QUALITY-ASSURANCE AND QUALITY-CONTROL PROCEDURES FOR AN URBAN WATER-QUALITY MONITORING PROGRAM, GWINNETT COUNTY, GEORGIA

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Abstract. The U.S. Geological Survey develops quality-assurance and quality-control procedures so that its water-quality data are of the highest possible quality and represent stream conditions. These procedures include personnel training, database management, cleaning equipment, blank sampling, concurrent point and cross-section sampling, concurrent replicate samples, and split replicate samples. The U.S. Geological Survey and Gwinnett County Watershed Monitoring program require one of two methods when collecting water-quality samples: the Equal-Width-Increment (EWI) method or automatic point sampler method. In order to obtain a representative sample during a storm, it is preferable to collect samples using the EWI method. This method collects several points along the stream cross section and at several times during the storm hydrograph. Because of the large labor requirements and difficulty in sampling storm flows consistently, EWI samples are often not practical; an alternative is to obtain a composite sample that represents the entire hydrograph using an automatic point sampler. The USGS uses quality-assurance and quality-control procedures in the Gwinnett County Watershed Monitoring program to assure that automatic point samples provide accurate, uncontaminated, and representative EWI samples.

INTRODUCTION

The U.S. Geological Survey (USGS), in cooperation with Gwinnett County, Department of Public Utilities, established a water-quality monitoring program in 1996. The Gwinnett County Watershed Monitoring (GCWM) program provides information that can aid land and water-resource managers in making resource management decisions that can affect water quality. This monitoring program includes the development of a network of real-time, continuous water-quality stations, augmented with intensive water-quality sampling and analysis of likely contaminants.

In order to collect accurate water-quality data for the GCWM program, the USGS has developed quality-assurance and quality-control (QA/QC) procedures. These procedures ensure that the equipment and procedures used to collect a water sample represent conditions within the stream. The QA specifies the procedures used to collect water-quality samples, the correct equipment, proper cleaning and storage of equipment, sample handling and processing, and the use and frequency of QC samples.

Several types of QC data are collected: equipment blanks and concurrent samples, concurrent replicate samples, and split replicate samples. These QC methods are used on the GCWM program in Gwinnett County, Georgia, where storm composite samples are collected across the runoff hydrograph using automatic point samplers. This paper will focus on equipment blanks and concurrent samples and shows results of the QA/QC data collected from 1997 to 2002 in six watersheds in Gwinnett County, Georgia.

SAMPLE METHODS

The USGS monitors urban water quality at six stations in Gwinnett County using automatic point samplers. Urban streams often have a rapid response to rainfall, making it difficult to manually sample the initial flush of runoff from the watershed. Automatic point samplers provide the opportunity to sample the initial rise, as well as the complete hydrograph at multiple sites during the same rainfall event. Two of several specific types QC samples called by the GCWM program QA plan are: equipment blanks and concurrent samples.

Equipment Blanks

Blank water, a solution free of analyte(s) of interest at a specified detection level, is used to evaluate the cleaning procedures used for cleaning the automatic point samplers (Wilde and others, 1998). In the GCWM program, equipment blanks indicate if there is any potential for contaminating the environmental sample. Table 1 shows the results of 22 blank samples that were collected by the six different automatic point samplers installed on the GCWM program from 1997 to 2002.

All 22 equipment blanks were analyzed individually for the number of detections and for the average detected concentration. Shown in Table 1 are the specified detection limits of the laboratory method used to analyze the samples. The final column shows the range of the average storm sample concentrations for each of the six watersheds from 1997 to 2002. The equipment blank results show that there is no detectable contamination introduced by use of the automatic point samplers for total suspended solids, total NO_2+NO_3 as nitrogen (N), and total phosphorus as phosphorus (P), total unfiltered copper, total unfiltered lead. One out of 20 equipment blanks (5 percent) were contaminated with total dissolved solids. The average contamination concentration of total dissolved solids, 4.0 milligram per liter (mg/L) is below the range of typical storm sample concentrations. Eight out of 22 equipment blanks (36 percent) were contaminated with zinc. The average contamination concentration of zinc, 9.7 microgram per liter (µg/L) is below the range of typical storm sample concentrations. The GCWM program is continuing to modify cleaning procedures to eliminate contamination.

