

EVALUATION OF NUTRIENT QUALITY- ASSURANCE DATA FOR ALEXANDERS AND MOUNT ROCK SPRING BASINS, CUMBERLAND COUNTY, PENNSYLVANIA

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CONVERSION FACTORS AND ABBREVIATED WATER-QUALITY UNITS

Temperature is given in degrees Celsius (°C), which can be converted to degrees Fahrenheit (°F) by use of the following equation:

$$^{\circ}\text{F} = 1.8 (^{\circ}\text{C}) + 32$$

Abbreviated water-quality units used in this report:

mL, milliliter
mg, milligram
mg/L, milligram per liters

Evaluation of Nutrient Quality-Assurance Data for Alexanders and Mount Rock Springs Basins, Cumberland County, Pennsylvania

by *Emitt C. Witt III, Daniel J. Hippe, and Rhonda M. Giovannitti*

ABSTRACT

A total of 304 nutrient samples were collected from May 1990 through September 1991 to determine concentrations and loads of nutrients in water discharged from two spring basins in Cumberland County, Pa. Fifty-four percent of these nutrient samples were for the evaluation of (1) laboratory consistency, (2) container and preservative cleanliness, (3) maintenance of analyte representativeness as affected by three different preservation methods, and (4) comparison of analyte results with the "Most Probable Value" for Standard Reference Water Samples. Results of 37 duplicate analyses indicate that the Pennsylvania Department of Environmental Resources, Bureau of Laboratories (principal laboratory) remained within its ± 10 percent goal for all but one analyte. Results of the blank analysis show that the sampling containers did not compromise the water quality. However, mercuric-chloride-preservation blanks apparently contained measurable ammonium in four of five samples and ammonium plus organic nitrogen in two of five samples. Interlaboratory results indicate substantial differences in the determination of nitrate and ammonium plus organic nitrogen between the principal laboratory and the U.S. Geological Survey National Water-Quality Laboratory. In comparison with the U.S. Environmental Protection Agency Quality-Control Samples, the principal laboratory was sufficiently accurate in its determination of nutrient analytes. Analysis of replicate samples indicated that sulfuric-acid preservative best maintained the representativeness of the analytes nitrate and ammonium plus organic nitrogen, whereas, mercuric chloride best

maintained the representativeness of orthophosphate. Comparison of nutrient analyte determinations with the Most Probable Value for each preservation method shows that two of five analytes with no chemical preservative compare well, three of five with mercuric-chloride preservative compare well, and three of five with sulfuric-acid preservative compare well.

INTRODUCTION

Much of the prime agricultural land in Pennsylvania is underlain by carbonate rocks. Ground-water resources in carbonate-rock aquifers are highly susceptible to contamination from fertilizers and pesticides applied to agricultural land. From May 1990 through May 1991, the U.S. Geological Survey (USGS) conducted a study in Cumberland County, Pa., to determine concentrations and loads of nutrients and selected pesticides in discharge from Alexanders and Mount Rock Springs and to compare the loads of pesticides in spring discharge to the quantity of pesticides applied to agricultural areas within the spring basins (D.J. Hippe and others, U.S. Geological Survey, written commun., 1991). The study was conducted in cooperation with the Pennsylvania Department of Environmental Resources (PaDER), Bureau of Water-Quality Management.

A preliminary evaluation of nutrient data collected for the project indicated that some variation in nutrient concentrations (especially total ammonium and organic nitrogen) between quality-assurance samples may have been attributed to differences in sample-preservation methods. As a result of this preliminary evaluation, additional

quality-assurance samples were analyzed to further evaluate the variation in nutrient concentrations caused by laboratory-analytical methods, field-sampling methods, and three different preservation methods.

This report presents these nutrient data and evaluates the quality assurance of these data, with emphasis on comparison of three nutrient sample-preservation methods. Results are graphically and statistically compared to evaluate for precision, bias, and variation in nutrient concentrations caused by laboratory-analytical methods, field-sampling methods, and preservation methods.

Many chemical constituents of environmental concern are reactive or unstable, so that transformations that occur between the time of sample collection and analysis can result in chemical data that are not representative of the sample medium. However, most environmental samples (regardless of their chemical stability) are analyzed at centralized laboratories because, in part, of the lack of accurate field methods or the high cost of operating portable laboratories. This often results in holding times of from 1 to 10 days between the time of sample collection and laboratory analysis. Numerous preservation methods have been developed to retard or inhibit chemical transformations that can occur prior to analysis, and maximum holding times have been recommended for water samples containing analytes that cannot be effectively preserved (Fishman and others, 1986).

Nutrients are among the many reactive analytes for which preservation methods have been developed. Chilling or addition of a chemical preservative are methods commonly used for preservation of water samples prior to nutrient analysis (Jenkins, 1968; Klingaman and Nelson, 1976; Fishman and others, 1986). Depending upon the nutrients of concern, the U.S. Environmental Protection Agency (USEPA) has recommended chilling to 4°C or a combination of the addition of sulfuric acid to a pH less than 2 and chilling to 4°C for preservation of samples for nutrient analysis (U.S. Environmental Protection Agency, 1982). Since 1980, the USGS has required the use of a mercuric-chloride additive and chilling to 4°C for preservation of

all nutrient samples to be analyzed by the National Water-Quality Laboratory (NWQL). A combination of chilling to 4°C and rapid analysis (within 48 hours of collection) of water samples has been adopted by a number of laboratories and government agencies, including the PaDER, as an alternative to addition of chemical preservatives.

Scientists, as well as monitoring and law-enforcement officials, all have concerns regarding the proper preservation of nutrient samples to assure that chemical data accurately represent the resource conditions at the time of sampling. The actual preservation requirements of nutrient samples will vary for different sample matrices depending on the chemical and biological composition of the matrix. Additional concerns with regard to the decision to use chemical preservatives are the added expense of obtaining contaminant-free preservative, additional quality-assurance requirements, time and expense to set up laboratory instrumentation, and occupational and environmental hazards related to the use and disposal of hazardous preservatives and preserved water samples.

METHODS OF DATA COLLECTION AND ANALYSIS

Nutrient quality-assurance data were evaluated from (1) replicate whole-water samples, (2) blank samples, (3) USEPA quality-control samples, (4) USGS Standard Reference Water Samples (SRWS), and (5) laboratory duplicate samples. Replicate samples included sequential replicates and churn-split replicates collected from four springs and four wells located in Cumberland County, Pa. Replicate samples from the four springs were collected from the centroid of flow at each spring opening. Replicate samples from the wells were collected at a point prior to entry into the pressure tank after a 20 minute drawdown period or a stabilization of temperature and specific conductance was observed. Churn-split replicate subsamples were made according to methods of Ward and Harr (1990). All water samples were placed in 250-mL opaque, high-density polyethylene bottles and preserved either by chilling or a combination of chilling and addition of a chemical preservative.

Additional quality-assurance samples were obtained from a number of sources. SRWS were obtained from the USGS, Branch of Quality Assurance in Denver, Co. The SRWS were prepared and stored according to Long and Farrar (U.S. Geological Survey, written commun., 1991). Nutrient quality-control samples were obtained from the USEPA, Environmental Monitoring Systems Laboratory in Cincinnati, Oh., and diluted in double-distilled water according to USEPA instructions. Preservation blanks were prepared by use of double-distilled or deionized water from the USGS, Pennsylvania District Laboratory. Duplicate data were provided by the PaDER, Bureau of Laboratories. Sequential replicate samples were analyzed both by the PaDER, Bureau of Laboratories and the USGS, NWQL in Arvada, Co.

Most project nutrient samples were preserved by one of two methods depending on sample holding times incurred prior to delivery to the analytical laboratory. Chilling was used for water samples that would be subjected to holding times of less than 24 hours. For water samples that would be subjected to longer holding times, a 1 mL solution of mercuric chloride, containing 13 mg of Hg²⁺, was added to samples, resulting in final sample concentrations of about 40 mg/L of Hg²⁺. These water samples were also chilled. Mercuric-chloride preservative was delivered from individually packaged, sealed glass ampules.

As part of a formal comparison of nutrient preservation methods, selected quality-assurance subsamples were also acidified to a pH of less than 2 standard units by use of concentrated sulfuric acid. The sulfuric acid was delivered from a bulk container by a graduated 1-mL pipette. The concentrated sulfuric acid was supplied by the PaDER, Bureau of Laboratories.

All quality-assurance samples were analyzed for total nitrate, nitrite, ammonium, ammonium plus organic (Kjeldahl) nitrogen, total phosphorus, and orthophosphate. Nutrient samples were analyzed by the PaDER, Bureau of Laboratories, in Harrisburg, Pa. The analytical methods used were as directed by the USEPA (1979) and are listed by method number in table 1. Results of

all nutrient analyses for the Alexanders and Mount Rock Springs project are given in tables 9 and 10 (at the end of report).

Two major statistics were used for the interpretation of quality-assurance data in this report: the Relative Percent Difference (RPD) and the Relative Standard Deviation (RSD). The RPD is a measure of the difference between two measurements in relation to the average of the two measurements and is represented as the absolute percent difference by the relation

$$RPD = \frac{2|X_2 - X_1|}{X_2 + X_1} \times 100. \quad (1)$$

The RPD is a useful descriptive statistic for comparing the results of analyses from two laboratories and for comparing results of analysis of a known standard with results from a given laboratory. The RPD was used to assess interlaboratory precision in this report.

The RSD is a dimensionless measure of the amount of dispersion around the mean of a given sample. The RSD is calculated as follows:

$$RSD = \frac{s}{\bar{X}} \times 100, \quad (2)$$

where *s* is the standard deviation, and *X* is the mean concentration for a given test group. The standard deviation is a parametric statistic that describes the dispersion around the mean and has the same units as the mean. The equation for estimating the standard deviation is as follows:

$$s = \sqrt{\frac{\sum (X_i - \bar{X})^2}{n - 1}}, \quad (3)$$

where *n* is the sample size, *X_i* is the value of an individual sample, and *X* is the average of all samples within a group.

The RSD is a useful determination of the degree of variation that can be expected from the mean of a group of measurements of a given sample. In this report, the RSD was used to evaluate the representativeness of sample quality through replicate analysis as a result of three preservation methods.

Table 1.--Analytical methods used for nutrient analysis at the Pennsylvania Department of Environmental Resources, Bureau of Laboratories

[mg/L, milligrams per liter, PaDER, Pennsylvania Department of Environmental Resources; USEPA, U.S. Environmental Protection Agency]

Analyte	WATSTORE/ STORET No.	Analytical method ¹	Analytical method lower detection limit ¹	PaDER lower detection limit
Total ammonium, in mg/L as N	00610	USEPA Method 350.1	0.01	0.02
Total nitrate, in mg/L as N	00620	USEPA Method 353.2	.05	.04
Total nitrite, in mg/L as N	00615	USEPA Method 353.2	.05	.004
Total ammonium and organic (Kjeldahl) nitrogen, in mg/L as N	00625	USEPA Method 351.2	.1	.2
Total phosphorus, in mg/L as P	00665	USEPA Method 365.4	.01	.02
Orthophosphate, in mg/L as P	70507	USEPA Method 365.1	.01	² .002 - .02

¹ U.S. Environmental Protection Agency, 1979.

² Lower detection limit varied over the study period.

EVALUATION OF NUTRIENT QUALITY-ASSURANCE DATA

Quality assurance is a system of activities whose purpose is to produce a product or a service with the assurance that it meets defined standards of quality with a stated level of confidence (Taylor, 1988). Quality-assurance sampling and laboratory analyses were performed for this cooperative project to evaluate variation in nutrient analytical results caused by (1) laboratory analytical methods, (2) container and preservative quality, and (3) sample-preservation methods. Three separate analyses of quality-assurance data are presented on the basis of laboratory duplicate analyses, blank samples, reference standards, and replicate samples.

Laboratory Duplicate Samples

Analysis of laboratory duplicate samples specifically involves two or more separate aliquots for analytical determinations of a single sample to determine the precision of an analytical method. Duplicate-sample analysis

is routinely performed at the PaDER, Bureau of Laboratories on every tenth sample submitted for analysis. All duplications used separate time frames so that no duplicate was in a consecutive position in the automated analyzer. The ammonium plus organic nitrogen analyses were performed on different days by use of separate Kjeldahl digestions and again, separate time frames within the automated analyzer. A report is produced twice monthly that summarizes the results of these routine duplicate analyses. PaDER, Bureau of Laboratories has established a precision goal of ± 10 percent difference for duplication of all nutrient analytes (Lynn Shafer, Pennsylvania Department of Environmental Resources, Bureau of Laboratories, oral commun., 1991). The laboratory generally met these quality-assurance goals for nutrient analyses during the period over which water samples were analyzed for the cooperative project.

Additional results of laboratory duplicate samples were obtained from repeated analysis of SRWS that were a part of the quality-assurance samples submitted for the

cooperative project (table 2). Duplicate analyses represent 7.2 percent of the entire quality-assurance data base for the cooperative project. Of the 37 sets of duplicate results, 25 were for ammonium plus organic nitrogen, 3 were for ammonium, 2 were for nitrite, 2 were for total nitrate, 2 were for total phosphorus, and 3 were for orthophosphate.

The precision goals for evaluation of duplicate analyses were based on RSD observed in analytical results of the USGS analytical evaluation program for SRWS numbers N-30 and N-31 (D.E. Erdmann, U.S. Geological Survey, written commun., 1991). The RSD was determined for each nutrient analyte and consisted of the standard

Table 2.—Results of duplicate analyses for nutrient analytes from the Pennsylvania Department of Environmental Resources, Bureau of Laboratories

[concentrations are in milligrams per liter; \bar{x} , mean; SD, standard deviation; σ , standard error; RSD, relative standard deviation, in percent; <, less than; --, not calculated]

Analyte	\bar{x}	SD	σ	RSD
Ammonium	0.59	0	0	0
	.03	0	0	0
	.23	0	0	0
Nitrate	<.04	--	--	--
	1.35	0	0	0
Nitrite	<.004	--	--	--
	.062	0	0	0
Ammonium plus organic nitrogen	.15	.0057	.0040	3.7
	.18	.012	.0085	6.7
	.24	.0078	.0053	3.2
	.53	.013	.0090	2.4
	.28	.039	.028	14
	1.04	.028	.020	2.7
	.57	.023	.016	3.9
	.93	.016	.012	1.7
	.20	.011	.0075	5.2
	.23	.013	.0095	5.9
	.59	.011	.0075	1.8
	1.08	.035	.025	3.3
	.52	.026	.018	4.9
	.28	.030	.022	11
	.93	.050	.035	5.3
	.18	.013	.0095	7.4
	.47	.0057	.0040	1.2
	1.04	.066	.047	6.3
	.57	.017	.012	3.0
.29	.0057	.0040	2.0	
.99	.048	.034	4.9	
.46	.016	.011	3.4	
.95	.11	.076	11	
.49	.051	.036	11	
1.01	.024	.017	2.4	
Total phosphorus	<.02	--	--	--
	.28	0	0	0
Orthophosphate	.002	.0007	.0005	28
	<.002	--	--	--
	.262	.0028	.002	1.0

deviation for the analyte divided by the Most Probable Value (MPV) for that analyte and multiplied by 100. The RSD for each nutrient analyte is listed in table 3. The RSD precision goals range from 4 percent for total phosphorus to 32 percent for ammonium plus organic nitrogen. For the cooperative project, the laboratory method would be considered imprecise if the laboratory duplicate measurement routinely exceeded the RSD goal for that analyte.

