DATA REPORT

Hydrodynamic and Water Quality Measurements

in

the Appomattox River

A Report To the City of Petersburg

VIMS Data Report No. 25

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and
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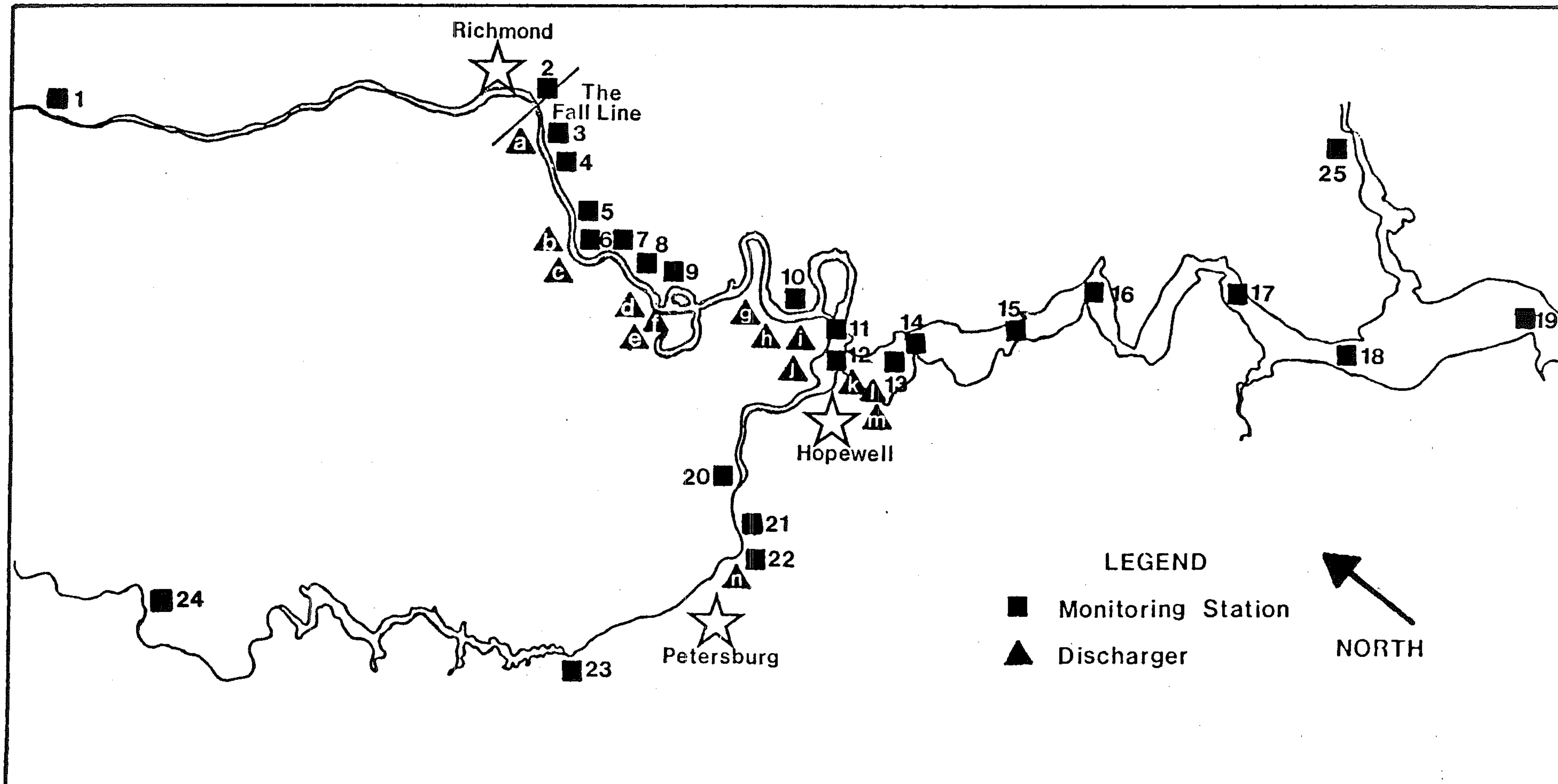
INTRODUCTION

In 1984 the City of Petersburg hired the Virginia Institute of Marine Science to conduct field studies in the Appomattox River estuary. These studies had several purposes. First the resulting data would document the physical setting and the water quality conditions existing in the river. Secondly, that data set was intended to be sufficient to permit initial water quality model studies to be performed. This report provides tabular summaries of the data resulting from those field studies.

It should be noted that these studies were undertaken concurrently with the so-called Richmond-Crater monitoring program on the upper tidal James River. The Richmond-Crater water quality surveys began in the summer of 1983 and covered that portion of the James between the fall line and the Chickahominy River (See Figure 1). Only a few stations were located in the Appomattox in 1983, but the number of stations in the Appomattox was significantly larger in 1984 (See Figure 2). Those surveys provide an overview of conditions in the James and Appomattox River systems and also document the seasonal variations in water quality. The Richmond-Crater studies of the upper tidal James and the tidal Appomattox were conducted under the aegis of the Richmond Regional Planning District Commission. The field work was done by the staff of the Piedmont Regional Office of the Virginia State Water Control Board (SWCB) and the Virginia Institute of Marine Science, and the Occoquan Monitoring Lab of Virginia Tech processed and analyzed the data and also did laboratory analyses.

The field program in the Petersburg study consisted of a so-called "intensive survey" of water quality conditions, physical and process oriented studies, and a series of slackwater surveys, all designed to provide a relatively complete and comprehensive data base for the Appomattox River. In addition to the monthly slackwater surveys conducted by SWCB personnel for the Richmond-Crater study, there were slackwater surveys of the Appomattox roughly two weeks before (low water slack), four days prior to (high water slack), and one week after (low water slack) the intensive survey.

The next chapter includes information on the field measurements that describe the physical setting, and the following chapter describes the water quality studies. Most of the data are presented in tables in the appendices. The quality assurance program is described in the final chapter of the data report.



PREPARED BY: The Richmond Regional Planning
District Commission - District 15

Date: 12/01/83

Figure 1. James River Water Quality Monitoring Network. (from Grizzard & Weand, 1984)

