
22OCT90
NOV90
11DEC90
JAN91
O5FEB91
04MAR91
22APR91
28MAY91
17JUN91
22JUL91
19AUG91
23SEP91
Date of Sample Collection
0 m
10 m
30 m

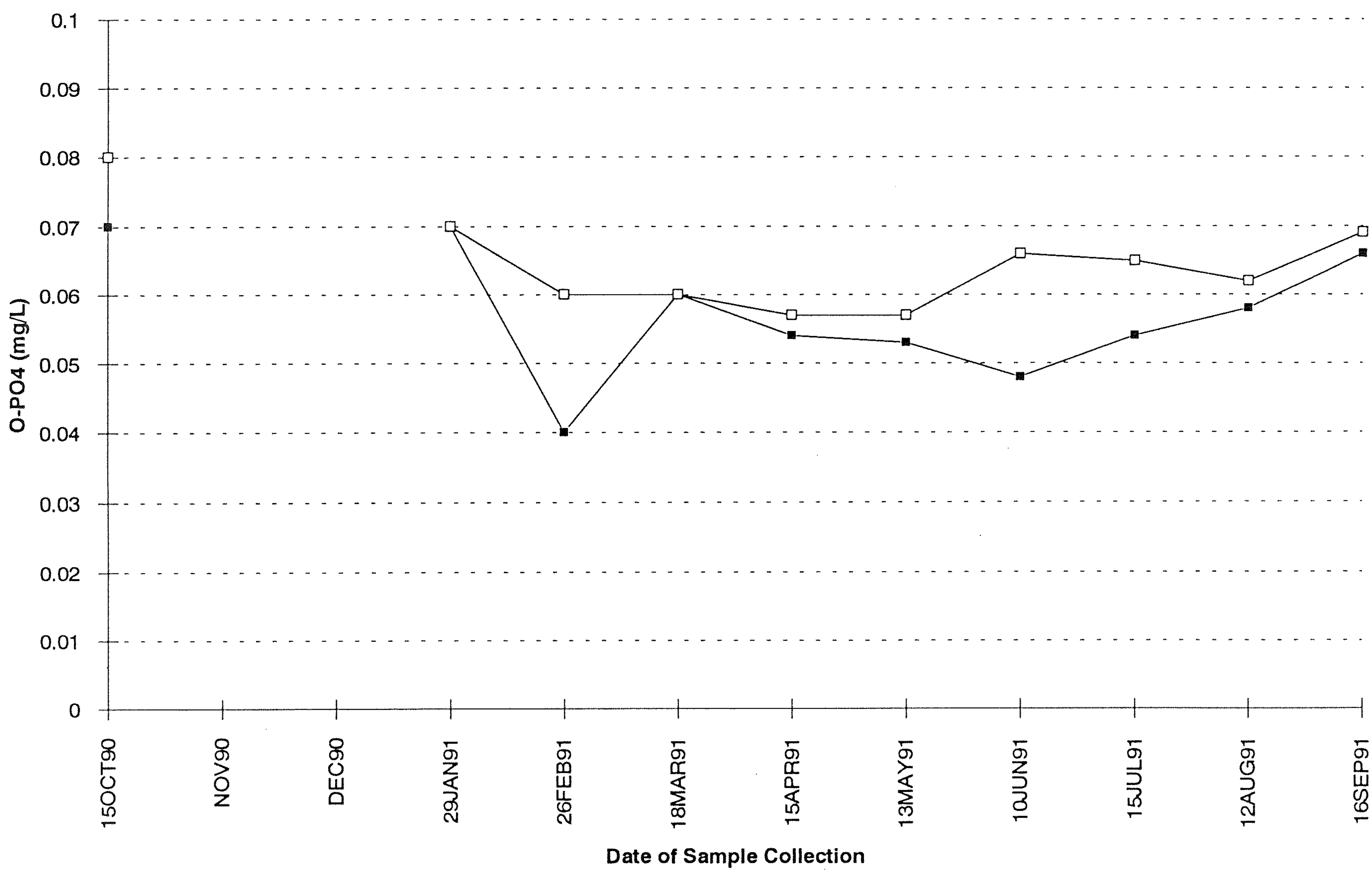
Station NSQ001: Dissolved O-PO4 (mg/L) for Wateryear 1991



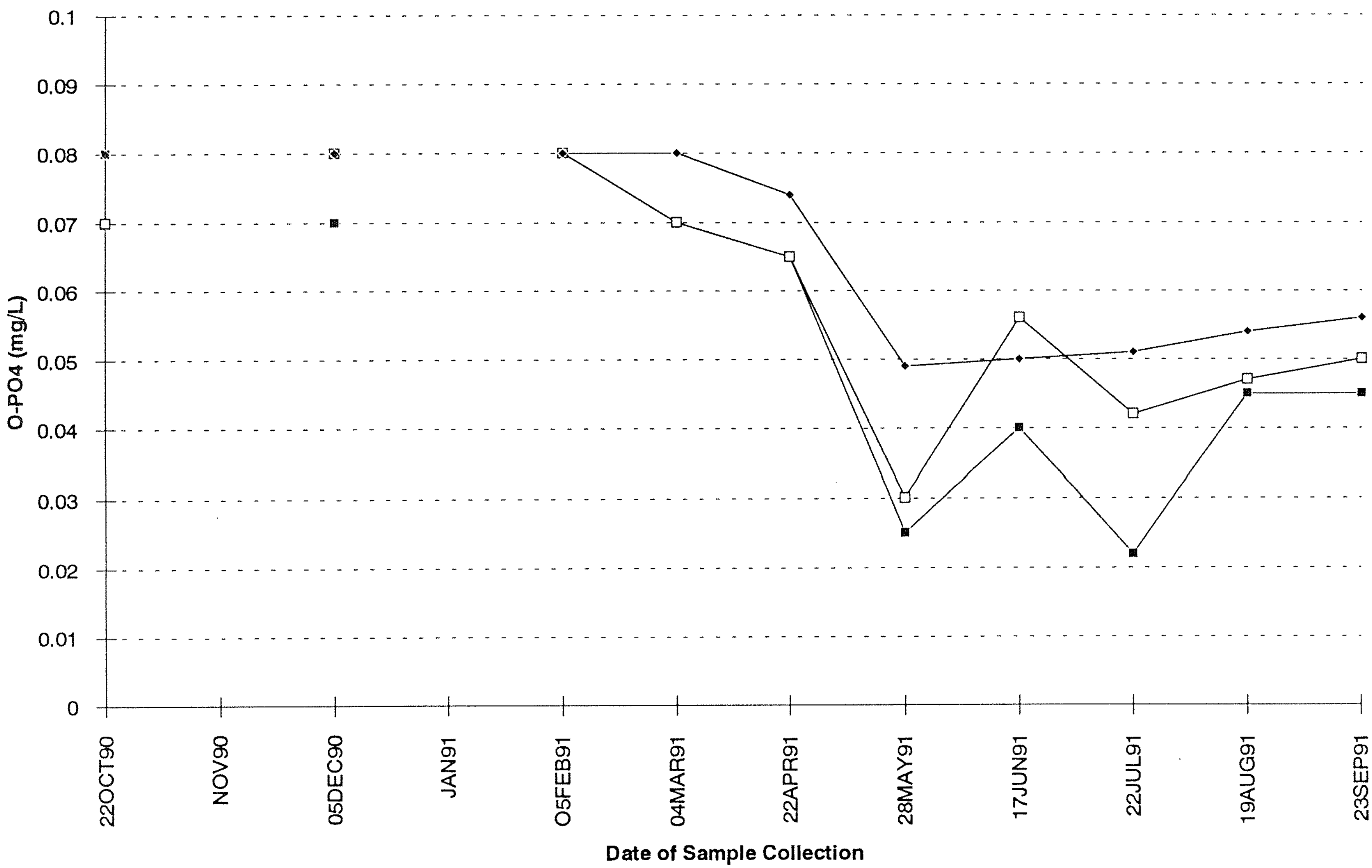
Station OAK004: Dissolved O-PO4 (mg/L) for Wateryear 1991



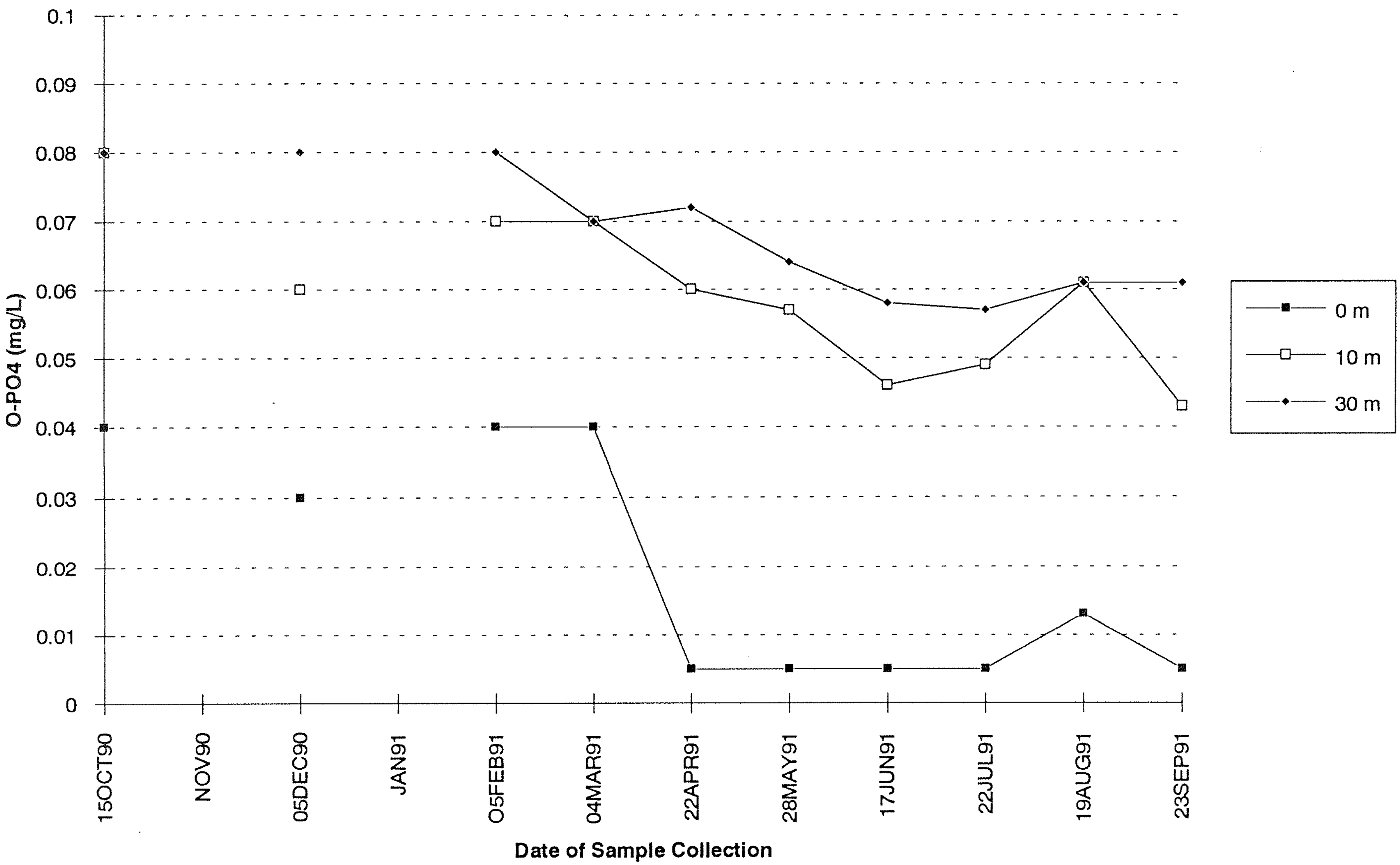
Station PAH008: Dissolved O-PO4 (mg/L) for Wateryear 1991

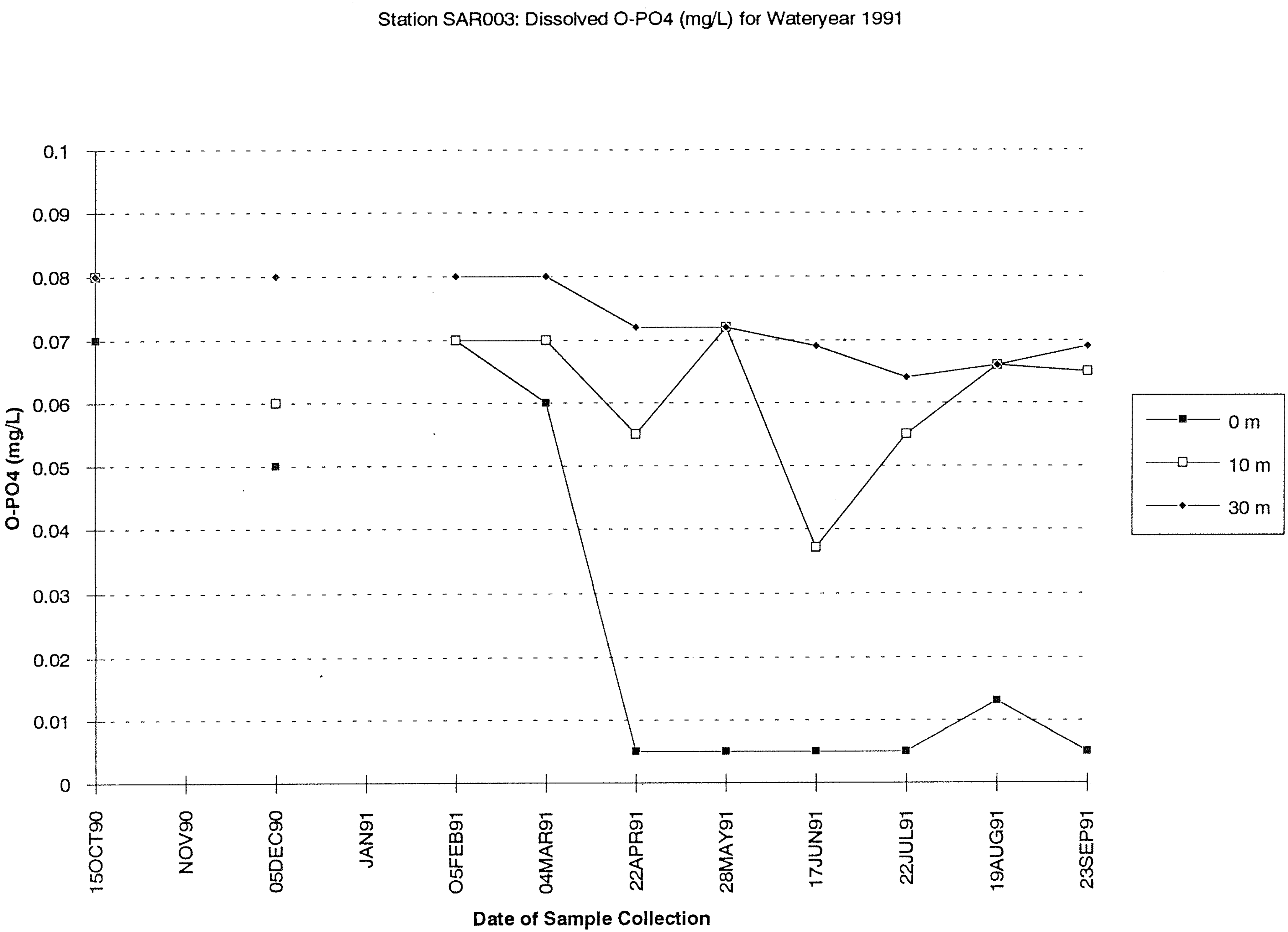


Station PSB003: Dissolved O-PO4 (mg/L) for Wateryear 1991

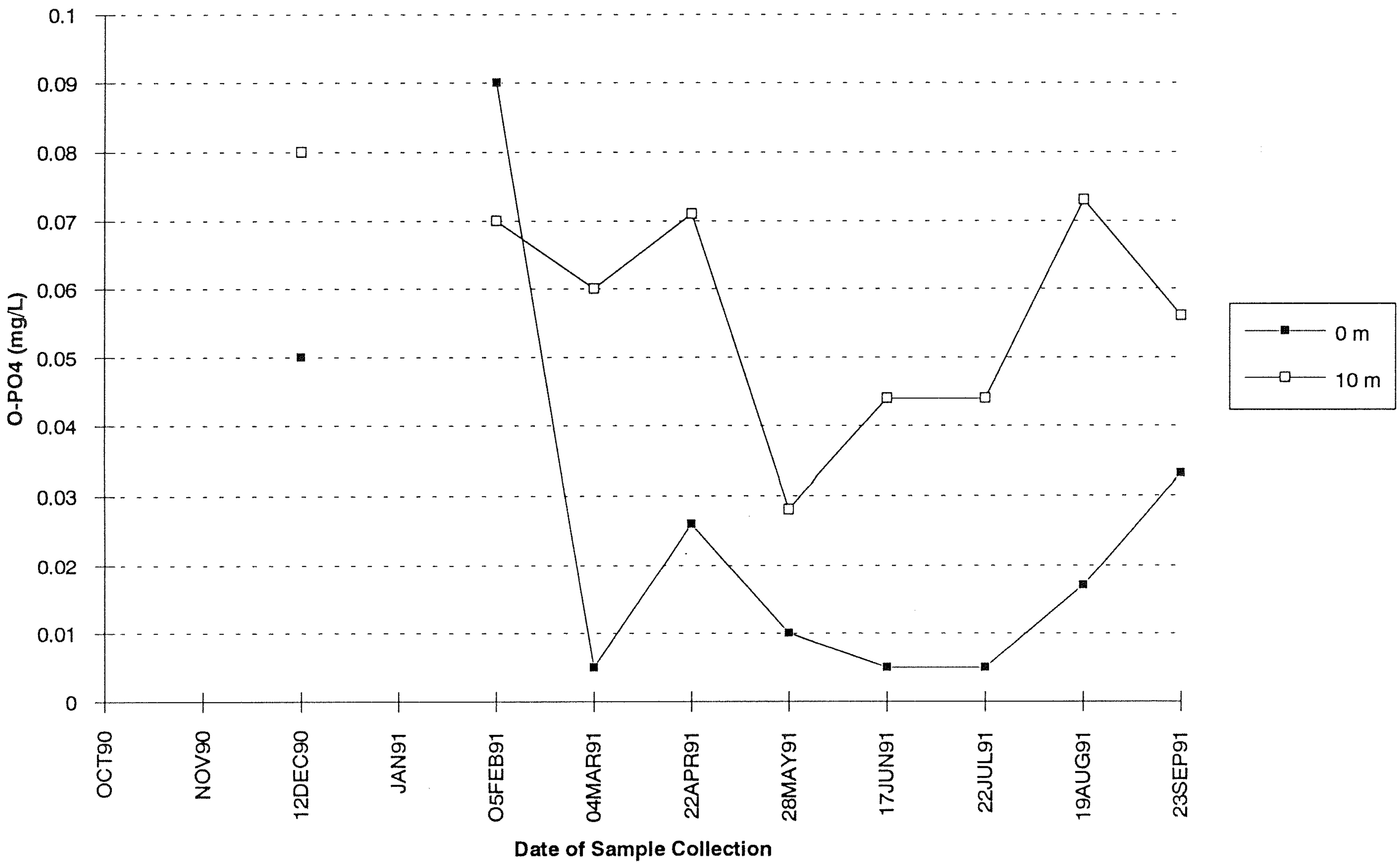


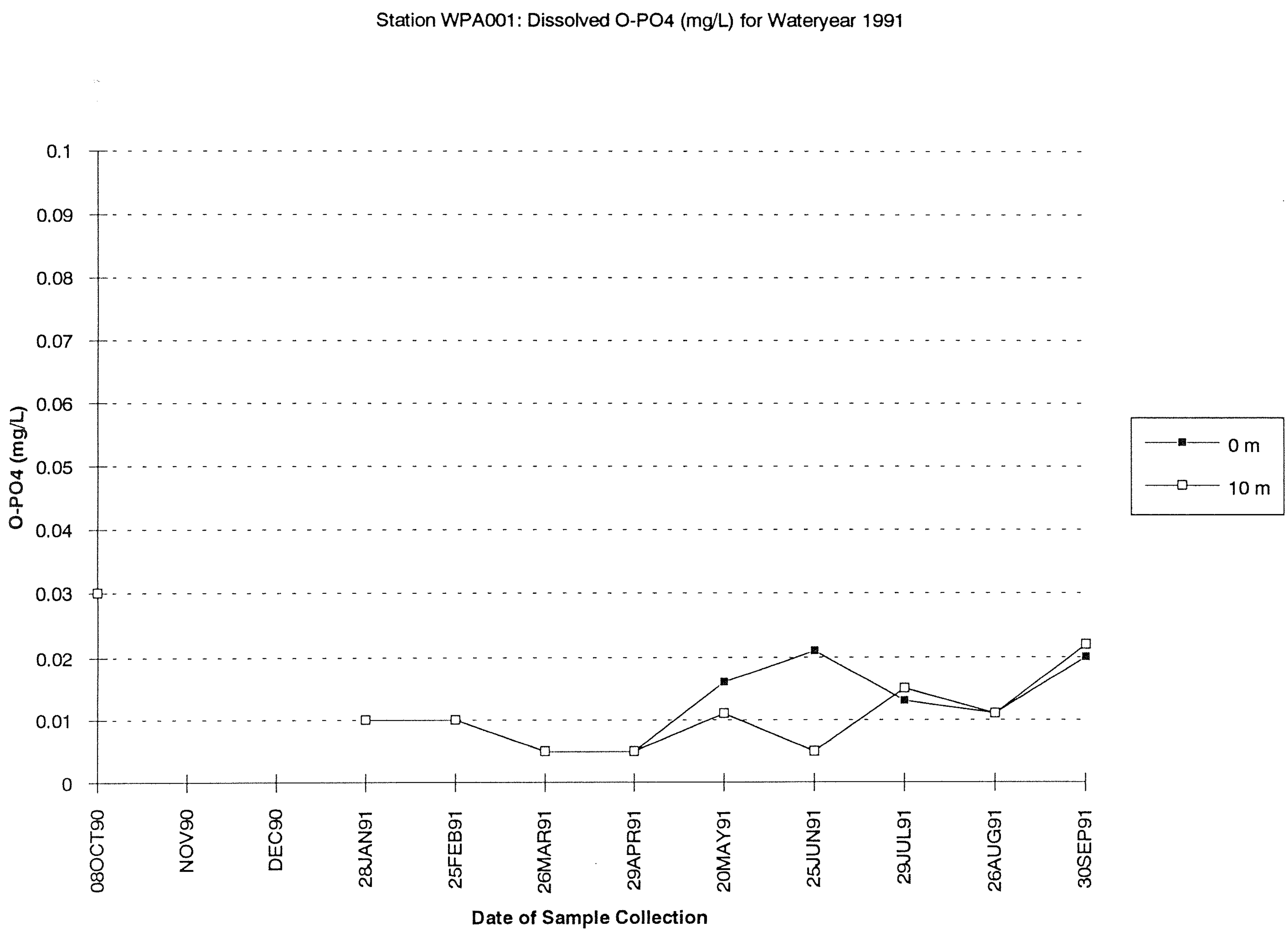
Station PSS019: Dissolved O-PO4 (mg/L) for Wateryear 1991



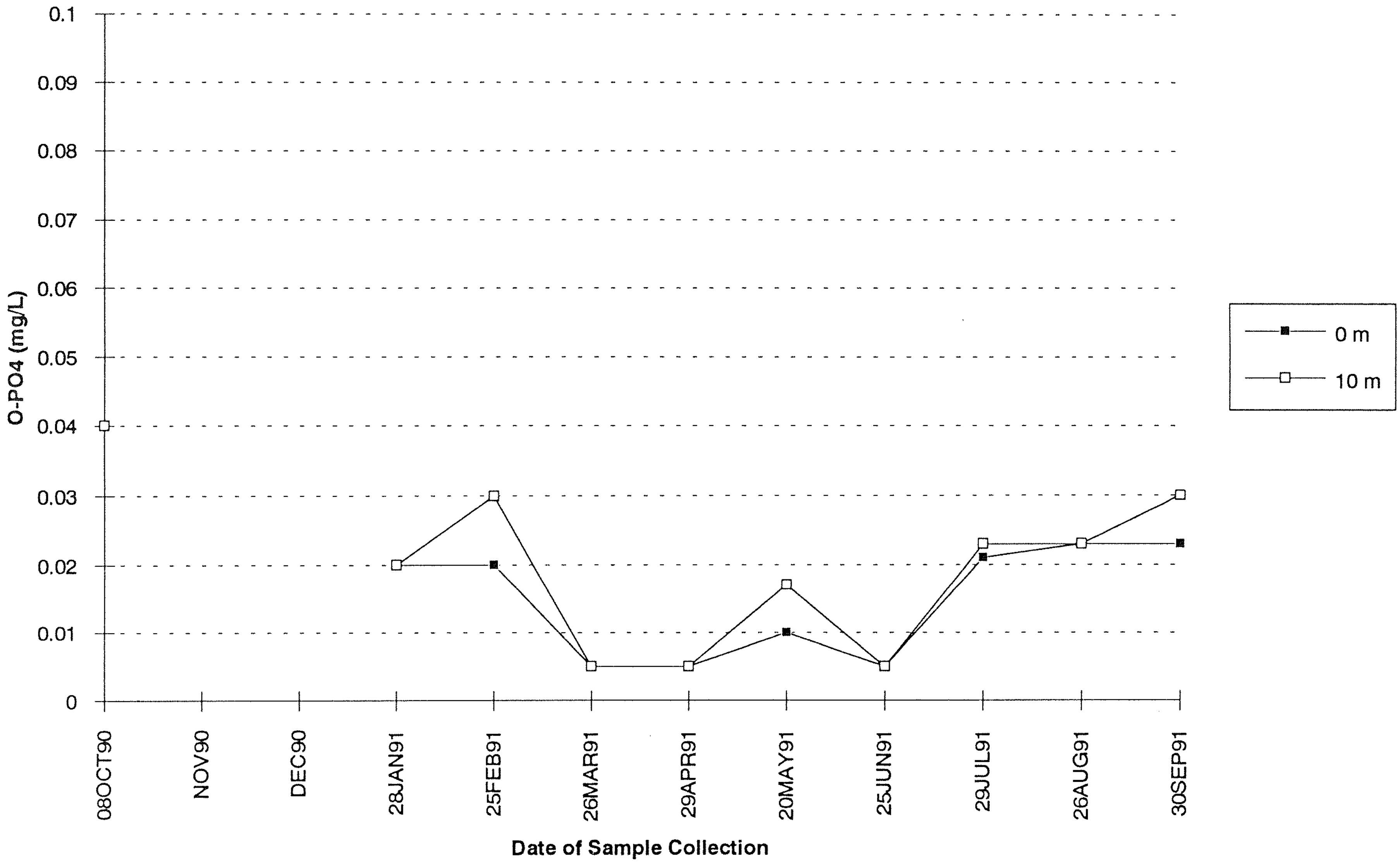

Station SAR003: Dissolved O-PO4 (mg/L) for Wateryear 1991
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
O-PO4 (mg/L)
15OCT90
NOV90
05DEC90
JAN91
05FEB91
04MAR91
22APR91
28MAY91
17JUN91
22JUL91
19AUG91
23SEP91
Date of Sample Collection
0 m
10 m
30 m

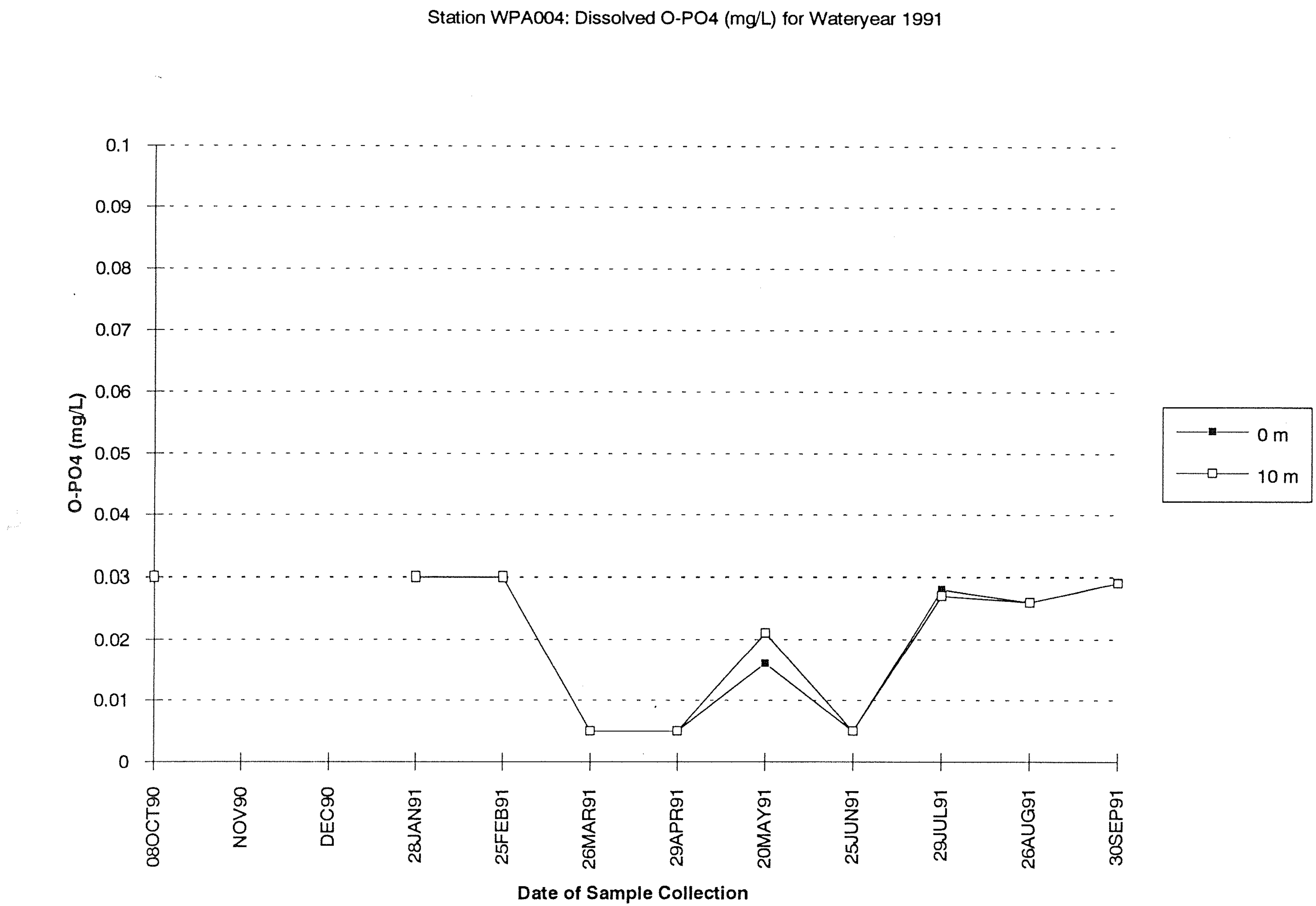
Station SKG003: Dissolved O-PO4 (mg/L) for Wateryear 1991




Station WPA001: Dissolved O-PO4 (mg/L) for Wateryear 1991
O-PO4 (mg/L)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
08OCT90
NOV90
DEC90
28JAN91
25FEB91
26MAR91
29APR91
20MAY91
25JUN91
29JUL91
26AUG91
30SEP91
Date of Sample Collection
0 m
10 m

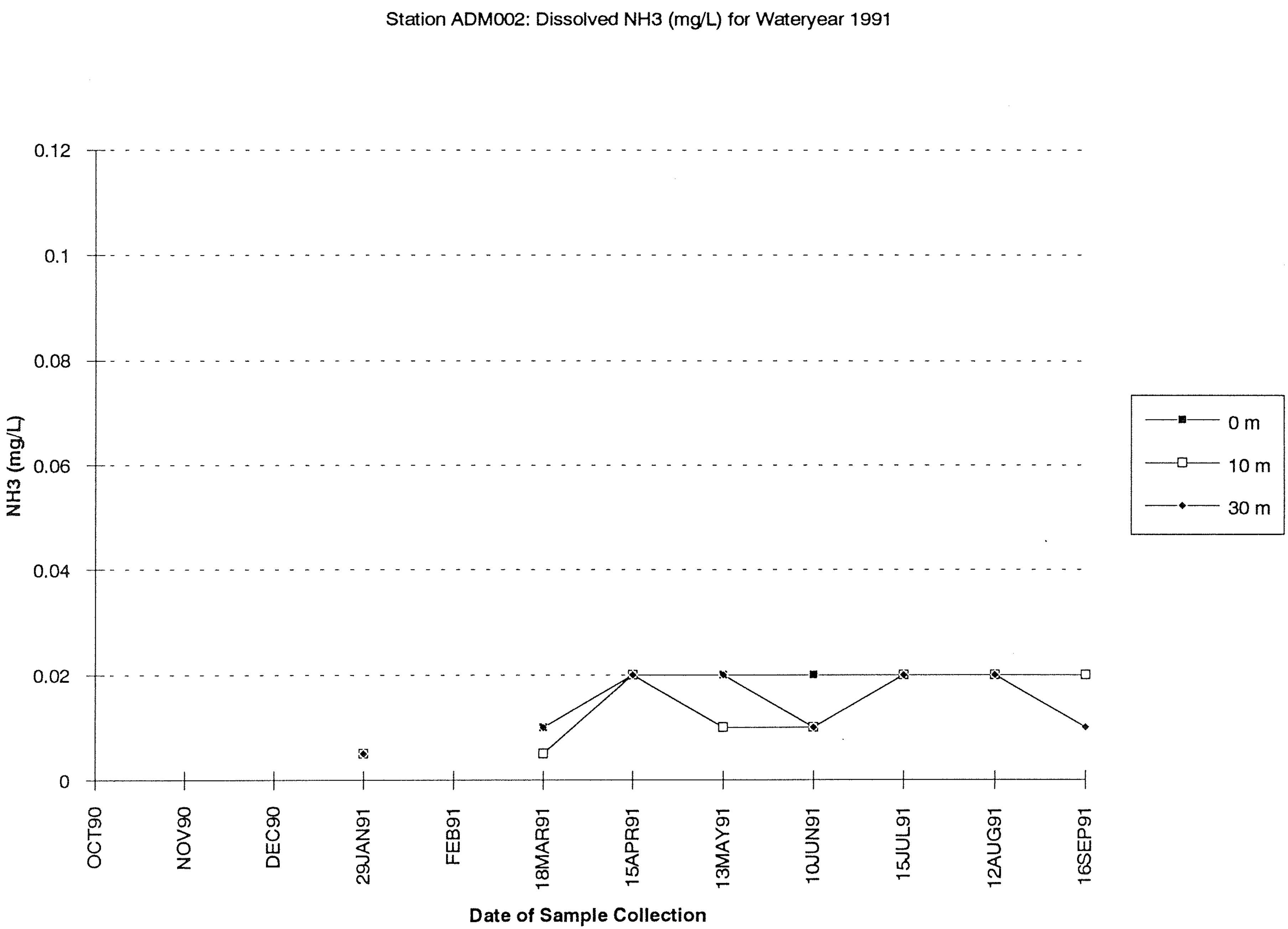
Station WPA003: Dissolved O-PO4 (mg/L) for Wateryear 1991




Station WPA004: Dissolved O-PO4 (mg/L) for Wateryear 1991
O-PO4 (mg/L)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
08OCT90
NOV90
DEC90
28JAN91
25FEB91
26MAR91
29APR91
20MAY91
25JUN91
29JUL91
26AUG91
30SEP91
Date of Sample Collection
0 m
10 m

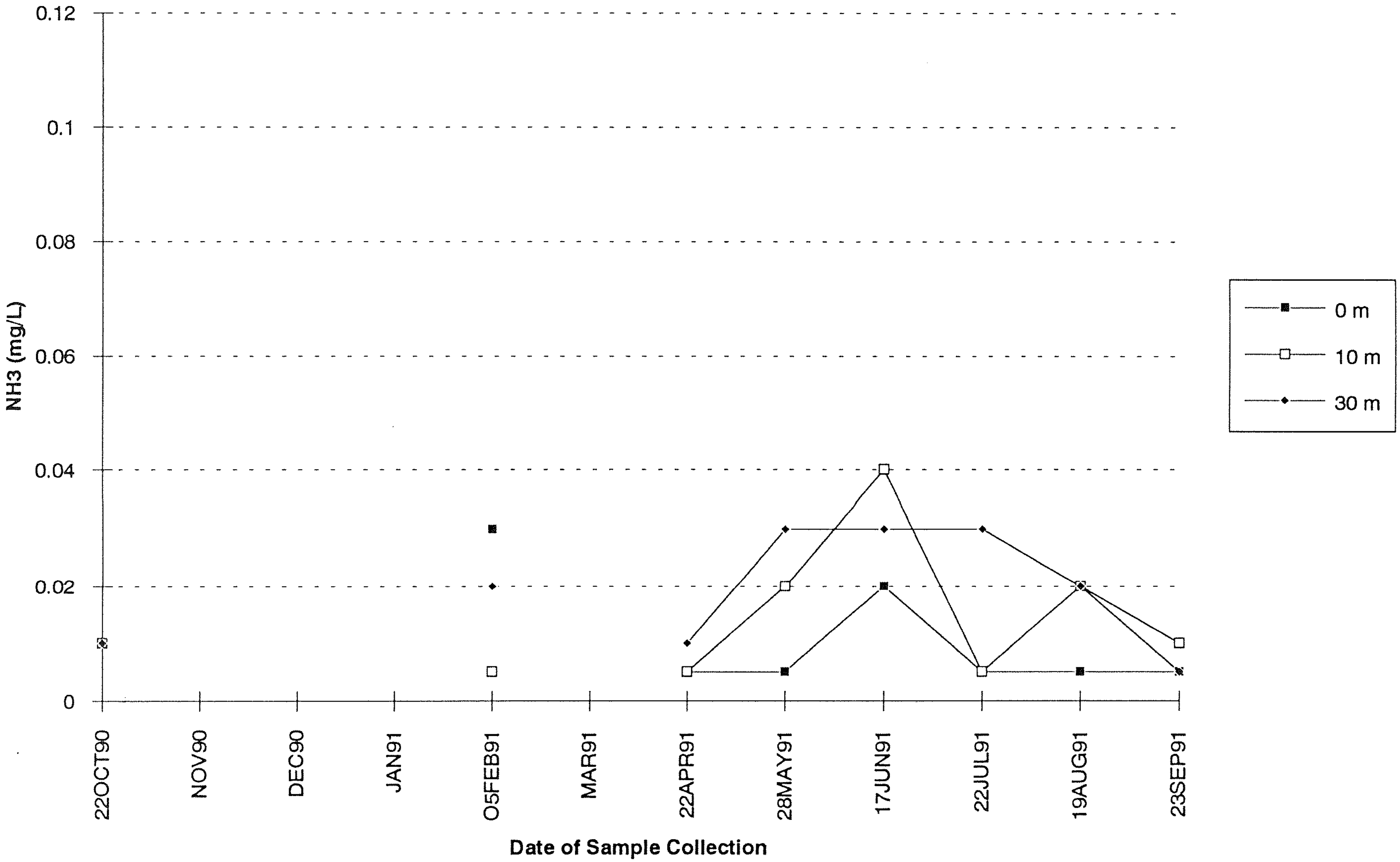
APPENDIX G

PLOTS OF AMMONIUM CONCENTRATIONS FOR EACH WY 1991 STATION AT ALL DEPTHS

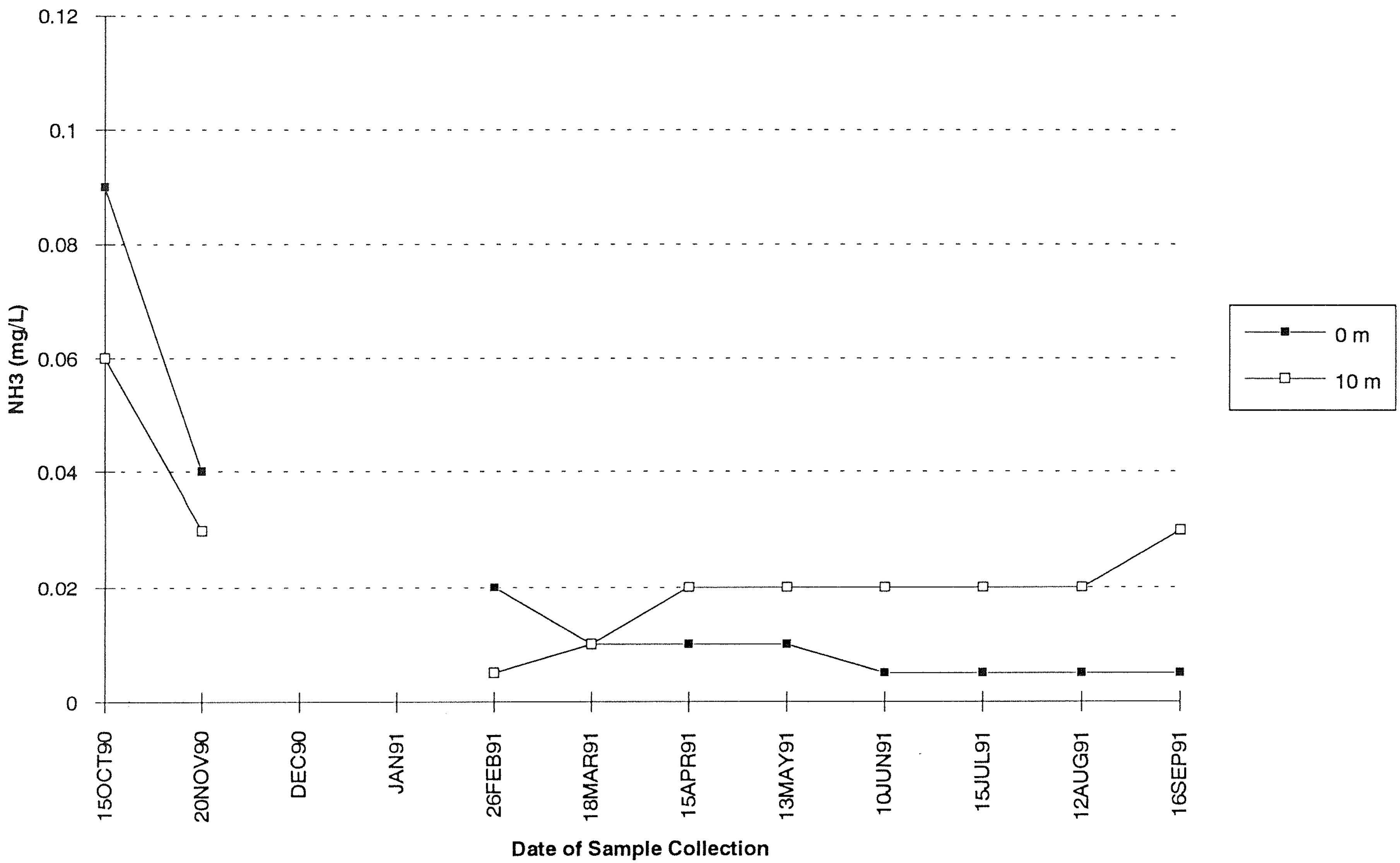


Station ADM002: Dissolved NH3 (mg/L) for Wateryear 1991
0.12
0.1
0.08
0.06
0.04
0.02
0
NH3 (mg/L)
OCT90
NOV90
DEC90
29JAN91
FEB91
18MAR91
15APR91
13MAY91
10JUN91
15JUL91
12AUG91
16SEP91
Date of Sample Collection
0 m
10 m
30 m

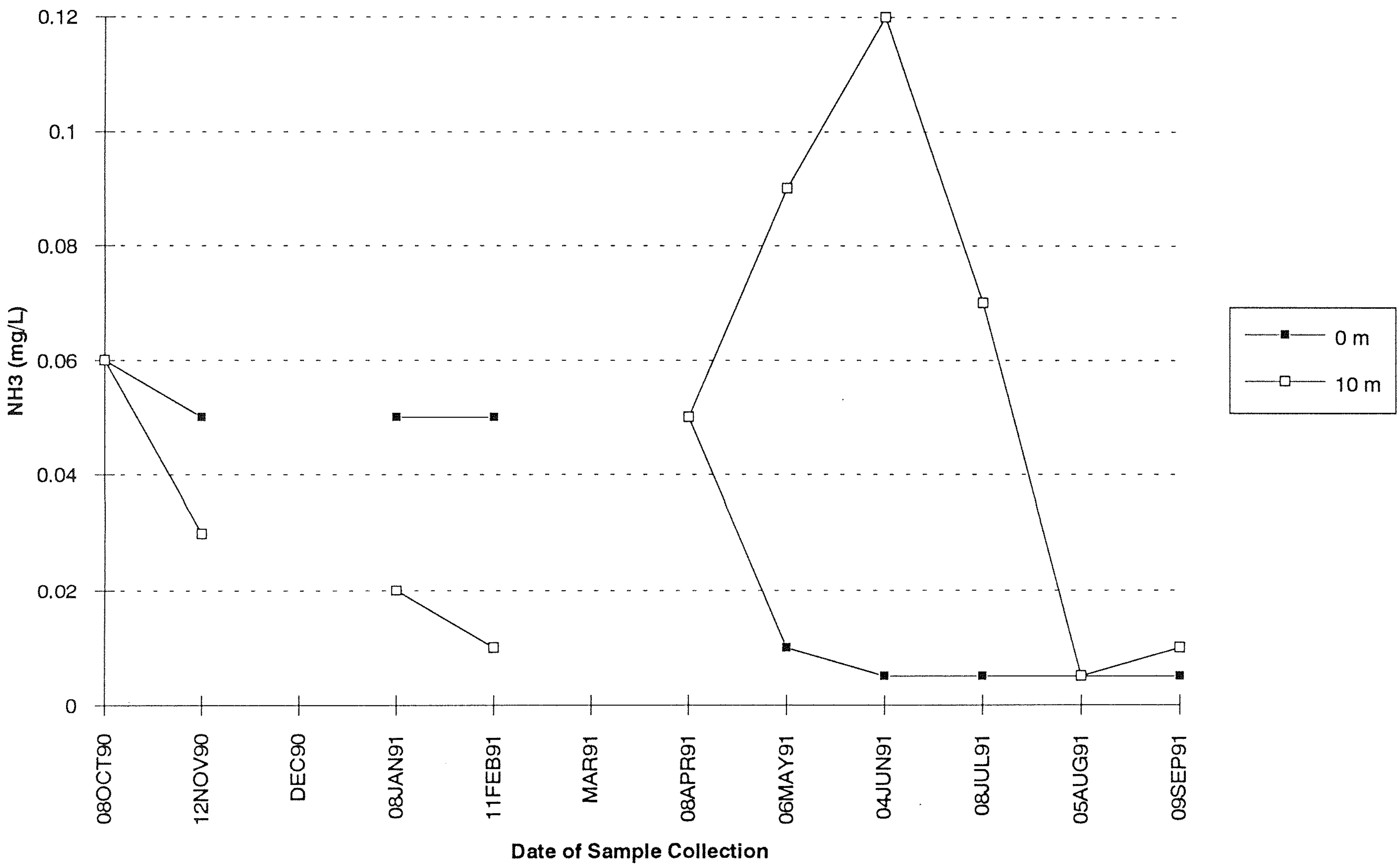
Station ADM003: Dissolved NH3 (mg/L) for Wateryear 1991



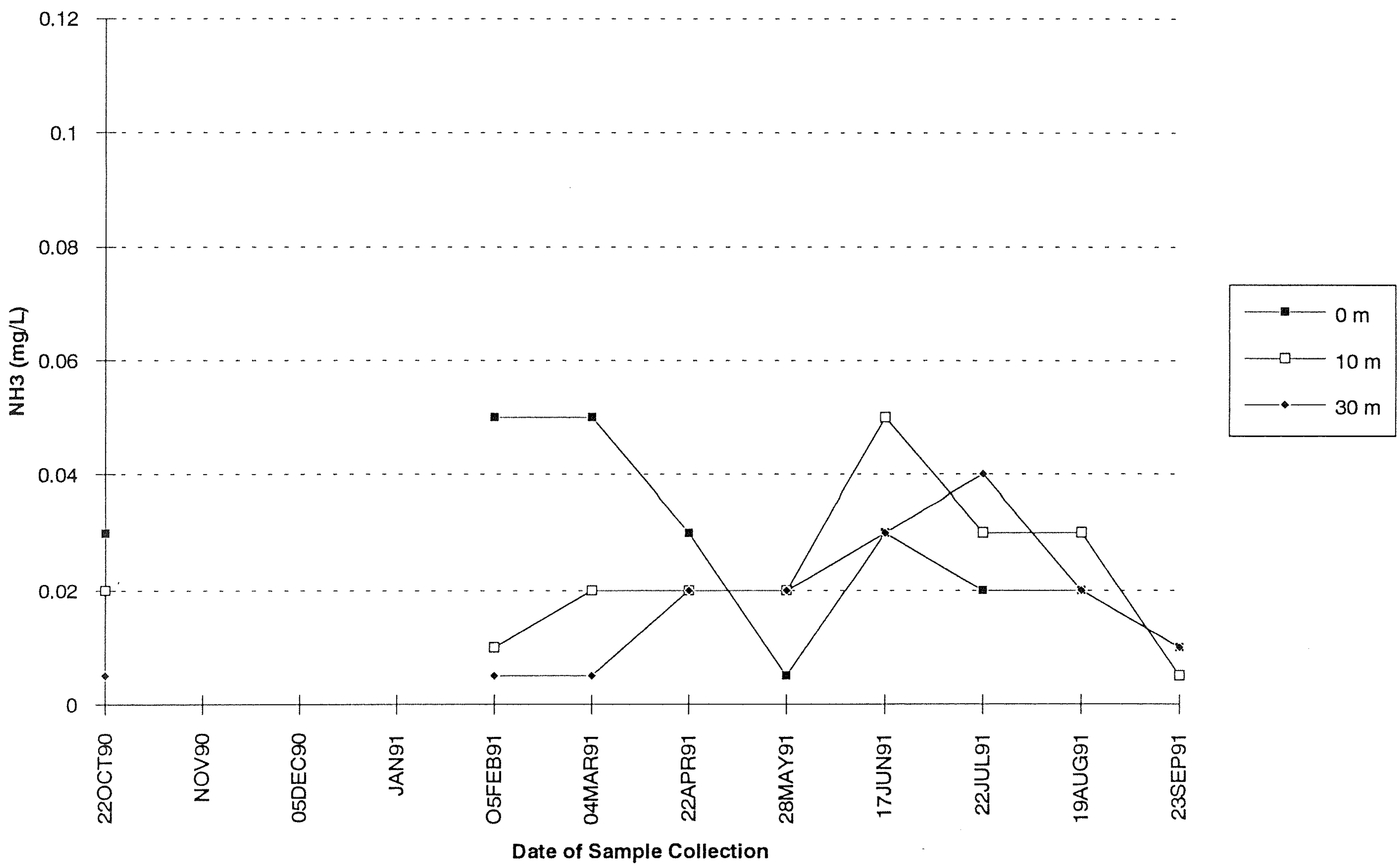
Station BLL009: Dissolved NH3 (mg/L) for Wateryear 1991



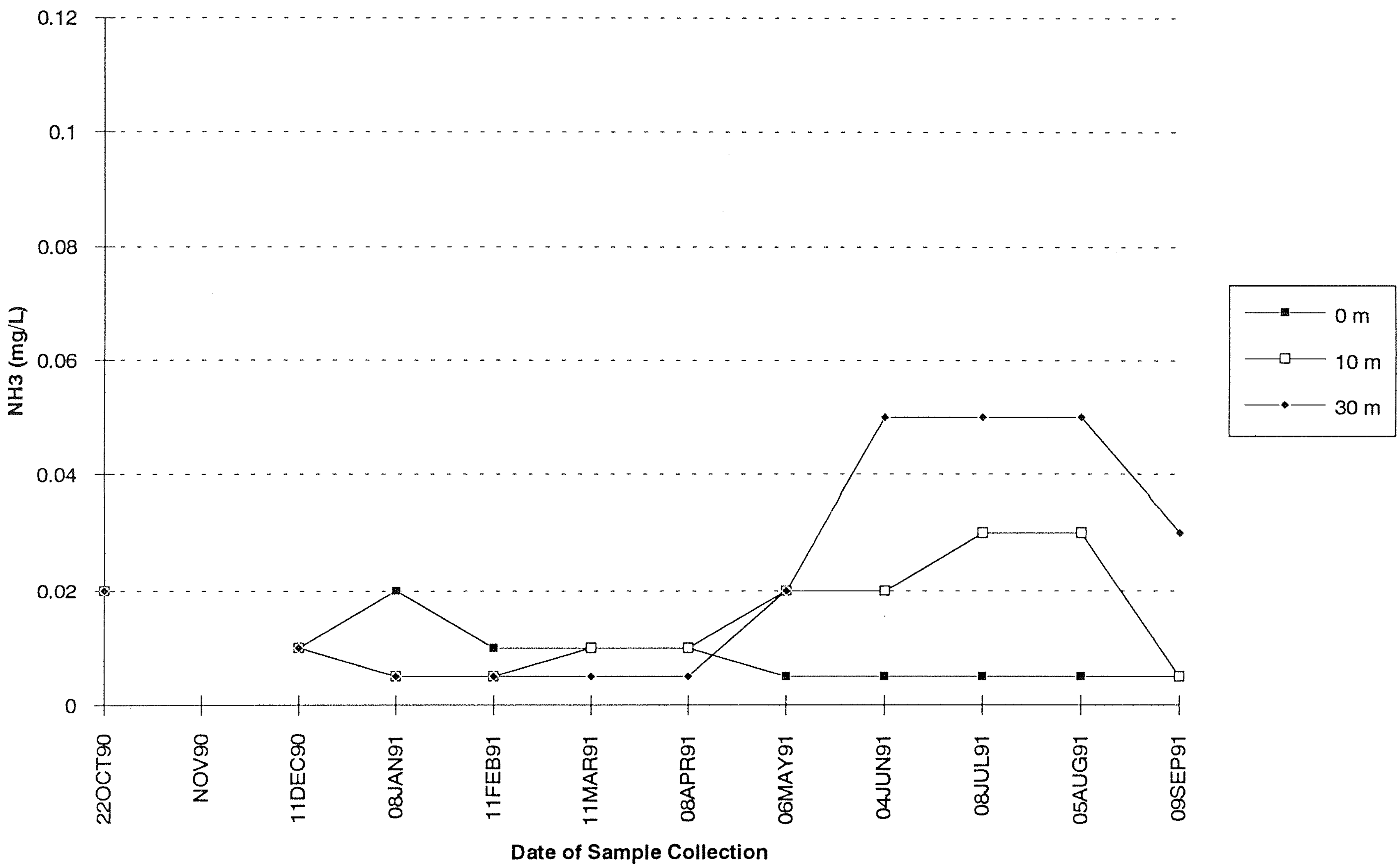
Station BUD005: Dissolved NH3 (mg/L) for Wateryear 1991



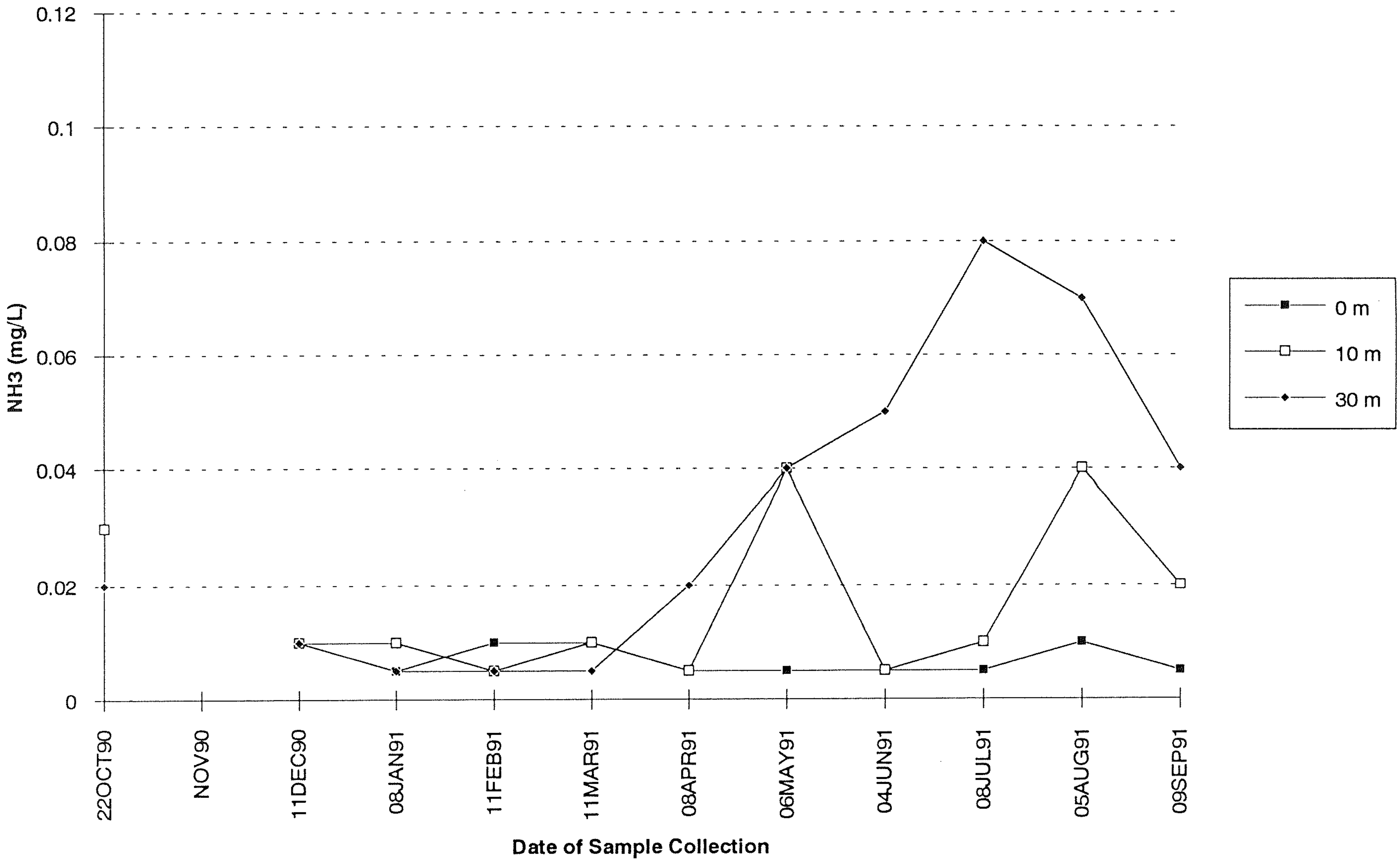
Station CMB003: Dissolved NH3 (mg/L) for Wateryear 1991



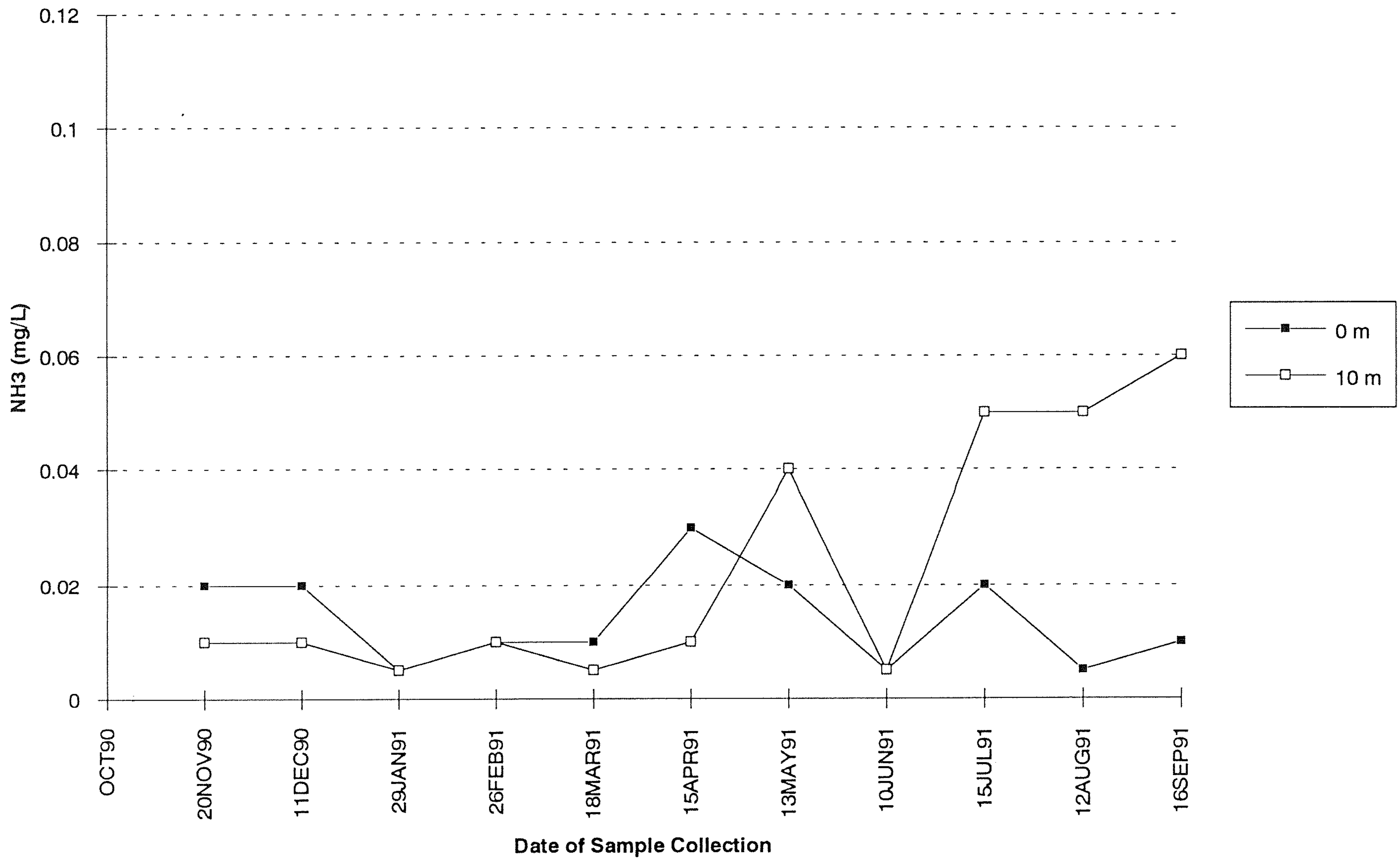
Station CRR001: Dissolved NH3 (mg/L) for Wateryear 1991