Table 3.--Precision goals for evaluation of laboratory duplicate and replicate quality-assurance samples

[RSD, relative standard deviation, in percent]

Analyte	RSD precision goal
Ammonium	10
Nitrate	5
Nitrite	5
Nitrate plus nitrite	5
Ammonium plus organic nitrogen	32
Total phosphorus	4
Orthophosphate	8

Overall, the PaDER laboratory performed duplicate analyses well, with all but one duplicate analysis meeting the RSD precision goals for the cooperative project. None of the 25 duplicate analyses of ammonium plus organic nitrogen exceeded the RSD precision goal of 32 percent. The RSD ranged from 1.2 to 14 percent (table 2). The average RSD for all 25 ammonium plus organic nitrogen duplicates was 5.3 percent. Results of duplicate analyses for ammonium, nitrite, nitrate, and total phosphorus were also within the precision goals of the cooperative project (table 2). Orthophosphate exceeded the RSD goal for one of three sets of duplicate samples (table 2). However, this result was not considered a serious quality-assurance problem regarding the laboratory's analytical precision because the exceedance value was for duplicate measurements at the lower limit of analytical detection.

Blank Analyses

Analysis of blank samples, composed of double-distilled or deionized water in sample containers with and without preservatives, were used to evaluate potential contamination from the shipping container or preservative. One double-distilled and seven deionized water samples were analyzed for the cooperative project. One blank sample was without preservative, five contained mercuric-chloride preservative, and one contained sulfuric-acid preservative. The unpreserved sample was used to evaluate potential contamination of shipping containers, and the preserved deionized water samples were used to describe potential contamination from each of the two preservation methods employed. Table 4 lists the results of the blank analysis study.

The double-distilled water blank sample without added preservative contained trace concentrations of ammonium, nitrate, total phosphorus, and orthophosphate. There was some doubt as to the actual purity of the double-distilled water. Therefore, no conclusions were made on the basis of this sample regarding whether or not the sample bottles were a source of nutrient contamination. A subsequent deionized water blank sample did not contain detectable nutrient analytes, suggesting that sample containers probably were not a source of nutrient contamination of project samples.

Four of five mercuric-chloride-preservation blanks contained trace concentrations of ammonium or organic nitrogen (table 4). Ammonium was present in four of five samples; concentrations ranged from 0.02 to 0.03 mg/L as nitrogen. Ammonium plus organic nitrogen was present in two of five samples, with concentrations of 0.21 and 0.24 mg/L as nitrogen. The source of these trace concentrations of ammonium and ammonium plus organic nitrogen contamination is not known. A mechanism for ammonium contamination is sorption of atmospheric ammonium by nutrient samples. Sorption of ammonium can potentially occur during collection, preservation, shipping, storage, or analysis of nutrient samples. The source of organic-nitrogen contamination is not known, but could include the deionized water, sample bottles, preservative, or the laboratory.

Table 4.—Results of blank-sample analyses

[concentrations are in milligrams per liter; DD, double-distilled water; DI, deionized water; HgCl₂, mercuric chloride; H₂SO₄, sulfuric acid; NA, not analyzed]

Analyte	Blank matrix	Chemical preservative	Number of observations	Number of observations exceeding detection limit	Analytical detection limit	Range of values
Ammonium	DD	None	1	1	0.02	0.02
	DI	None	1	0	.02	-
	DI	HgCl ₂	5	4	.02	.02 - .03
	DI	H ₂ SO ₄	1	0	.02	-
Nitrate	DD	None	1	1	.04	.04
	DI	None	1	0	.04	-
	DI	HgCl ₂	5	0	.04	-
	DI	H ₂ SO ₄	1	NA	.04	NA
Nitrite	DD	None	1	0	.004	-
	DI	None	1	0	.004	-
	DI	HgCl ₂	5	0	.004	-
	DI	H ₂ SO ₄	1	NA	.004	NA
Ammonium plus organic nitrogen	DD	None	1	0	.20	-
	DI	None	1	0	.20	-
	DI	HgCl ₂	5	2	.20	.21 - .24
	DI	H ₂ SO ₄	1	0	.20	-
Total phosphorus	DD	None	1	1	.02	.02
	DI	None	1	0	.02	-
	DI	HgCl ₂	5	0	.02	-
	DI	H ₂ SO ₄	1	0	.02	-
Orthophosphate	DD	None	1	1	.002	.004
	DI	None	1	0	.002	-
	DI	HgCl ₂	5	0	.002	-
	DI	H ₂ SO ₄	1	0	.002	-

The sulfuric-acid-preservation blank did not contain detectable nutrient contamination, although accurate determination of nitrite concentrations in the sample was not possible because of a matrix interference (Vince White, Pennsylvania Department of Environmental Resources, Bureau of Laboratories, oral commun, 1991). Because of concerns over ammonium sorption by acidified samples, additional acid preservation blanks normally would be merited, but were not deemed necessary given the limited use of this preservative during the project.

Quality-assurance data from the eight blank samples indicated that there may have been trace concentrations of ammonium and ammonium plus organic nitrogen contamination in project samples. Contaminant levels, however, were at or just

above detection limits, and the actual contaminant source and contamination pathway was not known. Therefore, given the limited amount of data for each preservation method, a conclusion cannot be made about the potential for any preservation method to compromise sample representativeness.

Interlaboratory Analyses

Sequential replicate whole-water samples were collected from each spring on November 19, 1990, to compare nutrient analyte concentrations as determined by PaDER, Bureau of Laboratories and the USGS, NWQL. Chemical preservative was not added to the replicate samples analyzed at PaDER, whereas mercuric-chloride preservative was added to the replicate samples analyzed at

NWQL. Samples were shipped to both laboratories within 24 hours of collection. It should be noted that water samples may have been analyzed at the PaDER laboratory in a more timely manner because of the shorter shipping distance. The analytical results and calculated RPD between replicate pairs are shown in table 5. Large RPD values were observed for a number of nutrient analytes, including one ammonium replicate, three nitrate replicates, two nitrite replicates, and three ammonium plus organic nitrogen replicates. Concentrations of ammonium, nitrite, and ammonium plus organic nitrogen were within an order of magnitude of the laboratories' lower detection limits and certainly contributed to the rather large interlaboratory RPD's. Concentrations of nitrate, however, are well above the laboratories' lower detection limit. Concentrations of nitrate determined at PaDER were consistently lower than those at NWQL. The large RPD's may be caused by systematic bias in one or both laboratories rather than sampling or laboratory imprecision. There is also some indication of bias in ammonium plus organic nitrogen determinations by one or both laboratories. The reason for this apparent bias is not known.

U.S. Environmental Protection Agency Quality-Control-Sample Analyses

Two USEPA quality-control samples were analyzed to evaluate the accuracy of nutrient determinations by the PaDER, Bureau of Laboratories. Samples were prepared on September 6 and October 16, 1990, at the USGS, Pennsylvania District Office. Samples were diluted with double-distilled water to provide final sample concentrations that were similar to nitrate and ammonium plus organic nitrogen concentrations of project samples. No chemical preservative was added to these samples. The quality-control samples did not contain nitrite, but did contain ammonium, total phosphorus, and orthophosphate at much greater concentrations than most project samples. The PaDER results, mean recoverable analyte concentrations, and percent differences are listed in table 6. The PaDER results were within the USEPA goals (U.S. Environmental Protection Agency, Environmental Monitoring Systems Labora-

tory, written commun., 1989) for all but one analysis of one analyte (table 7). The USEPA criteria suggests that if the analytical result is within the 95-percent confidence interval, then the result is not significantly different from the true value and is acceptable. Orthophosphate was the only analyte determination to fall outside of the 95-percent confidence interval. Although the degree of exceedance was small, the result is considered significantly different from the true value and is not acceptable. Analysis of these quality-control samples indicate that PaDER, Bureau of Laboratories was sufficiently accurate analyzing for nitrate and ammonium plus organic nitrogen for USEPA quality-control samples with concentrations similar to project samples. The PaDER, Bureau of Laboratories also was sufficiently accurate for ammonium, total phosphorus, and orthophosphate determinations of samples with concentrations greater than in project samples.

Replicate Analyses

Replicate samples are a group of two or more samples collected such that they are thought to be identical in composition. Replicate samples commonly are collected to assess the adequacy of sample collection methods to obtain representative samples. However, for the cooperative project, replicate samples were collected to compare which of three preservation methods best maintained the representativeness of the sample during repeated analysis. Replicate samples comprised a majority of the quality-assurance data for the cooperative project.

Fifty-six cases of replicate samples ranging from two to three samples per case were evaluated to determine the variability and representativeness of analytical results as effected by sample preservation method (table 8). There were 18 replicate cases with no chemical preservative, 22 replicate cases with mercuric-chloride preservative, and 16 replicate cases with sulfuric-acid preservative. The variability within each of these case groups was assessed by evaluating the RSD's and average margins of error between samples. The RSD analyte precision criteria established for evaluation of duplicate analysis also was used for evaluation of

Table 5.--Results of Interlaboratory comparison of sequential replicate nutrient samples

[Concentrations are in milligrams per liter; PaDER, result from Pennsylvania Department of Environmental Resources, Bureau of Laboratories; NWQL, result from U.S. Geological Survey National Water-Quality Laboratory; RPD, relative percent difference; <, less than; --, not computed]

Date	Site	Analyte																	
		Ammonium		Nitrate		Nitrite		Ammonium plus organic nitrogen		Total phosphorus		Orthophosphate							
		PaDER NWQL RPD	PaDER NWQL RPD	PaDER NWQL RPD	PaDER NWQL RPD	PaDER NWQL RPD	PaDER NWQL RPD												
11/19/90	SP-17	0.02	0.02	0	5.15	6.0	15	<0.004	<0.01	--	<0.20	0.40	67	<0.01	<0.01	--	<0.004	<0.01	--
11/19/90	SP-16	.02	.01	67	4.75	5.6	16	<.004	<.01	--	<.20	.70	111	<.01	<.01	--	<.002	<.01	--
11/19/90	SP-33	.03	.03	0	5.41	5.8	6.9	<.004	.01	86	<.20	.90	127	.01	.01	0	.02	.02	0
11/19/90	SP-34	<.02	.02	--	5.02	6.0	18	<.004	.01	86	.30	.30	0	<.01	<.01	--	<.005	<.01	--

Table 6.--Results of U.S. Environmental Protection Agency Quality-Control Samples analyzed by the Pennsylvania Department of Environmental Resources, Bureau of Laboratories.

[Quality-control samples did not contain measurable nitrite; concentrations are in milligrams per liter; PaDER, result by Pennsylvania Department of Environmental Resources, Bureau of Laboratories; USEPA, mean recoverable analyte concentration from quality-control-sample instructions; PD, percent difference; --, not analyzed]

Ampoule ¹	Dilution factor ²	Analyte														
		Ammonium		Nitrate		Ammonium plus organic nitrogen		Total phosphorus		Orthophosphate						
		PaDER USEPA PD	PaDER USEPA PD	PaDER USEPA PD	PaDER USEPA PD	PaDER USEPA PD	PaDER USEPA PD									
N1	3	5.61	5.85	-4.1	6.29	5.96	+5.5	--	--	--	--	--	--	1.08	1.22	-11
N1	3	5.39	5.85	-7.9	6.29	5.96	+5.5	--	--	--	--	--	--	1.12	1.22	-8.2
N2	.1	--	--	--	--	--	--	0.69	0.54	+27	0.16	0.16	0	--	--	--
N2	.1	--	--	--	--	--	--	.49	.54	-9.3	.16	.16	0	--	--	--

¹ Ampoules were from USEPA lot number WP1188.

² Dilution factor of 3 reflects analyte concentrations at 3 times greater than directed, a dilution factor of .1 reflects concentrations 10 times less than directed.

**Table 7.—Evaluation statistics and results for the
U.S. Environmental Protection Agency quality-control-sample analyses**
[USEPA, U.S. Environmental Protection Agency]

Analyte	USEPA 95-percent confidence interval ¹	Number of analyses exceeding the confidence interval
Ammonium	5.14 - 6.56	0
Nitrate	5.14 - 6.78	0
Ammonium plus organic nitrogen	.17 - .91	0
Total phosphorus	.12 - .20	0
Orthophosphate	1.10 - 1.34	1

¹ The 95-percent confidence interval represents the mean recovery plus or minus two standard deviations and was developed from May 1987 regression equations derived through Water Pollution Performance Evaluation Studies (U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, written commun., 1989)

replicate samples (table 3). For example, if the RSD exceeded the precision goal among samples within a replicate case for a specific preservation method, that preservation method was not adequate for maintaining the representativeness of the project sample. In addition, the average margins of error for all exceedance cases within each preservation group were calculated to show the variability associated with each preservation method exceeding the RSD goals. This dual approach for evaluating replicate samples was used to describe the relation of each analyte with each preservation method.

Ammonium was occasionally detected in spring samples at concentrations that were near the analytical detection limit of 0.02 mg/L as nitrogen. Only 22 of 56 cases contained measurable concentrations of this analyte (table 8). Ten of these cases exceeded the RSD precision goal for ammonium. Ammonium was present in replicate cases preserved by each method, with detectable concentrations in 5 of 18 unpreserved cases, 10 of 22 mercuric-chloride-preserved cases, and 7 of 16 sulfuric-acid-preserved cases. The RSD precision goals for ammonium were exceeded by four replicate cases with no preservative, three with mercuric-chloride preservative, and three with sulfuric-acid preservative. The average margins of error at the 95-percent confidence level for unpreserved, mercuric-chloride-preserved, and sulfuric-acid-preserved samples were ± 0.03 , ± 0.02 , and ± 0.01 mg/L,

respectively. From available quality-assurance data, no single preservation method contributed substantially greater variability in replicate sample concentrations. Because ammonium concentrations for the project were typically at or near the lower analytical detection limit, the variability associated with this analyte may be caused by variance in the analytical method rather than the preservation method. Ammonium concentrations for spring samples of this project are not of sufficient quality for interpretation because of their low levels and high variability between replicate samples.