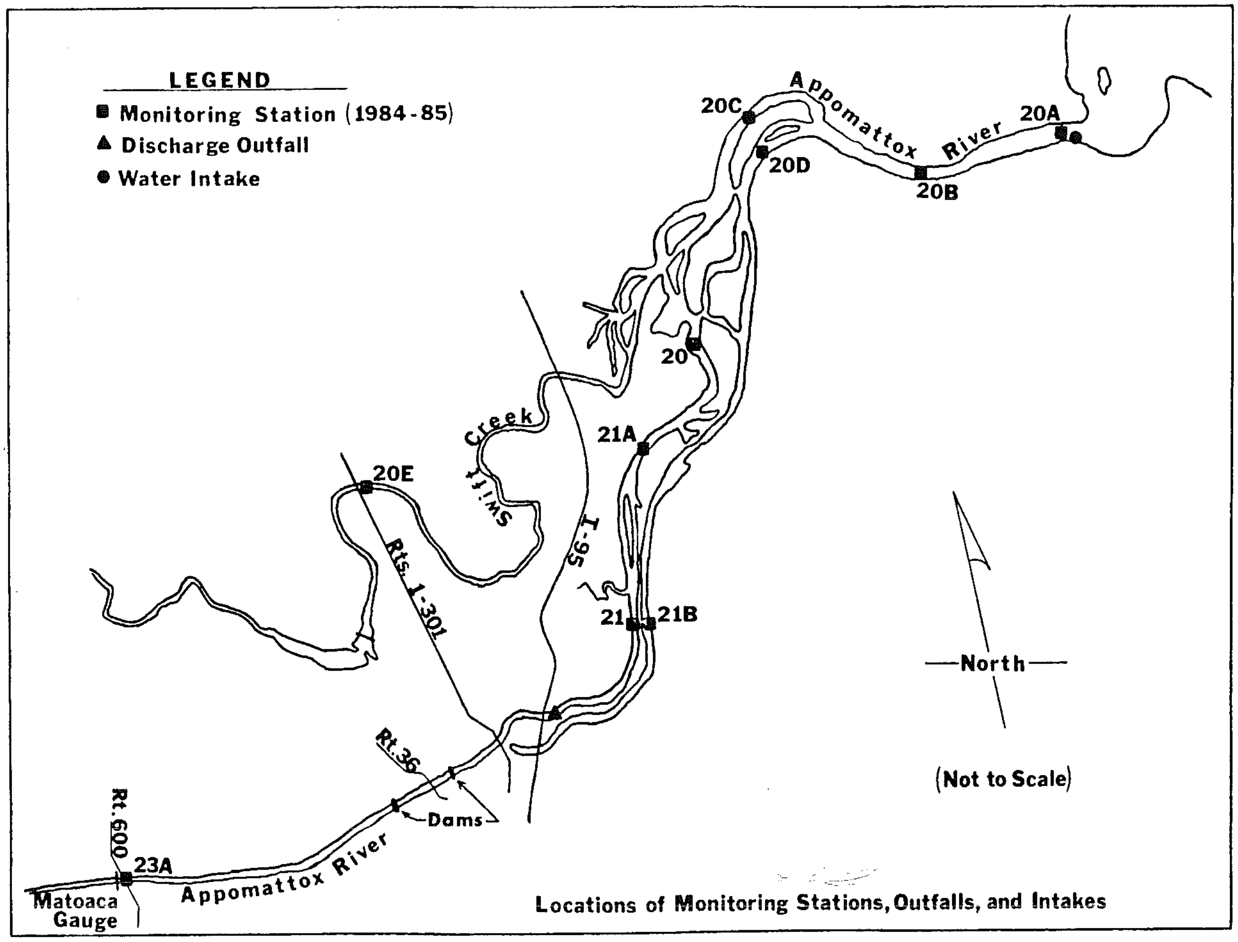


Figure 2. Locations of Monitoring Stations, Outfalls, and Intakes. (from Das, 1984)

HYDRODYNAMICS

Although the primary purpose of the program is to document present water quality conditions and provide the data necessary for application of a mathematical model of water quality, it is necessary to also understand the physical setting. In particular math models require information on the channel geometry and water quality conditions are greatly affected by the circulation patterns. Consequently the field efforts included bathymetric profiles of a number of channel transects, measurement of water elevations to observe tidal fluctuation, and measurement of water currents. Each of these will be described below.

Channel Bathymetry - On September 27, 1984 measurements were made to define the bathymetric profiles of the channel bottom at the nineteen locations shown in Figure 3. Where depth was sufficient, a recording fathometer was used. The distance of each transect from the mouth of the river, the cross-sectional area, and the average depth of the conveyancy portion are presented in Table 1. The bathymetric profiles are included in Appendix 1.

Table 1. Location, Cross-Sectional Area and Mean Depth of Appomattox River Transects.*

Transect No.	Distance from Mouth, miles	Cross-Sectional Area, ft^2	Mean Depth ft.
1	1.12	11,929	14.0
1A	2.18	5,482	16.0
2	3.13	9,081	11.3
3	4.64	3,867	10.1
Broad St.	6.00	688	4.5
4	6.38	1,730	4.3
5	7.70	1,360	5.3
6	9.50	1,269	8.3
7	10.87	835	6.1
S1	4.00	8,166	19.0
S2	5.60	2,961	9.3
Short Turn	5.62	1,120	4.7
Pye Alley	6.25	614	5.3
S2A	6.79	808	6.2
S3	7.22	1,432	9.5
S3A	8.26	548	5.7
S4A	8.35	1,036	8.7
S4	9.13	448	5.3
S5	10.84		

*Transect locations are shown graphically in Figure 3.

Tide stage - Tide gauges were installed roughly 3 to 4 weeks before the intensive water quality survey and were in place for approximately six weeks. Four Fisher-Porter recording tide gauges programmed to record water level at six-minute intervals were installed and operated at the locations and times indicated in Table 2. The complete tide gauge records are presented in tabular form in Appendix 2.

Table 2. Dates of Operation and Location of Tide Gages and Current Meters Installed during the Appomattox River Study

Instrument	Dates of Operation	Location*
Tide Gage	8/10/84 - 9/23/84	Hopewell
Tide Gage	7/31/84 - 9/17/84	Boat Harbor (near S4A)
Tide Gage	7/31/84 - 9/07/84	WWTP Pumping Station
Tide Gage	8/02/84 - 9/17/84	Pump House (near S5)
Current Meter	8/24/84 - 8/31/84	Station S3A
Current Meter	8/26/84 - 8/31/84	Station S4A
Current Meter	8/14/84 - 8/20/84	Station 5

*Locations also shown in Figure 3.

Current speed and direction - Three General Oceanics Model 6011 current meters were emplaced at two locations in the Appomattox River (see Figure 3 and Table 2). These locations correspond to water quality stations 5 on the northern branch (diversion channel) and stations S3A and S4A on the southern branch. The complete current records are presented in tables in Appendix 3.

Dye study - A dye study was conducted to document the dispersion and flushing characteristics of the river. In order to minimize field efforts, the dye release was timed to coincide with the intensive survey of water quality. On August 27,1984 fifteen (15.0) gallons of 20% Rhodamine WT fluorescent dye was released to the river via the Petersburg WWTP effluent during a flood half tidal cycle. This method of discharge resulted in a relatively well-mixed mass of dyed water at the high water slack (slack before ebb) at which time the intensive survey commenced. Slackwater surveys were made on several days following the dye release to document the water transport and dispersion patterns.

Table 3. Dye Sampling Schedule

Date	Time*	Type of Survey
8/28/84	1800-1935	HWS (slack before ebb)
8/29/84	0810-1024	HWS (slack before ebb)
8/29/84	1230-1333	LWS (slack before flood)
8/30/84	1405-1503	LWS (slack before flood)
9/02/84	0930-1107	HWS (slack before ebb)
9/04/84	0800-0952	LWS (slack before flood)
9/06/84	1143-1301	Late Flood
9/08/84	1342-1453	Late Flood

