QUALITY ASSURANCE PROJECT PLAN
(Revised May 1993; April 1995)
for
THE INLAND BAYS ESTUARY PROGRAM CITIZEN MONITORING PROJECT

prepared by

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for

The United States
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Region III

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1. PROJECT NAME: The Inland Bays Estuary Program Citizen Monitoring Project

2. PROJECT REQUESTED BY: U.S. EPA Region III

3. DATE OF REQUEST: April 7, 1991; Updated and Revised May 10, 1993, February 12, 2009.

4. DATE OF PROJECT INITIATION: October 1, 1990

5. PROJECT OFFICER: Robert C. Runowski, EPA Region III
   LOCAL PROJECT DIRECTOR: Joseph G. Farrell, Univ. of Delaware SGMAS
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6. QA OFFICER: Charles Jones Jr., QA Officer EPA Region III

7. PROJECT DESCRIPTION

Objective and Statement of Scope

As part of the National Estuary Program, broad goals and objectives are being developed to preserve the living resources and water quality of the bays. A major component of the Inland Bays Estuary Program (IBEP) is public participation as the Comprehensive Conservation and Management Plan (CCMP) is being developed. The CCMP is scheduled for completion by Fall 1993.

One area of public involvement that can provide significant impacts and major benefits in Delaware is citizen monitoring. Citizen monitoring is not unique to Delaware's Inland Bays. Many programs have emerged across the country where volunteers collect water quality information and also become part of the involved constituency committed to protecting aquatic resources. These programs have demonstrated that trained volunteers can collect reliable data.

The goals of this Citizen Monitoring Program are, first, to collect verifiable water quality data to be used to support public policy decisions with regard to the management of the Inland Bays and, second, to increase public participation and support for the protection and management of these resources.

Over the last four years the Inland Bays Citizen Monitoring Program has established:

- the feasibility of instituting citizen monitoring programs;

- the ability of citizen monitors to deliver data of known quality and provide observational information about the area monitored;

- the creation of standardized sampling procedures, and reporting formats; and

- the public interest value of the citizen monitoring program and the increased knowledge and understanding of the volunteers because of their participation.

Building on this success, we believe citizen monitors can make important contributions to our knowledge of the Inland Bays.

<u>Data Usage</u>

Department of Natural Resources and Environmental Control (DNREC) staff have expressed strong interest in obtaining data generated by citizen volunteers. In 1992 the state included the data obtained by our volunteers in their 305B report to the EPA. Department of Health and Social Services, Division of Public Health, and University of Delaware, College of Marine Studies (CMS) scientists have also expressed interest in obtaining accurate data generated by our monitoring program focused on specific environmental problems.

More specifically, the data collected in this project can be used to further assist in determining seasonal and other temporal trends and evaluating the water quality status of the Inland Bays. These data can supplement the data collected by the state water quality monitoring programs in the bays. A volunteer monitoring program that can deliver data of known quality can augment existing monitoring programs by:

- providing general long-term trend data in areas which are not routinely monitored;

- providing more frequent sampling to yield time-series data with the large number of points required to establish response and lag times in changes;

- capturing short-lived phenomena of interest (e.g. storms);

- providing observational information on weather, living resources, and site conditions; and

- answering short-term research questions.

Design and Rationale

The data to be collected was decided upon in consultation with DNREC and CMS staff and other citizen monitoring programs. These parameters include: dissolved oxygen, water and air temperature, tidal datum, pH, salinity, turbidity, nitrate-nitrogen, phosphate, bacteria and rainfall.

Data collection points are selected in order to provide a representative sample of Inland Bays near shore environments. Previous studies[1] have determined the relative abundances of these environments, and this data was considered when assigning locations to monitors. It is recognized, however, that there are limitations in the distance which citizen monitors will travel, and the most dedicated volunteers have been those that are collecting data at or near their home.

