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# The Volunteer Monitor's Guide To

# Quality Assurance Project Plans

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# Quality Assurance Project Plans

Dear Reader:

Across the country, volunteers are monitoring the condition of streams, rivers, lakes, reservoirs, estuaries, coastal waters, wetlands, and wells. The number and variety of these projects are continually on the rise. So, too, is the complexity of the monitoring volunteers conduct and the uses of the data they collect.

One of the most difficult issues facing volunteer environmental monitoring programs today is data credibility. Potential data users are often skeptical about volunteer data -- they may have doubts about the goals and objectives of the project, about how volunteers were trained, about how samples were collected, handled and stored, or about how data were analyzed and reports written. A key tool in breaking down this barrier of skepticism is the quality assurance project plan.

The quality assurance project plan, or QAPP, is a document that outlines the procedures that those who conduct a monitoring project will take to ensure that the data they collect and analyze meets project requirements. It is an invaluable planning and operating tool that outlines the project's methods of data collection, storage and analysis. It serves not only to convince skeptical data users about the quality of the project's findings, but also to record methods, goals and project implementation steps *for current and future volunteers* and for those who may wish to use the project's data over time.

Developing a QAPP is a dynamic, interactive process that should ideally involve quality assurance experts, potential data users, and members of the volunteer monitoring project team. It is not an easy process. This document is designed to encourage and facilitate the development of volunteer QAPPs by clearly presenting explanations and examples. Readers are urged to consult, as well, the additional resources listed in the appendices to this document, and to contact their state or U.S. Environmental Protection Agency (EPA) Regional quality assurance staff for specific information or guidance on their projects.

Sincerely,
*Geoffrey H. Grubbs, Director*
Assessment and Watershed Protection Division

# Contents:




## Acknowledgements

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Original illustations by Dave Skibiak and Emily Faalasli of Tetra Tech, Inc., and Elizabeth Yuster of the Maryland Volunteer Watershed Monitoring Association.

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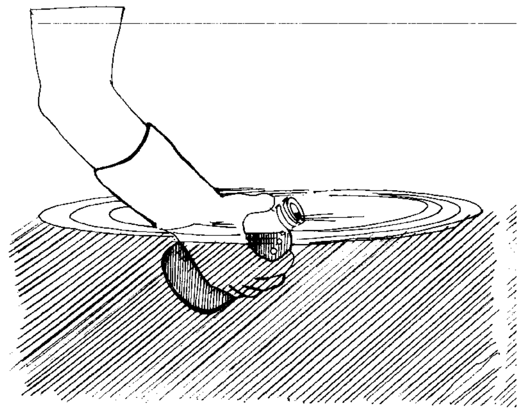
# EXECUTIVE SUMMARY

The Quality Assurance Project Plan, or QAPP, is a written document that outlines the procedures a monitoring project will use to ensure that the samples participants collect and analyze, the data they store and manage, and the reports they write are of high enough quality to meet project needs.

U.S. Environmental Protection Agency-funded monitoring programs must have an EPA-approved QAPP before sample collection begins. However, even programs that do not receive EPA money should consider developing a QAPP, especially if data might be used by state, federal, or local resource managers. A QAPP helps the data user and monitoring project leaders ensure that the collected data meet their needs and that the quality control steps needed to verify this are built into the project from the beginning.



Volunteer monitoring programs have long recognized the importance of well-designed monitoring projects; written field, lab, and data management protocols; trained volunteers; and effective presentation of results. Relatively few programs, however, have tackled the task of preparing a comprehensive QAPP that documents these important elements.

***EPA-funded monitoring programs must have an EPA-approved QAPP before sample collection begins. However, even programs that do not receive EPA money should consider developing a QAPP, especially if data might be used by state, federal, or local resource managers.***

This document is designed to help volunteer program coordinators develop such a QAPP.

## Steps to Developing a QAPP

Developing a QAPP is a dynamic, interactive process that should ideally involve state and EPA regional QA experts,

potential data users, and key members of the volunteer monitoring project. There are 11 steps a volunteer monitoring project coordinator might take to prepare a QAPP. These are:

Step 1: *Establish a small team* whose members will serve as advisors in helping you develop the QAPP by offering feedback and guidance throughout the entire process.

***A QAPP helps the data user and monitoring project leaders ensure that the data collected meet their needs.***


Step 2: *Determine the goals & objectives of your project*--why it's needed, who will use the data, and how the data will be used.

Step 3: *Collect background information* to help you in designing your project.

Step 4: *Refine your project's* goals once you've collected more information.

Step 5: *Design your project's sampling, analytical & data requirements*--essentially, what, how, when, and where you'll be monitoring.

Step 6: *Develop an implementation plan* that lays out project logistics.

Step 7: *Draft your standard operating procedures (SOPs) & QAPP*.

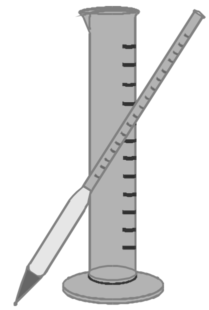
Step 8: *Solicit feedback on your draft SOPs & QAPP* from state or EPA regional QA contacts and potential data users.

Step 9: *Revise your QAPP* based on review comments and submit it for approval.

Step 10: *Once your QAPP is approved, begin your monitoring program.*

Step 11: *Evaluate and refine your project over time*, and reflect any major changes in a revised QAPP.

**The "PARCC" Parameters**



Taken together, the terms **P**recision, **A**ccuracy, **R**epresentativeness, **C**ompleteness, and **C**omparability, comprise the major data quality indicators used to assess the quality of your data. It is essential to understand these terms and to address them in your QAPP. Chapter 3 of this document includes a discussion of these indicators and gives examples of how to evaluate the quality of your data in relation to these terms.

## Basic QA/QC Concepts

It is important to understand the terminology of quality assurance and quality control in order to develop a QAPP. Key definitions include:

***Precision*** -- the degree of agreement among repeated measurements of the same characteristic. It may be determined by calculating the standard deviation, or relative percent difference, among samples taken from the same place at the same time.

***Accuracy*** -- measures how close your results are to a *true* or expected value and can be determined by comparing your analysis of a standard or reference sample to its actual value.

***Representativeness*** -- the extent to which measurements actually represent the true environmental condition or population at the time a sample was collected.

***Completeness*** -- the comparison between the amount of valid, or usable, data you originally planned to collect, versus how much you collected.

***Comparability*** -- the extent to which data can be compared between sample locations or periods of time within a project, or between projects.

## Elements of a QAPP

According to EPA guidance, 24 distinct elements can be included in a QAPP, although not all elements may be necessary for all programs. Which elements you end up including in your QAPP depends on your project's goals, objectives, scope, data uses, and on the guidance you receive from your state or

***According to EPA guidance, 24 distinct elements can be included in a QAPP, although not all elements may be necessary for all programs.***

EPA regional quality assurance contacts. The 24 elements are grouped into four overall categories and are listed below:

**Project Management** **(elements 1-9)**

1. Title and Approval Page
2. Table of Contents
3. Distribution List
4. Project/Task Organization
5. Problem Identification/ Background
6. Project/Task Description
7. Data Quality Objectives for Measurement Data
8. Training Requirements/Certification
9. Documentation and Records

**Measurement/Data Acquisition** **(elements 10-19)**

10. Sampling Process Design
11. Sampling Methods Requirements
12. Sample Handling and Custody Requirements
13. Analytical Methods Requirements
14. Quality Control Requirements
15. Instrument/Equipment Testing, Inspection, and Maintenance Requirements
16. Instrument Calibration and Frequency
17. Inspection/Acceptance Requirements for Supplies
18. Data Acquisition Requirements
19. Data Management

**Assessment and Oversight** **(elements 20-21)**

20. Assessment and Response Actions
21. Reports

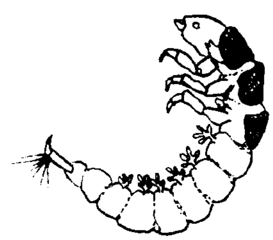
**Data Validation and Usability** **(elements 22-24)**

22. Data Review, Validation, and Verification Requirements
23. Validation and Verification Methods
24. Reconciliation with Data Quality Objectives

# Chapter 1: INTRODUCTION

Across the country, volunteers are monitoring the condition of streams, rivers, lakes, reservoirs, estuaries, coastal waters, wetlands, and wells. The number and variety of these projects is continually on the rise; so, too, is the complexity of the monitoring they conduct and the uses of the data they collect.

Most volunteer monitoring projects evaluate the chemical, physical, or biological condition of waters in a given watershed. They may address different kinds of waters—e.g., streams with associated embayments—and they may conduct several types of monitoring activities. Some projects may address only one type of monitoring in one type of waterbody, e.g., nutrient sampling in estuaries. More comprehensive projects may take basic chemical measurements of conditions such as dissolved oxygen levels, pH, or salinity, evaluate the physical condition of streamside habitat, and evaluate the biological condition of aquatic insects or vegetation.

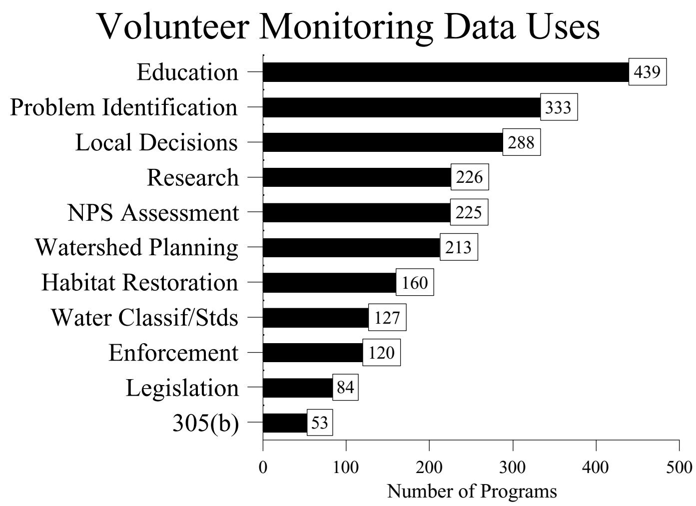


**Top 20 Parameters Assessed by Volunteer Monitors**

Water temperature
pH
Dissolved Oxygen
Macroinvertebrates
Debris clean-up
Habitat assessments
Nitrogen
Phosphorus
Turbidity
Coliform bacteria
Secchi depth
Aquatic vegetation
Flow
Birds/Wildlife
Fish
Watershed mapping
Rainfall
Photographic surveys
Salinity
Sediment assessments

Source: *Directory of Volunteer Environmental Monitoring Programs, 4th Edition*

Not only do volunteer projects monitor many different parameters and types of waters, they are also organized and supported in many different ways. Volunteer monitoring projects may be associated with state, interstate, local, or federal agencies, with environmental organizations or universities, or may be entirely independent. Financial support may come from government grants, partnerships with business, endowments, independent fundraising efforts, corporate donations, membership dues, or a combination of any and all of these sources. Most volunteer projects are fairly small and have very small budgets--based on EPA's latest *Directory of Volunteer Environmental Monitoring Programs, 4th Edition*, we know that the median program size is 25 volunteers, and the median annual budget is under $5,000. However, there are also volunteer programs with over 1,000 volunteers and those with annual budgets of more than $50,000.