*daylight savings time

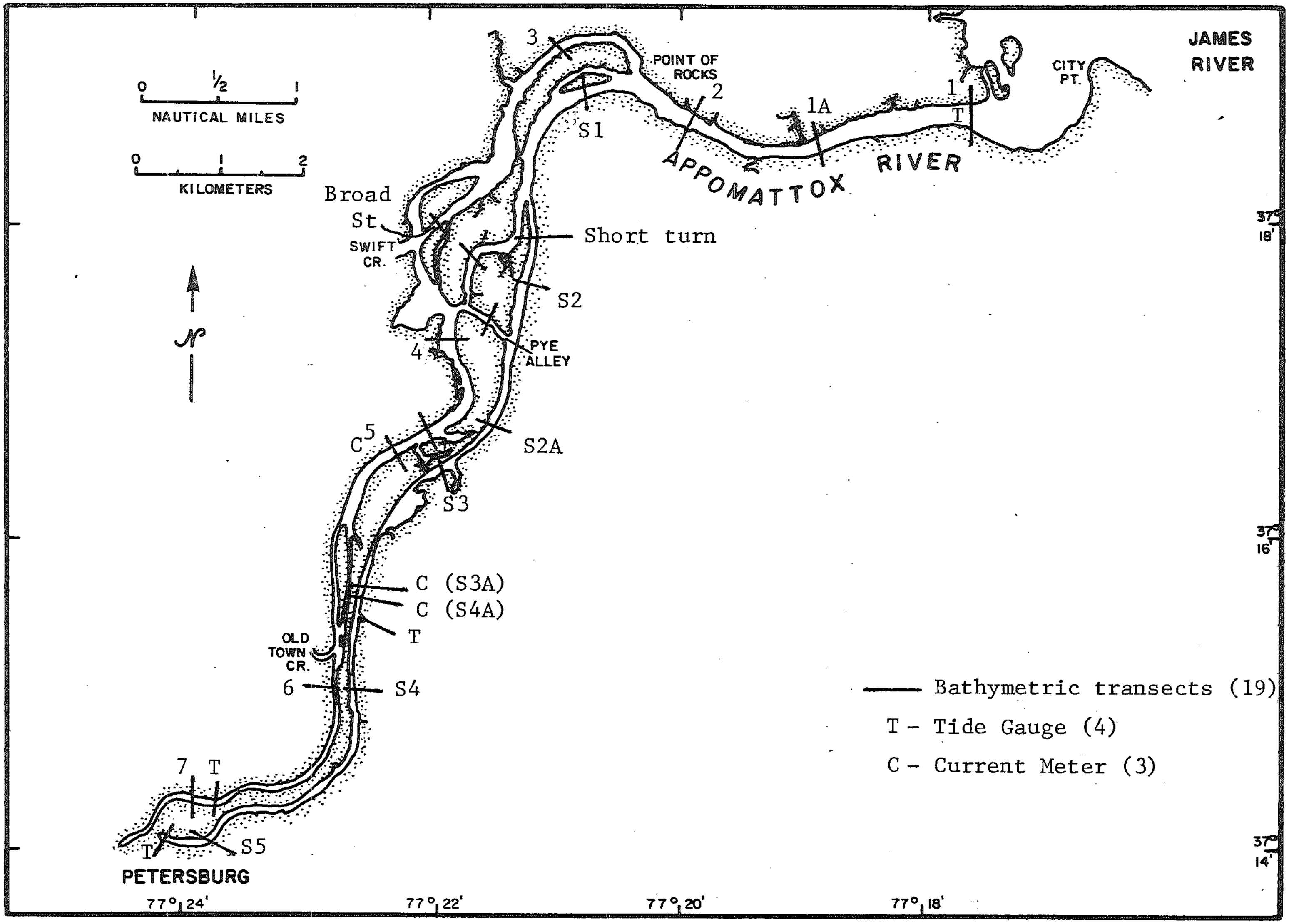


Figure 3. Location of Appomattox River bathymetry transects, tide gauge, and current meters.

WATER QUALITY

The purpose of the water quality monitoring was to document present conditions and to assemble sufficient data to allow a mathematical model of water quality processes to be applied to the river. Consequently it was necessary to monitor conditions over both the short term and the longer term. Same slack surveys provide a "snap shot" of conditions in the river. When spaced over a period of months, these surveys allow seasonal variations in water quality to be observed. Conditions also vary over shorter time intervals. The intensive survey provided around-the-clock sampling for twenty six hours. Thus two complete tidal cycles were monitored and sampling occurred during both day and night periods, so both tidal and diurnal variations should be apparent in the record.

Slackwater Surveys - Slackwater surveys were conducted by the SWCB on roughly a monthly basis as part of the James River study. Additional slackwater surveys were conducted for this study between August 10 and September 4,1984 (Table 4). In view of constraints imposed by the shallow depths and obstructions to navigation in the creek, all surveys were conducted during daylight periods. The surveys were conducted under varying conditions of freshwater flow and wasteloading and were designed to provide data both for assessing stream conditions and for validation of the water quality model.

Table 4. Slackwater Survey Schedule

Date	Time*	Type
8/10/84	1011-1309	Low water slack (SBF)
8/23/84	1115-1342	High water slack (SBE)
9/04/84	0800-0952	Low water slack (SBF)

*Daylight savings time

Sixteen stations were sampled during the study - twelve stations along the axis of the river, three stations above the head of tide on Swift Creek, Appomattox falls, and the Appomattox Canal, and one station at the Petersburg wastewater treatment plant (WWTP). Stations locations are shown in Figure 4.

At each station **in situ** measurements of dissolved oxygen, water temperature, and secchi depth were taken. Also at each station, samples were withdrawn from the mid-depth of the water column and analyzed for the following parameters:

Total Nitrogen	CBOD-5
Ammonia Nitrogen	CBOD-30 (taken at select times only)
Nitrite + Nitrate Nitrogen	Dye (Sept. 4 survey only)
Total Phosphorus	Chlorophyll
Ortho Phosphorus	

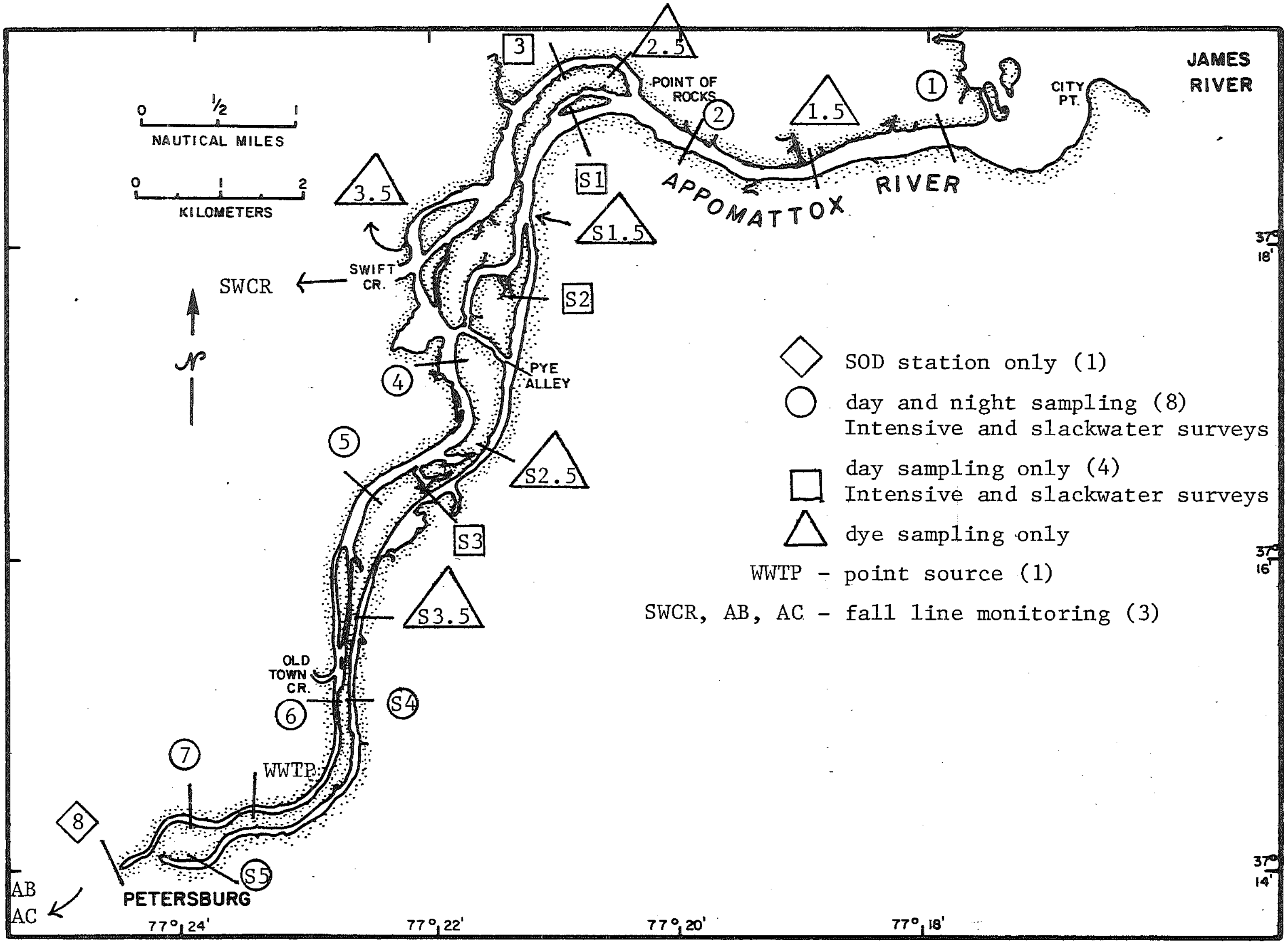


Figure 4. Water quality sampling stations.