Nitrate was the primary nitrogen containing analyte present in the spring samples. Only 5 of 56 replicate cases exceeded the RSD precision goal of 5 percent for nitrate (table 8). The range of the exceedance values was from 5.6 to 37 percent. One of 18 cases without chemical preservative, 4 of 22 cases with mercuric-chloride preservative, and none of 16 cases with sulfuric-acid preservative exceeded the RSD precision goal for nitrate. The average margin of error at the 95-percent confidence level for the no preservative exceedance case was ± 3.14 mg/L; the average margin of error for the mercuric-chloride-preserved cases was ± 1.27 mg/L. Although the replicate samples preserved with mercuric chloride were most likely to exceed the RSD precision goal, the average margin of error was less than the exceedance case without additives.

Preservation with sulfuric acid achieved the most repeatable nitrate concentrations among the replicate samples collected for the cooperative project.

Nitrite was rarely detected in water samples collected during the cooperative project and was detected in only five replicate cases (table 8). Two of five cases were SRWS that have nitrite concentrations in excess of the spring samples. Nitrite concentrations were not determined for the sulfuric-acid preserved replicate samples because sulfuric acid converts all nitrite to nitrate prior to analysis. Therefore, analysis for nitrite from sulfuric-acid-preserved samples produces unrepresentative values. The RSD values for all five cases were within the precision goals of the project. However, there was an insufficient number of cases with detectable nitrite to evaluate the variability of nitrite concentrations as a result of preservation method.

Ammonium plus organic nitrogen commonly was present in spring samples at concentrations near the analytical detection limit of 0.20 mg/L as nitrogen. Ammonium plus organic nitrogen was detected in 43 of 56 replicate cases (table 8). Seven of 56 replicate cases exceeded the RSD precision goal for the analyte. The largest exceedance value of any nutrient analyte was 75 percent. Ammonium plus organic nitrogen was present in replicate cases preserved by each method, with detectable concentrations in 11 of 18 replicates with no preservative, in all 22 replicates with mercuric-chloride preservative, and in 10 of 16 replicates with sulfuric-acid preservative. For each of the spring replicate samples, the mean ammonium plus organic nitrogen concentrations were largest for those cases preserved with mercuric chloride (table 8). The RSD precision goals for ammonium plus organic nitrogen were exceeded in replicate cases preserved by each method, with two replicate cases with no preservative, four with mercuric-chloride preservative, and one with sulfuric-acid preservative. The average margins of error at the 95-percent confidence level for each of the exceedance groups were ± 0.51 mg/L for unpreserved replicates, ± 0.63 mg/L for mercuric-chloride-preserved replicates, and ± 0.32 mg/L for the sulfuric-acid-preserved replicates. The best replication

of results for replicate samples of this analyte was achieved by use of sulfuric acid as a preservative.

Total phosphorus commonly was present in spring samples at very low concentrations--at or near the detection limit of 0.02 mg/L as phosphorus. Forty-three of 56 replicate cases had detectable concentrations of total phosphorus, but 40 replicate cases had mean concentrations at the detection limit (table 8). Four replicate cases exceeded the RSD precision goal of 4.0 percent. The range of exceedance values was from 7.2 to 25 percent. Total phosphorus was present in replicate cases preserved by each method, with detectable concentrations in 14 of 18 cases with no preservative, 16 of 22 cases with mercuric-chloride preservative, and 13 of 16 cases with sulfuric-acid preservative. The replicate cases that exceeded the RSD precision goals were two cases with no preservative and two cases with mercuric-chloride preservative. The average margin of error at the 95-percent confidence level for replicate cases with no preservative was ± 0.013 mg/L and for replicate cases with mercuric-chloride preservative was ± 0.20 mg/L. The high margin of error for the mercuric-chloride-preserved replicates was attributed to a SRWS replicates with total phosphorus concentrations two orders of magnitude greater than the spring and well replicate cases and therefore is not comparable. The results of replicate sample analyses indicate that there was no clear difference in intersample variability among the preservation methods.

Orthophosphate was present in most spring samples at concentrations that were within the range of PaDER detection limits. The level of analytical detection changed repeatedly during the cooperative project, depending on sample peak heights relative to the background levels (Lynn Shaefer, Pennsylvania Department of Environmental Resources, Bureau of Laboratories, oral commun., 1991). The range of detection levels was from ± 0.002 to ± 0.02 mg/L, such that a majority of spring samples had orthophosphate concentrations within the range of these detection limits. Forty-eight of 56 replicate cases had detectable orthophosphate, including 16 of 18 replicate cases with no preservative, 16 of 22 replicate

Table 8.--Nutrient analyses of replicate cases preserved by three methods
 [x̄, mean; RSD, relative standard deviation, in percent; σ, standard error; <, less than; HgCl₂, mercuric chloride; H₂SO₄, sulfuric acid; --, not calculated]

Date	Site	Sample size	Preservation method	Analyte																	
				Nitrate			Nitrite			Ammonium			Total kjeldahl nitrogen			Total phosphorus			Orthophosphate		
				x̄	RSD	σ	x̄	RSD	σ	x̄	RSD	σ	x̄	RSD	σ	x̄	RSD	σ	x̄	RSD	σ
4-10-91	SP-33	3	NONE	<0.02	0	0	6.05	0	0	<0.004	0	0	0.23	13	0.02	0.02	25	0.003	<0.01	0	0
4-10-91	SP-33	3	HgCl ₂	<0.02	0	0	6.05	0	0	.004	0	0	.70	7.4	.03	.02	25	.003	<.01	0	0
4-10-91	SP-33	3	H ₂ SO ₄	<0.02	0	0	5.81	0	0	--	--	--	.26	22	.03	.02	0	0	.01	0	0
4-21-91	SP-33	3	NONE	<0.02	0	0	6.11	1.2	.03	<0.004	0	0	.32	33	.06	.02	0	0	<.002	0	0
4-21-91	SP-33	3	HgCl ₂	.02	0	0	6.03	1.2	.04	<0.004	0	0	.81	7.8	.04	.02	0	0	<.002	0	0
4-21-91	SP-33	3	H ₂ SO ₄	.02	0	0	5.77	1.3	.04	--	--	--	.44	10	.03	.02	0	0	.003	16	.0003
5-07-91	SP-33	3	NONE	<0.02	0	0	6.07	0	0	<0.004	0	0	.37	75	.16	.02	0	0	.003	0	0
5-07-91	SP-33	3	HgCl ₂	<0.02	0	0	5.85	4.7	.16	<0.004	0	0	.61	3.4	.01	.02	0	0	.006	10	.0003
5-07-91	SP-33	3	H ₂ SO ₄	<0.02	0	0	5.54	2.4	.08	--	--	--	.20	0	0	.02	0	0	.007	20	.001
5-22-91	SP-33	3	NONE	.04	27	.01	6.07	0	0	.004	0	0	.30	0	0	.02	0	0	.005	11	.0003
5-22-91	SP-33	3	HgCl ₂	.02	25	.003	6.07	0	0	.004	0	0	.47	52	.14	.02	0	0	.006	0	0
5-22-91	SP-33	3	H ₂ SO ₄	.04	13	.003	6.21	2.3	.16	--	--	--	.21	8	.01	.02	0	0	.007	14	.0006
4-10-91	SP-34	3	NONE	<0.02	0	0	6.05	0	0	<0.004	0	0	.27	19	.03	.02	0	0	.010	0	0
4-10-91	SP-34	3	HgCl ₂	<0.02	0	0	6.05	0	0	<0.004	0	0	.80	28	.13	.02	0	0	.010	0	0
4-10-91	SP-34	3	H ₂ SO ₄	<0.02	0	0	6.21	4.5	.16	--	--	--	.21	11	.01	.02	0	0	.010	0	0
4-21-91	SP-34	3	NONE	<0.02	0	0	6.11	1.2	.04	<0.004	0	0	.20	0	0	.02	0	0	.003	17	.0003
4-21-91	SP-34	3	HgCl ₂	<0.02	0	0	6.07	0	0	<0.004	0	0	.68	8.9	.04	.02	0	0	.004	0	0
4-21-91	SP-34	3	H ₂ SO ₄	.02	0	0	5.72	1.3	.04	--	--	--	<.20	0	0	.02	0	0	.004	13	.0003
5-07-91	SP-34	3	NONE	<0.02	0	0	6.03	1.2	.04	<0.004	0	0	.27	18	.03	<.02	0	0	.003	0	0
5-07-91	SP-34	3	HgCl ₂	<0.02	0	0	6.07	0	0	<0.004	0	0	.70	9.1	.04	<.02	0	0	.005	27	.0008
5-07-91	SP-34	3	H ₂ SO ₄	<0.02	0	0	5.59	2.8	.09	--	--	--	.33	6.9	.01	<.02	0	0	.006	0	0
5-22-91	SP-34	3	NONE	.03	35	.01	6.07	0	0	<0.004	0	0	<.20	0	0	.02	0	0	.005	12	.0006
5-22-91	SP-34	3	HgCl ₂	.02	0	0	5.90	3.4	.11	<0.004	0	0	.55	21	.07	.02	0	0	.006	10	.0006
5-22-91	SP-34	3	H ₂ SO ₄	.03	17	.003	5.76	3.5	.12	--	--	--	.21	5.6	.01	.02	0	0	.007	20	.0008
5-22-91	STD	2	HgCl ₂	.22	3.2	.005	.32	0	0	.097	1.5	.001	.82	13	.08	.29	0	0	.262	.1	0
5-22-91	STD	2	HgCl ₂	.58	1.2	.005	1.34	1.5	.02	.151	2.8	.003	1.34	5.8	.06	1.77	7.2	.09	1.53	1.7	.018
10-16-90	SP-17	2	NONE	<0.02	0	0	3.37	37	.73	<0.004	0	0	<.20	0	0	<.02	0	0	.004	35	.001
4-10-91	SP-17	3	NONE	<0.02	0	0	6.28	0	0	<0.004	0	0	.26	26	.04	.02	0	0	.01	0	0

Table 8.--Nutrient analyses of replicate cases preserved by three methods--Continued

Date	Site	Sample size	Preservation method	Analyte																	
				Nitrate			Nitrite			Ammonium			Total kjeldahl nitrogen			Total phosphorus			Orthophosphate		
				\bar{x}	RSD	σ	\bar{x}	RSD	σ	\bar{x}	RSD	σ	\bar{x}	RSD	σ	\bar{x}	RSD	σ	\bar{x}	RSD	σ
4-10-91	SP-17	3	HgCl ₂	<.02	0	0	6.29	0	0	<.004	0	0	0.62	18	0.06	0.02	0	0	0.01	0	0
4-10-91	SP-17	3	H ₂ SO ₄	<.02	0	0	5.89	2.3	.08	--	--	--	.26	22	.08	.02	0	0	.01	0	0
4-21-91	SP-17	3	NONE	<.02	0	0	6.29	1.3	.05	<.004	0	0	<.20	0	0	.02	0	0	.006	10	.0003
4-21-91	SP-17	3	HgCl ₂	.02	0	0	5.06	15	.44	<.004	0	0	.72	21	.09	.02	0	0	.005	11	.0003
4-21-91	SP-17	3	H ₂ SO ₄	<.02	0	0	5.77	1.3	.04	--	--	--	.21	5.6	.01	.02	0	0	.005	0	0
5-07-91	SP-17	3	NONE	<.02	0	0	6.07	0	0	<.004	0	0	<.20	0	0	<.02	0	0	.006	11	.0003
5-07-91	SP-17	3	HgCl ₂	<.02	0	0	6.20	2.2	.08	<.004	0	0	.48	11	.03	<.02	0	0	.006	0	0
5-07-91	SP-17	3	H ₂ SO ₄	<.02	0	0	5.81	0	0	--	--	--	<.20	0	0	<.02	0	0	.007	0	0
5-22-91	SP-17	3	NONE	.04	16	.003	6.20	0	0	<.004	0	0	.28	21	.03	.02	0	0	.006	0	0
5-22-91	SP-17	3	HgCl ₂	.02	25	.003	6.11	1.2	.04	<.004	0	0	.46	11	.03	.02	0	0	.006	0	0
5-22-91	SP-17	3	H ₂ SO ₄	.04	0	0	5.76	3.5	.12	--	--	--	.32	64	.12	.02	0	0	.007	21	.0009
9-06-90	SP-16	2	NONE	.02	0	0	5.41	0	0	<.004	0	0	<.20	0	0	.02	0	0	.005	0	0
4-10-91	SP-16	3	NONE	<.02	0	0	5.81	0	0	<.004	0	0	.21	5.6	.01	.03	22	.003	.01	0	0
4-10-91	SP-16	3	HgCl ₂	<.02	0	0	5.65	2.4	.08	<.004	0	0	.50	19	.06	.02	0	0	.01	0	0
4-10-91	SP-16	3	H ₂ SO ₄	<.02	0	0	5.40	2.7	.08	--	--	--	<.20	0	0	.02	0	0	.01	0	0
4-21-91	SP-16	3	NONE	<.02	0	0	5.72	1.3	.04	<.004	0	0	.74	9.4	.04	.02	0	0	.003	43	.0006
4-21-91	SP-16	3	HgCl ₂	.02	0	0	5.22	8.9	.27	<.004	0	0	<.20	0	0	.02	0	0	.003	17	.0003
4-21-91	SP-16	3	H ₂ SO ₄	.02	0	0	5.45	1.4	.04	--	--	--	<.20	0	0	.02	0	0	.003	43	.0003
5-07-91	SP-16	3	NONE	<.02	0	0	5.77	2.6	.09	<.004	0	0	.27	26	.04	<.02	0	0	.01	17	.0006
5-07-91	SP-16	3	HgCl ₂	<.02	0	0	5.72	1.3	.04	<.004	0	0	.53	37	.12	<.02	0	0	.006	0	0
5-07-91	SP-16	3	H ₂ SO ₄	<.02	0	0	5.15	0	0	--	--	--	<.20	0	0	<.02	0	0	.005	11	.0005
5-22-91	SP-16	3	NONE	.02	22	.01	5.59	1.4	.05	<.004	0	0	<.20	0	0	.02	0	0	.01	10	.0003
5-22-91	SP-16	3	HgCl ₂	.02	22	.01	5.50	5.6	.13	<.004	0	0	.50	6.2	.02	.02	0	0	.006	0	0
5-22-91	SP-16	3	H ₂ SO ₄	.04	16	.003	5.24	3.7	.11	--	--	--	<.20	0	0	.02	0	0	.006	9.1	0
3-21-91	WELL 878	2	HgCl ₂	<.02	0	0	7.99	4.3	.25	<.004	0	0	.48	11	.05	<.02	0	0	<.02	0	0
3-21-91	WELL 879	2	HgCl ₂	<.02	0	0	7.02	0	0	<.004	0	0	.46	20	.07	<.02	0	0	<.02	0	0
3-22-91	WELL 882	2	HgCl ₂	<.02	0	0	4.72	3.6	.12	<.004	0	0	.41	33	.09	.02	0	0	<.02	0	0
3-22-91	WELL 883	2	HgCl ₂	.02	0	0	4.72	11	.36	<.004	0	0	.55	45	.18	<.02	0	0	<.02	0	0

cases with mercuric-chloride preservative, and all 16 replicate cases with sulfuric-acid preservative. Twenty-three of 56 replicate cases (41 percent) exceeded the RSD precision goal for orthophosphate. The range of exceedance values was from 9.1 to 43 percent. The preservation method associated with the exceedance cases include nine replicate cases with no preservative, five replicate cases with mercuric-chloride preservative, and nine replicate cases with sulfuric-acid preservative. The average margins of error at the 95-percent confidence level for cases that exceeded RSD goals were ± 0.002 mg/L for cases with no preservative, ± 0.0018 mg/L for cases with mercuric-chloride preservative, and ± 0.0014 mg/L for cases with sulfuric-acid preservative. The lack of repeatability for all preservation methods may actually be caused, in part, by the imprecision of analytical determinations at the very low concentrations of orthophosphate present in the spring samples.