Source: *Directory of Volunteer Environmental Monitoring Programs, 4th Edition*

Although the goals and objectives of volunteer projects vary greatly, virtually all volunteers hope to educate themselves and others about water quality problems and thereby promote a sense of stewardship for the environment. Many projects, in fact, establish these as their goals. These projects might be called primarily *education* oriented.

Other projects seek a more active role in the management of local water resources, and therefore strive to collect data that can be used in making water quality management decisions. Common uses of volunteer data include local planning decisions, such as identifying where to route a highway; local priority setting, such as determining which county lakes require restoration; screening for potential pollution problems, which might then be investigated more thoroughly by water quality agencies; and providing data for state water quality reports, which might then be used for statewide or national priority setting. Projects doing this type of monitoring might be called primarily *data* oriented. Data oriented volunteer projects, in particular, must continuously wrestle with the issue of credibility. They must prove to skeptics that their volunteers collect good-quality data that is:

***Although the goals and objectives of volunteer projects vary greatly, virtually all volunteers hope to educate themselves and others about water quality problems and thereby promote a sense of stewardship for the environment.***

- consistent over time and within projects and group members
- collected and analyzed using standardized and acceptable techniques
- comparable to data collected in other assessments using the same methods

These projects must adopt protocols that are straightforward enough for volunteers to master and yet sophisticated enough to generate data of value to resource managers.

This delicate and difficult path cannot be successfully navigated without a quality assurance plan that details a project's standard operating procedures in the field and lab, outlines project organization, and addresses issues such as training requirements, instrument calibration, and internal checks on how data are collected, analyzed, and reported. Just how detailed such a plan needs to be depends to a large extent on the goals of the volunteer monitoring project.

***A Quality Assurance Project Plan, or QAPP, is a written document outlining the procedures a monitoring project will use to ensure the data it collects and analyzes meets project requirements.***

## What Is a Quality Assurance Project Plan?

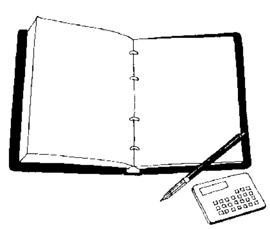
A Quality Assurance Project Plan, or QAPP, is a written document outlining the procedures a monitoring project will use to ensure the data it collects and analyzes meets project requirements. The U.S. Environmental Protection Agency (EPA) has issued interim guidance that establishes up to 24 distinct elements of a QAPP (see *Appendix C: References*). Together, these elements of a QAPP comprise a project's quality assurance system. As we will discuss below, not all 24 elements need be addressed in every QAPP.

By law, any EPA-funded monitoring project must have an EPA-approved QAPP before it can begin collecting samples. The purpose of this requirement is to ensure that the data collected by monitoring projects are of known and suitable quality and quantity. Typical sources of EPA funding for volunteer monitoring projects include Lake Water Quality Assessment Grants (under Section 314 of the Clean Water Act) or grants under the nonpoint source pollution control program (Section 319 of the Clean Water Act). Quality assurance staff in each of EPA's 10 regional offices are available to review volunteer monitoring QAPPs and have authority to recommend approval or disapproval of QAPPs. In addition, volunteer monitoring coordinators and individual EPA project officers in the EPA Regions may be able to assist projects seeking advice on the preparation of QAPPs. (See Appendix A, Regional Quality Assurance Contacts.)

### Why Should You Develop a QAPP?

**The QAPP is an invaluable planning and operating tool that should be developed in the early stages of the volunteer monitoring project.**

Even if a volunteer monitoring project does not receive any EPA money through grants, the coordinating group should still consider developing a QAPP, especially if it is a data oriented project and seeks to have its information used by state, federal, or local resource managers.



Few water quality agencies will use volunteer data unless methods of data collection, storage, and analysis can be documented. Clear and concise documentation of procedures also allows newcomers to the project to continue monitoring using the same methods as those who came before them.

This is particularly important to a volunteer project that may see volunteers come and go and that intends to establish a baseline of water quality information that can be compared over time.

## About This Document

The purpose of this document is to provide volunteer monitoring programs with the information they need to develop a quality

***The purpose of this document is to provide volunteer monitoring programs with the information they need to develop a quality assurance project plan.***

assurance project plan. It does not suggest specific field, laboratory, or analytical techniques or procedures, and is not a "how to" manual. It is organized as follows:

***Executive Summary*** introduces the reader to the steps involved in developing a QAPP, fundamental QA/QC concepts, and the basic elements of a QAPP.

***Chapter 1: Introduction*** provides background on volunteer monitoring, discusses the purposes of QAPPs, and outlines the structure of this document.

***Chapter 2: Developing a QAPP*** outlines the steps a volunteer monitoring project should take as it moves toward developing a quality assurance system, documenting its procedures in a QAPP, seeking approval of its QAPP, and updating the QAPP over time.

***Chapter 3: QA/QC: Basic Concepts*** introduces basic quality assurance/quality control (QA/QC) concepts and definitions that are needed in developing a quality assurance system and a QAPP. Examples from a fictional project--the *Volunteer Creek Monitoring Project*--are used to illustrate these concepts.

***Chapter 4: Elements of a QAPP*** presents the basic elements of a volunteer monitoring quality assurance project plan (QAPP), again with examples from the QAPP of the fictional *Volunteer Creek Monitoring Project*.

***Appendix A: Glossary*** defines various terms and concepts associated with quality assurance and control.

***Appendix B: EPA Regional Contacts*** is a list of people within EPA who can assist, and offer guidance to, volunteer monitoring programs. Each of the 10

EPA regions has a volunteer monitoring coordinator as well as QA staff. This appendix also shows which states and U.S. territories are within each of the 10 regions.

***Appendix C: References*** is a list of documents and articles relevant to volunteer monitoring and quality assurance issues. All EPA volunteer monitoring documents are available by contacting the National Volunteer Monitoring Coordinator at USEPA. The address is given in the appendix.

***Appendix D: Abbreviated QAPP Form*** is an example of the layout and structure of a quality assurance project plan. Some programs may wish to adapt this form to fit their plan.

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This document is not intended as a stand-alone reference document. Volunteer monitoring programs are strongly urged to consult the references listed in Appendix C for further information on quality assurance/quality control and the Quality Assurance Project Plan process.

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# Chapter 2: DEVELOPING A QAPP

The purpose of this chapter is to discuss the steps a volunteer monitoring program might take in preparing a ***quality assurance project plan (QAPP)***. If your plan does not need to be approved by EPA (that is, you are not receiving EPA grant or contract money to conduct your monitoring), you need not submit your QAPP for EPA approval. In that case, consult your data users, such as the state or county water quality agency, regarding their QAPP requirements.

Developing a QAPP is a dynamic, interactive process. Seek as much feedback as possible from those who have gone before you in the QAPP development process. You will be investing a substantial amount of time and energy, but don't be discouraged. The person who writes the QAPP is usually the one who ends up with the most technical expertise and monitoring insights. Your efforts will pay off in a living document that helps current and future volunteers, staff, and data users understand exactly how your project works.

**STEPS TO DEVELOPING A QAPP**

| | |
|---|---|
| step 1: | Establish a QAPP team |
| step 2: | Determine the goals & objectives of your project |
| step 3: | Collect background information |
| step 4: | Refine your project |
| step 5: | Design your projects sampling, analytical & data requirements |
| step 6: | Develop an implementation plan |
| step 7: | Draft your standard operating procedures (SOPs) & QAPP |
| step 8: | Solicit feedback on your draft SOPs & QAPP |
| step 9: | Revise your QAPP & submit it for final approval |
| step 10: | Begin your monitoring project |
| step 11: | Evaluate and refine your QAPP |

## STEP 1

## Establish a small QAPP team

It will be helpful to pull together a small team of two or three people who can help you develop the QAPP. Include representatives from groups participating in the monitoring project who have technical expertise in different areas of the project.

Take the time to establish contact with your state, local or EPA Quality Assurance Officer, or other experienced volunteer organizations. Remember, if you are getting any EPA funding through a grant or contract, EPA must approve your QAPP. However, even if EPA approval isn't needed, you can consult with

EPA QA representatives if you need advice. Let them know a bit about your project, and find out if they have any resources that might help you out (such as a copy of an approved volunteer monitoring QAPP, or specific regional guidance on preparing plans). Also ask your QA contact if he or she would be willing to review your draft plan.


## STEP 2

## Determine the goals and objectives of your project

Why are you developing this monitoring project? Who will use its information, and how will it be used? What will be the basis for judging the usability of the data collected? If you don't have answers to these questions, you may flounder when it comes time to put your QAPP down on paper.

***Why are you developing this monitoring project? Who will use its information, and how will it be used? If you don't have answers to these questions, you may flounder when it comes time to put your QAPP down on paper.***

Project goals could include, for example:

› identifying trends in a lake to determine if nuisance vegetation problems are on the rise

› monitoring in conjunction with the county health department to be sure a beach is safe for swimmers

› teaching local elementary schoolers about stream macroinvertebrates

› monitoring the effectiveness of a stream restoration project

Write down your goal. The more specific your project's goal, the easier it will be to design a QAPP. Identify the objectives of your project--that is, the specific statements of how you will achieve your goal. For example, if your project's goal is to identify trends in a lake plagued by nuisance vegetation, your objectives might be to collect three years of data on weed beds, algae, and nutrients, and to develop yearly reports for nearby lake residents.

Knowing the use of the collected data will help you determine the right kind of data to collect, and the level of effort necessary to collect, analyze, store, and report it. Volunteer monitoring data can be used to screen for problems, educate youth and the community, supplement state agency data, help set statewide priorities for pollution control, and a myriad of other uses. Each use of volunteer data has potentially different requirements.

***Knowing the use of the collected data will help you determine the right kind of data to collect, and the level of effort necessary to collect, analyze, store, and report it...Each use of volunteer data has potentially different requirements.***

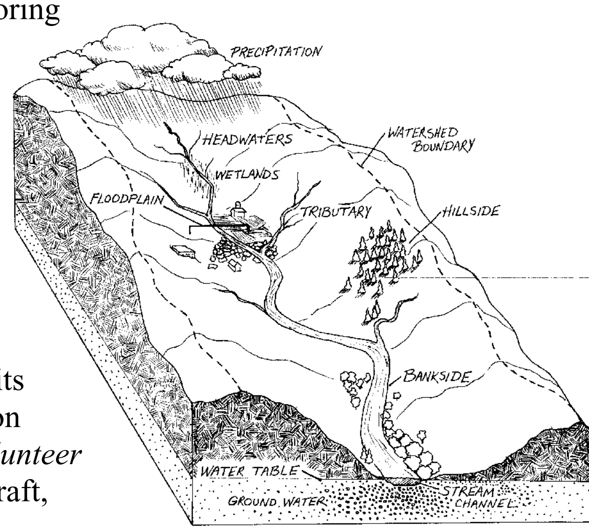
Your project should be designed to meet the needs of your data users. Data users can include the volunteers themselves, state water quality analysts, local planning agencies, parks staff, or many others. You will also probably need to strike a balance between data quality and available resources.

## STEP 3

## Collect background information

As you learn more about the area you are choosing to monitor, you will be better able to design an effective monitoring project. Begin by contacting programs and agencies that might already monitor in your area. Talk to the state water quality agency, the county and/or city environmental office, local universities, and neighboring volunteer monitoring programs. Ask about their sampling locations, what parameters they monitor and what methods they use.