Table 1.   Monitoring Parameters and Collection Frequency

Parameter	Collection Frequency	Method/Instrument
Temperature	Weekly	Thermometer
Turbidity	Weekly	Secchi Disk
Salinity	Weekly	Hydrometer
Dissolved Oxygen	Weekly	Micro-Winkler Titration
pH	Weekly	Digital Meter
Nitrates	Semimonthly	Laboratory Analysis
Phosphate	Semimonthly	Laboratory Analysis
Bacteria	Monthly	Laboratory Analysis
Rainfall	Daily	Rain Gauge

[1] Swisher, Mary Lou, 1982, The Rates and Causes of Shore Erosion Around a Transgressive Coastal Lagoon, Rehoboth Bay, Delaware, M.S. Thesis, University of Delaware.

8. PROJECT FISCAL INFORMATION

Please see the proposal, "Inland Bays Estuary Program: Citizen Monitoring Project" previously submitted to the EPA.

9. SCHEDULE OF TASKS AND PRODUCTS

Recruit and Train Volunteers (January 1 - ongoing)

- Introduce volunteers to citizen monitoring program.
- Hold training workshops as needed for new monitors.

Citizen Monitoring (January 1 -December 31)

- Coordinate citizen data collection year round. Data collected weekly April 1 to October 15 and semimonthly from October 16 to March 31.
- Pick up nutrient samples semimonthly and bacteria samples monthly.

Data Management (January 1 - ongoing)

- Data is entered on a 486DX using Paradox for Windows database management system and is available to users in various formats. In Dos: Lotus 123 v.2.2, and Quattro Pro 4.0. In Windows: Paradox for Windows 4.5 and Quattro Pro for Windows 5.0. Regular reports are provided to citizen monitors, resource managers, and CMS scientists.

Quality Assurance (January 1 - ongoing)

- Hold quality control sessions every six months (April and October) to help assess accuracy of tests and effectiveness of training.
- Conduct field inspections of monitors unable to attend QA/QC sessions or showing substandard performance.

10. PROJECT ORGANIZATION AND RESPONSIBILITY

Joseph G. Farrell, Marine Resource Management Specialist at the University of Delaware Sea Grant Marine Advisory Service (SGMAS), is the project manager and will report to the EPA. Part-time field coordinator, Reneé J. Karrh, assists the project manager as field coordinator, quality assurance officer, and database manager.

11. DATA QUALITY REQUIREMENTS AND ASSESSMENTS

Precision and Accuracy[2]

The initial testing of several methods used in this program was conducted at the EPA Central Regional Laboratory, Annapolis, MD under the supervision of the Chesapeake Bay Program quality assurance officer and various other chemists and technicians. It was not felt necessary to duplicate their results, so this information is included where appropriate. Where results from the Delaware program have become available this data has been revised as necessary.

Table 2. Sensitivity, Precision, Accuracy, and Range of Tests

	Sensitivity	Precision	Accuracy	Range
Thermometer	0.5 °C	±1.0 °C	±0.5 °C	-5 to +45 °C
pH Meter	0.1 pH	±0.4 pH	±0.2 pH	0 to 14 pH
Hydrometer	0.1 ppt	±1.0 ppt	±0.82 ppt	0.0 to > 100 ppt
Dissolved Oxygen Test	0.1 mg/L	±0.9 mg/L	±0.3 mg/L	0.0 mg/L and up
Secchi Disk	0.05 m	±0.15 m	N/A	N/A

Values reported are averages over more than one test group.

DISSOLVED OXYGEN. Testing kits from several manufacturers were compared by ACB staff with results obtained from Standard Winkler titrations and with Y.S.I. probes. The LaMotte kit proved to be more accurate than similar tests and was less expensive than comparably accurate tests.

The bias in DO values determined with the LaMotte kit was reported as n mg/l. This was arrived at by carrying out a paired t analysis of the standard deviation of the mean difference between results of four paired measurements with the Kit and a Standard Winkler titration.