Comparison of Preservation Methods

The replicate-sample data provide some indication of the representativeness of sample results for the three preservation methods during repeated analysis. However, analysis of replicate samples does not provide data necessary to compare the accuracy or potential bias of analytical results from samples preserved by the various preservation methods. Two rounds of nutrient SRWS were analyzed to evaluate the accuracy and potential bias caused by differences in sample-preservation methods. Each round included both a low and high concentration nutrient SRWS. The low concentration SRWS (N30) had a total-nitrogen concentration of 0.75 mg/L and a total-phosphorus concentration of 0.23 mg/L; the high concentration SRWS (N31) had a total-nitrogen concentration of 2.25 mg/L and a total-phosphorus concentration of 1.61 mg/L (D. Erdmann, U.S. Geological Survey, Branch of Quality Assurance, written commun., 1991). The nitrogen content of both SRWS was within an order of magnitude of the nitrogen content of the project samples; the phosphorus content of both SRWS was one to two orders of magnitude greater than the project samples.

The first round of SRWS analyses included two samples with no chemical preservative, four samples with mercuric-chloride preservative, and two samples with sulfuric-acid preservative. The second round of SRWS analyses included 16 mercuric-chloride-preservation samples that were analyzed by use of mercuric-chloride-preserved calibration standards. The following discussion is based on data collected from the two rounds of SRWS analyses.

The first round of SRWS analyses was performed to evaluate the accuracy of results from samples preserved by three methods. The measured analyte concentrations were compared to the MPV's for each nutrient SRWS by use of the same RSD precision goal criteria that was applied to the duplicate and replicate sample analyses. The measured analyte concentrations for SRWS preserved by each method and the MPV are shown in figure 1.

The SRWS with no chemical preservative had acceptable analytical results for two of five nutrient analytes (fig. 1). Measured ammonium concentrations for both standards were within the RSD goals. Measured ammonium plus organic nitrogen concentrations also were within the RSD goals. The nitrate plus nitrite, total phosphorus, and orthophosphate RSD goals were all exceeded, with RSD's of 16 percent for low concentration SRWS, and 22.5 and 9.5 percent for high concentration SRWS, respectively.

The SRWS with mercuric-chloride preservative had acceptable analytical results for three of five nutrient analytes (fig. 1). Measured ammonium concentrations for both standards were within the RSD goal. Measured ammonium plus organic nitrogen concentrations were substantially higher than the MPV and exceeded the RSD goal; the low and high concentration standards had RSD's of 63 and 41 percent, respectively. Measured nitrate plus nitrite concentrations were within the RSD goals. Measured total-phosphorus concentrations exceeded the RSD goal for the high concentration standard--an RSD of 6.7 percent was observed. Measured orthophosphate concentrations met the RSD goal for both the low and high concentration standards.

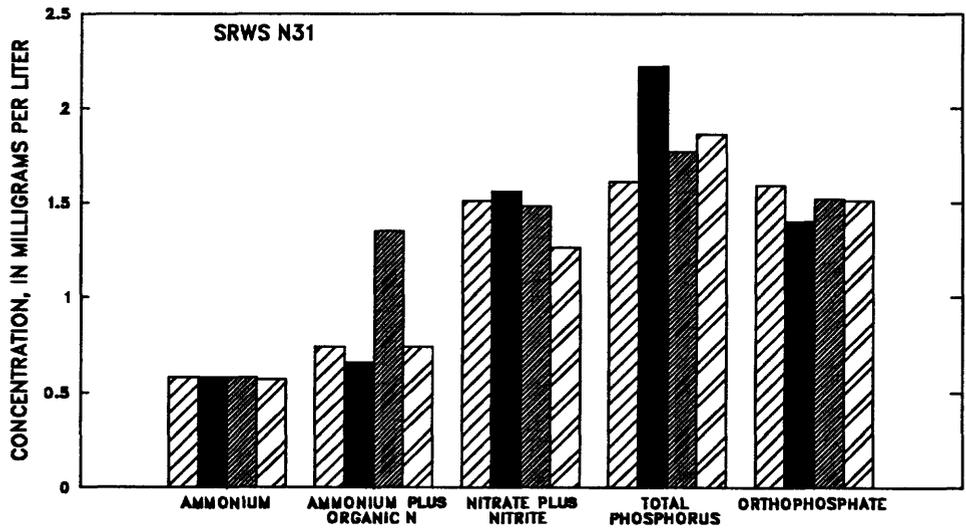
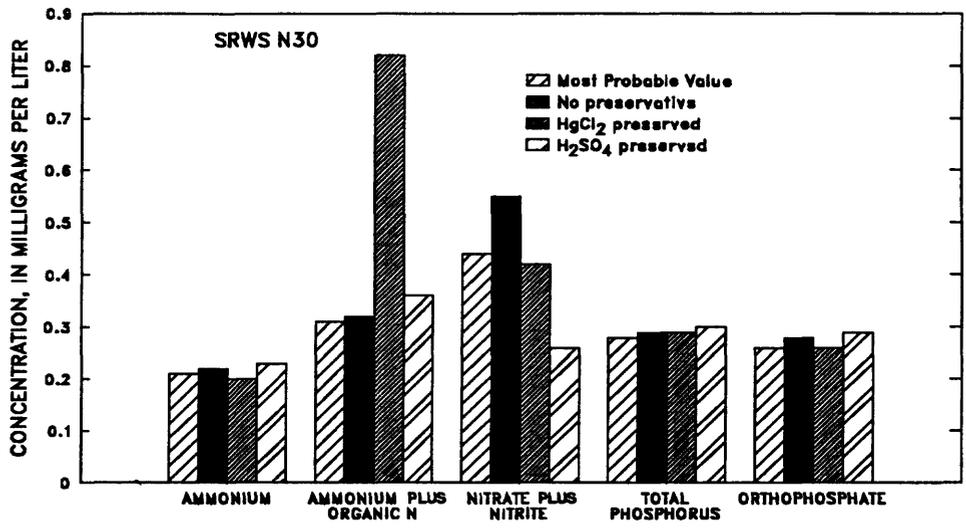


Figure 1.—Comparison of the Standard Reference Water Sample preserved by three methods with the “Most Probable Value” for each nutrient analyte.

The SRWS with sulfuric-acid preservative had acceptable analytical results for three of five nutrient analytes (fig. 1). The measured ammonium concentrations for both the low and high concentration standards were within the RSD goal. The measured ammonium plus organic nitrogen concentrations also were within the RSD goal. The measured nitrate plus nitrite concentrations for both the low and high concentration standards exceeded the RSD goals. The low and high RSD's for this analyte were 35 and 13 percent, respectively. The measured total-phosphorus concentrations for both the low and high concentration standards also exceeded the RSD precision goal. The low and high RSD's for the total phosphorus analyte were 4.9 and 10 percent, respectively. The measured orthophosphate concentrations for both the low and high concentration standards were within the RSD goal.

Results of first round of SRWS analyses, although limited in the number of analyses, indicate that no single preservation method provided acceptable results for all the nutrient analytes in both the low and high concentration standards. Measurements of ammonium concentration were acceptable for each preservation method. Measurements of nitrite plus nitrate, which was the major nutrient analyte present in project samples, were only acceptable with mercuric-chloride preservative. Measurements of ammonium plus organic nitrogen were acceptable with either no preservative or sulfuric-acid preservative. Measurements of total phosphorus were not acceptable for any of the preservation methods. Measurements of orthophosphate were acceptable for mercuric-chloride and sulfuric-acid preservative.

A second round of SRWS analyses were performed for the purpose of evaluating whether or not laboratory standard solutions treated with mercuric chloride would improve

the accuracy of nutrient determinations of samples that were preserved with mercuric chloride. Mercuric chloride was added to laboratory nutrient standard solutions to a final concentration of 40 mg/L of Hg^{2+} , the same concentration as in mercuric-chloride-preservation samples. Eight low and high concentration SRWS were analyzed with these mercuric chloride treated laboratory standard solutions. Mean nutrient concentrations of the low and high concentration SRWS and the associated MPV's are shown in figure 2.

The results of this experiment show that all nutrient analytes, on the average, are within the RSD precision goal. The RSD for ammonium was larger during the secondary test--RSD's were 9.4 percent for the low concentration and 1.2 percent for the high concentration standard. Ammonium plus organic nitrogen had a lesser positive bias than in the primary set. The RSD for the low concentration standard was 37 percent, which exceeds the RSD precision goal of 32 percent. The RSD for the high concentration standard was 19.4 percent, which was within the RSD precision goal. Both nitrate and nitrite were within the RSD precision goals; the RSD's for the low and high concentration standards were 3.3 and 5.3 percent, respectively. Total-phosphorus concentrations compared well with the MPV; the RSD for the low concentration standard was zero and the RSD for the high concentration standard was 1.33 percent. These results represent a substantial improvement compared to the results of the primary analysis. Orthophosphate also compared well with the MPV. The RSD for the low concentration standard was 0.0 percent and the high concentration standard was 2.7 percent. These results also represent a substantial improvement over the analytical precision obtained in the previous primary data set.

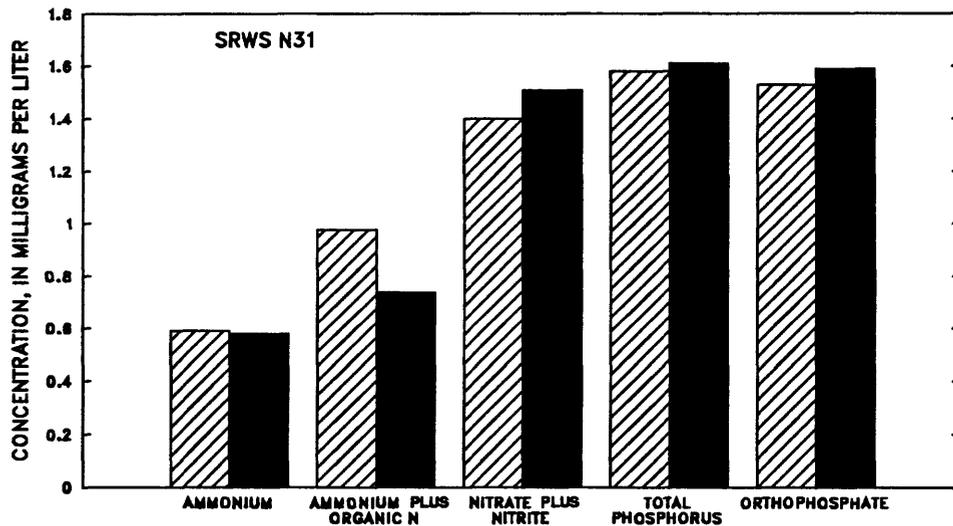
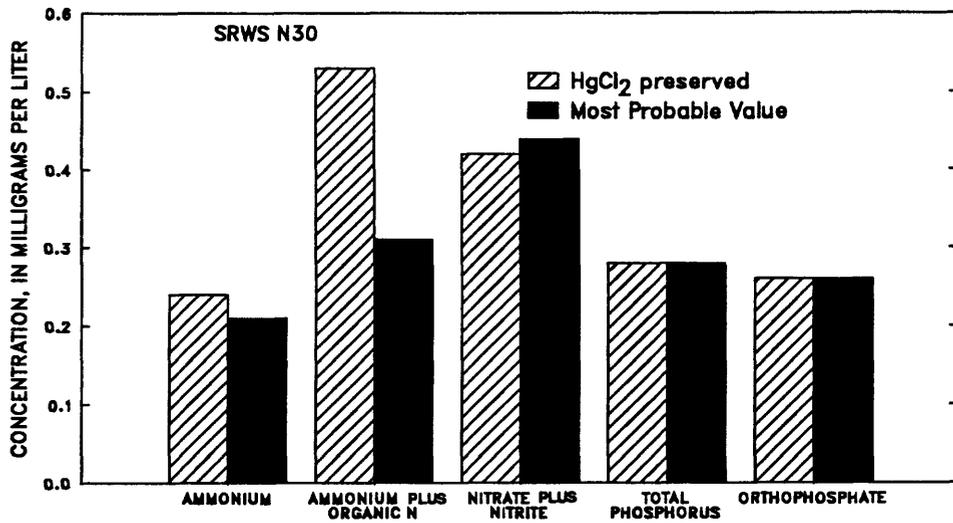


Figure 2.—Comparison of the secondary analysis for mercuric-chloride-preserved Standard Reference Water Samples with the “Most Probable Value” for each analyte.

CONCLUSIONS

The quality of nutrient data collected for the Alexanders and Mount Rock Spring basins has been evaluated by use of 164 of 304 nutrient samples collected for the project. Because nearly 54 percent of the data collected for this project has been quality-assurance data, a detailed quality-assurance evaluation describing laboratory consistency, container and preservative cleanliness, and preservation method was warranted.

Laboratory duplicate analysis suggests that the principal laboratory met its precision goal of ± 10 percent for analysis of nutrient analytes for the cooperative project. Results of duplicate sample analyses for ammonium, nitrate, nitrite, ammonium plus organic nitrogen, and total phosphorus were within the RSD precision goals established for the cooperative project. Orthophosphate exceeded the RSD precision goal for one of three sets of duplicate sample analyses.

Blank samples were contaminated by ammonium for four of five mercuric-chloride-preservation samples. This contamination was small (less than 0.02 mg/L) and not considered a serious problem. Sulfuric acid did not compromise sample quality but should be investigated more thoroughly as ammonium is readily sorbed from the atmosphere by acidic solutions. Because only one of eight blanks was preserved with sulfuric acid, no conclusion can be made concerning the potential for this additive to compromise sample representativeness.

Interlaboratory results of replicate samples indicate potential bias in nitrate and ammonium plus organic nitrogen concentrations between the principal laboratory PaDER and the USGS, NWQL. Nutrient determinations of USEPA quality-control samples, however, suggest that the PaDER laboratory was sufficiently accurate in its determinations of nitrate and ammonium plus organic nitrogen at concentrations similar to those of spring samples, and with one exception was also sufficiently accurate in determinations of ammonium, total phosphorus, and orthophosphate at higher concentrations than those of spring samples.