If they are already monitoring in your chosen area, find out if they will share their data, and identify what gaps exist that your project could fill. If no monitoring is ongoing, find out what kind of data your local or state agencies could use (if one of your goals is that these agencies use your data), where they would prefer you locate your sampling sites, and what monitoring methods they recommend. Government agencies are not likely to use your data unless it fills a gap in their monitoring network and was collected using approved protocols.




A watershed survey can help you set the foundation for your monitoring project design. This is simply a practical investigation of how the watershed works, its history, and its stressors. For information on conducting a watershed survey, consult *Volunteer Stream Monitoring: A Methods Manual* (Draft, April 1995, EPA 841-D-95-001).

## STEP 4

### Refine your project

Once you've collected background information for your project and coordinated with potential data users, you may find it necessary to refine your original project goals and objectives. You may have found, for example, that the county already regularly monitors weed and algae growth in your lake. In that case, your project might better examine nutrient inputs from tributaries, lake water clarity, or other parameters.

***Once you've collected background information for your project and coordinated with potential data users, you may find it necessary to refine your original project goals and objectives.***

Don't hesitate to reevaluate your project goals and objectives. Now is the best possible time to do so: *before* you've invested time, money, and effort in equipment purchases, training, grant proposals and quality assurance plan development.

## STEP 5

### Design your project's sampling, analytical, and data requirements

Once you feel comfortable with your project's goals and objectives, and have gathered as much background information as possible on the area you will be monitoring, it is time to focus on the details of your project. Convene a planning committee consisting of the project coordinator, key volunteers, scientific advisors, and data users, along with your QAPP team. This committee should address the following questions:

› What parameters or conditions will you monitor, and which are most important to your needs? Which are of secondary importance?

› How good does your monitoring data need to be?

› How will you pick your sampling sites, and how will you identify them over time?

› What methods or protocols will you use for sampling and analyzing samples?

› When will you conduct the monitoring?

› How will you manage your data and ensure your data are credible?

As a general rule, it is a good idea to start small and build to a more ambitious project as your volunteers and staff grow more experienced.

## STEP 6

## Develop an implementation plan

You've done the hard part once you've developed your monitoring project design. The next step is to decide the particulars -- the logistics, if you will. These are, essentially, the whos and whens of your project.

Determine *who* will carry out individual tasks such as volunteer training, data management, report generation, assuring lab and field quality assurance, and recruiting volunteers. If you send your samples to an outside lab, choose the lab and specify why you chose it.

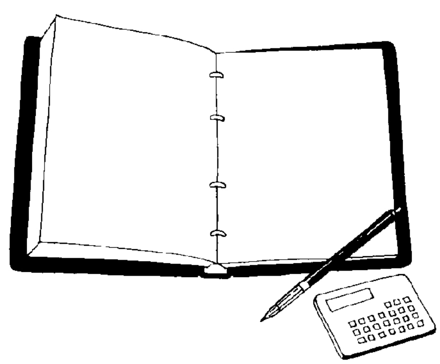
Set up schedules for *when* you will recruit and train volunteers, conduct sampling and lab work, produce reports, and report back to volunteers or the community.

***Your standard operating procedures (SOPs) are the details on all the methods you expect your volunteers to use. This can serve as the project handbook you give your volunteers.***

## STEP 7

## Draft your standard operating procedures and QAPP

Now it's time to actually write your standard operating procedures and develop a draft QAPP. Your standard operating procedures (SOPs) are the details on all the methods you expect your volunteers to use and can serve as the project handbook you give your volunteers. Remember, there are many SOPs already available for sampling and analytical procedures. Where possible, adapt your procedures from existing methods and modify them as needed to fit your project objectives. Be sure to reference and cite any existing methods and documents you use in your project.



You should append your standard operating procedures to your QAPP and refer to them throughout the QAPP document. Use the elements described in Chapter 4 as your guide in developing a draft QAPP. Your written plan can be elaborate or simple, depending on your project goals.

## STEP 8

## Solicit feedback on your draft SOPs and QAPP

Draft QAPP in hand, your next step is to run the draft by people "in the know." These are, primarily, state and EPA Regional volunteer monitoring coordinators and Quality Assurance Officers, EPA project officers, and any other agency data users (such as a representative from the county planning office or Natural Resource Conservation Service, if you are collecting data you hope they will use). Ask for their feedback and suggestions. Expect their review to take up to two or three months (times will vary).

***Based on the comments you receive from the review of your draft plan, you may have to revise your QAPP.***

While you are waiting for comments, you should probably try out your procedures with volunteers on a trial basis, to see if they really work. Don't plan to use the data at this early stage, however; you will probably be finding quirks in your plan, and the data will not be accepted by your data users until the QAPP is approved and accepted.

You may find that some of your QA contacts resist the idea of reviewing your draft plan. This is because they are often quite overburdened. Don't give up; after a reasonable time has elapsed since you submitted your plan, call back and inquire if you should submit the draft elsewhere for review. Solicit all the comments you can, from as many sources as possible.

## STEP 9

## Revise your QAPP and submit it for final approval

Based on the comments you receive from the review of your draft plan, you may have to revise your QAPP. This could involve simply being more specific about existing methods and quality control procedures in the plan, or actually modifying your procedures to meet agency requirements. Once you have revised or fine-tuned your QAPP, submit it to the proper agency for formal approval.

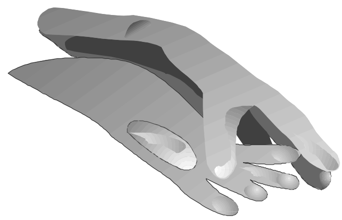
Final review/approval can take a couple of months. During this time, you may be asked to incorporate additional comments, although this is less likely if you had previously asked the approving official to review your draft.

***Note: If you are developing a QAPP simply to document your methods and are not working in cooperation with a state, local, or federal agency, you need not submit a QAPP for review and approval.***

## STEP 10

## Once the QAPP is approved, begin your monitoring project

Once you've received EPA and/or state approval of your QAPP, your monitoring project can begin. Follow the procedures described in your QAPP to train volunteers and staff, conduct sampling, analyze samples, compile results, and develop any reports.



## STEP 11

## Evaluate and refine your project over time

As time goes on, you may decide to improve on sampling techniques, site selection, lab procedures or any of the other elements of your monitoring project design. Project evaluation should occur *during* the course of your project rather than after the project or a sampling season is completed.

If you make any substantive changes in your QAPP, document them and seek EPA/state approval for the changes. A phone call to your QA official can help you determine if the changes require a new QAPP. Also, always be prepared for formal audits or QC inquiries from data users during the course of your project.

# Chapter 3: SOME BASIC QA/QC CONCEPTS

As coordinator of a volunteer monitoring program, you are probably involved in many aspects of project planning, sample collection, laboratory analysis, data review, and data assessment. You should be considering quality assurance and quality control activities in every one of these steps.

***Quality assurance (QA)*** refers to the overall *management system* which includes the organization, planning, data collection, quality control, documentation, evaluation, and reporting activities of your group. QA provides the information you need to ascertain the quality of your data and whether it meets the requirements of your project. QA ensures that your data will meet defined standards of quality with a stated level of confidence.

***QA ensures that your data will meet defined standards of quality with a stated level of confidence.***

***Quality control (QC)*** refers to the routine *technical activities* whose purpose is, essentially, error control. Since errors can occur in either the field, the laboratory or in the office, QC must be part of each of these functions. QC should include both internal and external measures (see side box).

Together, QA and QC help you produce data of known quality, enhance the credibility of your group in reporting monitoring results, and ultimately save time and money. However, a good QA/QC program is only successful if everyone consents to follow it and if all project components are available in writing. The Quality Assurance Project Plan (QAPP) is the written record of your QA/QC program.

This chapter is designed to introduce you to the terminology of quality assurance/quality control. The key terms we will be addressing are: precision, accuracy (sometimes referred to as bias), representativeness, completeness, comparability, and sensitivity. You will

### QC Measures

**Internal Quality Control** is a set of measures that the project undertakes *among its own samplers and within its own lab* to identify and correct analytical errors. Examples include lab analyst training and certification, proper equipment calibration and documentation, laboratory analysis of samples with known concentrations or repeated analysis of the same sample, and collection and analysis of multiple samples from the field.

**External Quality Control** is a set of measures that involves *laboratories and people outside of the program*. These measures include performance audits by outside personnel, collection of samples by people outside of the program from a few of the same sites at the same time as the volunteers, and splitting some of the samples for analysis at another lab.

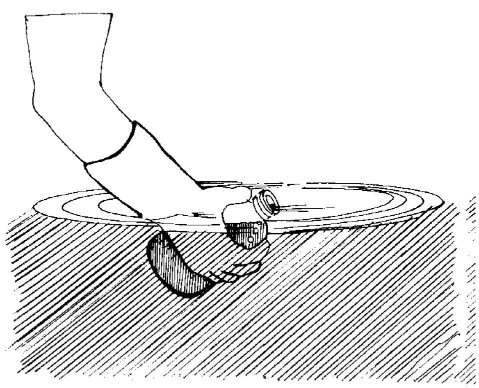
External and internal QC measures are described in more detail in the "QC Samples" box at the end of this chapter.

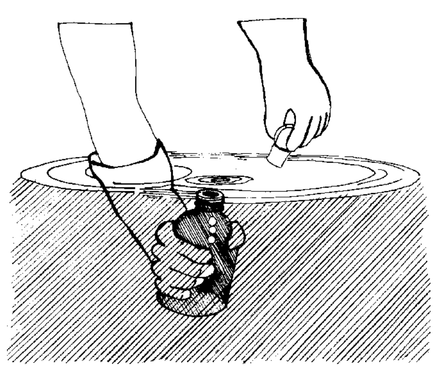
***Measures of precision, accuracy, representativeness, completeness, comparability, and sensitivity help us evaluate sources of variability and error and thereby increase confidence in our data.***

be seeing these terms again, so you may want to spend some time getting to know them.

In natural systems, such as streams, lakes, estuaries, and wetlands, variability is a factor of life. Changes in temperature, flow, sunlight, and many other factors affect these systems and the animals that inhabit them. Variability also occurs when we attempt to monitor such systems. Each of us reads, measures, and interprets differently; we may also apply different levels of effort in how we monitor. The equipment we use may be contaminated, broken or incorrectly calibrated. These and many other differences can lead to variability in monitoring results. Measures of precision, accuracy, representativeness, completeness, comparability, and sensitivity help us evaluate sources of variability and error and thereby increase confidence in our data.

Because all projects have different goals, data users and uses, capabilities, and methods, this document cannot tell you what levels of precision, accuracy, representativeness, completeness, comparability, and sensitivity are acceptable for your individual project. You will need to consult your advisory panel (in particular, your data users), the laboratory you deal with, and peer reviewers to determine acceptance criteria for your monitoring project.





## Precision

Precision is the degree of agreement among repeated measurements of the same characteristic on the same sample or on separate samples collected as close as possible in time and place. It tells you how consistent and reproducible your field or laboratory methods are by showing you how close your measurements are to each other. It does not mean that the sample results actually reflect the "true" value, but rather that your sampling and analysis are giving consistent results under similar conditions.

Typically, precision is monitored through the use of replicate samples or measurements. Replicate samples are two or more samples taken from the same place at the same time.

When you have many replicate samples, determine precision by calculating the **standard deviation(s)** of the samples. The standard deviation indicates the range of variation in the measurements you've taken. Many of today's calculators perform the standard deviation calculation.