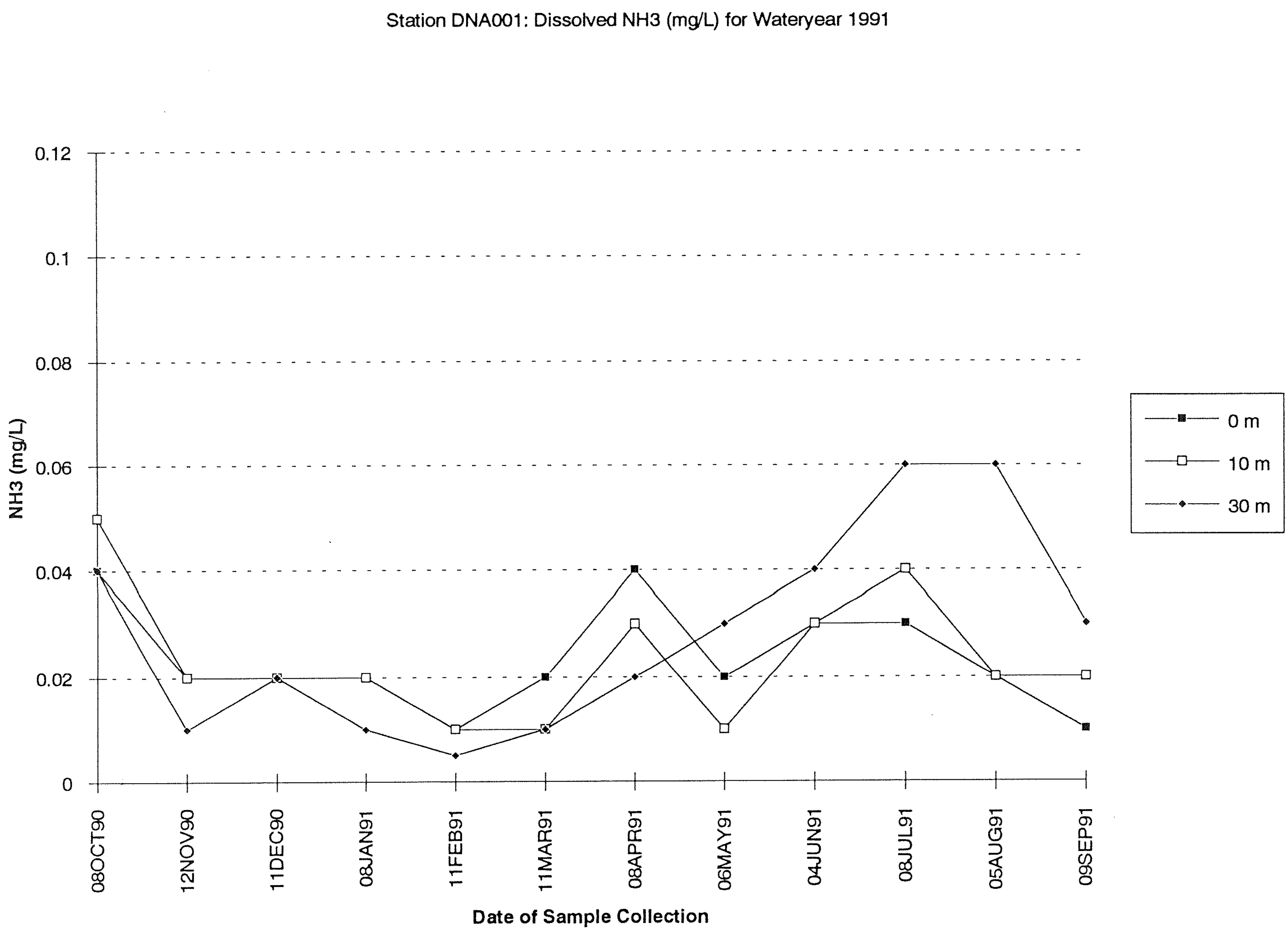


Station CSE001: Dissolved NH3 (mg/L) for Wateryear 1991



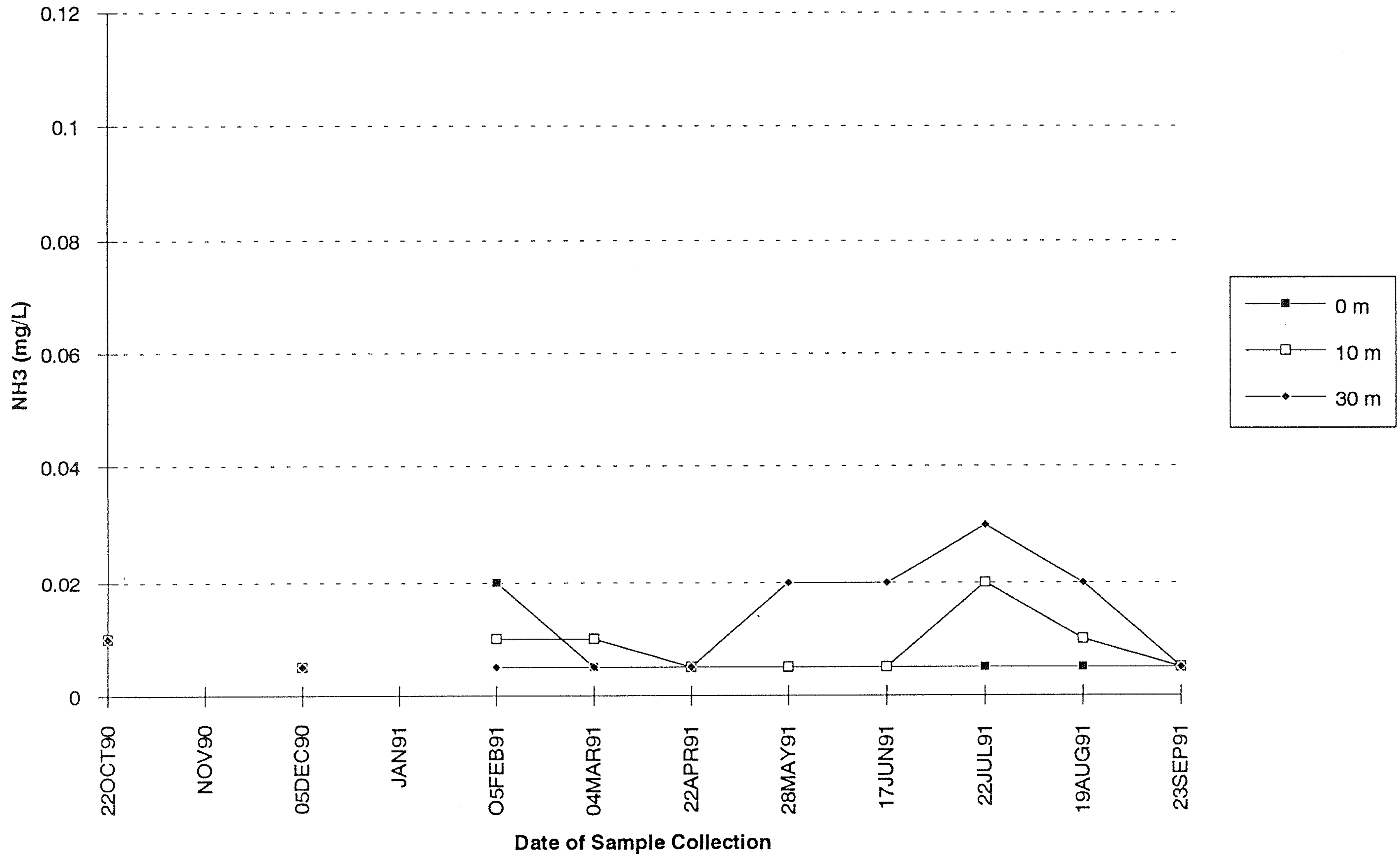
Station DIS001: Dissolved NH3 (mg/L) for Wateryear 1991



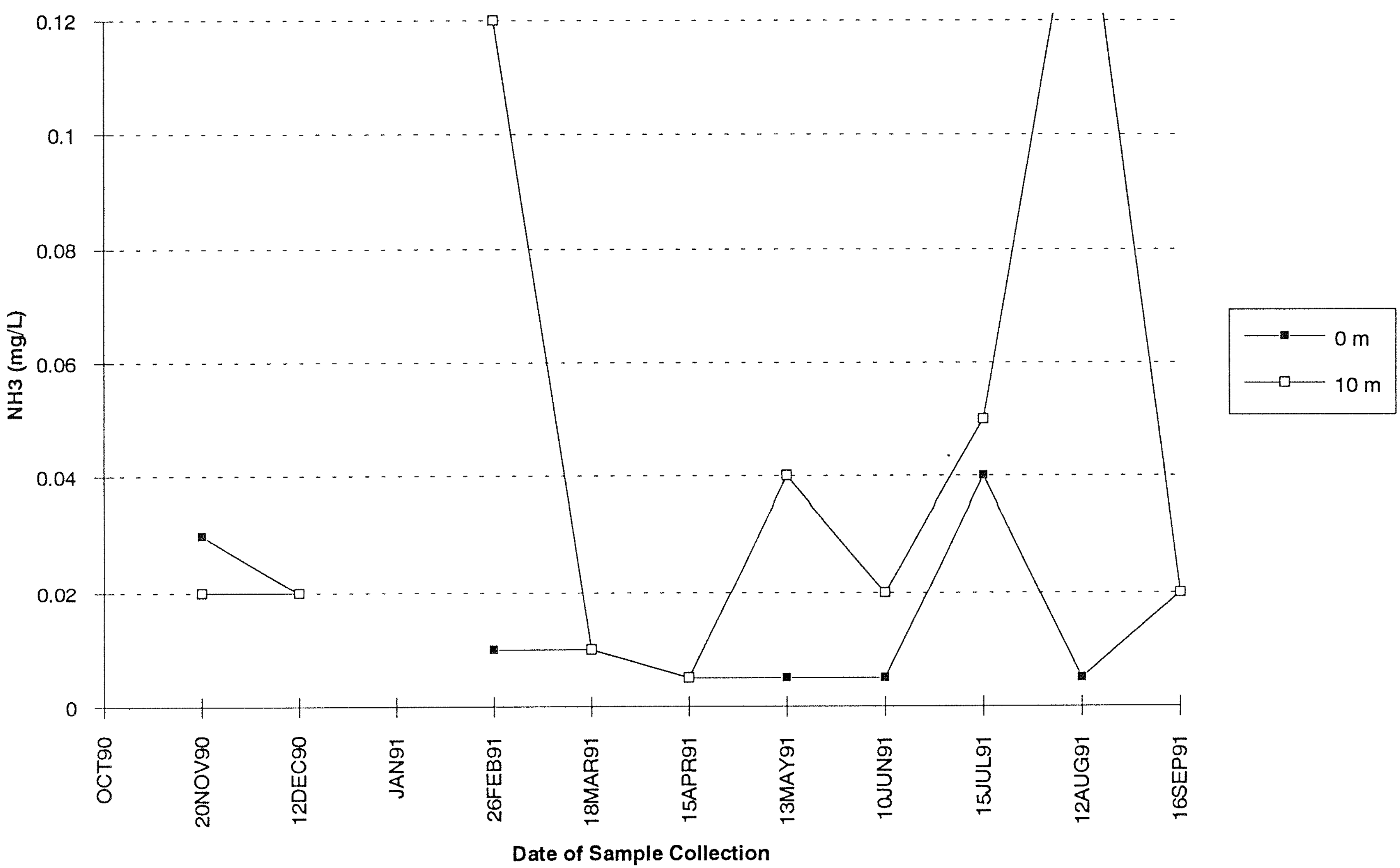


Station DNA001: Dissolved NH3 (mg/L) for Wateryear 1991
0.12
0.1
0.08
0.06
0.04
0.02
0
NH3 (mg/L)
0 m
10 m
30 m
08OCT90
12NOV90
11DEC90
08JAN91
11FEB91
11MAR91
08APR91
06MAY91
04JUN91
08JUL91
05AUG91
09SEP91
Date of Sample Collection

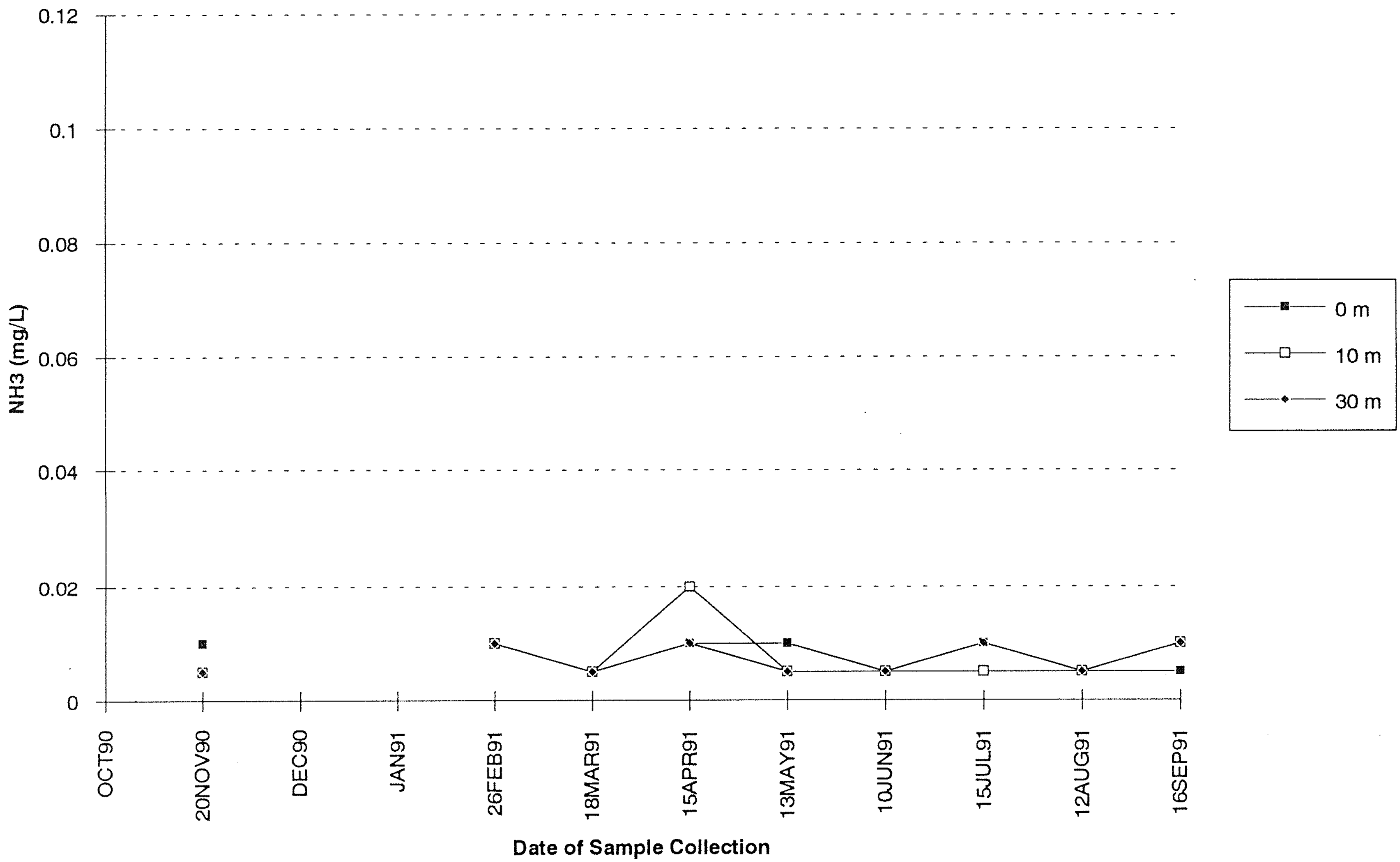
Station EAP001: Dissolved NH3 (mg/L) for Wateryear 1991



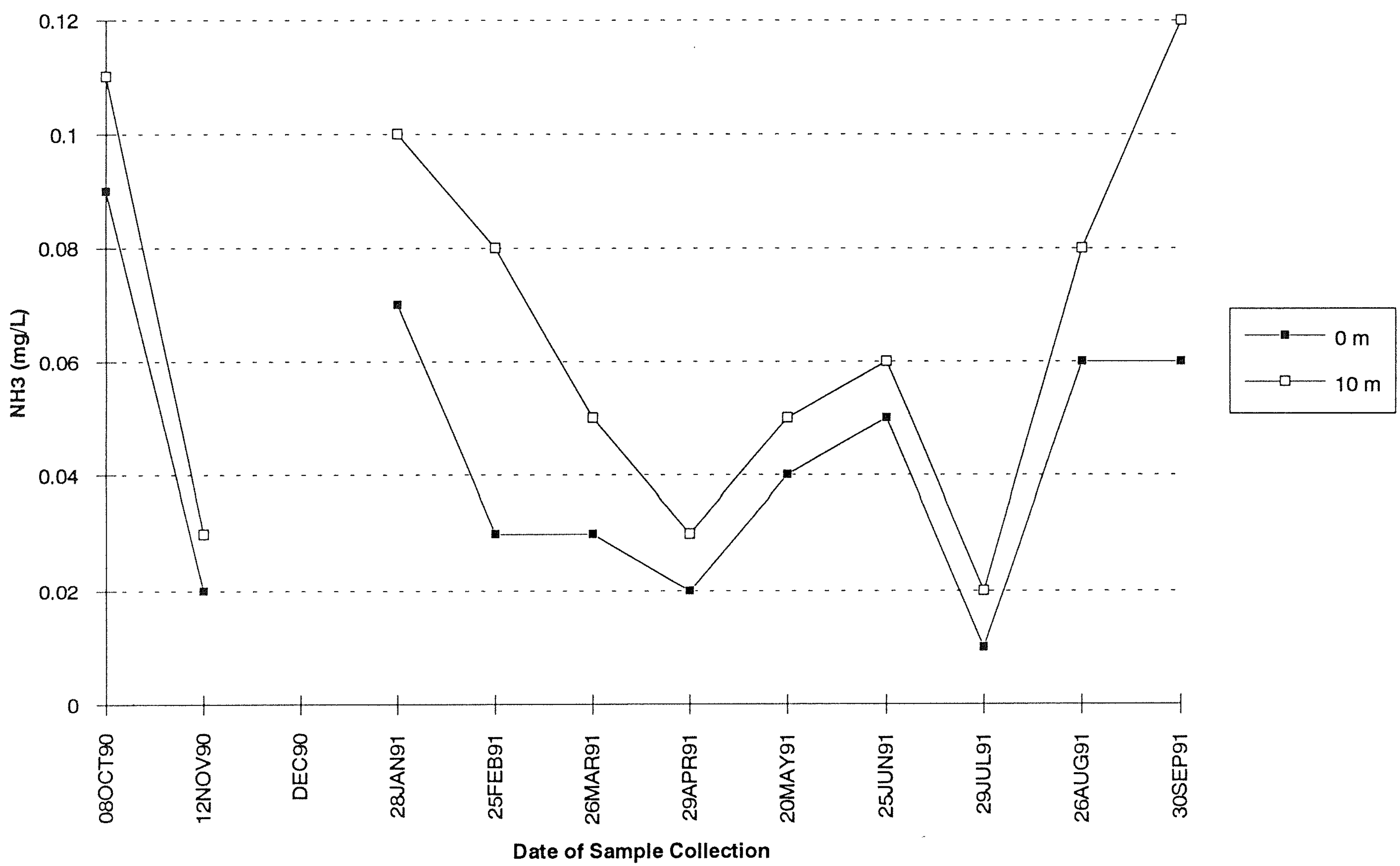
Station EAS001: Dissolved NH3 (mg/L) for Wateryear 1991



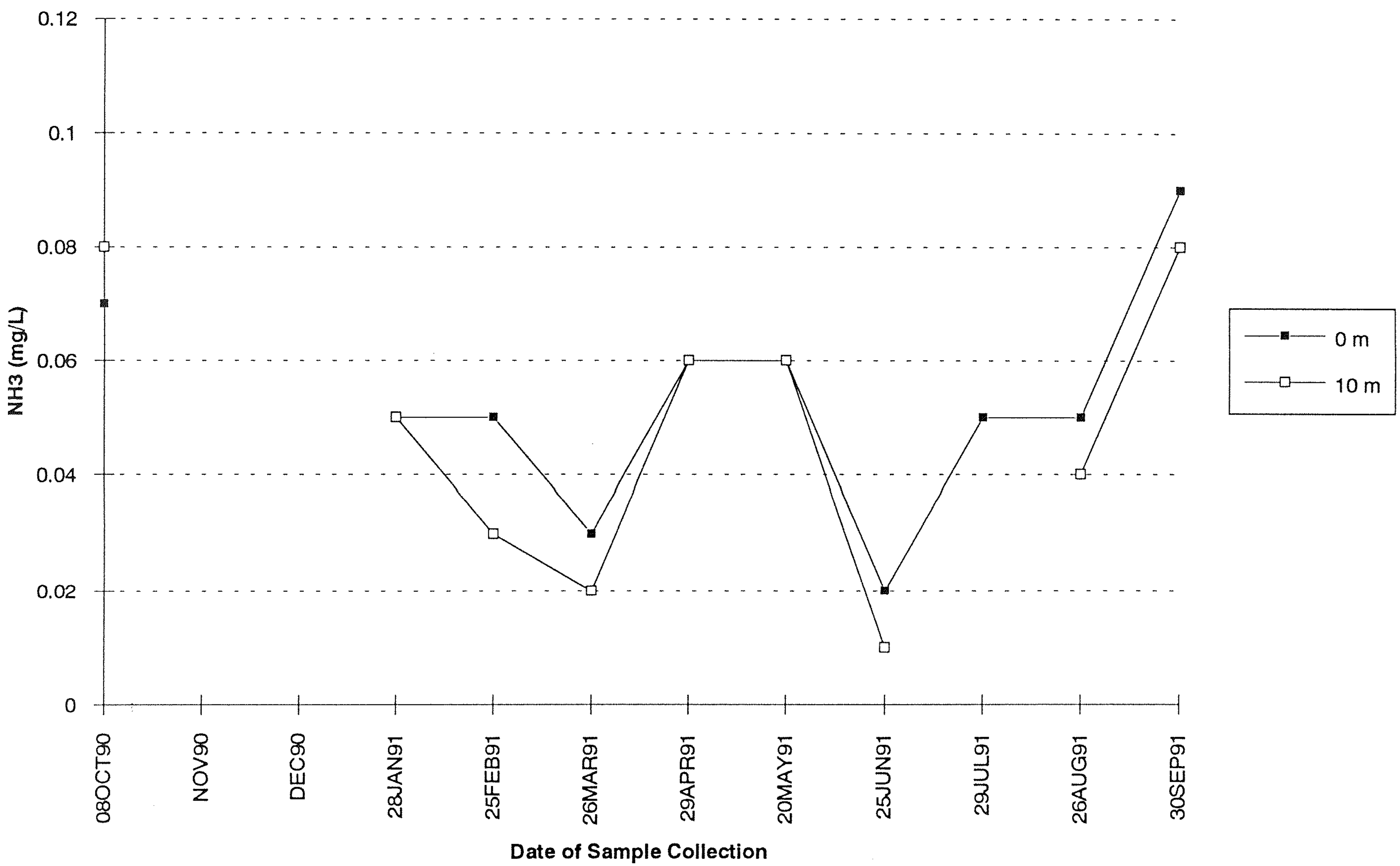
Station GRG002: Dissolved NH3 (mg/L) for Wateryear 1991

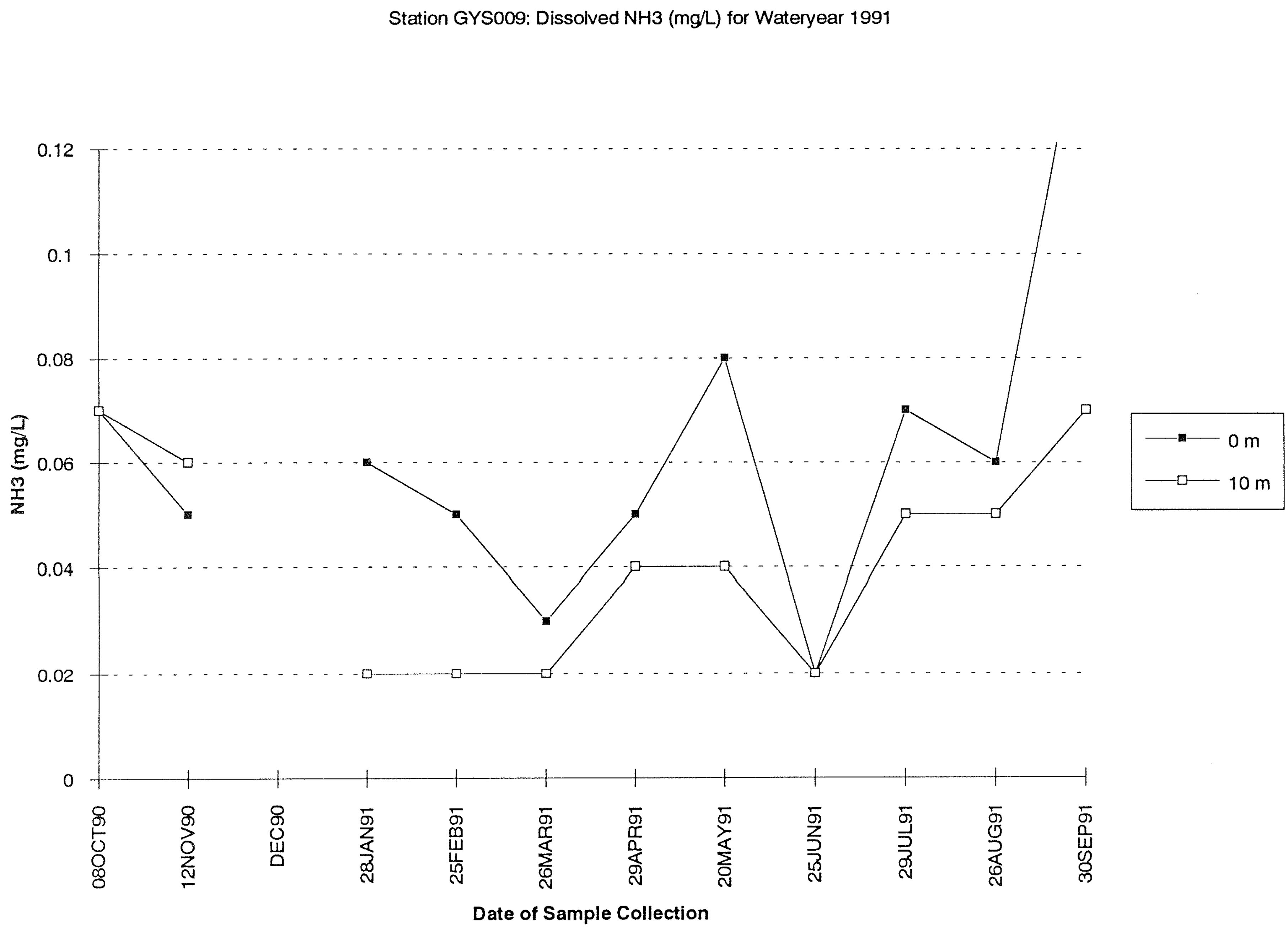


Station GYS004: Dissolved NH3 (mg/L) for Wateryear 1991

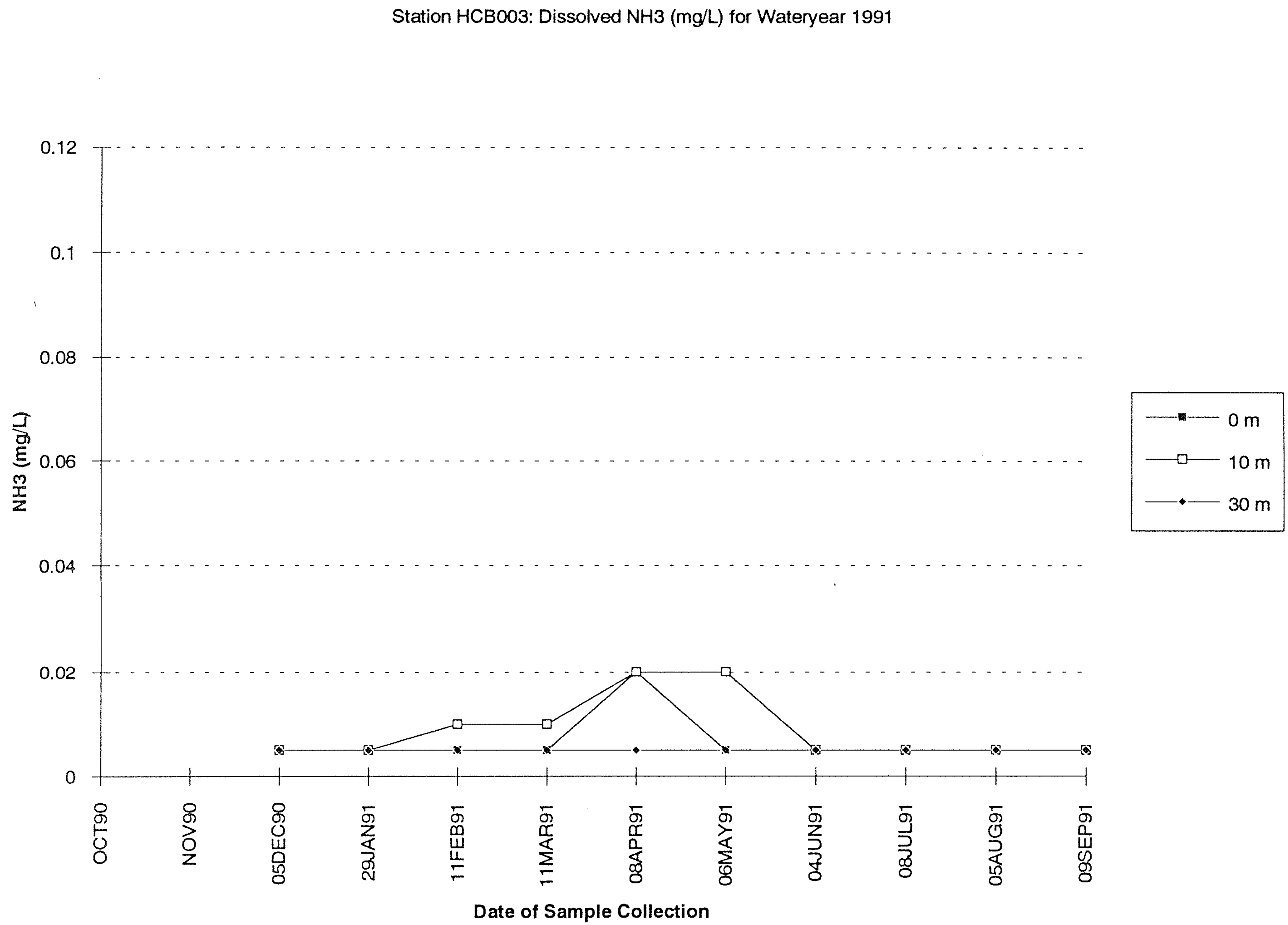


Station GYS008: Dissolved NH3 (mg/L) for Wateryear 1991

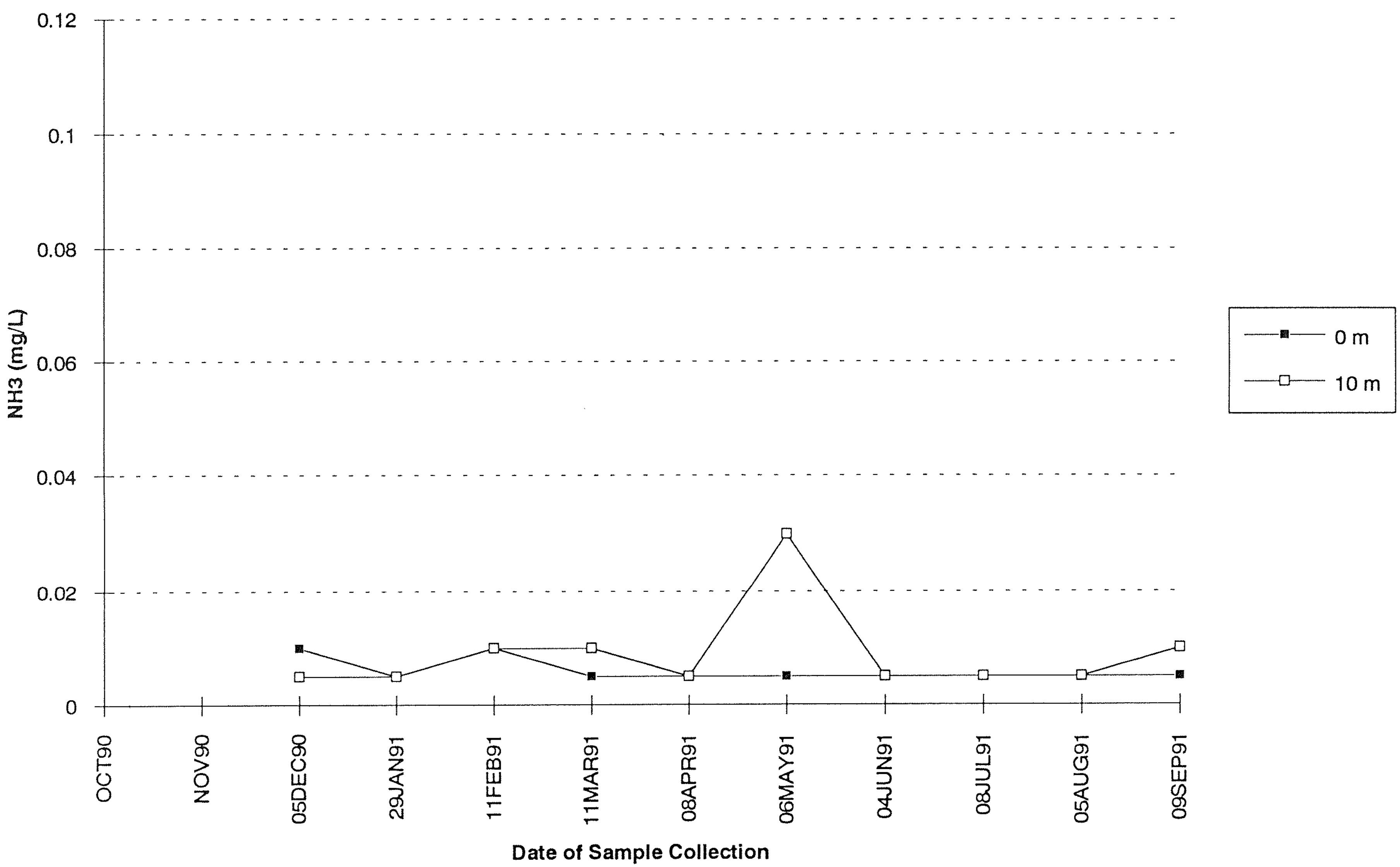


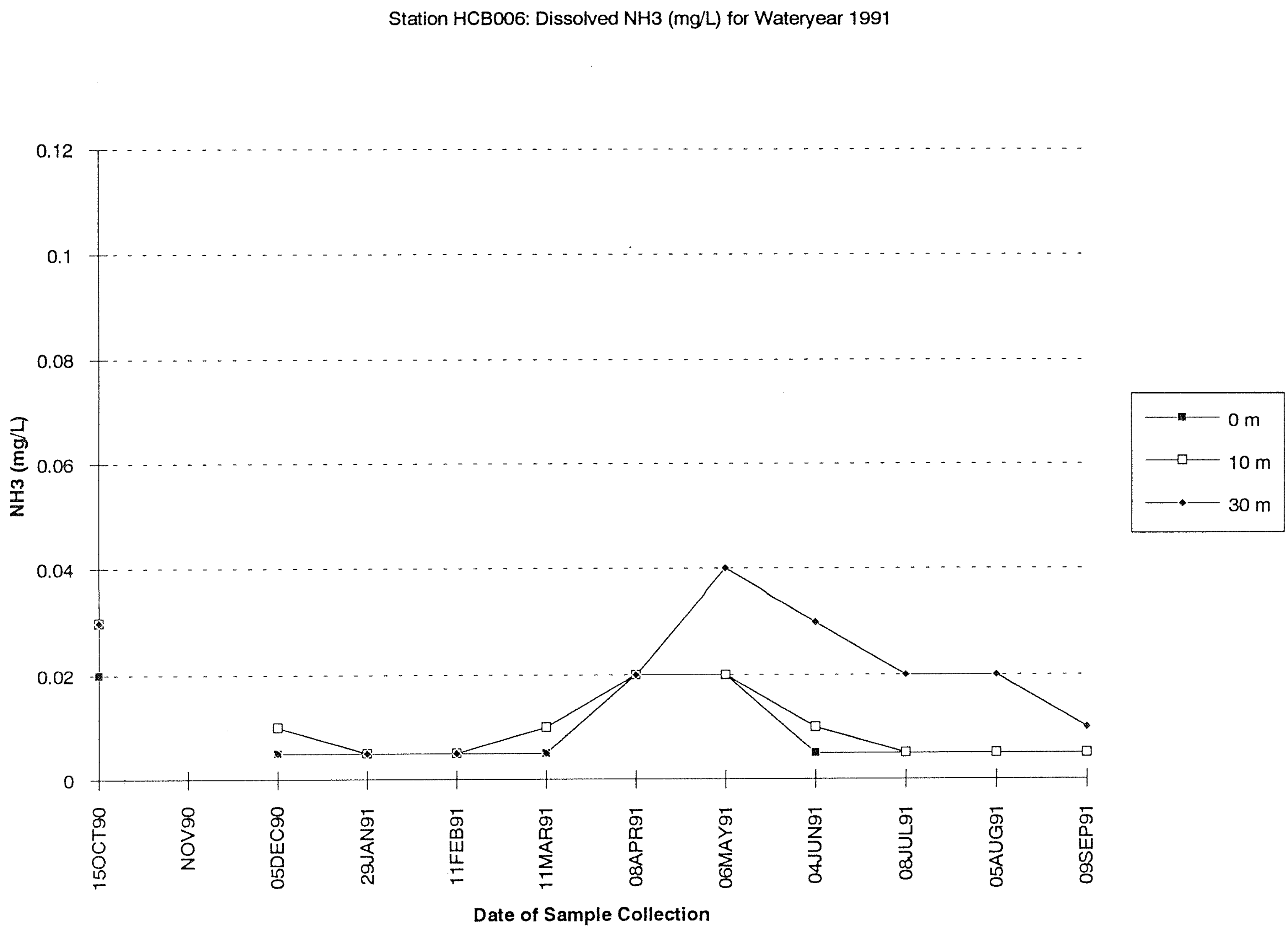


Station GYS009: Dissolved NH3 (mg/L) for Wateryear 1991
0.12
0.1
0.08
0.06
0.04
0.02
0
NH3 (mg/L)
08OCT90
12NOV90
DEC90
28JAN91
25FEB91
26MAR91
29APR91
20MAY91
25JUN91
29JUL91
26AUG91
30SEP91
Date of Sample Collection
0 m
10 m

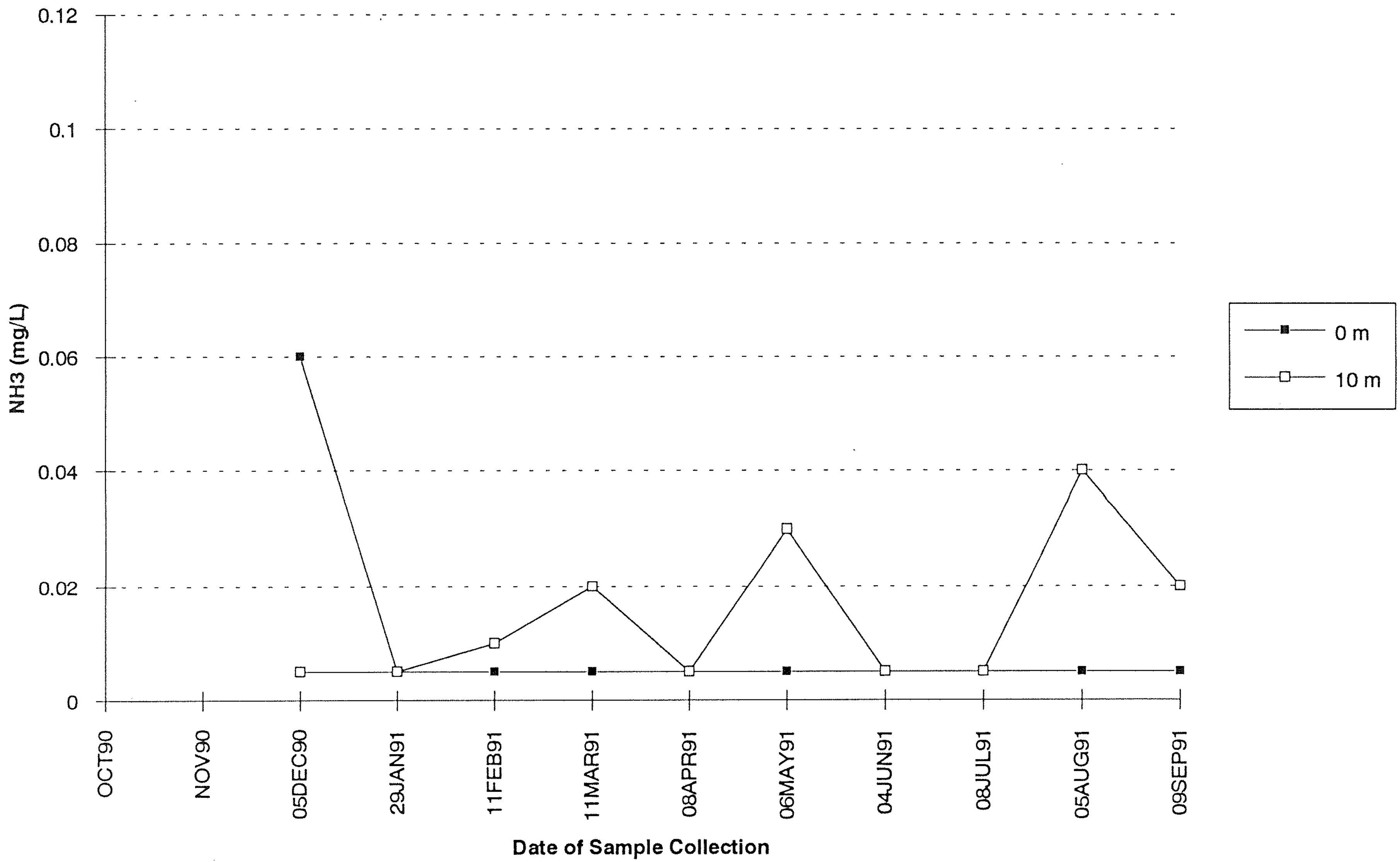

Station HCB003: Dissolved NH3 (mg/L) for Wateryear 1991
NH3 (mg/L)
0.12
0.1
0.08
0.06
0.04
0.02
0
OCT90
NOV90
05DEC90
29JAN91
11FEB91
11MAR91
08APR91
06MAY91
04JUN91
08JUL91
05AUG91
09SEP91
Date of Sample Collection
0 m
10 m
30 m

Station HCB004: Dissolved NH3 (mg/L) for Wateryear 1991

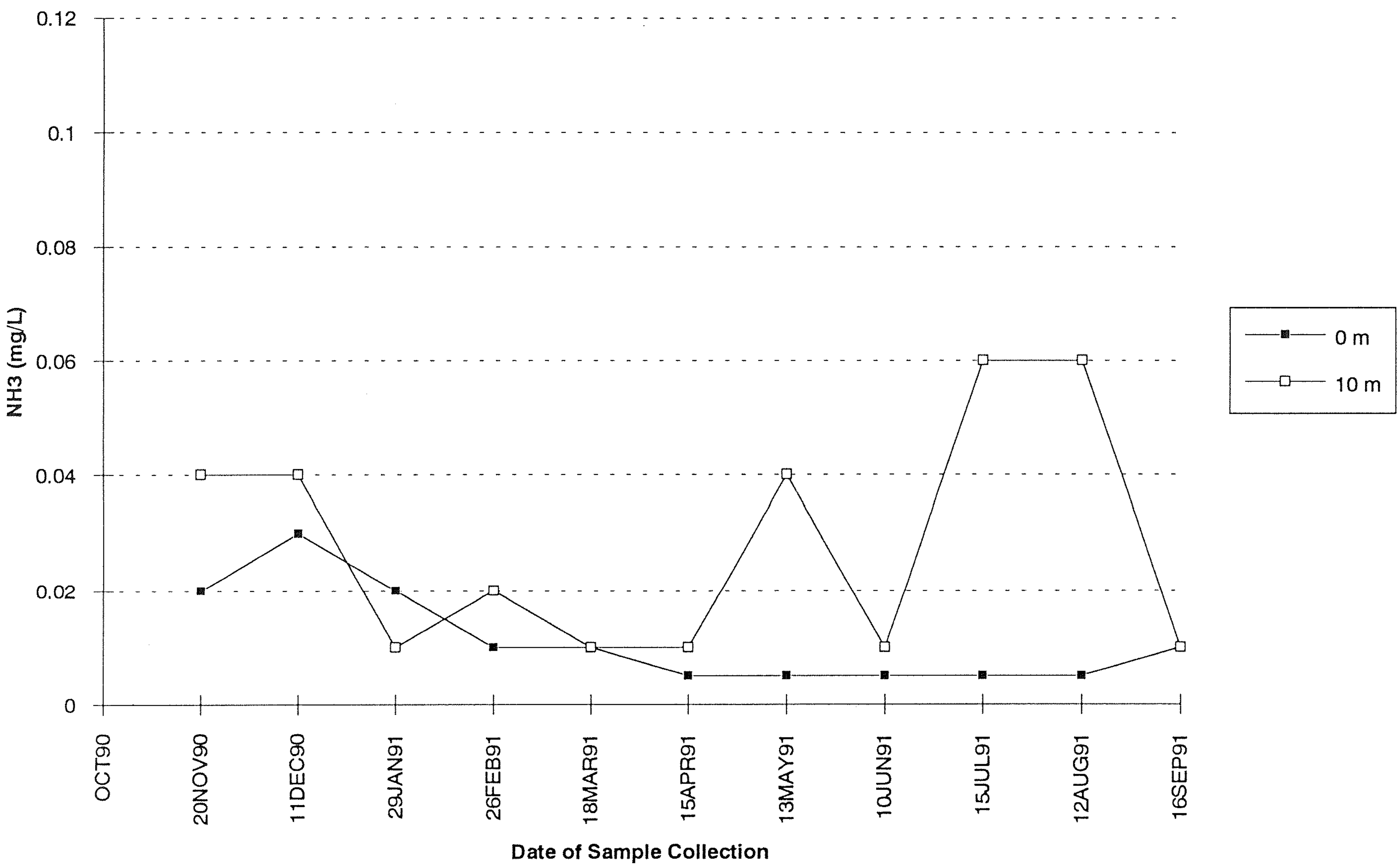



Station HCB006: Dissolved NH3 (mg/L) for Wateryear 1991
NH3 (mg/L)
0.12
0.1
0.08
0.06
0.04
0.02
0
15OCT90
NOV90
05DEC90
29JAN91
11FEB91
11MAR91
08APR91
06MAY91
04JUN91
08JUL91
05AUG91
09SEP91
Date of Sample Collection
0 m
10 m
30 m

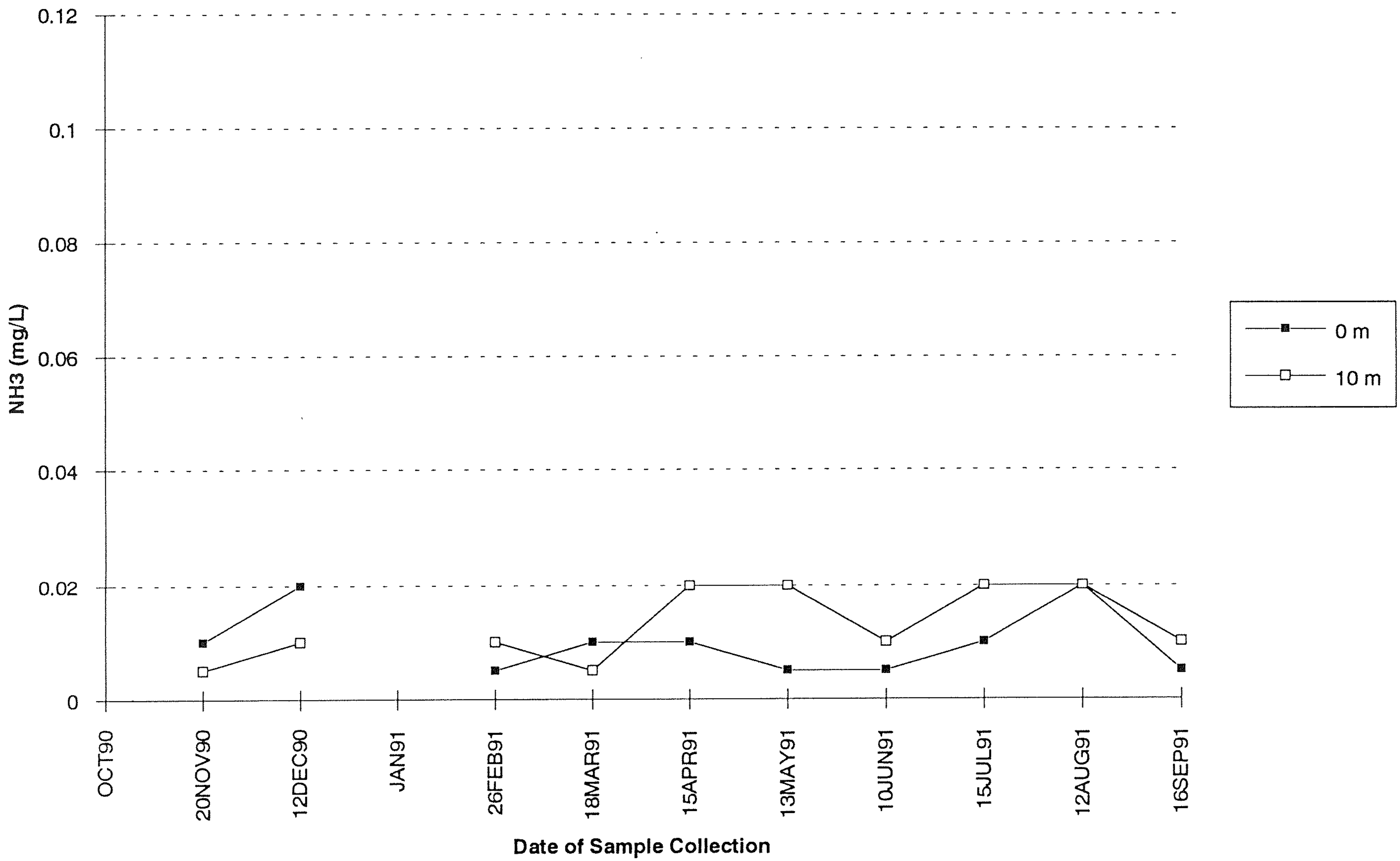
Station HCB007: Dissolved NH3 (mg/L) for Wateryear 1991



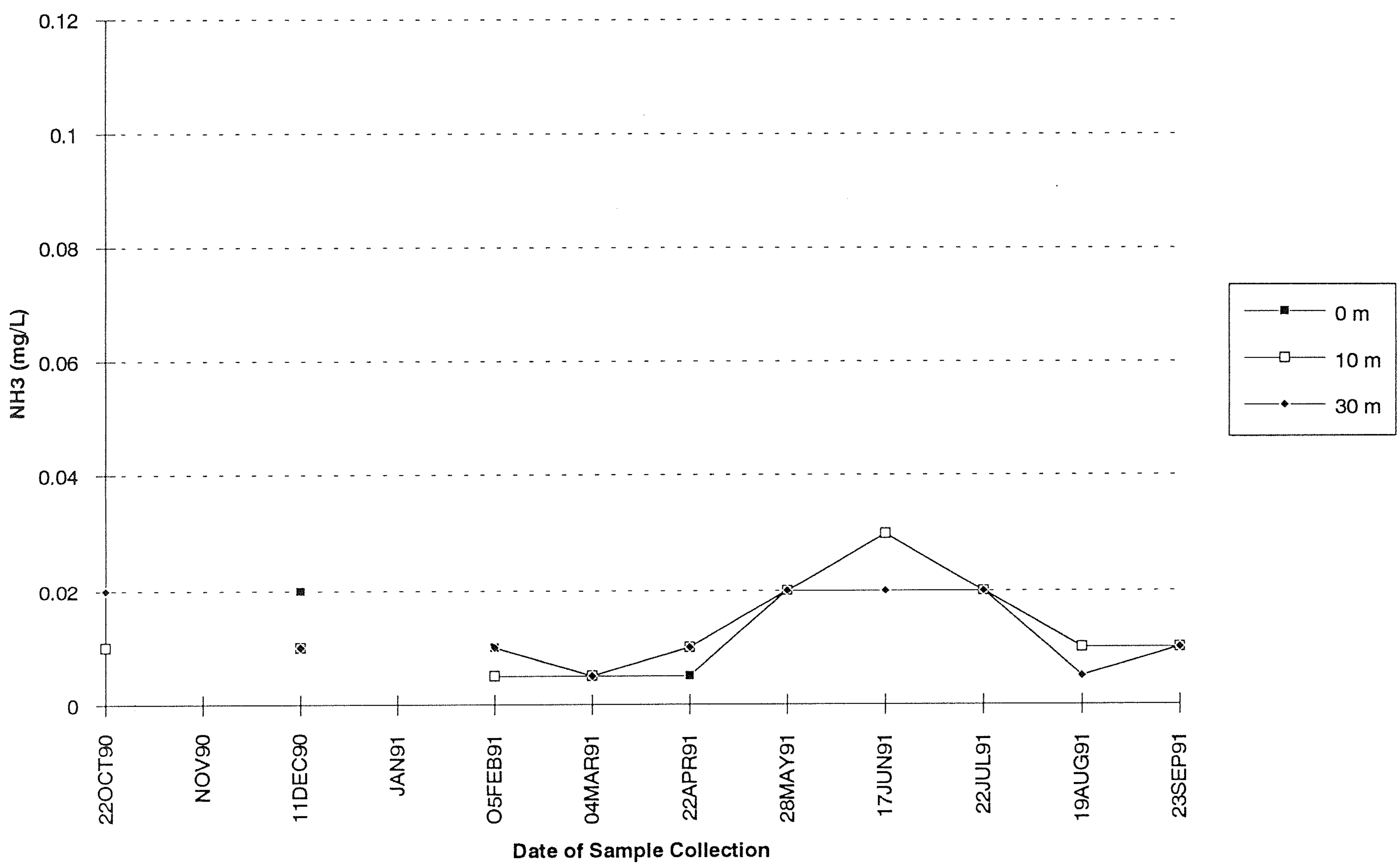
Station JDF005: Dissolved NH3 (mg/L) for Wateryear 1991



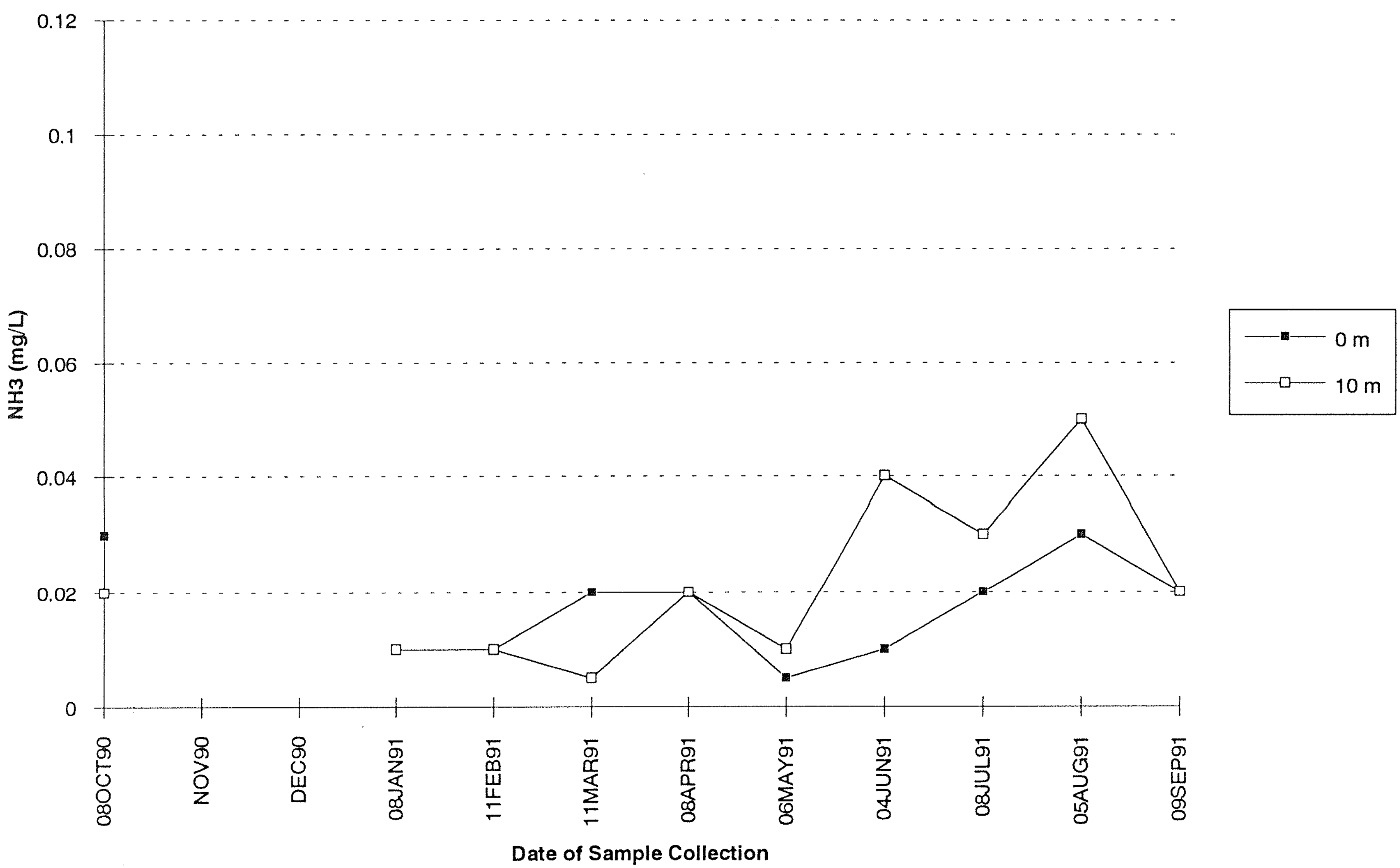
Station LOP001: Dissolved NH3 (mg/L) for Wateryear 1991



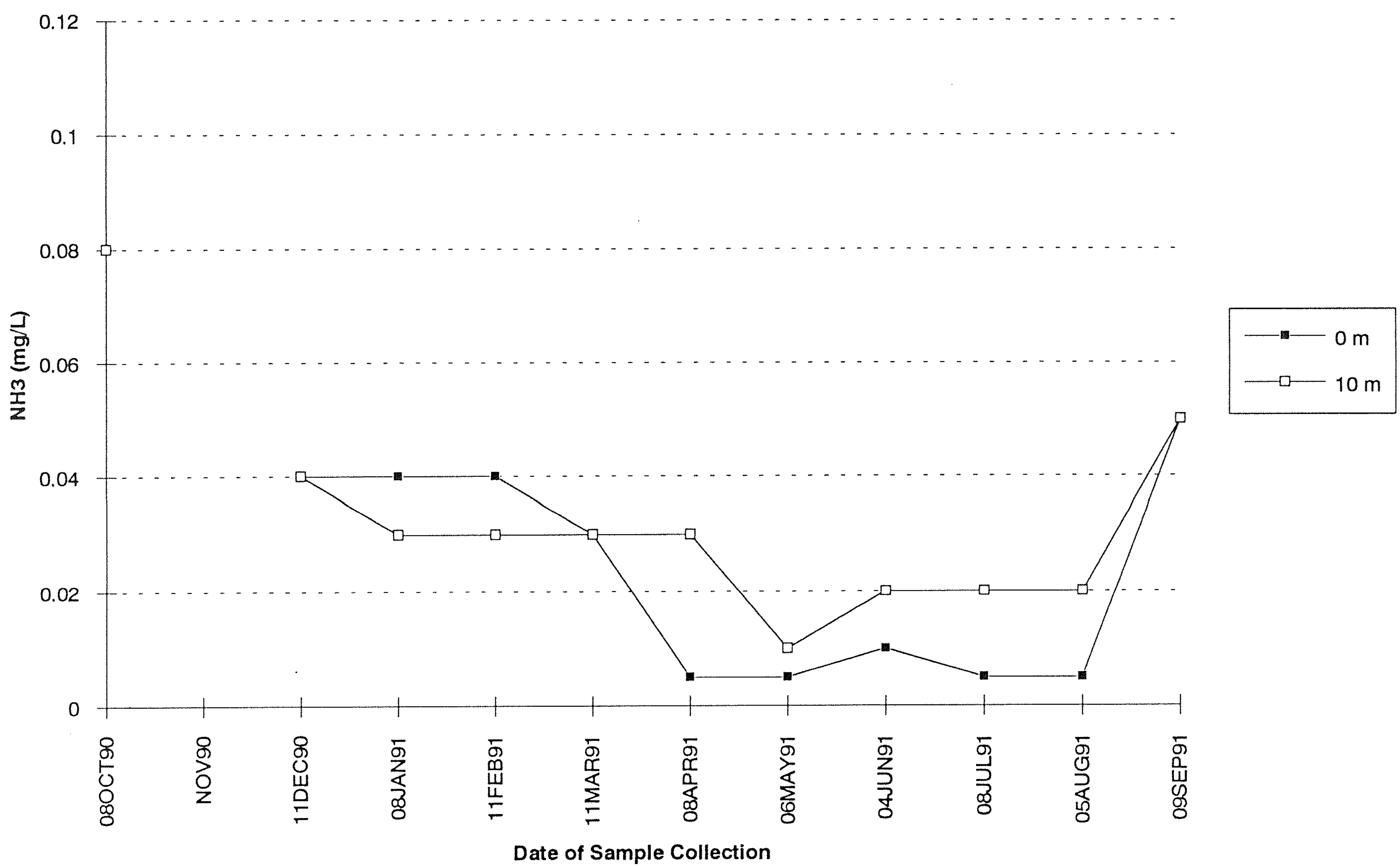
Station NRR001: Dissolved NH3 (mg/L) for Wateryear 1991