The precision of dissolved oxygen measurements obtained with the LaMotte micro-Winkler kit was stated as n mg/l ± 0.9 and was developed from a Precision Control Chart (Shewhart Construction Method). This chart was based on replicate

[2]For a more detailed description of the determination of the precision and accuracy of many of these tests see the Quality Assurance and Quality Control plan of the ACB.

samples taken by the ACB monitoring coordinator over a period of time. It computed an upper warning limit of 0.68 and an upper control limit of 0.9. Monitors titrate two samples at each sampling time. They are instructed to do a third titration if the difference between the first two is greater than 0.6 mg/l. The average of the two closer values is recorded. If values greater than 0.6 ppm apart are reported with no third test done, the results are not entered in the file. If a volunteer consistently reports values that are beyond the warning limit he/she is called to determine the cause of the problem. A site visit may be deemed necessary.

The precision of the DO data reported by the ACB was based on methods of testing how well the group of monitors agreed with a given reference standard. At the first ACB QC sessions a Y.S.I. DO meter was used as a reference. The mean and standard deviation of the differences between the meter and individual monitors was 0.40 ± 0.263 mg/l for one group of 0.270 ± 0.237 mg/l for the other group. These values may be expressed as a ratio of the mean of the absolute differences to the baseline (meter reading): Group 1--4.7 ± 3.1%; Group 2--3.5 ± 2.8%.

At subsequent sessions the ACB used the result obtained by their coordinator using a LaMotte kit as the reference standard. The ratios of the mean of individual measurements to the reference standard for four groups was 95% ± 2.4%, 92% ± 3.9%, 104% ± 1.5%, and 103% ± 4.9%. These ratios, which correspond to % Recovery (R), fall within the calculated warning limits of 86-118%R.

The titrating reagent used in Winkler titrations for dissolved oxygen is sodium thiosulfate. The ACB was concerned about the results of inexperienced volunteers using this reagent under conditions that precluded titrating against a standard each time a test was conducted. MAS plans to follow the ACB plan for ensuring the proper usage of this reagent. Their monitors are told to keep the reagents in their kit box in the dark and cool. They are cautioned about possible contamination and instructed in how to prevent it--never return any unused titrant to the storage bottle and thoroughly rinse all equipment after each use.

NITRATE AND ORTHOPHOSPHATE. After field testing the LaMotte nitrate and phosphate test kits for a period greater than a year, we chose to discontinue using the field kits, because the levels of nutrients found in the Inland Bays generally is below the detection levels for those kits. The monitors currently obtain a water sample every other week during their normal sampling routine and save it in the refrigerator until the Field Coordinator picks it up for analysis. Testing is done at CMS using the protocol set up by Dr. William Ullman, and PhD. candidate Susan Welch.   Dissolved nitrate-nitrite and orthophosphate concentrations are determined using an autoanalyzer.

The expected total variability for replicate analysis is 2-5%. The precision of nutrient analysis will be determined on at least one replicate analysis during each analytical run. If the difference between replicates is outside that expected for the particular analysis, an additional aliquot portion will be analyzed or the analytical work will be repeated.

The methods of nutrient analysis to be used measure reactive concentrations. Comparison to standard solutions is sufficient to demonstrate accuracy. There are some systematic errors associated with the variation in salinity of samples collected in estuaries. These affect the analysis of NH_4^+, NO_3^-, and $NO_3^-+NO_2^-$, using the automated methods. These systematic errors are comparable to the random errors and are likely to be important only at the lowest concentrations to be measured.[3]

TEMPERATURE MEASUREMENT. At the beginning of the ACB project, 49 armored thermometers reading from -5 °C to 45 °C were calibrated using NBS calibrated thermometers. The field (LaMotte) thermometers were placed in three water baths: 1) an ice bath; 2) large beaker of water that had been placed in a 20° incubator overnight and; 3) large beaker of water that had been placed in a 36° incubator overnight. At least two readings were taken on each thermometer.