The **relative standard deviation (RSD)**, or coefficient of variation, expresses the standard deviation as a percentage. This is generally easier for others to understand. The smaller the relative standard deviation (or standard deviation), the more precise your measurements.

When you have only two replicate samples, determine precision by calculating the **relative percent difference (RPD)** of the two samples. Again, the smaller the relative percent difference, the more precise your measurements.

## STANDARD DEVIATION

The Volunteer Creek Monitoring Project wants to determine the precision of its temperature assessment procedure. They have taken 4 replicate samples:

Replicate 1 ($X_1$) = 21.1$^0$ C
Replicate 2 ($X_2$) = 21.1$^0$ C
Replicate 3 ($X_3$) = 20.5$^0$ C
Replicate 4 ($X_4$) = 20.0$^0$ C

To determine the **Standard Deviation (s)**, use the following formula:

$$s = \sqrt{\sum_{i=1}^{n} \frac{(X_1 - \overline{X})^2}{n-1}}$$

where $x_i$ = measured value of the replicate, $\bar{x}$ = mean of replicate measurements, n = number of replicates, $\sum$ = the sum of the calculations for each measurement value--in this case, $X_1$ through $X_4$

First, figure out the mean, or average of the sample measurements. Mean = ($X_1$ + $X_2$ + $X_3$ + $X_4$) ÷ 4. In this example, the mean is equal to 20.68$^0$ C.

Then, for each sample measurement ($X_1$ through $X_4$), calculate the next part of the formula. For $X_1$ and $X_2$, the calculation would look like this:

$$\frac{(21.1 - 20.68)^2}{4-1} = \frac{(-0.42)^2}{3} = \frac{0.1764}{3} = 0.0588$$

For $X_3$ the calculation would be 0.0108; and for $X_4$ it would be 0.1541

Finally, add together the calculations for each measurement and find the square root of the sum: 0.0588 + 0.0588 + 0.0108 + 0.1541 = 0.2825. The square root of 0.2825 is 0.5315.

So, the standard deviation for temperature is 0.532 (rounded off).

## RELATIVE STANDARD DEVIATION

If we use the same replicate measurements as above in the standard deviation example, we can determine the **Relative Standard Deviation (RSD)**, or coefficient of variation, using the following formula:

$$RSD = \frac{s}{\overline{X}} \times 100$$

where s = standard deviation and $\bar{x}$ = mean of replicate samples.

We know s = 0.5315 and that $\bar{x}$ = 20.68. So, the RSD = 2.57. This means that our measurements deviate by about 2.57%.

## RELATIVE PERCENT DIFFERENCE

If the Volunteer Creek project had only two replicates (21.1$^0$ C and 20.5$^0$ C) they would use **Relative Percent Difference (RPD)** to determine precision.

$$RPD = \frac{(X_1 - X_2) \times 100}{(X_1 + X_2) \div 2}$$

where $X_1$ = the larger of the two values and $X_2$ = the smaller of the two values. In this example, $X_1$= 21.1$^0$ and $X_2$ = 20.5$^0$.

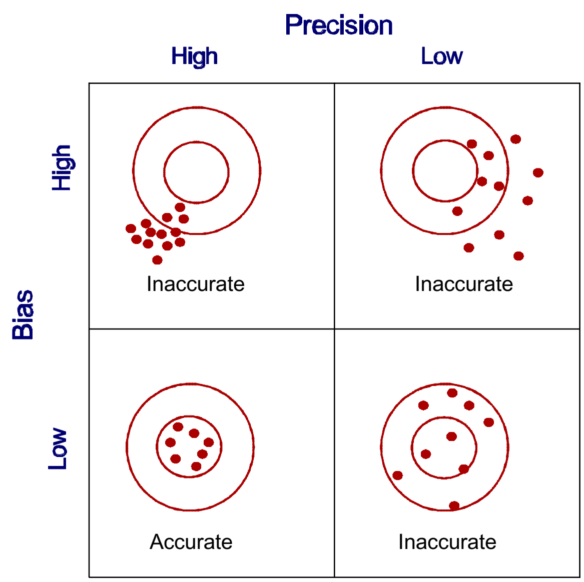
$$RPD = \frac{(21.1-20.5) \times 100}{(21.1+20.5) \div 2} = \frac{60.00}{20.8} = 2.88$$

So, in this example, the RPD between our sample measurements is 2.88%.

## Accuracy

Accuracy is a measure of confidence in a measurement. The smaller the difference between the measurement of a parameter and its "true" or expected value, the more accurate the measurement. The more precise or reproducible the result, the more reliable or accurate the result.

**PRECISION, BIAS, AND ACCURACY**




Measurement accuracy can be determined by comparing a sample that has a known value, such as a standard reference material or a performance evaluation sample, to a volunteer's measurement of that sample (see note below). Increasingly, however, some scientists, especially those involved with statistical analysis of measurement data, have begun to use the term "bias" to reflect this error in the measurement system and to use "accuracy" as indicating both the degree of precision and bias (see "bullseye" figure at left). For the purpose of this document, the term "accuracy" will be used.

If you are concerned that other components of a sample matrix (e.g., soil or sludge) may be interfering with analysis of a parameter, one way to measure accuracy is to add a known concentration of the parameter to a portion of the sample. This is called a spiked sample. The difference between the original measurement of the parameter in the sample and the measurement of the spiked sample should equal (or be close to) the added amount. The difference indicates your ability to obtain an accurate measurement.

**ACCURACY**

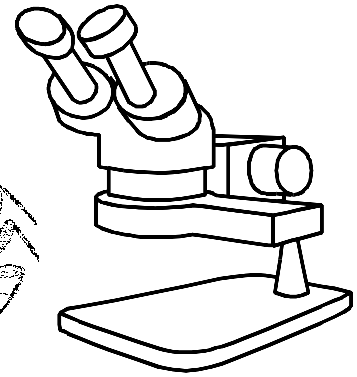
Attendance at QC training sessions is required for Volunteer Creek monitors. In the field, monitors use a Jones Wide-Range pH Kit, which covers a full range of expected pH values. During a recent training session, the monitors recorded the following results when testing a pH standard buffer solution of 7.0 units.

| | | | |
|---|---|---|---|
| 7.5 | 7.2 | 6.5 | 7.0 |
| 7.4 | 6.8 | 7.2 | 7.4 |
| 6.7 | 7.3 | 6.8 | 7.2 |

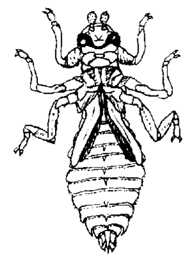
***Accuracy = average value - true value***

The average of these measurements is equal to 7.08 units. Since we know that the reference or “true” value is 7.0 units, the difference between the average pH value is off or biased by + 0.08 units. This level of accuracy is satisfactory for the data quality objectives of the project.

For many parameters such as secchi depth and macroinvertebrate abundance, no standard reference or performance evaluation samples exist. In these cases, the trainer's results may be considered the reference value to which the volunteer's results are compared. This process will help evaluate if the volunteer measurements are biased as compared to the trainer's.



If you are monitoring biological conditions by collecting and identifying specimens, maintaining a voucher collection is a good way to determine if your identification procedures are accurate. The voucher collection is a preserved archive of the organisms your volunteers have collected and identified. An expert taxonomist can then provide a "true" value by checking the identification in the voucher collection.



It is important to note that the relationship between a voucher collection and accurate identification cannot be expressed numerically in your QAPP. Rather, the QAPP document should indicate that you have a voucher collection and describe how it is used to evaluate consistent accurate identification in your program.

***Note: Standard reference material (in the form of solids or solutions with a certified known concentration of pollutant) can be obtained from a variety of companies, including the National Institute of Standard and Technologies, that sell quality control, proficiency, or scientific reference materials.***

## Representativeness

Representativeness is the extent to which measurements actually depict the true environmental condition or population you are evaluating. A number of factors may affect the representativeness of your data. For instance, are your sampling locations indicative of the waterbody? Data collected just below a pipe outfall is not representative of an entire stream. Minimizing the effects of variation is critical in the development of your sampling design.

## Completeness

Completeness is a measure of the number of samples you must take to be able to use the information, as compared to the number of samples you originally planned to take. Since there are many reasons why your volunteers may not collect as many samples as planned, as a general rule you should try to take more samples than you determine you actually need. This issue should be discussed within your QAPP team and by peer reviewers before field activities begin.

## COMPLETENESS

The Volunteer Creek Monitoring project planned to collect 20 samples, but because of volunteer illness and a severe storm, only 17 samples were actually collected. Furthermore, of these, two samples were judged invalid because too much time elapsed between sample collection and lab analysis. Thus, of the 20 samples planned, only 15 were judged valid.

The following formula is used to determine **Percent Completeness (%C).**

$$\%C = \frac{v}{T} x 100$$

where v = the number of planned measurements judged valid and T = the total number of measurements.

In this example, v = 15 and T = 20. In this case, percent completeness would be 75 percent. Is this enough information to be useful?

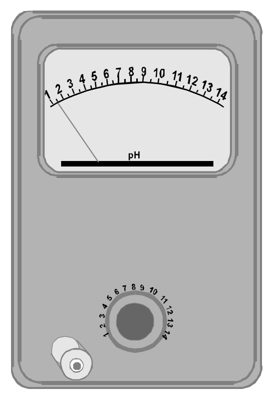
To calculate percent completeness, divide the number of measurements that have been judged valid by the total number of measurements you originally planned to take and then multiply by 100.

Remember, completeness requirements can be lowered if extra samples are factored into the project. The extra samples in turn, increase the likelihood of more representative data.

## Comparability

Comparability is the extent to which data from one study can be compared directly to either past data from the current project or data from another study. For example, you may wish to compare two seasons of summer data from your project or compare your summer data set to one collected 10 years ago by state biologists.

Using standardized sampling and analytical methods, units of reporting, and site selection procedures helps ensure comparability. However, it is important to keep in mind that some types of monitoring rely heavily on best professional judgement and that standard methods may not always exist.

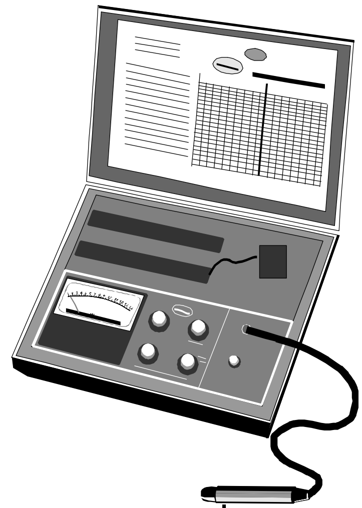



## Detection Limit

The term *detection limit* can apply to monitoring and analytical instruments as well as to methods. In general, detection limit is defined as the lowest concentration of a given pollutant your methods or equipment can detect and report as greater than zero. Readings that fall below the detection limit are too unreliable to use in your data set. Furthermore, as readings approach the detection limit (that is, as they go from higher, easier-to-detect concentrations to lower, harder-to-detect concentrations) they become less and less reliable. Manufacturers generally provide detection limit information with high-grade monitoring equipment such as meters.

## Measurement Range

The *measurement range* is the range of reliable measurements of an instrument or measuring device. Preassembled kits usually come with information indicating the measurement range that applies. For example, you might purchase a kit that is capable of detecting pH falling between 6.1 and 8.1. However, pH can theoretically range from 0.0 to 14.00. If acidic conditions (below 6) are a problem in the waters you are monitoring, you will need to use a kit or meter that is sensitive to the lower pH ranges.