Intensive survey - An intensive survey was conducted from highwater slack at 1500 on August 27 to highwater slack at 1600 on August 28,1984. The sampling during the intensive survey was continuous for two tidal cycles (approximately 25 hours) providing data on both the intratidal and diurnal parameter fluctuations in the river. The data from the intensive survey provide a basis for model calibration.

Sampling was conducted at the twelve intensive stations shown in Figure 4. The parameters and sampling intervals were as follows:

Nitrogen and phosphorus species	every three hours
Chlorophyll 'a'	every three hours
CBOD-5	every three hours
CBOD-30	beginning and end of survey
Dissolved Oxygen	every hour
Temperature	every hour
Secchi Depth	every hour
Dye	every hour

The results have been plotted to show longitudinal variations of the various water quality measures for the northern channel (Figures 5-a and b) and the southern channel (Figures 6-a and b). The solid line shows the average conditions; some estimate of the short term variability can be seen by the spread of the individual data points at each station. The presence of the WWTP is apparent in the profiles for orthophosphorus and ammonia nitrogen.

Input measurements - Concomitant with each slackwater survey, grab samples taken from the WWTP effluent and at the fall line were analyzed for the same parameters as the river samples. Table 5 includes selected entries from the August 1984 Monthly Discharge Monitoring Report and provides data on the quality and quantity of the effluent discharged by the Petersburg WWTP. The data given in Table 5 are for the days on which the slackwater surveys and the intensive survey occurred. Fresh-water inflow to the Appomattox River was gauged at the Route 600 bridge both before and after all water quality surveys. The riverflows are illustrated graphically in Figure 7 and are listed on a daily basis in Table 6.

Table 5
Monthly Discharge Monitoring Report
Petersburg WWTP

Date	Effluent Flow mgd	D.O.(Effluent) mg/l	BOD-5 mg/l
8/10/84	10.363	5.6	82
8/23/84	8.304	6.3	26
8/24/84	8.289	6.5	30
8/25/84	7.721	7.2	65
8/26/84	7.296	7.1	22
8/27/84	8.054	6.3	17
8/28/84	7.967	6.3	37
8/29/84	7.976	6.6	43
Average	8.246	6.5	40

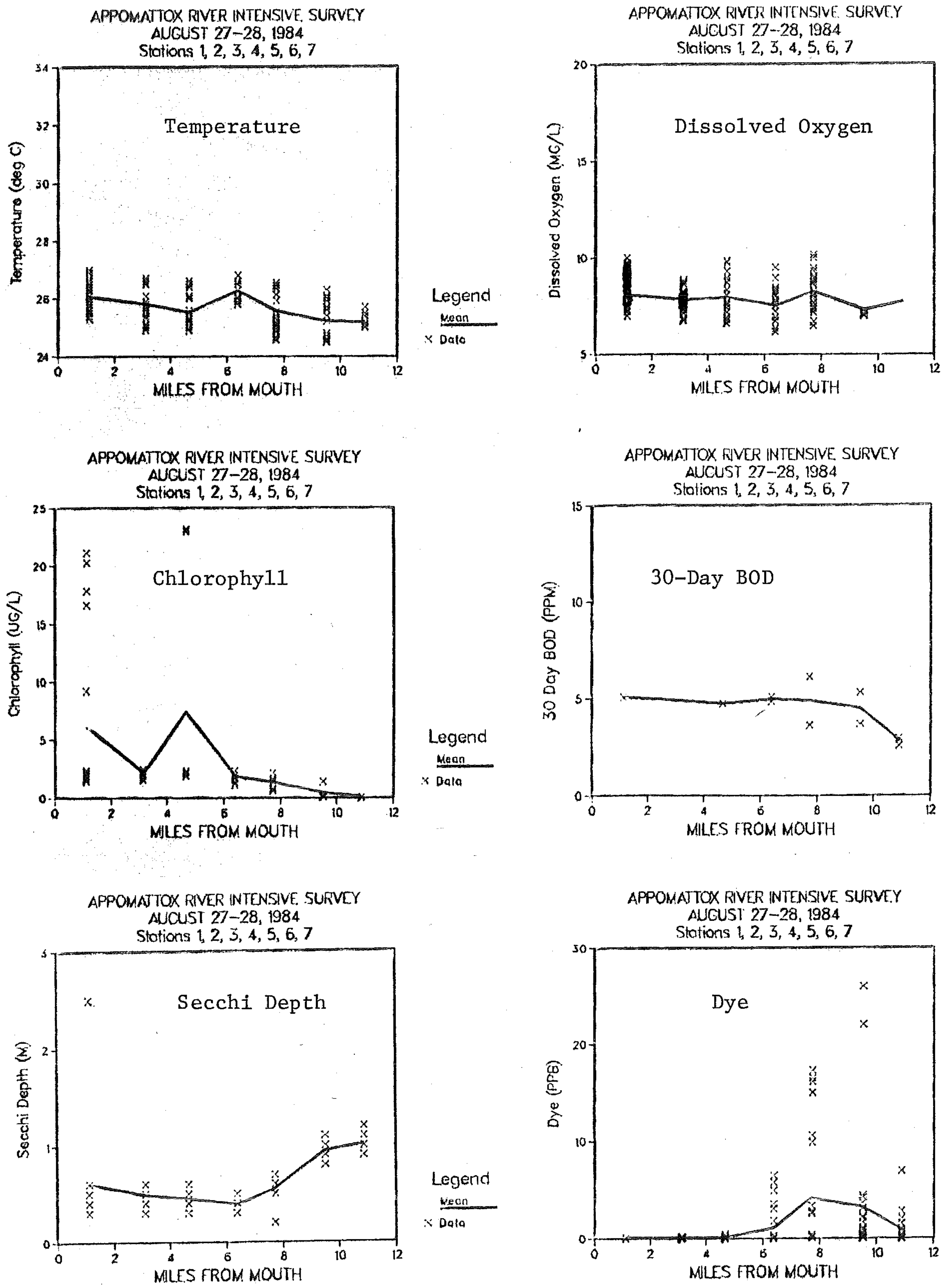


Figure 5a. Water quality in the northern channel of the Appomattox River on August 27-28, 1984.