The average difference between the "corrected readings" and readings of the certified thermometer over a range of 0-36°C was ±0.190°C. Since the thermometers read no closer than to 0.5 °C, they concluded that the error in any individual thermometer does not add sufficient bias to warrant the use of individual correction factors, or, for that matter, the use of any correction factor. Temperature measurements taken during the second quality control session, however, show a standard deviation of only 0.3°C. While this says nothing about the accuracy of any individual thermometer, it at least implies a reasonable level of quality. At each quality control session for the Inland Bays Program, volunteers check their thermometers in an ice-water bath and a room-temperature bath against an analytical thermometer. Thermometers not getting the same reading are replaced.

SALINITY DETERMINATION. We are using specific gravity hydrometers to determine salinity. These instruments are inexpensive and deliver consistent results for the trained observer. The accuracy reported by the ACB for the hydrometric method of determining salinity was ±0.82 parts per thousand (0/00). The method of arriving at this figure is described in the ACB report.

An effort has been made to determine the comparability of the hydrometric method for determining salinity. Details of these efforts are included in the ACB report. These results indicate that the citizen monitoring groups using the hydrometer and

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[3] Ullman, William J., et.al, 1992, Quality Assurance Project Plan for Phosphorus Fluxes and Utilization in Rehoboth and Indian River Bays. Submitted to U.S. E.P.A., Region III, Philadelphia PA. 4 November 1992.

titration kits to measure salinity should get similar results, excluding human error. The refractometer and salinometer appear to get consistently lower readings than the other two methods.

pH DETERMINATION. Citizen monitors will each be issued a simple "pen" type digital pH meter which is calibrated to a standard solution before each use. This solution is issued to the monitors along with the meter. The specifications of this instrument list its accuracy as ±0.2 pH units. Precision determined at the quality control sessions was, for each of six groups, ±0.2, ±0.4, ±0.2, ±0.4, ±0.4, and ±0.6 standard pH units.

LIMIT OF VISIBILITY. The secchi disk lines will be attached to the disk and marked in tenths of meters in black ink. Meter marks will be indicated in red ink.

Because the limit of visibility as determined by secchi depth is a measurement which depends on a number of subjective factors it is difficult to test for accuracy. However, standard deviation for the two groups at the first QC sessions was ± 0.17 m and ±0.09 m. There appears to fairly good agreement among individuals.

Representativeness

While the data collected by this project are intended to be useful, there was no specific use in mind for them at the inception of the project. To make the data more useful, however, sampling sites were chosen in a way which represents the variety of shoreline types. Major tributaries were also chosen to give an idea of the quality of water entering the bays.

Comparability

The model for the Inland Bays Monitor Program is the ACB program. Protocols and equipment used in this program are intended to make data collected in the inland bays compatible, and of similar quality to, data from the ACB program. the nutrient data is comparable the nutrient information found in the inland bays study by Dr. Ullman et al. The bacteria data are comparable to other data collected and analyzed by the Shellfish and Recreational Water Branch of the Division of Water Resources for the state Shellfish Sanitation Program.

Completeness

Volunteer monitors are requested to collect data and samples once a week from April 1 through October 15, and every other week from October 15 through April 1, of the following year. A nutrient sample is taken the first and third weeks of each month and a bacteria sample is taken the third Wednesday of every month throughout the year. Starting in May 1993, bacteria samples will be collected on the third Monday of months designated by the Shellfish and Recreational Waters Branch. However, it is assumed that some weeks will be missed for vacations, illness, and severe weather (i.e., wind, flooding, ice).

Many volunteers may be sampling from their own property which means that if they drop out of the project that site will no longer be accessible. If data from that location is considered important to the overall program, an effort will be make to recruit a replacement nearby at a site with similar ecological characteristics. However, it is recognized that when working with volunteers this may not always be practical. It is also recognized that it is difficult to terminate a volunteer. If it is determined that a monitor is unable to meet the data quality objectives (DQO's) for this project, consideration will be given to allowing the person to continue if he/she wishes. The data set will be flagged in the computer file as being unacceptable for inclusion in data analyses.