Concurrent Samples

Concurrent QC samples ensure that water-quality samples, collected by the automatic point sampler are representative of the stream cross-section conditions. Water-quality samples are collected concurrently, both manually and automatically, usually during the recession of a runoff hydrograph. The recession of the runoff hydrograph is likely to be well mixed, and less affected by temporal variation than is the rapid rise in flow. Manual samples are collected using the Equal-Width-Increment (EWI) method. Automatic samples are triggered simultaneously, and water is pumped through flexible plastic tubing from a single point in the stream. Comparisons between the two data sets are then made to evaluate how well the automatic point sample reflects the cross section. The following analysis is from a direct comparison of nutrient, total suspended solids, total dissolved solids, and total zinc from 10 concurrent samples collected at the 6 gaging stations on the GCWM program for the period from 2000 to 2002.

RESULTS FROM CONCURRENT SAMPLES

Plots of EWI sample versus point sample data are shown in Figure 1*A* through 1*D*; an equal-value line is shown for reference to relate where the automatic sample point concentrations would equal the EWI sample concentrations. Cross-section measurements during variable flow conditions are required to determine if discharge or seasonal changes significantly affect the distribution of constituent values in the cross section (Wagner and others, 2000). Stream water that is well mixed should show a linear relation between concurrent samples.

Table 1. Summary of equipment blank data for automatic sampling equipment and churn splitter

[<, less than; mg/L, milligram per liter; µg/L, microgram per liter; —, not applicable]

Parameter	Number of blanks	Number of blanks to fall below detection levels	Number of hits	Average contamination concentration	Detection limits	Average storm sample concentration
Total suspended solids	21	21	0	—	<1 mg/L	320–510 mg/L
Total dissolved solids	20	19	1	4 mg/L	<1 mg/L	38–67 mg/L
Total NO2+NO3 as nitrogen (N)	21	21	0	—	<.02 mg/L	0.4–1.1 mg/L
Total phosphorus as phosphorus (P)	21	21	0	—	<.02 mg/L	0.19–0.3 mg/L
Total unfiltered copper	22	22	0	—	<1 or <2 µg/L	3.0–14.0 µg/L
Total unfiltered zinc	22	14	8	9.7 µg/L	<1 or <2 µg/L	27.0–100.0 µg/L
Total unfiltered lead	22	22	0	—	<1 or <2 µg/L	10.0–16.0 µg/L