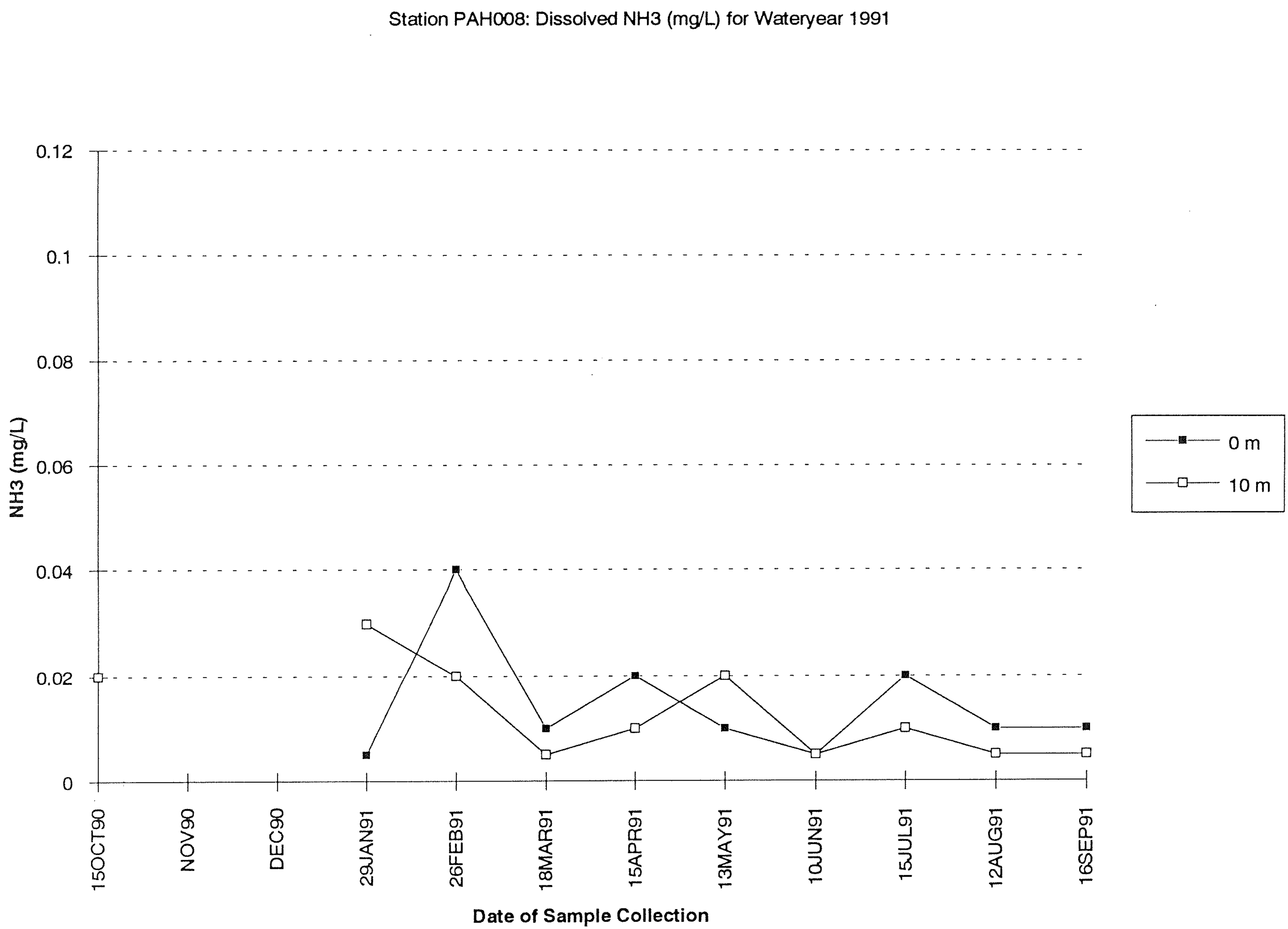


Station NSQ001: Dissolved NH3 (mg/L) for Wateryear 1991

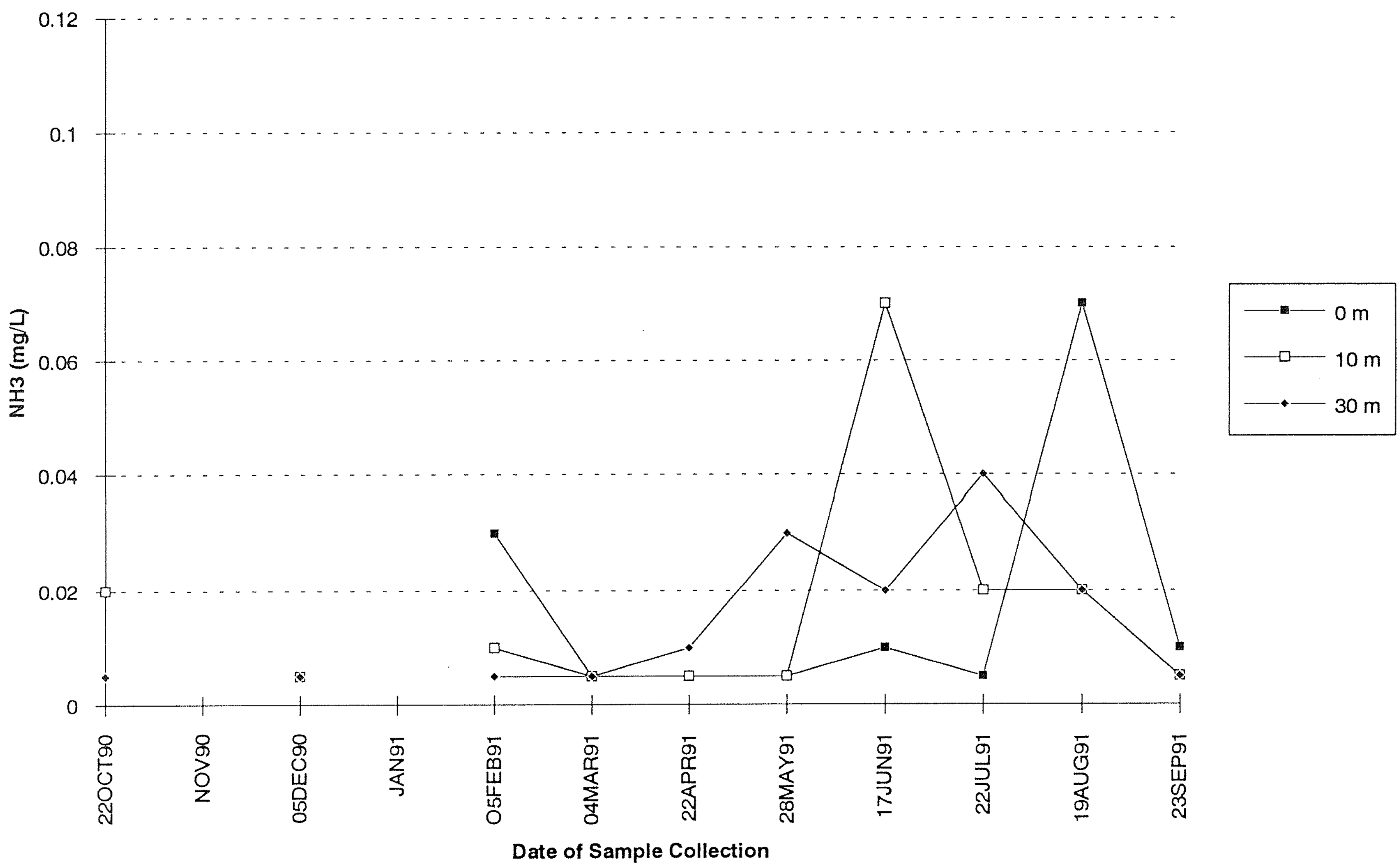


Station OAK004: Dissolved NH3 (mg/L) for Wateryear 1991

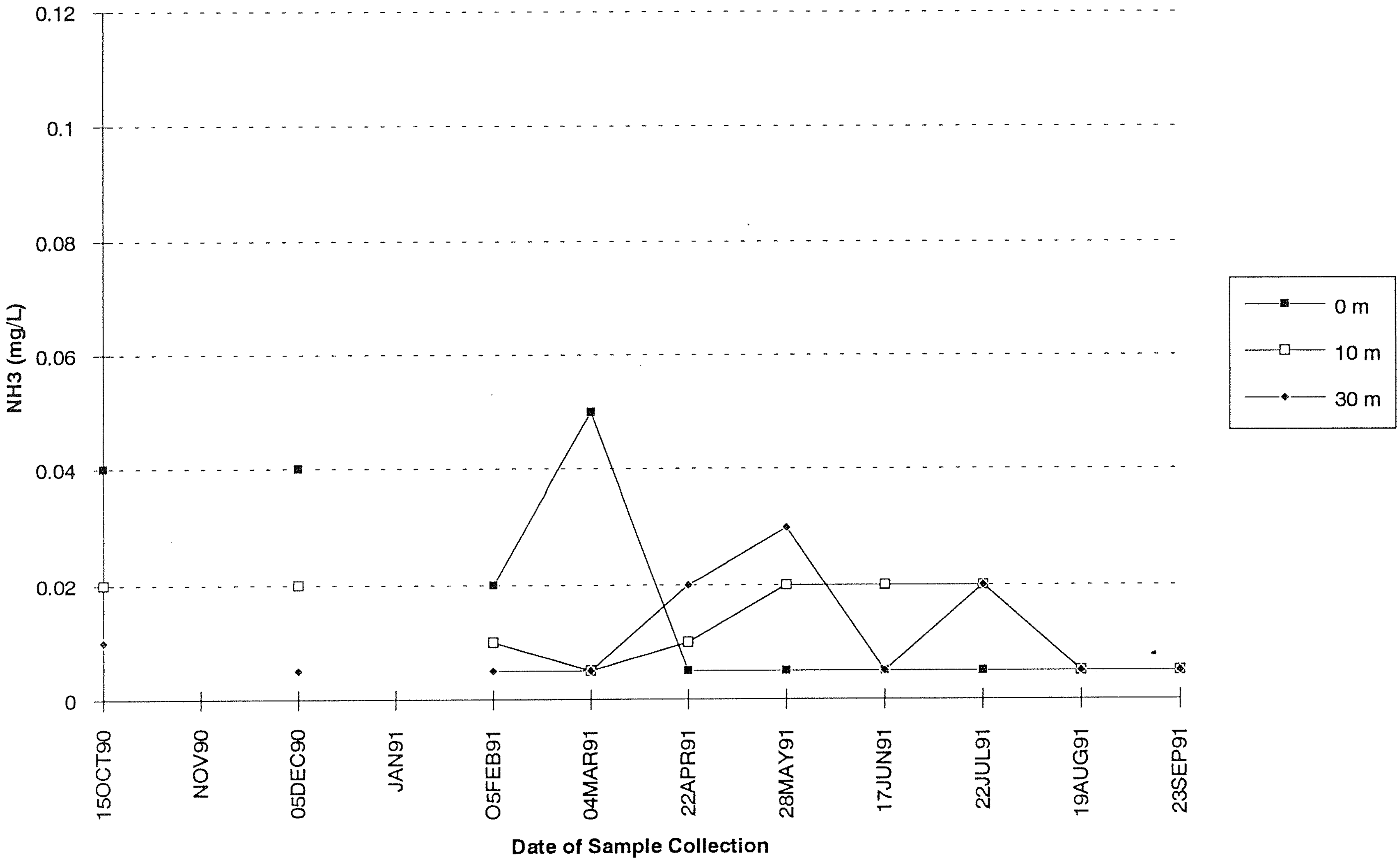



Station PAH008: Dissolved NH3 (mg/L) for Wateryear 1991
NH3 (mg/L)
0.12
0.1
0.08
0.06
0.04
0.02
0
15OCT90
NOV90
DEC90
29JAN91
26FEB91
18MAR91
15APR91
13MAY91
10JUN91
15JUL91
12AUG91
16SEP91
Date of Sample Collection
0 m
10 m

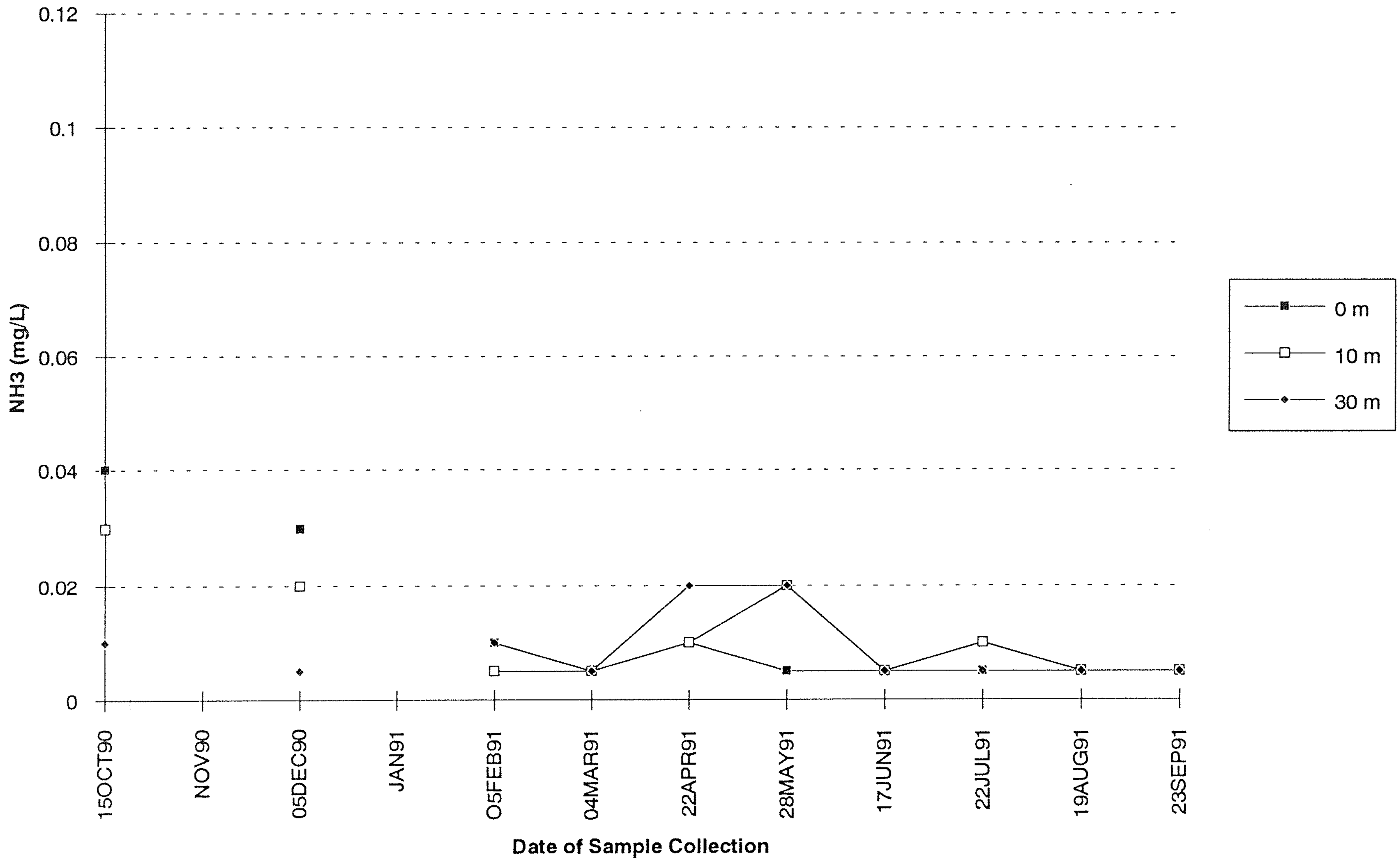
Station PSB003: Dissolved NH3 (mg/L) for Wateryear 1991



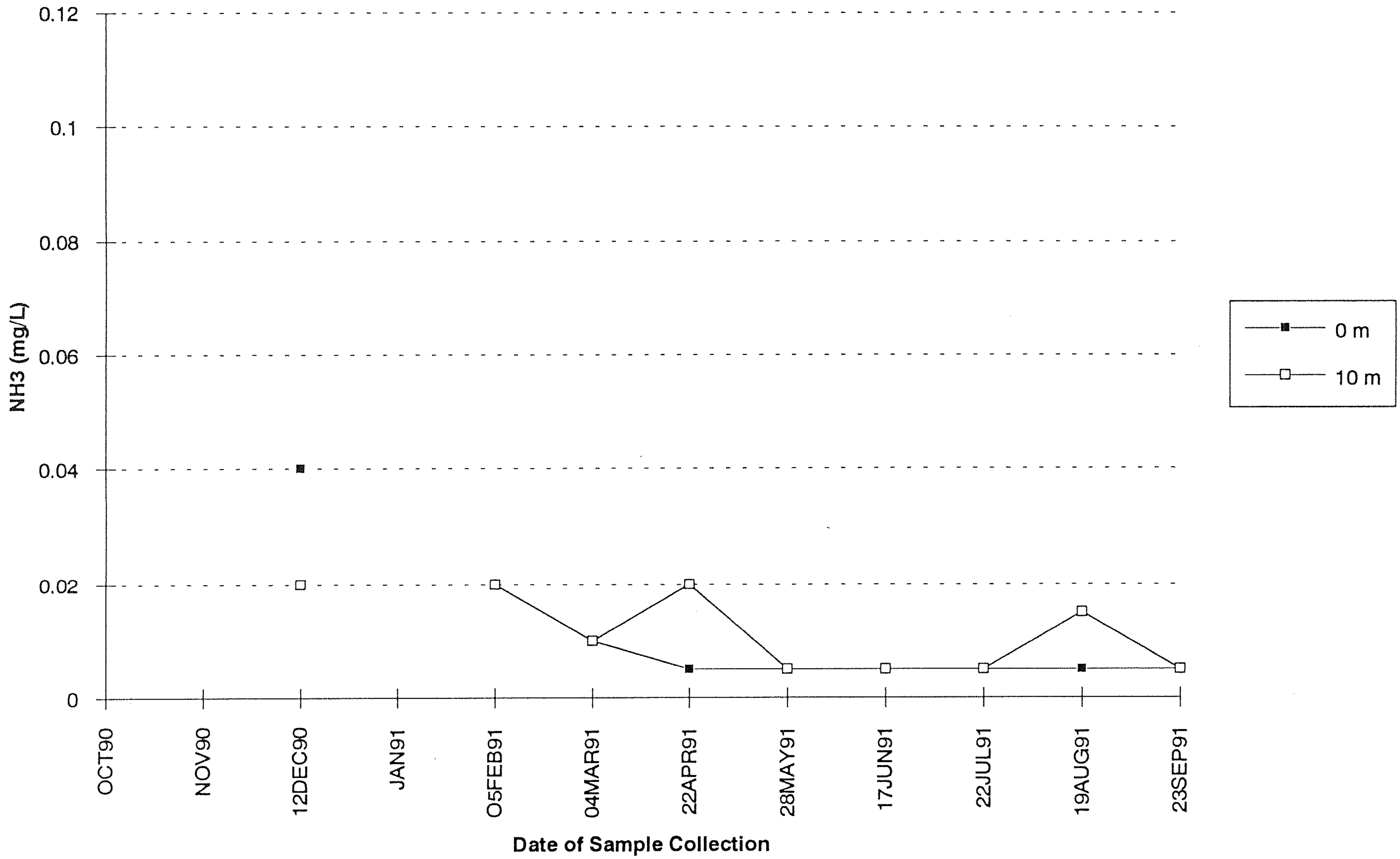
Station PSS019: Dissolved NH3 (mg/L) for Wateryear 1991



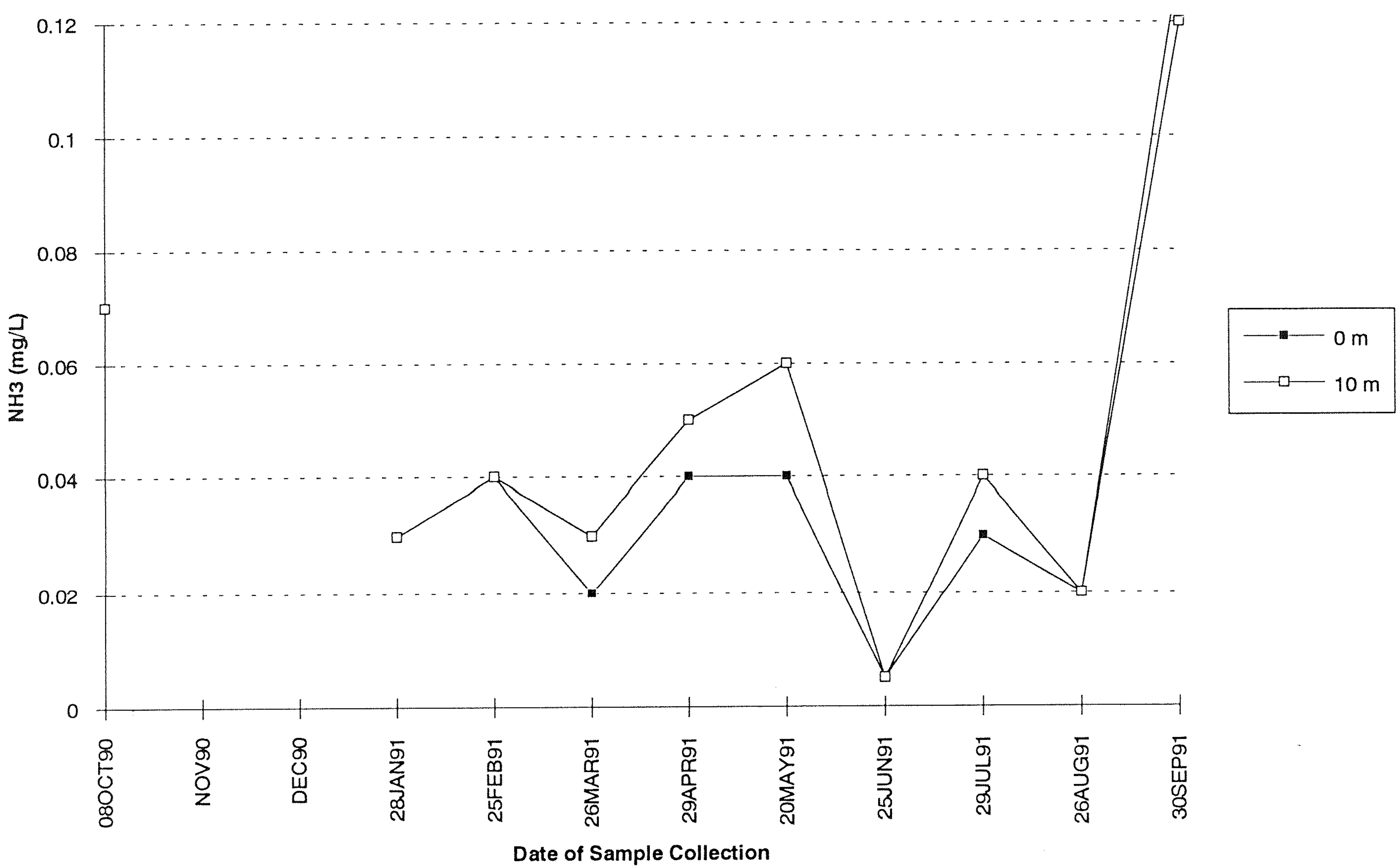
Station SAR003: Dissolved NH3 (mg/L) for Wateryear 1991



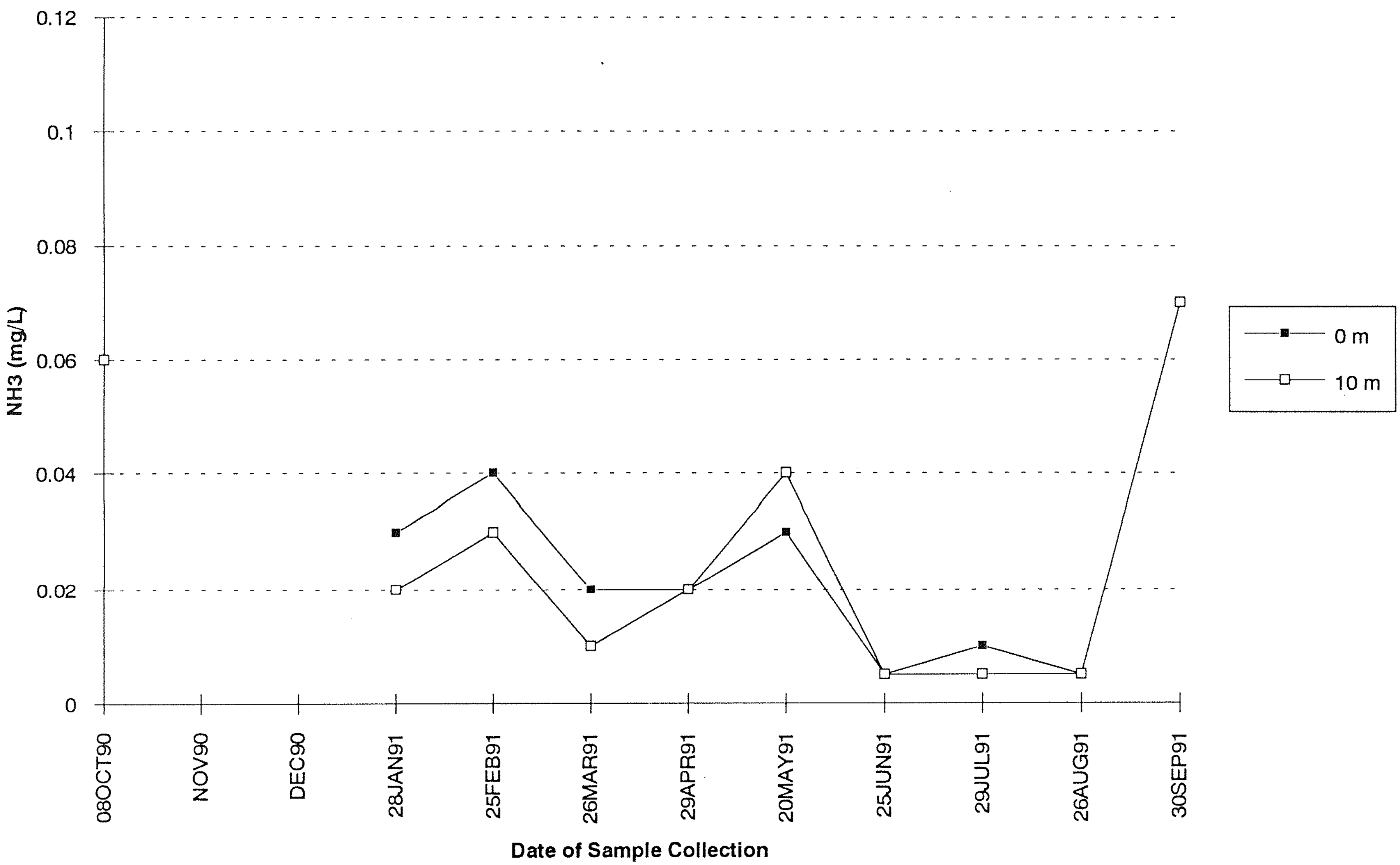
Station SKG003: Dissolved NH3 (mg/L) for Wateryear 1991



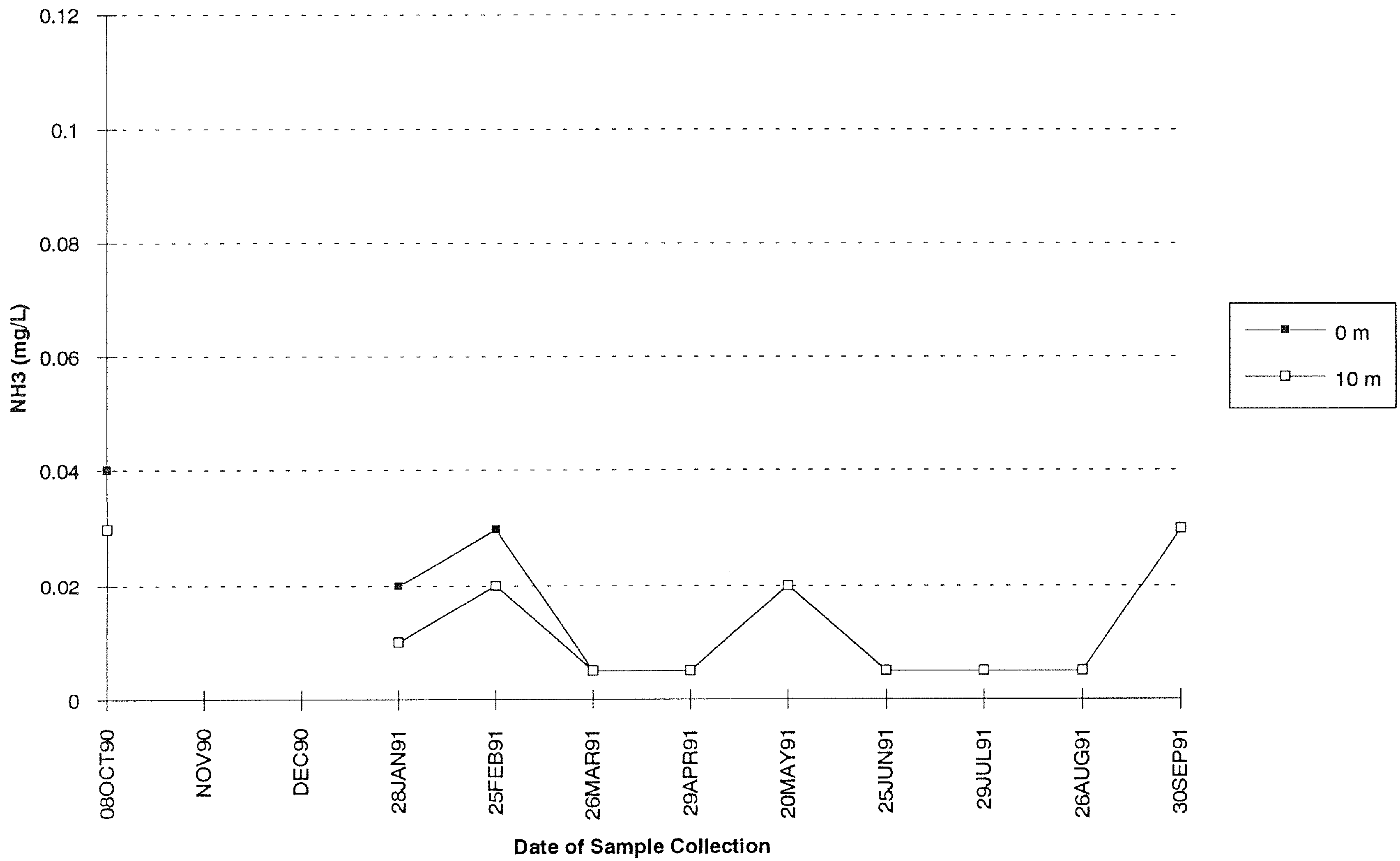
Station WPA001: Dissolved NH3 (mg/L) for Wateryear 1991



Station WPA003: Dissolved NH3 (mg/L) for Wateryear 1991



Station WPA004: Dissolved NH3 (mg/L) for Wateryear 1991



APPENDIX H

1990-1991 QUALITY ASSURANCE/QUALITY CONTROL ASSESSMENT MARINE WATER COLUMN MONITORING PROGRAM: FINAL REPORT

1990-1991 QUALITY ASSURANCE/QUALITY CONTROL ASSESSMENT
MARINE WATER COLUMN MONITORING PROGRAM

by
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October 1992

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INTRODUCTION

Beginning in January 1990, the Ambient Marine Water Column Monitoring Program initiated a field quality assurance/quality control (QA/QC) program. One station was selected randomly for each marine survey conducted (three surveys per month). At the selected QA station, a bottle cast was conducted and the samples were collected in duplicate (the bottle cast was split) for nutrient and chlorophyll *a* analysis. Fecal coliform bacteria samples were collected from two separate grabs, thus, were not split samples. The duplicate (split) samples were labeled as a station sample (STATION-DEPTH) and as a QA blind sample (QAMF#). The purpose of this initial QA sampling approach was to measure sampling and laboratory variability. Stations were randomly selected to cover the range of parameter concentrations seen throughout the station network.

In November 1990, the QA sampling procedure changed slightly. QA stations continued to be selected randomly for each survey; however, rather than splitting the bottle cast sample, three separate bottle casts were conducted, and a set of QA samples were collected from each individual cast. The first cast samples were labeled as station samples (STATION-DEPTH). The second cast samples were labeled as blind QA samples (QAMF#a.), as were the third cast samples (QAMF#b.). Fecal coliform bacteria samples were collected, as before, in duplicate from two separate grabs. The purpose of this sampling approach was to better measure variability encountered in the field.

Meanwhile, Manchester Laboratory, where most of the samples are analyzed for this program, was conducting routine laboratory QA procedures on the sample batches received. This included running sample splits (splitting the chosen sample and running the analysis separately, including filtering procedures), as well as analyzing blanks, spikes, and standard solutions of known concentrations. This routine measures laboratory variability and monitors equipment performance.

An evaluation of the results from the marine water column QA/QC program are summarized and tabulated. One purpose of this evaluation is to help determine whether or not detection limits for the parameters analyzed are adequate. Another is to help determine which water quality parameters are yielding useful information, and which parameters are too variable or low in concentration to be informative. Conclusions and recommendations are included.

METHODS

A QA/QC evaluation was conducted on field split samples collected from January 1990 to September 1990, on field replicate samples collected from October 1990 to September 1991, and on laboratory split samples collected from October 1990 to September 1991. Field split samples were taken at the same station, time, and depth with one bottle cast and were split into two separate containers in the field. Field replicates were sampled at the same station, time, and depth, but were taken with three separate bottle casts. Laboratory split samples (often termed laboratory duplicates) were from the same station, time, depth, cast, and container but were split at the laboratory and analyzed as two separate samples. (A completely separate laboratory analysis was conducted on each split sample.) Figure 1 displays a graphical representation of the three types of QA sampling schemes.

Field split and field replicate samples demonstrate variations due to a combination of field and laboratory variability. Laboratory split sample variances are due solely to laboratory variability.

In addition to laboratory split sample analysis, the results of laboratory check standards, spiked samples, and blanks analyzed from October 1990 to September 1991 were also evaluated. Below detection limit (BDL) data for all parameters (excluding fecal coliform) were not included in the QA/QC evaluation. Contract lab data were evaluated separately.

The parameters evaluated for all QA sample types include fecal coliform bacteria (#/100mL), chlorophyll *a* (mg/m^3 or micrograms/L), phaeopigment *a* (mg/m^3), dissolved orthophosphorous ($O\text{-}PO_4$, mg/L), dissolved ammonia (NH_3, mg/L), and dissolved nitrite-nitrate ($NO_2\text{-}NO_3$, mg/L). The QA/QC for dissolved nitrite (NO_2, mg/L) could not be accurately evaluated since 94 percent of the data lie below detection limits.

Sample mean, standard deviation, and relative standard deviation (RSD, coefficient of variance) were determined for all field split, field replicate and laboratory split samples. A combined (pooled) standard deviation was calculated for each parameter for field split (excluding fecal coliform), field replicate, and laboratory split samples.

Standard deviation(s) was calculated with the equation:

$$s=\sqrt{\sum (x_i-\bar{x})^2/(n-1)}$$

where x_i = the ith result
$\bar{x}$ = arithmetic mean of n results
n = number of data points

Note: In the above equation, n-1 is used instead of n since the sample (not the population) standard deviation was calculated.

Relative standard deviation (RSD) was calculated with the equation:

RSD = $100\ s/\bar{x}$

RSD was calculated instead of Relative Percent Difference (RPD). (RPD = $100\ D/\bar{x}$, where D = the absolute difference between a pair of results.) There were a total of three field replicate results for a specific station, time and depth; therefore, the RSD calculation was used (since the RPD calculation only applies to pairs of results). The RSD calculation was used for all results in order to directly compare the variability between field replicate, field split, and laboratory split samples. The RSD statistic (unlike the RPD) can also be directly related to the normal distribution curve (Stew Lombard, Personal Communication, January 1991).

For this assessment, combined (pooled) standard deviation was calculated with the equation:

$$s(pooled)=\sqrt{(\sum v_i s_i^2)/\sum v_i}$$

where v_i = the number degrees of freedom (N-1) of the ith estimate of s.
s_i = the individual sample standard deviation.

The pooled standard deviation for both triplicate and duplicate results were calculated with the above equation; however, in the future, a simplified equation will be used for pairs of results (see below).

$$s(pooled)forduplicates=\sqrt{\sum D_i^2/2m}$$

where D_i = the absolute difference between the ith pair of results.
m = the number of pairs of duplicate results.

RESULTS

Precision

Table 1 shows the percent of the data that falls within various RSD ranges. The objective RSD ranges based on the Ambient Marine Water Column Monitoring Plan (Janzen, 1992) are shaded. Table 2 shows the pooled standard deviation for each parameter. The results in both tables provide an estimate of the precision between field replicate, field split, and laboratory split samples for each parameter, as well as an estimate of the precision between individual parameters. For all parameters, laboratory split sample results seem to be more precise than field replicate results. Field split sample results generally are less precise than laboratory split sample results due to variations in sample handling and in water uniformity within the water bottle. Nutrient field split sample results indicate better precision than the results for field replicates due to additional variability in the sampling process (time separation between samples) and in the water column itself. However, for chlorophyll and phaeopigment, field split sample results are less precise than field replicate results. This difference in precision may be due to the fact that the fluorometric chlorophyll method was new at the time field split samples were being collected; thus, the lower precision is likely due to the fact that laboratory procedures were still in the refinement stage.

The QA/QC objectives for the marine ambient monitoring program are ±10% RSD for all nutrients, and ±20% RSD for fecal coliform bacteria, chlorophyll *a*, and phaeopigment (Janzen, 1990). The precision of laboratory split samples for all parameters, for the most part (78-99% of the data, depending on the parameter), is within the objective RSD range. Field replication results are less precise (Table 1). For fecal coliform bacteria, 58-60% of the field replicate data have an RSD within ±20%. For chlorophyll *a* and phaeopigments, 71% of the field replicate data have an RSD within ±20%. For O-PO_4, NH_3, and NO_2-NO_3, respectively, 77%, 57%, and 83% of the field replicate data have an RSD within ±10%. Nutrient data values closer to detection limits appear to be less precise. Nutrient field split sample precision is generally acceptable (79-100% of data are within the objective RSD range); however, chlorophyll *a* and phaeopigments have high field split sample variability, as mentioned above. The NO_2-NO_3 data have the best precision and fecal coliform bacteria data have the poorest precision of all parameters, both in field replicate and laboratory split samples.

Below Detection Limit Data

Table 3 shows the percent of data for each parameter from Wateryear 1991 (October 1990-September 1991) that falls below detection limits.

Fecal Coliform Bacteria

Fecal coliform bacteria counts were determined with the membrane filtration (MF) method. Table 4 shows the Wateryear 1991 stations that had fecal coliform counts above the criterion level of 14 organisms/100 mL and lists the highest three counts and the dates of the occurrences. The percent of all fecal coliform data that exceeded this level is also shown.

Check Standards, Spiked Samples, and Blanks

Table 5, 6, and 7 show the QA evaluation of the laboratory check standards, spiked samples, and blanks, respectively. The check standards for NO_2, NH_3, and O-PO_4 were accurate to within $\pm 4\%$ (Table 5). The check standards for NO_2-NO_3 were less accurate with mean error values ranging from 5 to 80%. The data (not shown) indicate that there was a problem with both the 0.500 and 0.075 check standard analyses for NO_2-NO_3 during April-June 1991.

The spiked sample recovery for all nutrients was good (all were within $\pm 30\%$, Table 6). The blanks were also fairly good (Table 7). Overall, blank averages were approximately 25% of the detection limit values; although, detection limit values were occasionally exceeded by blanks from O-PO_4, chlorophyll *a* and phaeopigment analyses (as indicated by the maximum data range values in Table 7).

Contract Laboratory Data

Table 8 shows the QA evaluation of contract laboratory chlorophyll *a* analysis conducted at the University of Washington (U.W.) Marine Chemistry Laboratory during August through November 1991. Samples were contracted out due to equipment failure during this period. The data results indicate poor precision both for field replicate and laboratory split samples.

DISCUSSION AND RECOMMENDATIONS

Fecal Coliform Bacteria

The QA results for fecal coliform bacteria show the field replicate results have poor precision (41% of the data for Wateryear 1990 and 1991 combined have a RSD greater than the acceptable 20%). The field pooled standard deviation varies from 3.2 to 13.2 (#organisms/100 mL). Higher standard deviations may be partly a function of higher value ranges. Laboratory split samples seem to be more precise (only 19% have a RSD greater than 20%). Fecal coliform bacteria precision was evaluated for 100 mL dilution samples only. Lower dilutions were often used for samples with higher concentrations of fecal coliform bacteria; therefore, the variability may be somewhat different. For Wateryear 1991, 58% of the data are below the detection limit (Table 3) and 85% of the data have less than the criterion of 14 organisms/100 mL (Table 4). During Wateryear 1991, only 15 of the 32 stations had fecal bacteria levels above the criterion of 14 organisms/100 mL.

Since field replicate results indicate poor precision for fecal coliform bacteria and values exceed the criterion of 14 organisms/100 mL at less than half the stations (with the majority of occurrences in late fall and winter as expected), it is recommended that samples be collected at fewer stations and in replicate, or be sampled at the stations routinely showing higher counts. We also recommend maintaining a few of the higher priority "background" stations (those with counts below detection limits). Fecal coliform bacteria monitoring conducted by the Department of Health collects at least 15 samples at any given station to control variability. This procedure was determined by the Food and Drug Administration. We are considering focusing this parameter collection for more intensive, seasonal surveys. In addition, the MF method used for the fecal coliform bacteria analysis "has limitations with saline waters and may recover only a fraction of the number present" according to Dale Van Donsel (Cliff Kirchmer, Personal Communication, March 1992). The limitations of the MF method should be considered by users of the fecal coliform bacteria data. The alternative method of analysis, MPN (most probable number) should be considered if it is feasible.

Nitrite

For Wateryear 1991, 94% of the dissolved NO_2 was below detection limits (Table 3). There are too few data values to analyze the variability of data above detection limits for field replicate and field split samples. There are only seven sets of laboratory split samples above detection limits (86% of these data have an RSD within the acceptable value of 10%). The NO_2-NO_3 values are generally equal to the NO_3 values since dissolved NO_2 values are below detection limits. Beginning June 1, 1992, dissolved NO_2 analysis will be discontinued at all but three urban bay stations (Bellingham Bay, Commencement Bay, and Budd Inlet) due to low concentrations.

Chlorophyll *a*

The QA results of the field replicate chlorophyll *a* analysis seem to have somewhat poor precision (29% of the data have a RSD greater than the acceptable value of 20%). This could be an indicator of the patchiness of phytoplankton in the water column and/or drift of the floatplane during sampling. The collection of field replicates at additional stations and depths is recommended to attain a better estimate of chlorophyll *a* concentration.

The field split samples collected in the first year the fluorometer was used by Manchester also indicate poor precision (40% of the data have an RSD greater than 20%). The field split sample variability can probably be attributed to the newness of the fluorometric method. Sample collection and handling methods probably improved as well over time.

The laboratory split samples appear to be good (only 6% of the data have an RSD greater than 20%). It appears that as the fluorometric procedure became more well known by the analyst(s), and as the analyst became more comfortable with the procedure, quality of the results improved. We recommend that the analyst conducting this procedure be consistent, and that the analysis always be conducted by the same person, if possible.

We recommend that Manchester own spare doors and bulbs to make repairs as needed to the fluorometer. The fluorometer must be recalibrated each time a bulb change occurs, in addition to an annual calibration. A log of the bulb age should be included in the calibration log since the age of the bulb will influence the fluorometer readings.

The laboratory should filter and run the chlorophyll *a* samples as soon as they are received by the lab. The holding time from sample collection to filtration must not exceed 24 hours. It is best to run the samples immediately after filtering, when possible (Mary Kay Talbot, Personal Communication, December 1991). It is strongly advised to conduct fluorometric analysis on the same day as sample receipt. If samples must be held for any length of time before analysis, samples should be filtered, then filters should be placed in an air tight container with desiccant (or in vials containing acetone) and stored frozen. The maximum holding time for frozen filters is 30 days. If filters are routinely frozen after filtration (due to a delay in sample analysis), it is recommended that field staff filter and freeze samples on the day of collection to minimize the holding time between sample collection and filtration.

Nutrients

For Wateryear 1991, the following percentage of the entire data set were below detection limits for each of the listed parameters:

O-PO_4	-	7.8%
NO_2	-	94.3%
NH_3	-	34.1%
NO_2-NO_3	-	11.0%

Detection limits for the NH_3 and NO_2-NO_3 (and NO_2, if analysis is not discontinued) should be lowered if possible. Nitrogen is usually the limiting nutrient in marine phytoplankton growth; therefore, lower detection limits for NO_2-NO_3 and NH_3 will allow better assessment of primary production and eutrophication processes.

Objective detection limits according to the Puget Sound Ambient Monitoring Plan (PSAMP) (1988):

Parameter	PSAMP Objectives	Realized Lab Detection Limit
Chlorophyll *a*	0.05 mg/m^3	0.05 mg/m^3
Phaeopigment	0.05 mg/m^3	0.05 mg/m^3
O-PO_4	0.002 mg/L	0.01 mg/L
NO_2	0.005 mg/L	0.01 mg/L
NH_3	Not Listed	0.01 mg/L
NO_2-NO_3	0.01 mg/L	0.01 mg/L

The realized laboratory instrument detection limits (Table 3) are equal to the objective detection limits listed in the PSAMP Plan for chlorophyll *a*, phaeopigments and NO_2-NO_3, but not for O-PO_4 and NO_2. Since O-PO_4 also plays a role in eutrophication dynamics in Puget Sound, the target detection limits should be attempted.

Furthermore, it is advisable to use lower check control standards for NH_3, O-PO_4, and NO_2 (if analysis is not discontinued), since the data have a much lower range than the lowest concentration check standard now used (*i.e.*, the majority of the data values are below 0.075 mg/L).

Contract Laboratory

Due to equipment failure at Manchester Laboratory, chlorophyll *a* samples collected during August through November 1991 surveys were sent to a contract laboratory for analysis. The results from these analysis showed poor precision for unknown reasons. Some samples were close to holding times and may have degraded. Possible thawing of samples during shipment to the contract lab may have also resulted in sample degradation. Care should be taken in the future to document procedures for sample handling and processing to assure the quality of the samples shipped to the contract laboratories.

Contract laboratory methods from chlorophyll *a* and other parameters contracted out should be documented in order to assure ongoing consistency in procedures. These methods should be consistent with those followed by Manchester Laboratory. Reporting limits with contract laboratories should always be consistent with Manchester Laboratory reporting limits. With any detection limit changes, be assured that the contract laboratory can handle the changes before contracting. Once detection limits are lowered, the limits shouldn't fluctuate. Furthermore, if sending samples to a contract laboratory, holding times should be considered.

RECOMMENDED ADDITIONAL FIELD QA/QC PROCEDURES

The Marine Water Column Program should start sending blind field check standard samples to the Manchester Laboratory, in addition to conducting field replication sampling at pre-determined sites each survey. This will help describe additional laboratory variabilities, as well as measuring sample handling variability.

The laboratory should start blank correcting low level sample results "otherwise, the results will be biased high by a concentration equal to the average blank responses" (Cliff Kirchmer, Personal Communication, March 1992).

Currently, as recommended by the Quality Assurance Office at the Department of Ecology, the Marine Water Column Program collects QA field replicate samples (three separate casts) at a pre-determined sampling location during each survey. The pre-determined location is preferably one with historically high parameter concentrations. Since many of the ambient samples collected during this program are at or below detection limits, stations that have higher parameter concentrations will give a better measure of field and sampling variability.

Figure 1: Field Replicate, Field Split and Laboratory Split Sampling Schemes

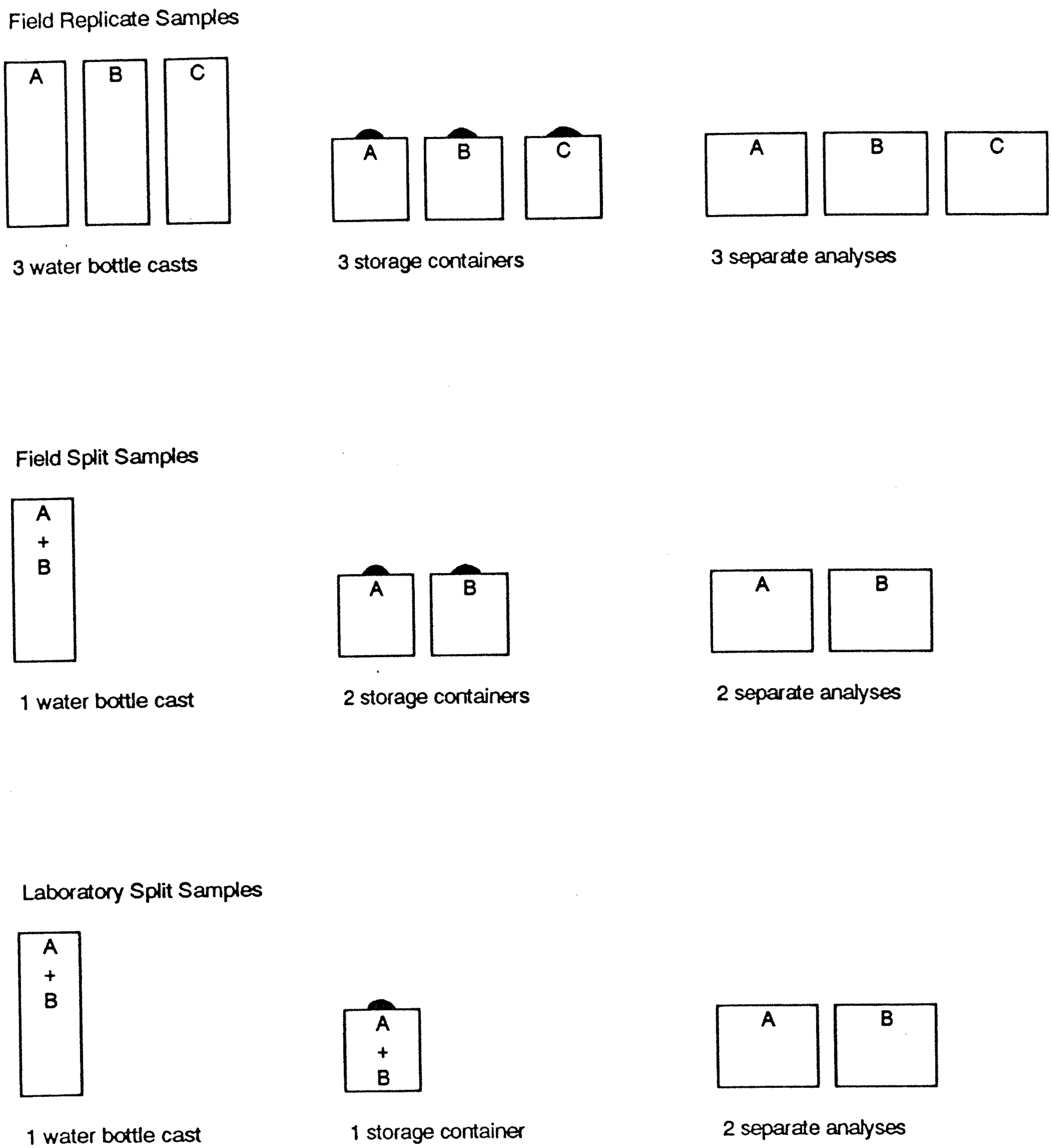


Table 1: Relative Standard Deviation (RSD) Ranges For Field Replicate, Field Split, and Laboratory Split Samples

RSD (%	Fec Col Field (91) % tot	Field (90) % tot	Lab Split % tot	Chl a Field Rep % tot	Field Split % tot	Lab Split % tot
<10	52.8%	48.0%	69.2%	29.4%	53.3%	69.0%
10-20	5.6%	12.0%	11.5%	41.2%	6.7%	23.8%
20-30	8.3%	0.0%	3.8%	14.7%	6.7%	6.0%
30-40	2.8%	4.0%	0.0%	11.8%	6.7%	1.2%
40-50	0.0%	0.0%	3.8%	0.0%	20.0%	0.0%
50-60	2.8%	8.0%	0.0%	2.9%	0.0%	0.0%
60-70	5.6%	0.0%	0.0%	0.0%	0.0%	0.0%
70-80	5.6%	4.0%	0.0%	0.0%	0.0%	0.0%
80-90	2.8%	0.0%	0.0%	0.0%	0.0%	0.0%
90-100	2.8%	0.0%	0.0%	0.0%	0.0%	0.0%
>100	8.3%	24.0%	11.5%	2.9%	6.7%	0.0%
Total #	36	25	26	34	15	84

RSD (%	Pheo Field Rep % tot	Field Split % tot	Lab Split % tot	O-PO4 Field Rep >DL % tot	Field Split >DL % tot	Lab Split >DL % tot
<10	32.4%	40.0%	71.4%	77.4%	84.6%	92.1%
10-20	38.2%	6.7%	19.0%	19.4%	11.5%	6.9%
20-30	11.8%	33.3%	8.3%	3.2%	0.0%	1.0%
30-40	11.8%	0.0%	1.2%	0.0%	0.0%	0.0%
40-50	0.0%	6.7%	0.0%	0.0%	3.8%	0.0%
50-60	2.9%	6.7%	0.0%	0.0%	0.0%	0.0%
60-70	0.0%	6.7%	0.0%	0.0%	0.0%	0.0%
70-80	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
80-90	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
90-100	2.9%	0.0%	0.0%	0.0%	0.0%	0.0%
>100	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total #	34	15	84	31	26	101

RSD (%	NH3 Field Rep >DL % tot	Field Split >DL % tot	Lab Split >DL % tot	NO2-NO3 Field Rep >DL % tot	Field Split >DL % tot	Lab Split >DL % tot
<10	56.5%	78.6%	77.6%	82.8%	100.0%	98.9%
10-20	30.4%	0.0%	13.4%	13.8%	0.0%	0.0%
20-30	8.7%	14.3%	6.0%	0.0%	0.0%	1.1%
30-40	4.3%	0.0%	3.0%	10.3%	0.0%	0.0%
40-50	0.0%	7.1%	0.0%	0.0%	0.0%	0.0%
50-60	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
60-70	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
70-80	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
80-90	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
90-100	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
>100	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total #	23	14	67	29	19	92

Shaded areas indicate the objective RSD range for each parameter.
BDL data for PO4, NH3 and NO2-NO3 were not included in the evaluation.
Fecal Coliform data from 100ml dilutions only.

Table 2: Pooled Standard Deviation (s) for Field Replicate, Field Split and Laboratory Split Samples

	Fec Col (#/100ml)			Chl a (mg/m3)		
	Field R(91)	Field R(90)	Lab Split	Field Rep	Field Split	Lab Split
s (pooled)	13.2	3.2	0.52	0.78	0.90	0.41
Data Range	0–120	0–45	0–47	0.11–18.4	0.07–24.0	0.05–18.5
Data Avg	9.1	7.2	5.4	2.3	3.1	2.3
# Samples	36	25	26	34	15	84

	Pheo (mg/m3)			O–PO4 (mg/L)		
	Field Rep	Field Split	Lab Split	Field Rep	Field Split	Lab Split
s (pooled)	0.92	0.90	0.41	0.0027	0.0031	0.0019
Data Range	0.16–14.4	0.21–13.4	0.06–13.8	0.01–0.08	0.01–0.08	0.01–0.12
Data Avg	2.23	3.07	2.21	0.042	0.050	0.060
# Samples	34	15	84	31	26	101

	NH3 (mg/m3)			NO3–NO2 (mg/L)		
	Field Rep	Field Split	Lab Split	Field Rep	Field Split	Lab Split
s (pooled)	0.0039	0.0033	0.0025	0.0136	0.0043	0.0040
Data Range	0.01–0.08	0.01–0.10	0.01–0.12	0.02–0.46	0.07–0.51	0.02–0.66
Data Avg	0.040	0.035	0.038	0.211	0.267	0.235
# Samples	23	14	67	29	19	92

BDL data for PO4, NH3 and NO2–NO3 were not included in the evaluation.
Fecal Coliform data from 100ml dilutions only.

Table 3: Data Less Than Detection Limits For Wateryear 1991

	Fec Col	NO2-NO3	NO2	NH3	O-PO4	Chl a	Pheo
DL =	1 (#/100ml)	0.01 (mg/L)	0.01 (mg/L)	0.01 (mg/L)	0.01 (mg/L)	0.05 (mg/m3)	0.05 (mg/m3)

MF 1 (Coast)	Fec Col	NO2-NO3	NO2	NH3	O-PO4	Chl a	Pheo
# < DL	10	12	122	17	21	0	0
TOTAL	60	123	123	123	123	98	98
% < DL	16.7%	9.8%	99.2%	13.8%	17.1%	0.0%	0.0%

MF 2 (North Sound)	Fec Col	NO2-NO3	NO2	NH3	O-PO4	Chl a	Pheo
# < DL	61	12	170	52	6	0	0
TOTAL	70	175	175	175	175	157	157
% < DL	87.1%	6.9%	97.1%	29.7%	3.4%	0.0%	0.0%

MF 3 (Central Sound)	Fec Col	NO2-NO3	NO2	NH3	O-PO4	Chl a	Pheo
# < DL	40	18	200	95	19	8	7
TOTAL	75	219	219	219	219	171	171
% < DL	53.3%	8.2%	91.3%	43.4%	8.7%	4.7%	4.1%

MF 4 (South Sound)	Fec Col	NO2-NO3	NO2	NH3	O-PO4	Chl a	Pheo
# < DL	74	45	252	105	16	1	0
TOTAL	116	272	272	273	273	248	248
% < DL	63.8%	16.5%	92.6%	38.5%	5.9%	0.4%	0.0%

Marine Flights Combined	Fec Col	NO2-NO3	NO2	NH3	O-PO4	Chl a	Pheo
# < DL	185	87	744	269	62	9	7
TOTAL	321	789	789	790	790	674	674
% < DL	57.6%	11.0%	94.3%	34.1%	7.8%	1.3%	1.0%

Table 4: WY 1991 water column stations that exceeded a fecal coliform bacteria count of 14 organisms/100 ml one or more times.

Station	Highest Count	2nd Highest Count	3rd Highest Count
North Sound			
BLL009	18 (15OCT90)	NA	NA
PSS019	>200 (15OCT90)	88 (04MAR91)	38 (05DEC91)
SKG003	20 (23SEP91)	16 (04MAR91)	NA
Central Sound			
ADM003	84 (05FEB91)	14 (22OCT90)	NA
CMB003	220 (05FEB91)	100 (05DEC90)	96 (04MAR91)
NRR001	14 (02FEB91)	NA	NA
PSB003	200 (05DEC90)	190 (05FEB91)	44 (22OCT90)
South Sound			
BUD005	32 (12NOV90)	14 (08JAN91)	NA
NSQ001	23 (08APR91)	NA	NA
OAK004	79 (08JAN91)	73 (12DEC90)	21 (06MAY91)
CSE002	35 (11FEB91)	NA	NA
Coastal			
GYS004	140 (28JAN91)	120 (25JUN91)	73 (12NOV90)
GYS008	250 (30SEP91)	110 (26AUG91)	14 (25JUN91)
GYS009	92 (12NOV90)	73 (29JUL91)	67 (30SEP91)
WPA001	100 (25JUN91)	46 (26MAR91)	35 (20MAY91)

NA = Not Applicable

Marine Flight	% Data >14 Organisms/100ml
1	38.7%
2	1.4%
3	20.9%
4	6.3%
MF: 2,3,4 (Sound Only)	9.1%
MF: 1,2,3,4 (Coast and Sound)	14.8%

Table 5: Evaluation of Lab Check Standards (Oct 90 - Sep 91)

NO2-NO3 (mg/L)

Ck Stand	Wt Avg	Data Range of Averages	Percent Error (Wt Avg-Stand)/Stand
0.500	0.344	0.050-0.517	-31.2%
0.075	0.135	0.076-0.293	80.0%
0.431 (SLS)	0.459	0.445-0.481	-5.4%

NO2 (mg/L)

Ck Stand	Wt Avg	Data Range of Averages	Percent Error (Wt Avg-Stand)/Stand
0.500	0.497	0.465-0.513	-0.6%
0.075	0.077	0.072-0.083	2.7%

NH3 (mg/L)

Ck Stand	Wt Avg	Data Range of Averages	Percent Error (Wt Avg-Stand)/Stand
0.500	0.493	0.479-0.511	-1.4%
0.075	0.075	0.070-0.088	0.0%
0.151 (SLS)	0.152	0.148-0.154	0.7%
0.154 (SLS)	0.151	0.137-0.169	-1.9%

PO4 (mg/L)

Ck Stand	Wt Avg	Data Range of Averages	Percent Error (Wt Avg-Stand)/Stand
0.500	0.504	0.496-0.518	0.8%
0.075	0.078	0.074-0.080	4.0%
0.154 (SLS)	0.16	0.158-0.177	3.9%

SLS = commercial standard with a pre-determined concentration.