The coordinator keeps replacement equipment and reagents on hand at all times and sends requested replacements by return mail. One can anticipate the amount of reagent needed for most tests and see that they are received by monitors before the current ones are used up. Reagents should not be stored more than six months.

We have assumed that all monitors will take a vacation and may miss a couple of weeks for other reasons during the year. If someone plans to be away for an extended period of time, particularly in the summer, we encourage them to find a reliable substitute to collect the data. One possible solution is to have neighbors plan to share a site. Substitute monitors should be trained and checked out by a coordinator or training assistant. In actual practice, this has proven to be difficult due to lack of notice and travel time. Our training video should provide very useful support in this situation.

12. SAMPLING AND ANALYTICAL METHODS

Complete sampling procedures are included in Appendix [2], Citizen Monitoring Manual.

The volunteers attend an initial training session. The session includes a demonstration and explanation of the procedures by the field coordinator, followed by performance of all the tests by the new volunteers. Volunteers who are unable to attend a session are trained by the coordinator individually. Two quality control sessions per year are conducted by the monitoring coordinator, to assess volunteer performance. A training video has also been developed and is available. It serves as an initial training document and then also for reinforcement. Each team received a copy.

Water quality factors are measured weekly at each site. Sampling frequency is reduced to a biweekly "winter" schedule from October 16, to March 31. This is the schedule that will be followed for the duration of the program.

Factors measured include water and air temperature; pH using an inexpensive digital meter; water clarity using a Secchi disk; salinity using a hydrometer; dissolved oxygen using a micro-Winkler titration kit and nitrates and phosphate using laboratory analysis at CMS. Finally coliform bacteria and *Escherichia coli* are tested by the state Division of Public Health. Monitors report daily rainfall if they have interest and a sufficiently clear space to install a rain gauge. Rain gauges are not installed at sites that are not on private property because of the threat of vandalism.

Information on weather and general observations about the site (live or dead organisms, debris, oil slicks, ice, odor, water color, anything unusual) is recorded on a Data Collection Form and sent to the project coordinator. Data are entered into a file in a microcomputer where it is stored and available to the public upon request.

OBTAINING THE WATER SAMPLE. The water sample is obtained in a bucket that is rinsed twice with the water to be tested. The bucket is then gently filled about two thirds full. The protocol calls for this sample to be used to determine water temperature, salinity, pH, and dissolved oxygen. (See Appendix [2], Citizen Monitoring Manual, for complete protocol.)

TEMPERATURE. Armored thermometers reading from -5.0 degrees Celsius to +45.0 degrees Celsius were purchased from LaMotte Chemical Products. The field thermometers are sufficiently accurate to make it unnecessary to carry out corrections for each value of air and water temperature.

SALINITY. Salinity is determined by the hydrometric method as described in Standard methods for the Examination of Water and Wastewater. Nalgene 500 ml graduated cylinders are used as hydrometer jars. The specific gravity value is corrected for temperature of the water in the hydrometer jar and converted to salinity by each monitor, and ultimately by the computer.

Thermometers and hydrometers are checked for calibration once a year at a QC session. Replacements are calibrated by the coordinator using a calibrated conductivity meter.

LIMIT OF VISIBILITY. Secchi disks with black and white quadrants and measuring 8 inches (920 cm) in diameter are used to determine the limit of visibility. A nylon line, approximately 3 m long, was tied to each disk by the coordinator. The line was marked in black in 0.1 m increments while being stretched. Each one meter increment is marked in red. The disks are obtained from LaMotte Chemical Products. Inc. The Secchi disk is also used to determine water depth.

pH. Monitors are given a simple "pen" type digital pH meter. The pH of the sample can be read directly from the meter's display.