Replicate-sample analysis was successful in defining the representativeness of repeated measurements of sample composition as influenced by three different preservation methods. Ammonium exceeded the RSD precision goals for 10 of 56 cases during the study. The exceedance cases were equally distributed among the three preservation

groups; therefore, no single preservation method prevailed over the other. Nitrate concentration compared well among the replicate samples for all preservation methods; however, sulfuric acid best preserved the representativeness of the nitrate analyte. Nitrite could not be adequately evaluated because concentrations were below analytical detection for all but five cases. Ammonium plus organic nitrogen was within the RSD precision goals for 49 of 56 replicate cases. Chilling to 4°C with no additives or the addition of sulfuric acid were the best preservation methods for this analyte. Total phosphorus was detectable in 43 of 56 cases. Replicate-sample analysis was unable to associate a specific preservation method with this analyte because most cases were at or below analytical detection limits. Orthophosphate yielded extremely poor results. More than 40 percent of the replicate cases exceeded the RSD precision goal. None of the preservation methods adequately maintained sample representativeness, which was certainly caused by the low orthophosphate concentrations in the replicate samples.

Comparison of the MPV with the results of each analyte for each of the preservation methods suggest, with the limited number of analyses, that no single preservative was adequate for all nutrient analytes. Ammonium was comparable with the MPV for all preservation methods. However, nitrate was best preserved with mercuric chloride. Ammonium plus organic nitrogen was most comparable with the MPV following preservation with either no additives or sulfuric acid. mercuric-chloride-preservation samples improved in comparability with the MPV if the analytical instrument was calibrated with mercuric-chloride-preserved standards as a precursor to analysis of the analytes. Total phosphorus and orthophosphate both compared well with the MPV when samples were preserved with mercuric chloride. Again, a substantial improvement in the comparison of these analytes was observed when the analytical instrument was calibrated with mercuric-chloride-preserved standards.

The results and interpretations presented here are based on the available quality-assurance data for a single nutrient related project. Because the quality-assurance data base was not specifically designed to assess preservation methods, these conclusions should not be a recommendation for specific preservation methods. However, these results should suggest that not all is known about the currently used nutrient preservation methods and that they merit further study.

REFERENCES CITED

- Fishman, M.J., Schroder, L.J., and Shockey, M.W., 1986, Evaluation of methods for preservation of water samples for nutrient analysis: Intern. Jour. Environmental Studies, v. 26, p. 231-238.
- Jenkins, D., 1968, The differentiation, analysis, and preservation of nitrogen and phosphorus forms in natural waters: *in* Trace Inorganics in Water: Washington D.C., American Chemical Society, Advances in Chemistry Series 73, p. 265-280.
- Klingaman, E.D., and Nelson, D.W., 1976, Evaluation of methods for preserving the levels of soluble inorganic phosphorus and nitrogen in unfiltered water samples: Journal of Environmental Quality, v. 5, p. 42-46.
- Taylor, J.K., 1987, Quality assurance of chemical measurements: Lewis Publishers, Inc., Chelsea, Michigan, 328 p.
- U.S. Environmental Protection Agency, 1979, Methods for chemical analysis of water and wastes: Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio, EPA-600/4-79-020.
- _____, 1982, Handbook for sampling and sample preservation of water and wastewater: Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio, EPA-600/4-82-029.
- Ward, J.R., and Harr, A., eds., 1990, Methods for collection and processing of surface-water and bed-materials samples for physical and chemical analyses: U.S. Geological Survey Open-File Report 90-140, 71 p.

Table 9.--Nutrient-quality data for Alexanders and Mount Rock Spring basins,

May 1, 1990, to September 12, 1991

[mg/L, milligrams per liter; <, less than]

SAMPLE ID:

DD - double distilled water from U.S. Geological Survey Pennsylvania District Office
DI - detonized water from U.S. Geological Survey Pennsylvania District Office
SP-16 - Principle spring opening of Alexanders Spring Creek
SP-17 - Principle spring opening of Mount Rock Spring Creek
SP-33 - Spring opening of Unnamed Tributary to Mount Rock Spring Creek
SP-34 - Spring opening of Unnamed Tributary to Mount Rock Spring Creek
SRWS N30 - U.S. Geological Survey, Branch of Quality Assurance, Standard Reference Water Sample N30
SRWS N31 - U.S. Geological Survey, Branch of Quality Assurance, Standard Reference Water Sample N31
USEPA N1 - U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory,
Nutrients Quality-Control Sample N1
USEPA N2 - U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory,
Nutrients Quality-Control Sample N2

SAMPLE TYPE:

BLANK - field or preservation blank
CSREP - churn-split replicate sample
INTERLAB - sequential replicate analyzed at multiple laboratories
REG - regular grab sample from centroid of flow of spring opening
SEQREP - sequential replicate sample
STD - nutrient standard

CHEMICAL PRESERVATION:

HgCl₂ - mercuric-chloride preservative
H₂SO₄ - sulfuric-acid preservative
NONE - no chemical preservation

ANALYZING LABORATORY:

PaDER - Pennsylvania Department of Environmental Resources, Bureau of Laboratories, Harrisburg, Pa.
NWQL - U.S. Geological Survey, National Water-Quality Laboratory, Arvada, Co.

Table 9.--Nutrient-quality data for Alexanders and Mount Rock Spring basins, May 1, 1990, to September 12, 1991--Continued

Sample ID	Sample date	Sample time	Sample type	Chemical preservation	Analyzing laboratory	Nitrogen, ammonia		Nitrogen, nitrite		Nitrogen, nitrate		Nitrogen, ammonia + organic		Phosphorus, ortho	
						(mg/L as N) (00610)	total	(mg/L as N) (00615)	total	(mg/L as N) (00620)	total	(mg/L as N) (00625)	total	(mg/L as P) (00665)	total
SP-16	05-01-90	1045	REG	HgCl ₂	PaDER	<0.02	<0.004	<0.004	5.02	0.30	0.02	0.013			
SP-16	05-04-90	1200	REG	HgCl ₂	PaDER	<0.02	<0.004	<0.004	5.28	.34	.02	.008			
SP-16	05-10-90	2015	REG	HgCl ₂	PaDER	<0.02	<0.004	<0.004	5.28	.38	<.02	.007			
SP-16	05-21-90	1100	REG	HgCl ₂	PaDER	<0.02	<0.004	<0.004	4.75	.56	.02	.008			
SP-16	05-21-90	1715	REG	HgCl ₂	PaDER	<0.02	<0.004	<0.004	5.15	.36	.02	.008			
SP-16	05-22-90	1000	REG	HgCl ₂	PaDER	<0.02	<0.004	<0.004	5.28	.30	.02	.008			
SP-16	05-29-90	1215	REG	HgCl ₂	PaDER	<0.02	<0.004	<0.004	5.02	.34	.02	.008			
SP-16	05-29-90	2000	REG	HgCl ₂	PaDER	<0.02	<0.004	<0.004	4.62	.36	.02	.009			
SP-16	05-30-90	0900	REG	HgCl ₂	PaDER	<0.02	<0.004	<0.004	5.28	.36	.02	.010			
SP-16	05-31-90	0930	REG	HgCl ₂	PaDER	<0.02	<0.004	<0.004	5.02	.33	.02	.010			
SP-16	06-21-90	0915	REG	HgCl ₂	PaDER	<0.02	<0.004	<0.004	4.36	.43	.02	.009			
SP-16	07-11-90	0845	REG	HgCl ₂	PaDER	<0.02	<0.004	<0.004	5.02	.65	.02	.011			
SP-16	07-13-90	0815	REG	HgCl ₂	PaDER	<0.02	<0.004	<0.004	5.15	.33	.03	.009			
SP-16	07-31-90	0800	REG	HgCl ₂	PaDER	<0.02	<0.004	<0.004	4.36	.35	.02	.011			
SP-16	08-08-90	0815	REG	NONE	PaDER	<0.02	<0.004	<0.004	3.96	<.20	.02	<.002			
SP-16	08-20-90	1430	REG	NONE	PaDER	<0.02	<0.004	<0.004	5.94	.27	<.02	.006			
SP-16	08-21-90	0815	REG	NONE	PaDER	<0.02	<0.004	<0.004	5.81	<.20	<.02	.006			
SP-16	08-22-90	0815	REG	NONE	PaDER	<0.02	<0.004	<0.004	5.28	<.20	.03	.010			
SP-16	08-23-90	0815	REG	NONE	PaDER	.02	<0.004	<0.004	5.28	.34	.03	.010			
SP-16	08-25-90	1200	REG	HgCl ₂	PaDER	<0.02	<0.004	<0.004	5.28	<.20	.03	.017			
SP-16	08-27-90	0815	REG	NONE	PaDER	<0.02	<0.004	<0.004	5.41	<.20	.03	.011			
SP-16	09-06-90	1615	SEQREP	NONE	PaDER	.02	<0.004	<0.004	5.41	<.20	.02	.006			
SP-16	09-06-90	1616	SEQREP	NONE	PaDER	<0.02	<0.004	<0.004	5.41	<.20	.02	.005			
SP-16	09-25-90	1200	REG	NONE	PaDER	<0.02	<0.004	<0.004	5.57	<.20	.02	.004			
SP-16	10-16-90	1000	REG	NONE	PaDER	.02	<0.004	<0.004	3.30	<.20	.02	.006			
SP-16	10-18-90	1330	REG	HgCl ₂	PaDER	<0.02	<0.004	<0.004	5.81	<.20	<.02	.005			
SP-16	10-24-90	0845	REG	HgCl ₂	PaDER	.03	<0.010	<0.010	5.30	.70	<.01	<.010			
SP-16	11-19-90	1045	INTERLAB	HgCl ₂	NWQL	.01	<0.010	<0.010	5.60	.70	<.01	<.010			
SP-16	11-19-90	1045	INTERLAB	NONE	PaDER	.02	<0.004	<0.004	4.75	<.20	<.01	<.002			
SP-16	12-04-90	1530	REG	NONE	PaDER	.02	<0.004	<0.004	4.62	<.20	<.02	.003			
SP-16	01-04-91	1530	REG	NONE	PaDER	.03	<0.004	<0.004	4.75	.88	<.02	.010			
SP-16	01-29-91	1000	REG	NONE	PaDER	.03	<0.004	<0.004	5.54	.37	.03	.006			
SP-16	02-11-91	1315	SEQREP	HgCl ₂	PaDER	.02	<0.004	<0.004	5.41	.75	.02	.004			
SP-16	02-11-91	1316	SEQREP	NONE	PaDER	.02	<0.004	<0.004	5.41	.21	.02	.006			
SP-16	02-28-91	1200	REG	NONE	PaDER	.02	<0.004	<0.004	6.05	.39	<.02	.005			

Table 9.--Nutrient-quality data for Alexanders and Mount Rock Spring basins, May 1, 1990, to September 12, 1991--Continued

Sample ID	Sample date	Sample time	Sample type	Chemical preservation	Analyzing laboratory	Nitrogen, ammonia total (mg/L as N) (00610)		Nitrogen, nitrite total (mg/L as N) (00615)		Nitrogen, nitrate total (mg/L as N) (00620)		Nitrogen, ammonia + organic total (mg/L as N) (00625)		Phosphorus ortho total (mg/L as P) (70507)	
						ammonia total	Nitrogen, nitrite total	Nitrogen, nitrate total	Nitrogen, ammonia + organic total	Phosphorus ortho total					
SP-16	04-02-91	1100	SEGREP	NONE	PaDER	<0.02	<0.004	5.81	0.20	0.02	0.010				
SP-16	04-02-91	1101	SEGREP	HgCl ₂	PaDER	<0.02	<0.004	5.32	.58	.02	.010				
SP-16	04-10-91	1500	CSREP	NONE	PaDER	<0.02	<0.004	5.81	.20	.03	.010				
SP-16	04-10-91	1501	CSREP	NONE	PaDER	<0.02	<0.004	5.81	.22	.03	.010				
SP-16	04-10-91	1502	CSREP	NONE	PaDER	<0.02	<0.004	5.81	<.20	.02	<.010				
SP-16	04-10-91	1503	CSREP	HgCl ₂	PaDER	<0.02	<0.004	5.81	.61	.02	.010				
SP-16	04-10-91	1504	CSREP	HgCl ₂	PaDER	<0.02	<0.004	5.57	.48	.02	.010				
SP-16	04-10-91	1505	CSREP	HgCl ₂	PaDER	<0.02	<0.004	5.57	.42	.02	<.010				
SP-16	04-10-91	1506	CSREP	H ₂ SO ₄	PaDER	<0.02	--	5.57	<.20	.02	.010				
SP-16	04-10-91	1507	CSREP	H ₂ SO ₄	PaDER	<0.02	--	5.32	<.20	.02	.010				
SP-16	04-10-91	1508	CSREP	H ₂ SO ₄	PaDER	<0.02	--	5.32	<.20	.02	.010				
SP-16	04-21-91	1115	CSREP	NONE	PaDER	<0.02	<0.004	5.68	<.20	.02	.002				
SP-16	04-21-91	1116	CSREP	NONE	PaDER	<0.02	<0.004	5.81	<.20	.02	.004				
SP-16	04-21-91	1117	CSREP	NONE	PaDER	<0.02	<0.004	5.68	<.20	.02	.002				
SP-16	04-21-91	1118	CSREP	HgCl ₂	PaDER	<0.02	<0.004	4.75	.70	.02	.004				
SP-16	04-21-91	1119	CSREP	HgCl ₂	PaDER	.02	<0.004	5.28	.82	.02	.003				
SP-16	04-21-91	1120	CSREP	HgCl ₂	PaDER	.02	<0.004	5.68	.70	.02	.003				
SP-16	04-21-91	1121	CSREP	H ₂ SO ₄	PaDER	.02	--	5.54	<.20	.02	.004				
SP-16	04-21-91	1122	CSREP	H ₂ SO ₄	PaDER	<0.02	--	5.41	<.20	.02	.002				
SP-16	04-21-91	1123	CSREP	H ₂ SO ₄	PaDER	.02	--	5.41	<.20	.02	<.002				
SP-16	05-07-91	1245	CSREP	NONE	PaDER	<0.02	<0.004	5.94	.34	<.02	.007				
SP-16	05-07-91	1246	CSREP	NONE	PaDER	<0.02	<0.004	5.68	.27	<.02	.006				
SP-16	05-07-91	1247	CSREP	NONE	PaDER	<0.02	<0.004	5.68	<.20	<.02	.005				
SP-16	05-07-91	1248	CSREP	HgCl ₂	PaDER	<0.02	<0.004	5.68	.76	<.02	.006				
SP-16	05-07-91	1249	CSREP	HgCl ₂	PaDER	<0.02	<0.004	5.81	.46	<.02	.006				
SP-16	05-07-91	1250	CSREP	HgCl ₂	PaDER	<0.02	<0.004	5.68	.38	<.02	.006				
SP-16	05-07-91	1251	CSREP	H ₂ SO ₄	PaDER	<0.02	--	5.15	<.20	<.02	.006				
SP-16	05-07-91	1252	CSREP	H ₂ SO ₄	PaDER	<0.02	--	5.15	<.20	<.02	.005				
SP-16	05-07-91	1253	CSREP	H ₂ SO ₄	PaDER	<0.02	--	5.15	<.20	<.02	.005				
SP-16	05-22-91	0830	CSREP	NONE	PaDER	.03	<0.004	5.68	.20	.02	.006				
SP-16	05-22-91	0831	CSREP	NONE	PaDER	.02	<0.004	5.54	<.20	.02	.006				
SP-16	05-22-91	0832	CSREP	NONE	PaDER	.02	<0.004	5.54	<.20	.02	.005				
SP-16	05-22-91	0833	CSREP	HgCl ₂	PaDER	.02	<0.004	5.68	.47	.02	.006				
SP-16	05-22-91	0834	CSREP	HgCl ₂	PaDER	.02	<0.004	5.68	.53	.02	.006				
SP-16	05-22-91	0835	CSREP	HgCl ₂	PaDER	.03	<0.004	5.15	.49	.02	.006				