Table 6: Evaluation of Laboratory Spiked Samples (Oct 90 – Sep 91)

	% Wt Avg Spike Recovery	Data Range of Averages
NO2-NO3 (mg/L)	91%	73–102%
NO2 (mg/L)	102%	93–110%
NH3 (mg/L)	91%	71–102%
PO4 (mg/L)	102%	90–105%

Range of acceptable spike recovery data is 70–130%

Table 7: Evaluation of Laboratory Blanks (Oct 90 - Sep 91)

	Blank Wt Avg	Data Range of Averages	Detect Limit
NO2-NO3 (mg/L)	0.0016	-0.0001 to 0.0037	0.01 mg/L
NO2 (mg/L)	0.0024	-0.0002 to 0.0047	0.01 mg/L
NH3 (mg/L)	0.0022	-0.0021 to 0.0043	0.01 mg/L
PO4 (mg/L)	0.0033	0.0002 to 0.0165	0.01 mg/L
Chl a (mg/m3)	0.0165	-0.0140 to 0.0560	0.05 mg/m3
Pheo (mg/m3)	0.0121	-0.0230 to 0.0923	0.05 mg/m3

Table 8: QA Evaluation For Chlorophyll a and Phaeopigment Contract Lab Data

Chl a (mg/m3)

Date	MF	QA Stat	Field Rep RSD (%)	Lab Split RSD (%)
09SEP91	4	BUD005	58.0	59.8 82.8
16SEP91	2	BUD005	70.4	64.6 48.2
23SEP91	3	CMB003	2.0	2.3 2.8
30SEP91	1	WPA003	56.7	16.9 7.0
07NOV91	4	OAK004	26.9	55.7 27.5
14NOV91	2	BLL009	12.8	42.5 14.0
		s (pooled)	1.96	3.14
		Data Range	1.16–27.43	0.96–20.80

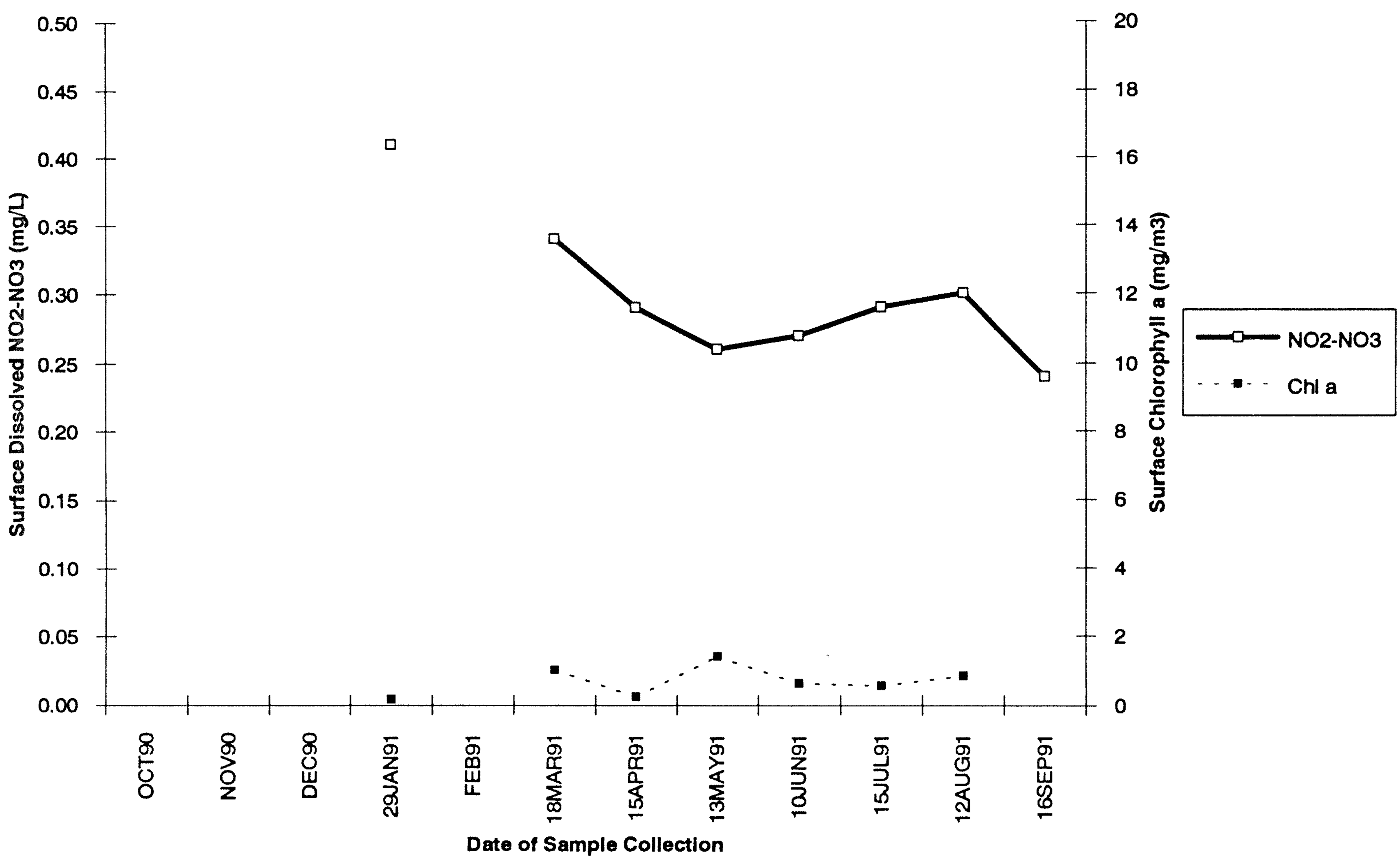
Pheo (mg/m3)

Date	MF	QA Stat	Field Rep RSD (%)	Lab Split RSD (%)
09SEP91	4	BUD005	46.5	39.6 69.5
16SEP91	2	BUD005	41.8	20.6 24.5
23SEP91	3	CMB003	10.7	141.4 1.8
30SEP91	1	WPA003	45.7	16.0 11.1
07NOV91	4	OAK004	25.8	5.4 27.3
14NOV91	2	BLL009	37.5	14.1 69.2
		s (pooled)	0.48	0.79
		Data Range	0.27–4.51	0.00–4.13

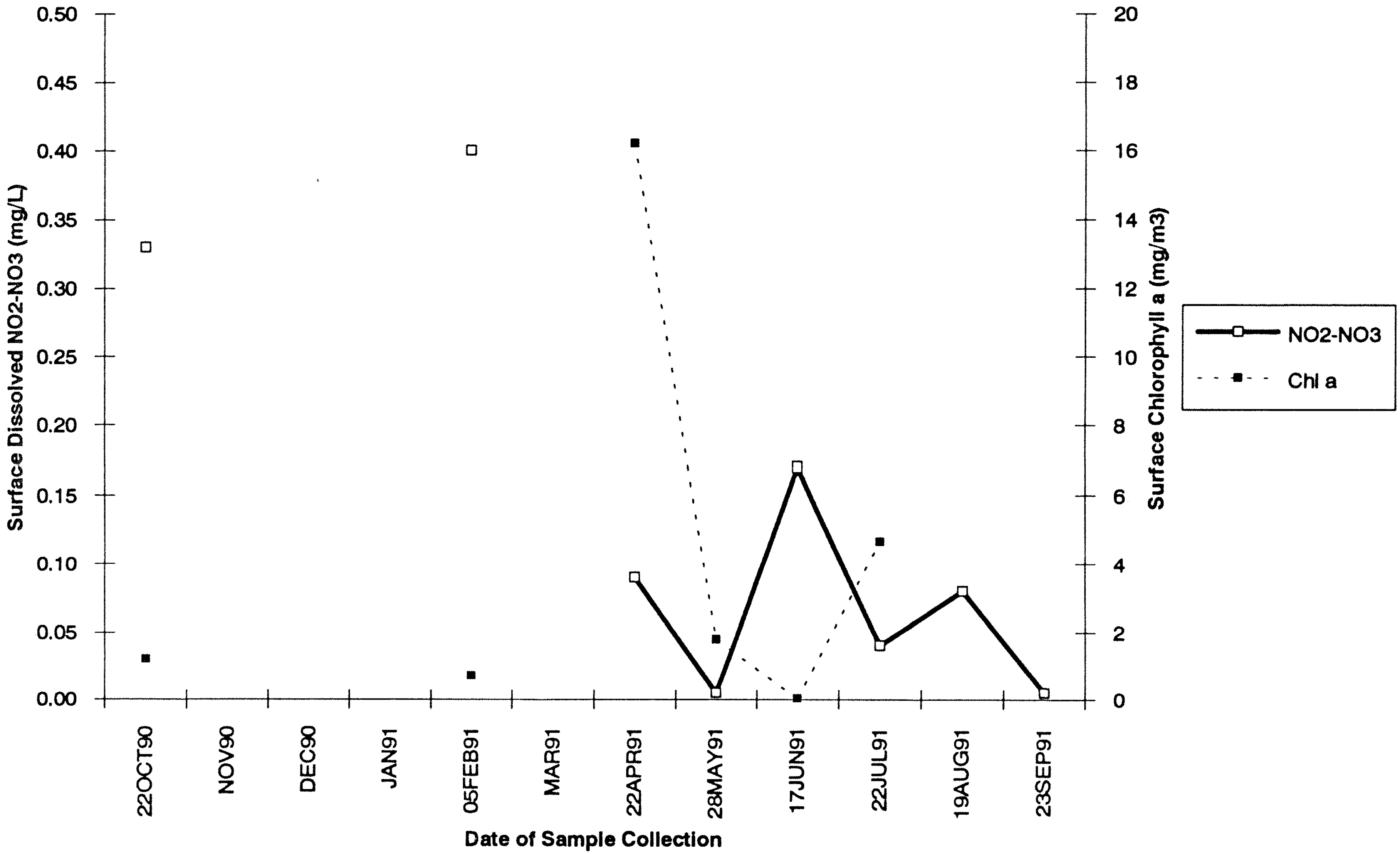
APPENDIX I

PLOTS OF SURFACE NITROGEN AND CHLOROPHYLL A CONCENTRATIONS FOR ALL WY 1991 STATIONS

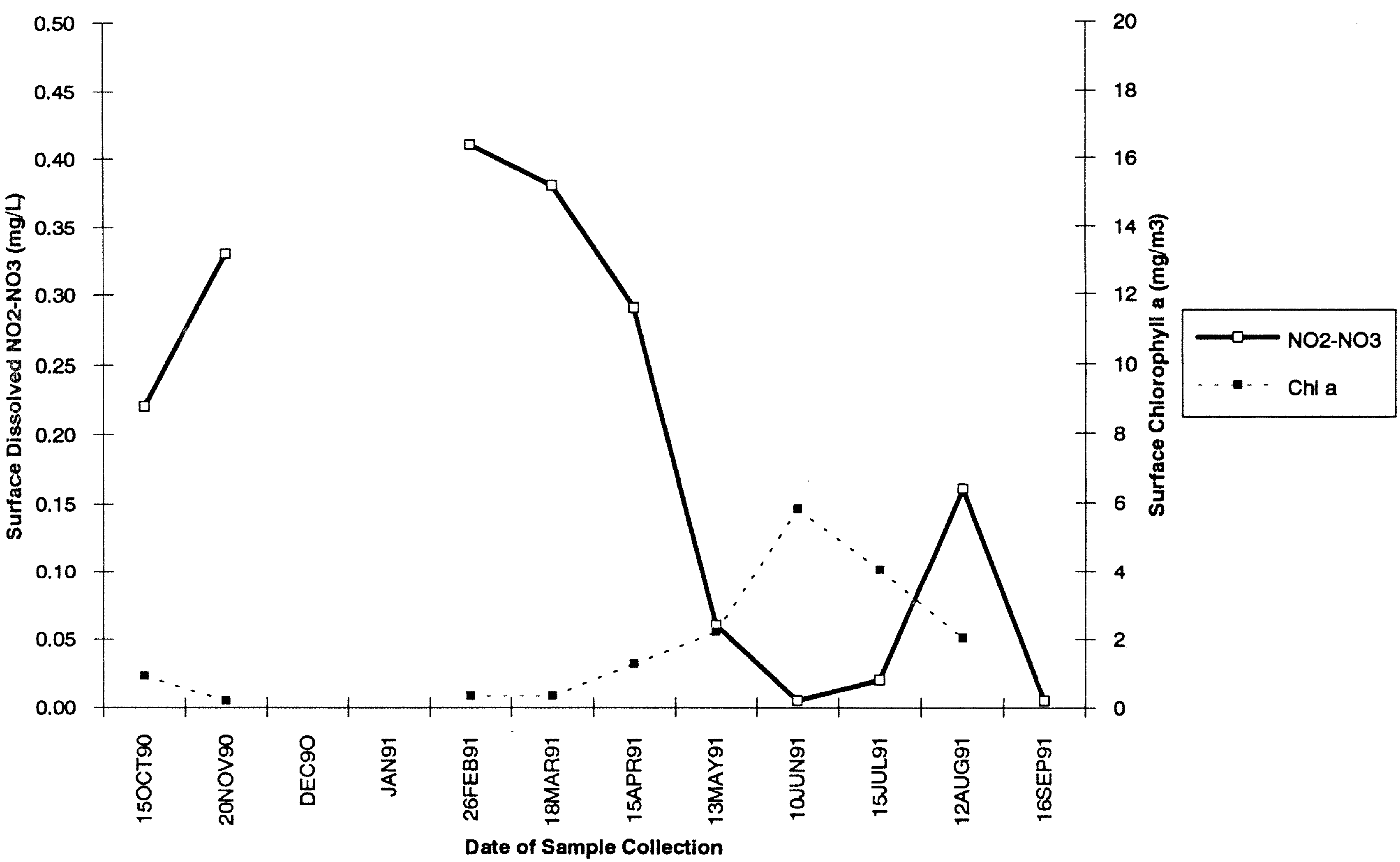
Station ADM002: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



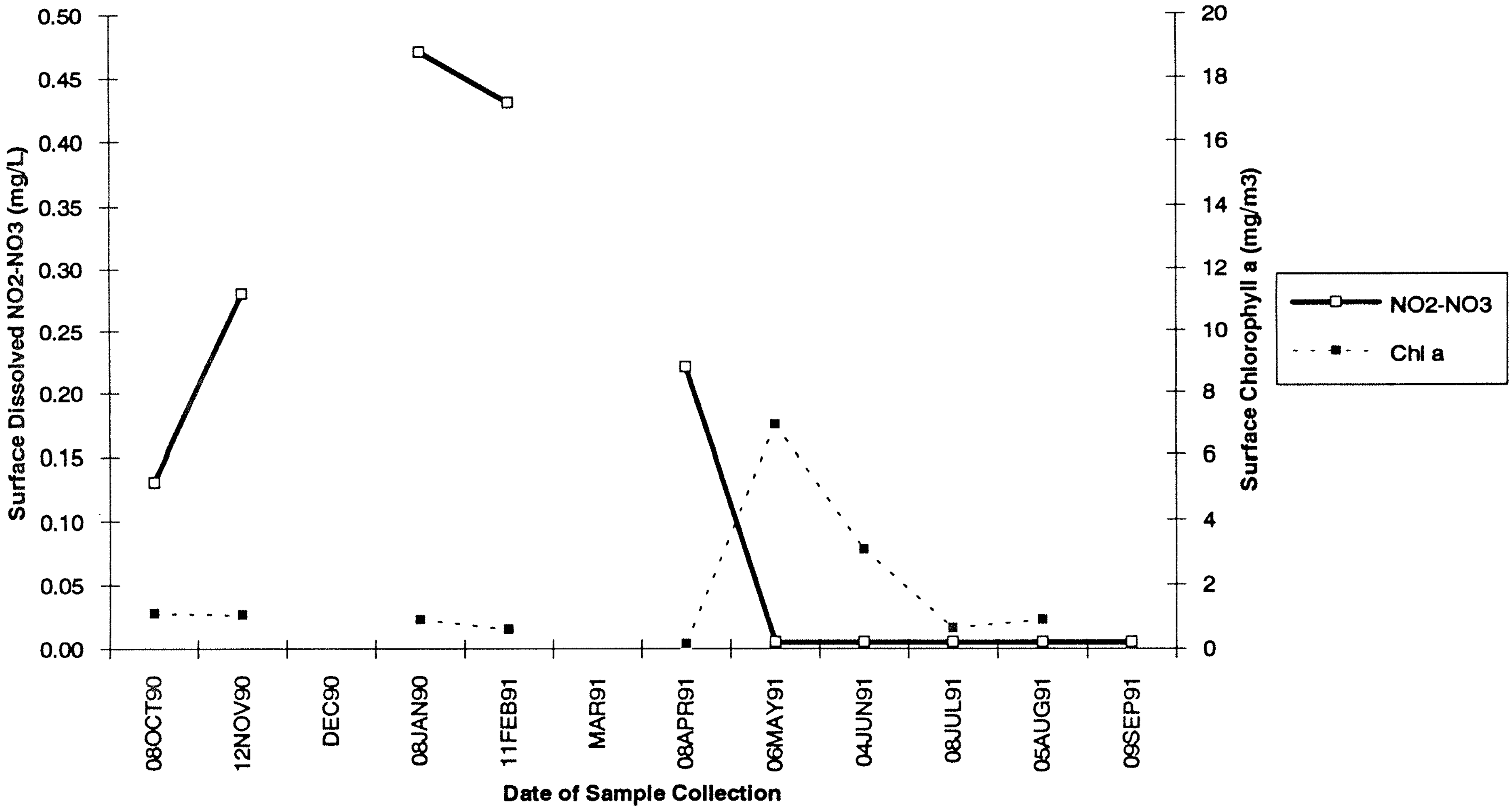
Station ADM003: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



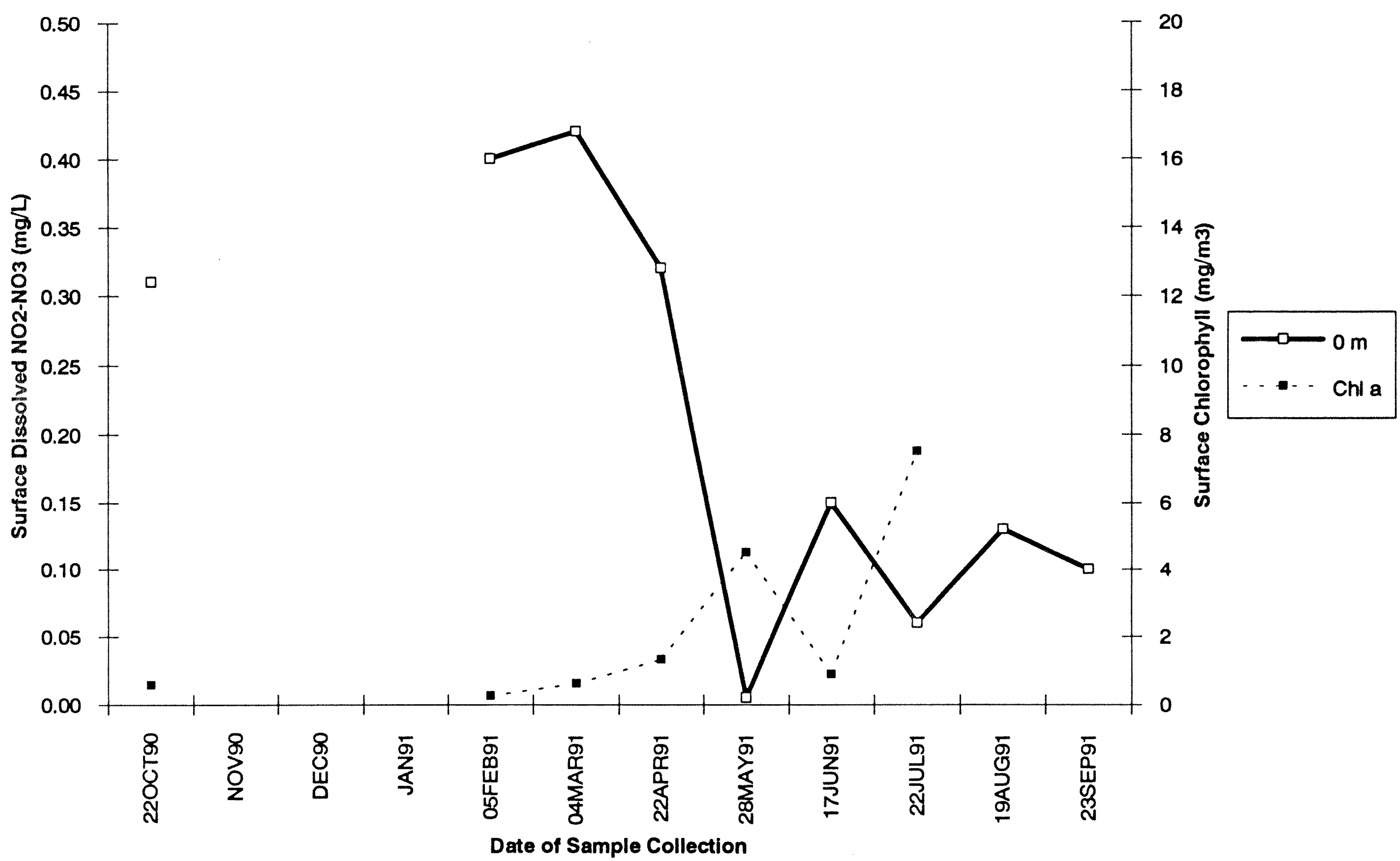
Station BLL009: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



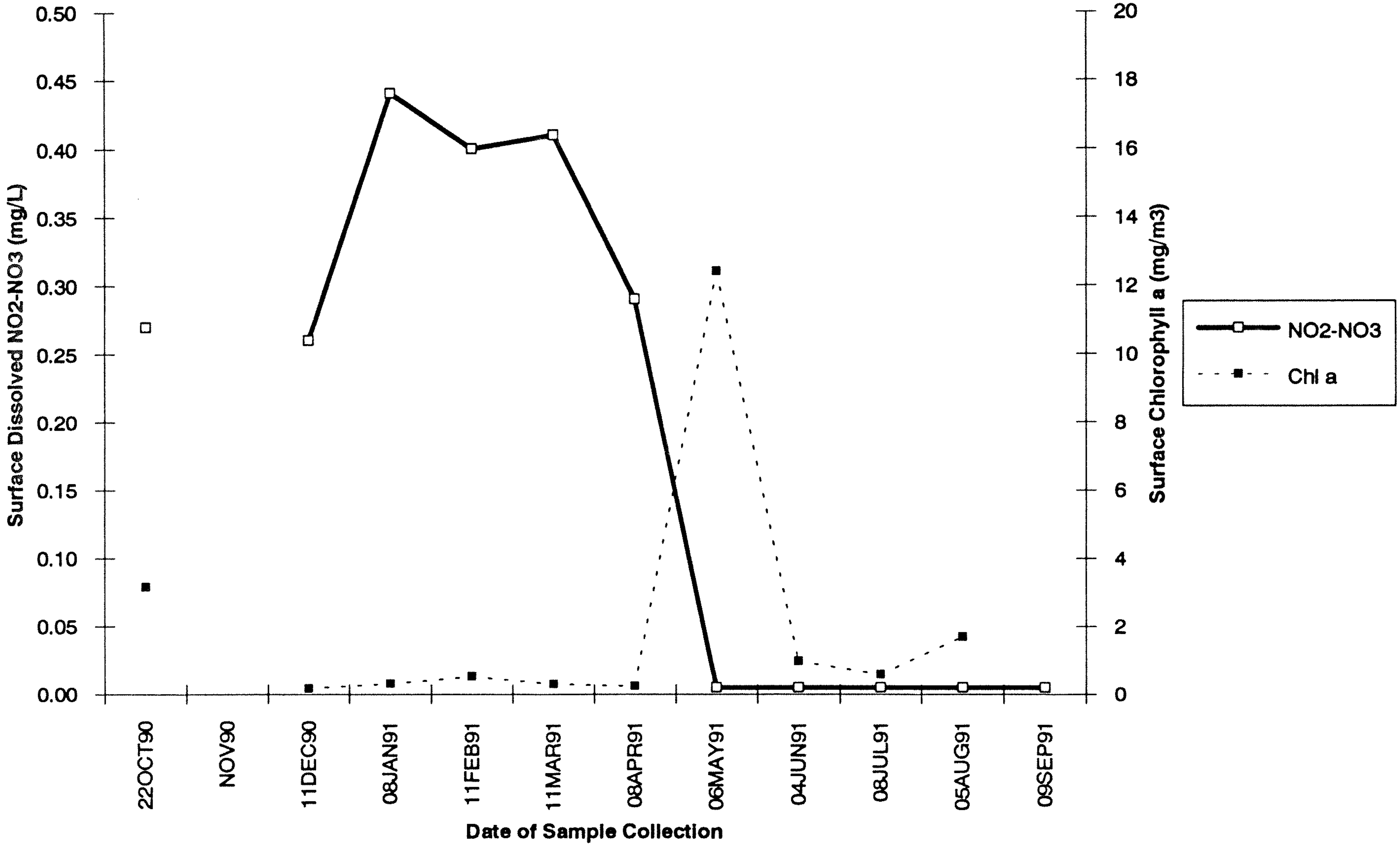
Station BUD005: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



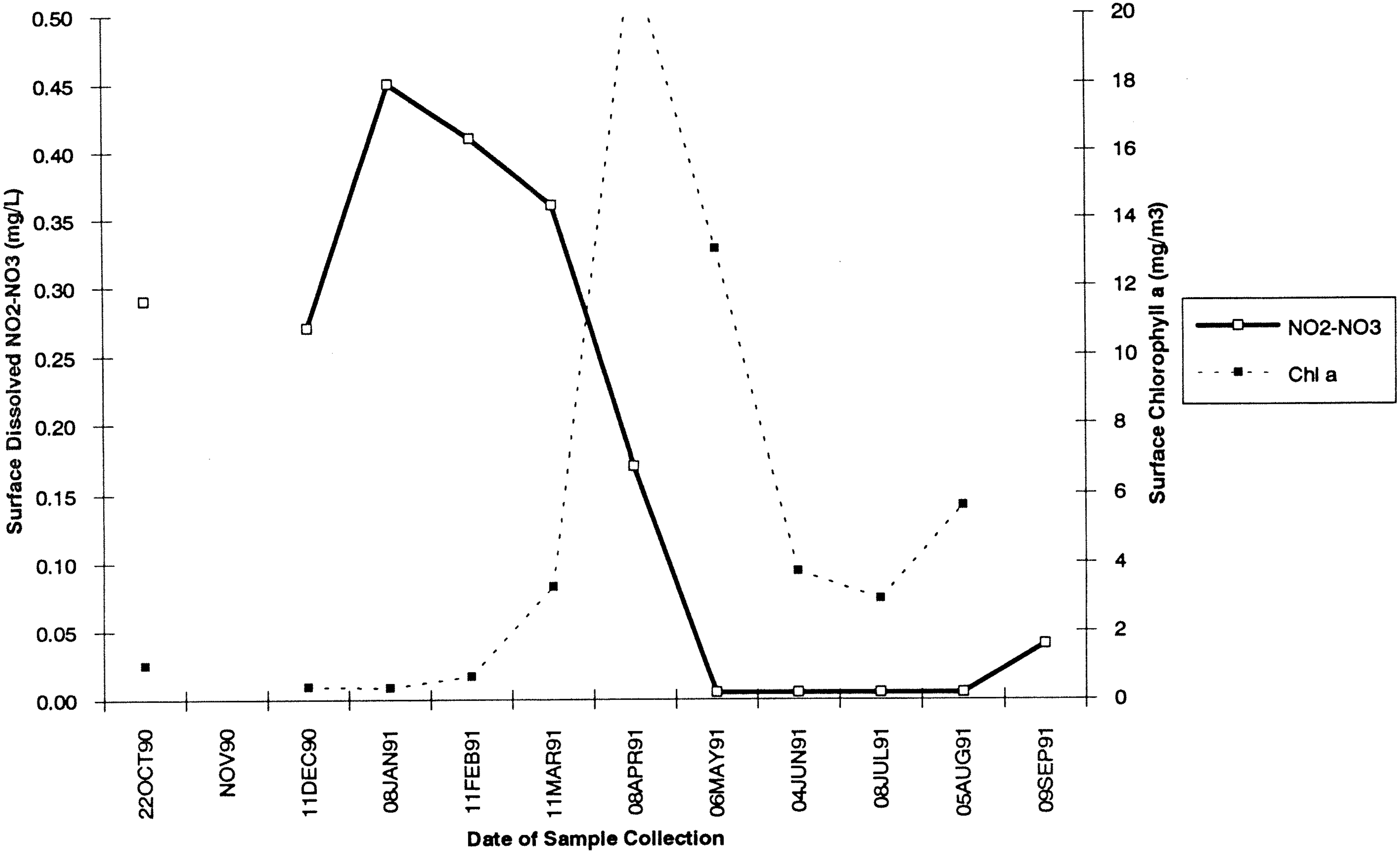
Station CMB003: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



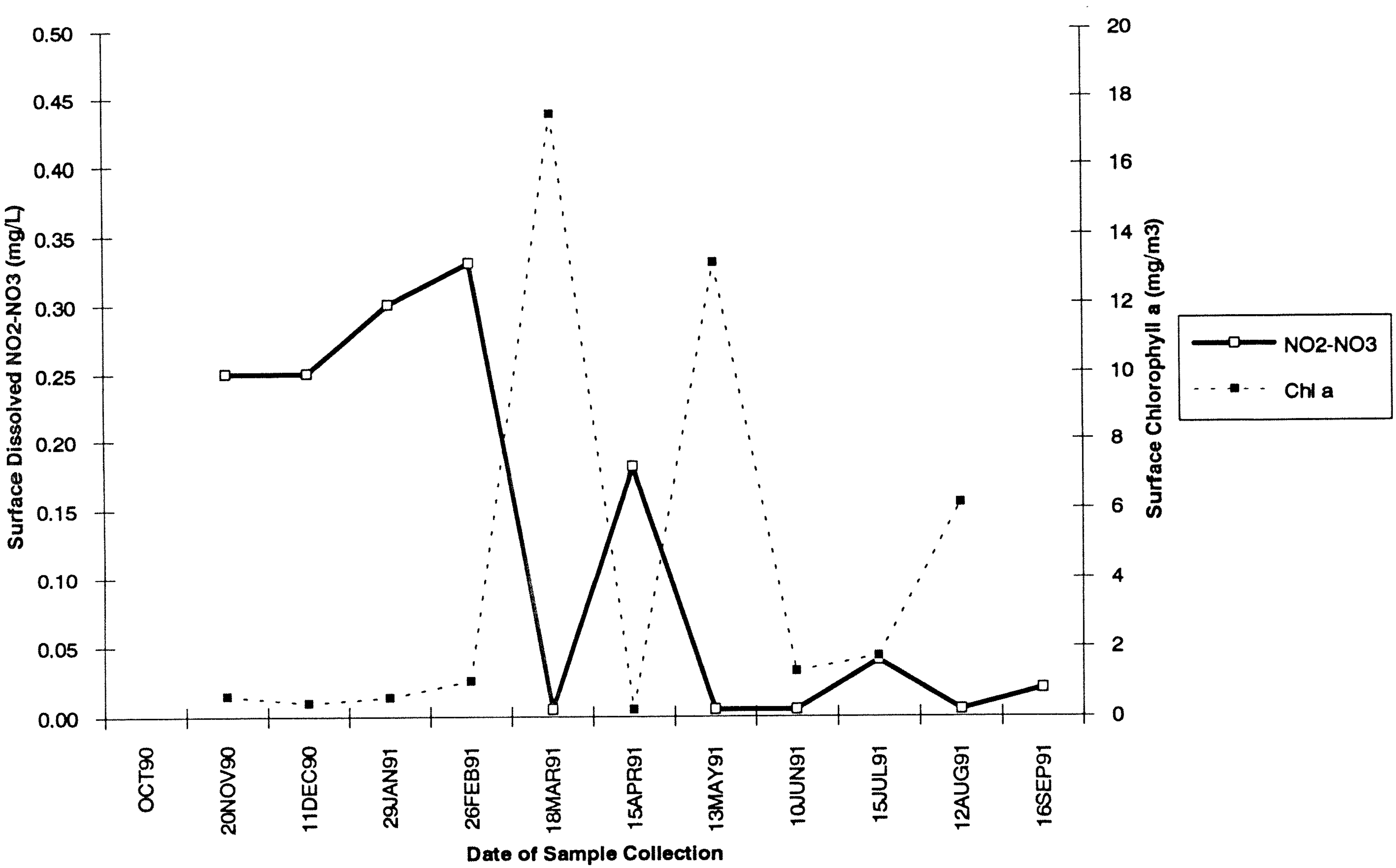
Station CRR001: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



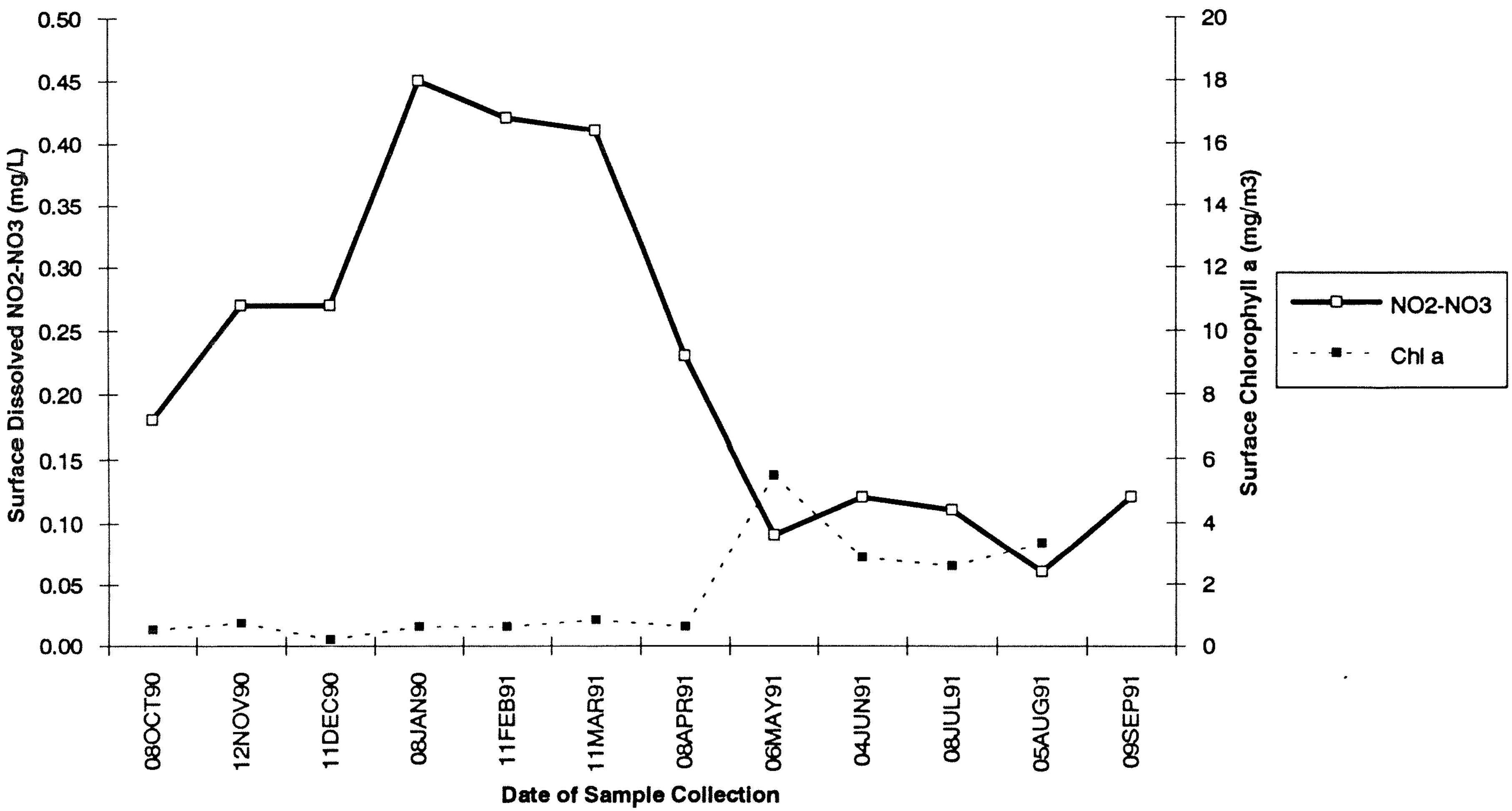
Station CSE001: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)

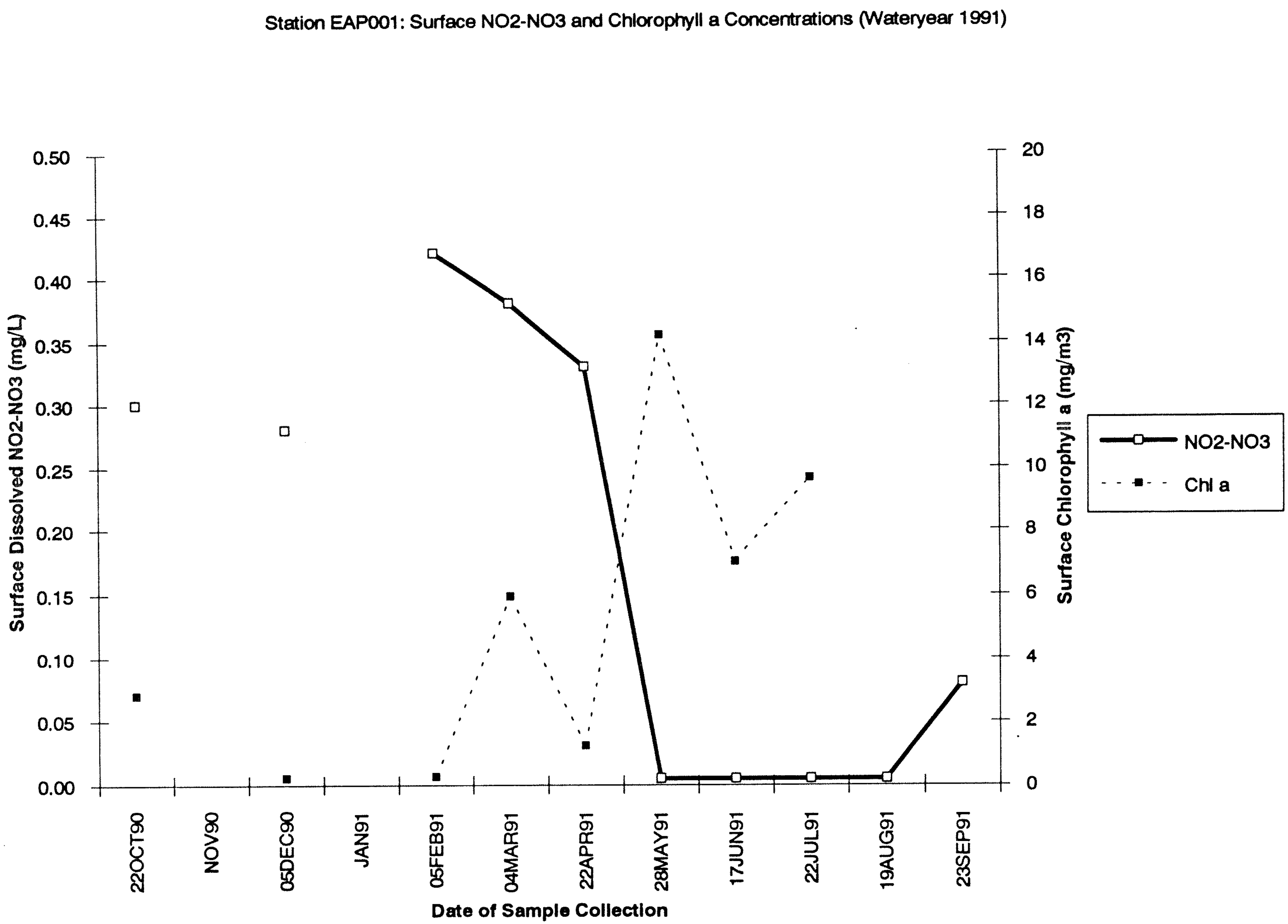


Station DIS001: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)

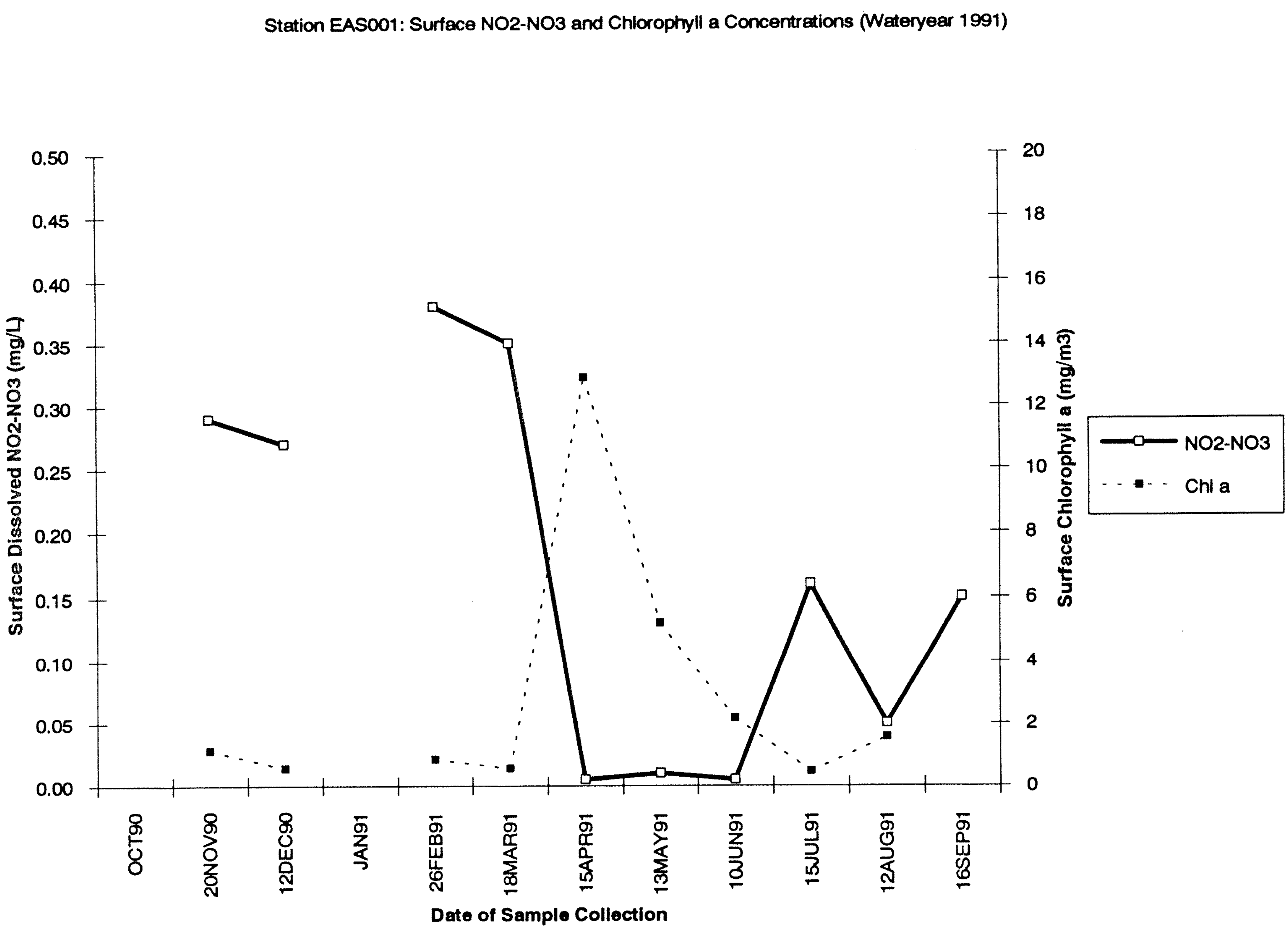


Station DNA001:Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



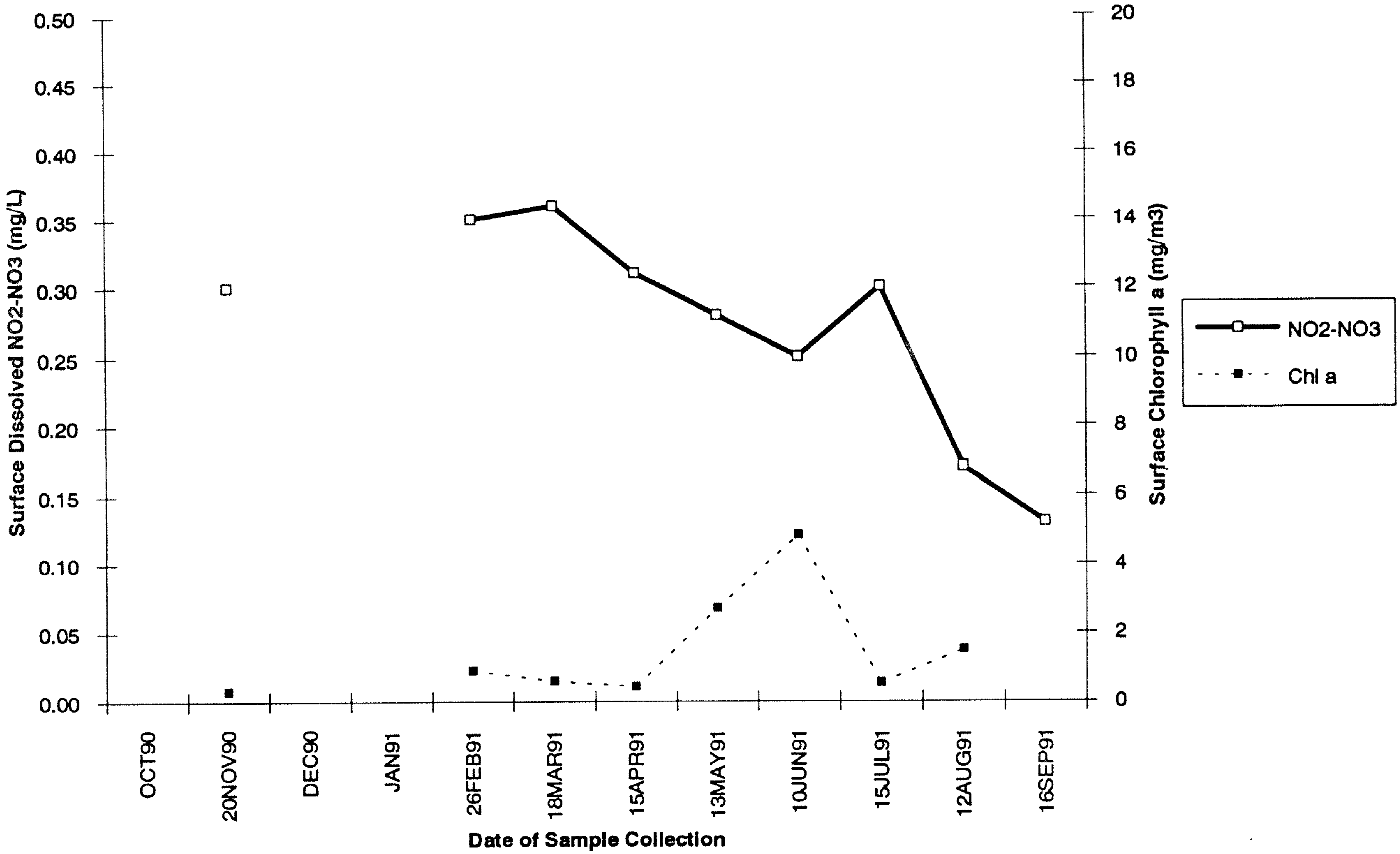


Station EAP001: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)
Surface Dissolved NO2-NO3 (mg/L)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Surface Chlorophyll a (mg/m3)
20
18
16
14
12
10
8
6
4
2
0
NO2-NO3
Chl a
22OCT90
NOV90
05DEC90
JAN91
05FEB91
04MAR91
22APR91
28MAY91
17JUN91
22JUL91
19AUG91
23SEP91
Date of Sample Collection

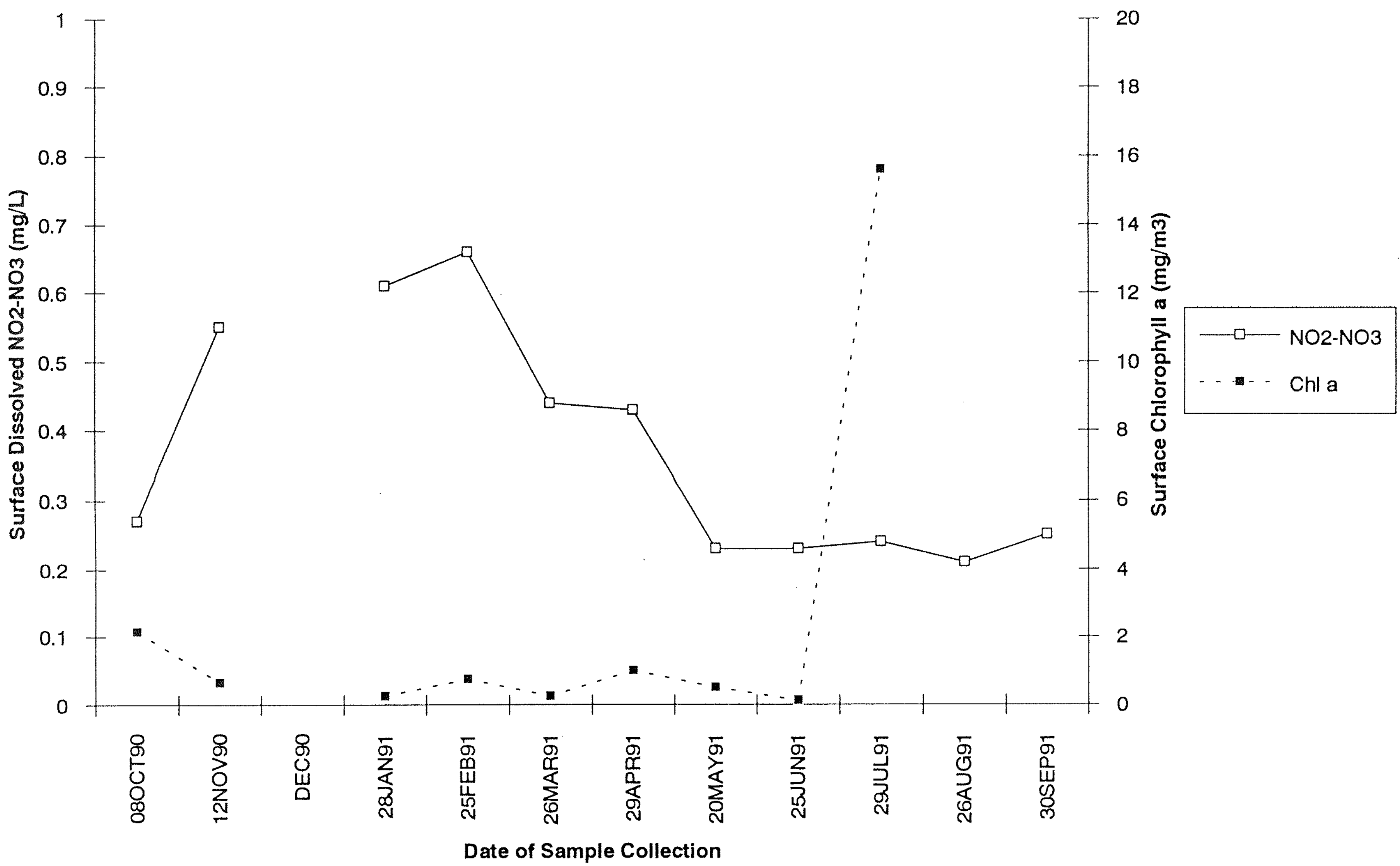


Station EAS001: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)
Surface Dissolved NO2-NO3 (mg/L)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Surface Chlorophyll a (mg/m3)
20
18
16
14
12
10
8
6
4
2
0
NO2-NO3
Chl a
OCT90
20NOV90
12DEC90
JAN91
26FEB91
18MAR91
15APR91
13MAY91
10JUN91
15JUL91
12AUG91
16SEP91
Date of Sample Collection

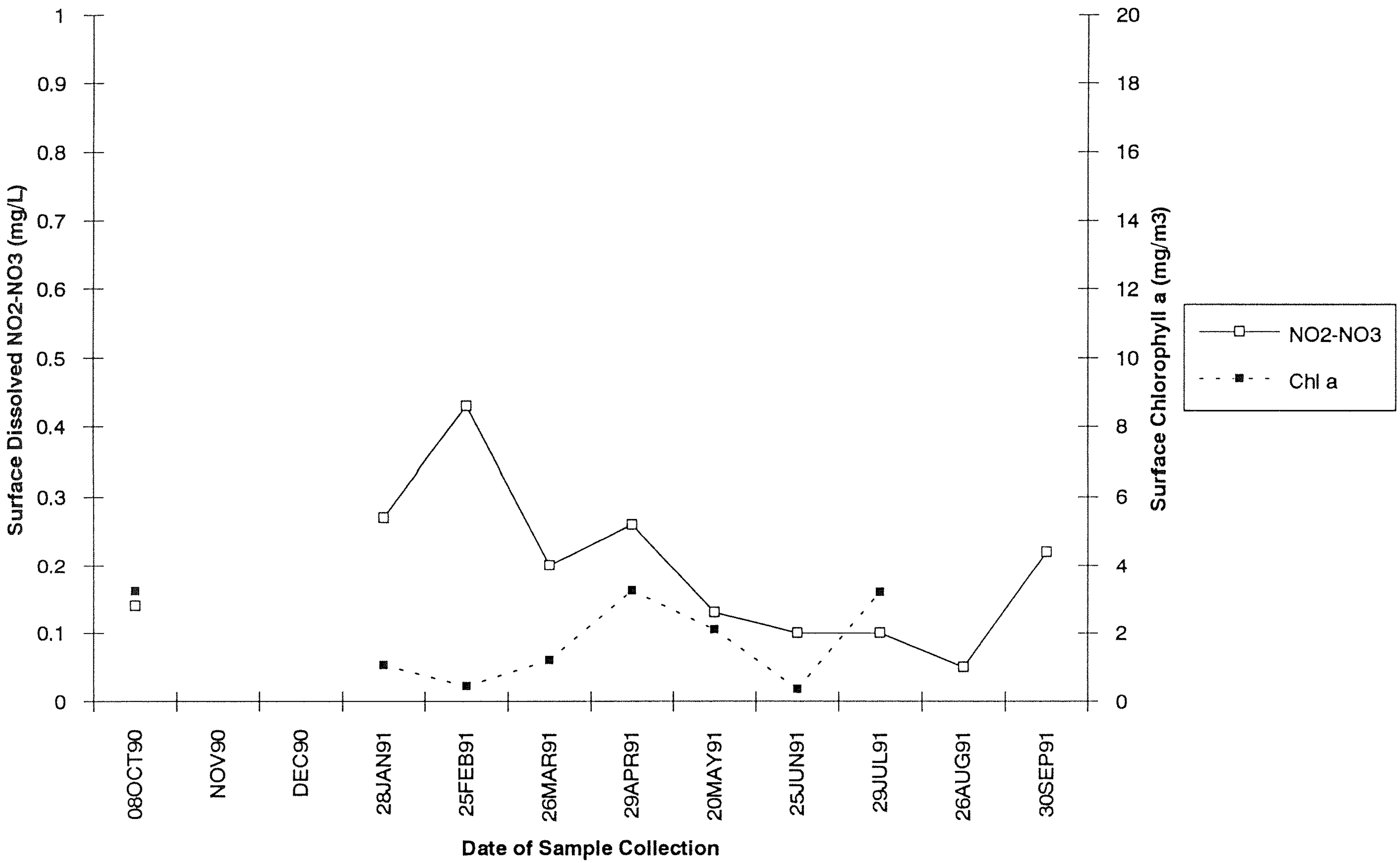
Station GRG002: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



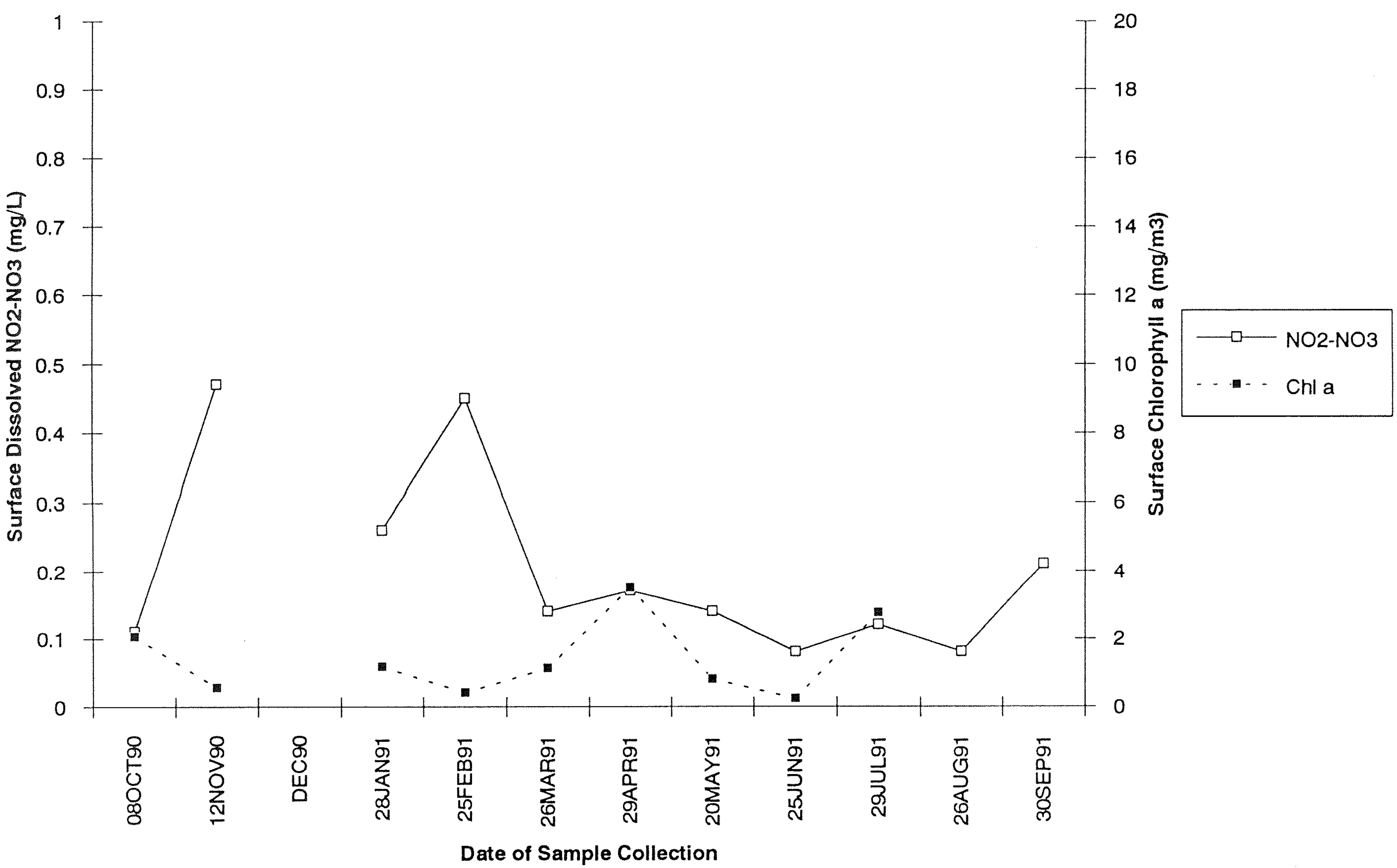
Station GYS004: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



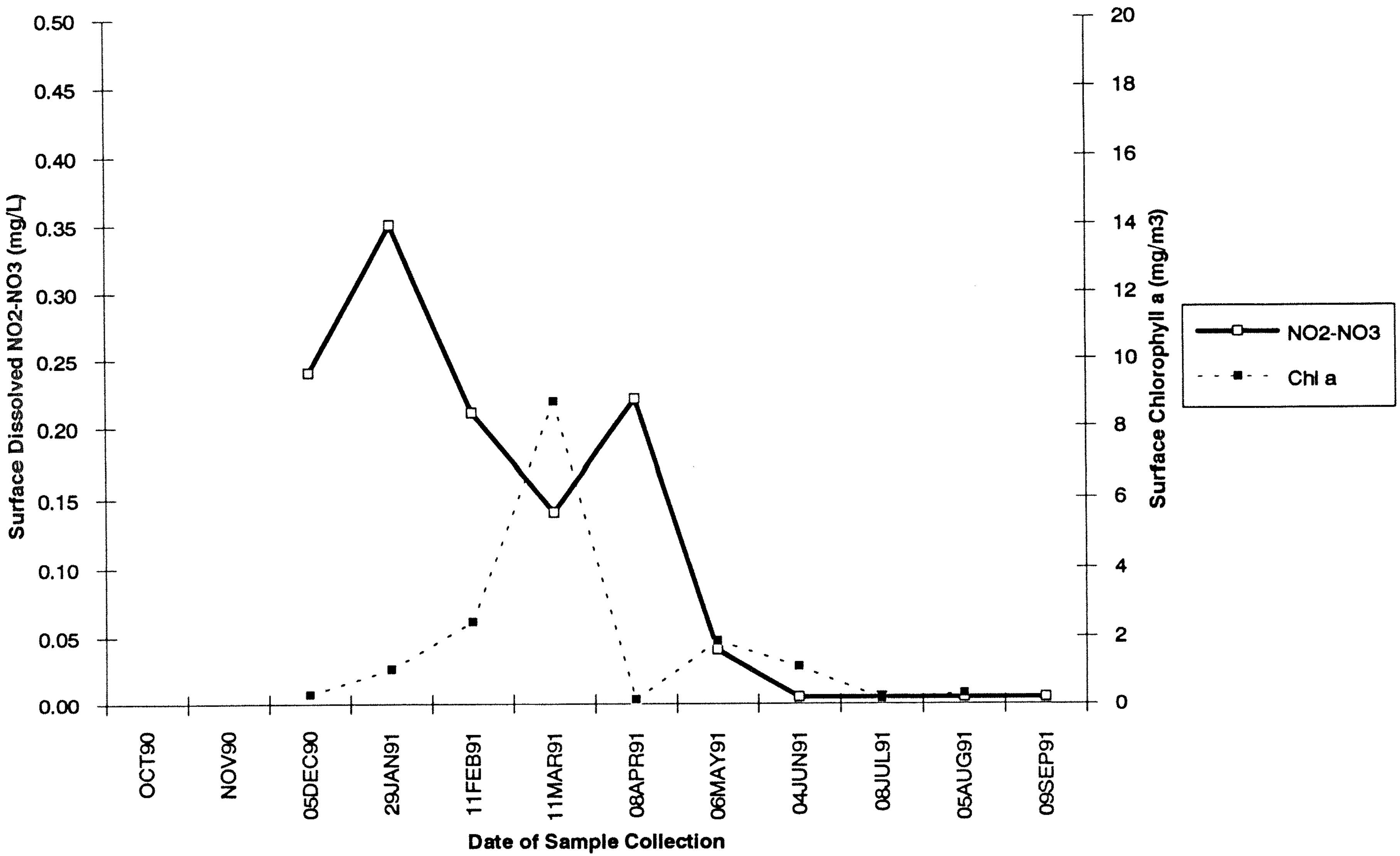
Station GYS008: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)

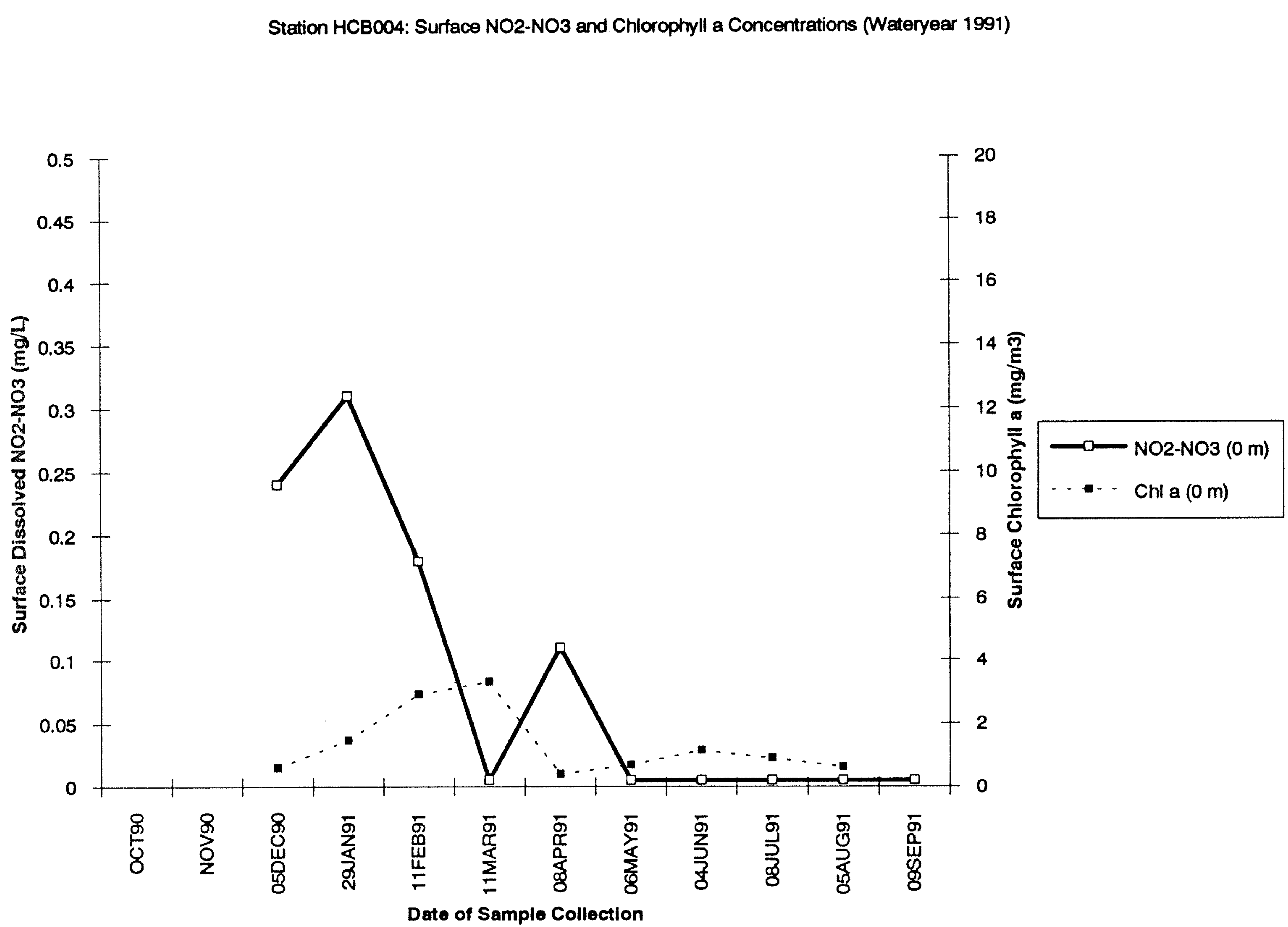


Station GYS009: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)