DISSOLVED OXYGEN. The test for dissolved oxygen is made using a water analysis kit which employs a modified Winkler method. The sample of water to be tested is collected with a minimum of contact with the air. Duplicate samples are collected and titrated. Manganese sulfate and alkaline potassium iodide solutions are added to the water sample and mixed. A precipitate forms which is allowed to settle. With saline water a ten-minute contact time with the precipitate is required. The precipitate is a manganese hydroxide floc. Sulfamic acid powder is added and mixed until both reagent and precipitate dissolve. The sulfamic acid reaction frees iodine in proportion to the amount of oxygen present in the test sample. A portion of this solution is decanted to a test vial. A direct reading titrator (syringe) is used to titrate with sodium thiosulfate solution. Starch solution is added as the endpoint indicator. The concentration of dissolved oxygen, expressed in mg/l is read directly from the titrator scale in 0.2 mg/l increments.

NUTRIENTS. Two hundred fifty milliliters of sample water are collected in clean polyethylene bottles by the volunteers. These samples kept cold until collected and returned to the laboratory for filtration through a Whatman GF/F filter. The resulting filtrate is then frozen for storage until analysis for both nitrate and orthophosphate concentrations.

Prior to October, 1993, nitrate concentrations were determined in the lab using Cadmium Reduction detection as NO_2^- using an autoanalyzer. The references for this method are Gilbert, P.M. and T.C. Loder, 1977. Automated Analysis of Nutrients in Seawater: A Manual of Techniques, Woods Hole Oceanographic Institution Technical; Report, WHOI-77-47, page 46, and the Technicon Industrial Method No. 158-71W, 1972. Suspended phosphorus was measured in the lab using a Molybdenum Blue method for a spectrophotometer, as in the reference: Strickland, J. D. F. and T. R. Parsons, 1972. A Practical Handbook of Seawater Analysis, 2nd Edition, Bulletin of the Fisheries Research Board of Canada, pp. 310.

Since October 1993, nitrate and orthophosphate concentrations are determined on an autoanalyzer (Enviroflow 3500, Peristorp Analytical). A standard curve is used to calibrate the instrument, and replicates of a mid-range standard are run with the sample to determine method precision.

Nitrate concentration is measured according to the method provided by the equipment manufacturer: Nitrate-Nitrite in Seawater. Document 000630, Rev. C. Alpkem Corporation, Wilsonville, Oregon, 1993. The authors summarize the method as follows:

> Nitrate is reduced quantitatively to nitrite by cadmium metal in the form of an Open Tubular Cadmium Reactor (OTCR). The nitrite thus formed plus any originally present in the sample is determined as an azo dye at 540 nm following its diazotization with sulfanilamide and subsequent coupling with N-1-naphthyelthyendiamine dihydrochloride.

The manufacturer states a range of 0.02 - 40 μm and a method precision of 0.93% RSD. (RSD is the relative standard deviation of the measured concentration of replicates, in this case of replicate readings of the mid-range standard).

Orthophosphate concentration is measured according to the method provided by the equipment manufacturer: Orthophosphate in Seawater. Document 000629. Alpkem Corporation, Wilsonville, Oregon, 1992. The authors summarize the method as follows:

> Orthophosphate reacts with molybdenum (VI) and antimony (III) in an acid medium to form an antimonyphosphomolybdate complex. This complex is subsequently reduced with ascorbic acid to form a blue color and the absorbance is measured at 660 nm.

The manufacturer states a range of 0.04 - 2.0 μm and a method precision of 0.85% RSD. (RSD is the relative standard deviation of the measured concentration of replicates, in this case of replicate readings of the mid-range standard).

13. SAMPLE CUSTODY PROCEDURES

The field coordinator acid washes the sample containers before each use. The bottles are then distributed to the volunteers. On the sample day the volunteers rinse the bottle once with sample water, fill the bottle, and mark it with their name and the date the sample was taken. The bottle is then placed in a refrigerator until the sample is picked up by the field coordinator, who puts the sample on ice for transport to the university. At the university lab, the 150 ml of the sample is filtered, labeled, and frozen until analysis.