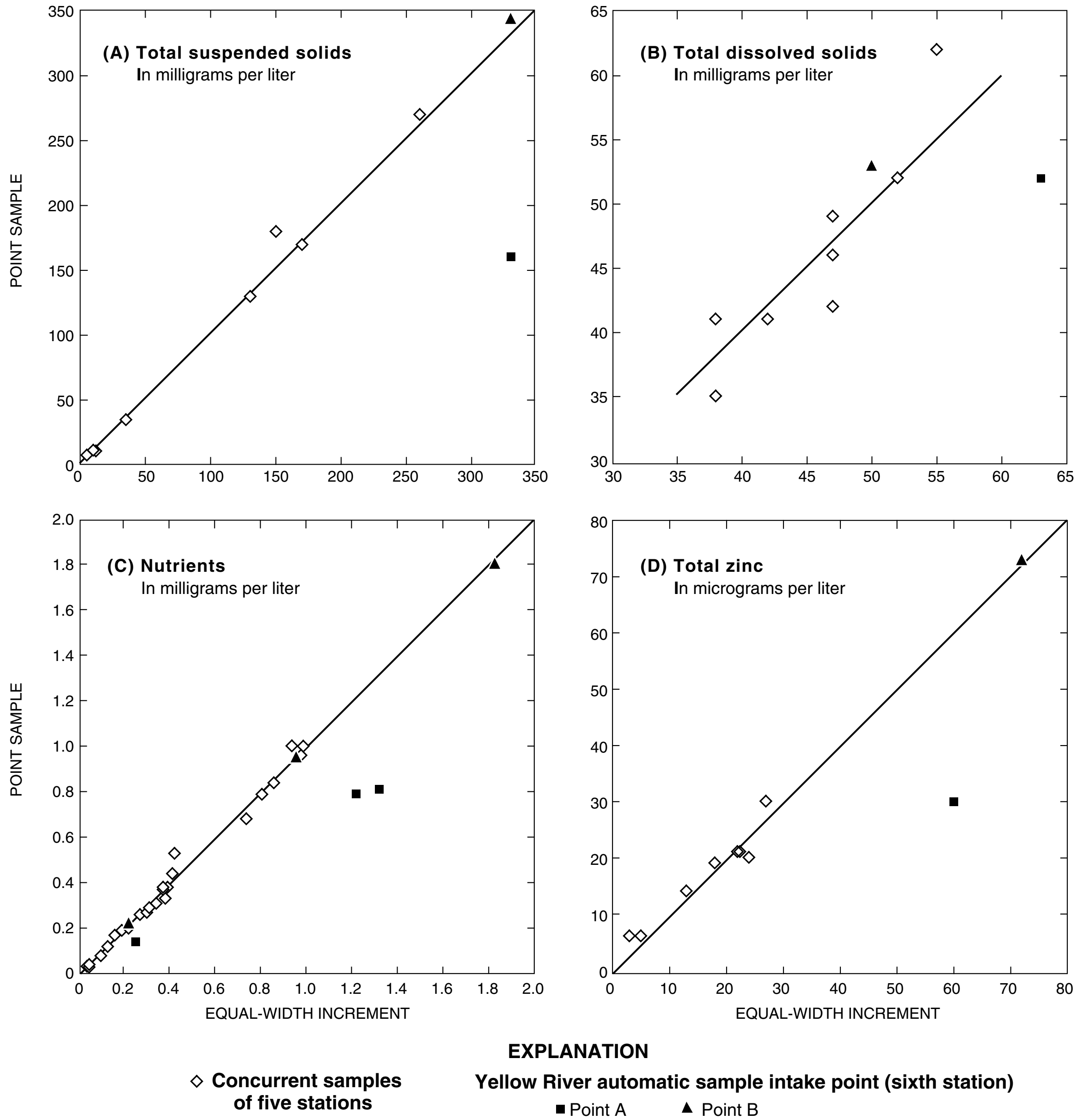

Figure 1. Point sample plotted against equal-width increment for *(A)* total suspended solids, *(B)* total dissolved solids, *(C)* nutrients, and *(D)* total zinc, comparing concurrent samples from six sites in Gwinnett County, Georgia.

Choosing the best point for an automatic sampler is essential. The point needs to be well mixed and representative of the average conditions in the cross section and river basin. Figure 1*A* through 1*D* shows a linear trend but also contain outliers. The largest outliers were collected at the Yellow River automatic sampler intake point A (ASIP A), a point not well mixed. Yellow River ASIP A was selected during a time of extensive bridge construction. The original sampling point coincided with the proposed bridge site, so the sampler was moved downstream to ASIP A. During a site inspection at high flow, it was observed that ASIP A was affected by a nearby tributary carrying runoff from the construction of the new bridge and was not mixed with the Yellow River cross section. In this concurrent sample the cross section for the EWI was taken from the downstream side of the new bridge just upstream from the effects of tributary and was more representative of Yellow River and of the basin. The results of the concurrent sample of Yellow River ASIP A are between 17.5 to 51 percent off the equal-value line for total suspended solids, total dissolved solids, nutrients, and total zinc. When the bridge construction was complete, Yellow River ASIP A was moved upstream to Yellow River ASIP B, on the downstream side of the new bridge. Yellow River ASIP B is more representative of the entire cross section and the water quality of the Yellow River basin. The results of the concurrent sample of Yellow River ASIP B are between 1 to 5 percent of the equal-value line for total suspended solids, total dissolved solids, nutrients, and total zinc.

Concurrent sample data collected at the other five stream stations plot close to the equal-value line in Figure 1*A* through 1*D*. The largest outliers come from a concurrent sample collected during baseflow when there is typically poor stream mixing compared to storm events.

CONCLUSION

The USGS has developed QA/QC procedures for use in the Gwinnett County QCWM program in collecting accurate water-quality data using automatic point samplers. The use of automatic point samplers is critical to collecting urban water-quality data at times when manual samples are difficult and unobtainable. However, rigorous QA/QC is imperative when using automatic point samplers. Equipment blanks need to be collected and analyzed to ensure that inefficient or improper cleaning of automatic point samplers does not compromise water-quality data. In addition, because automatic point samplers are used to collect a point sample from storm runoff in urban watersheds at a point that is well representative of the entire cross section, one must collect concurrent samples to correlate the point sampler with EWI samples.

LITERATURE CITED

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