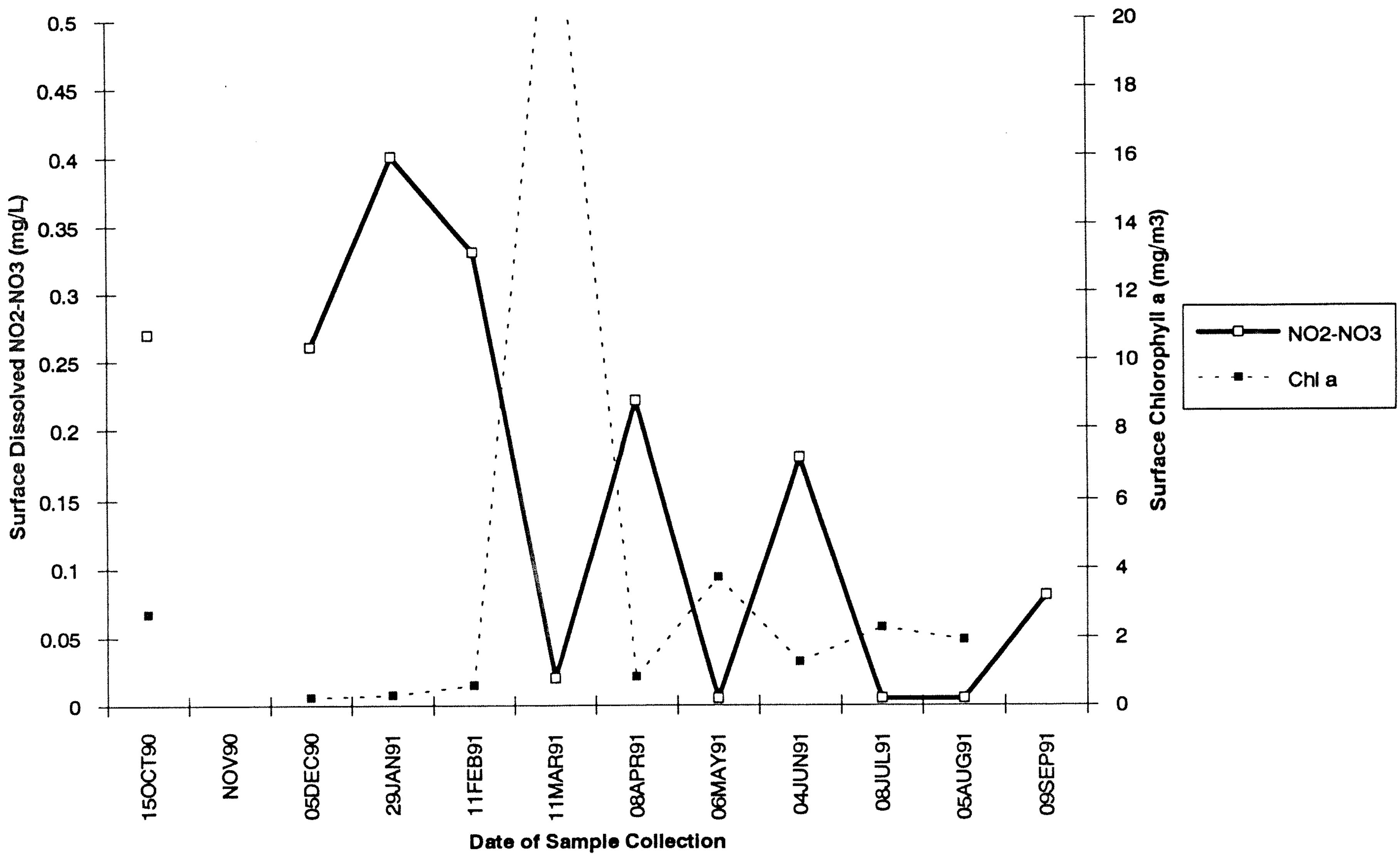


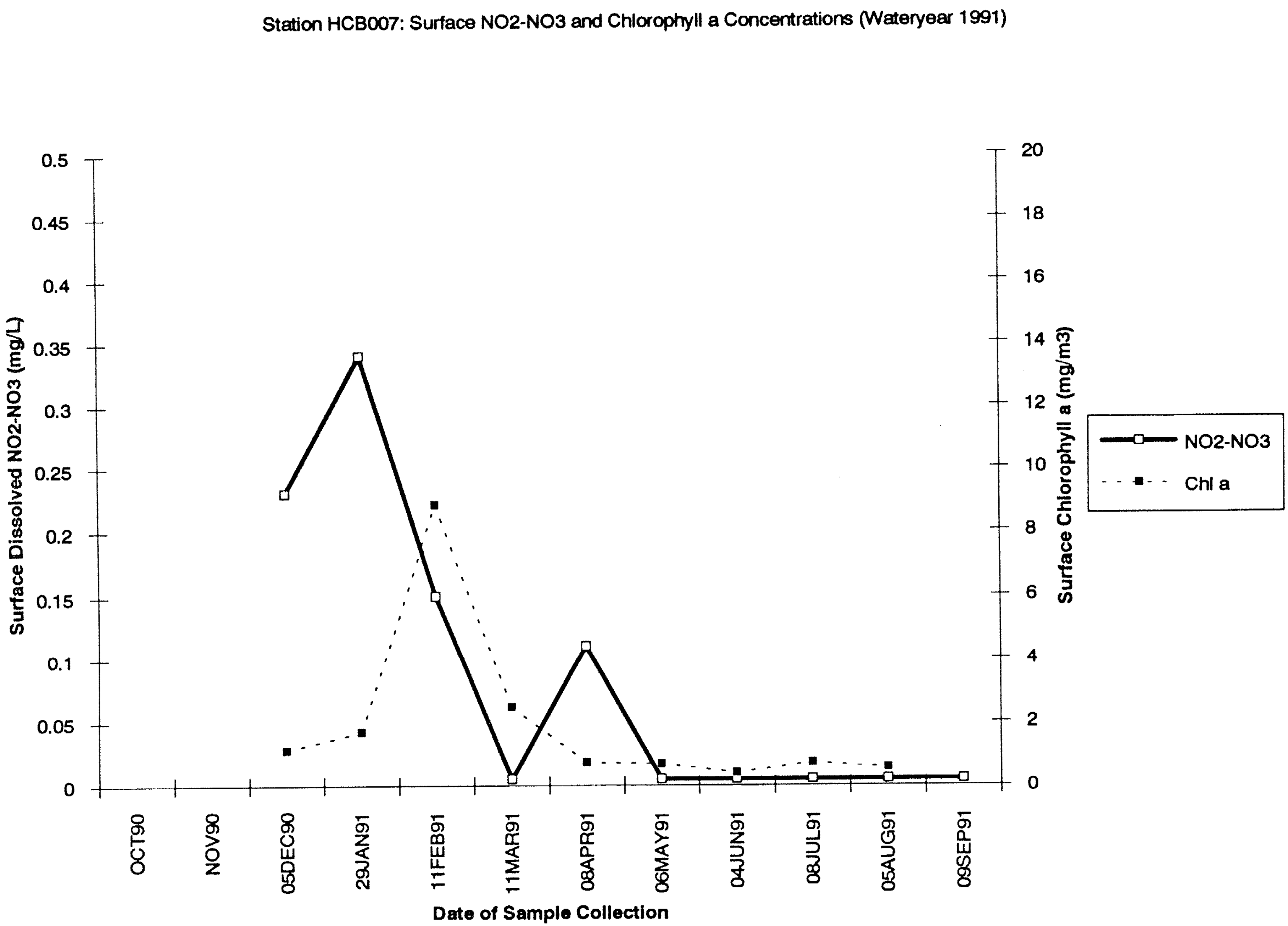
Station HCB003: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)




Station HCB004: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)
Surface Dissolved NO2-NO3 (mg/L)
Surface Chlorophyll a (mg/m3)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
20
18
16
14
12
10
8
6
4
2
0
NO2-NO3 (0 m)
Chl a (0 m)
OCT90
NOV90
05DEC90
29JAN91
11FEB91
11MAR91
08APR91
06MAY91
04JUN91
08JUL91
05AUG91
09SEP91
Date of Sample Collection

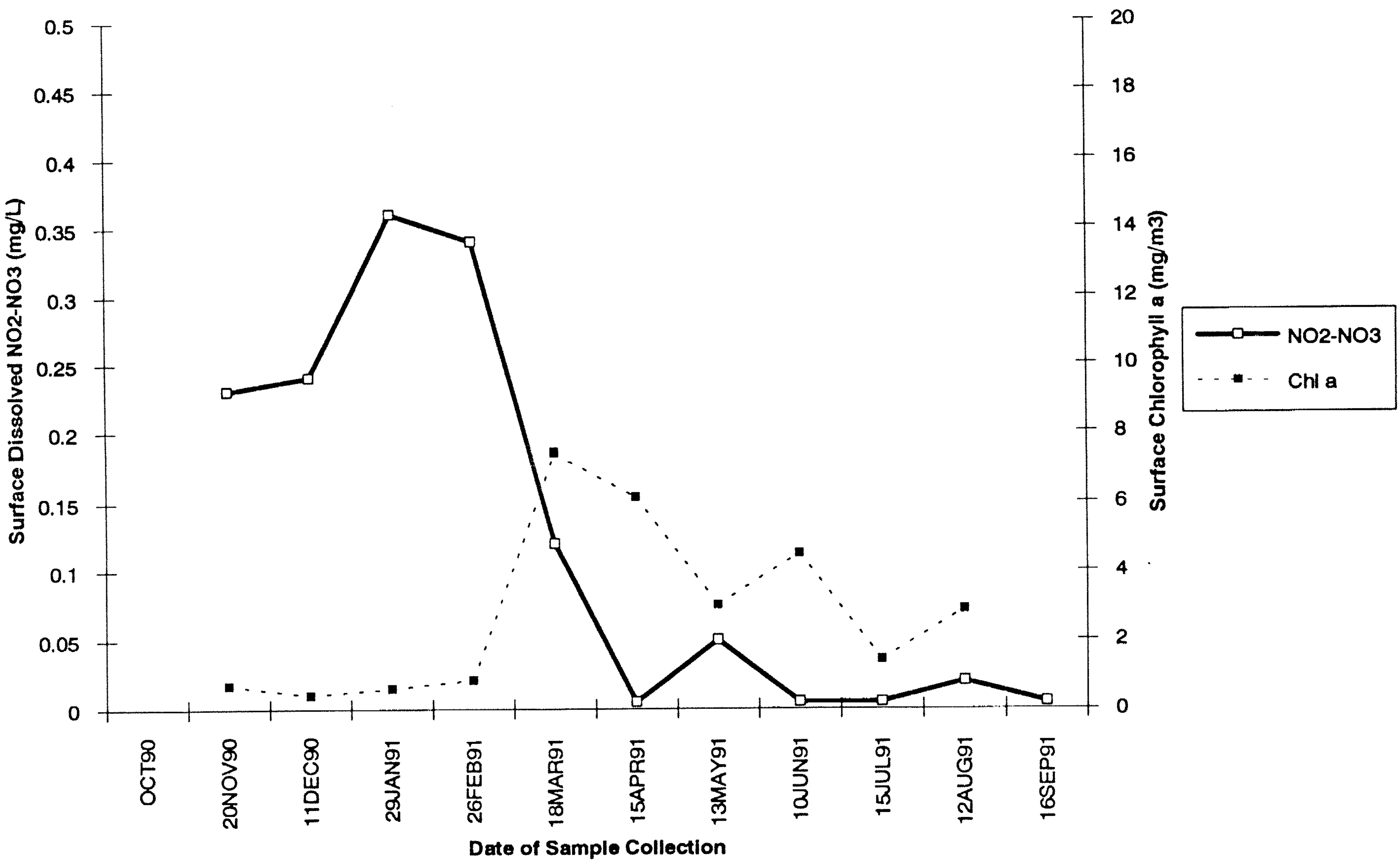
Station HCB006: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



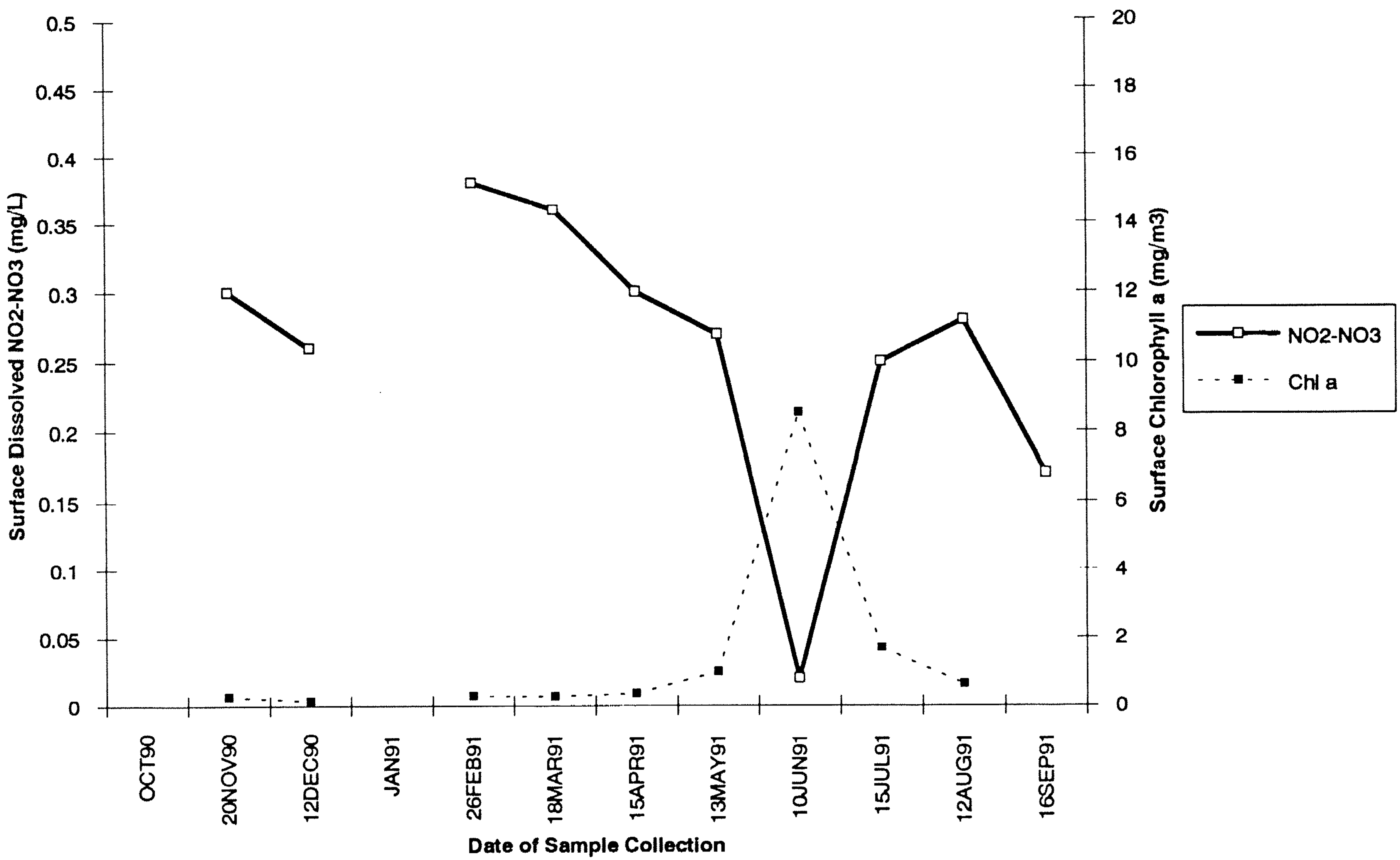


Station HCB007: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)
Surface Dissolved NO2-NO3 (mg/L)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Surface Chlorophyll a (mg/m3)
20
18
16
14
12
10
8
6
4
2
0
NO2-NO3
Chl a
OCT90
NOV90
05DEC90
29JAN91
11FEB91
11MAR91
08APR91
06MAY91
04JUN91
08JUL91
05AUG91
09SEP91
Date of Sample Collection

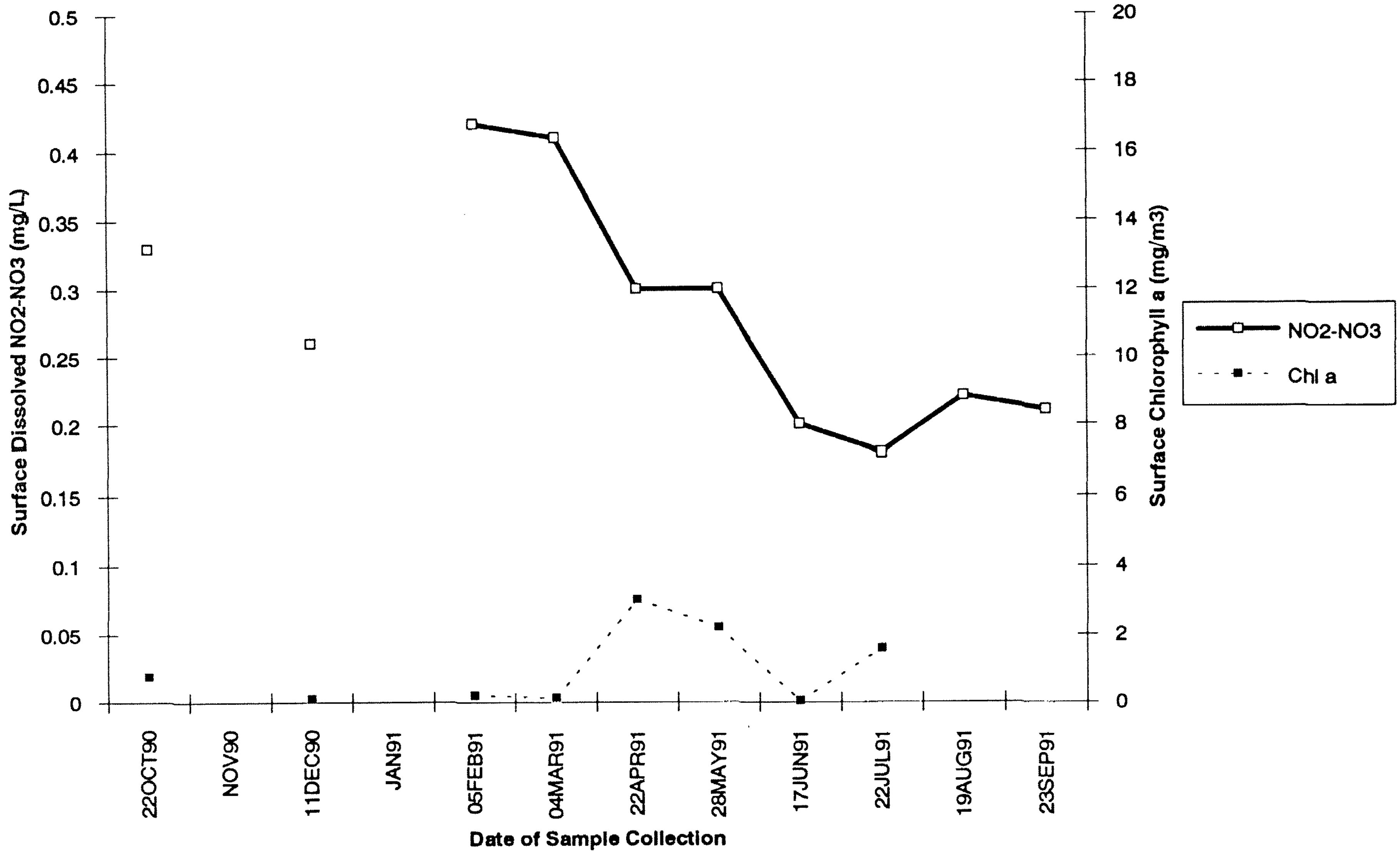
Station JDF005: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



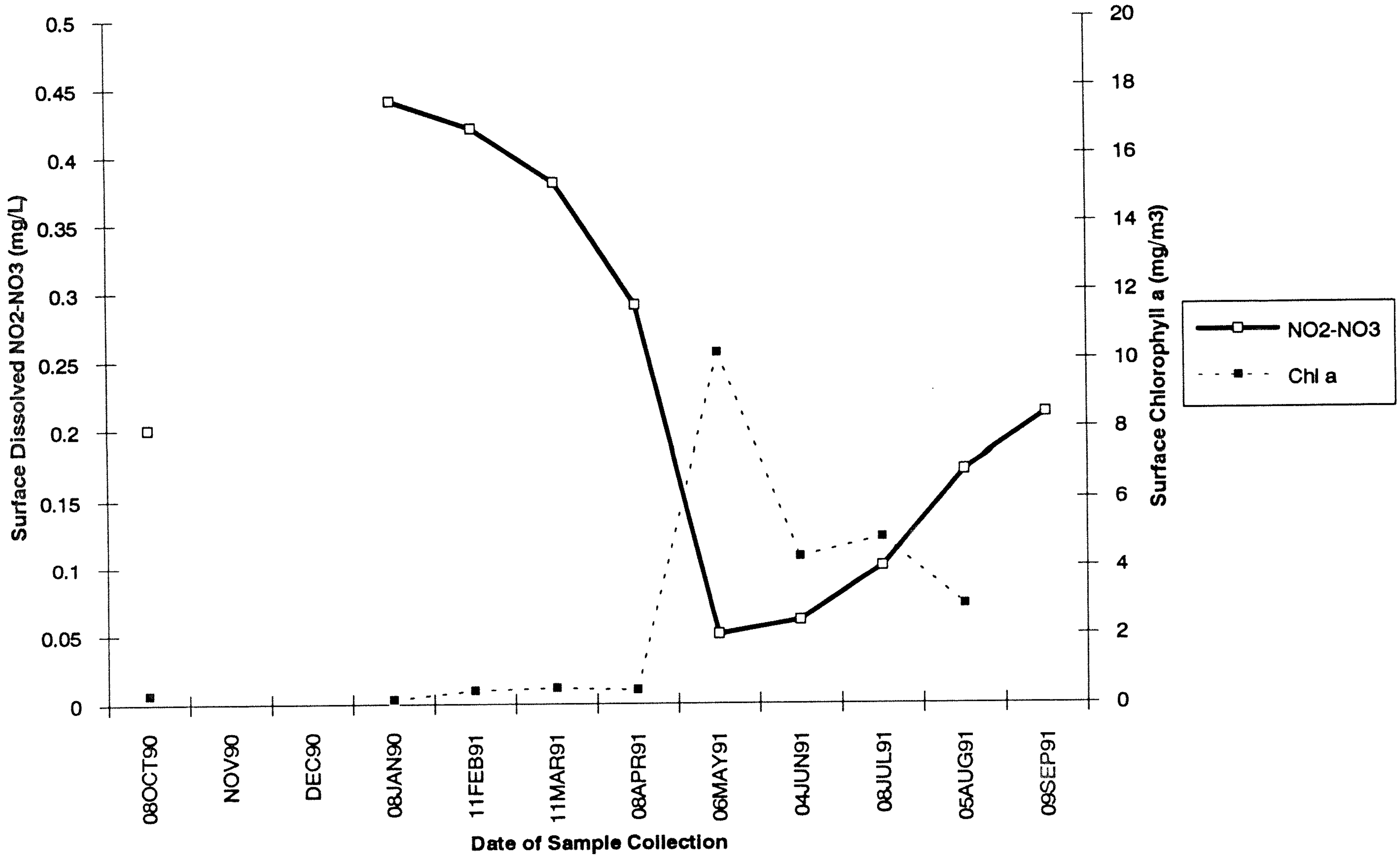
Station LOP001: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)

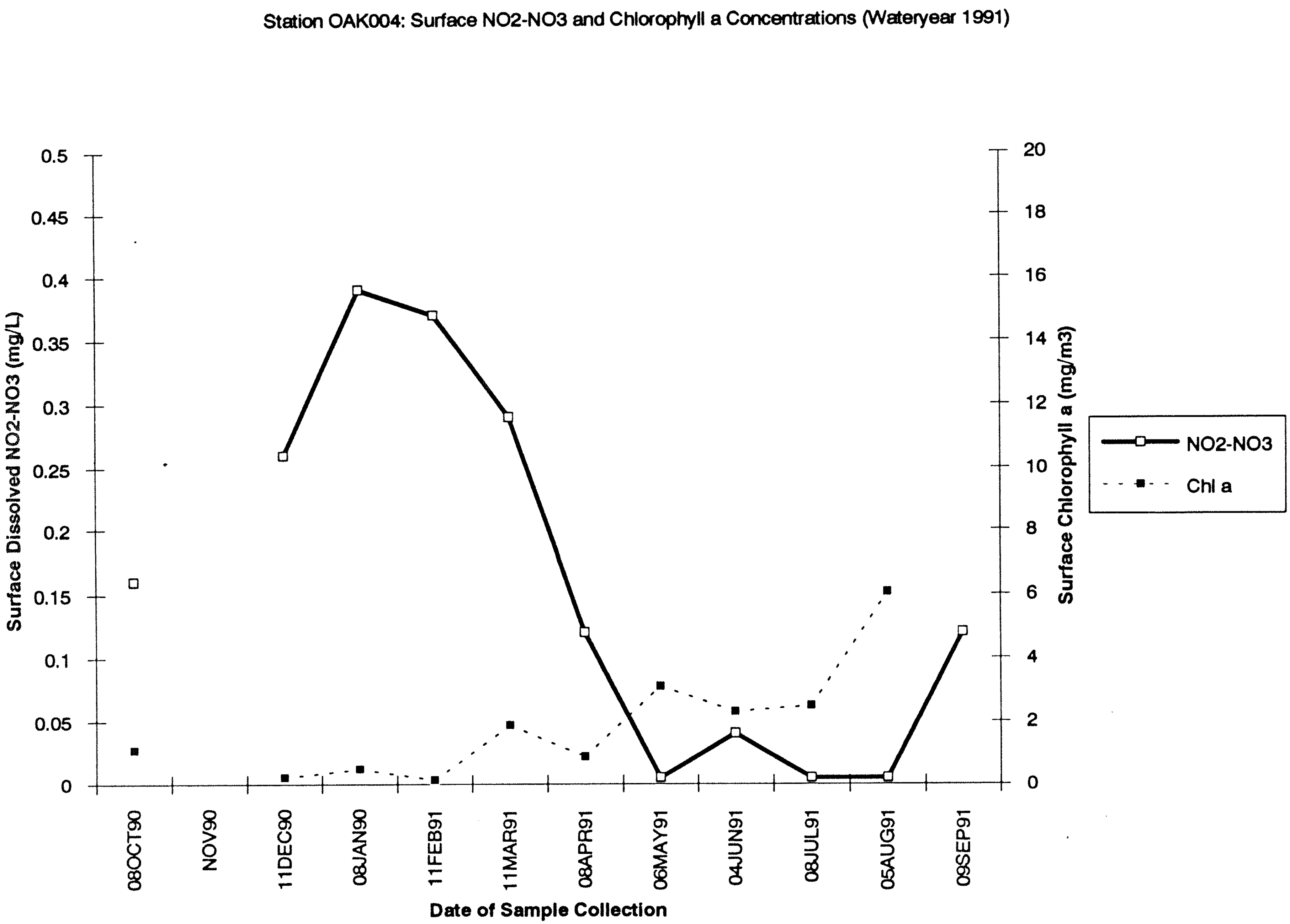


Station NRR001: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



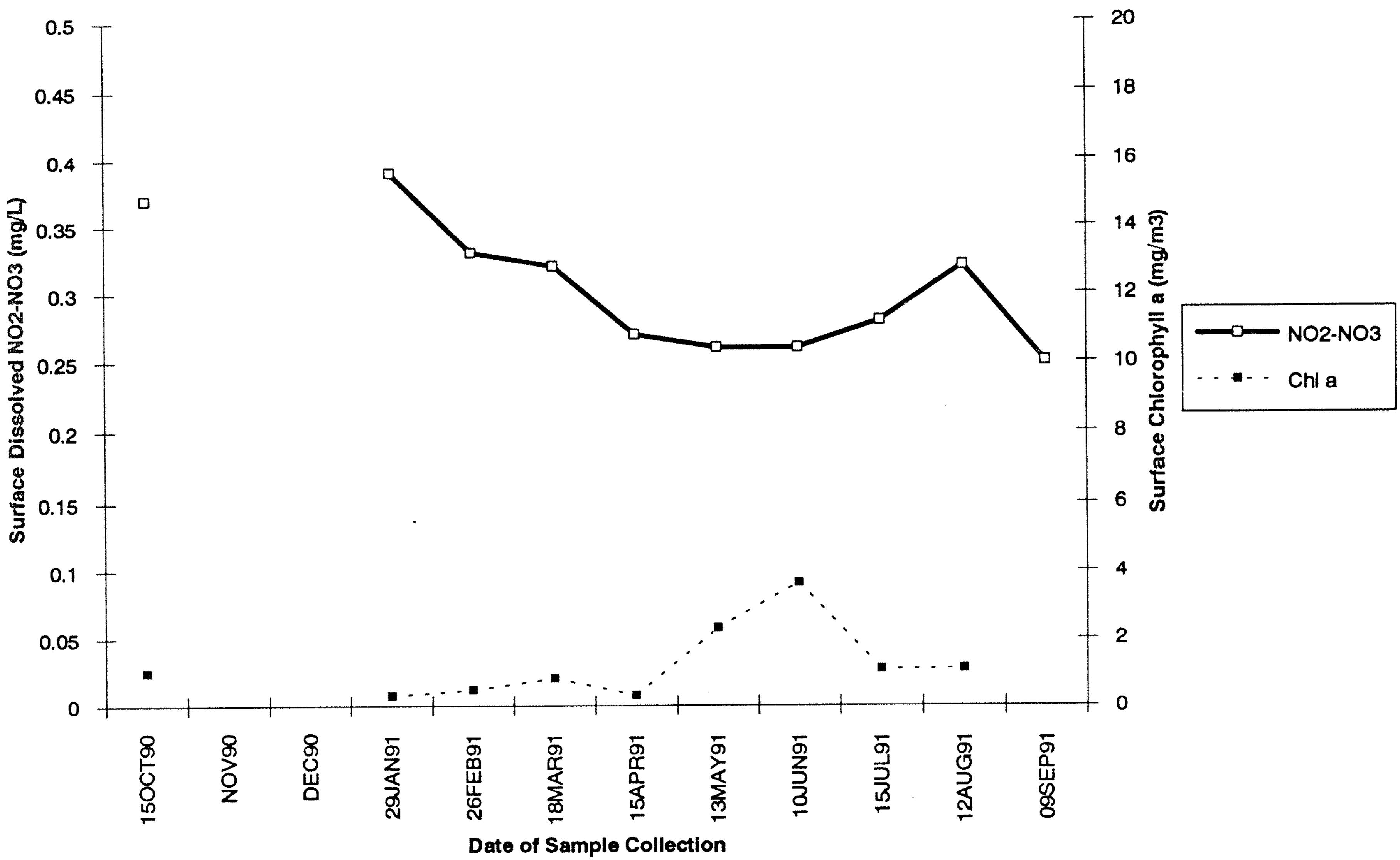
Station NSQ001: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



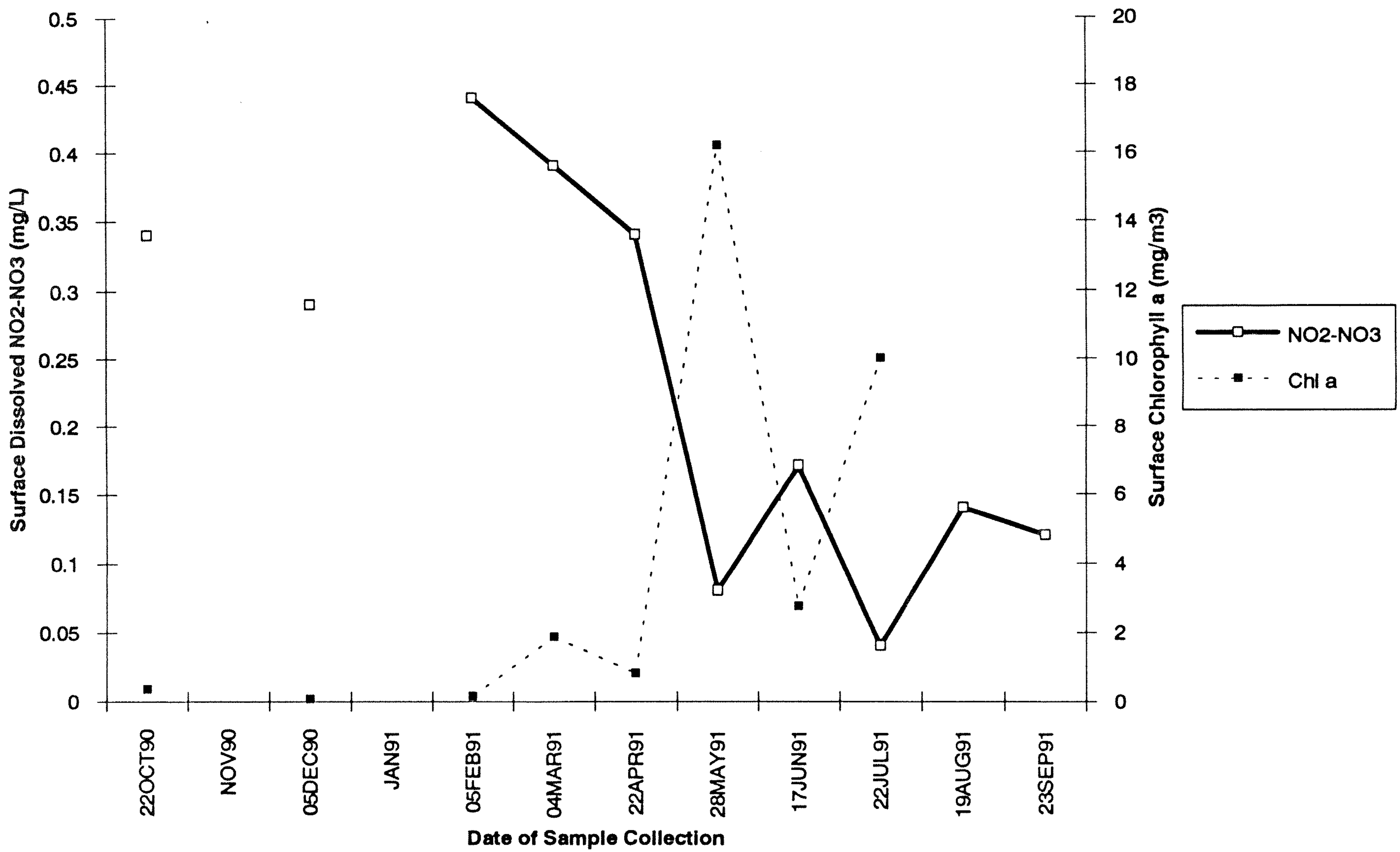


Station OAK004: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)
Surface Dissolved NO2-NO3 (mg/L)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Surface Chlorophyll a (mg/m3)
20
18
16
14
12
10
8
6
4
2
0
NO2-NO3
Chl a
08OCT90
NOV90
11DEC90
08JAN90
11FEB91
11MAR91
08APR91
06MAY91
04JUN91
08JUL91
05AUG91
09SEP91
Date of Sample Collection

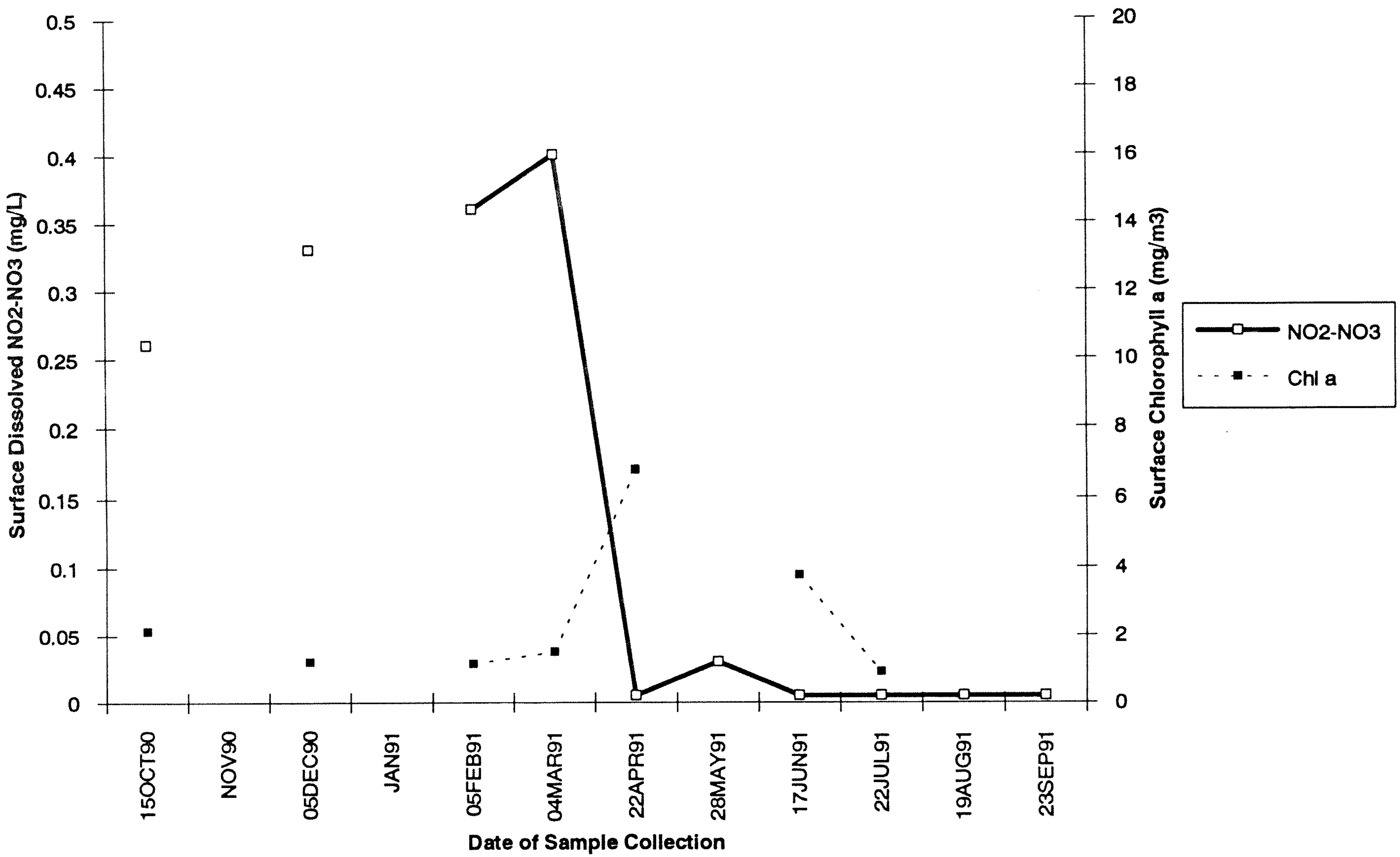
Station PAH008: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



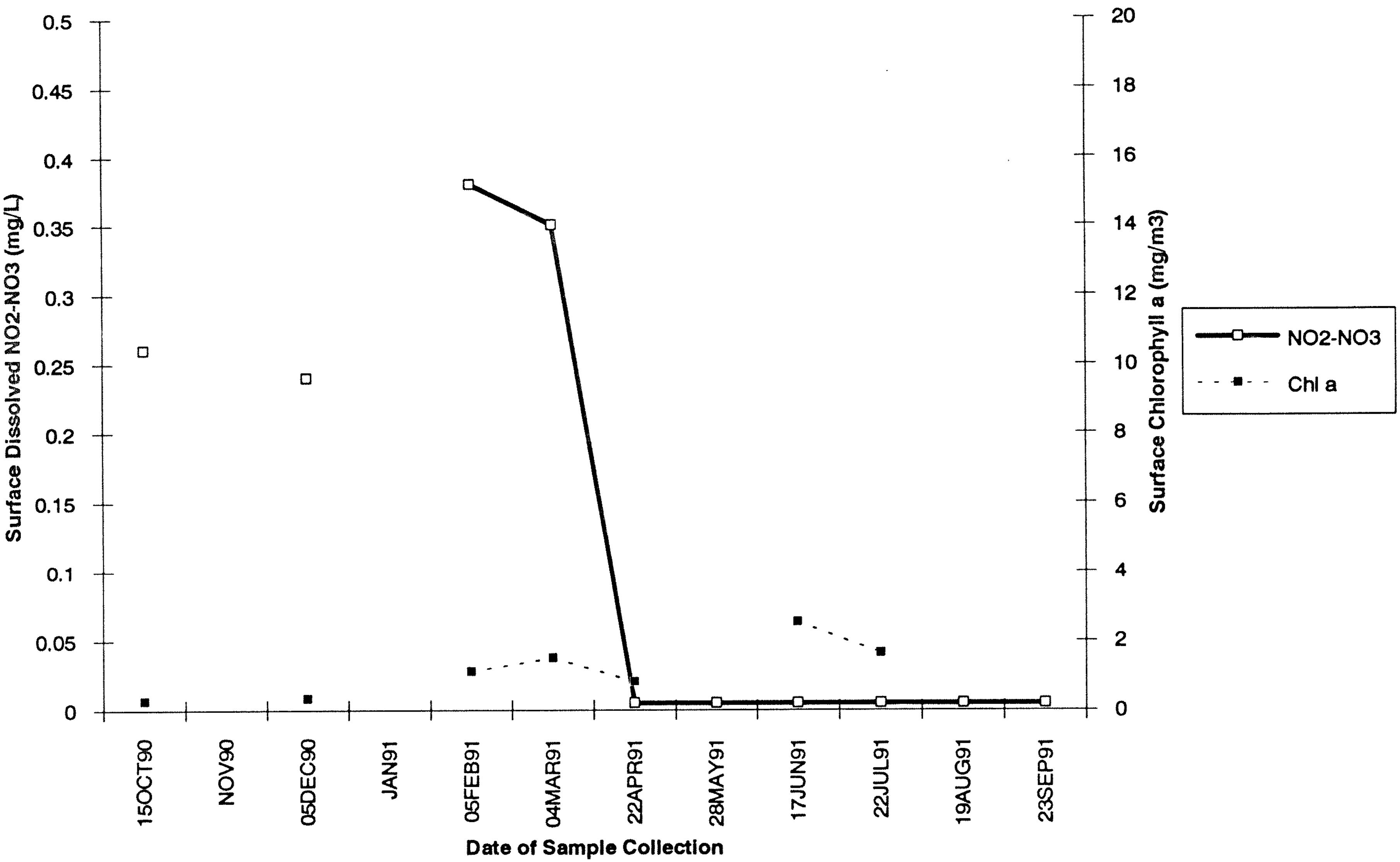
Station PSB003: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



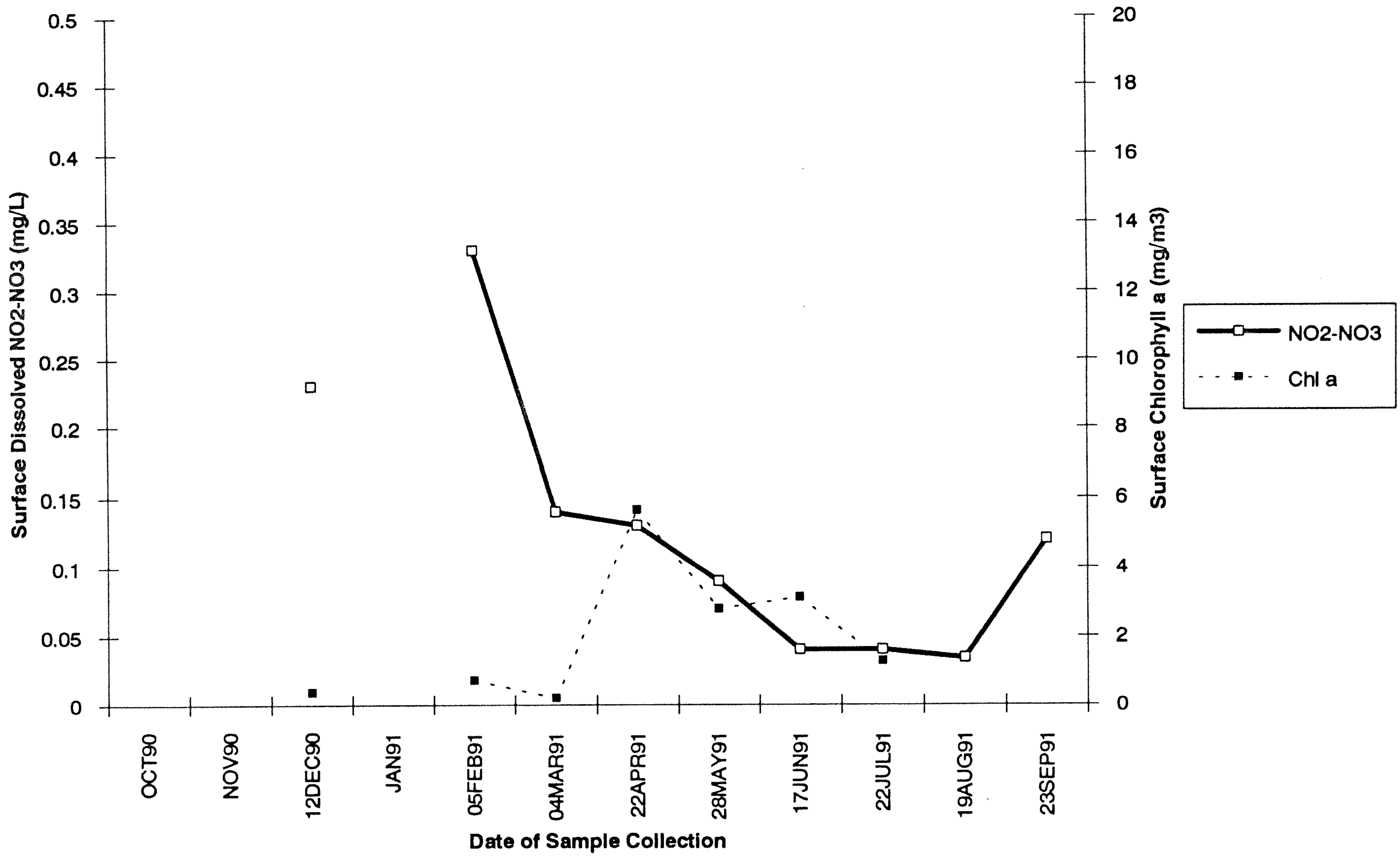
Station PSS019: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



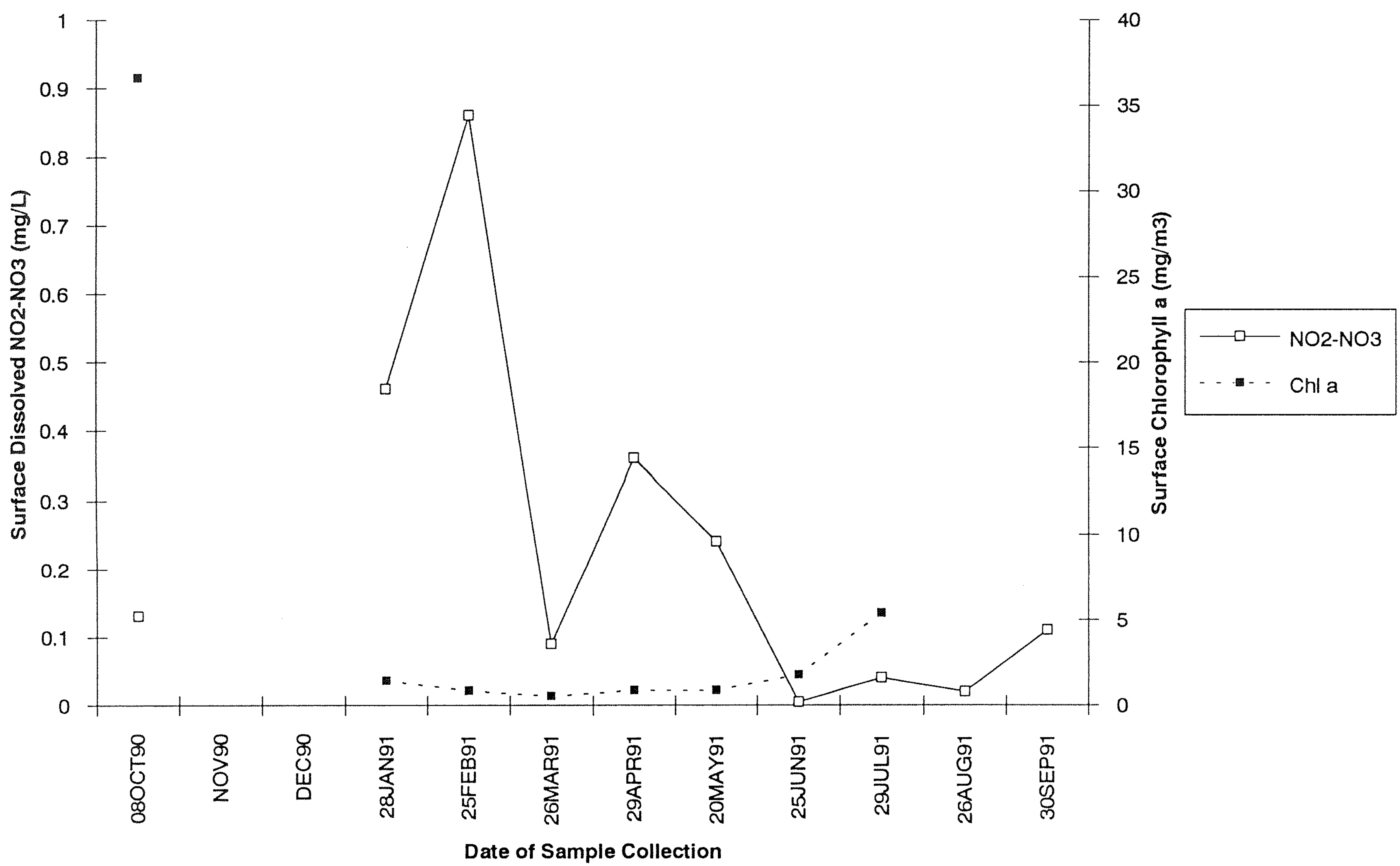
Station SAR003: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



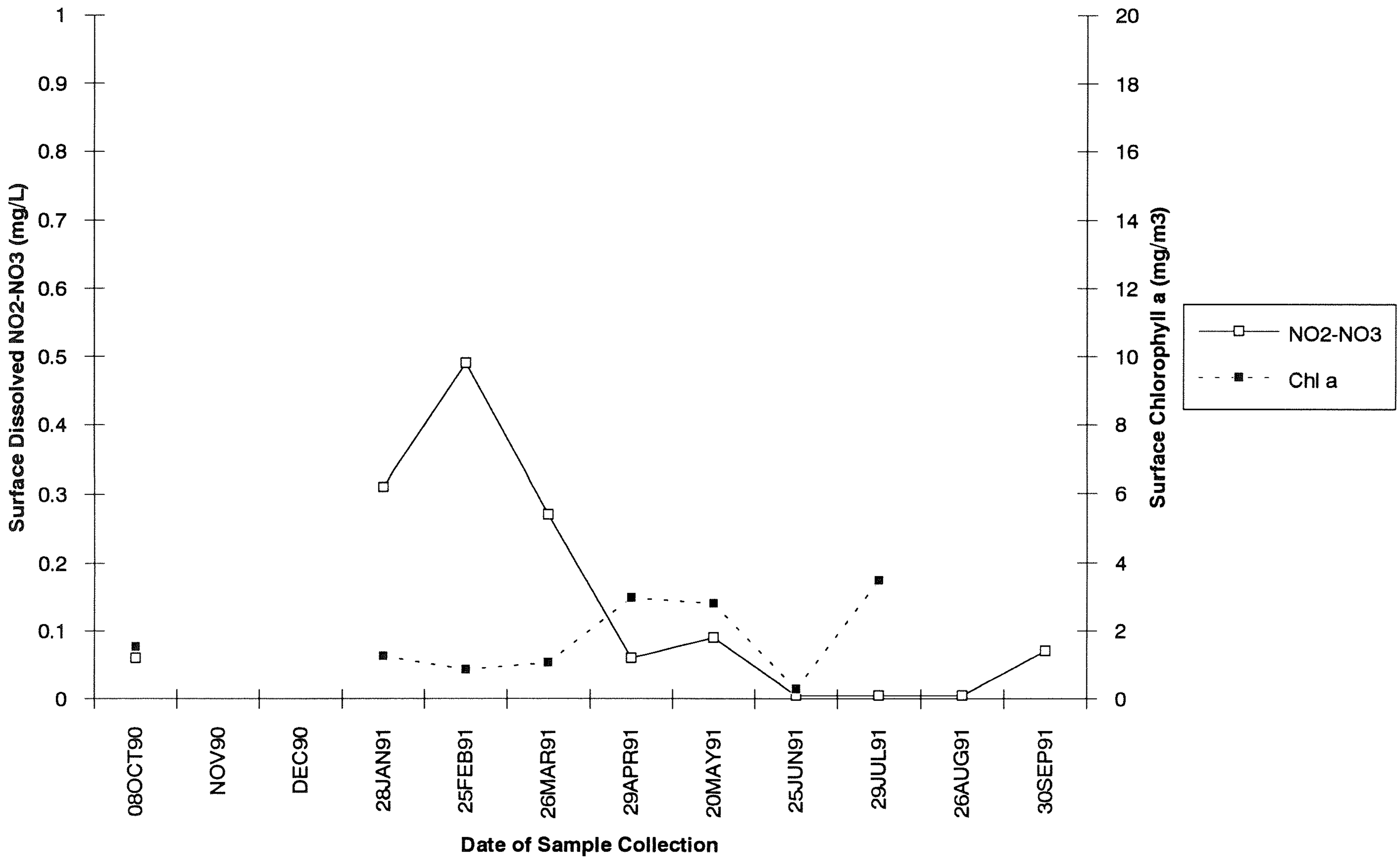
Station SKG003: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



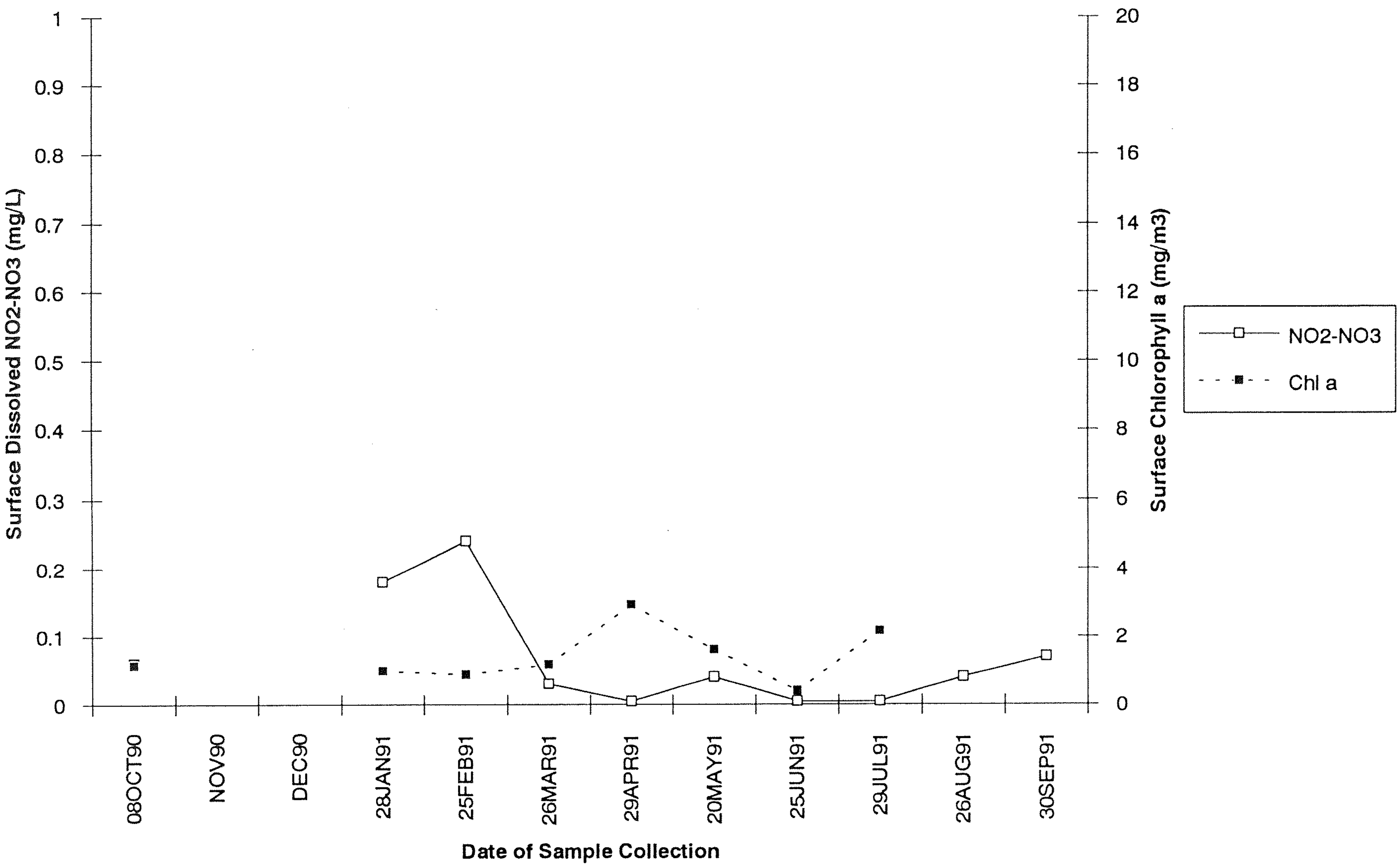
Station WPA001: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



Station WPA003: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



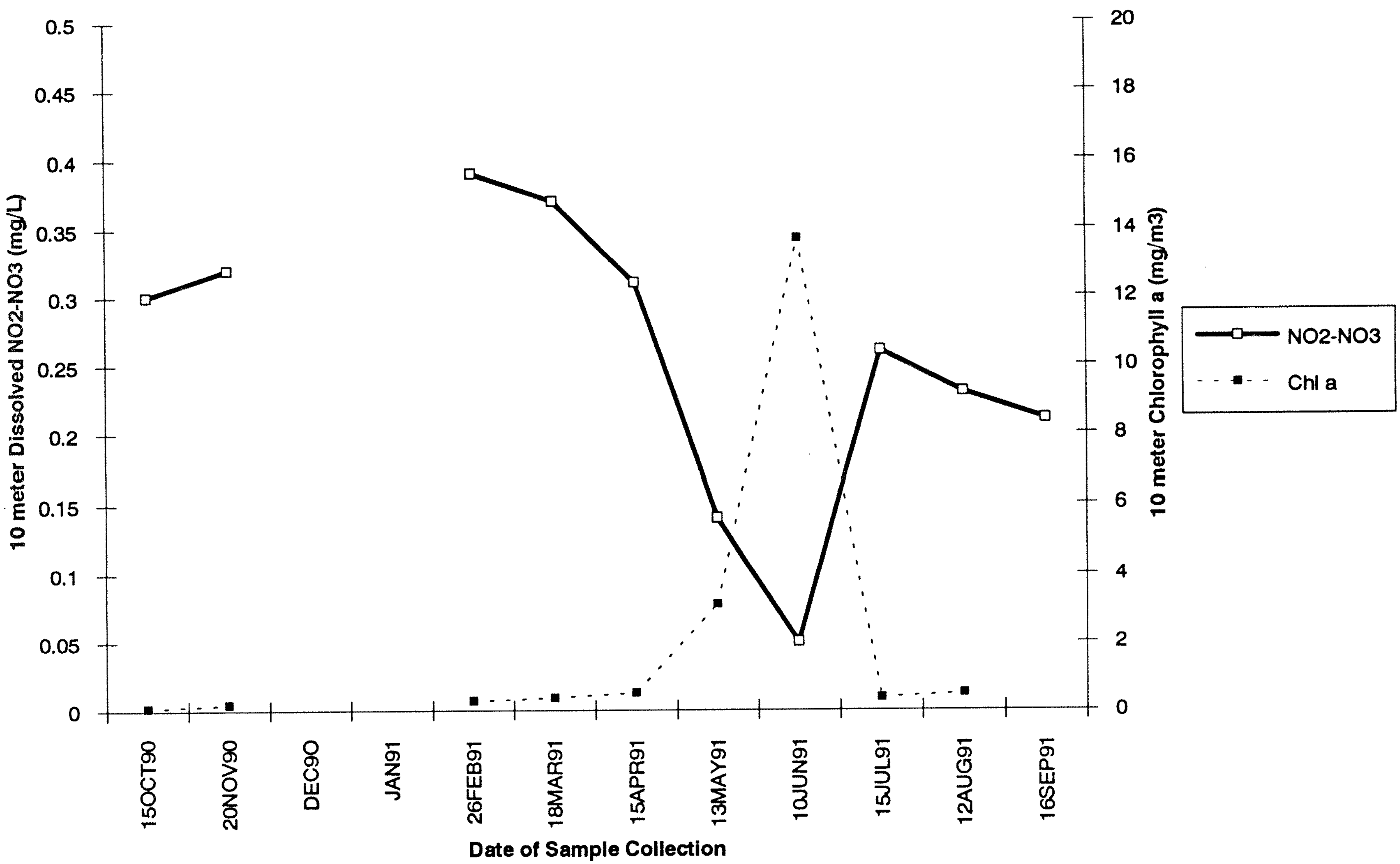
Station WPA004: Surface NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



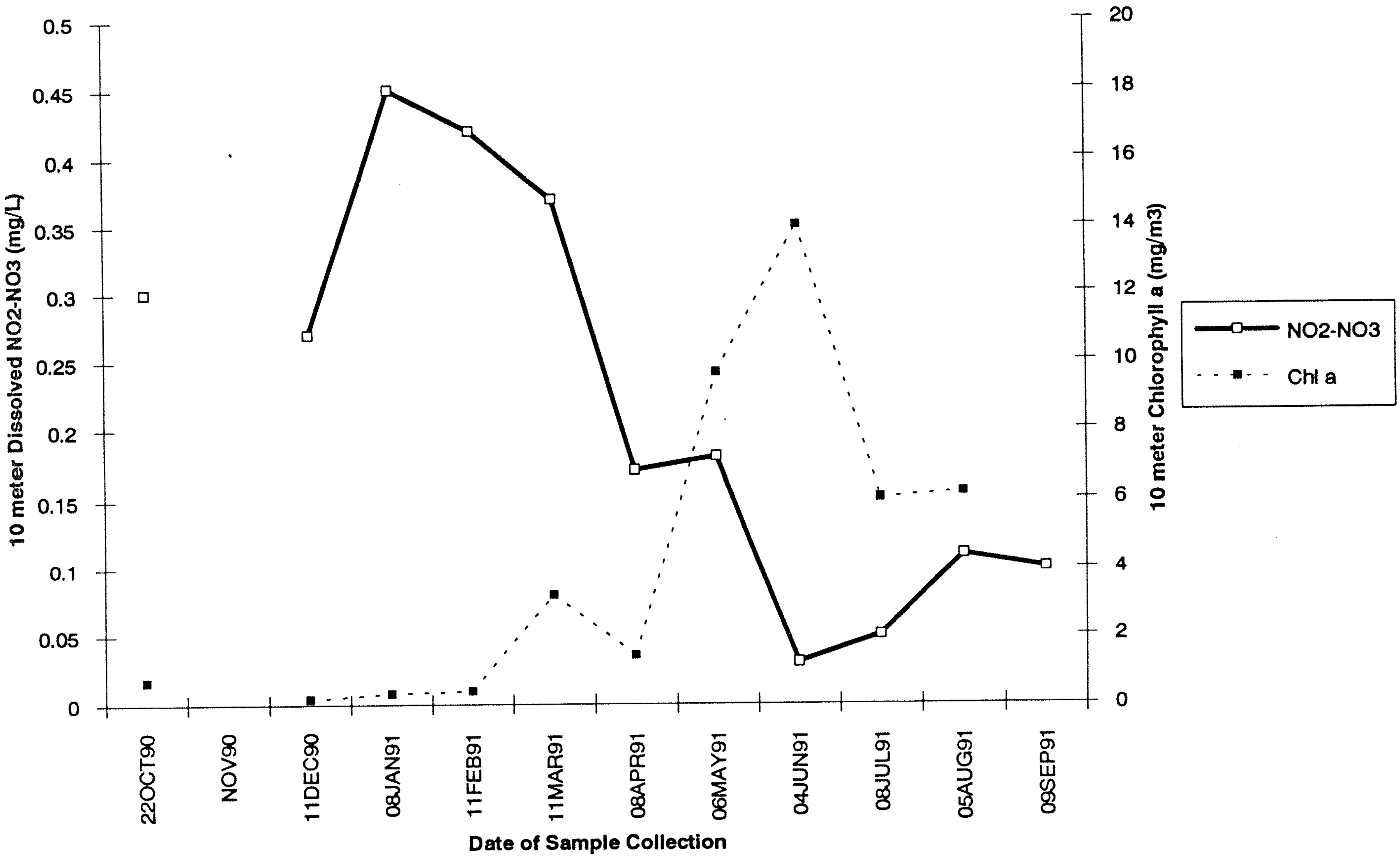
APPENDIX J

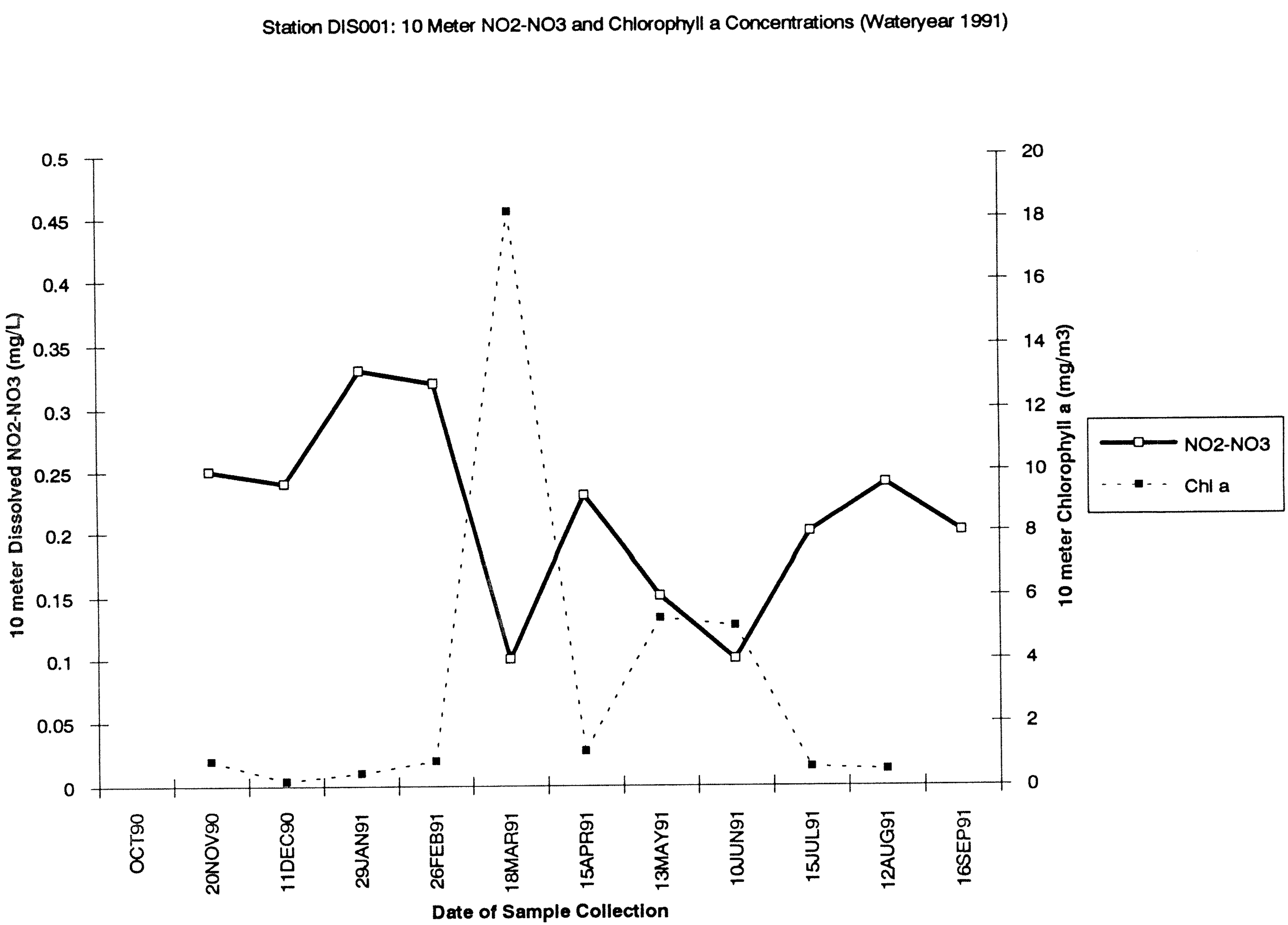
PLOTS OF 10-METER NUTRIENT AND CHLOROPHYLL A CONCENTRATIONS FOR SELECT WY 1991 STATIONS