Table 9.--Nutrient-quality data for Alexanders and Mount Rock Spring basins, May 1, 1990, to September 12, 1991--Continued

Sample ID	Sample date	Sample time	Sample type	Chemical preservation	Analyzing laboratory	Nitrogen, ammonia		Nitrogen, nitrite		Nitrogen, nitrate		Nitrogen, ammonia + organic		Phosphorus, ortho	
						total (mg/L as N) (00610)	total (mg/L as N) (00615)	total (mg/L as N) (00620)	total (mg/L as N) (00625)	total (mg/L as P) (00665)	total (mg/L as P) (70507)				
SP-16	05-22-91	0836	CSREP	H ₂ SO ₄	PaDER	0.04	--	--	5.28	5.28	<0.20	0.02	0.007		
SP-16	05-22-91	0837	CSREP	H ₂ SO ₄	PaDER	.03	--	--	5.02	5.02	<.20	.02	.006		
SP-16	05-22-91	0838	CSREP	H ₂ SO ₄	PaDER	.04	--	--	5.41	5.41	<.20	<.02	.006		
SP-17	05-01-90	1500	REG	HgCl ₂	PaDER	<.02	<.004	<.004	5.54	5.54	.37	.02	.011		
SP-17	05-04-90	1430	REG	HgCl ₂	PaDER	<.02	<.004	<.004	5.68	5.68	.29	.02	.010		
SP-17	05-10-90	1840	REG	HgCl ₂	PaDER	<.02	<.004	<.004	4.62	4.62	.31	.02	.010		
SP-17	05-21-90	1000	REG	HgCl ₂	PaDER	<.02	<.004	<.004	5.54	5.54	.47	.03	.011		
SP-17	05-21-90	1615	REG	HgCl ₂	PaDER	<.02	<.004	<.004	4.88	4.88	.39	.03	.010		
SP-17	05-22-90	0915	REG	HgCl ₂	PaDER	<.02	<.004	<.004	4.62	4.62	.39	.03	.011		
SP-17	05-29-90	1100	REG	HgCl ₂	PaDER	<.02	<.004	<.004	5.15	5.15	.37	.03	.014		
SP-17	05-29-90	1730	REG	HgCl ₂	PaDER	<.02	<.004	<.004	5.41	5.41	.35	.03	.014		
SP-17	05-30-90	0815	REG	HgCl ₂	PaDER	<.02	<.004	<.004	4.62	4.62	.39	.03	.022		
SP-17	05-31-90	0830	REG	HgCl ₂	PaDER	<.02	<.004	<.004	5.54	5.54	.37	.03	.010		
SP-17	06-21-90	1000	REG	HgCl ₂	PaDER	<.02	<.004	<.004	4.36	4.36	.39	.03	.010		
SP-17	07-11-90	0945	REG	HgCl ₂	PaDER	<.02	<.004	<.004	5.68	5.68	.39	.03	.009		
SP-17	07-13-90	0845	REG	HgCl ₂	PaDER	<.02	<.004	<.004	5.68	5.68	.37	.03	.010		
SP-17	07-31-90	0830	REG	HgCl ₂	PaDER	<.02	<.004	<.004	5.68	5.68	.37	.03	.009		
SP-17	08-08-90	0900	REG	NONE	PaDER	<.02	<.004	<.004	5.28	5.28	<.20	.02	<.002		
SP-17	08-20-90	1500	REG	NONE	PaDER	<.02	<.004	<.004	5.68	5.68	<.20	<.02	.008		
SP-17	08-21-90	0845	REG	NONE	PaDER	<.02	<.004	<.004	6.07	6.07	<.20	<.02	.010		
SP-17	08-22-90	0845	REG	NONE	PaDER	.02	.004	.004	5.02	5.02	<.20	.04	.027		
SP-17	08-23-90	0845	REG	NONE	PaDER	<.02	<.004	<.004	5.54	5.54	<.20	.03	.016		
SP-17	08-25-90	1115	REG	HgCl ₂	PaDER	<.02	<.004	<.004	5.54	5.54	<.20	.03	.011		
SP-17	08-27-90	0845	REG	NONE	PaDER	<.02	<.004	<.004	5.54	5.54	<.20	.03	.010		
SP-17	09-06-90	1545	REG	NONE	PaDER	.03	<.004	<.004	5.81	5.81	<.20	.02	.007		
SP-17	09-25-90	0945	REG	NONE	PaDER	<.02	<.004	<.004	5.81	5.81	<.20	.02	.010		
SP-17	10-16-90	1045	SEQREP	NONE	PaDER	<.02	<.004	<.004	4.09	4.09	<.20	<.02	.003		
SP-17	10-16-90	1046	SEQREP	NONE	PaDER	<.02	<.004	<.004	2.64	2.64	<.20	<.02	.005		
SP-17	10-18-90	1145	REG	HgCl ₂	PaDER	.02	<.004	<.004	5.81	5.81	<.20	<.02	.005		
SP-17	11-19-90	1115	INTERLAB	HgCl ₂	NWQL	.02	<.010	<.010	6.00	6.00	.40	<.01	<.010		
SP-17	11-19-90	1115	INTERLAB	NONE	PaDER	.02	<.004	<.004	5.15	5.15	<.20	<.01	<.004		
SP-17	12-04-90	1545	REG	NONE	PaDER	.02	<.004	<.004	5.41	5.41	<.20	<.02	.005		
SP-17	01-04-91	1700	REG	NONE	PaDER	.02	<.004	<.004	5.54	5.54	.90	<.02	.010		
SP-17	01-29-91	1045	REG	NONE	PaDER	.02	<.004	<.004	6.73	6.73	.47	.03	.008		
SP-17	02-11-91	1345	REG	HgCl ₂	PaDER	.02	<.004	<.004	5.81	5.81	.69	.02	.006		

Table 9.--Nutrient-quality data for Alexanders and Mount Rock Spring basins, May 1, 1990, to September 12, 1991--Continued

Sample ID	Sample date	Sample time	Sample type	Chemical preservation	Analyzing laboratory	Nitrogen, ammonia total (mg/L as N) (00610)	Nitrogen, nitrite total (mg/L as N) (00615)	Nitrogen, nitrate total (mg/L as N) (00620)	Nitrogen, ammonia + organic total (mg/L as N) (00625)	Phosphorus total (mg/L as P) (00665)	Phosphorus ortho total (mg/L as P) (70507)
SP-17	02-28-91	1315	SEQREP	NONE	PaDER	0.02	0.004	6.53	0.52	0.02	0.006
SP-17	02-28-91	1316	SEQREP	HgCl ₂	PaDER	.02	.004	6.29	1.12	<.02	.006
SP-17	04-02-91	1400	SEQREP	NONE	PaDER	<.02	<.004	6.29	<.20	.02	.010
SP-17	04-02-91	1401	SEQREP	HgCl ₂	PaDER	<.02	<.004	6.05	.42	.02	.010
SP-17	04-10-91	1345	CSREP	NONE	PaDER	<.02	<.004	6.29	<.20	.02	.010
SP-17	04-10-91	1346	CSREP	NONE	PaDER	<.02	<.004	6.29	.33	.02	.010
SP-17	04-10-91	1347	CSREP	NONE	PaDER	<.02	<.004	6.29	.24	.02	.010
SP-17	04-10-91	1348	CSREP	HgCl ₂	PaDER	<.02	<.004	6.29	.69	.02	.010
SP-17	04-10-91	1349	CSREP	HgCl ₂	PaDER	<.02	<.004	6.29	.67	.02	.010
SP-17	04-10-91	1350	CSREP	HgCl ₂	PaDER	<.02	<.004	6.29	.49	.02	.010
SP-17	04-10-91	1351	CSREP	H ₂ SO ₄	PaDER	<.02	--	5.81	.33	.02	.010
SP-17	04-10-91	1352	CSREP	H ₂ SO ₄	PaDER	<.02	--	6.05	.24	.02	.010
SP-17	04-10-91	1353	CSREP	H ₂ SO ₄	PaDER	<.02	--	5.81	.22	.02	.010
SP-17	04-21-91	1345	CSREP	NONE	PaDER	<.02	<.004	6.34	<.20	.02	.006
SP-17	04-21-91	1346	CSREP	NONE	PaDER	<.02	<.004	6.34	<.20	.02	.006
SP-17	04-21-91	1347	CSREP	NONE	PaDER	<.02	<.004	6.20	<.20	.02	.005
SP-17	04-21-91	1348	CSREP	HgCl ₂	PaDER	<.02	<.004	5.68	.84	.02	.006
SP-17	04-21-91	1349	CSREP	HgCl ₂	PaDER	.02	<.004	4.22	.77	.02	.005
SP-17	04-21-91	1350	CSREP	HgCl ₂	PaDER	.02	<.004	5.28	.55	.02	.005
SP-17	04-21-91	1351	CSREP	H ₂ SO ₄	PaDER	.02	--	5.68	<.20	<.02	.005
SP-17	04-21-91	1352	CSREP	H ₂ SO ₄	PaDER	<.02	--	5.81	<.20	.02	.005
SP-17	04-21-91	1353	CSREP	H ₂ SO ₄	PaDER	<.02	--	5.81	.22	.02	.005
SP-17	05-07-91	1015	CSREP	NONE	PaDER	<.02	<.004	6.07	<.20	<.02	.005
SP-17	05-07-91	1016	CSREP	NONE	PaDER	<.02	<.004	6.07	<.20	<.02	.006
SP-17	05-07-91	1017	CSREP	NONE	PaDER	<.02	<.004	6.07	<.20	<.02	.006
SP-17	05-07-91	1018	CSREP	HgCl ₂	PaDER	<.02	<.004	6.07	.52	<.02	.006
SP-17	05-07-91	1019	CSREP	HgCl ₂	PaDER	<.02	<.004	6.20	.50	<.02	.006
SP-17	05-07-91	1020	CSREP	HgCl ₂	PaDER	<.02	<.004	6.34	.42	<.02	.006
SP-17	05-07-91	1021	CSREP	H ₂ SO ₄	PaDER	<.02	--	5.81	<.20	<.02	.007
SP-17	05-07-91	1022	CSREP	H ₂ SO ₄	PaDER	<.02	--	5.81	<.20	<.02	.007
SP-17	05-07-91	1023	CSREP	H ₂ SO ₄	PaDER	<.02	--	5.81	<.20	<.02	--
SP-17	05-22-91	0915	CSREP	NONE	PaDER	.03	<.004	6.20	.24	.02	.006
SP-17	05-22-91	0916	CSREP	NONE	PaDER	.04	<.004	6.20	.26	.02	.006
SP-17	05-22-91	0917	CSREP	NONE	PaDER	.04	<.004	6.20	.35	.02	.006
SP-17	05-22-91	0918	CSREP	HgCl ₂	PaDER	<.02	<.004	6.07	.41	.02	--

Table 9.--Nutrient-quality data for Alexanders and Mount Rock Spring basins, May 1, 1990, to September 12, 1991--Continued

Sample ID	Sample date	Sample time	Sample type	Chemical preservation	Analyzing laboratory	Nitrogen, ammonia		Nitrogen, nitrite		Nitrogen, nitrate		Nitrogen, ammonia + organic		Phosphorus, ortho	
						total (mg/L as N) (00610)	total (mg/L as N) (00615)	total (mg/L as N) (00620)	total (mg/L as N) (00625)	total (mg/L as P) (00665)	total (mg/L as P) (70507)				
SP-17	05-22-91	0919	CSREP	HgCl ₂	PaDER	0.02	<0.004	6.07	0.47	0.02	0.006				
SP-17	05-22-91	0920	CSREP	HgCl ₂	PaDER	.03	<.004	6.20	.51	.02	.006				
SP-17	05-22-91	0921	CSREP	H ₂ SO ₄	PaDER	.04	--	5.94	.55	.02	.009				
SP-17	05-22-91	0922	CSREP	H ₂ SO ₄	PaDER	.04	--	5.54	<.20	<.02	.006				
SP-17	05-22-91	0923	CSREP	H ₂ SO ₄	PaDER	.04	--	5.81	.20	.02	.007				
SP-33	05-01-90	1410	REG	HgCl ₂	PaDER	<.02	.004	5.41	.41	.03	.011				
SP-33	05-04-90	1315	REG	HgCl ₂	PaDER	<.02	.004	5.15	.45	.03	.010				
SP-33	05-10-90	1800	REG	HgCl ₂	PaDER	<.02	.004	5.02	.39	.03	.010				
SP-33	05-21-90	0850	REG	HgCl ₂	PaDER	<.02	.004	5.02	.43	.03	.012				
SP-33	05-21-90	1530	REG	HgCl ₂	PaDER	<.02	<.004	5.28	.47	.04	.010				
SP-33	05-22-90	0800	REG	HgCl ₂	PaDER	<.02	<.004	4.49	.41	.03	.010				
SP-33	05-29-90	0945	REG	HgCl ₂	PaDER	<.02	<.004	4.88	.43	.03	.012				
SP-33	05-29-90	1900	REG	HgCl ₂	PaDER	<.02	<.004	4.62	.47	.03	.018				
SP-33	05-30-90	0745	REG	HgCl ₂	PaDER	<.02	.004	4.75	<.20	.03	.010				
SP-33	05-31-90	0800	REG	HgCl ₂	PaDER	<.02	<.004	5.54	.39	.03	.011				
SP-33	06-21-90	1045	REG	HgCl ₂	PaDER	<.02	<.004	5.54	.47	.03	.009				
SP-33	07-11-90	1000	REG	HgCl ₂	PaDER	<.02	<.004	4.75	.39	.04	.013				
SP-33	07-13-90	0930	REG	HgCl ₂	PaDER	<.02	<.004	4.09	.31	.04	.012				
SP-33	07-31-90	0930	REG	HgCl ₂	PaDER	<.02	<.004	5.02	.37	.04	.020				
SP-33	08-08-90	0930	REG	NONE	PaDER	<.02	<.004	5.41	<.20	.02	.005				
SP-33	08-23-90	0930	REG	NONE	PaDER	.02	<.004	5.28	<.20	.03	.015				
SP-33	08-25-90	1015	REG	HgCl ₂	PaDER	<.02	<.004	5.02	.35	.03	.022				
SP-33	08-27-90	0945	REG	NONE	PaDER	<.02	.008	5.14	<.20	.03	.020				
SP-33	10-16-90	1115	REG	NONE	PaDER	.02	<.004	3.83	<.20	.03	.019				
SP-33	10-18-90	1215	REG	NONE	PaDER	<.02	<.004	5.57	<.20	.02	.014				
SP-33	11-19-90	1200	INTERLAB	HgCl ₂	NWGL	.03	.010	5.80	.90	.01	.020				
SP-33	11-19-90	1200	INTERLAB	NONE	PaDER	.03	<.004	5.41	<.20	.01	.020				
SP-33	12-04-90	1630	REG	NONE	PaDER	.02	<.004	5.81	<.20	.02	.004				
SP-33	01-04-91	1600	REG	NONE	PaDER	<.02	<.004	5.81	1.11	<.02	.012				
SP-33	01-29-91	1115	REG	NONE	PaDER	.02	<.004	5.94	.70	.04	.008				
SP-33	02-11-91	1415	REG	HgCl ₂	PaDER	.02	<.004	5.54	.84	.02	.006				
SP-33	02-28-91	1345	SEQREP	NONE	PaDER	.02	.006	6.53	.69	.02	.008				
SP-33	02-28-91	1346	SEQREP	HgCl ₂	PaDER	<.02	.004	6.53	.63	.02	.009				
SP-33	04-02-91	1230	SEQREP	NONE	PaDER	<.02	<.004	6.29	<.20	.02	.010				
SP-33	04-02-91	1231	SEQREP	HgCl ₂	PaDER	<.02	<.004	6.05	.66	.02	.010				