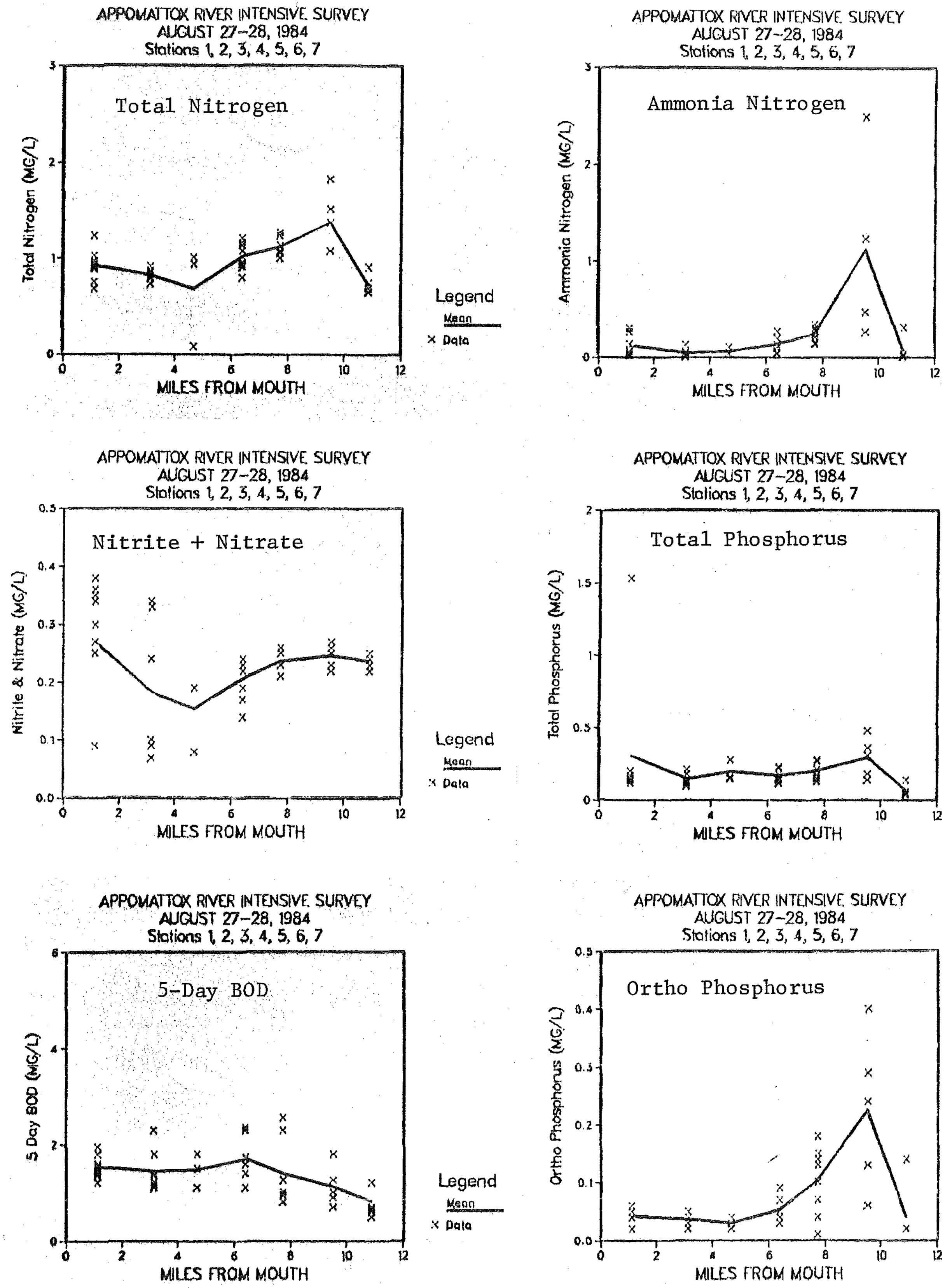


Figure 5b. Water quality in the northern channel of the Appomattox River on August 27-28, 1984.

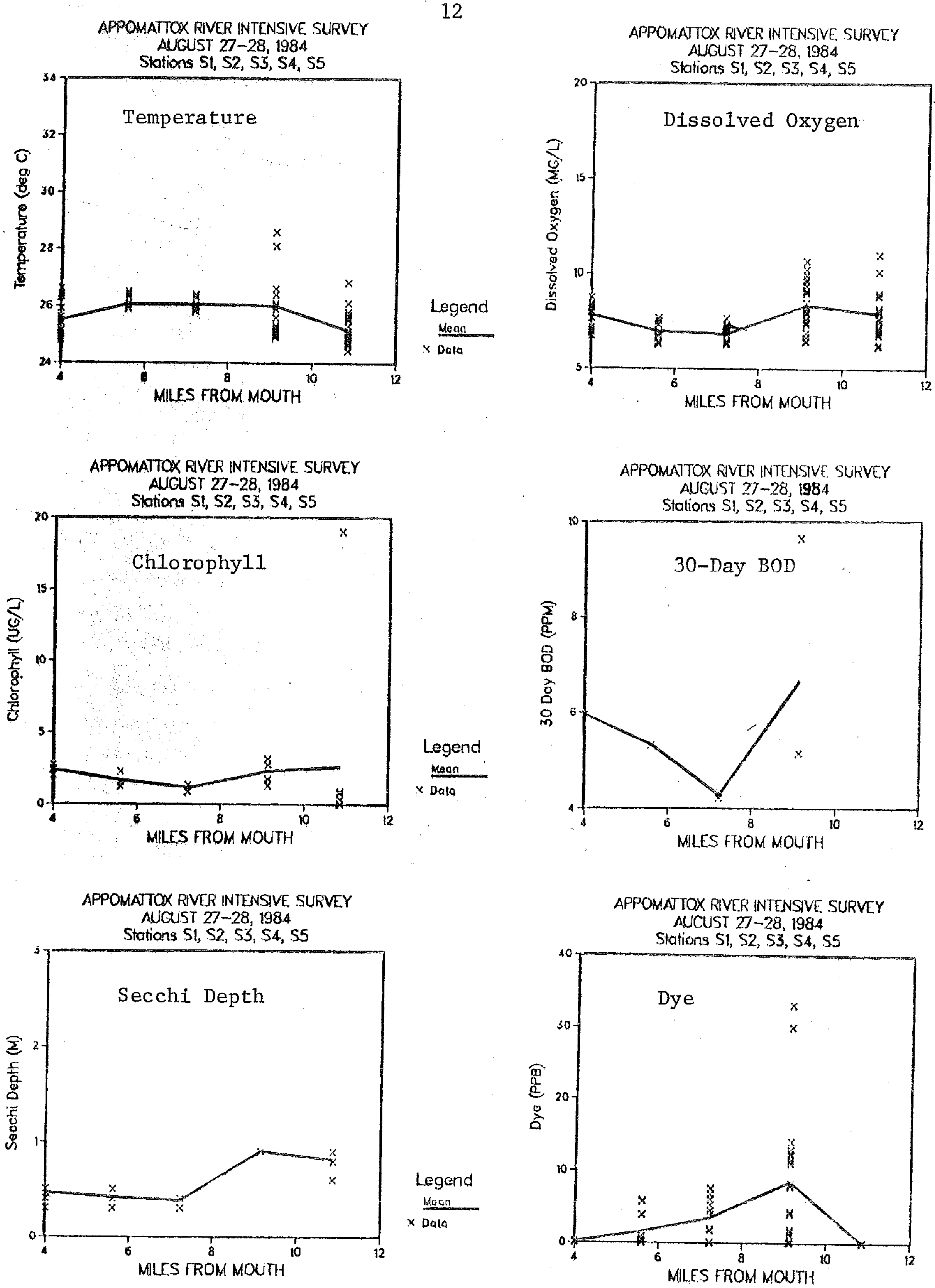


Figure 6a. Water quality in the southern channel of the Appomattox River on August 27-28, 1984.