## Quality Control (QC) Samples

Contamination is a common source of error in both sampling and analytical procedures. QC samples help you identify when and how contamination might occur. For most projects, there is no set number of field or laboratory QC samples which must be taken. The general rule is that 10% of samples should be QC samples. This means that if 20 samples are collected, at least one additional sample must be added as a QC sample. The laboratory must also run its own QC samples. For a new monitoring project or for a new analytical procedure, it is a good idea to increase the number of QC samples (up to 20%) until you have full confidence in the procedures you are using.

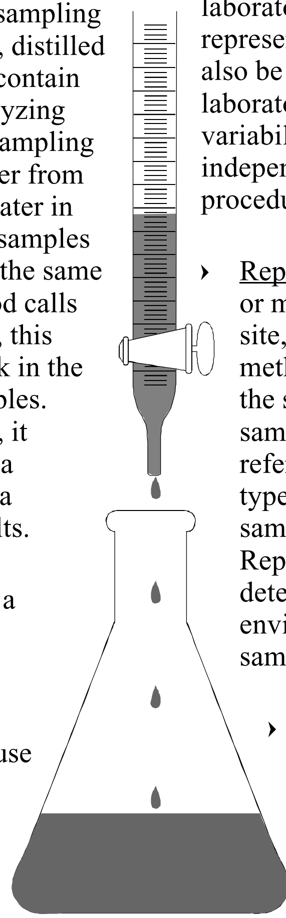
***The general rule is that 10% of samples should be quality control (QC) samples.***

When the project is over, determine data quality by evaluating the results of all the QC samples and determining precision and accuracy. For QC samples that are not blind to the lab, require the lab to calculate and report precision and accuracy results. Lab reported precision and accuracy results can then be checked during data validation.

The decision to accept data, reject it, or accept only a portion of it is should be made after analysis of all QC data. Various types of QC samples are described in the box on the next page.

# QC SAMPLES

- A field blank is a "clean" sample, produced in the field, used to detect analytical problems during the whole process (sampling, transport, and lab analysis). To create a field blank, take a clean sampling container with "clean" water (i.e., distilled or deionized water that does not contain any of the substance you are analyzing for) to the sampling site. Other sampling containers will be filled with water from the site. Except for the type of water in them, the field blank and all site samples should be handled and treated in the same way. For example, if your method calls for the addition of a preservative, this should be added to the field blank in the same manner as in the other samples. When the field blank is analyzed, it should read as analyte-free or, at a minimum, the reading should be a factor of 5 below all sample results.



- An equipment or rinsate blank is a "clean" sample used to check the cleanliness of sample collection equipment. This type of blank is used to evaluate if there is carryover contamination from reuse of the same sampling equipment. A sample of distilled water is collected in a sample container using regular collection equipment and analyzed as a sample.

- A split sample is one sample that is divided equally into two or more sample containers and then analyzed by different analysts or labs. Split samples are used to measure precision. Samples should be thoroughly mixed before they are divided. Large errors can occur if the analyte is not equally distributed into the two containers. A sample can be split in the field, called a field split, or in the laboratory, a lab split. The lab split measures analytical precision while the field split measures both analytical and field sampling precision. In addition, a sample split in the field and submitted to the laboratory without informing the laboratory represents a blind sample. Split samples can also be submitted to two different laboratories for analysis to measure the variability in results between laboratories independently using the same analytical procedures.

- Replicate samples are obtained when two or more samples are taken from the same site, at the same time, using the same method, and independently analyzed in the same manner. When only two samples are taken, they are sometimes referred to as duplicate samples. These types of samples are representative of the same environmental condition. Replicates (or duplicates) can be used to detect both the natural variability in the environment and that caused by field sampling methods.

- Spiked samples are samples to which a known concentration of the analyte of interest has been added. Spiked samples are used to measure accuracy. If this is done in the field, the results reflect the effects of preservation, shipping, laboratory preparation, and analysis. If done in the laboratory, they reflect the effects of the analysis from the point when the compound is added, e.g. just prior to the measurement step. Percent recovery of the spike material is used to calculate analytical accuracy.

# Chapter 4: ELEMENTS OF A QAPP

This chapter discusses the 24 elements of a Quality Assurance Project Plan, as outlined in EPA quality assurance guidance, *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations* (EPA QA/R-5, August 1994). It is very likely that not all elements will apply to your project. This is an issue that should be discussed with your QAPP team and any group who will be approving the QAPP. If your project does not require all 24 elements, indicate in your QAPP which elements you will not be including. This will make review and approval of your QAPP faster and easier.

Throughout this chapter, brief examples are included. The examples are drawn from a fictional monitoring project--the *Volunteer Creek Monitoring Project*. They are not intended to be comprehensive, but rather simply to help illustrate the type of information that might be included in the elements of a QAPP. For more information, you may wish to contact other volunteer monitoring programs with approved QAPPs.

### ELEMENTS OF A QAPP

**Project Management** **(elements 1-9)**

1. Title and Approval Page
2. Table of Contents
3. Distribution List
4. Project/Task Organization
5. Problem Identification/ Background
6. Project/Task Description
7. Data Quality Objectives for Measurement Data
8. Training Requirements/ Certification
9. Documentation and Records

**Measurement/Data Acquisition** **(elements 10-19)**

10. Sampling Process Design
11. Sampling Methods Requirements
12. Sample Handling and Custody Requirements
13. Analytical Methods Requirements
14. Quality Control Requirements
15. Instrument/Equipment Testing, Inspection, and Maintenance Requirements
16. Instrument Calibration and Frequency
17. Inspection/Acceptance Requirements for Supplies
18. Data Acquisition Requirements
19. Data Management

**Assessment and Oversight** **(elements 20-21)**

20. Assessment and Response Actions
21. Reports

**Data Validation and Usability** **(elements 22-24)**

22. Data Review, Validation, and Verification Requirements
23. Validation and Verification Methods
24. Reconciliation with Data Quality Objectives

## 1 TITLE AND APPROVAL PAGE

Your title page should include the following:

- title and date of the QAPP
- names of the organizations involved in the project
- names, titles, signatures, and document signature dates of all appropriate approving officials such as project manager, project QA officer, and, if the project is funded by EPA, the EPA project manager and QA officer.

## 2 TABLE OF CONTENTS

A Table of Contents should include section headings with appropriate page numbers and a list of figures and tables.

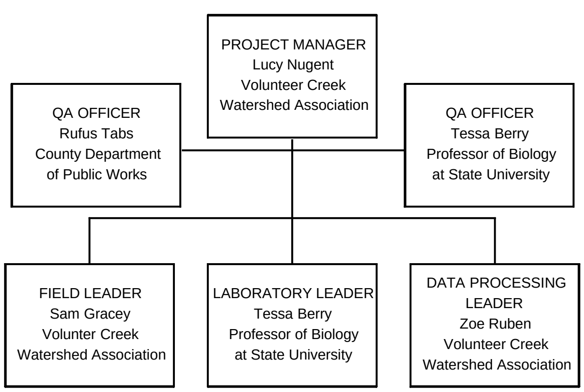
## 3 DISTRIBUTION LIST

List the individuals and organizations that will receive a copy of your approved QAPP and any subsequent revisions. Include representatives of all groups involved in your monitoring effort.

## 4 PROJECT/ TASK ORGANIZATION

Identify all key personnel and organizations that are involved in your program, including data users. List their specific roles and responsibilities. In many monitoring projects, one individual may have several responsibilities. An organizational chart is a good way to graphically display the roles of key players.


### ELEMENT 4
**Project/Task Organization**




In addition to the project officers shown, the Volunteer Creek Monitoring Project also has an Advisory Panel consisting of representatives from EPA, the state Department of Environmental Conservation (DEC), and the County Department of Public Works (DPW). Each of the leaders shown serves on the Advisory Panel. Major responsibilities of all personnel are detailed in the Volunteer Creek SOPs, attached to this document. The primary data users are the state DEC and the County DPW.

## 5 PROBLEM DEFINITION / BACKGROUND

In a narrative, briefly state the problem your monitoring project is designed to address. Include any background information such as previous studies that indicate why this project is needed. Identify how your data will be used and who will use it.

### ELEMENT 5
**Problem Definition/Background**

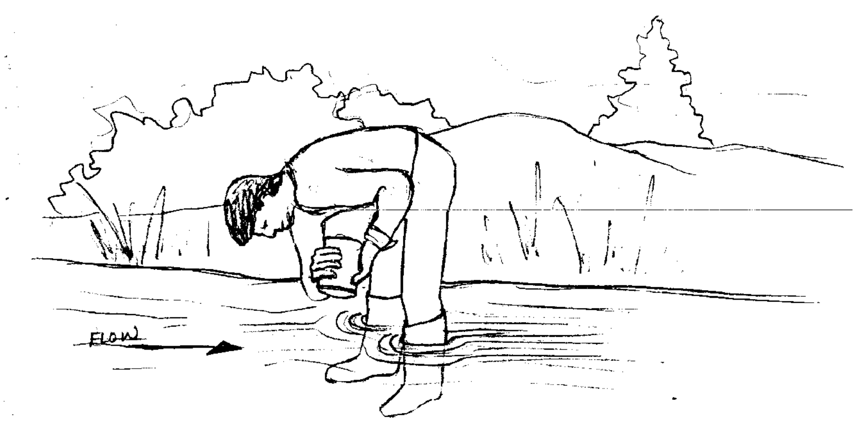
Volunteer Creek flows through an urbanizing watershed. As more communities are built, the quantity of stormwater runoff will increase. Working together, local residents and government agencies have developed plans to implement best management practices, or BMPs, designed to minimize the potential negative water quality impacts to Volunteer Creek.

The organizers of the monitoring project, including the Volunteer Creek Watershed Association, the County Department of Public Works and the State Department of Natural Resources, want to document conditions of the stream before and after development to evaluate the effects of stormwater management BMPs.

The data collected will be used by the county and state to evaluate how well these BMPs are working and to help identify specific problems that require further attention or study. The watershed association will also use the data to educate residents on the connections between land-use and water quality.

## 6 PROJECT/TASK DESCRIPTION

In general terms, describe the work your volunteers will perform and where it will take place. Identify what kinds of samples will be taken, what kinds of conditions they will measure, which are critical, and which are of secondary importance. Indicate how you will evaluate your results--that is, how you will be making sense out of what you find. For example, you may be comparing your water quality readings to State or EPA standards, or comparing your macroinvertebrate evaluations to State-established reference conditions or historical information.



Include an overall project timetable that outlines beginning and ending dates for the entire project as well as for specific activities within the project. The timetable should include information about sampling frequency, lab schedules, and reporting cycles.

## ELEMENT 6
### Project/Task Description

From January through March 1996, the Watershed Association will conduct initial volunteer recruitment and training in conjunction with the county and state. A second recruitment drive as well as training and retraining sessions will be held from August to October.

Monthly water sampling of temperature, pH, turbidity, and dissolved oxygen will occur throughout the calendar year at each of 20 sites. At the same sites, macroinvertebrate and habitat assessments will be conducted in March, July, and October. In order to characterize the stream and to create a baseline of data, each of these evaluations is a critical component of the overall study. For informational and educational purposes, volunteers will also record characteristics such as water odor and color during each assessment. Macroinvertebrate taxonomy will take place in April, August, and November at the state university biology laboratory.