Table 9.--Nutrient-quality data for Alexanders and Mount Rock Spring basins, May 1, 1990, to September 12, 1991--Continued

Sample ID	Sample date	Sample time	Sample type	Chemical preservation	Analyzing laboratory	Nitrogen, ammonia total (mg/L as N) (00610)		Nitrogen, nitrite total (mg/L as N) (00615)		Nitrogen, nitrate total (mg/L as N) (00620)		Nitrogen, ammonia + organic total (mg/L as N) (00625)		Phosphorus ortho total (mg/L as P) (70507)	
						ammonia total	ammonia	nitrite total	nitrite	nitrate total	nitrate	ammonia + organic total	ammonia	ortho total	
SP-33	04-10-91	1230	CSREP	NONE	PaDER	<.02	<.004	6.05	0.22	6.05	0.22	0.02	<.010		
SP-33	04-10-91	1231	CSREP	NONE	PaDER	<.02	<.004	6.05	.26	6.05	.26	.03	<.010		
SP-33	04-10-91	1232	CSREP	NONE	PaDER	<.02	<.004	6.05	<.20	6.05	<.20	.02	<.010		
SP-33	04-10-91	1233	CSREP	HgCl ₂	PaDER	<.02	<.004	6.05	.67	6.05	.67	.02	<.010		
SP-33	04-10-91	1234	CSREP	HgCl ₂	PaDER	<.02	<.004	6.05	.67	6.05	.67	.03	<.010		
SP-33	04-10-91	1235	CSREP	HgCl ₂	PaDER	<.02	<.004	6.05	.76	6.05	.76	.02	<.010		
SP-33	04-10-91	1236	CSREP	H ₂ SO ₄	PaDER	<.02	--	5.81	<.20	5.81	<.20	.02	.010		
SP-33	04-10-91	1237	CSREP	H ₂ SO ₄	PaDER	<.02	--	5.81	.28	5.81	.28	.02	.010		
SP-33	04-10-91	1238	CSREP	H ₂ SO ₄	PaDER	<.02	--	5.81	.31	5.81	.31	.02	.010		
SP-33	04-21-91	1230	CSREP	NONE	PaDER	<.02	<.004	6.20	.39	6.20	.39	.02	<.002		
SP-33	04-21-91	1231	CSREP	NONE	PaDER	<.02	<.004	6.07	.37	6.07	.37	.02	.002		
SP-33	04-21-91	1232	CSREP	NONE	PaDER	<.02	<.004	6.07	<.20	6.07	<.20	.02	<.002		
SP-33	04-21-91	1233	CSREP	HgCl ₂	PaDER	.02	<.004	6.07	.74	6.07	.74	.02	<.002		
SP-33	04-21-91	1234	CSREP	HgCl ₂	PaDER	.02	<.004	6.07	.85	6.07	.85	.02	<.002		
SP-33	04-21-91	1235	CSREP	HgCl ₂	PaDER	.02	<.004	5.94	.85	5.94	.85	.02	<.002		
SP-33	04-21-91	1236	CSREP	H ₂ SO ₄	PaDER	.02	--	5.81	.48	5.81	.48	.02	.003		
SP-33	04-21-91	1237	CSREP	H ₂ SO ₄	PaDER	.02	--	5.81	.45	5.81	.45	.02	.004		
SP-33	04-21-91	1238	CSREP	H ₂ SO ₄	PaDER	<.02	--	5.68	.39	5.68	.39	.02	.004		
SP-33	05-07-91	1115	CSREP	NONE	PaDER	<.02	<.004	6.07	.22	6.07	.22	<.02	.003		
SP-33	05-07-91	1116	CSREP	NONE	PaDER	<.02	<.004	6.07	<.20	6.07	<.20	<.02	.003		
SP-33	05-07-91	1117	CSREP	NONE	PaDER	<.02	<.004	6.07	.69	6.07	.69	<.02	.003		
SP-33	05-07-91	1118	CSREP	HgCl ₂	PaDER	<.02	.004	6.07	.63	6.07	.63	<.02	.006		
SP-33	05-07-91	1119	CSREP	HgCl ₂	PaDER	<.02	<.004	5.54	.59	5.54	.59	<.02	.005		
SP-33	05-07-91	1120	CSREP	HgCl ₂	PaDER	<.02	<.004	5.94	.62	5.94	.62	<.02	.006		
SP-33	05-07-91	1121	CSREP	H ₂ SO ₄	PaDER	<.02	--	5.41	<.20	5.41	<.20	<.02	.008		
SP-33	05-07-91	1122	CSREP	H ₂ SO ₄	PaDER	<.02	--	5.68	<.20	5.68	<.20	<.02	.006		
SP-33	05-07-91	1123	CSREP	H ₂ SO ₄	PaDER	<.02	--	5.54	<.20	5.54	<.20	.02	--		
SP-33	05-22-91	0715	CSREP	NONE	PaDER	.05	.004	6.07	.30	6.07	.30	.02	.006		
SP-33	05-22-91	0716	CSREP	NONE	PaDER	.05	.004	6.07	.30	6.07	.30	.02	.005		
SP-33	05-22-91	0717	CSREP	NONE	PaDER	.03	.004	6.07	.30	6.07	.30	.02	.005		
SP-33	05-22-91	0718	CSREP	HgCl ₂	PaDER	.02	.004	6.07	.64	6.07	.64	.02	.006		
SP-33	05-22-91	0719	CSREP	HgCl ₂	PaDER	.02	.004	6.07	<.20	6.07	<.20	.02	.006		
SP-33	05-22-91	0720	CSREP	HgCl ₂	PaDER	.03	.004	6.07	.57	6.07	.57	.02	.006		
SP-33	05-22-91	0721	CSREP	H ₂ SO ₄	PaDER	.04	--	5.81	<.20	5.81	<.20	.02	.008		
SP-33	05-22-91	0722	CSREP	H ₂ SO ₄	PaDER	.04	--	5.81	<.20	5.81	<.20	.02	.007		

Table 9.--Nutrient-quality data for Alexanders and Mount Rock Spring basins, May 1, 1990, to September 12, 1991--Continued

Sample ID	Sample date	Sample time	Sample type	Chemical preservation	Analyzing laboratory	Nitrogen, ammonia		Nitrogen, nitrite		Nitrogen, nitrate		Nitrogen, ammonia + organic		Phosphorus, ortho	
						total (mg/L as N) (06610)	total (mg/L as N) (06615)	total (mg/L as N) (06620)	total (mg/L as N) (06625)	total (mg/L as P) (06665)	total (mg/L as P) (70507)				
SP-33	05-22-91	0723	CSREP	H ₂ SO ₄	PaDER	0.05	--	5.54	<0.20	0.02	0.006				
SP-34	08-20-90	1530	REG	NONE	PaDER	<.02	<.004	5.54	<.20	<.02	.011				
SP-34	08-21-90	0915	REG	NONE	PaDER	<.02	<.004	6.47	<.20	<.02	.009				
SP-34	08-22-90	0915	REG	NONE	PaDER	.02	<.004	5.68	<.20	.03	.009				
SP-34	08-23-90	0945	REG	NONE	PaDER	<.02	<.004	5.68	.38	.03	.008				
SP-34	08-25-90	1045	REG	HgCl ₂	PaDER	<.02	<.004	5.81	.21	.03	.013				
SP-34	08-27-90	1000	REG	NONE	PaDER	<.02	<.004	5.94	<.20	.02	.010				
SP-34	09-06-90	1500	REG	NONE	PaDER	.02	<.004	5.94	<.20	.02	.008				
SP-34	09-25-90	1300	REG	NONE	PaDER	<.02	<.004	5.81	<.20	.02	.013				
SP-34	10-16-90	1145	REG	NONE	PaDER	.02	<.004	2.90	<.20	<.02	.005				
SP-34	10-18-90	1245	REG	NONE	PaDER	<.02	<.004	6.05	<.20	.02	.007				
SP-34	11-19-90	1230	INTERLAB	HgCl ₂	NWQL	.02	.010	6.00	.30	<.01	<.010				
SP-34	11-19-90	1230	INTERLAB	NONE	PaDER	<.02	<.004	5.02	.30	<.01	<.005				
SP-34	12-04-90	1645	REG	NONE	PaDER	.02	<.004	5.15	<.20	<.02	.005				
SP-34	01-04-91	1630	REG	NONE	PaDER	<.02	<.004	6.05	.73	<.02	.015				
SP-34	01-29-91	1130	REG	NONE	PaDER	.02	<.004	5.68	.53	.03	.007				
SP-34	02-11-91	1430	SEQREP	HgCl ₂	PaDER	.02	<.004	5.81	1.01	.02	.005				
SP-34	02-11-91	1431	SEQREP	NONE	PaDER	.02	<.004	5.54	.25	.02	.004				
SP-34	02-28-91	1400	SEQREP	NONE	PaDER	<.02	.004	6.29	<.20	.02	.008				
SP-34	02-28-91	1401	SEQREP	HgCl ₂	PaDER	<.02	.004	6.53	.72	.02	.007				
SP-34	04-02-91	1300	SEQREP	NONE	PaDER	<.02	<.004	6.29	.28	.02	.010				
SP-34	04-02-91	1301	SEQREP	HgCl ₂	PaDER	<.02	<.004	5.32	.67	.02	.010				
SP-34	04-10-91	1245	CSREP	NONE	PaDER	<.02	<.004	6.05	.31	.02	<.010				
SP-34	04-10-91	1246	CSREP	NONE	PaDER	<.02	<.004	6.05	.21	.02	<.010				
SP-34	04-10-91	1247	CSREP	NONE	PaDER	<.02	<.004	6.05	.28	.02	<.010				
SP-34	04-10-91	1248	CSREP	HgCl ₂	PaDER	<.02	<.004	6.05	.88	.02	.010				
SP-34	04-10-91	1249	CSREP	HgCl ₂	PaDER	<.02	<.004	6.05	.55	.02	<.010				
SP-34	04-10-91	1250	CSREP	HgCl ₂	PaDER	<.02	<.004	6.05	.98	.02	<.010				
SP-34	04-10-91	1251	CSREP	H ₂ SO ₄	PaDER	<.02	--	6.05	.24	.02	.010				
SP-34	04-10-91	1252	CSREP	H ₂ SO ₄	PaDER	<.02	--	6.53	<.20	.02	.010				
SP-34	04-10-91	1253	CSREP	H ₂ SO ₄	PaDER	<.02	--	6.05	<.20	.02	<.010				
SP-34	04-21-91	1300	CSREP	NONE	PaDER	<.02	<.004	6.20	--	.02	.004				
SP-34	04-21-91	1301	CSREP	NONE	PaDER	<.02	<.004	6.07	<.20	.02	.003				
SP-34	04-21-91	1302	CSREP	NONE	PaDER	<.02	<.004	6.07	<.20	.02	.003				
SP-34	04-21-91	1303	CSREP	HgCl ₂	PaDER	<.02	<.004	6.07	.67	.02	.004				

Table 9.--Nutrient-quality data for Alexanders and Mount Rock Spring basins, May 1, 1990, to September 12, 1991--Continued