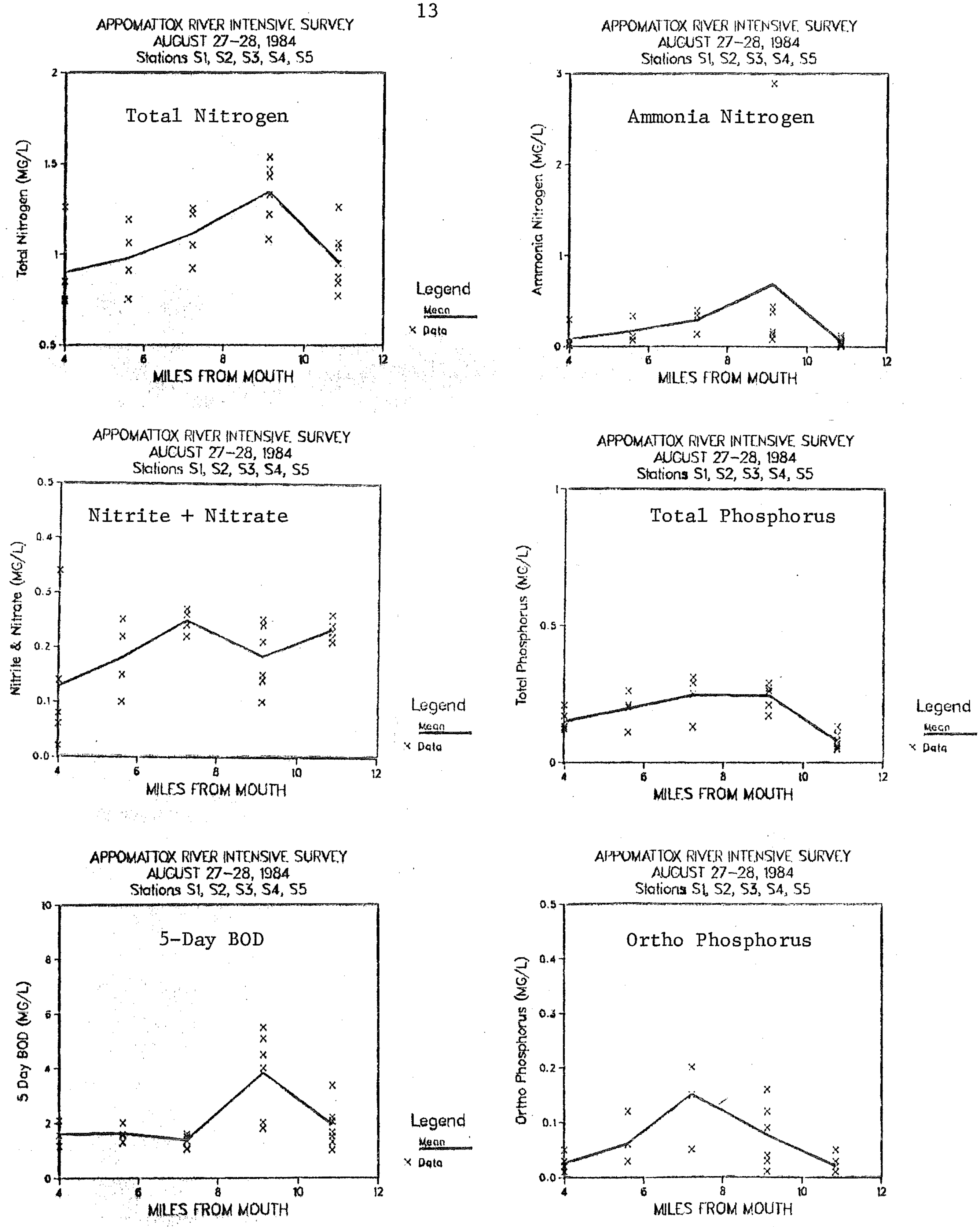


Figure 6b. Water quality in the southern channel of the Appomattox River on August 27-28, 1984.

TABLE 6. Appomattox River FLow at the Route 600 Bridge

MONTH	DATE	FLOW (cfs)	MONTH	DATE	FLOW (cfs)	MONTH	DATE	FLOW (cfs)
AUG.	1	1115	AUG.	24	555	SEPT.	16	274
	2	725		25	455		17	274
	3	595		26	399		18	274
	4	575		27	435		19	274
	5	535		28	371		20	274
	6	479		29	331		21	272
	7	547		30	317		22	272
	8	579		31	320		23	272
	9	483	SEPT.	1	320		24	272
	10	459		2	311		25	272
	11	495		3	305		26	274
	12	644		4	317		27	274
	13	1205		5	308		28	274
	14	2910		6	290		29	282
	15	3300		7	285		30	282
	16	1820		8	280			
	17	1010		9	280			
	18	680		10	277			
	19	1235		11	277			
	20	1400		12	280			
	21	1160		13	277			
	22	797		14	277			
	23	680		15	277			

* Special discharge measurements by U. S. Geological Survey on Aug.28, 1984:
Upper Appomattox River Canal at Rt. 600 at Motoaca, VA: 12.80 cfs
Swift Creek at U.S. Highway 1 at Colonial Height, VA: 9.30 cfs

Sediment Oxygen Demand and nutrient fluxes - In addition to the monitoring of water quality in the river, it also is necessary to collect ancilliary information which helps one to understand why conditions are as they are. The highly organic sediments typical of many estuaries and especially those fringed by marshes can exert an important influence on the quality of the overlying water. In particular the degradation of the organic matter and its consumption by benthic organisms result in an oxygen demand that can be quite large, especially for shallow systems. Similarly the regeneration of nutrients within the bottom sediments can affect the amounts and relative proportions of the nutrient species in the water column.

Sediment oxygen demand (SOD) in the Appomattox River was measured with a closed-chamber benthic respirometer while closed-chamber nutrient domes were utilized to measure benthic nutrient fluxes. Similar field measurements have been made for the upper tidal James River. The Appomattox River field work was conducted from July 6 to September 25, 1984. The results of the SOD measurements are presented in Table 7 and those for the nutrient flux measurements in Table 8.

Data summaries - The data from the water quality surveys have been summarized in tables. Appendix 4 includes the results of the slackwater surveys to monitor dye levels, the water quality slack surveys conducted under this program, and the monitoring of the Petersburg wastewater treatment plant discharge and the river inflows at the fall line. In Appendix 5 the results of the intensive survey have been tabulated.

Table 7. Sediment Oxygen Demand - Appomattox River

Date	Sta.	Ambient Water Temperature (deg C)	Ambient Dis. Oxygen (mg/l)	S.O.D. (gm/m2/day)
7/25/84	6	27.6	7.82	ND*
9/11/84	S4	24.4	9.02	0.76
7/25/84	8	27.2	7.78	2.20
9/11/84	8	24.3	7.78	1.68

*ND = none detected

Table 8. Benthic Nutrient Flux - Appomattox River

Date	Sta.	Depth m	NH4 mg/m2/hr	NO3 mg/m2/hr	PO4 mg/m2/hr	DO gm/m2/day
7/9/84	4	1.5	-3.22	-2.99	-1.29	-2.05
9/25/84	4	1.8	999.	999.	-0.36	-1.45
9/24/84	6	2.2	8.54	-1.92	4.41	-1.01
7/6/84	S4	1.5	-3.20	-1.35	0.31	-2.45