Similarly, sample custody for the bacteria program starts with each volunteer being given a clean, in this case autoclaved and capped, bottle which is filled to two-thirds full by the monitor after 12:00 p.m. on the designated sample day. At this time, a Division of Public Health form is filled out with all the pertinent information. The sample is then kept refrigerated until it is picked up by the field coordinator who stores them overnight. Division of Public Health staff pick up the samples by 10:00 a.m. the following day and transport the samples to the state lab in Smyrna for testing in the Shellfish Sanitation Program.

14. CALIBRATION PROCEDURES, VOLUNTEER TRAINING AND PREVENTIVE MAINTENANCE

A variety of approaches to checking quality control on a monitoring program using volunteers has been developed. The challenge is to carry out QC exercises that do assess precision of the data and are also fun and interesting for the volunteers. It is important to have sufficient space and light to carry out the required measurements. Access to a sink for cleanup water and waste disposal is also necessary.

The original training session requires about three hours. Each individual carries out the tests along with the monitoring coordinator. Training assistants circulate around the group answering questions and correcting observed poor technique.

The first QC session will be held three months after the monitors begin their sampling to make sure that they are all doing the tests correctly and to answer questions about the more subtle aspects of sampling. This session is conducted like the training. It is important to allow time to look at the results and discuss why any out-of-line results were obtained.

QC sessions are held every six months. Monitors are urged to attend all sessions. If a volunteer does not attend at least one of these sessions a year, the coordinator (or a training assistant) will make a site visit, run through the sampling procedures with the monitor and make sure the individual is carrying out the procedures in the prescribed manner. There is also a training video which may be helpful in reinforcing proper analytical technique. As stated in Section 11, if it is determined that a monitor is unable to meet the DQO's for this project, consideration will be given to allowing the person to continue if he/she wishes. The data set (or that portion which is deficient) must be flagged as unacceptable for inclusion in data analyses.

Various ways to actually test the monitors have been worked out. QC sessions can include different combinations of approaches. Essentially, there are two basic approaches: 1) have them all test the same water with their equipment in the way they do it at home; 2) have them read/record already set up laboratory tests. Their results then provide a measure of how well they perform as a group or how precisely they measure the characteristics and constituents required.

Data collected at the QC sessions is used to assess and update the accuracy and precision of the data collected in this program. Results and analyses from the QC sessions are stored by the coordinator in a file on the program microcomputer.

Instruments and methods used in this volunteer monitoring project have been chosen based on simplicity of use, cost, and accuracy. All kits and equipment are compared once a year at a QC session where they are used by the volunteers to test a given water sample. Any faulty equipment is then replaced. The coordinator keeps all records on the maintenance and calibration of the kits and equipment stored on a microcomputer.

Liquid chemical reagents are replaced when needed, but never later than every six months; powder chemical reagents (sulfamic acid powder) are replaced within one year. LaMotte Chemical will provide the program with quality control information that will allow comparison of different batches of test kit chemical reagents. We have been advised by a LaMotte representative that sampling error of volunteers is expected to be far greater than any error introduced by variations in chemical batches.

In the lab standards are prepared just prior to analysis using reagent grade chemicals. Any diluted samples not used immediately will be destroyed. In some cases alternative methods or equipment will be substituted for that normally used if a problem arises.

15. DOCUMENTATION, DATA REDUCTION, AND REPORTING

Data are reported on a data collection form supplied to the monitors. The monitors are instructed to make a copy of the form and to send the original to the Coordinator after each weekly sampling. Monitors keep a copy to guard against loss in the mail and to facilitate discussion of later questions about data reported. Specific gravity readings and water temperature in the hydrometer jar are recorded by monitors. Conversion to salinity is carried out using standardized tables. Duplicate DO results are recorded by the monitors and the average is entered in the computer file. Data is stored on a microcomputer in the Marine Advisory Service office.