Following each assessment, all data will be entered into the computerized management system and analyzed. Interim report of findings will be produced and distributed in May and September. A final, year-end report will be produced and distributed in January 1997.

| MAJOR TASK CATEGORIES | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| volunteer recruitment, training, and re-training | X | X | X | | | | | X | X | X | | |
| monthly pH, temp., turbidity, & dissolved oxygen sampling | X | X | X | X | X | X | X | X | X | X | X | X |
| seasonal macroinvertebrate & habitat assessments | | | X | | | | X | | | X | | |
| lab analysis | | | | X | | | | X | | | X | |
| data processing, analysis & reporting | | | | | X | X | | | X | X | X | X |

## 7 DATA QUALITY OBJECTIVES FOR MEASUREMENT DATA

Data Quality Objectives (DQOs) are the quantitative and qualitative terms you use to describe how good your data need to be to meet your project's objectives. DQOs for *measurement data* (referred to here as data quality indicators) are precision, accuracy, representativeness, completeness, comparability, and measurement range. Provide information on these indicators, in quantitative terms if possible. See Chapter 3 for a further discussion of these terms.

Since it is important to develop a QAPP prior to monitoring, it may not be possible to include actual numbers for some of the data quality measurements within the first version of the document. You will need, however, to discuss your goals or objectives for data quality and the methods you will use to make actual determinations after monitoring has begun. You must also discuss at what point changes will be made if project specifications are not achieved. Data quality indicators should be given for each parameter you are measuring, in each "matrix" (i.e., substance you are sampling from, such as water or sediment). The easiest way to present quantitative information is in a table.

In some types of monitoring, particularly macroinvertebrate monitoring and habitat assessment, some data quality indicators cannot be quantitatively expressed. In that case, you can fulfill this requirement of the QAPP by citing and describing the method used and by providing as many of the data quality indicators as possible (e.g., completeness, representativeness, and comparability) in narrative form.

## ELEMENT 7
### Data Quality Objectives for Measurement Data

**Precision, Accuracy, Measurement Range**
The following table illustrates the precision, accuracy and measurement range for the Volunteer Creek pH, temperature, turbidity, and dissolved oxygen assessments.

| Matrix | Parameter | Precision | Accuracy | MR* |
|---|---|---|---|---|
| water | pH | ±20% | ±0.5 | 3 to 10.5 units |
| water | temperature | ±20% | | |
| water | dissolved oxygen | ±20% | ±0.3mg/L | 1 to 20 mg/l |
| water | turbidity | ±20% | ±0.2mg/L | 0 to 1000 NTU |

* MR = measurement range

**Representativeness**
In the Volunteer Creek project's assessment, representativeness depends largely on randomized sampling. The creek is a high-gradient stream with a predominance of riffle habitats. Monitoring sites selected for this study are indicative of that habitat type and the program uses sampling techniques developed for high-gradient streams. In addition, for the macroinvertebrate collection, volunteers sample at three locations within the riffle and then composite (combine) the samples so as to be more generally reflective of the entire riffle habitat.

**Comparability**
One of the ways that the Volunteer Creek program ensures comparability is to follow the monitoring protocol established by the State for assessment and analysis. Volunteers also use standardized taxonomic keys to identify macroinvertebrates to the family level.

**Completeness**
There are no legal or compliance uses anticipated for the Volunteer Creek data. In addition, there is no fraction of the planned data that must be collected in order to fulfill a statistical criteria. It is expected that samples will be collected from at least 90% of the sites unless unanticipated weather conditions prevent sampling.

***Precision*** is the degree of agreement among repeated measurements of the same characteristic, or parameter, and gives information about the consistency of your methods.

***Accuracy*** is a measure of confidence that describes how close a measurement is to its “true” value.

***Measurement Range*** is the range of reliable readings of an instrument or measuring device, as specified by the manufacturer.

***Representativeness*** is the extent to which measurements actually represent the true environmental condition.

***Comparability*** is the degree to which data can be compared directly to similar studies. Using standardized sampling, analytical methods, and units of reporting helps to ensure comparability.

***Completeness*** is the comparison between the amount of data you planned to collect versus how much usable data you collected, expressed as a percentage.

## 8 TRAINING REQUIREMENTS / CERTIFICATION

Identify any specialized training or certification requirements your volunteers will need to successfully complete their tasks. Discuss how you will provide such training, who will be conducting the training, and how you will evaluate volunteer performance.

### ELEMENT 8
#### Training Requirements/ Certification

Volunteer Creek monitors participate in a two-day field training course conducted by state and local water quality personnel. On the first day, volunteers are instructed how to calibrate equipment and perform physical and chemical tests and analyses. The second day is devoted to macroinvertebrate and habitat sampling. Volunteers for the taxonomy lab receive a separate day of training. All participants are required to attend an annual refresher course as well.

Performance is evaluated in the field and the lab. During initial and renewal training sessions, volunteers perform a simultaneous dip-in determination of pH, temperature, and dissolved oxygen. Volunteers also determine turbidity levels of water samples using meters at the lab. In addition, during training, participants conduct macroinvertebrate sampling in small groups with trainers. To evaluate volunteer skill in the taxonomy lab, volunteers are trained and re-trained using previously identified samples from earlier assessments.

# 9 Documentation and Records

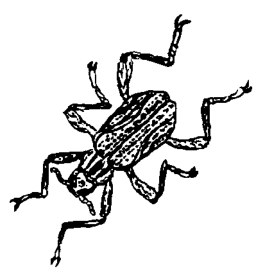
Identify the field and laboratory information and records you need for this project. These records may include raw data, QC checks, field data sheets, laboratory forms, and voucher collections. Include information on how long, and where, records will be maintained. Copies of all forms to be used in the project should be attached to the QAPP.

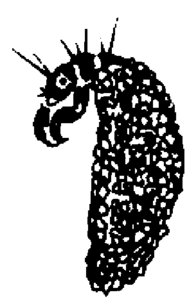
## Element 9
### Documentation and Records

Each Volunteer Creek field sampling sheet must be completed on-site at the time sampling occurs. Volunteers record site number, location, the date and time the sample was collected, and the name of each team member. Contact information for the team captain or monitor responsible for returning field sheets and macroinvertebrate samples to the watershed association office is also included on each field sheet.

Volunteers make a copy of each field sheet and keep the copy with their records. The original is returned to the Volunteer Creek Watershed Association office along with the macroinvertebrate sample (if taken). Field sheets are archived for three years. After macroinvertebrate samples have been identified, laboratory record sheets are maintained in the watershed association office for three years. Hard copies of all data as well as computer back-up disks are maintained by the Association. A macroinvertebrate voucher collection is maintained by the state university biology lab for five years.

| VOLUNTEER CREEK MONITORING PROJECT | | |
|---|---|---|
| Site #: _____ | Site Location: | |
| Date: __/__/__ | Time: _____ AM PM | |
| Team Captain: | | Phone #: |
| Address: | | |
| Other Monitoring Team Members: | | |





# 10 Sampling Process Design

Outline the experimental design of the project including information on types of samples required, sampling frequency, sampling period (e.g., season), and how you will select sample sites and identify them over time. Indicate whether any constraints such as weather, seasonal variations, stream flow or site access might affect scheduled activities, and how you will handle those constraints. Include site safety plans. You may cite the sections of your program's SOPs which detail the sampling design of the project, in place of extensive discussion.

## Element 10
### Sampling Process Design

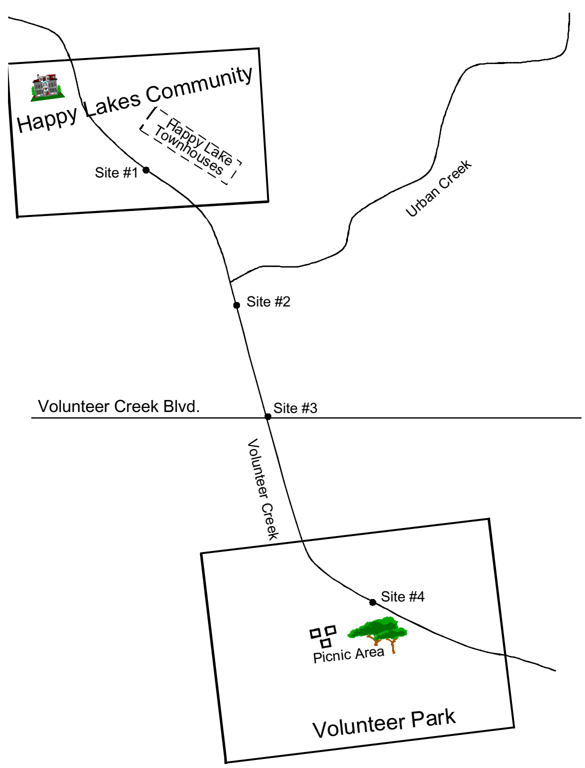
Volunteer Creek monitoring sites are sampled monthly for pH, temperature, turbidity, and dissolved oxygen. In March, July and October, a macroinvertebrate and habitat assessment is conducted at each site. Monitoring sites are identified by a number and a location.

If possible, volunteers are asked to wait at least 10 days after a heavy rain or snowfall before sampling. If this is not possible, they are instructed to contact the Field Leader so that this information can be noted immediately. In addition, if volunteers cannot conduct the scheduled sampling, they are instructed to contact the Field Leader as soon as possible, so that an alternative monitor can be found. Volunteers are instructed to work in teams of at least two people. Three team members are recommended for the macroinvertebrate sampling. If a scheduled team cannot conduct the sampling together, the team captain is instructed to contact the Field Leader so that arrangements can be made for a substitute.

Prior to final site selection, permission to access the stream is obtained from all property owners. If for some reason access to the site is a problem, the team captain is instructed to contact the Field Leader. All constraints and safety plans are detailed in the Volunteer Creek SOPs.

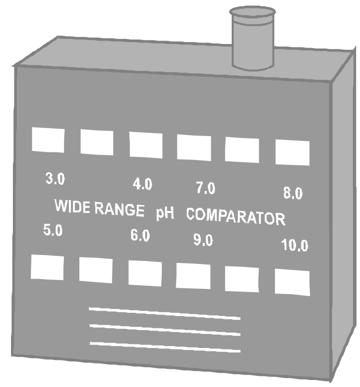
Four, or 20%, of the sampling sites surround Volunteer Creek Boulevard, which is being widened to accommodate growing residential and commercial development. They are located as follows:

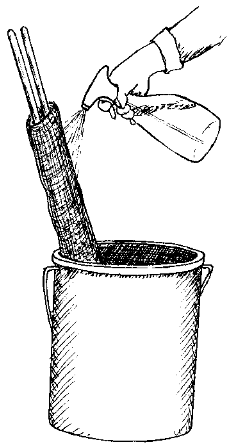
- Site #1 adjacent to the new townhome development in the Happy Lakes Community
- Site #2 downstream of the confluence with Urban Creek
- Site #3 at the crossing of Volunteer Creek Boulevard
- Site #4 within Volunteer Park, adjacent to the picnic area



# 11 Sampling Methods Requirements

Describe your sampling methods. Include information on parameters to be sampled, how samples will be taken, equipment and containers used, sample preservation methods used, and holding times (time between taking samples and analyzing them). If samples are composited (i.e., mixed), describe how this will be done. Describe procedures for decontamination and equipment-cleaning. (For example, kick nets need to be thoroughly rinsed and examined for clinging organisms between sampling events.) Most of this information can be presented in a table or you may also cite any SOPs that contain this information.