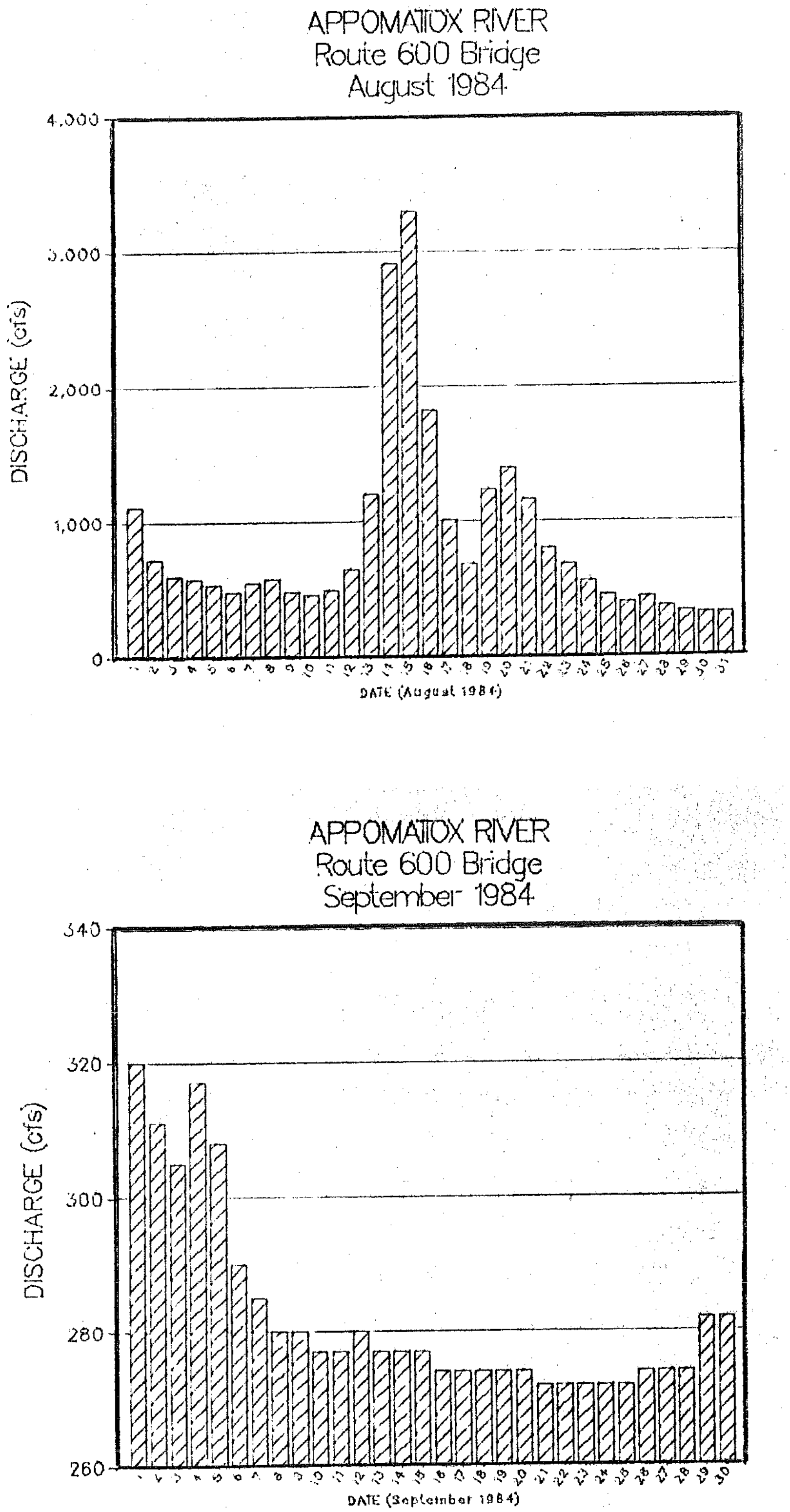


Figure 7. Appomattox River flow in August and September, 1984.

QUALITY ASSURANCE PLAN

The purpose of the field study was to observe changes in water quality with sufficient detail that the causes of those changes could be determined, if only in a general sense. Furthermore it was understood that at some time in the future a mathematical model of water quality would be utilized to study these water quality variations. If the resulting data set is to be useful for those purposes, then the measurements must be of high quality. The purpose of a quality assurance plan is to insure that the quality of the data is the best possible to meet the program goals.

Although many think of quality assurance as essentially a laboratory program, in fact all possible sources of error should be controlled. Thus the quality assurance program includes things such as sample custody, calibration and maintenance of both field and laboratory instruments, routine laboratory quality control procedures, and data processing. Each of these will be discussed in general terms in the following sections.

Field Aspects

Field Measurements - **In situ** measurements are made for parameters such as dissolved oxygen levels, water temperature and conductivity. In general the field instruments are subjected to rigorous calibration procedures annually and after any significant breakdown and repair. Instruments are checked prior to each field survey to insure that they are in good working condition and to document the minor variations that exist between the original calibration and present conditions. Those procedures have been described in detail by Neilson and Salley (1985) and have been approved by the U. S. Environmental Protection Agency (Trovato, 1984). If the check indicates that the instrument is out of calibration then it is either repaired or else another instrument is substituted.

Preventative Maintenance - Field instruments are maintained regularly. Each instrument is checked for accuracy of calibration before use on a sampling run. Minor malfunctions are noted in log books to aid in trouble-shooting problems. During periods of lower field activity, especially during the winter, major overhauls of the equipment are completed and much preventative maintenance occurs.

Check Samples - Routinely during field surveys spot samples are collected for salinity and dissolved oxygen analyses in the laboratory. These occasions when both in situ readings and laboratory derived readings are available provide the primary internal quality control check.

Sample Transfer - The field sampling team returns samples to the Nutrient Analysis Laboratory (NAL) and logs in that batch of samples. The NAL staff then has custody of the samples. Although efforts are made to insure the safety of the samples, the individual laboratories at VIMS are not watched by security guards during non-working hours, nor are samples stored in locked cabinets Thus the data which are generated could not be used for court cases or other instances which require constant control over sample custody. On the other hand, every effort is made to safeguard the integrity of each sample.

Laboratory Quality Control Procedures

Calibration of Laboratory Instruments - General maintenance and calibration of laboratory instruments is performed by the technician for each analysis. Routinely laboratory instruments are checked by qualified instrument technicians for calibration and further maintenance if necessary. The technician performing the water quality analyses is responsible for those analyses, including quality control. In this fashion problems are recognized immediately and rectified as quickly as possible thereafter.

Standards - For each set of samples at least five standards are run. The standards curve is tested by a least squares fit; only those with a correlation coefficient greater than 0.995 are accepted. Slope and intercepts of the standard curves also are recorded.

Duplicates and Spikes - For every ten samples run, one duplicate and one spike are run. Reagent blanks also are run, as are blanks to test dissolved nutrient contamination from filters. Filter blanks are run with each new set of filters. Shrewhart control charts, according to the procedures set forth in the EPA handbook (600/4-79-019), are kept. If an analysis is out of control according to the control limits of the current charts, the analysis is corrected and the samples are rerun. If the duplicates and spikes are outside the control limits of the current charts, the analysis is corrected and the samples rerun. The quality control data is reviewed daily by the laboratory supervisor to insure the quality of the data.

Inter-laboratory Comparisons - When possible, blind duplicates are used in analysis. If another laboratory can participate, samples are split. Reference type standards provide independent checks on the analytical system. These include both EPA reference standards and commercially available reference standards. Samples from the Appomattox River were analyzed by a private laboratory hired by the City of Petersburg, and the VIMS' NAL. The results of those tests are presented in a later section.

Other Comments - Holding times and preservation techniques are consistent with EPA guidelines. If for some reason the integrity of the sample has been lost, the data is not reported. It has been found that communications with other laboratories about their procedures and solution to problems of quality control is an additional check and also a preventative measure to reduce quality control problems.

Audits and Inspections - The NAL devotes most of its quality control efforts towards internal audits and checks. However EPA special samples and similar samples available from commercial groups are run periodically to see if systematic errors are present. In addition the NAL is visited and inspected by EPA personnel to insure conformance with EPA-approved procedures and methods. A visit in the fall of 1984 indicated that "a good quality assurance program has been instituted". (Trovato, 1984)

Preventative Maintenance - Laboratory instruments are maintained regularly. In addition the computer based program for reduction of nutrient data includes information on the specific instruments used and the analyst. Thus it is possible to monitor specific instruments or to go back to prior work and examine the records to see if problems have arisen suddenly or if the problem has been developing over some period of time.

Corrective Actions for Out-of-Control Situations - When instruments malfunction or are suspected of malfunctioning, corrective procedures are taken. In the NAL the calibration curve which is fitted to the standards is inspected to insure that the results are satisfactory. Additionally the duplicates and spikes are compared with historical measures of quality control to insure that out-of-control situations do not develop.

When these situations do develop, sample analysis ceases until the causes of the problem can be determined (e.g. deterioration of reagents or malfunction of instrument or error by analyst). In most instances it is possible to rerun the analyses as soon as the problems are rectified. In a few instances, the volume of sample required is so large that it is not possible to repeat the analysis (e.g. macro-Kjeldahl analyses). For that case there is no data for those samples and those analyses.

Reporting Procedures - Log books and other records of the instrument maintenance are maintained for both field and laboratory instruments. The NAL data are archived, both in terms of lab sheets and the computer records. Thus it is possible to re-examine records at a later date if questions arise regarding specific data points.

Quality Assurance Data for the Appomattox River Survey

Duplicate samples were collected during the field survey in August 1984. For the most part the duplicate samples were analyzed by the VIMS' Nutrient Analysis Laboratory and by Environmental Laboratories. The latter had been hired by the City of Petersburg to provide an external check on the water quality analyses being performed. The results of those duplicate analyses are summarized in the following tables of inter-laboratory comparisons.

On a few occasions both of the duplicate sample pairs were returned to the VIMS' NAL for analysis. These samples thus provided a "blind" test of NAL procedures because the analysts were not aware that the samples were in fact taken at the same time and place. The results of those analyses are summarized in the VIMS field duplicates tables.