Station BLL009: 10 Meter NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)

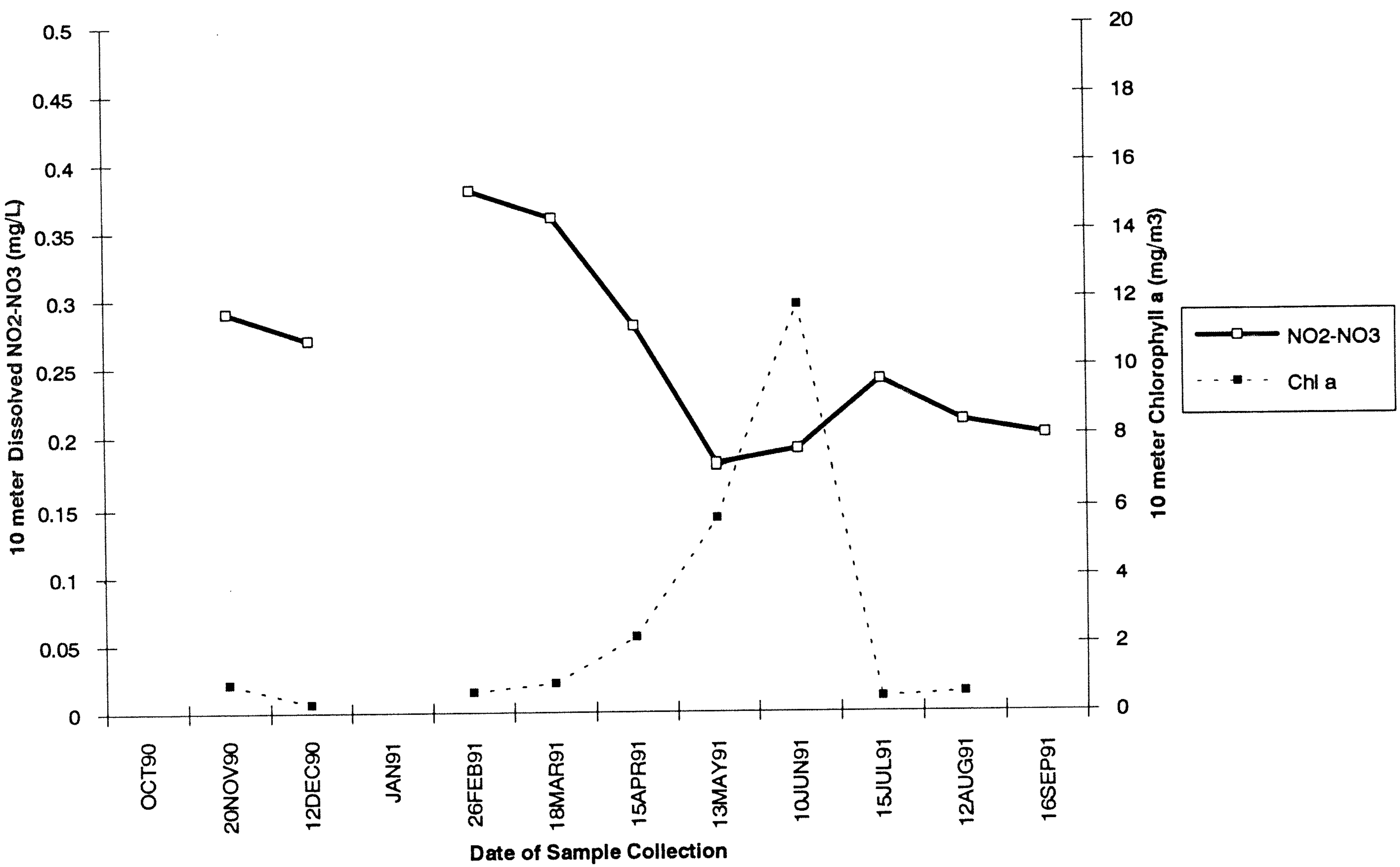


Station CSE001: 10 Meter NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)

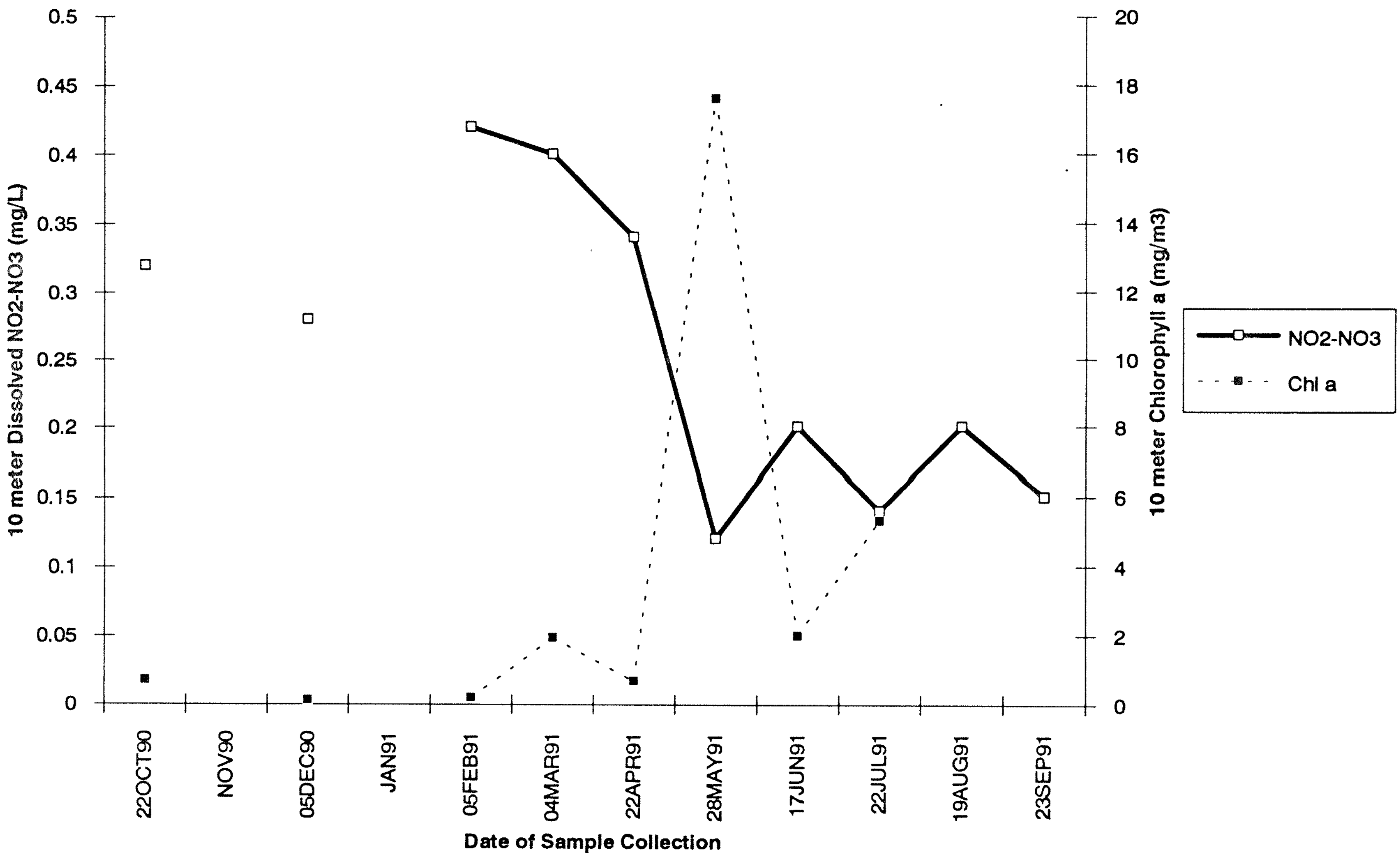



Station DIS001: 10 Meter NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
10 meter Dissolved NO2-NO3 (mg/L)
20
18
16
14
12
10
8
6
4
2
0
10 meter Chlorophyll a (mg/m3)
NO2-NO3
Chl a
OCT90
20NOV90
11DEC90
29JAN91
26FEB91
18MAR91
15APR91
13MAY91
10JUN91
15JUL91
12AUG91
16SEP91
Date of Sample Collection

Station EAS001: 10 Meter NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



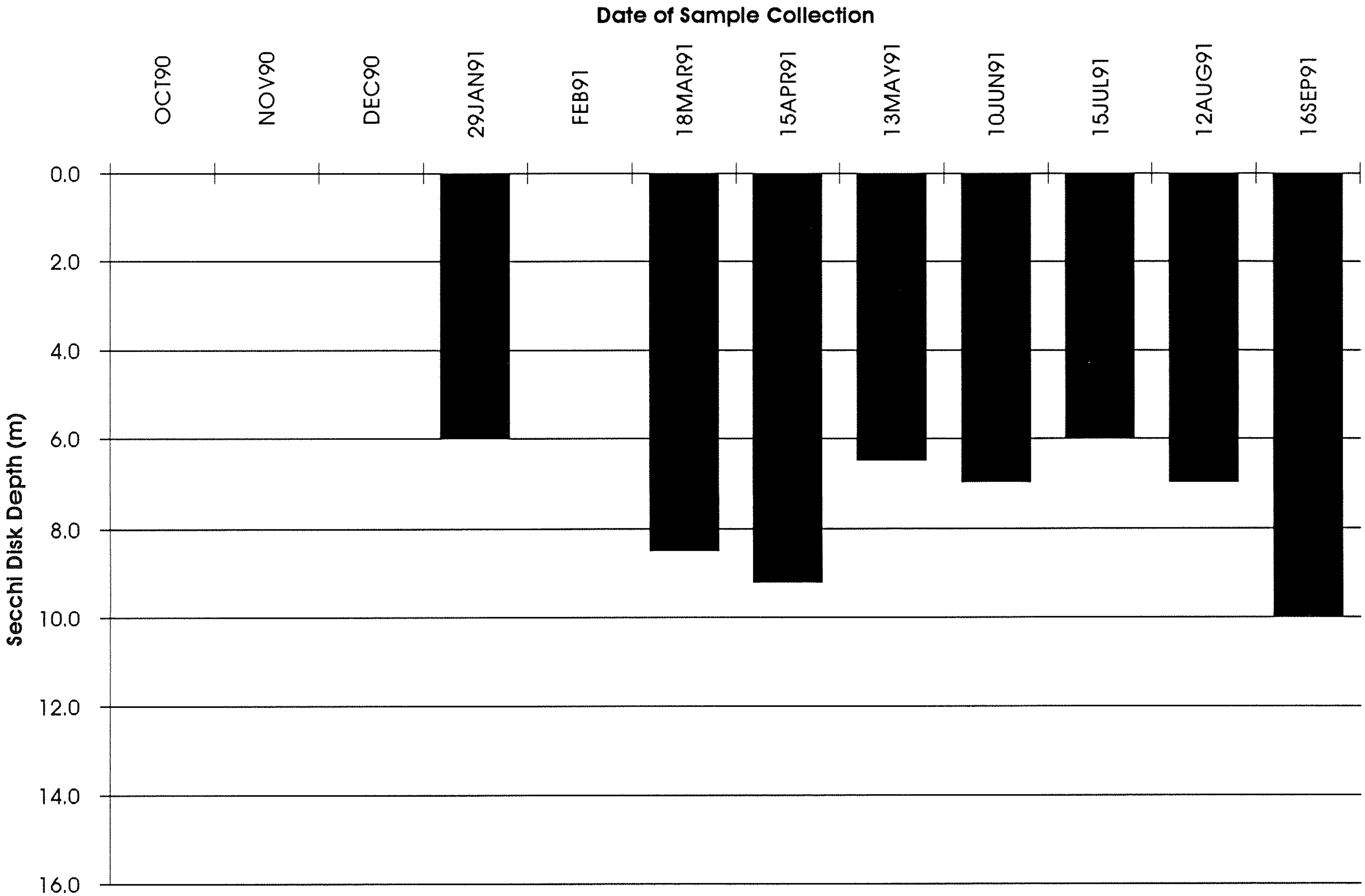
Station PSB003: 10 Meter NO2-NO3 and Chlorophyll a Concentrations (Wateryear 1991)



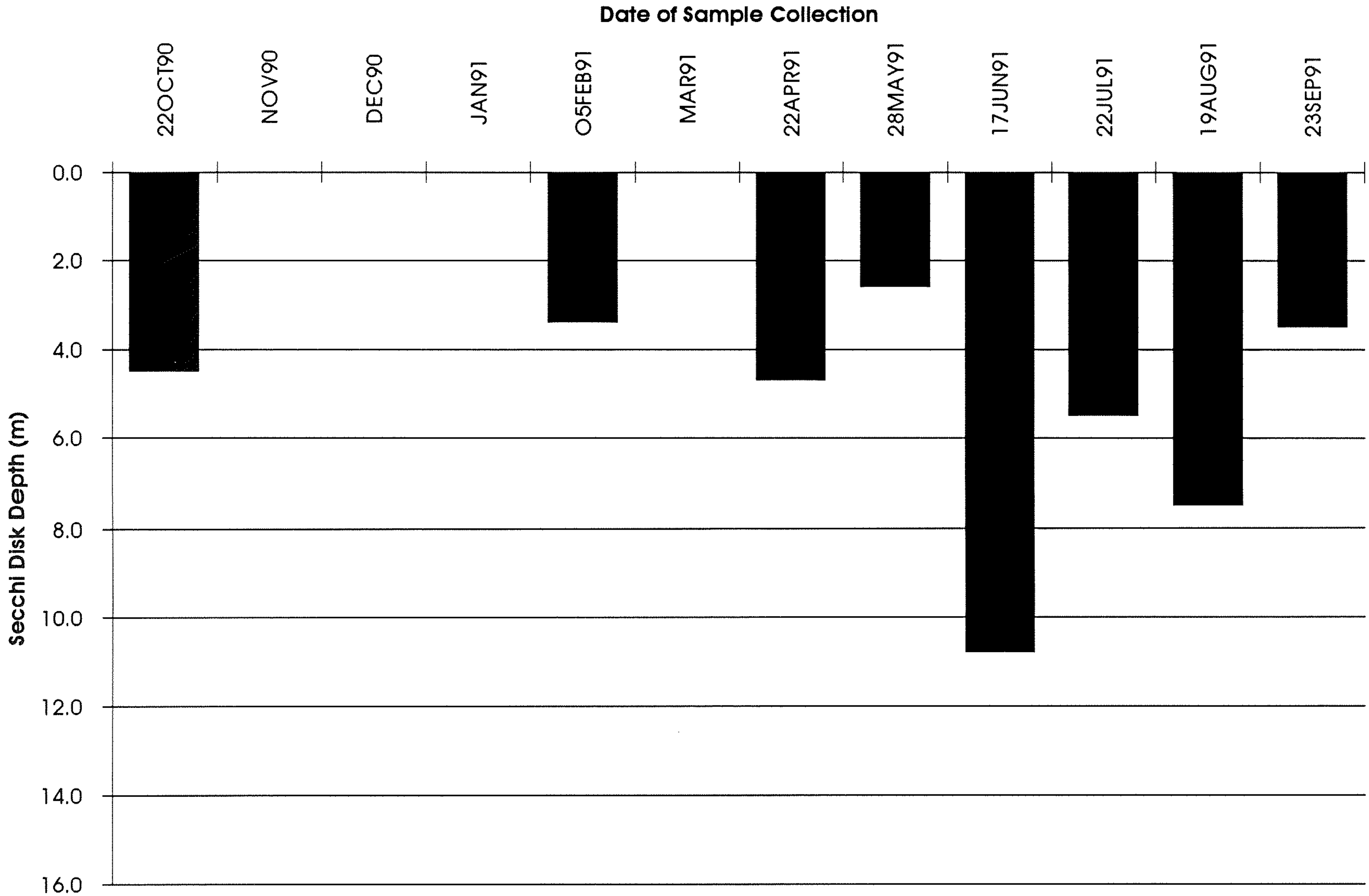
APPENDIX K

TIME SERIES BAR GRAPHS OF SECCHI DEPTH MEASUREMENTS FOR ALL WY 1991 STATIONS

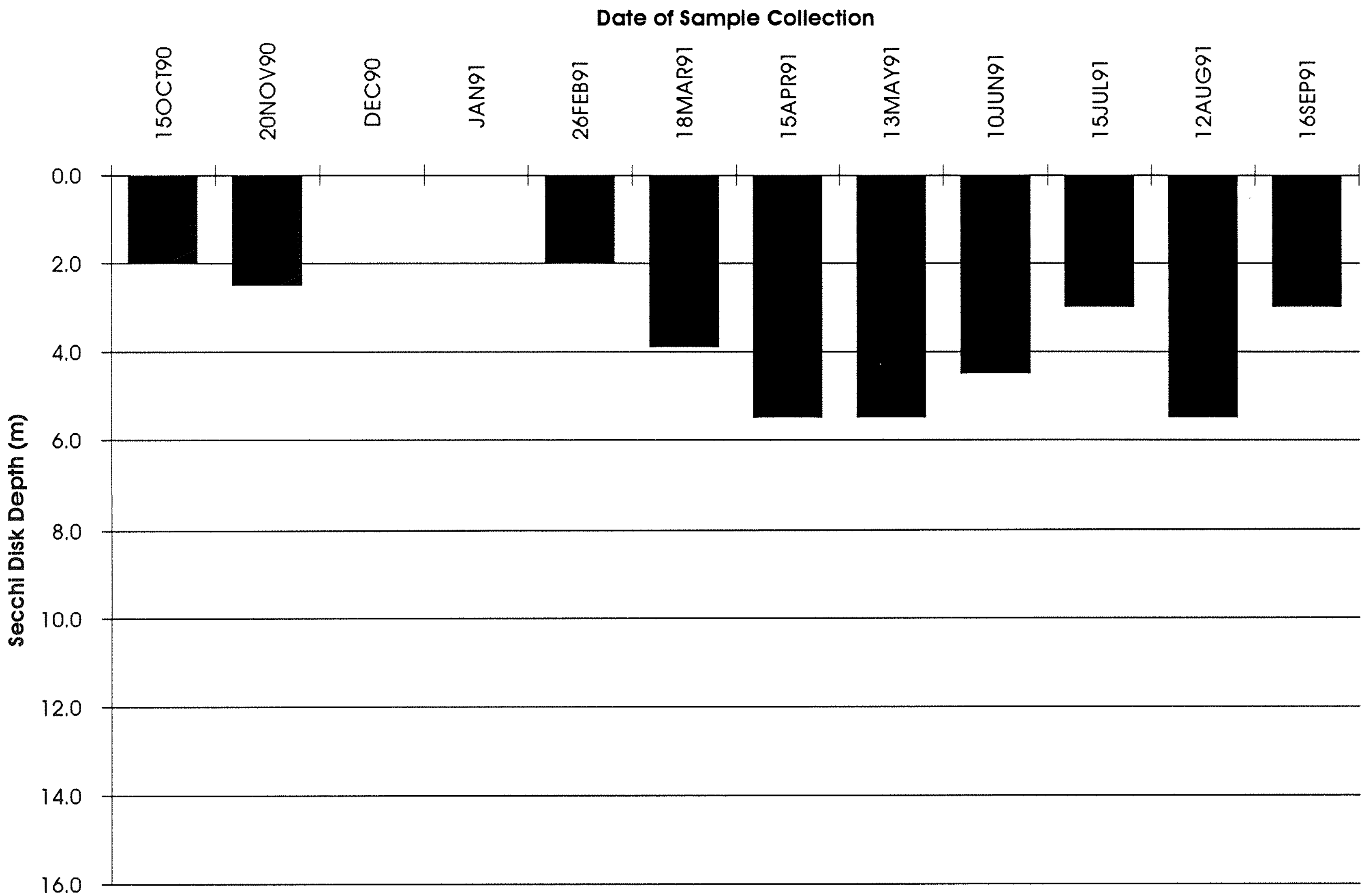
Station ADM002: Secchi Disk Depths for Wateryear 1991



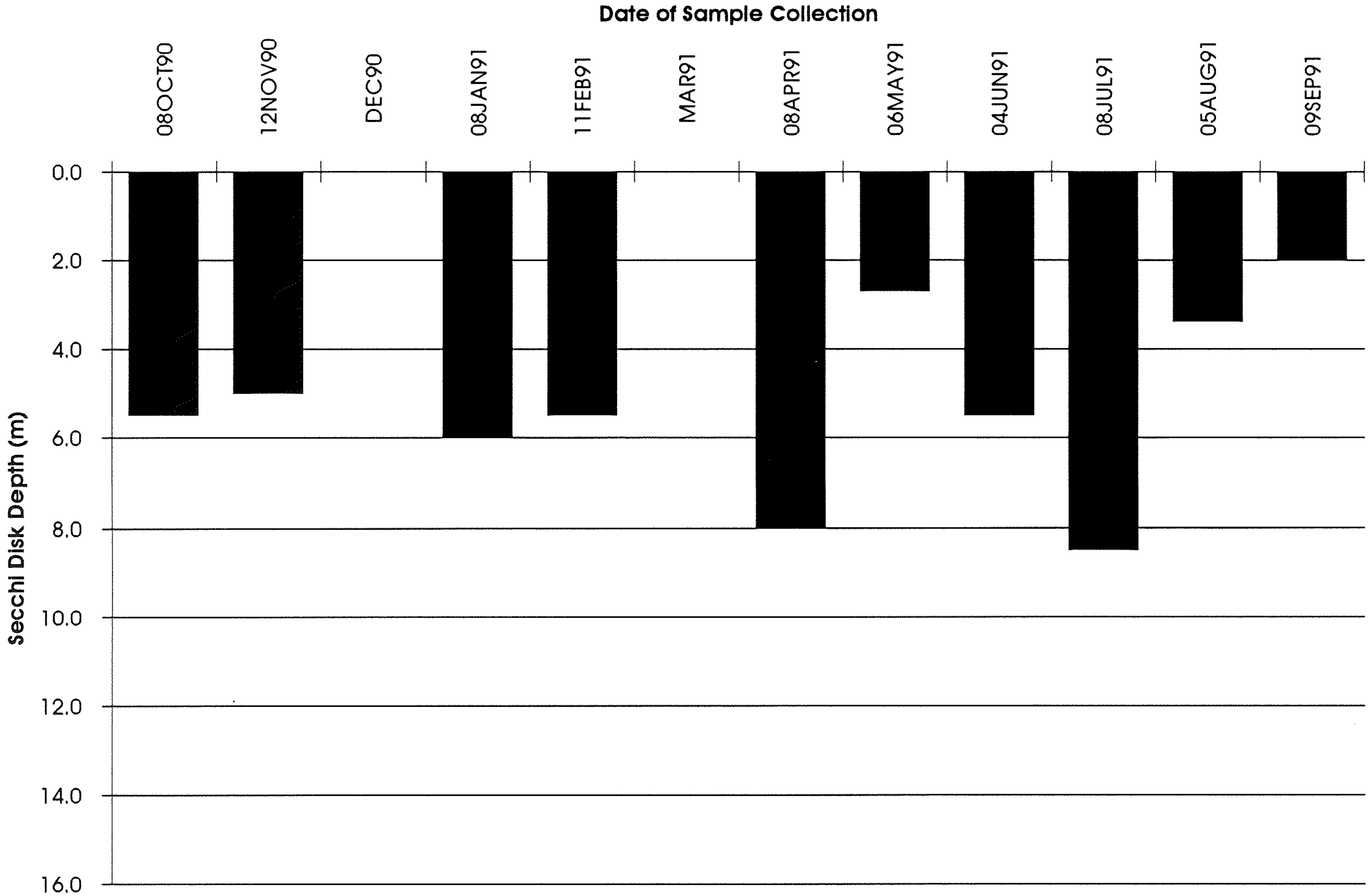
Station ADM003: Secchi Disk Depths for Wateryear 1991



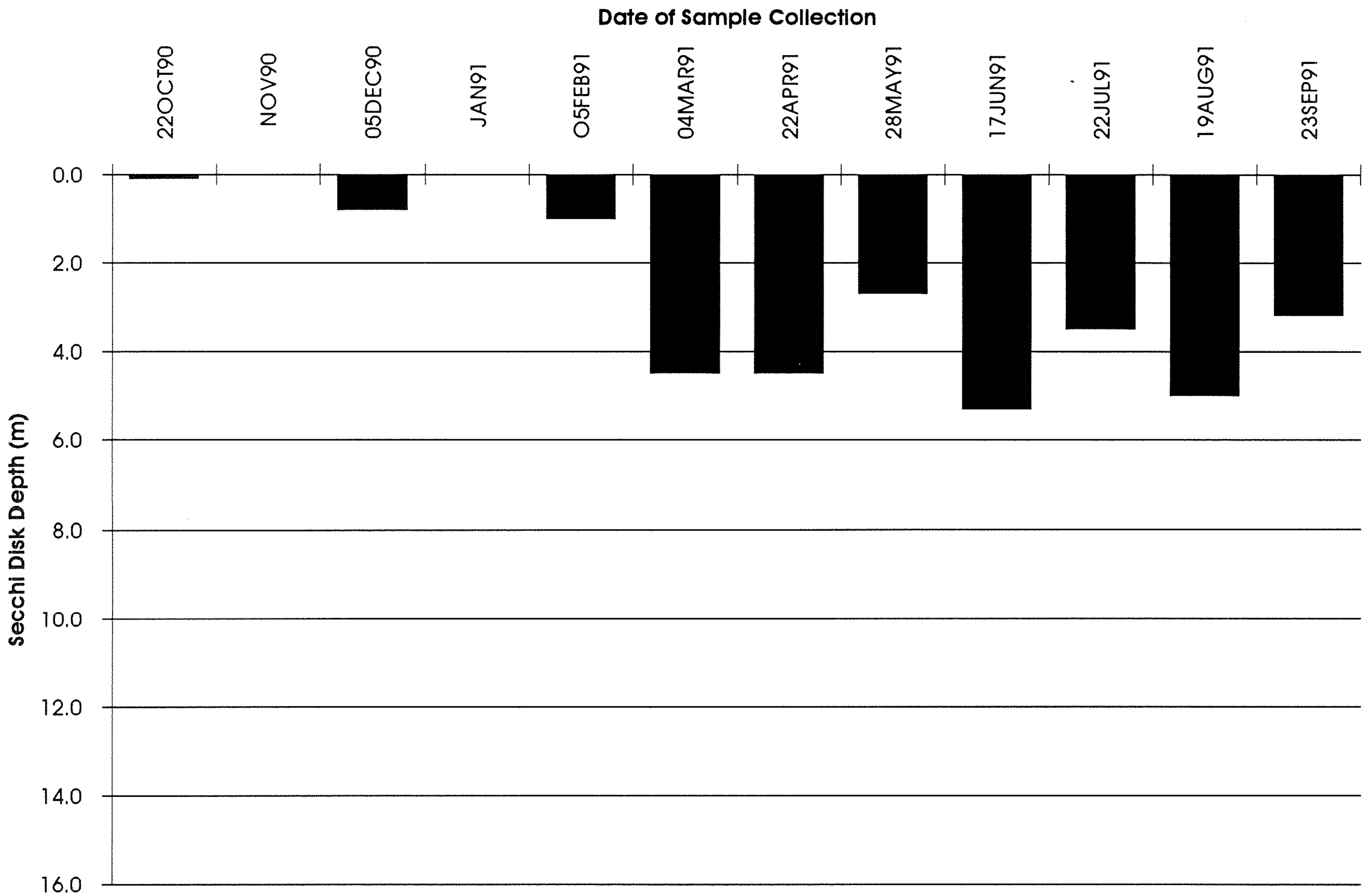
Station BLL009: Secchi Disk Depths for Wateryear 1991



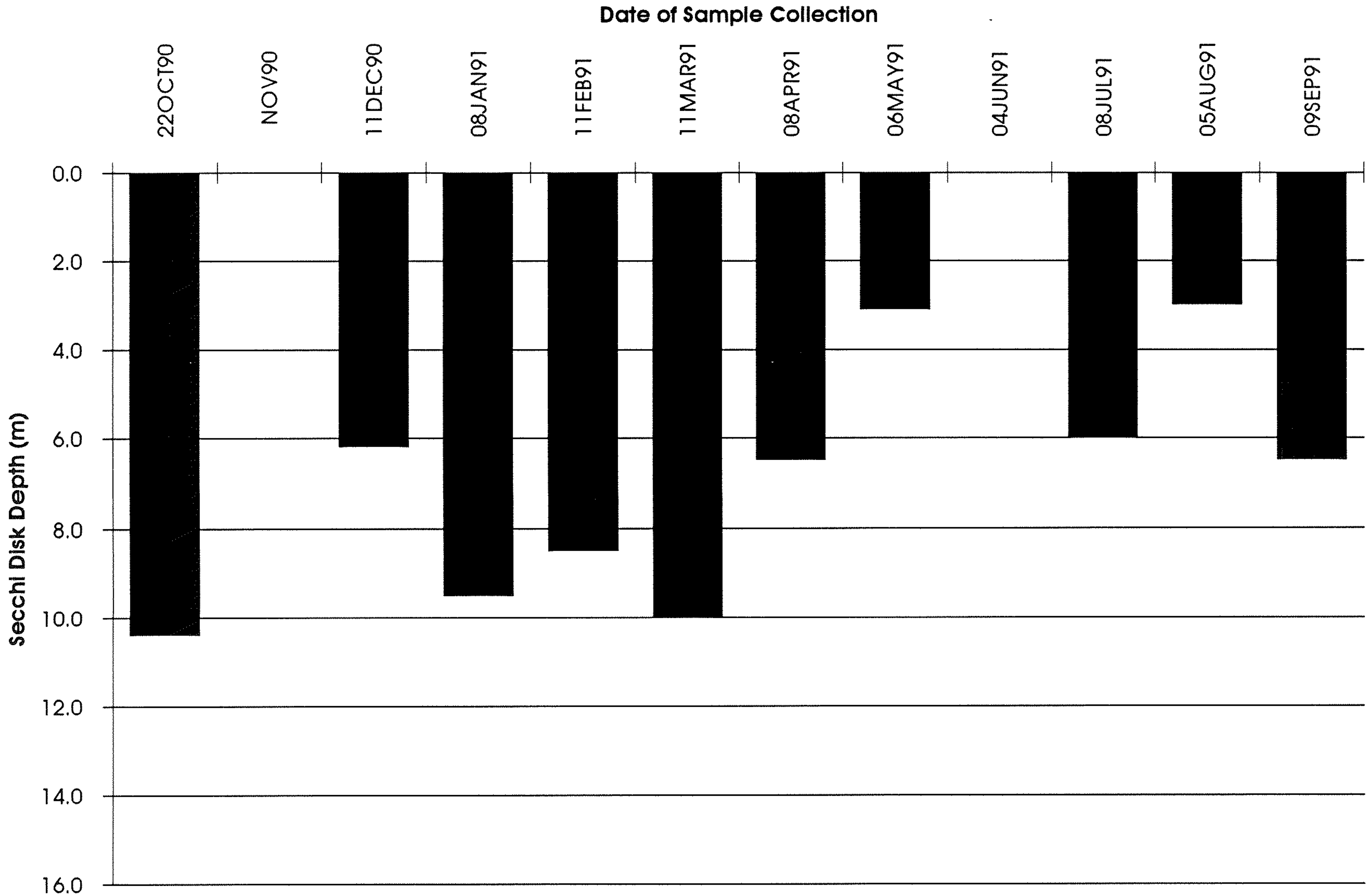
Station BUD005: Secchi Disk Depths for Wateryear 1991



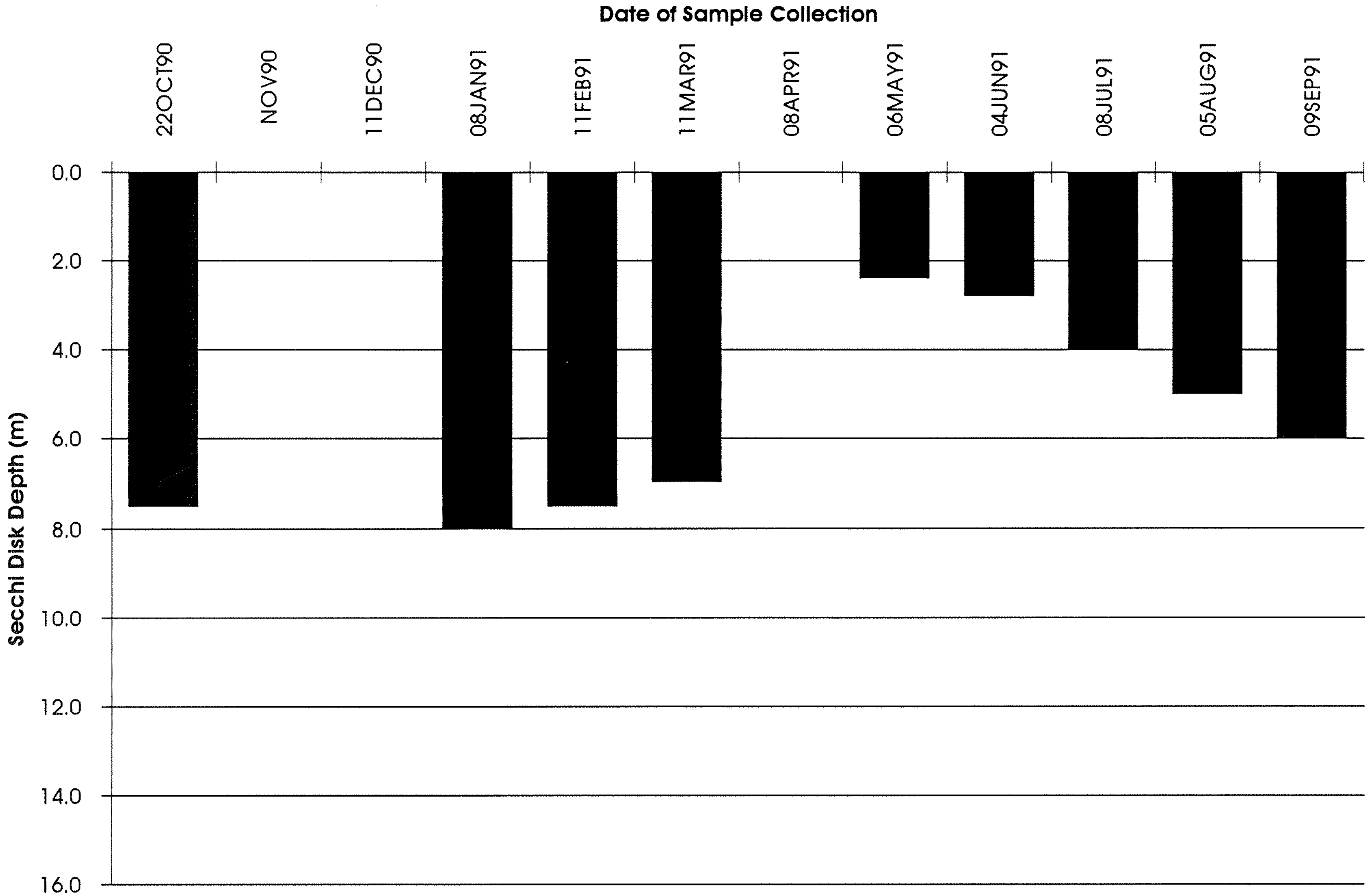
Station CMB003: Secchi Disk Depths for Wateryear 1991



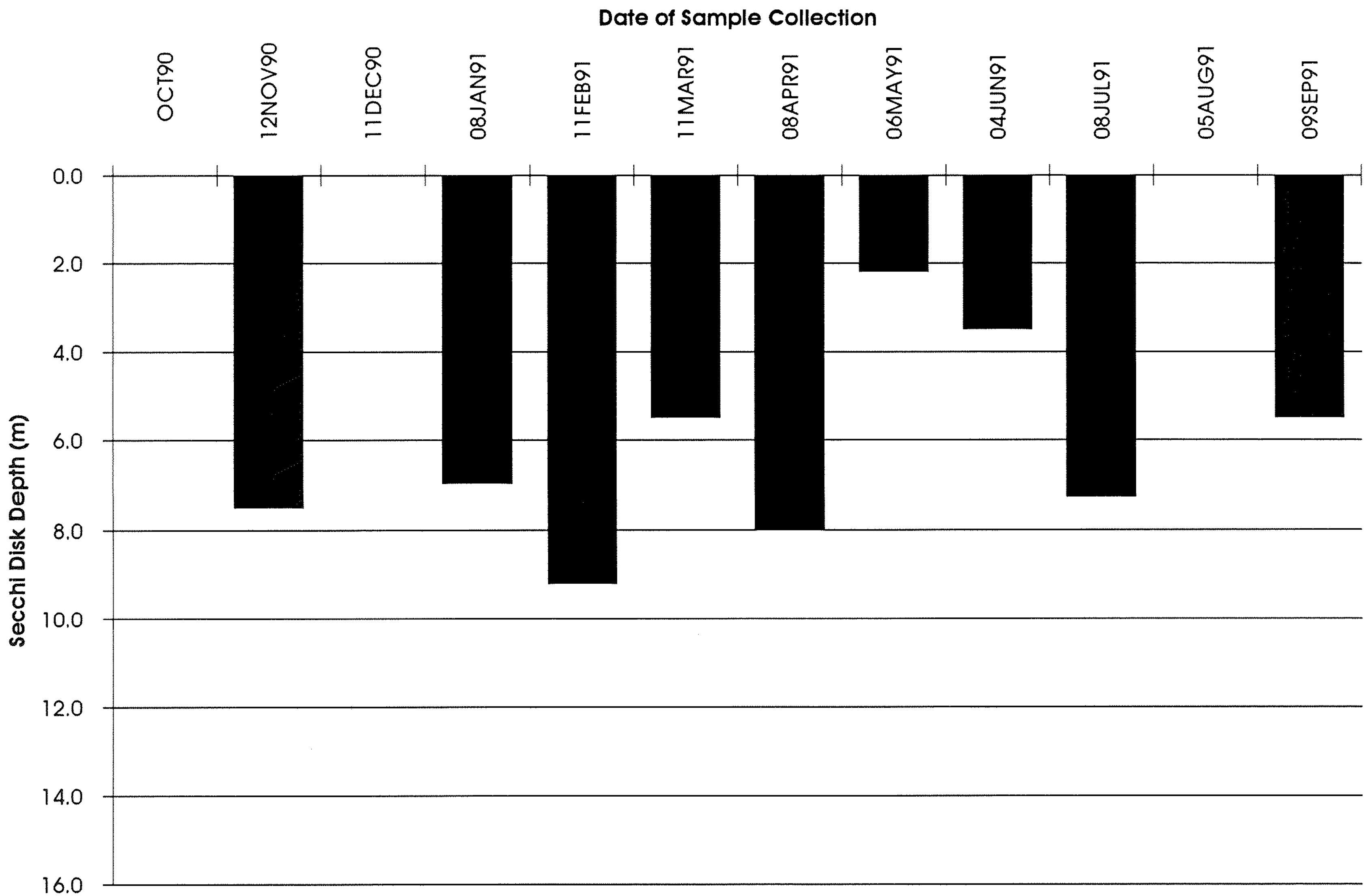
Station CRR001: Secchi Disk Depths for Wateryear 1991



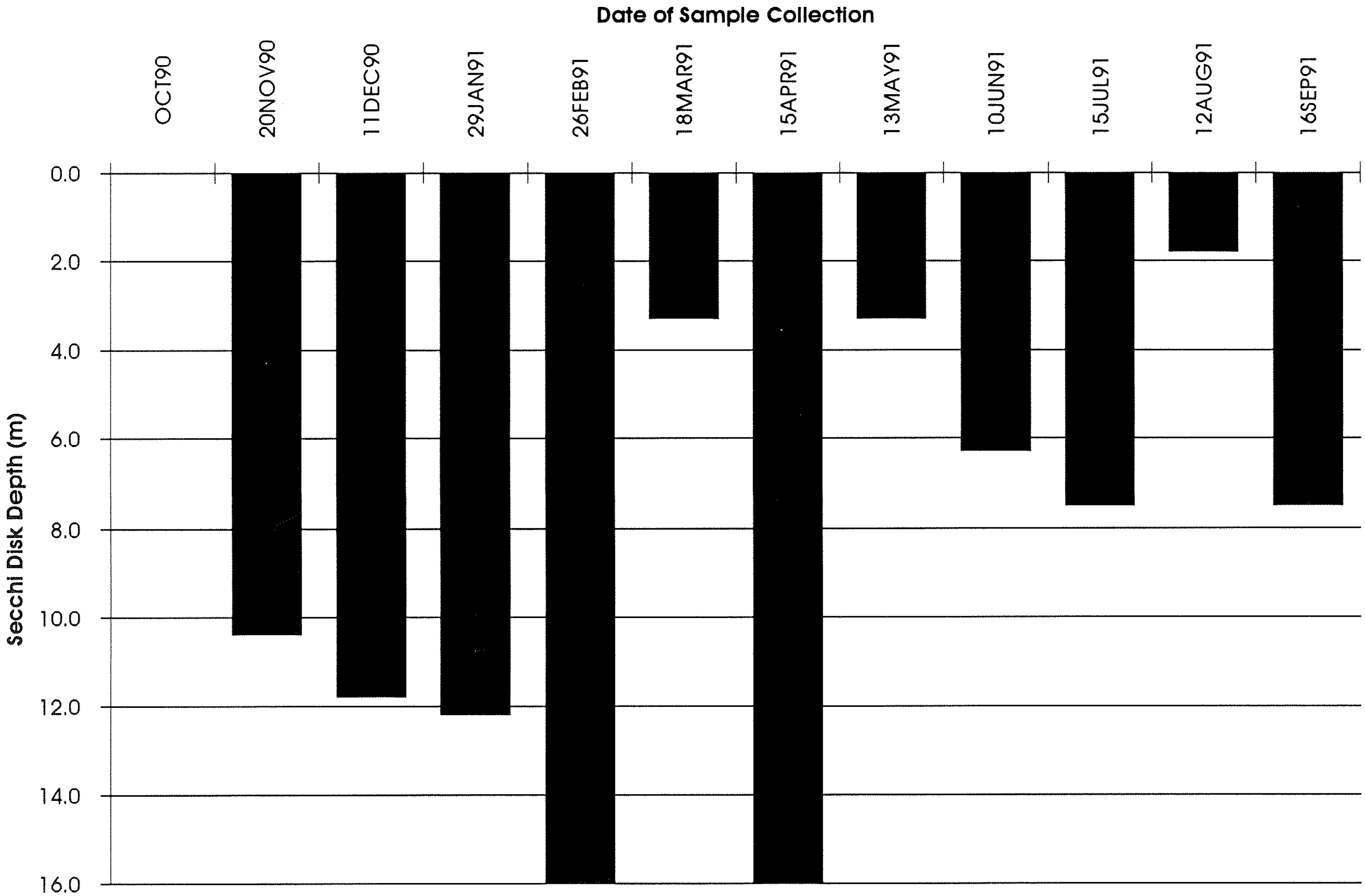
Station CSE001: Secchi Disk Depths for Wateryear 1991



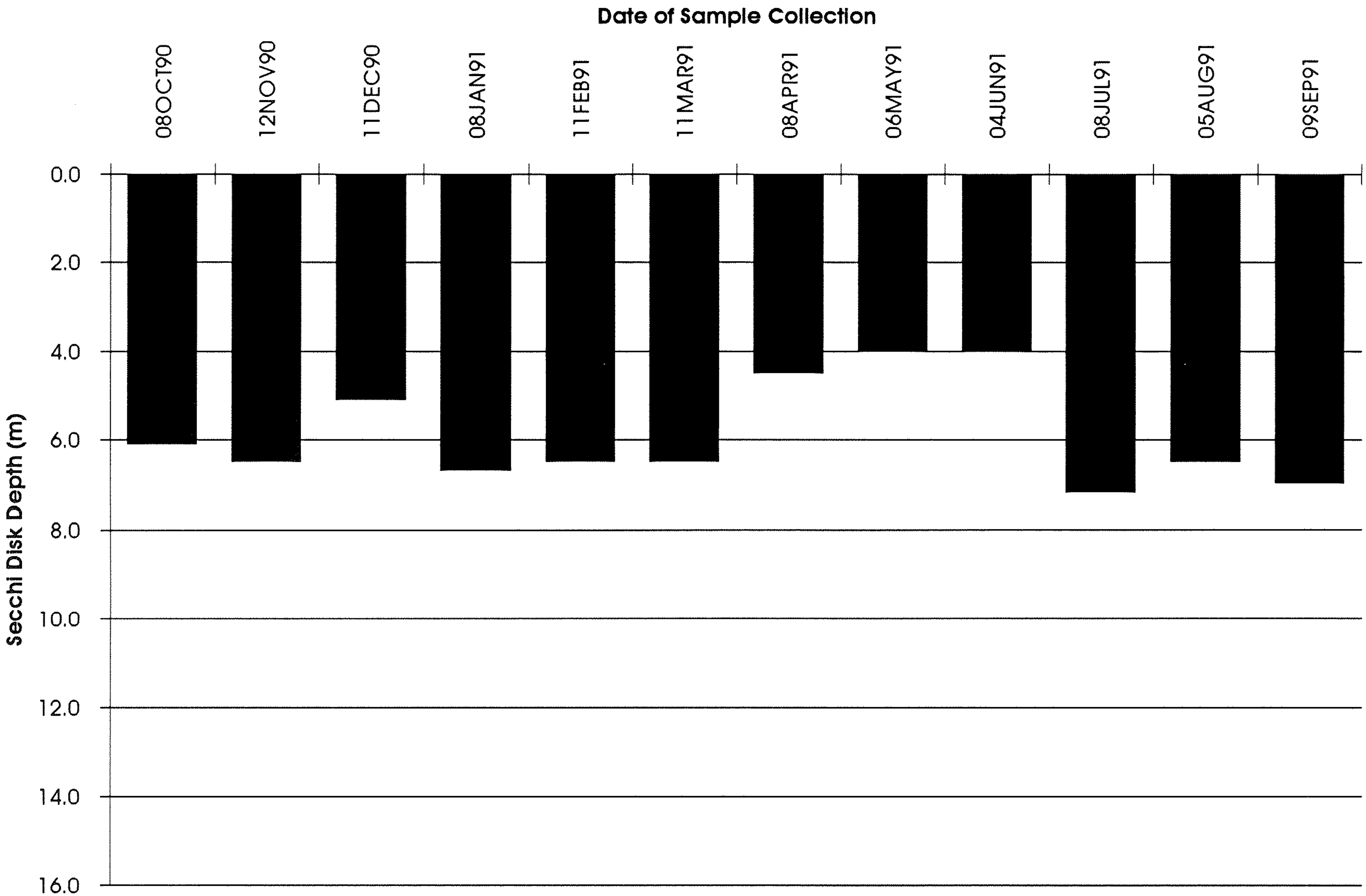
Station CSE002: Secchi Disk Depths for Wateryear 1991



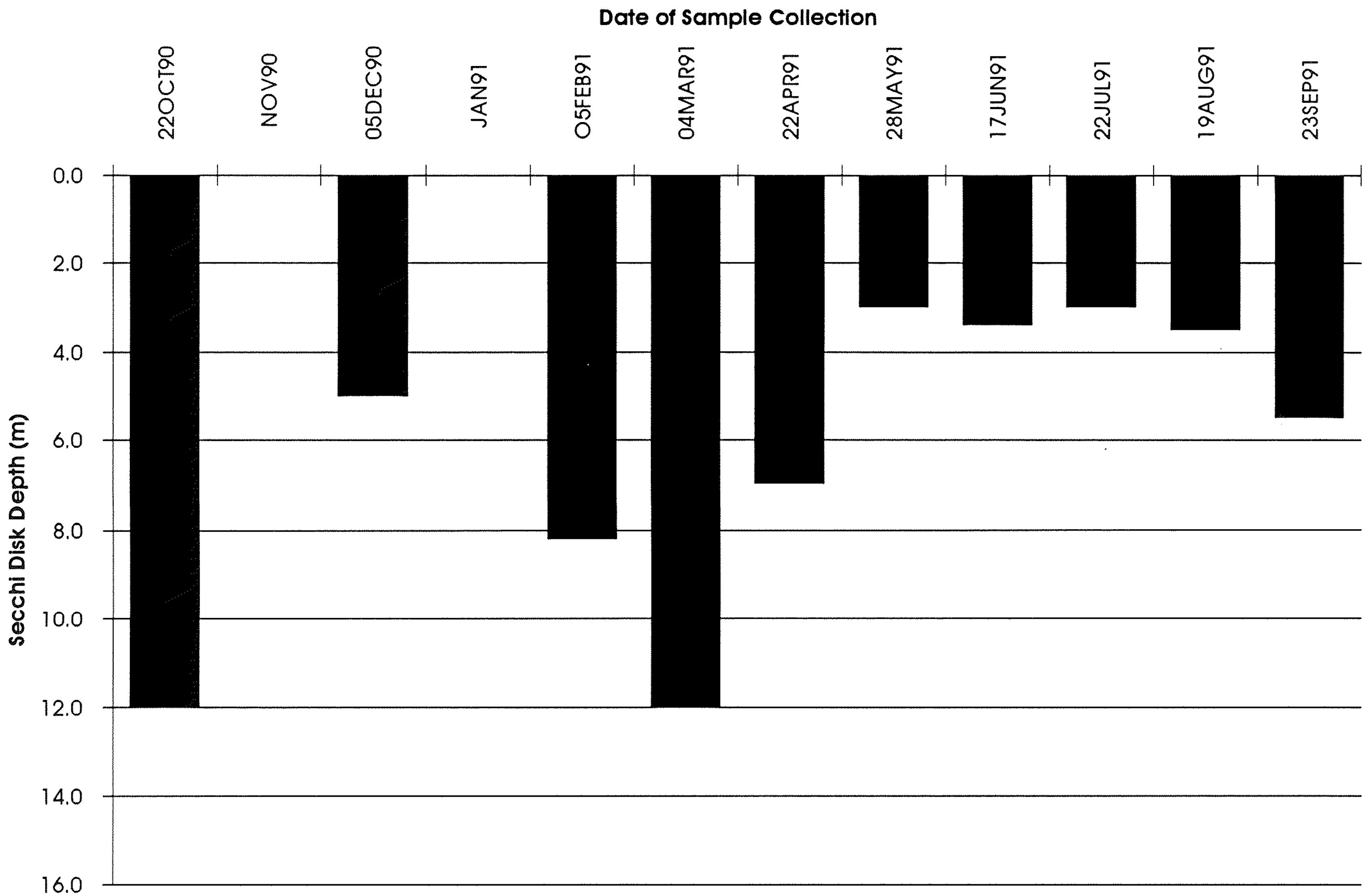
Station DIS001: Secchi Disk Depths for Wateryear 1991



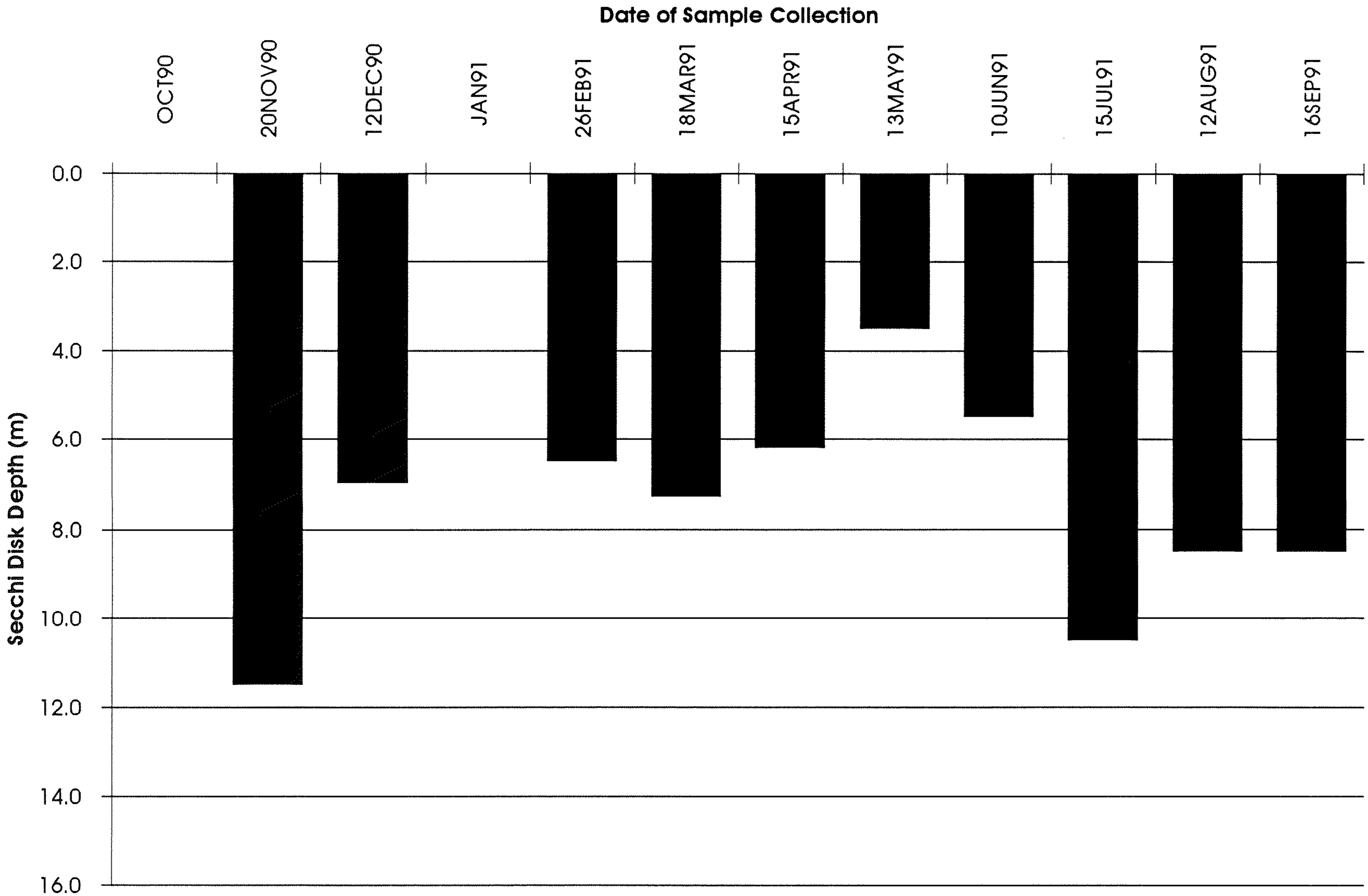
Station DNA001: Secchi Disk Depths for Wateryear 1991



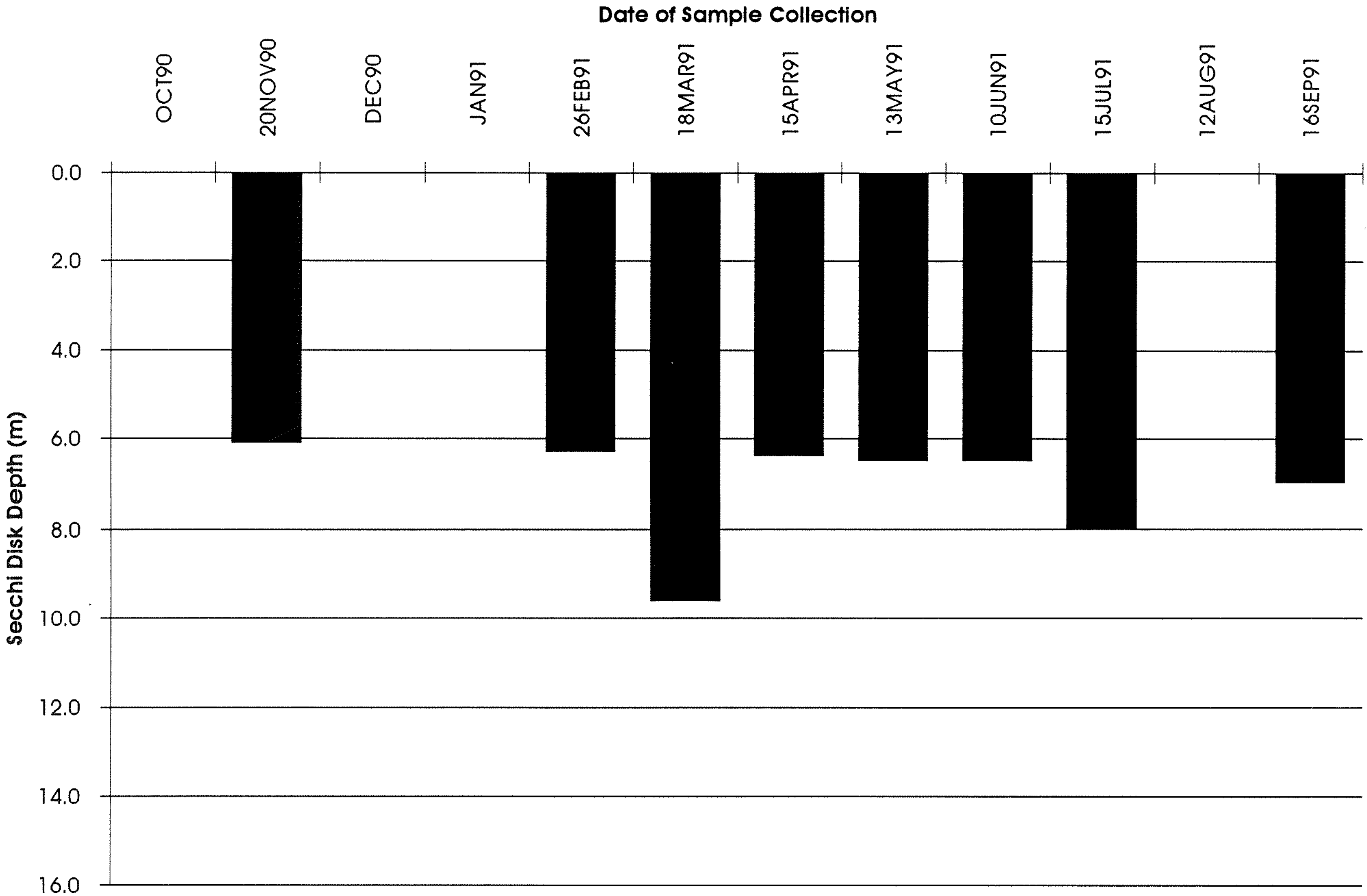
Station EAP001: Secchi Disk Depths for Wateryear 1991



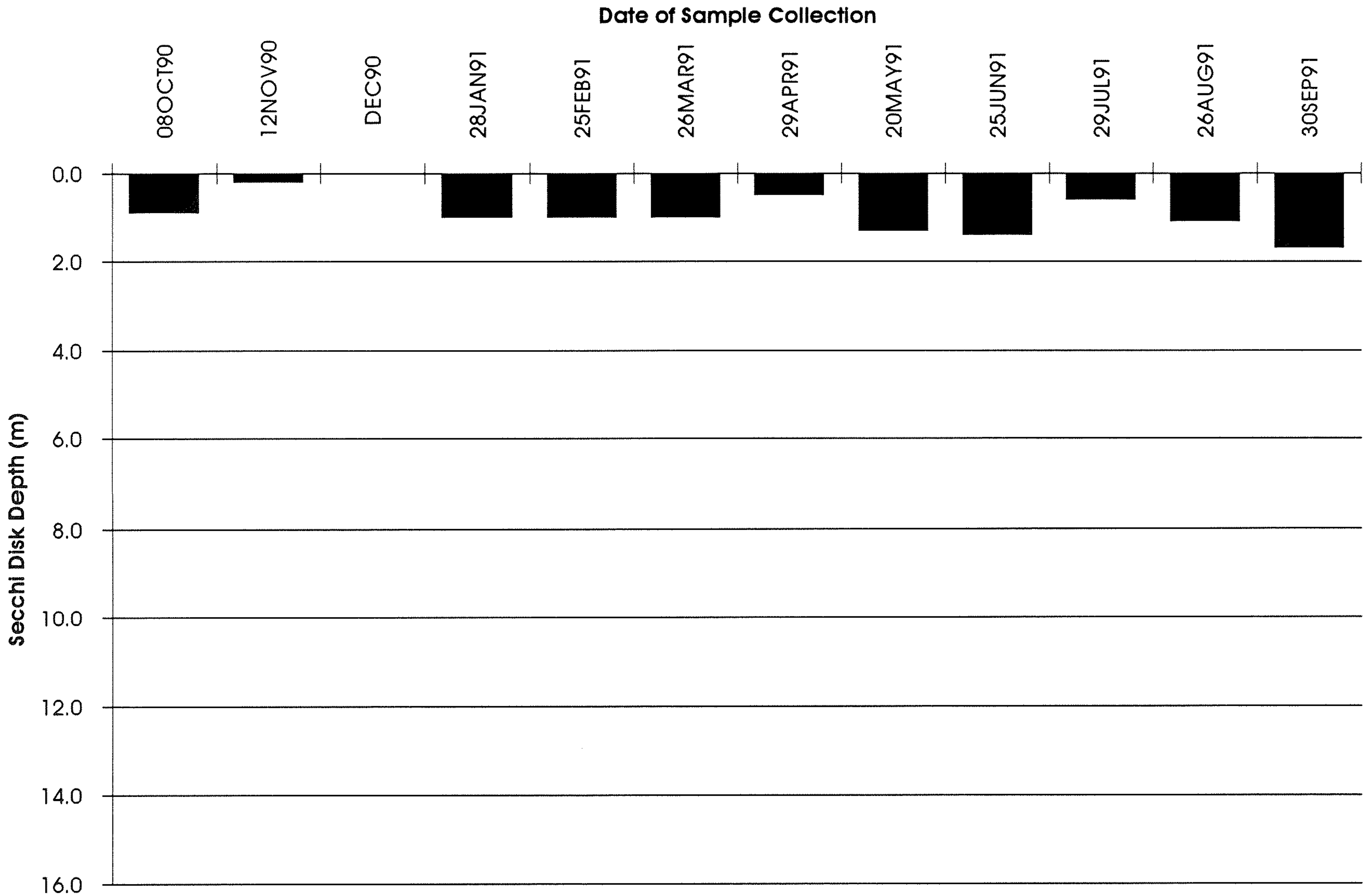
Station EAS001: Secchi Disk Depths for Wateryear 1991