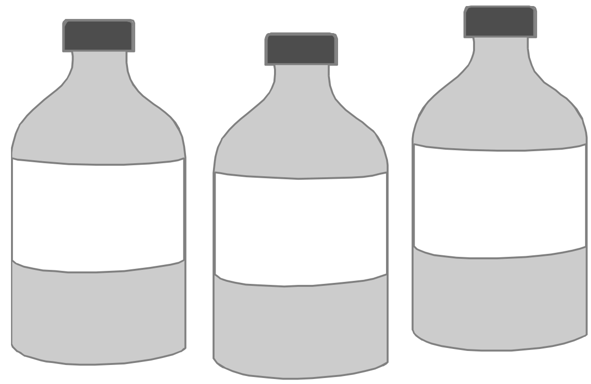
## Element 11
### Sampling Methods Requirements

The Volunteer Creek SOP, attached to this document, contains detailed information on all sampling protocols and equipment. The table below summarizes a portion of this information.

| Matrix | Parameter | Sampling Equipment | Sample Holding Container | Method Sample Preservative | Maximum Holding Time |
|---|---|---|---|---|---|
| water | pH | Jones pH color comparator kits | screw top, glass sample bottle | none | immediately |
| water | temperature | Smith armored thermometer | none, measurement taken instream | none | immediately |
| water | dissolved oxygen | Jones DO kit | screw top, glass sample bottle | none | immediately |
| water | turbidity | Jones turbidity meter | screw top glass sample bottle | store on ice | 48 hours |
| substrate | macroinvertebrates | 3' X 3' kicknet; 500 micron mesh | 1 liter plastic wide-mouth bottle | 90% ethyl alcohol | 6 weeks |

# 12 Sample Handling and Custody Requirements

Sample handling procedures apply to projects that bring samples from the field to the lab for analysis, identification, or storage.



These samples should be properly labeled in the field. At a minimum, the sample identification label should include sample location, sample number, date and time of collection, sample type, sampler's name, and method used to preserve sample.

Describe the procedures used to keep track of samples that will be delivered or shipped to a laboratory for analysis. Include any chain-of-custody forms and written procedures field crews and lab personnel should follow when collecting, transferring, storing, analyzing, and disposing of samples.

## Element 12

### Sample Handling and Custody Requirements

All macroinvertebrate samples collected as part of the Volunteer Creek project are labeled in the field. The chain-of-custody for these samples is as follows: In the field, samples are the responsibility of, and stay with, the team captain. Once samples have been collected they are returned, by the monitoring team captain, to the Volunteer Creek Watershed Association office for temporary storage. The date and time of arrival is recorded by the Field Leader who is then responsible for transporting samples to the university laboratory for analysis. The date and time of arrival is also recorded at the lab by the Laboratory Leader. After samples are analyzed, laboratory information is added to the label. Samples are then stored and maintained in the university's biological lab for a minimum of three years. A chain-of-custody form is used to record all transport and storage information

VOLUNTEER CREEK PROJECT
MACROINVERTEBRATE SAMPLE LABEL

FIELD INFORMATION:

Site #: __________ Location: ________________

Sample Number _______ of ________

Preservation Method: __________ Gear: _______

Date: __/__/__ Time: _______ AM PM

Team Captain: ______________________________

Phone #: __________________________________

LAB INFORMATION:

Date: __/__/__ Time: _______ AM PM

Analyst: ___________________________________

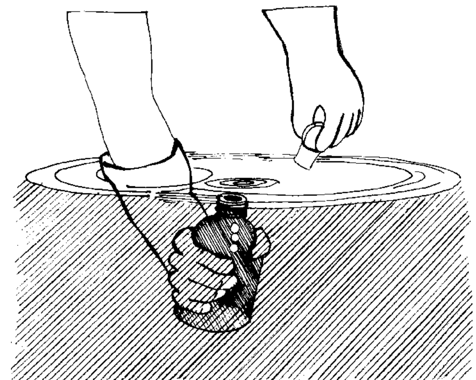
Phone #: __________________________________

## 13 ANALYTICAL METHODS REQUIREMENTS

List the analytical methods and equipment needed for the analysis of each parameter, either in the field or the lab. If your program uses standard methods, cite these. If your program's methods differ from the standard or are not readily available in a standard reference, describe the analytical methods or cite and attach the program's SOPs.

### ELEMENT 13
#### Analytical Methods Requirements

In the Volunteer Creek project, pH, temperature and dissolved oxygen are measured using protocols outlined in the *Citizen's Program for the Chesapeake Bay's Citizen Monitoring Manual*. Protocols for measuring turbidity come from the EPA document, *Volunteer Stream Monitoring: A Methods Manual*. Macroinvertebrate and habitat assessment methods and equipment are based on the protocols established by the state monitoring program. Each of these protocols is detailed in the Volunteer Creek SOP, attached to this document.



## 14 QUALITY CONTROL REQUIREMENTS

List the number and types of field and laboratory quality control samples your volunteers will take. (See Chapter 3 for a discussion of quality control samples.) This information can be presented in a table. If you use an outside laboratory, cite or attach the lab's QA/QC plan.

QC checks for biological monitoring programs can be described narratively, and, if appropriate, should include discussion of replicate sample collection, cross checks by different field crews, periodic sorting checks of lab samples, and maintenance of voucher and reference collections. Describe what actions you will take if the QC samples reveal a sampling or analytical problem.

### ELEMENT 14
#### Quality Control Requirements

Replicate samples for all measurement parameters are taken at three (randomly selected) sites of the 20 Volunteer Creek monitoring sites during each sampling period (i.e. monthly for pH, temperature, turbidity, and dissolved oxygen and seasonally for macroinvertebrates). Additional QC samples include split samples and field blanks, each taken at 10% of the sites.

In addition, at least three of the macroinvertebrate samples will be reidentified by the laboratory leader during each lab session. Both a macroinvertebrate voucher and reference collection will be maintained. If sampler problems are found, the data is either thrown-out or qualified, depending on the degree of the problem, and arrangements made for monitor retraining. All volunteers are retrained at least once a year in both field and lab procedures by professional personnel.

# 15 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

Describe your plan for routine inspection and preventive maintenance of field and lab equipment and facilities. Identify what equipment will be routinely inspected, and what spare parts and replacement equipment will be on hand to keep field and lab operations running smoothly. Include an equipment maintenance schedule, if appropriate.

## Element 15
### Instrument/Equipment Testing, Inspection, and Maintenance Requirements

As part of its instrument and equipment maintenance, the Volunteer Creek project performs a variety of tests. Before usage, the mercury column of each thermometer is inspected for breaks. Replacement thermometers are available from the Field Leader at the Watershed Association office. All pH and DO kits are checked to be sure all reagents, bottles, droppers, and color comparators are clean and in good working order. Reagents are replaced annually according to manufacturer's recommendations. Reagents and replacement bottles are available from the Field Leader. The turbidity meters are inspected by the Lab Manager prior to each sampling event and maintenance logs are kept on each meter. The Field Leader maintains a maintenance log book to track scheduled maintenance on all equipment. All records and equipment are held at the Volunteer Creek Watershed Association offices.

# 16 Instrument Calibration and Frequency

Identify how you will calibrate sampling and analytical instruments. Include information on how frequently instruments will be calibrated, and the types of standards or certified equipment that will be used to calibrate sampling instruments. Indicate how you will maintain calibration

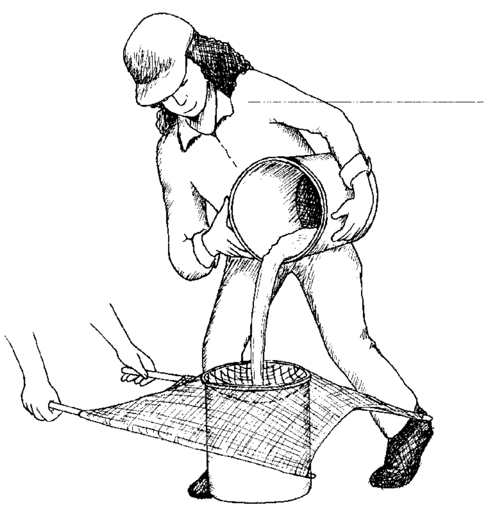
## Element 16
### Instrument Calibration and Frequency

The Volunteer Creek project's turbidity meters will be calibrated, prior to each sampling event, according to the manufacturer's instructions and using the manufacturer's turbidity standards. Calibration results are recorded in a log book and maintained by the Lab Manager. Calibration procedures and standards are contained in the SOP manual, available upon request.

records and ensure that records can be traced to each instrument. Instrument calibration procedures for biological monitoring programs should include routine procedures that ensure that equipment is clean and in working order.

## 17 Inspection and Acceptance Requirements for Supplies

Describe how you determine if supplies such as sample bottles, nets, and reagants are adequate for your program's needs.



### Element 17
**Inspection and Acceptance Requirements for Supplies**

The Volunteer Creek project uses kick-nets for macroinvertebrate assessments. The nets are 3' X 3' attached to cylindrical wooden poles. The mesh used is 500 micron and is consistent with that used by the state monitoring program. Netting, cut into appropriate size squares, is purchased from a scientific supply house. Poles and hardware are purchased from a local supplier. All supplies and equipment are purchased under the supervision of the Field Leader.

Nets are assembled by shop students at Volunteer Creek High School. After assembly, all nets are inspected by the Field Leader. Any net that does not meet standards is taken apart and reassembled, if possible. Nets that cannot be reassembled are used for educational demonstrations. Kits and extra reagents are ordered from Smith and Jones Chemical Supply Company and inspected upon arrival by the Field Leader. Broken bottles and incomplete kits are shipped back to the manufacturer for replacement.

## 18 Data Acquisition Requirements

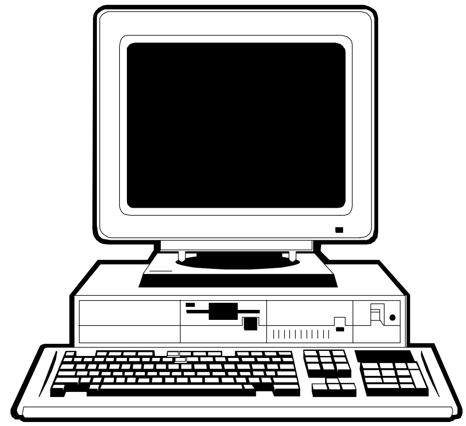
Identify any types of data your project uses that are not obtained through your monitoring activities. Examples of these types of data include historical information, information from topographical maps or aerial photos, or reports from other monitoring groups. Discuss any limits on the use of this data resulting from uncertainty about its quality.

### Element 18
**Data Acquisition Requirements**

For the Volunteer Creek macroinvertebrate assessment analysis, pollution tolerance values assigned to organisms and metric calculation formulas are taken from the literature and documentation provided by the state water quality agency. U.S.G.S. 7.5 minute topographic maps are used to identify site locations, land-use activities, and landscape features during an initial watershed survey.

## 19 Data Management

Trace the path your data take, from field collection and lab analysis to data storage and use. Discuss how you check for accuracy and completeness of field and lab forms, and how you minimize and correct errors in calculations, data entry to forms and databases, and report writing. Provide examples of forms and checklists. Identify the computer hardware and software you use to manage your data.