16. DATA VALIDATION

The monitoring coordinator looks over each form as it is received for decimal point errors, missing site and/or monitor numbers and general problems. Monitors are contacted by phone or mail to answer questions about data that appears to be incorrect. Dissolved oxygen values that are beyond the upper control limit are not entered into the file. A monitor that reports dissolved oxygen values at or above the upper warning limit two weeks running is contacted and reminded of the protocol to conduct a third titration when the duplicates differ by greater than 0.6 mg/l. Replacement equipment and reagent requests are filled immediately. Questions are answered by phone or mail.

The entire database was edited for typographic and other errors in December 1994. Since that time, the entered data is checked once a week against the original datasheets for typographical errors and against standardized hydrometer conversion tables for other errors (incorrect conversions, rounding errors). Necessary corrections are made to the database, and a hardcopy of each week's data, with needed corrections, is kept on file in the Field Coordinator's office.

17. PERFORMANCE AND SYSTEM AUDITS

No performance and system audits beyond the described QC sessions are planned for this project. The activities included in the QC exercises basically constitute performance and system audits. A discussion of any difference in results obtained can clear up difficulties and differences in technique without embarrassing or putting a particular individual on the spot. Defective equipment or outdated reagents can be replaced at that time. A copy of an individual's results compared to the reference standard is sent to each participant. The results obtained by laboratory analysis are used as a reference standard. It is necessary to contact monitors whose results were unacceptable by phone or in person.

The results recorded by the individual monitors at QC sessions are kept by the coordinator in a computer file.

It would be possible to have the QAO conduct or observe a QC session to fulfill a requirement for a system audit.

18. CORRECTIVE ACTION

The responsibility for deciding to take corrective action rests with the monitoring coordinator. Data collection forms will be looked at by the coordinator as they are received. Editorial changes may be made at this time so that the data entry person will be able to enter the data correctly. Particular things to check and correct, if necessary, include:

- Readable date
- Time of day in 24 hour time
- Consistent monitor and site name
- Site number
- After checking with the monitor by telephone, add missing decimals and zero values where absent, particularly on secchi and water depth
- Correct conversion of hydrometer reading to salinity
- Average DO test results if necessary and check for warning limit

If any of the data is questionable, the monitor should be contacted by phone or letter to find out what the problem is and to indicate what should be done to correct the problem.

The only measurement for which we have stated upper control and warning limits is the dissolved oxygen test. If a monitor reports duplicate values that are beyond the

UCL two weeks in a row or a third test has not been run, he/she should be contacted to see if the results can be tightened up by more careful techniques.

19. REPORTS

An annual report will be prepared by the monitoring coordinator and presented to the US EPA for the purpose of apprising them of the status of the Citizens Monitoring Program. This report will include:

- A status report on the program as a whole
- Results of QC sessions
- The level of participation for the year
- A summary of the data with comments on any observed trends
- Any problems that have arisen
- A printout of the data set for the current year

APPENDIX 1. MAP OF CITIZENS MONITORING SITES

APPENDIX 2. CITIZENS WATER MONITORING MANUAL

APPENDIX 3. DATA COLLECTION FORM

APPENDIX 4. LIST OF EQUIPMENT AND REAGENTS

A bucket that will hold about two gallons of water is used to collect a water sample. It is preferable to have a white bucket so that one can observe the color of the water and sediment in the sample. It is also easier to see any plants or animals that happen to be caught up in the bucket. The bucket may have a rope tied to the handle.

Equipment ordered from LaMotte Chemical, Chestertown, MD.

Dissolved Oxygen Test kit (7414)
Armored Thermometer (1066)
B/W Secchi Disk (0171)
Sampling Bottle (0688-DO)

Equipment ordered from Fisher Scientific, Springfield, NJ

pH Electrode pH Tester (12 300 51)
pH 7.00 Buffer Solution (SB108 500)
Hydrometers, 1.000-1.070 (11 555G)
500 mL PMP Graduated Cylinders (08 572 7F)