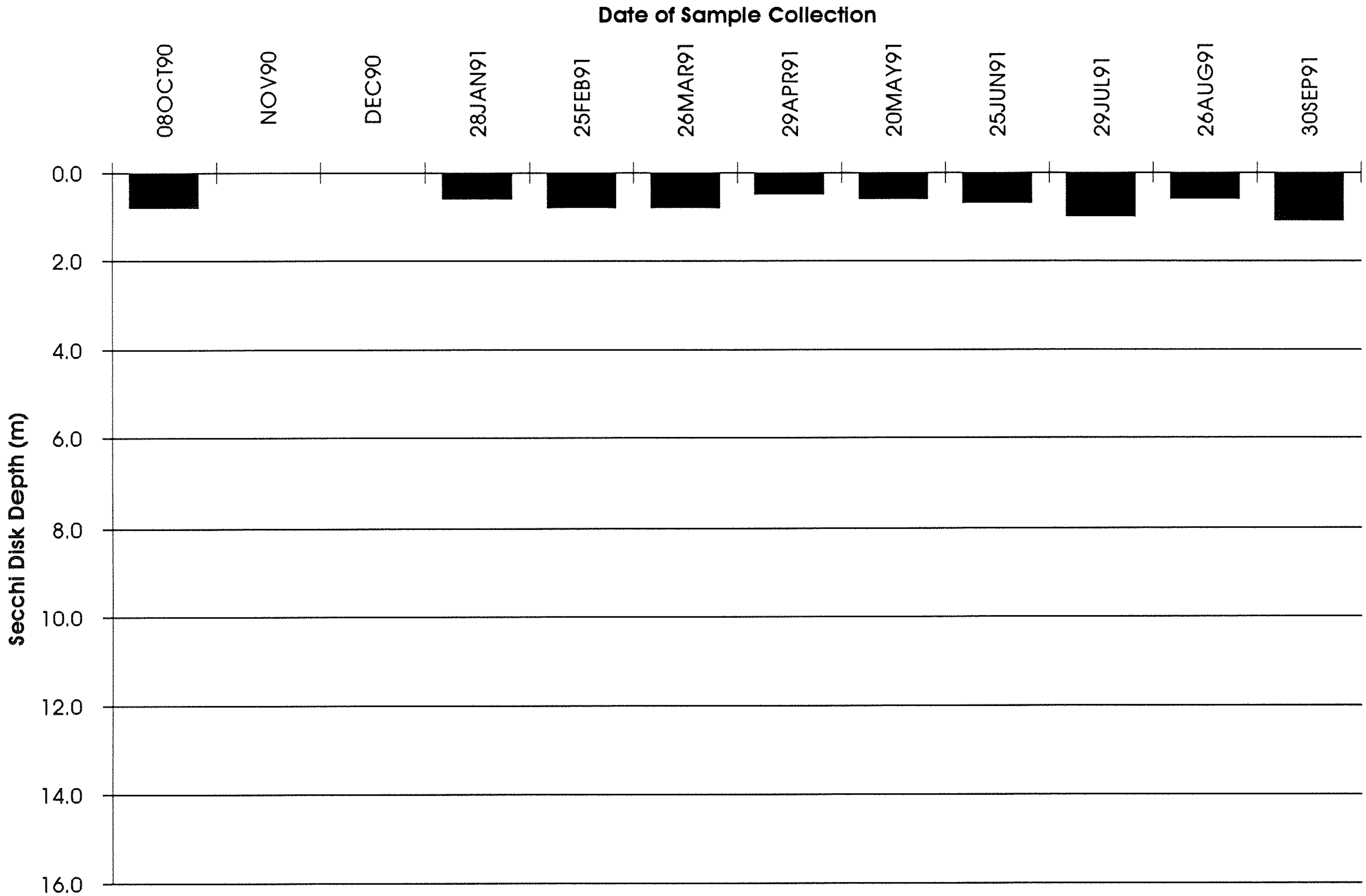
Station GRG002: Secchi Disk Depths for Wateryear 1991



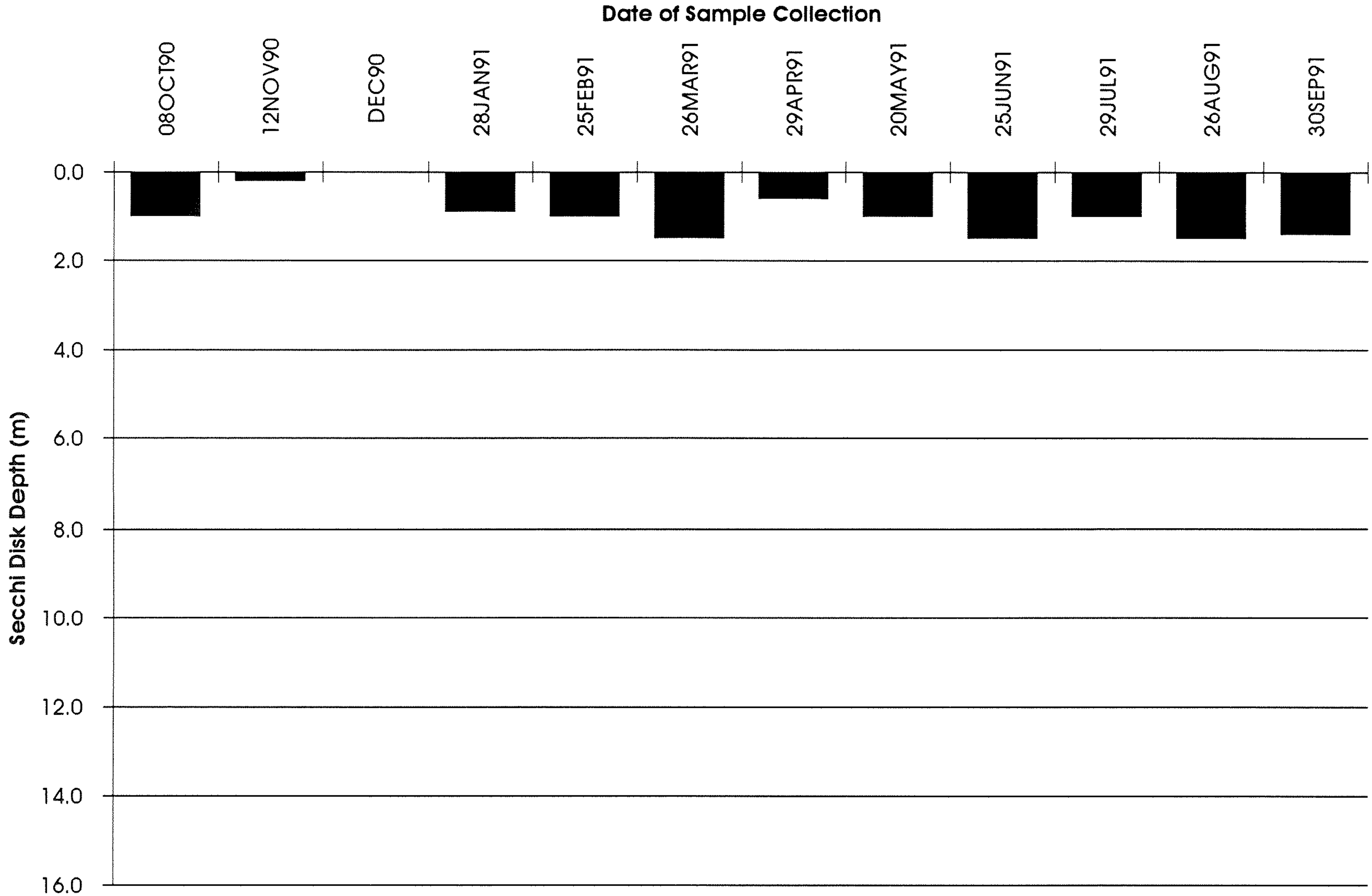
Station GYS004: Secchi Disk Depths for Wateryear 1991



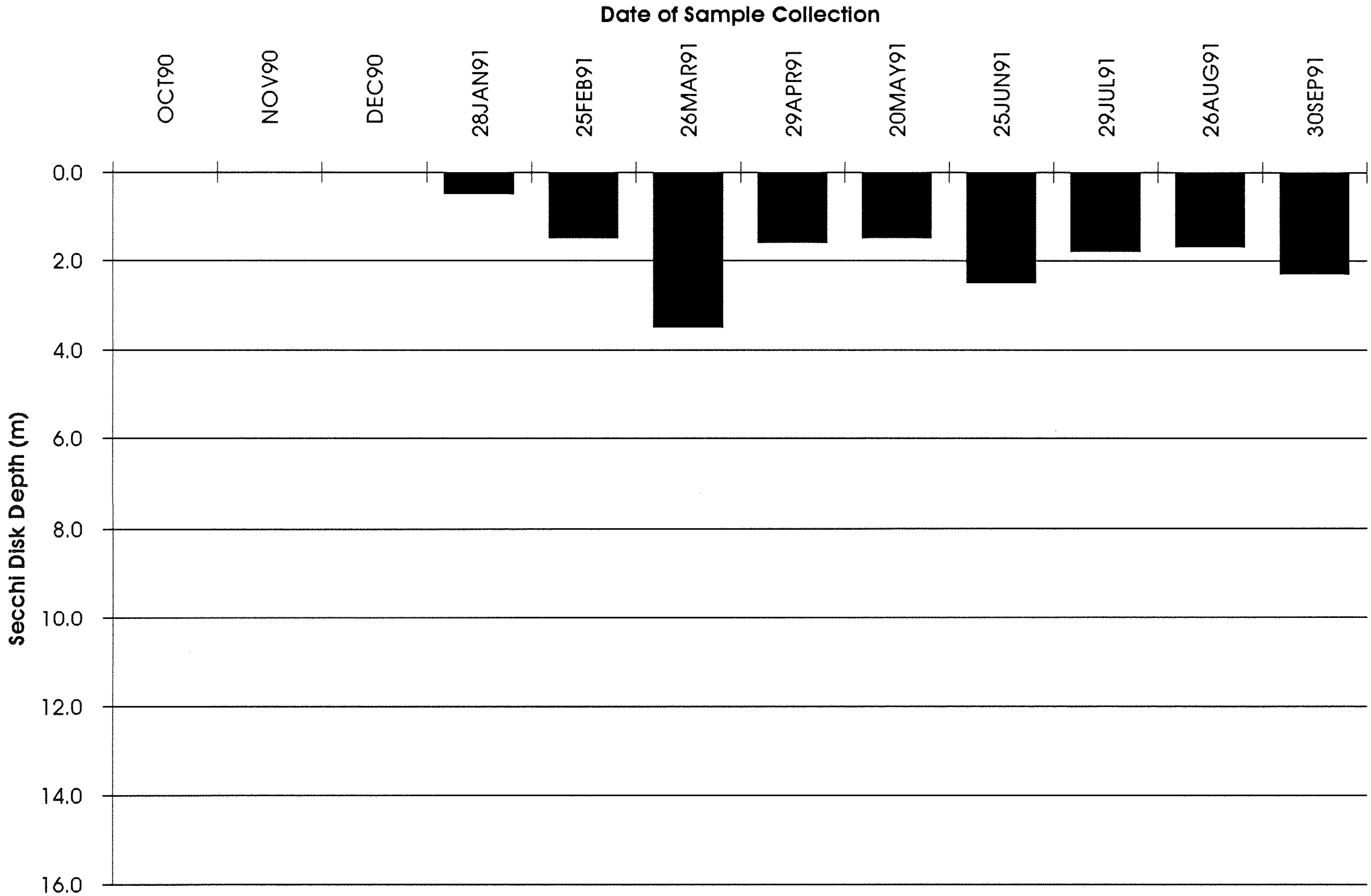
Station GYS008: Secchi Disk Depths for Wateryear 1991



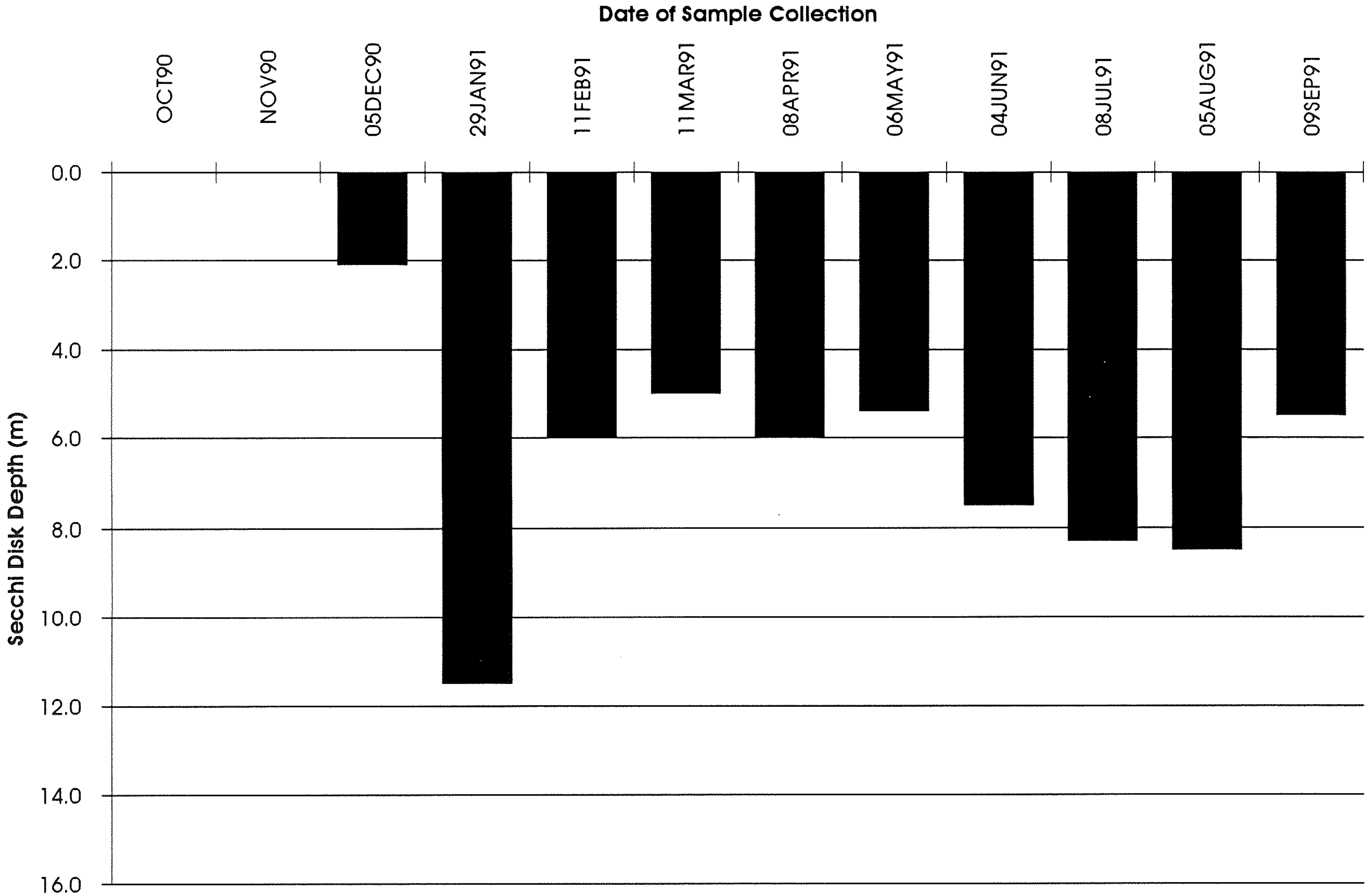
Station GYS009: Secchi Disk Depths for Wateryear 1991



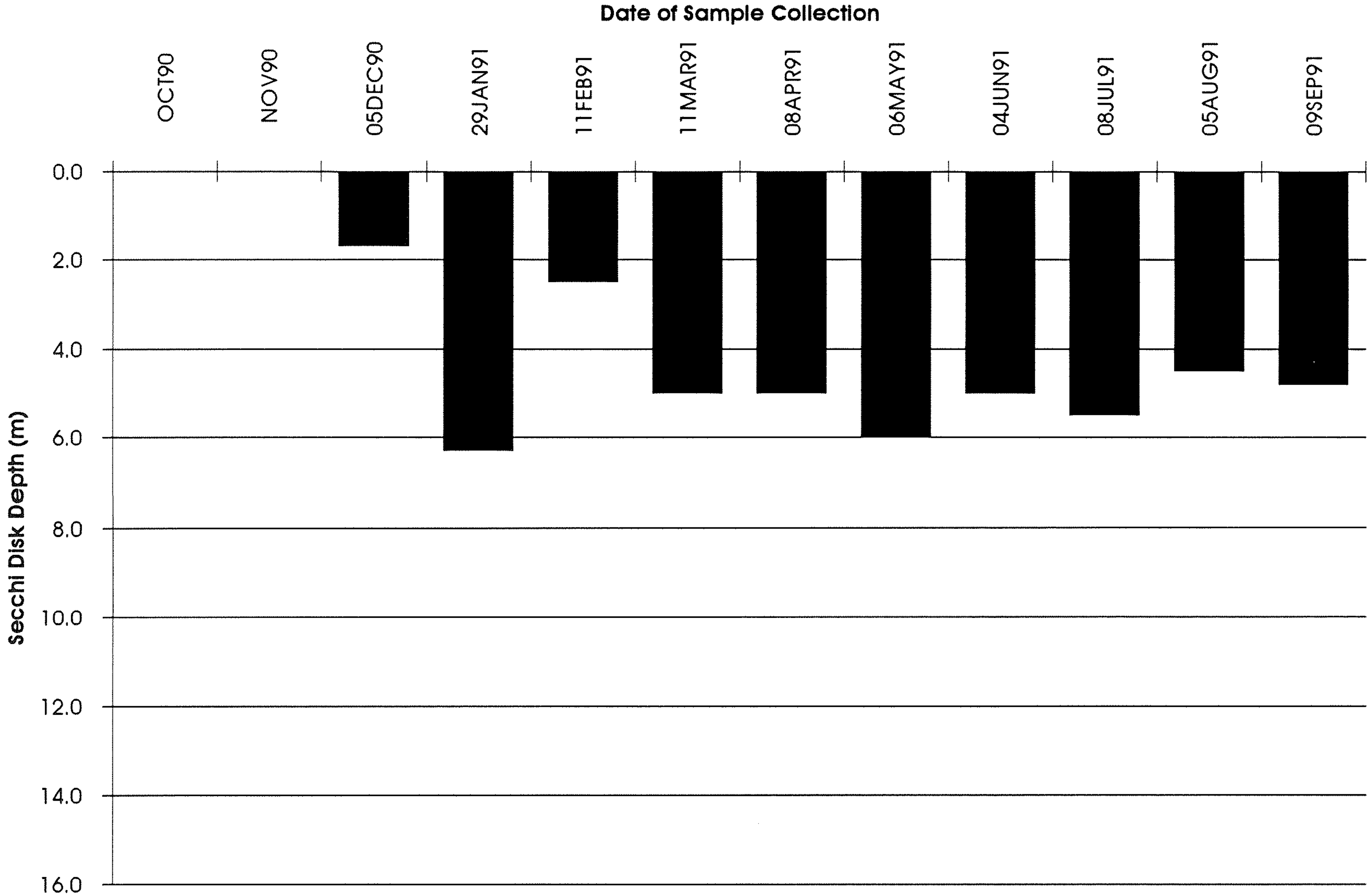
Station GYS016: Secchi Disk Depths for Wateryear 1991



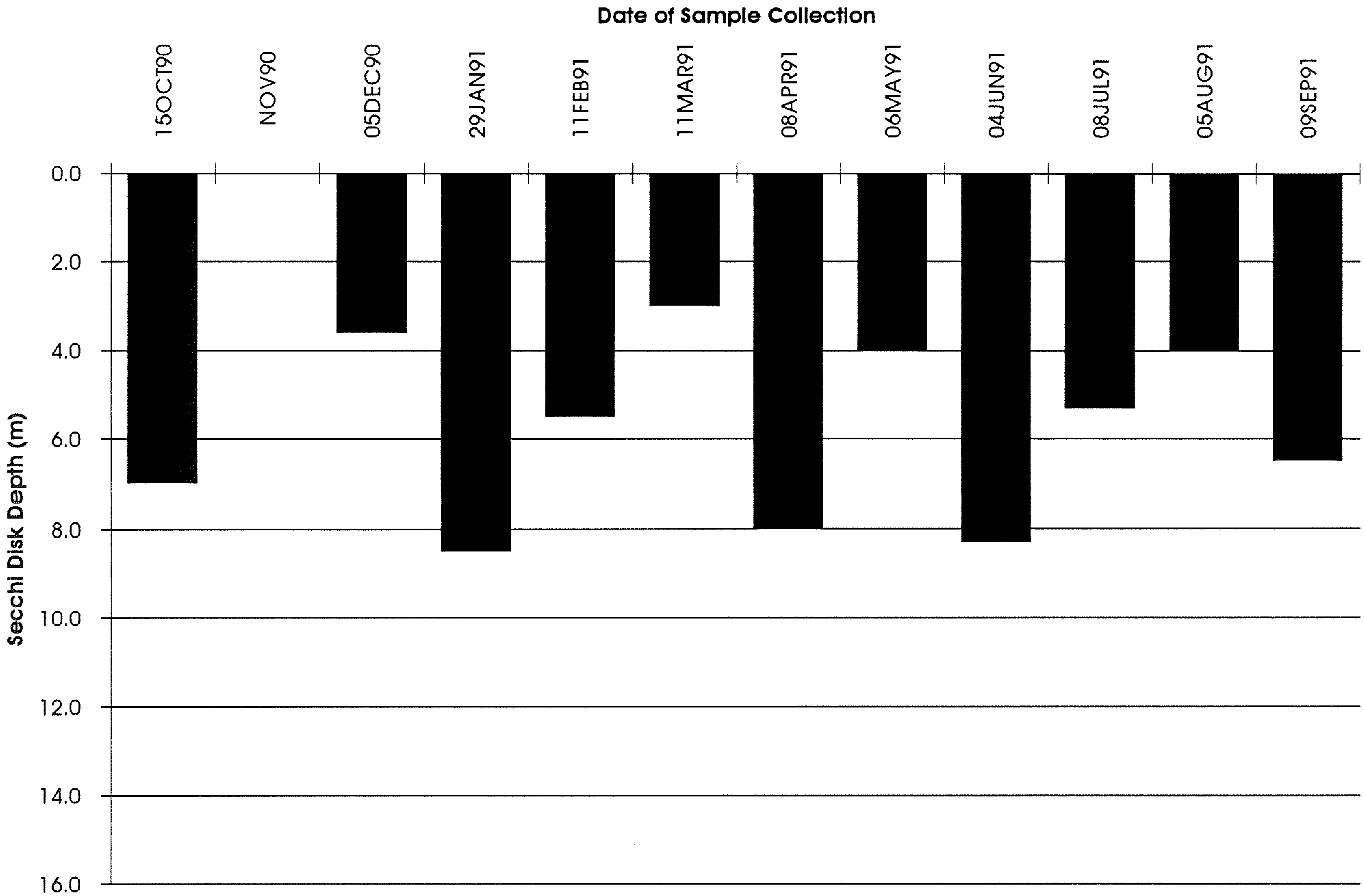
Station HCB003: Secchi Disk Depths for Wateryear 1991



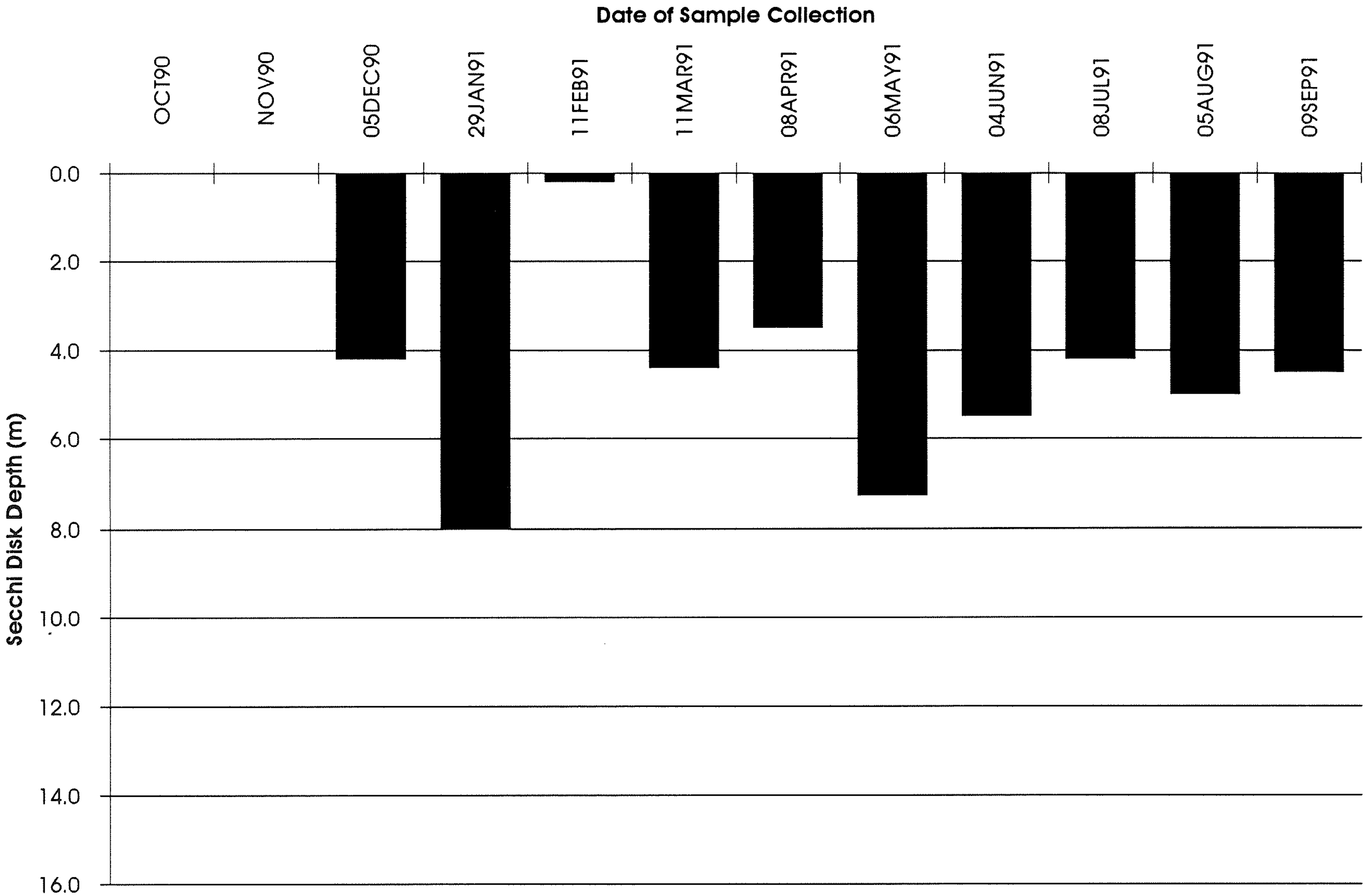
Station HCB004: Secchi Disk Depths for Wateryear 1991



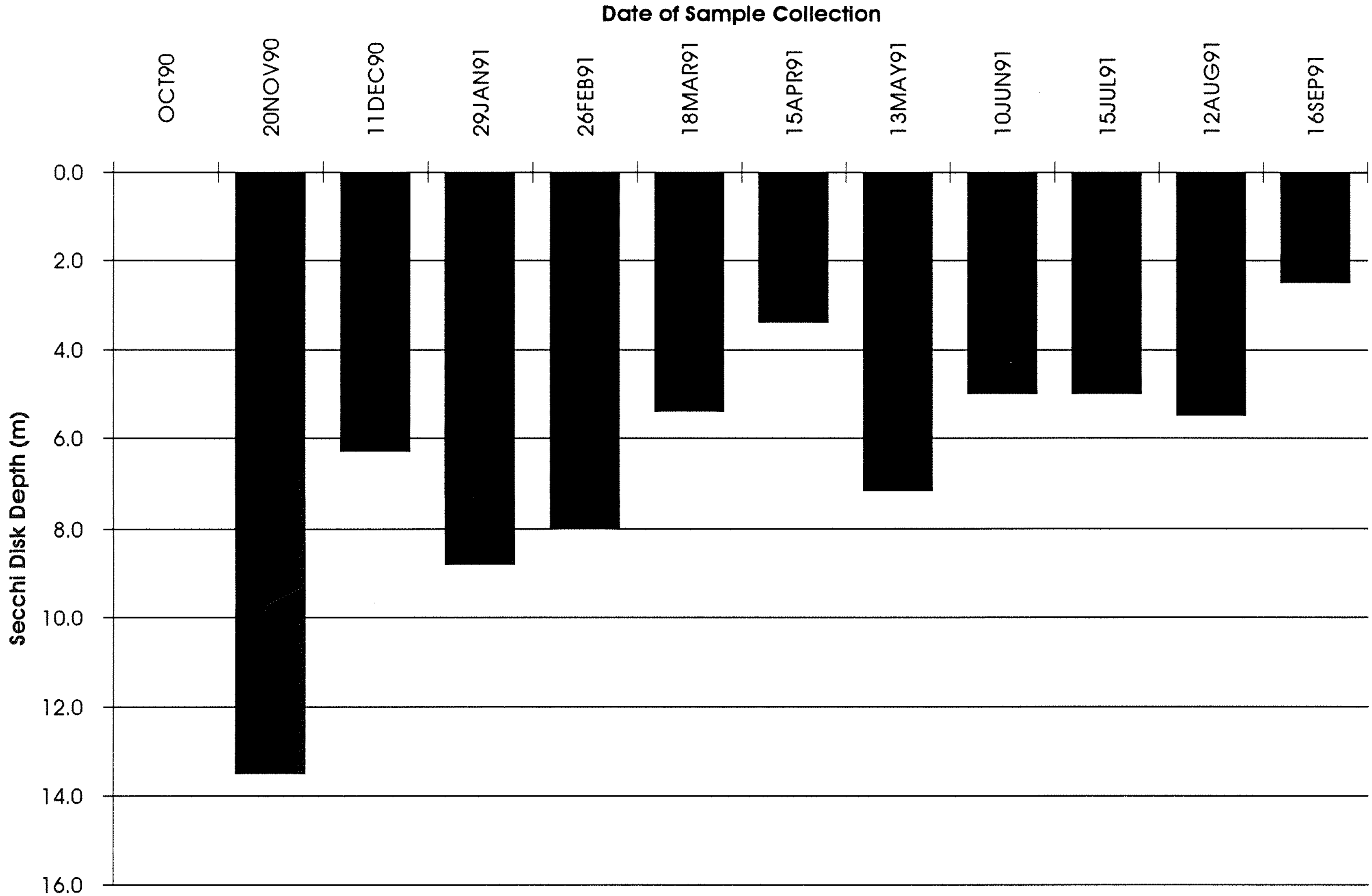
Station HCB006: Secchi Disk Depths for Wateryear 1991



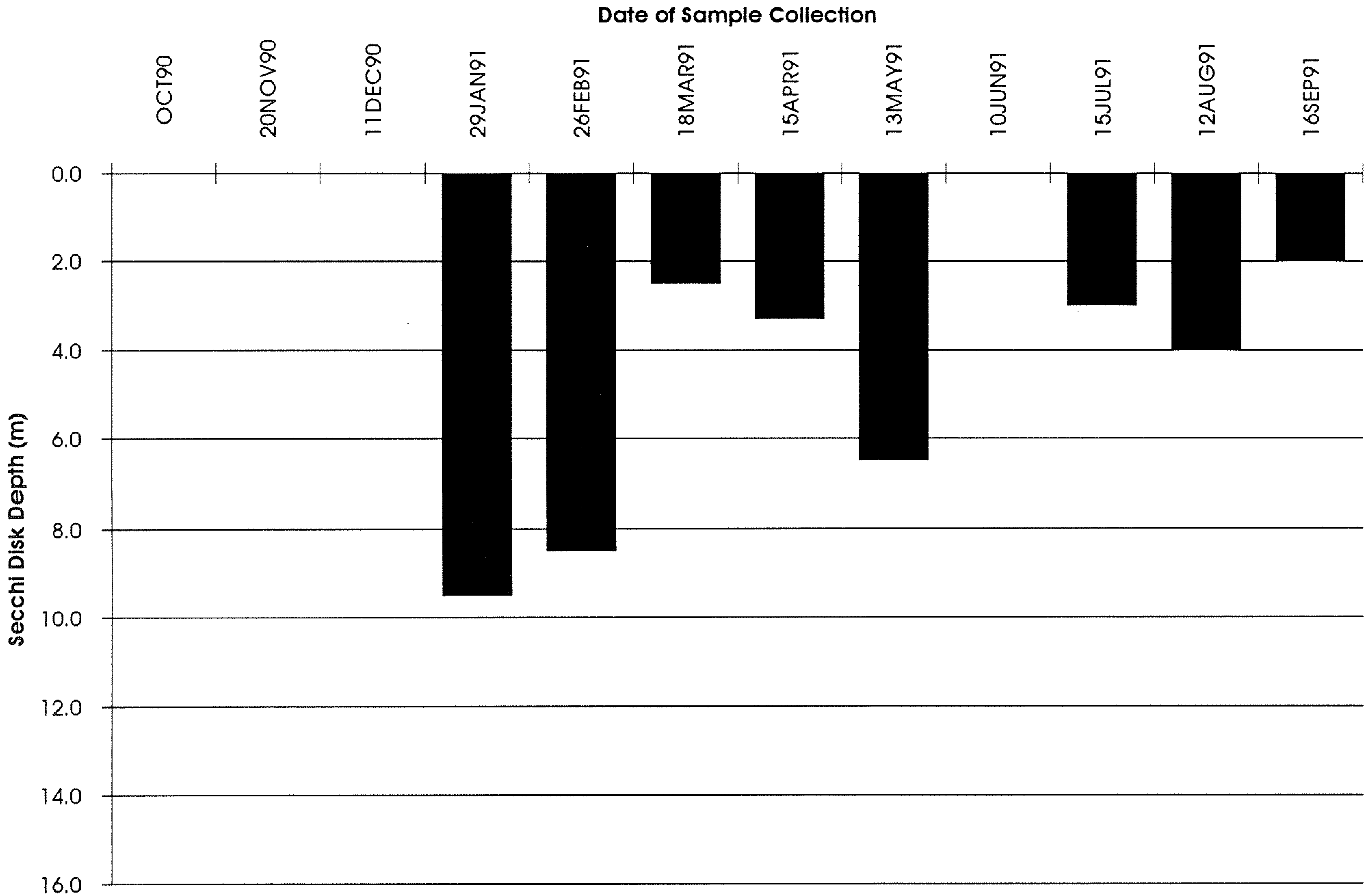
Station HCB007: Secchi Disk Depths for Wateryear 1991



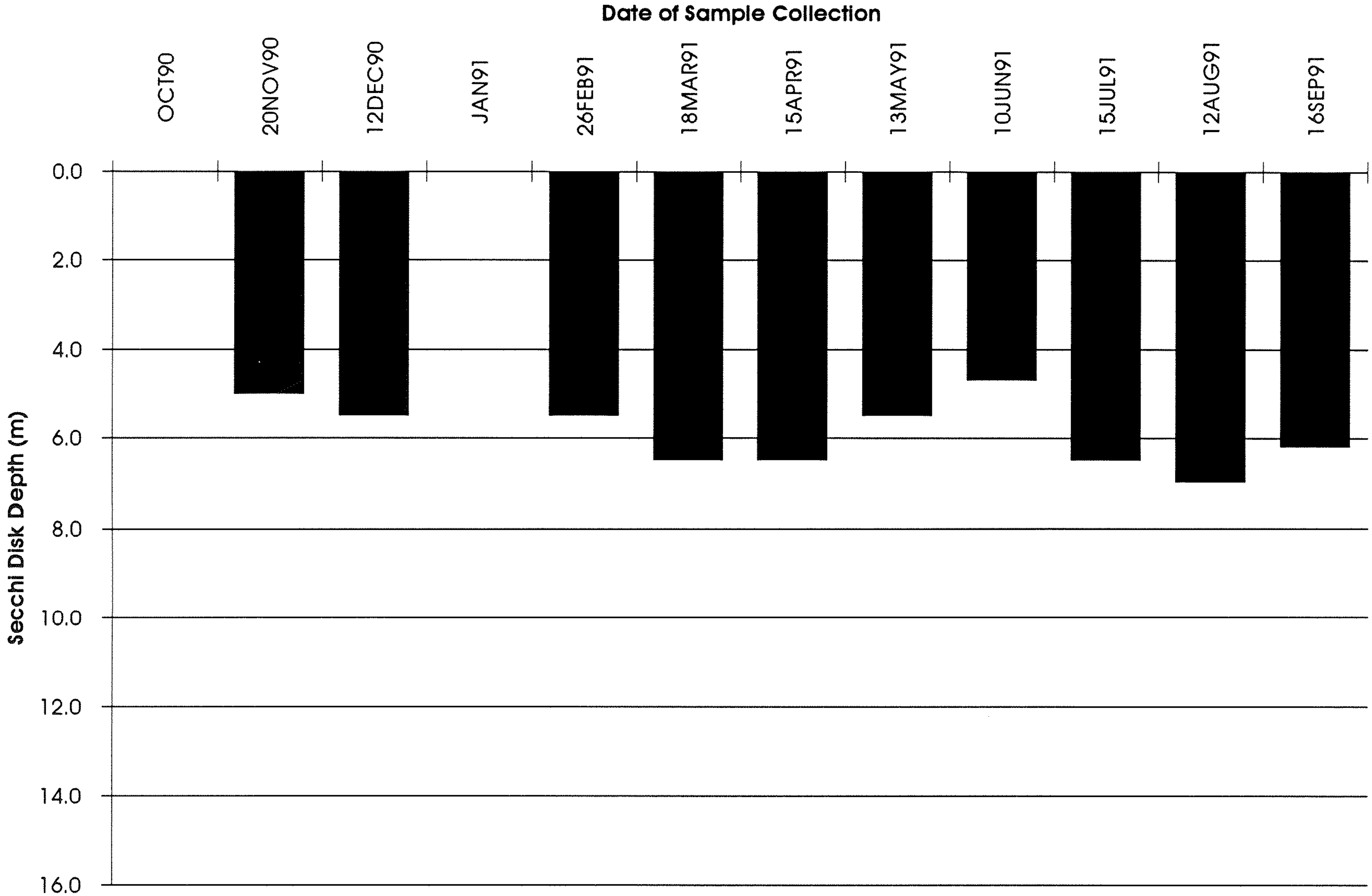
Station JDF005: Secchi Disk Depths for Wateryear 1991

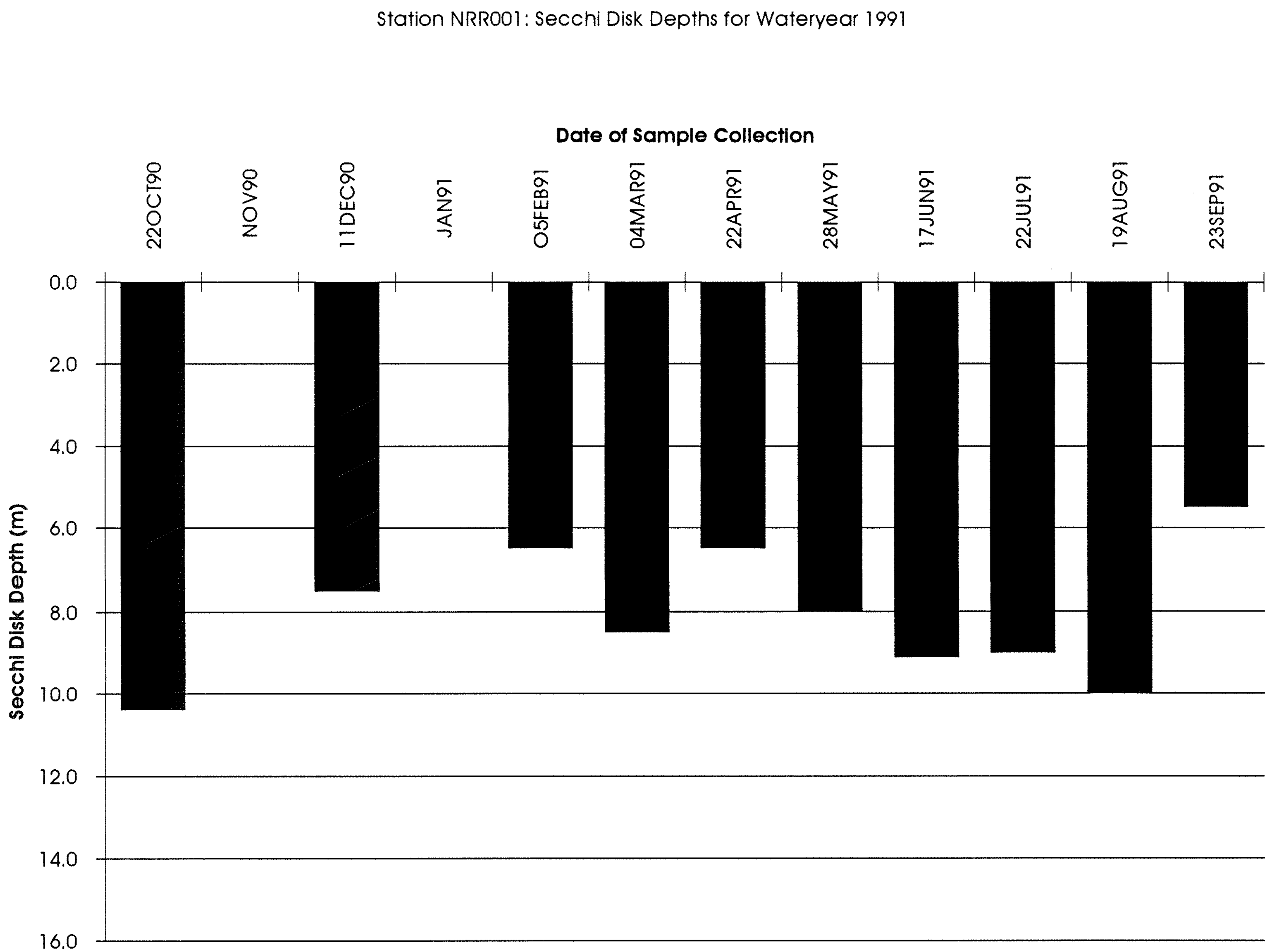


Station JDF007: Secchi Disk Depths for Wateryear 1991



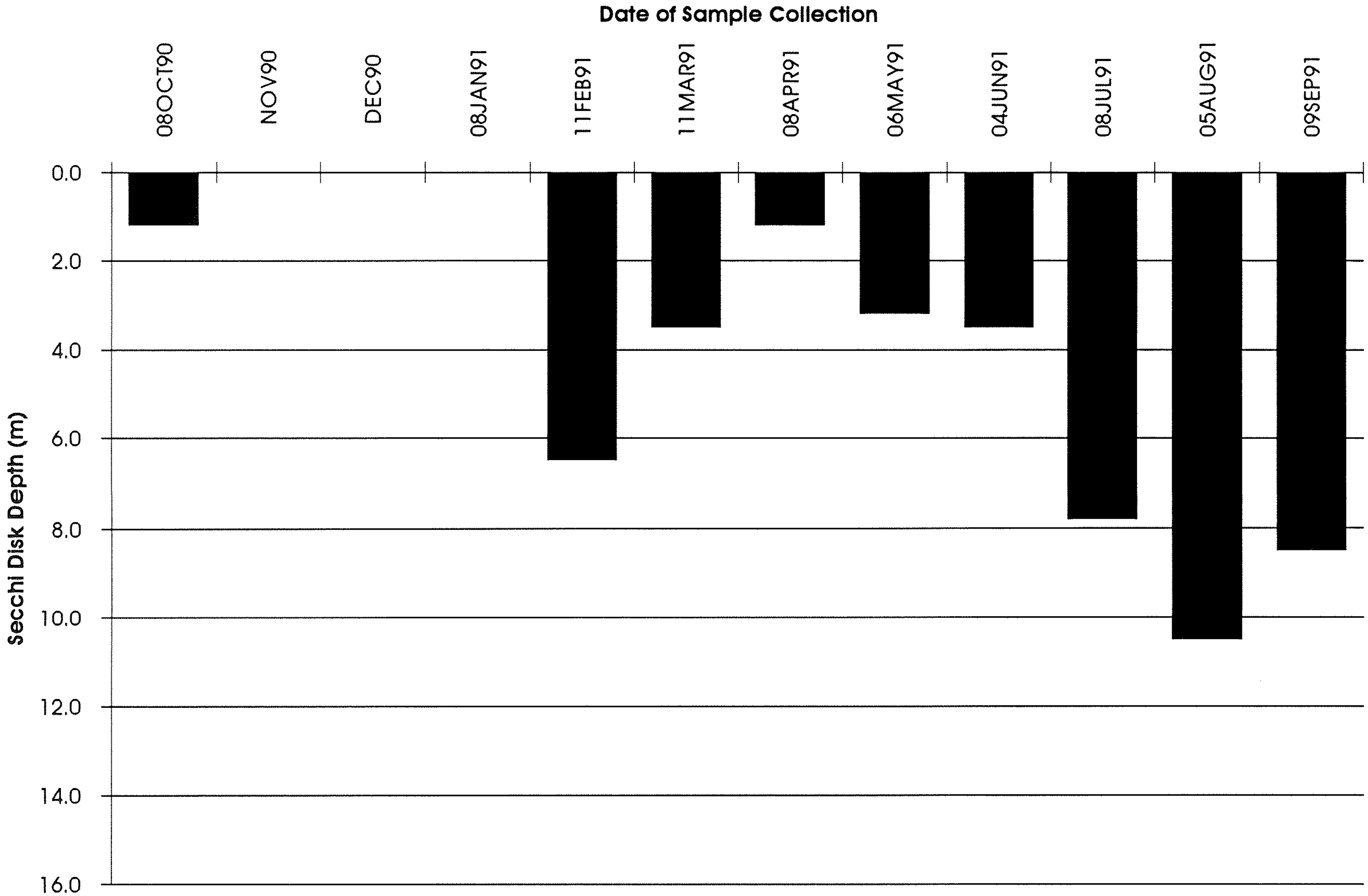
Station LOP001: Secchi Disk Depths for Wateryear 1991



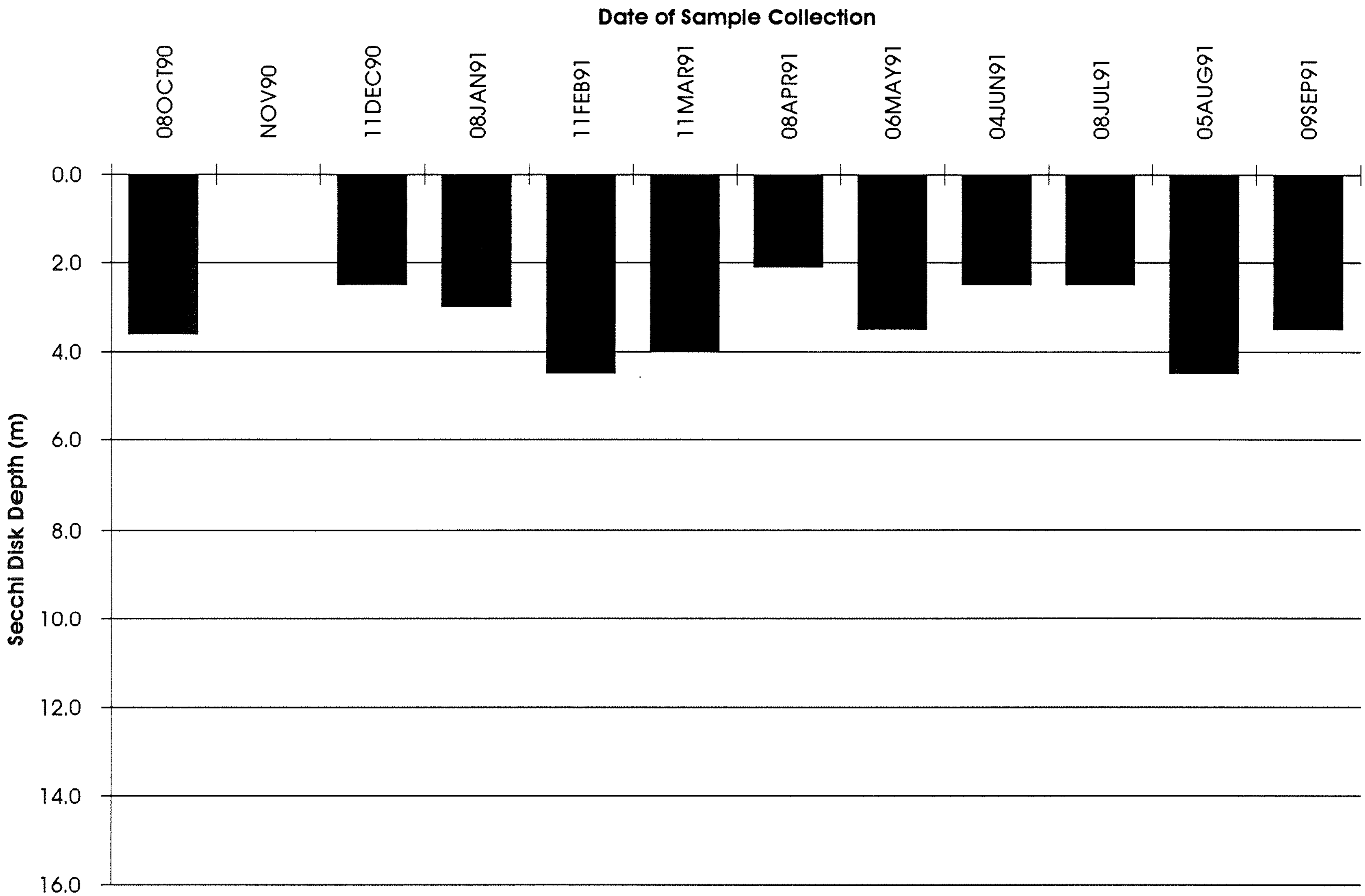


Station NRR001: Secchi Disk Depths for Wateryear 1991
Date of Sample Collection
22OCT90
NOV90
11DEC90
JAN91
05FEB91
04MAR91
22APR91
28MAY91
17JUN91
22JUL91
19AUG91
23SEP91
Secchi Disk Depth (m)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0

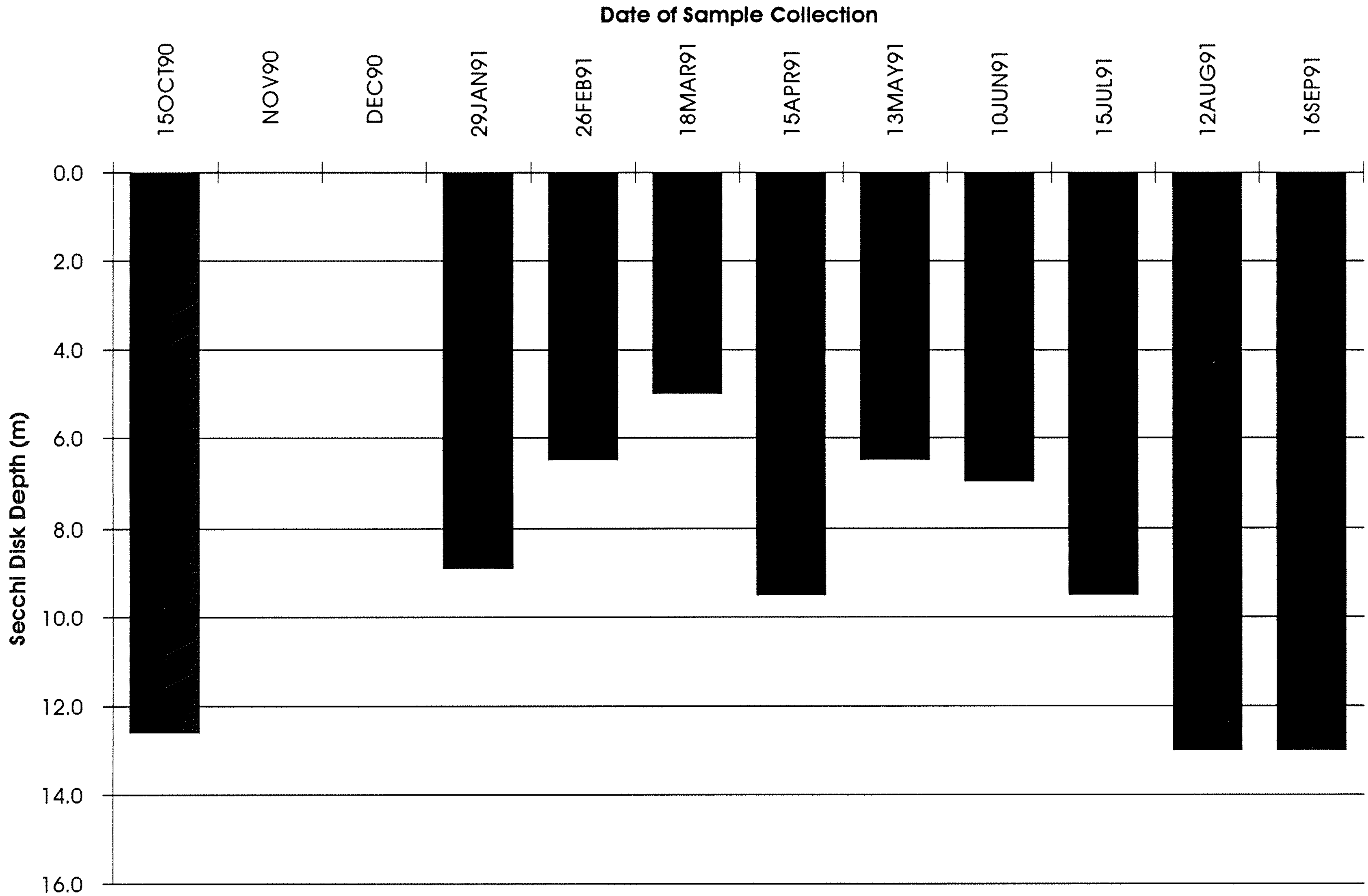
Station NSQ001: Secchi Disk Depths for Wateryear 1991



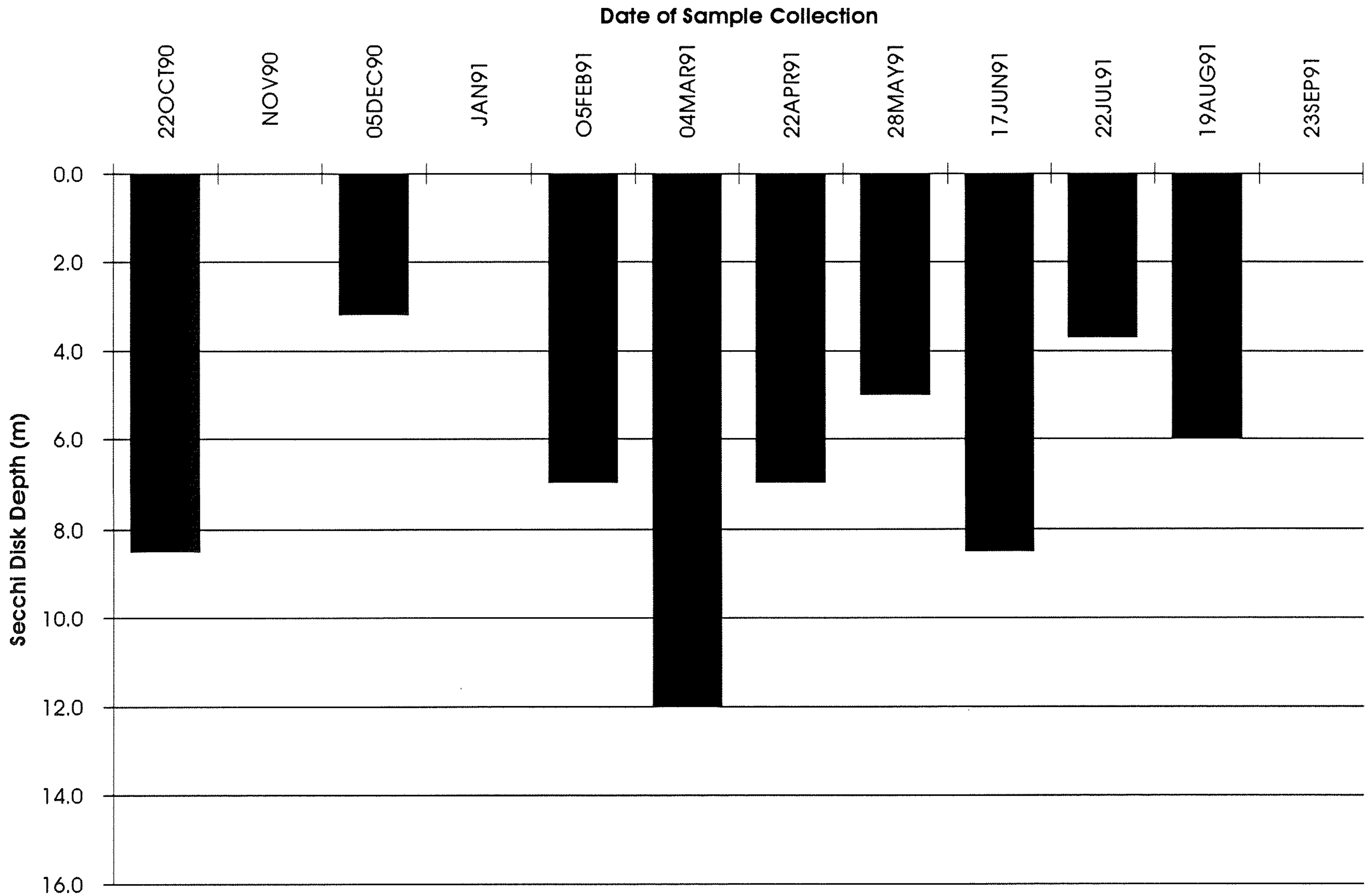
Station OAK004: Secchi Disk Depths for Wateryear 1991



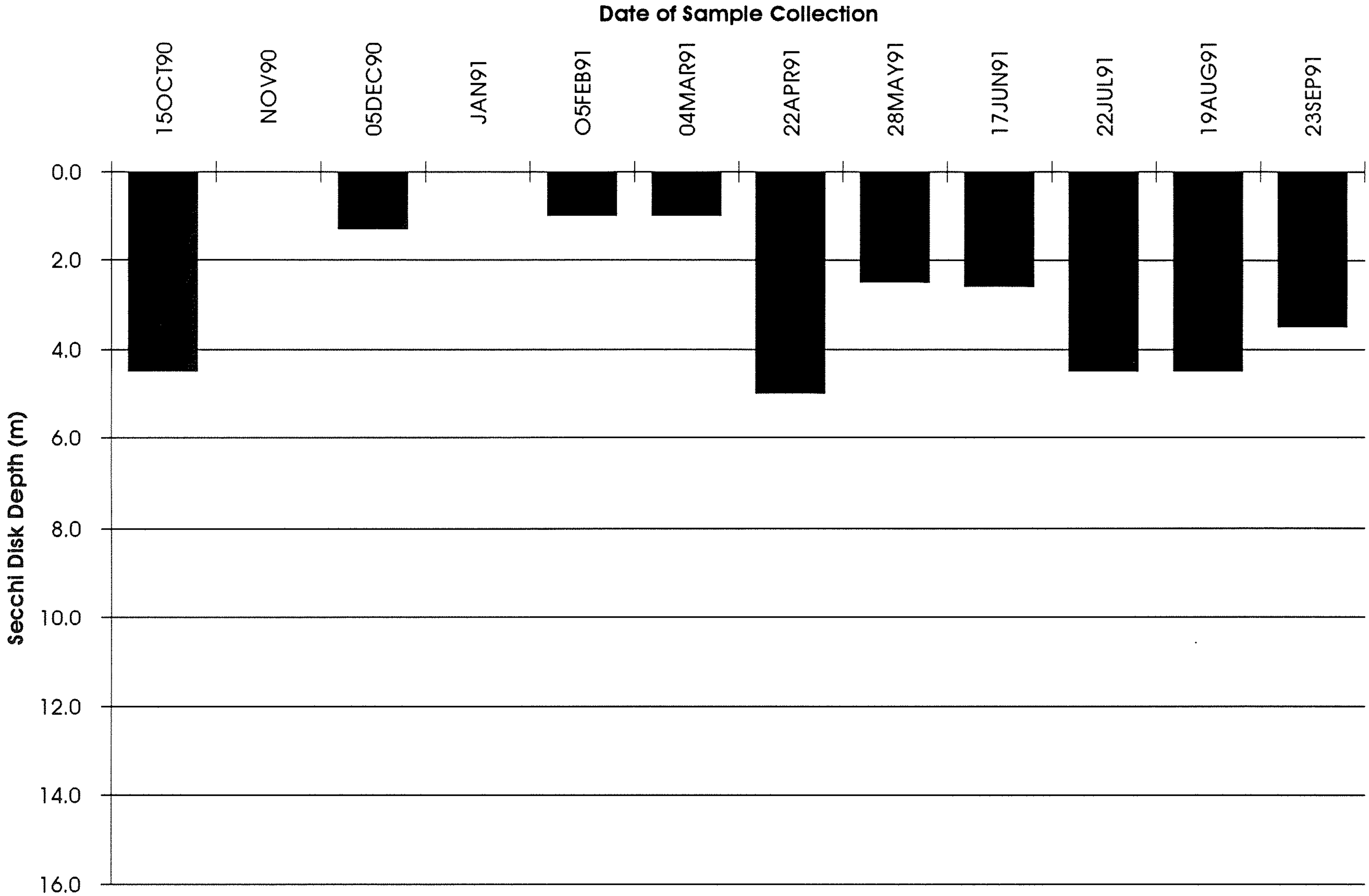
Station PAH008: Secchi Disk Depths for Wateryear 1991