The standard internal quality control procedures were followed during the Appomattox study. The results of the laboratory duplicates, spiked samples, and standards can be obtained from the NAL if desired.

TABLE 9. INTER-LABORATORY COMPARISONS

Dissolved Oxygen (mg/l)
Winkler Titrations

Station	Date	Time	VIMS	Env. Labs.
AB	25/08/84	1213	7.62	7.35
"	"	0836	7.44	7.40
"	26/08/84	0900	7.14	7.69
"	"	1522	7.66	7.72
"	27/08/84	0910	7.34	7.83
"	28/08/84	0828	7.34	7.15
WWTP	25/08/84	0804	5.85	5.51
"	26/08/84	0950	6.33	5.75
"	27/08/84	1017	6.21	3.86
"	28/08/84	1037	7.04	6.04
SWCR	25/08/84	1425	8.24	7.58
"	27/08/84	1140	7.84	6.96
5	27/08/84	1800	9.44	10.58
"	"	2200	8.81	8.20
"	28/08/84	2400	7.65	6.81
"	"	0300	8.12	3.85
"	"	0600	7.33	7.03
"	"	0900	6.68	6.29
"	"	1200	9.01	9.31
6	27/08/84	2121	7.46	7.34
"	28/08/84	0014	7.58	9.57
"	"	0315	7.20	8.07
"	"	0617	7.20	7.83
"	"	0900	7.34	7.78
"	"	1200	7.18	7.51
"	"	1500	7.06	7.69
7	28/08/84	0330	7.50	7.42

BOD (mg/l)

Station	Date	Time	VIMS	Env. Labs.
5	27/08/84	2200	1.00	nf*
"	28/08/84	0300	1.25	<1
"	"	0900	0.95	<1
"	"	1500	2.55	2.00
6	28/08/84	0900	1.80	1.00
"	"	1500	0.70	2.00

* not found

UBOD (mg/1)

AB	26/08/84	0900	6.15	6.00
"	28/08/84	2028	6.80	4.00
WWTP	26/08/84	0950	77.98	116.00
"	28/08/84	1037	34.27	21.00
SWCR	25/08/84	1425	4.58	8.00
"	27/08/84	1140	3.35	3.00
S2	28/08/84	1615	5.32	5.00
S3	27/08/84	1500	4.33	3.00
"	28/08/84	1615	4.22	3.00
S4	27/08/84	1456	9.65	5.00
"	28/08/84	1615	5.15	3.00
S5	27/08/84	1516	3.60	3.00
4	27/08/84	1500	5.06	2.00
"	28/08/84	1607	4.83	5.00
5	28/08/84	1615	6.12	6.00
6	27/08/84	1505	3.68	3.00
7	27/08/84	1516	2.95	2.00

Total Phosphorus (mg/1)

Station	Date	Time	VIMS	Env. Labs.
AB	26/08/84	0900	0.06	0.06
"	28/08/84	2028	0.05	0.06
WWTP	26/08/84	0950	3.58	2.26
"	28/08/84	1037	3.12	6.51
5	27/08/84	2200	0.19	0.20
"	28/08/84	0300	0.17	0.21
"	"	0900	0.19	0.23
"	"	1500	0.27	0.35
6	28/08/84	0900	0.48	0.46

Ortho Phosphorus (mg/1)

AB	26/08/84	0900	0.02	0.04
"	28/08/84	2028	0.02	0.03
WWTP	26/08/84	0950	1.37	2.06
"	28/08/84	1037	2.30	6.07
5	27/08/84	2200	0.01	0.12
"	28/08/84	0300	0.10	0.09
"	"	0900	0.13	0.15
"	"	1500	0.14	0.18
6	28/08/84	0900	0.40	0.48

Table 9 (Cont'd)

Nitrite + Nitrate Nitrogen (mg/l)

Station	Date	Time	VIMS	Env. Labs.
AB	26/08/84	0900	0.18	0.27
"	28/08/84	2028	0.20	0.24
WWTP	26/08/84	0950	0.03	0.12
"	28/08/84	1037	0.42	0.07
5	27/08/84	2200	0.16	0.28
"	28/08/84	0300	0.21	0.27
"	"	0900	0.26	0.29
"	"	1500	0.25	0.35
6	"	0900	0.22	0.24

Ammonia Nitrogen (mg/l)

Station	Date	Time	VIMS	Env. Labs.
AB	26/08/84	0900	0.06	0.51
"	28/08/84	2028	0.04	0.21
WWTP	26/08/84	0950	12.00	12.00
"	28/08/84	1037	15.11	14.60
5	27/08/84	2200	0.21	0.50
"	28/08/84	0300	0.21	0.37
"	"	0900	0.24	0.43
"	"	1500	0.30	0.44
6	"	0900	1.23	0.14

Total Nitrogen (mg/l)

Station	Date	Time	VIMS	Env. Labs.
AB	26/08/84	0900	0.88	0.94
"	28/08/84	2028	0.68	0.69
WWTP	26/08/84	0950	12.84	13.50
"	28/08/84	1037	16.03	12.90
5	27/08/84	2200	1.13	0.85
"	28/08/84	0300	1.07	1.19
"	"	0900	1.05	0.94
"	"	1500	1.23	1.07
6	"	0900	1.51	1.53

TABLE 10. VIMS FIELD DUPLICATES

Dissolved Oxygen (mg/l)

Station	Date	Time	#1	#2
5	28/08/84	1500	8.89	8.65
6	27/08/84	1800	7.08	7.22
7	27/08/84	1810	7.98	7.92
"	"	2129	7.78	7.68
"	28/08/84	0023	7.60	7.64
"	"	0621	7.40	7.34
S4	27/08/84	1800	8.18	8.20
"	"	2105	9.15	9.29
"	"	0006	9.37	9.21
"	28/08/84		7.42	7.28
"	"	0611	6.45	7.14
"	"	1200	7.36	9.35*

* Bubbles in bottle

BOD (mg/l)

6	27/08/84	2121	1.00	1.35
"	28/08/84	0315	0.90	0.90
7	27/08/84	2129	0.70	0.60
"	28/08/84	0330	0.60	0.75
S4	27/08/84	2105	1.80	2.50
"	28/08/84	0006	2.00	2.00

Total Phosphorus (mg/l)

Station	Date	Time	#1	#2
6	27/08/84	2121	0.356	0.374
"	28/08/84	0315	0.307	0.303
7	27/08/84	2129	0.042	0.045
"	28/08/84	0330	0.044	0.04
S4	27/08/84	2105	0.185	0.166
"	28/08/84	0304	0.287	0.295

Ortho Phosphorus (mg/1)

6	27/08/84	2121	0.291	0.307
"	28/08/84	0315	0.238	0.227
7	27/08/84	2129	0.016	0.013
"	28/08/84	0330	0.019	0.012
S4	27/08/84	2105	0.038	0.040
"	28/08/84	0304	0.159	0.156

Nitrite + Nitrate Nitrogen (mg/1)

6	27/08/84	2121	0.363	0.236
"	28/08/84	0315	0.290	0.178
7	27/08/84	2129	0.239	0.240
"	28/08/84	0330	0.240	0.235
S4	27/08/84	2105	0.155	0.153
"	28/08/84	0304	0.267	0.251

Ammonia Nitrogen (mg/1)

6	27/08/84	2121	0.934	0.697
"	28/08/84	0315	0.469	0.464
7	27/08/84	2129	0.013	0.005
"	28/08/84	0330	0.013	0.016
S4	27/08/84	2105	0.112	0.130
"	28/08/84	0304	0.578	0.448

Total Nitrogen (mg/1)

6	27/08/84	2121	1.37	1.44
"	28/08/84	0315	1.82	1.36
7	27/08/84	2129	0.65	0.72
"	28/08/84	0330	0.66	0.70
S4	27/08/84	2105	0.98	1.08
"	28/08/84	0304	1.43	1.41

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