Sample ID	Sample date	Sample time	Sample type	Chemical preservation	Analyzing laboratory	Nitrogen, ammonia		Nitrogen, nitrite		Nitrogen, nitrate		Nitrogen, ammonia + organic		Phosphorus ortho	
						total (mg/L as N) (00610)	(mg/L as N) (00615)	total (mg/L as N) (00620)	total (mg/L as N) (00625)	total (mg/L as P) (00665)	total (mg/L as P) (70507)				
SP-34	04-21-91	1304	CSREP	HgCl ₂	PaDER	<.02	<.004	6.07	0.63	0.02	0.04	0.04	0.04	0.04	0.04
SP-34	04-21-91	1305	CSREP	HgCl ₂	PaDER	<.02	<.004	6.07	.75	.02	.04	.04	.04	.04	.04
SP-34	04-21-91	1306	CSREP	H ₂ SO ₄	PaDER	.02	--	5.68	<.20	.02	.05	.05	.05	.05	.05
SP-34	04-21-91	1307	CSREP	H ₂ SO ₄	PaDER	.02	--	5.68	<.20	.02	.04	.04	.04	.04	.04
SP-34	04-21-91	1308	CSREP	H ₂ SO ₄	PaDER	.02	--	5.81	<.20	.02	.04	.04	.04	.04	.04
SP-34	05-07-91	1200	CSREP	NONE	PaDER	<.02	<.004	5.94	.22	<.02	.03	.03	.03	.03	.03
SP-34	05-07-91	1201	CSREP	NONE	PaDER	<.02	<.004	6.07	.28	<.02	.03	.03	.03	.03	.03
SP-34	05-07-91	1202	CSREP	NONE	PaDER	<.02	<.004	6.07	.32	<.02	.03	.03	.03	.03	.03
SP-34	05-07-91	1203	CSREP	HgCl ₂	PaDER	<.02	<.004	6.07	.75	<.02	.07	.07	.07	.07	.07
SP-34	05-07-91	1204	CSREP	HgCl ₂	PaDER	<.02	<.004	6.07	.63	<.02	.06	.06	.06	.06	.06
SP-34	05-07-91	1205	CSREP	HgCl ₂	PaDER	<.02	<.004	6.07	.73	<.02	.04	.04	.04	.04	.04
SP-34	05-07-91	1206	CSREP	H ₂ SO ₄	PaDER	<.02	--	5.68	.36	<.02	.06	.06	.06	.06	.06
SP-34	05-07-91	1207	CSREP	H ₂ SO ₄	PaDER	<.02	--	5.68	.32	<.02	.06	.06	.06	.06	.06
SP-34	05-07-91	1208	CSREP	H ₂ SO ₄	PaDER	<.02	--	5.41	.32	<.02	.06	.06	.06	.06	.06
SP-34	05-22-91	0745	CSREP	NONE	PaDER	.04	<.004	6.07	<.20	.02	.05	.05	.05	.05	.05
SP-34	05-22-91	0746	CSREP	NONE	PaDER	.04	<.004	6.07	<.20	.02	.05	.05	.05	.05	.05
SP-34	05-22-91	0747	CSREP	NONE	PaDER	.02	<.004	6.07	<.20	.02	.04	.04	.04	.04	.04
SP-34	05-22-91	0748	CSREP	HgCl ₂	PaDER	.02	<.004	6.07	.52	.02	.06	.06	.06	.06	.06
SP-34	05-22-91	0749	CSREP	HgCl ₂	PaDER	.02	<.004	5.94	.68	.02	.06	.06	.06	.06	.06
SP-34	05-22-91	0750	CSREP	HgCl ₂	PaDER	.02	<.004	5.68	.46	.02	.05	.05	.05	.05	.05
SP-34	05-22-91	0751	CSREP	H ₂ SO ₄	PaDER	.03	--	5.94	.22	.02	.08	.08	.08	.08	.08
SP-34	05-22-91	0752	CSREP	H ₂ SO ₄	PaDER	.03	--	5.81	<.20	.03	.09	.09	.09	.09	.09
SP-34	05-22-91	0753	CSREP	H ₂ SO ₄	PaDER	.04	--	5.54	<.20	.02	.06	.06	.06	.06	.06
USEPA N1	09-06-90	1515	STD	NONE	PaDER	5.61	--	6.29	--	--	1.08	1.08	1.08	1.08	1.08
USEPA N1	11-20-90	0800	STD	NONE	PaDER	5.39	--	6.29	--	--	1.12	1.12	1.12	1.12	1.12
USEPA N2	10-16-90	2000	STD	NONE	PaDER	--	--	--	.49	.16	--	--	--	--	--
USEPA N2	11-20-90	0830	STD	NONE	PaDER	--	--	--	.69	.16	--	--	--	--	--
DD	09-06-90	1400	BLANK	NONE	PaDER	.04	<.004	.04	<.20	.02	.04	.04	.04	.04	.04
DI	05-07-91	1045	BLANK	NONE	PaDER	<.02	<.004	<.04	<.20	<.02	<.02	<.02	<.02	<.02	<.02
DI	05-07-91	1046	BLANK	HgCl ₂	PaDER	<.02	<.004	<.04	<.20	<.02	<.02	<.02	<.02	<.02	<.02
DI	05-07-91	1047	BLANK	H ₂ SO ₄	PaDER	<.02	--	--	<.20	<.02	<.02	<.02	<.02	<.02	<.02
DI	09-12-91	1200	BLANK	HgCl ₂	PaDER	.02	<.004	<.04	.21	<.02	<.02	<.02	<.02	<.02	<.02
DI	09-12-91	1201	BLANK	HgCl ₂	PaDER	.02	<.004	<.04	.24	<.02	<.02	<.02	<.02	<.02	<.02
DI	09-12-91	1202	BLANK	HgCl ₂	PaDER	.03	<.004	<.04	<.20	<.02	<.02	<.02	<.02	<.02	<.02
DI	09-12-91	1203	BLANK	HgCl ₂	PaDER	.03	<.004	<.04	<.20	<.02	<.02	<.02	<.02	<.02	<.02

Table 9.--Nutrient-quality data for Alexanders and Mount Rock Spring basins, May 1, 1990, to September 12, 1991--Continued

Sample ID	Sample date	Sample time	Sample type	Chemical preservation	Analyzing laboratory	Nitrogen, ammonia total (mg/L as N) (00610)		Nitrogen, nitrite total (mg/L as N) (00615)		Nitrogen, nitrate total (mg/L as N) (00620)		Nitrogen, ammonia + organic total (mg/L as N) (00625)		Phosphorus ortho total (mg/L as P) (70507)	
						ammonia total	nitrite total	nitrate total	ammonia + organic total	Phosphorus total					
SRWS N30	05-22-91	1400	STD/CSREP	NONE	PaDER	0.22	0.170	0.38	0.32	0.29	0.276				
SRWS N31	05-22-91	1401	STD/CSREP	NONE	PaDER	.58	.324	1.24	.66	2.22	1.398				
SRWS N30	05-22-91	1403	STD/CSREP	HgCl ₂	PaDER	.22	.098	.32	.89	.29	.263				
SRWS N30	05-22-91	1404	STD/CSREP	HgCl ₂	PaDER	.21	.096	.32	.74	.29	.261				
SRWS N31	05-22-91	1402	STD/CSREP	HgCl ₂	PaDER	.59	.148	1.35	1.29	1.86	1.548				
SRWS N31	05-22-91	1405	STD/CSREP	HgCl ₂	PaDER	.58	.154	1.32	1.40	1.68	1.512				
SRWS N30	05-22-91	1406	STD/CSREP	H ₂ SO ₄	PaDER	.23	.144	.12	.36	.30	.286				
SRWS N31	05-22-91	1407	STD/CSREP	H ₂ SO ₄	PaDER	.57	.264	1.00	.74	1.86	1.512				
SRWS N30	09-12-91	1204	STD/CSREP	HgCl ₂	PaDER	.23	.044	.37	.54	.28	.259				
SRWS N30	09-12-91	1205	STD/CSREP	HgCl ₂	PaDER	.23	.050	.37	.56	.28	.259				
SRWS N30	09-12-91	1206	STD/CSREP	HgCl ₂	PaDER	.23	.050	.37	.60	.28	.256				
SRWS N30	09-12-91	1207	STD/CSREP	HgCl ₂	PaDER	.23	.052	.37	.53	.28	.259				
SRWS N30	09-12-91	1208	STD/CSREP	HgCl ₂	PaDER	.25	.052	.37	.46	.28	.257				
SRWS N30	09-12-91	1209	STD/CSREP	HgCl ₂	PaDER	.24	.052	.37	.56	.28	.259				
SRWS N30	09-12-91	1210	STD/CSREP	HgCl ₂	PaDER	.23	.046	.37	.45	.28	.260				
SRWS N30	09-12-91	1211	STD/CSREP	HgCl ₂	PaDER	.25	.050	.37	.52	.28	.261				
SRWS N31	09-12-91	1212	STD/CSREP	HgCl ₂	PaDER	.59	.066	1.32	1.00	1.50	1.500				
SRWS N31	09-12-91	1213	STD/CSREP	HgCl ₂	PaDER	.59	.064	1.32	.88	1.62	1.560				
SRWS N31	09-12-91	1214	STD/CSREP	HgCl ₂	PaDER	.59	.060	1.33	.95	1.54	1.540				
SRWS N31	09-12-91	1215	STD/CSREP	HgCl ₂	PaDER	.59	.064	1.37	1.02	1.66	1.520				
SRWS N31	09-12-91	1216	STD/CSREP	HgCl ₂	PaDER	.60	.064	1.34	.92	1.64	1.480				
SRWS N31	09-12-91	1217	STD/CSREP	HgCl ₂	PaDER	.59	.064	1.34	1.05	1.62	1.560				
SRWS N31	09-12-91	1218	STD/CSREP	HgCl ₂	PaDER	.59	.060	1.35	.90	1.56	1.560				
SRWS N31	09-12-91	1219	STD/CSREP	HgCl ₂	PaDER	.62	.062	1.35	1.08	1.52	1.500				

Table 10.--Nutrient-quality data for wells in the Alexanders and Mount Rock Spring basins, March 11-22, 1991

[USGS, U.S. Geological Survey; mg/L, milligrams per liter; <, less than]

USGS well number	Station number	Date	Nitrogen, ammonia total (mg/L as N) (00610)	Nitrogen, nitrite total (mg/L as N) (00615)	Nitrogen, nitrate total (mg/L as N) (00620)	Nitrogen, ammonia + organic total (mg/L as N) (00625)	Phosphorus total (mg/L as P) (00665)	Phosphorus ortho total (mg/L as P) (70507)
Cu-461	400919077180801	03-13-91	0.030	<0.004	2.3	<0.20	0.020	<0.020
549	401032077143701	03-11-91	<.020	<.004	9.64	.61	<.020	<.020
838	400922077150601	03-11-91	<.020	<.004	6.34	.85	<.020	<.020
839	400953077163901	03-11-91	<.020	<.004	6.47	.83	<.020	<.020
840	401011077170501	03-12-91	.020	<.004	5.54	1.3	.020	<.020
841	401010077170701	03-12-91	<.020	<.004	6.34	.81	.020	<.020
842	401033077162801	03-12-91	<.020	<.004	3.70	.83	.020	<.020
843	400946077165001	03-12-91	<.020	<.004	3.43	.72	.020	<.020
844	400754077184801	03-12-91	<.020	<.004	4.22	.83	.030	.020
845	400708077185501	03-12-91	<.020	<.004	4.09	.37	<.020	<.020
846	400707077185501	03-12-91	<.020	<.004	.68	.58	<.020	<.020
847	400938077190001	03-12-91	<.020	<.004	4.62	.94	<.020	<.020
848	400809077164701	03-13-91	<.020	<.004	7.02	1.2	.020	<.020
849	400808077162001	03-13-91	<.020	<.004	16.0	.32	.020	<.020
850	400829077161201	03-13-91	<.020	<.004	8.23	.44	.020	<.020
851	400827077161301	03-13-91	<.020	<.004	7.99	.72	.020	<.020
852	400813077173201	03-13-91	<.020	<.004	8.71	.24	.020	<.020
853	400818077173001	03-13-91	.020	<.004	11.1	<.20	.020	<.020
854	400838077160201	03-13-91	.020	<.004	7.26	<.20	.020	<.020
855	400840077175401	03-13-91	.030	<.004	12.3	<.20	.020	<.020
856	400945077161101	03-14-91	<.020	<.004	14.7	.21	.020	<.020
857	401004077185701	03-13-91	<.020	<.004	4.11	<.20	.020	<.020
858	400958077183901	03-14-91	<.020	<.004	5.57	.28	.020	<.020
859	401012077183901	03-14-91	<.020	<.004	5.32	.28	<.020	<.020
860	401110077184101	03-14-91	<.020	<.004	7.26	.60	--	--
861	401013077191601	03-14-91	<.020	<.004	4.84	.36	<.020	<.020
862	400850077184801	03-14-91	<.020	<.004	2.38	<.20	<.020	<.020
863	400800077192001	03-14-91	<.020	.004	7.50	.28	<.020	<.020
864	401005077132101	03-20-91	.030	<.004	3.43	.41	.020	<.020
865	401008077133201	03-20-91	.050	<.004	4.36	.45	.020	<.020
861	401013077191601	03-14-91	<.020	<.004	4.84	.36	<.020	<.020
862	400850077184801	03-14-91	<.020	<.004	2.38	<.20	<.020	<.020
863	400800077192001	03-14-91	<.020	.004	7.50	.28	<.020	<.020
864	401005077132101	03-20-91	.030	<.004	3.43	.41	.020	<.020
865	401008077133201	03-20-91	.050	<.004	4.36	.45	.020	<.020

**Table 10.--Nutrient-quality data for wells in the Alexanders and
Mount Rock Spring basins, March 11-22, 1991--Continued**

USGS well number	Station number	Date	Nitrogen,	Nitrogen,	Nitrogen,	Nitrogen,	Phosphorus	Phosphorus
			ammonia total (mg/L as N) (00610)	nitrite total (mg/L as N) (00615)	nitrate total (mg/L as N) (00620)	ammonia + organic total (mg/L as N) (00625)	total (mg/L as P) (00665)	ortho total (mg/L as P) (70507)
Cu-866	400958077140701	03-20-91	0.030	<0.004	14.8	0.60	0.040	<0.020
867	400923077150201	03-20-91	.020	<.004	6.07	.43	.020	<.020
868	400920077144001	03-20-91	.020	<.004	5.15	.31	.020	<.020
869	400951077162301	03-20-91	.020	<.004	7.26	.20	.020	<.020
870	400927077194001	03-20-91	.030	.004	35.1	.49	.040	.020
871	400944077200201	03-20-91	.020	<.004	10.6	.24	.020	<.020
872	400945077202201	03-20-91	<.020	<.004	12.1	.45	.020	<.020
873	400939077201701	03-20-91	<.020	.006	7.26	.60	.020	<.020
874	400958077161901	03-20-91	<.020	<.004	6.29	.53	.020	<.020
875	400746077171901	03-21-91	.020	.004	6.05	.35	.020	<.020
876	400845077203901	03-21-91	.020	.004	6.78	.54	.020	<.020
877	400954077180801	03-21-91	.020	<.004	6.78	.20	.020	<.020
878	400907077165801	03-21-91	.020	<.004	8.23	.50	<.020	<.020
		03-21-91	<.020	<.004	7.74	.43	<.020	<.020
879	400910077164201	03-21-91	<.020	<.004	7.02	.39	.020	<.020
		03-21-91	<.020	<.004	7.02	.52	<.020	<.020
880	400903077163301	03-21-91	<.020	<.004	7.26	<.20	<.020	<.020
881	400900077152801	03-21-91	.020	.004	6.29	.68	<.020	<.020
882	401042077143401	03-22-91	<.020	<.004	4.60	.50	.020	<.020
		03-22-91	<.020	<.004	4.84	.31	.020	<.020
883	401044077142201	03-22-91	.020	<.004	5.08	.37	<.020	<.020
		03-22-91	.020	<.004	4.36	.72	<.020	<.020
884	400748077162001	03-21-91	<.020	.004	7.02	<.20	.020	<.020
885	400953077181101	03-21-91	<.020	<.004	7.02	.69	.020	<.020