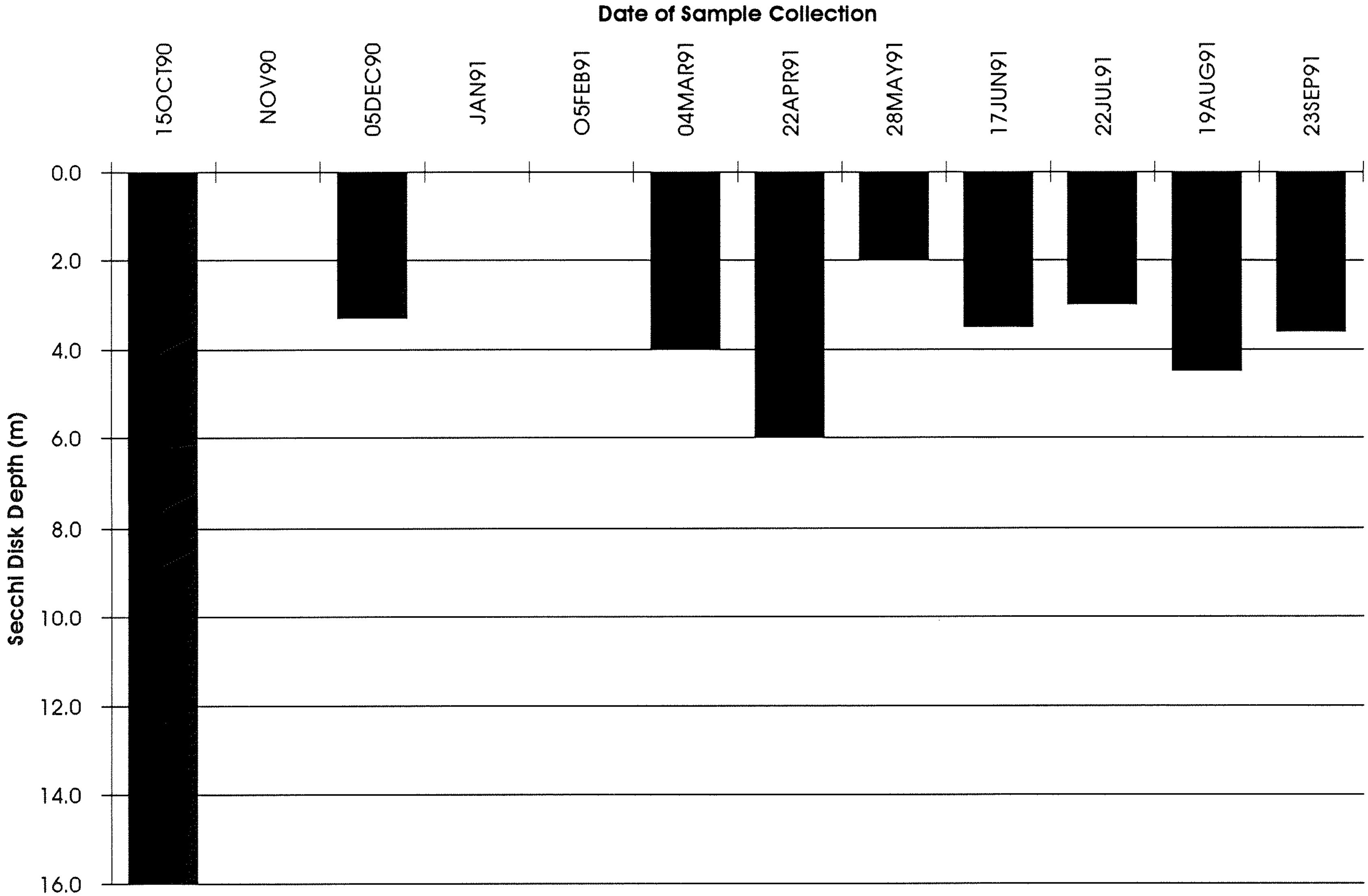
Station PSB003: Secchi Disk Depths for Wateryear 1991



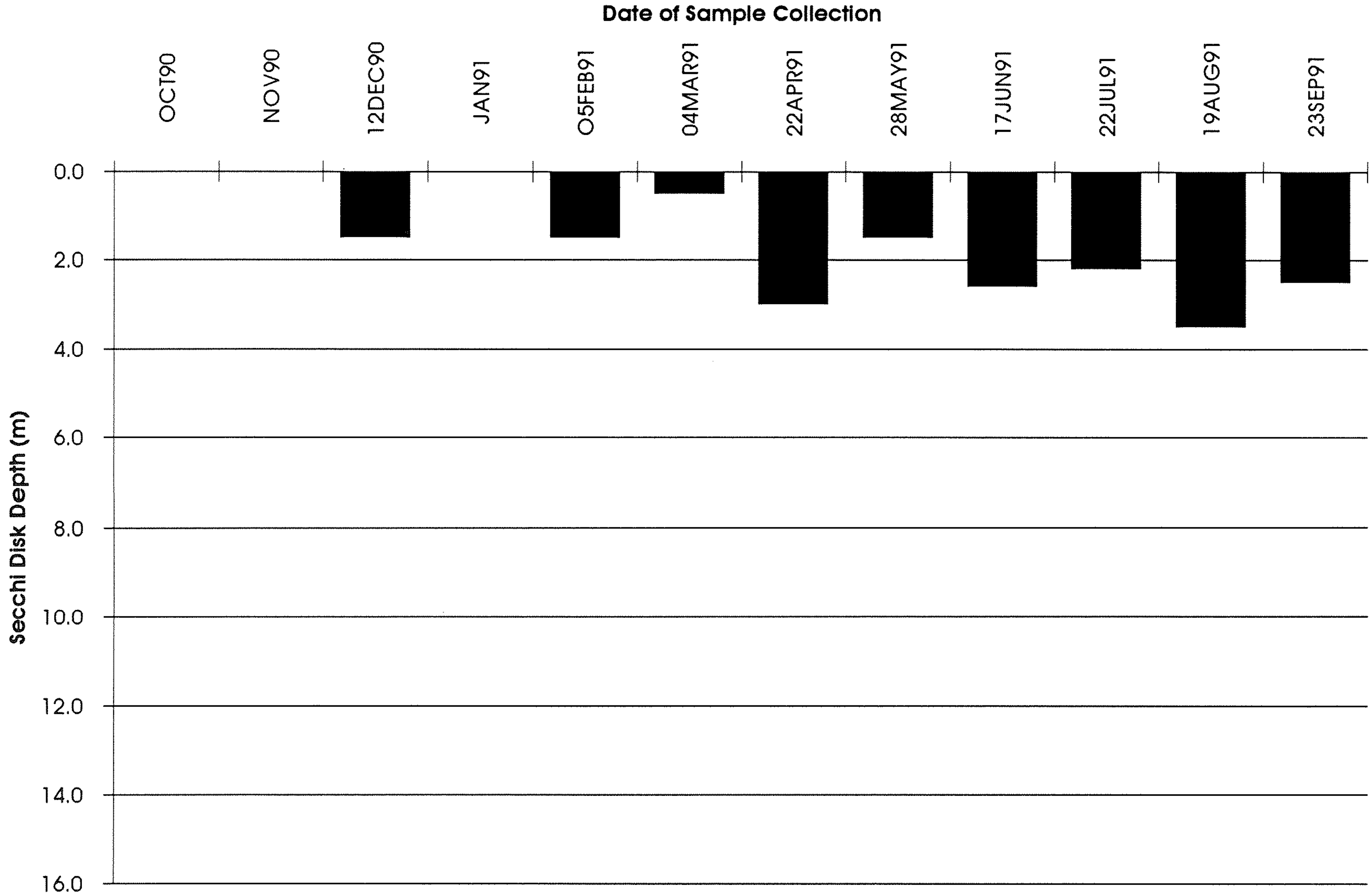
Station PSS019: Secchi Disk Depths for Wateryear 1991



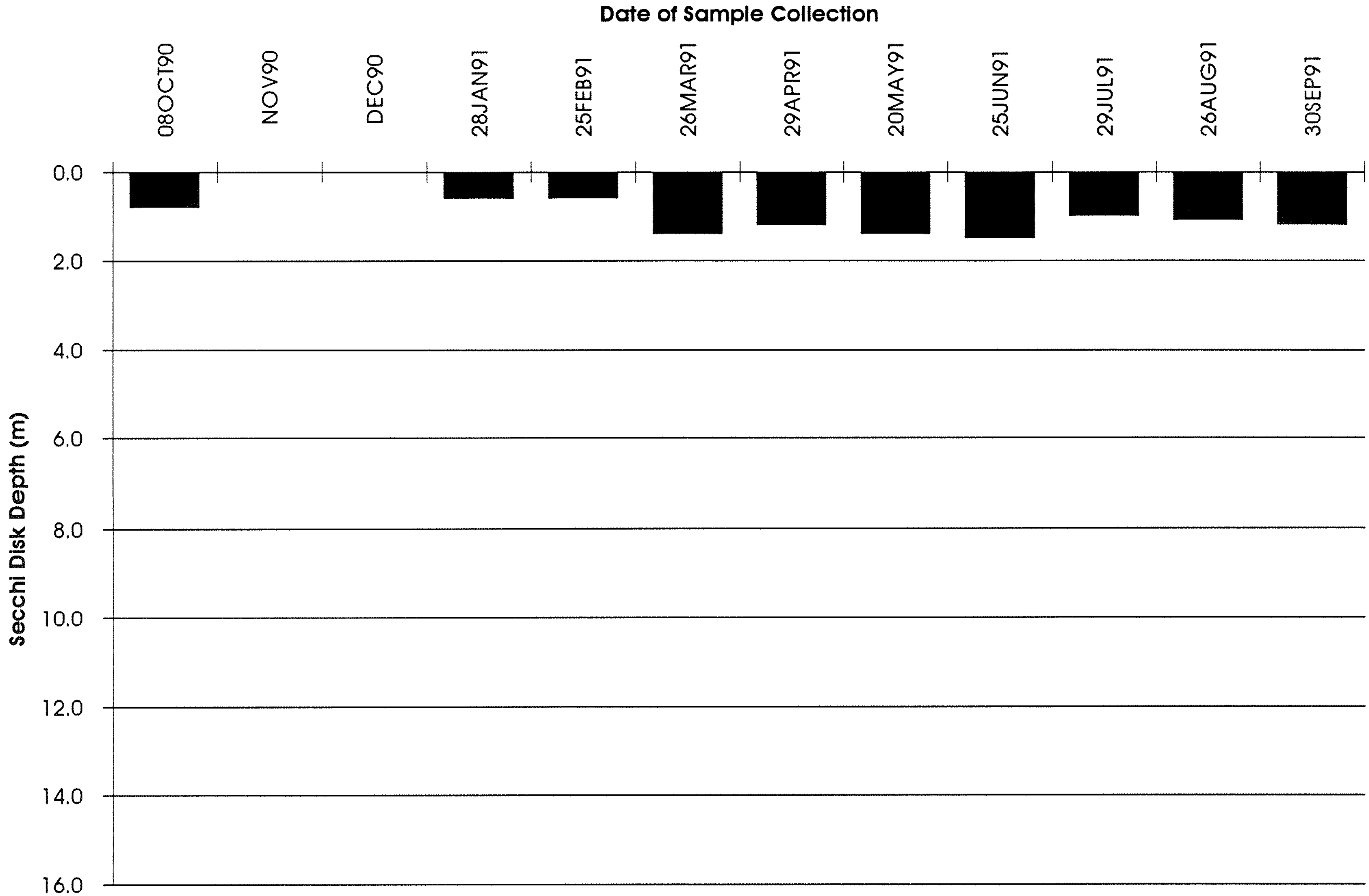
Station SAR003: Secchi Disk Depths for Wateryear 1991



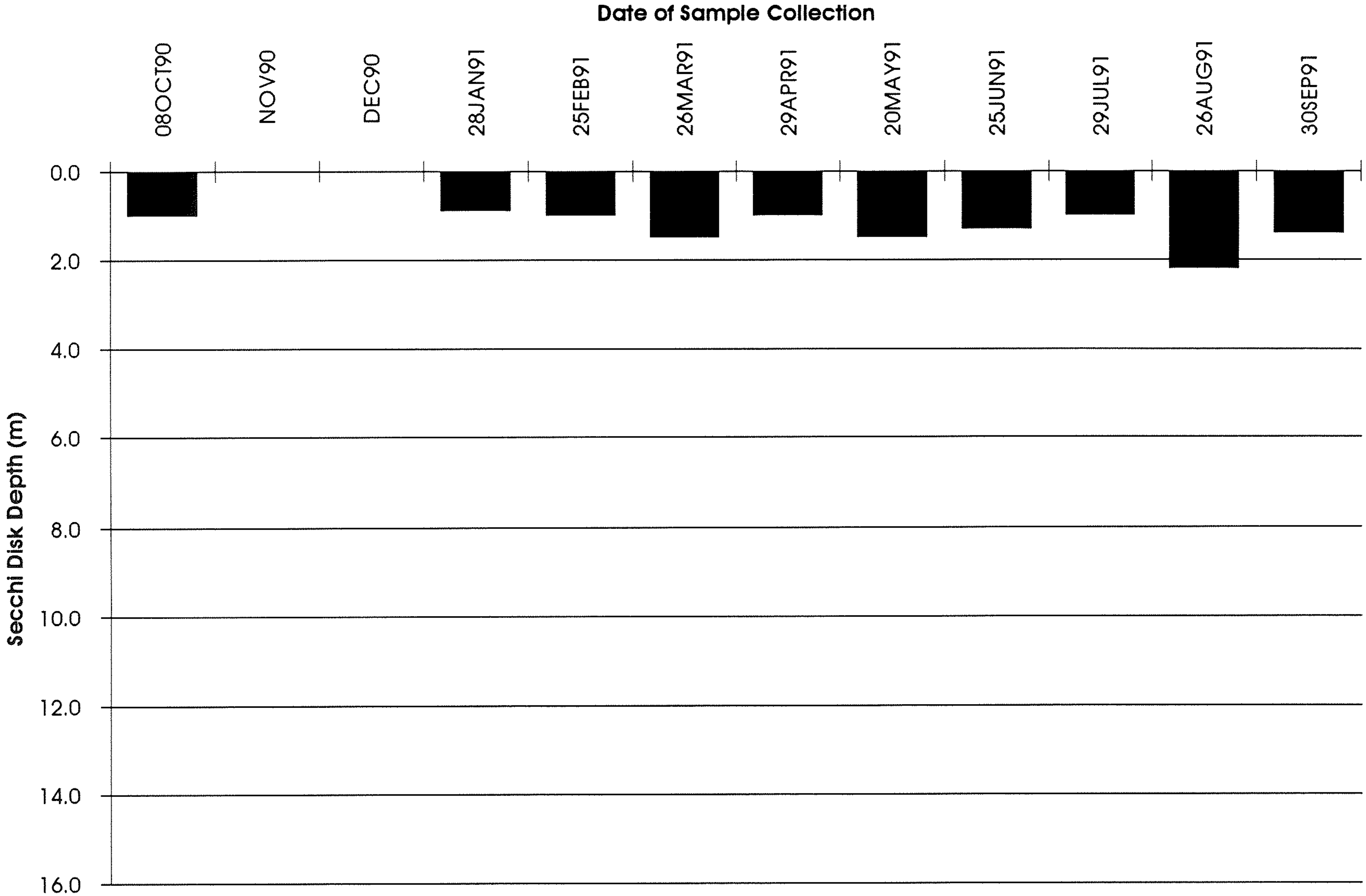
Station SKG003: Secchi Disk Depths for Wateryear 1991



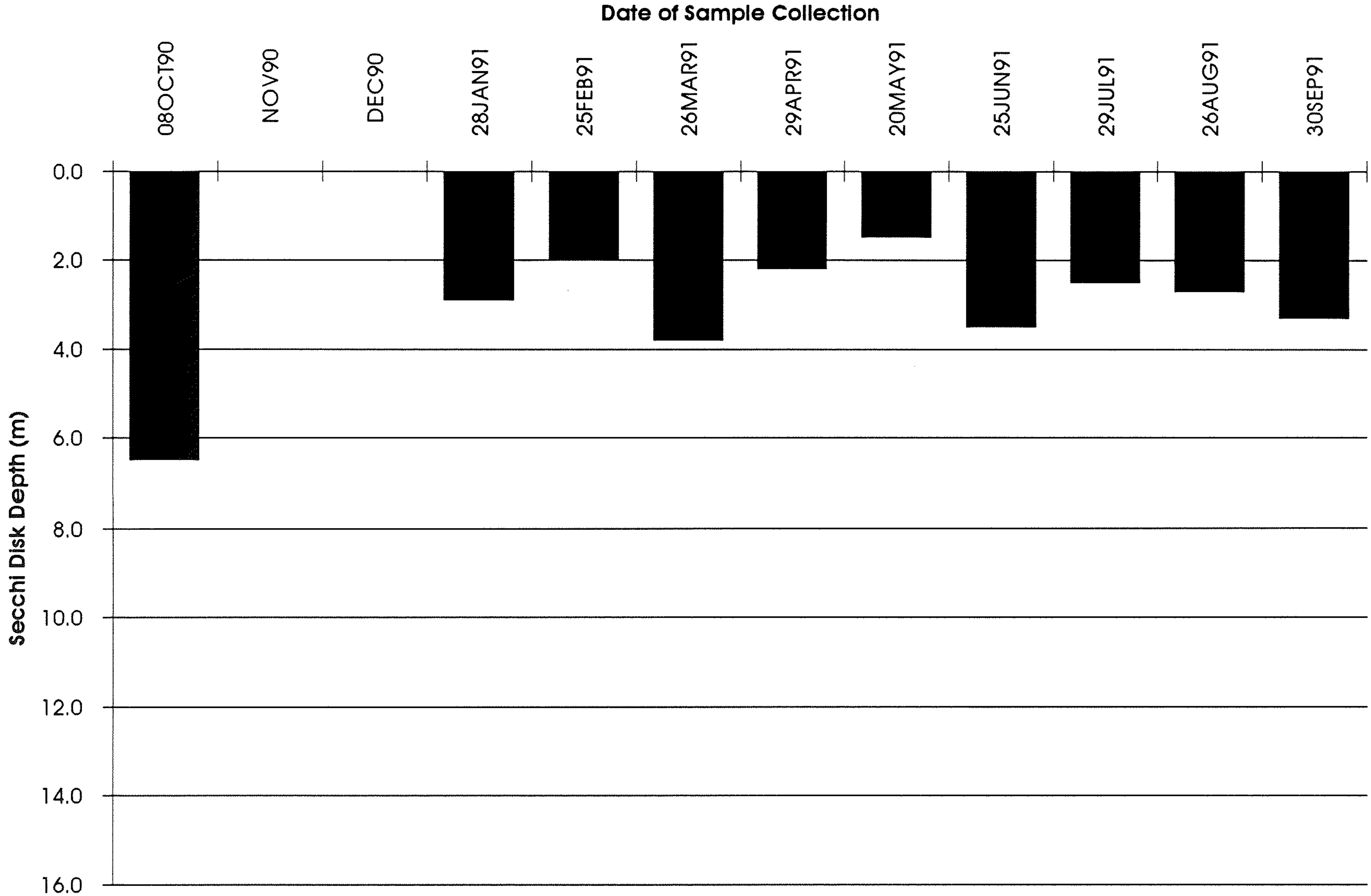
Station WPA001: Secchi Disk Depths for Wateryear 1991



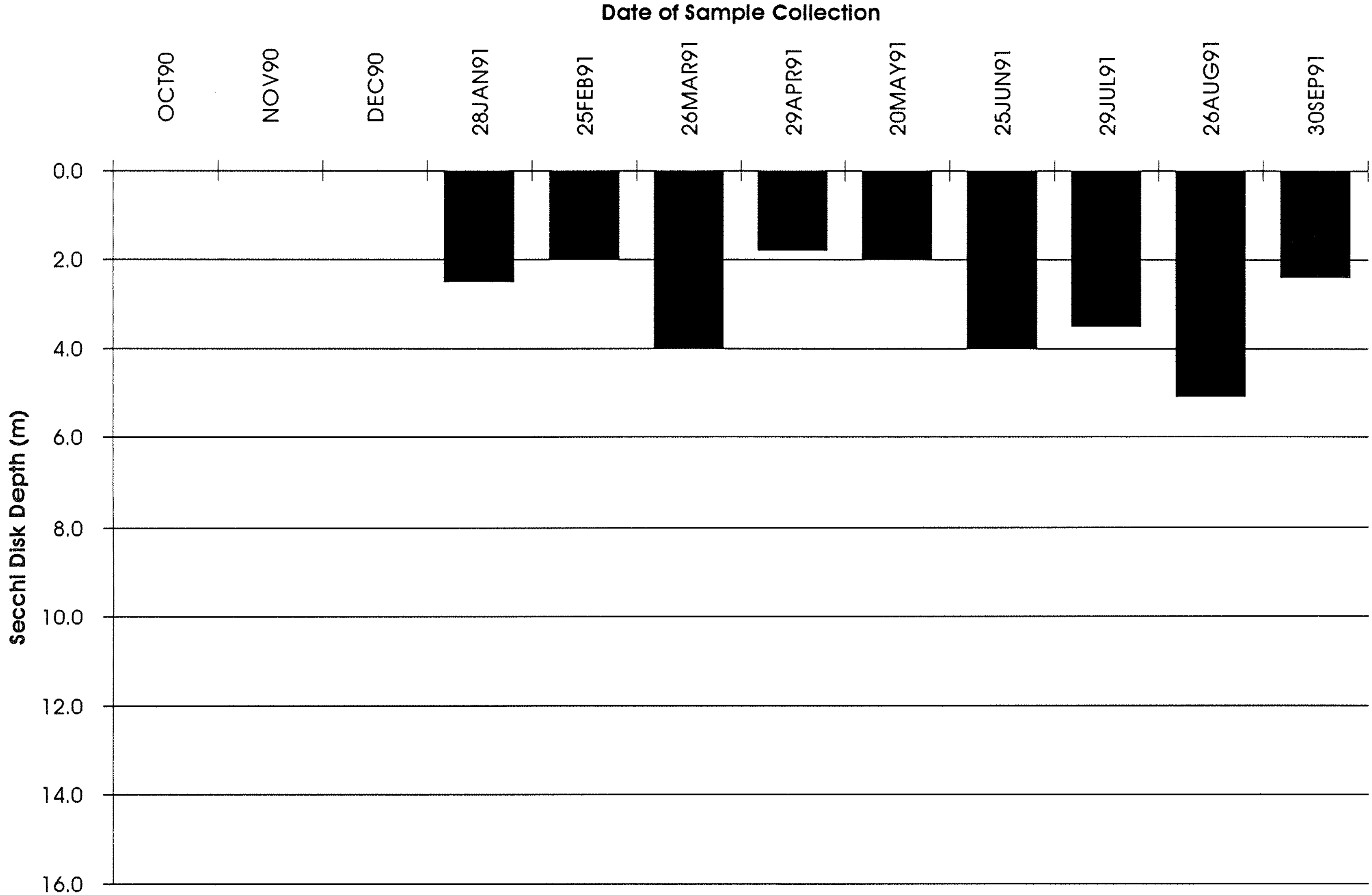
Station WPA003: Secchi Disk Depths for Wateryear 1991



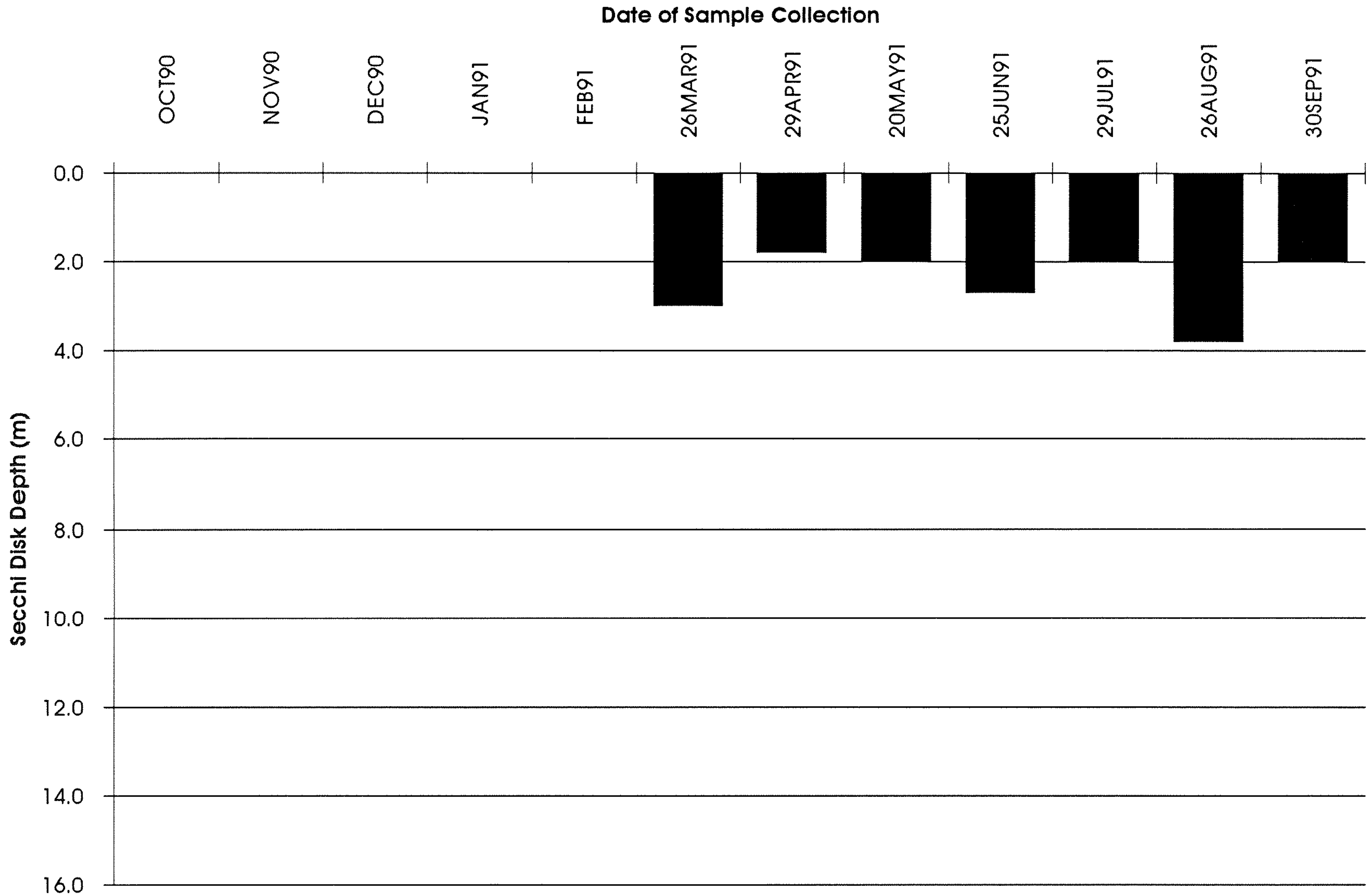
Station WPA004: Secchi Disk Depths for Wateryear 1991



Station WPA006: Secchi Disk Depths for Wateryear 1991



Station WPA007: Secchi Disk Depths for Wateryear 1991



APPENDIX L

RIVER DISCHARGE DATA FOR WASHINGTON COASTAL RIVERS IN WY 1991

UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - WASHINGTON 04/13/92

STATION NUMBER 12031000 CHEHALIS RIVER AT PORTER, WASH. STREAM SOURCE AGENCY USGS
LATITUDE 465617 LONGITUDE 1231845 DRAINAGE AREA 1294.00 DATUM 23.64 STATE 53 COUNTY 027

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	425	3110	15500	e4050	3300	4280	2950	2430	1370	932	438	606
2	432	2450	17300	e4100	3910	4890	2850	2260	1280	872	433	594
3	537	2050	18000	3940	7450	8480	3360	2120	1210	817	425	551
4	670	2190	17200	3680	12000	12700	9790	2010	1150	775	415	499
5	934	2240	18500	3410	14700	13700	20700	1970	1110	737	410	467
6	828	1990	19600	3180	15700	11700	31100	1970	1090	717	411	442
7	740	1810	16300	3800	13300	8970	35800	2040	1090	695	410	430
8	636	1830	11600	6710	9290	7380	26700	2500	1100	671	415	422
9	575	2490	9030	9570	7140	6390	20900	3060	1110	647	416	431
10	548	5490	7850	9910	5960	5940	17000	2660	1040	638	417	426
11	525	7710	7480	10400	5260	5850	14500	2370	987	628	426	408
12	560	5560	7300	13700	5130	5830	11500	2160	985	623	421	402
13	584	5240	6840	18100	5960	6410	9040	2020	988	606	408	403
14	733	7460	6340	19900	6940	6150	7460	1920	1010	600	397	396
15	1170	8140	5810	19100	6810	5670	6470	1820	1040	596	388	393
16	1370	7090	5340	17800	6190	5160	5730	1710	1080	603	375	389
17	1440	5910	5100	15800	5610	4710	5080	1630	1190	605	373	383
18	1250	5020	5570	12000	5140	4310	4620	1670	1360	602	368	375
19	1370	4250	6280	9000	6400	4040	4190	1750	1180	588	364	368
20	1410	3880	e5670	7300	12500	3800	3820	1720	1140	575	359	364
21	1700	4050	e5100	6250	17000	3610	3490	1630	1430	557	357	361
22	2450	6040	e4600	5520	15700	3520	3220	1540	1810	543	350	358
23	2680	9720	e4200	4980	10900	3520	3020	1460	1560	521	342	361
24	1840	19100	e3900	4560	8070	3580	2950	1430	1360	512	340	361
25	1440	25400	e3600	4180	6630	4460	3160	1500	1240	515	337	359
26	1290	38800	e3410	3860	5720	4660	3110	1560	1160	518	338	359
27	1270	33100	3640	3570	5070	4390	3020	1570	1090	529	433	355
28	1210	24000	4740	3370	4600	3990	2970	1470	1020	508	438	358
29	1410	17700	e4690	3210	---	3650	2780	1400	972	489	519	362
30	2300	15000	e4000	3030	---	3360	2610	1420	948	468	565	364
31	3310	---	e3900	3020	---	3110	---	1470	---	453	633	---
TOTAL	37637	278820	258390	241000	232380	178210	273890	58240	35100	19140	12721	12347
MEAN	1214	9294	8335	7774	8299	5749	9130	1879	1170	617	410	412
MAX	3310	38800	19600	19900	17000	13700	35800	3060	1810	932	633	606
MIN	425	1810	3410	3020	3300	3110	2610	1400	948	453	337	355
AC-FT	74650	553000	512500	478000	460900	353500	543300	115500	69620	37960	25230	24490
CFSM	.94	7.18	6.44	6.01	6.41	4.44	7.06	1.45	.90	.48	.32	.32
IN.	1.08	8.02	7.43	6.93	6.68	5.12	7.87	1.67	1.01	.55	.37	.35

e Estimated

UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - WASHINGTON 04/13/92

STATION NUMBER 12079000 DESCHUTES RIVER NR RAINIER, WASH. STREAM SOURCE AGENCY USGS
LATITUDE 465108 LONGITUDE 1224003 DRAINAGE AREA 89.80 DATUM 350.00 STATE 53 COUNTY 067
FROM THE DCP
DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	35	276	958	202	199	259	235	183	128	87	45	72
2	37	203	787	194	964	827	248	173	122	82	43	61
3	42	166	686	177	1730	1660	291	164	117	78	43	52
4	61	164	1800	165	1600	1480	2540	155	111	75	43	48
5	79	156	1480	154	1580	986	5230	149	109	73	43	46
6	70	142	e850	148	955	683	1960	145	106	72	46	43
7	56	135	e600	259	627	554	1040	149	103	69	44	42
8	51	137	e490	576	470	472	752	226	103	68	43	41
9	48	403	468	556	377	425	742	218	99	66	48	41
10	48	966	517	547	319	421	727	195	93	67	51	40
11	49	510	500	794	285	386	610	177	90	65	48	39
12	60	317	445	2110	383	420	515	164	92	64	44	39
13	81	601	383	1540	433	410	450	157	98	61	43	39
14	81	866	331	962	442	370	405	150	107	61	42	38
15	102	584	292	1100	393	339	382	142	101	61	41	36
16	130	428	259	851	342	309	337	135	107	63	40	35
17	102	326	247	634	304	278	305	152	147	63	40	35
18	165	257	386	510	271	257	281	193	136	62	39	34
19	161	215	353	422	615	250	260	192	123	60	37	33
20	123	200	287	351	1990	244	243	177	132	60	36	33
21	157	195	229	305	1050	231	226	165	156	59	36	33
22	223	953	223	271	669	241	212	152	142	57	35	33
23	162	1140	197	246	500	231	203	142	131	56	35	33
24	130	e4000	183	226	405	256	239	144	122	55	35	34
25	114	e2000	179	206	343	311	255	150	114	60	35	34
26	140	e1100	175	189	301	387	239	169	107	57	35	35
27	125	765	227	175	271	333	234	161	101	54	38	33
28	168	552	262	172	249	284	218	151	95	49	47	34
29	220	577	198	159	---	251	208	144	93	48	74	36
30	461	690	187	152	---	229	196	145	92	48	66	35
31	378	---	182	175	---	223	---	134	---	47	56	---
TOTAL	3859	19024	14361	14528	18067	14007	19783	5053	3377	1947	1351	1187
MEAN	124	634	463	469	645	452	659	163	113	62.8	43.6	39.6
MAX	461	4000	1800	2110	1990	1660	5230	226	156	87	74	72
MIN	35	135	175	148	199	223	196	134	90	47	35	33
AC-FT	7650	37730	28490	28820	35840	27780	39240	10020	6700	3860	2680	2350
CFSM	1.39	7.06	5.16	5.22	7.19	5.03	7.34	1.82	1.25	.70	.49	.44
IN.	1.60	7.88	5.95	6.02	7.48	5.80	8.20	2.09	1.40	.81	.56	.49

e Estimated

UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - WASHINGTON 04/13/92

STATION NUMBER 12045500 ELWHA RIVER AT MCDONALD BR NR PRT ANGELES, WASH. STREAM SOURCE AGENCY USGS
LATITUDE 480318 LONGITUDE 1233455 DRAINAGE AREA 269.00 DATUM 200.00 STATE 53 COUNTY 009

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	373	1270	2850	971	3980	1610	809	1140	1560	1620	870	1660
2	373	1100	2590	937	12200	2540	826	1110	1630	1930	863	1270
3	364	1340	3600	898	7130	3130	1560	1140	1570	2210	868	1110
4	1360	1350	9380	854	11100	2810	4130	1250	1390	2170	872	1020
5	1160	1140	5520	838	10300	2230	3380	1400	1290	1890	877	932
6	626	1010	3720	837	5800	1870	2360	1640	1320	1670	833	879
7	449	1020	2880	810	4160	1800	1870	1500	1540	1490	803	876
8	384	1030	4300	815	4130	1560	1450	1560	1660	1600	1900	797
9	395	10300	6040	850	3750	1510	1560	1340	1730	1720	1450	760
10	539	14800	4620	933	3200	1400	1380	1440	2000	1660	950	708
11	410	6950	3210	2270	3040	1320	1280	1400	2180	1480	792	695
12	956	5010	2840	4780	3190	1290	1210	1310	1740	1690	734	716
13	672	9390	2470	6190	2900	1240	1180	1400	1480	1760	752	735
14	574	5270	2210	4640	3410	1140	1150	1400	1390	1460	754	656
15	1250	4040	2140	4080	3400	1110	1110	1380	1350	1380	752	652
16	802	3450	1890	3070	2850	1060	964	1310	1360	1290	752	628
17	647	3350	1970	2660	2480	975	1140	1480	1380	1280	751	646
18	726	2720	2010	2360	2290	982	1170	1490	1360	1280	752	628
19	652	2220	1640	2120	5500	1010	1160	1810	1470	1180	750	618
20	614	1910	1460	1860	4180	965	1300	2290	1640	1150	675	624
21	2240	2080	1420	1690	3240	963	1410	2270	1630	1080	682	557
22	1110	7480	1470	1580	2730	931	1550	1990	1610	1180	683	509
23	796	14300	1380	1470	2370	898	1630	1780	1560	1130	694	545
24	1260	21400	1360	1380	2180	855	1550	1720	1560	1300	585	558
25	2240	10600	1320	1290	1960	853	1360	1560	1520	1430	547	593
26	2220	6430	1250	1200	1810	827	1250	1420	1650	1170	522	554
27	1410	4960	1120	1150	1760	848	1140	1420	1620	1050	798	530
28	2160	3690	1190	1120	1700	823	1060	1400	1700	973	1020	569
29	1700	4460	1060	1070	---	803	1050	1560	1910	985	2060	529
30	2010	3360	865	1030	---	862	1040	1400	1690	967	5740	506
31	1440	---	1090	1210	---	780	---	1420	---	933	3190	---
TOTAL	31912	157430	80865	56963	116740	40995	44029	46730	47490	44108	34271	22060
MEAN	1029	5248	2609	1838	4169	1322	1468	1507	1583	1423	1106	735
MAX	2240	21400	9380	6190	12200	3130	4130	2290	2180	2210	5740	1660
MIN	364	1010	865	810	1700	780	809	1110	1290	933	522	506
AC-FT	63300	312300	160400	113000	231600	81310	87330	92690	94200	87490	67980	43760

UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - WASHINGTON 04/13/92

STATION NUMBER 12104500 GREEN RIVER NEAR LESTER, WASH. STREAM SOURCE AGENCY USGS
LATITUDE 471228 LONGITUDE 1213307 DRAINAGE AREA 96.20 DATUM 1480.00 STATE 53 COUNTY 033
PROVISIONAL DATA FROM THE DCP SUBJECT TO REVISION
DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	35	413	723	299	329	446	378	340	295	198	69	58
2	37	374	616	285	362	416	405	378	319	190	68	53
3	78	507	576	269	723	404	397	406	324	182	67	49
4	111	1140	651	261	763	425	759	434	294	171	66	47
5	117	1390	701	247	1110	390	2160	468	278	163	66	45
6	96	1040	638	238	1020	368	1350	463	265	154	68	45
7	80	903	565	236	831	347	760	468	269	143	83	46
8	72	991	540	235	733	338	521	547	272	138	70	46
9	66	2860	649	223	705	333	455	495	265	133	66	44
10	76	5780	825	226	695	329	401	426	266	128	65	45
11	69	2120	823	246	691	309	342	391	282	124	63	44
12	148	1270	718	495	751	294	326	412	279	120	61	42
13	218	1270	626	1050	919	283	328	417	284	117	58	44
14	265	1310	554	1420	1440	272	337	410	274	112	58	45
15	818	1140	500	1920	1340	263	346	398	258	110	56	43
16	738	1010	459	1240	1200	250	357	410	249	109	55	41
17	536	875	587	997	1020	242	369	432	253	110	54	40
18	799	755	988	940	874	241	390	487	240	103	53	40
19	756	654	746	849	3500	249	405	503	242	98	51	39
20	540	575	590	752	4870	244	450	489	314	94	50	39
21	1640	545	508	654	1940	243	507	472	332	91	49	38
22	1700	3580	469	580	1180	243	581	481	318	89	47	37
23	1020	3280	419	518	849	239	573	449	299	86	46	38
24	699	16300	403	472	684	239	502	413	279	87	46	37
25	516	6320	376	431	585	238	432	404	262	94	45	36
26	467	2080	358	400	522	228	370	386	247	85	45	35
27	394	1310	358	373	488	216	329	357	234	81	46	35
28	380	1000	339	357	466	210	300	338	224	78	57	35
29	358	887	299	334	---	207	311	334	216	77	70	36
30	382	782	292	318	---	207	311	321	207	74	58	36
31	406	---	292	322	---	261	---	298	---	71	54	---
TOTAL	13617	62461	17188	17187	30590	8974	15452	13027	8140	3610	1810	1258
MEAN	439	2082	554	554	1092	289	515	420	271	116	58.4	41.9
MAX	1700	16300	988	1920	4870	446	2160	547	332	198	83	58
MIN	35	374	292	223	329	207	300	298	207	71	45	35
AC-FT	27010	123900	34090	34090	60680	17800	30650	25840	16150	7160	3590	2500
CFSM	4.57	21.6	5.76	5.76	11.4	3.01	5.35	4.37	2.82	1.21	.61	.44
IN.	5.27	24.15	6.65	6.65	11.83	3.47	5.98	5.04	3.15	1.40	.70	.49

STATION NUMBER 12089500 NISQUALLY RIVER AT MCKENNA, WASH. STREAM SOURCE AGENCY USGS
LATITUDE 465601 LONGITUDE 1223333 DRAINAGE AREA 517.00 DATUM 285.47 STATE 53 COUNTY 053
FROM THE DCP
DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	549	901	2740	721	1600	1750	923	959	902	537	495	610
2	632	735	2690	673	2000	1920	757	928	864	508	474	600
3	658	663	2360	638	2960	2430	692	693	830	585	414	579
4	818	1150	3250	633	2930	2610	2820	633	842	799	373	575
5	793	987	3090	633	3260	2400	12200	617	833	828	349	564
6	705	856	2420	646	2650	2190	14800	606	707	848	414	536
7	646	948	2350	661	2250	2140	6330	619	532	851	415	461
8	621	1020	2600	752	2040	2090	3980	814	560	813	416	462
9	622	1230	2720	820	1900	2030	3310	910	551	560	423	466
10	629	2240	2740	928	1820	1940	3240	831	529	508	428	451
11	602	1930	2740	1260	1670	1920	3090	776	522	508	428	405
12	663	1700	2610	2790	1740	1960	2910	729	671	508	428	373
13	650	2140	2300	2930	2200	2150	2850	694	641	508	428	370
14	600	2750	1690	2450	3970	2140	2500	670	710	508	428	388
15	668	2210	1620	2710	5850	2080	2120	644	666	508	429	398
16	705	2230	1570	2510	5170	2010	2000	611	652	508	416	877
17	559	2620	1550	1930	3990	1950	1930	692	878	508	398	723
18	778	2550	1760	2010	1800	1820	1860	868	863	508	381	851
19	792	2450	1710	1850	2410	1220	1600	858	779	508	365	897
20	610	2370	1570	1490	7900	985	1120	781	968	508	366	775
21	723	2170	1470	1620	9770	953	1080	728	1100	505	398	391
22	938	3260	1450	1570	6410	983	1040	678	844	501	426	398
23	689	3640	1430	1520	3920	973	1020	638	741	501	421	382
24	602	6030	1420	e1490	3460	984	1060	645	676	499	421	387
25	572	13900	1420	e1200	2890	1110	1120	745	623	514	447	386
26	577	12900	1430	802	1930	1260	1060	901	591	499	528	383
27	585	5750	1460	770	1830	1120	1030	826	579	621	464	391
28	639	2740	1480	779	1760	1020	998	845	551	524	464	411
29	715	2690	1340	738	---	963	996	951	537	502	511	397
30	904	2780	1360	714	---	908	988	982	541	501	589	399
31	966	---	1360	985	---	914	---	935	---	497	583	---
TOTAL	21210	89540	61700	41223	92080	50923	81424	23807	21283	17581	13520	15286
MEAN	684	2985	1990	1330	3289	1643	2714	768	709	567	436	510
MAX	966	13900	3250	2930	9770	2610	14800	982	1100	851	589	897
MIN	549	663	1340	633	1600	908	692	606	522	497	349	370
AC-FT	42070	177600	122400	81770	182600	101000	161500	47220	42210	34870	26820	30320

e Estimated

UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - WASHINGTON 01/26/93

STATION NUMBER 12213100 NOOKSACK RIVER AT FERNDALE, WASH. STREAM SOURCE AGENCY USGS
LATITUDE 485042 LONGITUDE 1223517 DRAINAGE AREA 786.00 DATUM 4.61 STATE 53 COUNTY 073

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	945	4880	6270	3500	2890	3380	2400	2810	3480	e4250	2690	7740
2	950	4090	5900	2660	8870	4090	2720	2990	3880	e4700	2650	4420
3	981	3750	5730	2260	10400	6770	2990	3120	3630	e5300	2590	3370
4	13300	5150	11500	2080	9630	8970	7850	3250	3190	e5200	2740	2950
5	15000	5830	12200	2110	15600	5970	10400	3540	2850	e4750	2790	2760
6	6550	4490	7830	2290	12000	4820	8820	4570	3140	e4400	2610	2570
7	4240	4230	6230	2120	7650	4190	5860	4880	3650	e4000	2920	2380
8	3260	5120	6490	2760	8060	3770	4790	5700	4440	e4100	2910	2220
9	2770	13100	13000	3960	8220	3480	4820	5370	4500	e4200	3230	2010
10	4000	e46000	13400	3330	6480	3560	4640	4250	4700	e4000	3280	1860
11	3030	e55000	9470	3360	5760	3320	3850	3870	5620	e3950	3480	1810
12	3390	21900	7060	11400	7710	3230	3460	4360	5290	e4100	2690	1730
13	3670	19300	5770	17400	7500	3040	3290	4410	4440	e4400	2580	1790
14	2970	22700	5010	18700	7310	2870	3240	4230	3800	e4200	2380	1830
15	2880	12700	4550	15500	8300	2750	3130	3820	3390	e4100	2450	1570
16	3180	9620	4200	11100	8260	2600	3130	3720	3720	e3850	2550	1510
17	2960	8960	4610	8530	6580	2480	3150	4100	4490	4400	2780	1590
18	2870	7610	7040	7550	5550	2390	3260	5050	e4000	4790	2860	1550
19	3600	6310	4640	6710	9410	2450	3420	5210	e4400	3650	2740	1550
20	2880	5910	e4100	5540	12200	2460	3700	5470	e4900	3300	2530	1520
21	4280	5390	e3700	4800	8730	2380	4120	5080	e4900	3360	2340	1330
22	4870	9750	e3400	4250	6640	2460	4530	4830	e4400	3660	2180	1210
23	3530	20300	e3100	3820	5510	2340	4130	4340	e3900	3680	2090	1130
24	2920	41700	e2950	3500	4790	2250	4410	3980	e3850	4210	1870	1200
25	3000	39900	e2750	3230	4300	2160	4320	4200	e3900	4770	1630	1400
26	12100	16700	2660	3010	3970	2070	3570	3770	e3850	3780	1470	1480
27	5780	10500	2690	2840	3720	1970	3150	3430	e3800	3230	2210	1470
28	8040	8050	2540	2720	3570	1930	2970	3270	e4000	3090	4140	1420
29	6730	7450	3420	2490	---	1920	2830	3420	e4200	3040	5870	1310
30	6880	6930	3940	2420	---	1870	2710	3660	e3900	2820	6910	1190
31	6470	---	4690	2460	---	1920	---	3620	---	2620	6140	---
TOTAL	148026	433320	180840	168400	209610	99860	125660	128320	122210	123900	92300	61870
MEAN	4775	14440	5834	5432	7486	3221	4189	4139	4074	3997	2977	2062
MAX	15000	55000	13400	18700	15600	8970	10400	5700	5620	5300	6910	7740
MIN	945	3750	2540	2080	2890	1870	2400	2810	2850	2620	1470	1130
AC-FT	293600	859500	358700	334000	415800	198100	249200	254500	242400	245800	183100	122700
CFSM	6.08	18.4	7.42	6.91	9.52	4.10	5.33	5.27	5.18	5.08	3.79	2.62
IN.	7.01	20.51	8.56	7.97	9.92	4.73	5.95	6.07	5.78	5.86	4.37	2.93

UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - WASHINGTON 04/13/92

STATION NUMBER 12101500 PUYALLUP RIVER AT PUYALLUP, WASH. STREAM SOURCE AGENCY USGS
LATITUDE 471252 LONGITUDE 1222025 DRAINAGE AREA 948.00 DATUM STATE 53 COUNTY 053
FROM THE DCP
DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1390	3570	7700	1880	3090	4320	3540	2210	3590	3840	2360	2630
2	1600	3170	7070	2010	3870	4580	3680	2140	3880	4140	2160	1920
3	2450	3270	6520	2040	5790	5030	3580	2060	3580	4910	2160	1410
4	3510	5830	8450	2010	6110	5490	6310	2020	2300	5230	2490	1750
5	3050	5040	7630	2020	8660	4790	18900	1940	1940	4780	2540	1680
6	2280	3800	6650	1930	7570	4280	14700	2090	3780	4150	2560	1790
7	1920	3660	5720	2300	5500	3920	9160	2140	4380	3710	2710	1790
8	1770	3680	5360	2690	4480	3740	6760	3170	4520	3700	2890	1700
9	1690	7100	5830	2700	3850	3630	6900	2480	3760	3580	2900	1630
10	1960	14200	6440	3180	3620	3710	6370	2560	3970	3200	2470	1540
11	1820	8280	6310	3330	3520	3530	5450	2010	4530	3360	1980	1400
12	2640	5740	5730	7080	3830	3810	5210	2040	4520	3300	1900	1540
13	2590	7890	4910	9400	4810	3770	5060	2030	4240	3520	1850	1840
14	2280	8720	4640	9190	7950	3520	4930	2750	4080	3460	1840	1190
15	4700	6740	4410	9720	7710	3360	4860	2660	3640	3040	2000	837
16	4740	5750	4250	6880	6850	3230	4370	2670	3570	2940	2220	971
17	3310	5130	4280	6160	5800	3110	4220	2890	3600	2920	2260	1290
18	4250	4850	5320	5420	4980	3040	3710	3910	3240	2690	2380	1550
19	4860	4400	4670	4780	12600	3160	3660	3920	3320	2600	2410	1300
20	3870	4050	4130	4310	26600	3080	3240	3960	4940	2420	2270	1410
21	5290	4000	4050	4010	15700	3010	3310	3940	5520	2460	2100	1190
22	7200	7450	4170	3550	11800	3290	3850	4080	4820	2790	2110	962
23	4480	9790	4010	3340	9620	3440	4050	4470	4370	2800	1910	1210
24	3040	26900	3830	3320	7520	3480	4070	4250	4060	3080	1590	1120
25	2600	27800	2500	3300	5750	3470	3690	4500	3960	3410	1460	1260
26	3420	16400	2940	3190	5390	3540	3250	4470	3870	2990	1550	1370
27	3740	13400	2970	3110	5090	3290	3090	3980	3790	2460	1400	1460
28	3660	13300	2170	3120	4240	3320	2400	3710	4080	2420	1800	1620
29	3330	13000	2140	3080	---	3280	3090	3620	4310	2580	2330	1530
30	3440	9170	1840	2910	---	3240	2450	3910	4150	2430	2540	1350
31	3710	---	1910	2950	---	3320	---	3650	---	2330	2330	---
TOTAL	100590	256080	148550	124910	202300	113780	157860	96230	118310	101240	67470	44240
MEAN	3245	8536	4792	4029	7225	3670	5262	3104	3944	3266	2176	1475
MAX	7200	27800	8450	9720	26600	5490	18900	4500	5520	5230	2900	2630
MIN	1390	3170	1840	1880	3090	3010	2400	1940	1940	2330	1400	837
AC-FT	199500	507900	294600	247800	401300	225700	313100	190900	234700	200800	133800	87750

STATION NUMBER 12200500 SKAGIT RIVER NEAR MOUNT VERNON, WASH. STREAM SOURCE AGENCY USGS
LATITUDE 482642 LONGITUDE 1222003 DRAINAGE AREA 3093.00 DATUM STATE 53 COUNTY 057
FROM THE DCP
DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	7810	21800	36100	14500	17800	20500	13100	16400	20500	22900	16100	20500
2	7540	20400	34300	14900	24700	21800	e11500	14900	20900	26500	16700	17900
3	8860	19700	33400	14700	32800	25500	12300	15500	19900	31800	17200	16200
4	30400	21700	41900	14700	34900	28100	20300	17100	20700	36200	18300	13200
5	40800	22700	43500	14300	48800	24800	30700	18900	19500	34800	19200	12000
6	21800	21000	33000	13900	42000	22400	28300	21300	16800	33400	19100	e10800
7	16100	20600	27500	14100	30400	21200	21500	21800	18800	28600	19600	e10900
8	13800	21600	25300	15500	28400	20400	18900	23400	23400	27400	18900	e10700
9	12700	36700	35200	16500	35000	18200	17800	22900	24000	26300	18300	e10900
10	15200	e88700	36800	17500	33800	19400	17000	20700	24400	24800	18800	e9700
11	14100	e130000	32100	17800	31900	19100	14900	19300	26800	24000	19100	e9700
12	14800	86800	27300	29200	33300	18900	14100	19900	25400	24200	16900	e8100
13	16900	75000	24500	41500	28000	18600	13900	21000	24000	31300	15900	e8600
14	15800	77200	22500	43700	27200	18200	13000	20700	22600	29500	14000	e8700
15	16500	61400	20900	41500	29600	17900	14600	20000	21200	26100	13100	e6800
16	20700	50500	20000	33400	35600	17600	15000	19600	21000	24000	13400	e8200
17	18500	44500	20500	27900	29900	16600	16000	20900	22100	24000	13600	e8000
18	18100	41400	24300	25900	27100	12900	17700	23600	20600	22000	15800	e8400
19	18300	36400	21000	24200	34200	e11500	17600	24100	19900	21100	16800	e8700
20	16500	32300	18800	23100	44100	e13000	17800	24400	22000	23000	16000	e8000
21	17700	33600	18800	21700	37100	15900	18800	25100	24400	22600	15700	e7200
22	23300	42600	18600	20800	29800	15300	21500	24800	23000	23600	14400	e6200
23	19200	64100	17100	19900	26500	15600	22900	23700	21500	26100	13000	e7600
24	17600	e97200	16100	18900	29000	15300	23100	23000	21500	28100	12100	e8800
25	17200	e142000	15700	18300	28600	16300	23000	23100	21900	30000	e11300	e9100
26	28000	81200	15700	17900	26900	16200	20800	21000	22400	26800	e11000	e9600
27	22200	50900	15200	17000	22600	15500	19100	19700	21900	23300	e11500	e9500
28	22200	51100	e12800	16500	21300	12900	17500	18000	23300	21400	15100	e10400
29	22900	42600	13600	16500	---	12800	16300	19100	25600	20400	17600	e10100
30	22500	40800	14300	17100	---	12600	14600	21400	24600	19000	22900	e9800
31	22100	---	14300	16700	---	12700	---	21400	---	17300	19000	---
TOTAL	580110	1576500	751100	660100	871300	547700	543600	646700	664600	800500	500400	304300
MEAN	18710	52550	24230	21290	31120	17670	18120	20860	22150	25820	16140	10140
MAX	40800	142000	43500	43700	48800	28100	30700	25100	26800	36200	22900	20500
MIN	7540	19700	12800	13900	17800	11500	11500	14900	16800	17300	11000	6200
AC-FT	1151000	3127000	1490000	1309000	1728000	1086000	1078000	1283000	1318000	1588000	992500	603600

e Estimated

UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - WASHINGTON 04/13/92

STATION NUMBER 12150800 SNOHOMISH RIVER NEAR MONROE, WASH. STREAM SOURCE AGENCY USGS
LATITUDE 474952 LONGITUDE 1220250 DRAINAGE AREA 1537.00 DATUM 13.25 STATE 53 COUNTY 061

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	e1570	12300	20000	8380	6310	10300	5910	7420	9410	9850	e3520	3220
2	e2170	10300	17200	8180	10400	12000	6620	7920	10700	10900	3430	3060
3	e7150	9330	16700	7050	22000	16800	7460	8360	10800	13400	3360	2540
4	e14300	17700	25700	6030	26600	21400	19100	8610	9200	13700	3330	2410
5	e14200	16500	28400	5320	36300	17000	38100	9190	7830	11800	3280	2590
6	e10000	12700	20000	5040	29000	13900	33700	9910	7830	10300	3170	2770
7	e6640	11000	15900	5160	19700	12100	23900	11000	9250	9040	3210	2780
8	e4820	12800	14600	7050	15600	10900	17500	13100	10800	8890	3230	2780
9	e4270	40200	19100	9820	14000	10000	14700	12900	10800	8550	3060	3000
10	e5320	86400	25500	10200	12900	9890	13500	11000	10800	7960	3060	3170
11	e5700	80000	22800	12600	12000	9460	11600	9960	12900	7370	3030	3070
12	e6610	44700	17600	26200	14400	9450	9770	10400	13300	7120	2790	2650
13	e9730'	35200	14500	40300	16600	9090	9090	11200	13300	7560	2580	2140
14	10500	34800	12500	41700	18600	8340	8880	10800	12300	7060	2440	1810
15	17800	25400	11200	40700	20100	7560	9190	9800	10600	6430	2370	1780
16	22900	20500	10200	32100	19800	6940	8900	9350	9950	6050	2350	1710
17	16500	17600	11000	23100	17700	6480	8860	10600	11500	5720	2350	1650
18	16000	16000	18300	19100	15600	6160	9210	12300	10900	5470	2340	1620
19	16900	13100	14300	16500	36700	6230	9460	12100	10800	5200	2280	1590
20	12500	12400	11100	14000	56100	6070	10000	11700	13100	e5000	2210	1590
21	21700	11900	9410	12200	41200	5850	11100	11500	14500	e5000	2120	1560
22	29500	30400	8720	10900	28500	5790	12400	11900	12300	e5000	2060	1540
23	16900	58500	8140	10000	20600	5620	12000	11100	11300	e5450	2000	1540
24	11900	96100	7690	9190	16400	5440	11800	10400	10700	e6000	1940	1540
25	9910	132000	7410	8150	13500	5490	11300	12100	10200	e6400	1850	1540
26	13500	70300	6970	7530	11700	5200	9600	11400	9770	e5100	1780	1530
27	10700	42100	7890	6430	11200	5000	8610	9870	9180	e4500	1810	1510
28	11300	26300	8310	6120	10600	4710	8190	9060	9940	e4200	2390	1500
29	11900	23400	7350	5890	---	4640	7790	9370	11300	e4050	3820	1480
30	12500	24200	6990	5610	---	4510	7370	10200	10500	e3850	3740	1460
31	13800	---	7160	5450	---	4640	---	9760	---	e3650	3050	---
TOTAL	369190	1044130	432640	426000	574110	266960	375610	324280	325760	220570	83950	63130
MEAN	11910	34800	13960	13740	20500	8612	12520	10460	10860	7115	2708	2104
MAX	29500	132000	28400	41700	56100	21400	38100	13100	14500	13700	3820	3220
MIN	1570	9330	6970	5040	6310	4510	5910	7420	7830	3650	1780	1460
AC-FT	732300	2071000	858100	845000	1139000	529500	745000	643200	646100	437500	166500	125200
CFSM	7.75	22.6	9.08	8.94	13.3	5.60	8.15	6.81	7.06	4.63	1.76	1.37
IN.	8.94	25.27	10.47	10.31	13.90	6.46	9.09	7.85	7.88	5.34	2.03	1.53

e Estimated

UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - WASHINGTON 04/13/92

STATION NUMBER 12167000 N.F. STILLAGUAMISH R. NR. ARLINGTON, WASH. STREAM SOURCE AGENCY USGS
LATITUDE 481542 LONGITUDE 1220247 DRAINAGE AREA 262.00 DATUM 89.34 STATE 53 COUNTY 061

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	195	1980	2970	1740	1890	1690	1180	1140	1060	872	e379	e1350
2	280	1620	2530	1260	6530	3240	1330	1170	1090	909	e379	e837
3	2400	1720	3900	937	6260	5000	1490	1170	1000	974	e362	e655
4	8250	2300	10500	785	9150	5730	8090	1190	888	940	e362	e534
5	4790	2590	6270	670	15000	3060	12400	1360	821	843	e362	490
6	1960	1870	4060	626	5540	2280	5710	1920	907	780	e362	454
7	1360	2150	3370	1010	3810	1900	3410	2140	994	712	e362	427
8	1060	2940	4690	2210	4730	1790	2620	3320	1230	698	e362	430
9	926	24200	9380	2690	4070	1540	2630	2380	1080	667	e362	447
10	2160	30000	7170	2340	3440	1490	2230	1720	1090	639	e397	404
11	1250	9690	4870	4380	3120	1430	1820	1490	1230	603	e415	375
12	2040	5040	3440	15500	4740	1350	1630	1550	1670	592	e362	357
13	2360	14100	2740	15800	3930	1390	1570	1450	1710	651	e362	371
14	1790	7460	2310	13900	4610	1310	1590	1300	1390	668	e327	371
15	3490	4700	2030	12000	4330	1210	1700	1130	1190	636	e309	338
16	2660	3740	1790	5690	3890	1100	1630	1130	1790	639	e309	323
17	1770	4200	3920	4240	3240	1050	1580	1250	2260	561	e327	312
18	2910	3140	4680	3880	2830	1020	1600	1660	1600	537	e327	307
19	2530	2570	2500	3430	12900	1110	1610	1440	1330	491	e327	299
20	1970	2360	2020	2810	8050	1080	1700	1350	1380	466	e309	291
21	3860	2430	1980	2380	4580	1040	1830	1290	1250	449	e292	284
22	2670	14700	e1420	2060	3340	1100	1880	1230	1120	451	e292	275
23	1940	24600	e1160	1810	2700	1030	1600	1100	1060	446	e275	269
24	1520	34200	1100	1600	2320	994	1840	1240	1030	481	e275	260
25	2170	15400	1030	1400	2060	929	1620	1760	984	552	e275	259
26	3490	5600	954	1230	1920	848	1380	1360	936	485	e275	259
27	2100	4110	1200	1090	1820	794	1250	1150	878	435	e397	258
28	4040	3350	987	1060	1760	784	1200	1070	898	427	e866	255
29	3550	3980	923	892	---	787	1200	1090	960	e413	e1590	250
30	2990	3490	955	872	---	749	1130	1430	986	e397	e1920	245
31	2470	---	847	920	---	835	---	1210	---	e397	e995	---
TOTAL	76951	240230	97696	111212	132560	49660	72450	45190	35812	18811	14515	11986
MEAN	2482	8008	3151	3587	4734	1602	2415	1458	1194	607	468	400
MAX	8250	34200	10500	15800	15000	5730	12400	3320	2260	974	1920	1350
MIN	195	1620	847	626	1760	749	1130	1070	821	397	275	245
AC-FT	152600	476500	193800	220600	262900	98500	143700	89630	71030	37310	28790	23770
CFSM	9.47	30.6	12.0	13.7	18.1	6.11	9.22	5.56	4.56	2.32	1.79	1.52
IN.	10.93	34.11	13.87	15.79	18.82	7.05	10.29	6.42	5.08	2.67	2.06	1.70

e Estimated

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UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - WASHINGTON 04/13/92

STATION NUMBER 12013500 WILLAPA RIVER NEAR WILLAPA, WASH. STREAM SOURCE AGENCY USGS
LATITUDE 463900 LONGITUDE 1233910 DRAINAGE AREA 130.00 DATUM 3.57 STATE 53 COUNTY 049
FROM THE DCP
DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	36	694	2260	550	521	514	372	342	184	124	46	158
2	44	574	2030	512	2260	1110	381	315	173	114	46	110
3	147	525	1690	478	3040	1900	1240	294	162	105	45	87
4	216	514	4860	447	4450	2260	5630	277	155	100	44	75
5	222	461	3390	416	4250	1640	7540	279	149	97	42	67
6	138	404	2070	401	2400	1280	3860	280	144	92	45	61
7	99	402	1480	888	1570	1040	2790	339	147	89	46	58
8	82	391	1210	1460	1160	868	2050	554	149	84	44	56
9	73	971	1050	1490	920	797	1850	442	136	82	48	54
10	75	2290	1010	1270	762	805	1670	387	127	82	49	51
11	70	1380	988	2110	699	756	1420	352	122	79	45	50
12	99	991	896	4500	833	883	1180	326	130	76	40	48
13	157	2280	851	3990	817	845	981	308	135	73	38	46
14	152	2010	759	2780	763	777	845	287	136	73	37	45
15	571	1660	693	2860	686	706	724	270	132	73	37	43
16	411	1260	628	2030	625	641	633	255	229	81	34	39
17	289	1050	644	1510	599	577	565	245	269	80	33	39
18	412	837	889	1180	554	533	514	241	191	77	32	37
19	364	754	759	944	1480	501	467	234	164	71	31	36
20	270	831	655	786	3150	458	426	218	172	68	29	35
21	634	1010	586	676	1930	492	391	208	256	63	27	35
22	625	2740	549	599	1340	508	364	193	211	62	28	35
23	431	2940	498	542	1030	477	352	183	189	58	27	37
24	329	9300	462	493	839	606	493	184	174	63	27	35
25	326	6900	438	449	709	644	528	240	164	81	27	35
26	488	2810	433	412	618	595	469	219	154	71	26	33
27	357	1870	547	383	553	540	447	197	147	64	47	33
28	486	1360	571	374	504	506	418	184	136	58	97	34
29	560	1810	483	341	---	469	391	183	129	53	196	35
30	1130	1830	452	319	---	431	366	231	129	49	214	33
31	896	---	475	427	---	400	---	204	---	47	193	---
TOTAL	10189	52849	34306	35617	39062	24559	39357	8471	4895	2389	1720	1540
MEAN	329	1762	1107	1149	1395	792	1312	273	163	77.1	55.5	51.3
MAX	1130	9300	4860	4500	4450	2260	7540	554	269	124	214	158
MIN	36	391	433	319	504	400	352	183	122	47	26	33
AC-FT	20210	104800	68050	70650	77480	48710	78060	16800	9710	4740	3410	3050
CFSM	2.53	13.6	8.51	8.84	10.7	6.09	10.1	2.10	1.26	.59	.43	.39
IN.	2.92	15.12	9.82	10.19	11.18	7.03	11.26	2.42	1.40	.68	.49	.44