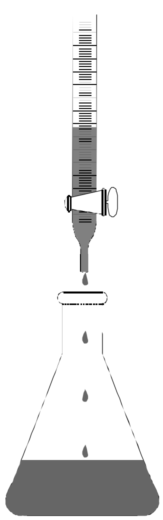


### Element 19
**Data Management**

Field data sheets are inspected and signed by the sampling team captain before leaving the site. Field sheets are given to the field leader at the end of the sampling day for review. Within 72 hours, the field leader will contact any samplers whose field sheets contain significant errors or omissions.

The lab manager will review sample labels for turbidity and macroinvertebrate samples and remove from the dataset any that cannot be attributed to specific samplers, have not been properly preserved, or that exceed the maximum holding time. The laboratory manager will also sign-off on lab bench sheets after all QC checks have been completed. These bench sheets will be transported to the Watershed Association offices so that the data can be entered.

All data will be entered into a "Volbase" computerized spreadsheet/data base program designed for this project and compatible with hardware and software used by both the state and county water resource agencies. As a QC check, finalized data will be reviewed by a second individual.



## 20 Assessments and Response Actions

Discuss how you evaluate field, lab, and data management activities, organizations (such as contract labs) and individuals in the course of your project. These can include evaluations of volunteer *performance* (for example, through field visits by staff or in laboratory refresher sessions); audits of *systems* such as equipment and analytical procedures; and audits of *data quality* (e.g., comparing actual data results with project quality objectives).

Include information on how your project will correct any problems identified through these assessments. Corrective actions might include calibrating equipment more frequently, increasing the number of regularly scheduled training sessions, or rescheduling field or lab activities.

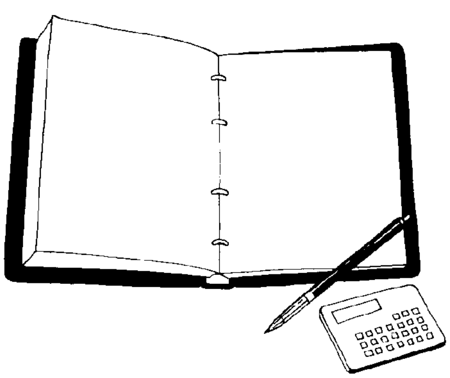
## ELEMENT 20
### Assessment and Response Actions

Review of Volunteer Creek field activities is the responsibility of the Field Leader, in conjunction with the Project Manager and the Quality Assurance Officer. Each field team will be accompanied and their performance evaluated by one of these individuals once a year. If possible, volunteers in need of performance improvement will be retrained on-site during the evaluation. In addition, volunteers attend yearly training renewal workshops. If errors in sampling techniques are consistently identified, retraining may be scheduled more frequently.

All field and laboratory activities may be reviewed by state and EPA quality assurance officers as requested. Systems and data quality audits are performed by the QA Officer twice yearly. Any identified procedural problems will be corrected based on recommendations from the QA Officer.

## 21 REPORTS

Identify the frequency, content, and distribution of reports to data users, sponsors, and partnership organizations that detail project status, results of internal assessments and audits, and how QA problems have been resolved.



## ELEMENT 21
### Reports

Volunteer Creek Interim reports will be produced and distributed in May (data collected from January-April) and September (data collected from May-August). A year-end report will be produced and distributed in January of the following year (data collected from September-December, as well as full-year results). The Project Manager is responsible for all report production and distribution. Reports will be forwarded to the county, state, regional EPA office, and other members of the Advisory Panel. These reports will consist of data results, interpretation of data (if possible), information on project status, volunteer highlights, results of QC audits and internal assessments. Summaries of all reports, highlighting the assessment results, project status, and volunteer achievements, will be distributed to all volunteers and Watershed Association members.

## 22 Data Review, Validation and Verification Requirements

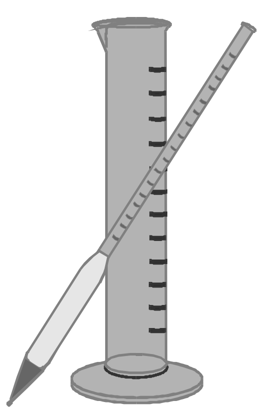
State how you review data and make decisions regarding accepting, rejecting, or qualifying the data. All that is needed here is a brief statement of what will be done, by whom.

### Element 22
#### Data Review, Validation, and Verification Requirements

All Volunteer Creek field and laboratory data is reviewed by the Project Manager, QA Officer, and Data Processing Leader to determine if the data meet QAPP objectives. In addition, personnel from the State Department of Natural Resources who are not directly connected to this project will also review data on a quarterly basis. Decisions to reject or qualify data are made by the Project Manager and the QA Officer.

## 23 Validation and Verification Methods

Describe the procedures you use to validate and verify data. This can include, for example, comparing computer entries to field data sheets; looking for data gaps; analyzing quality control data such as chain of custody information, spikes, and equipment calibrations; checking calculations; examining raw data for outliers or nonsensical readings; and reviewing graphs, tables and charts. Include a description of how errors, if detected, will be corrected, and how results will be conveyed to data users.



### Element 23
#### Validation and Verification Methods

As part of the Volunteer Creek protocol, any sample readings out of the expected range are reported to the Field Leader. A second sample is taken by the Field Leader as soon as possible to verify the condition. 10-20% of the macroinvertebrate samples are reidentified as a method of verifying data. and ensuring data quality. If an error of greater than 5% is found, all samples from that sampling period will be reidentified and the taxonomist(s) retrained.

Once the data has been entered into the Volunteer Creek database, the Data Processing Leader will print out the data and proofread it against the original data sheets. Errors in data entry will be corrected. Outliers and inconsistencies will be flagged for further review, or discarded. Problems with data quality will be discussed in the interim and final reports to data users.

# 24 Reconciliation with Data Quality Objectives

Once the data results are compiled, describe the process for determining whether the data meet project objectives. This should include calculating and comparing the project's actual data quality indicators (precision, accuracy, completeness, representativeness, and comparability) to those you specified at the start of the project, and describing what will be done if they are not the same. Actions might include discarding data, setting limits on the use of the data, or revising the project's data quality objectives.

## Element 24
### Reconciliation with Data Quality Objectives

As soon as possible after each sampling event, calculations and determinations for precision, completeness, and accuracy will be made and corrective action implemented if needed. If data quality indicators do not meet the project's specifications, data may be discarded and resampling may occur. The cause of failure will be evaluated. If the cause is found to be equipment failure, calibration/ maintenance techniques will be reassessed and improved. If the problem is found to be sampling team error, team members will be retrained. Any limitations on data use will be detailed in both interim and final reports, and other documentation as needed.

If failure to meet project specifications is found to be unrelated to equipment, methods, or sample error, specifications may be revised for the next sampling season. Revisions will be submitted to the state and EPA quality assurance officers for approval.

# Appendix A: GLOSSARY

***Accuracy.*** A data quality indicator, accuracy is the extent of agreement between an observed value (sampling result) and the accepted, or true, value of the parameter being measured. High accuracy can be defined as a combination of high precision and low bias.

***Analyte.*** Within a medium, such as water, an analyte is a property or substance to be measured. Examples of analytes would include pH, dissolved oxygen, bacteria, and heavy metals.

***Bias.*** Often used as a data quality indicator, bias is the degree of systematic error present in the assessment or analysis process. When bias is present, the sampling result value will differ from the accepted, or true, value of the parameter being assessed.

***Data Quality Objectives (DQOs) specify the quality of the data needed in order to meet the monitoring project's goals.***

***Blind sample.*** A type of sample used for quality control purposes, a blind sample is a sample submitted to an analyst without their knowledge of its identity or composition. Blind samples are used to test the analyst's or laboratory's expertise in performing the sample analysis.

***Comparability.*** A data quality indicator, comparability is the degree to which different methods, data sets, and/or decisions agree or are similar.

***Completeness.*** A data quality indicator that is generally expressed as a percentage, completeness is the amount of valid data obtained compared to the amount of data planned.

***Data users.*** The group(s) that will be applying the data results for some purpose. Data users can include the monitors themselves as well as government agencies, schools, universities, businesses, watershed organizations, and community groups.

***Data quality objectives (DQOs).*** Data quality objectives are quantitative and qualitative statements describing the degree of the data's acceptability or utility to the data user(s). They include indicators such as accuracy, precision, representativeness, comparability, and completeness. DQOs specify the quality of the data needed in order to meet the monitoring project's goals. The planning process for ensuring environmental data are of the type, quality, and quantity needed for decision making is called the ***DQO process***.

***Detection limit.*** Applied to both methods and equipment, detection limits are the lowest concentration of a target analyte that a given method or piece of equipment can reliably ascertain and report as greater than zero.

***Duplicate sample.*** Used for quality control purposes, duplicate samples are two samples taken at the same time from, and representative of, the same site that are carried through all assessment and analytical procedures in an identical manner. Duplicate samples are used to measure natural variability as well as the precision of a method, monitor, and/or analyst. More than two duplicate samples are referred to as *replicate samples*.

***Environmental sample.*** An environmental sample is a specimen of any material collected from an environmental source, such as water or macroinvertebrates collected from a stream, lake, or estuary.

***Equipment or rinsate blank.*** Used for quality control purposes, equipment or rinsate blanks are types of field blanks used to check specifically for carryover contamination from reuse of the same sampling equipment (see *field blank*).

***Field blank.*** Used for quality control purposes, a field blank is a “clean” sample (e.g., distilled water) that is otherwise treated the same as other samples taken from the field. Field blanks are submitted to the analyst along with all other samples and are used to detect any contaminants that may be introduced during sample collection, storage, analysis, and transport.

***Instrument detection limit.*** The instrument detection limit is the lowest concentration of a given substance or analyte that can be reliably detected by analytical equipment or instruments (see *detection limit*).

***Matrix.*** A matrix is a specific type of medium, such as surface water or sediment, in which the analyte of interest may be contained.

***Measurement Range.*** The measurement range is the extent of reliable readings of an instrument or measuring device, as specified by the manufacturer.

***Method detection limit (MDL).*** The MDL is the lowest concentration of a given substance or analyte that can be reliably detected by an analytical procedure (see *detection limit*).

***Performance evaluation (PE) samples.*** Used for quality control purposes, a PE sample is a type of *blind sample*. The composition of PE samples is unknown to the analyst. PE samples are provided to evaluate the ability of the analyst or laboratory to produce analytical results within specified limits.

***Quality Assurance (QA) is an integrated management system designed to ensure that a product or service meets defined standards of quality with a stated level of confidence.***

***Precision.*** A data quality indicator, precision measures the level of agreement or variability among a set of repeated measurements, obtained under similar conditions. Precision is usually expressed as a *standard deviation* in absolute or relative terms.

***Protocols.*** Protocols are detailed, written, standardized procedures for field and/or laboratory operations.

***Quality assurance (QA).*** QA is an integrated management system designed to ensure that a product or service meets defined standards of quality with a stated level of confidence. QA activities involve planning quality control, quality assessment, reporting, and quality improvement.

***Quality assurance project plan (QAPP).*** A QAPP is a formal written document describing the detailed *quality control* procedures that will be used to achieve a specific project's data quality requirements.

***Quality control (QC).*** QC is the overall system of technical activities designed to measure quality and limit error in a product or service. A QC program manages quality so that data meets the needs of the user as expressed in a *quality assurance project plan*.

***Relative standard deviation (RSD).*** RSD is the *standard deviation* of a parameter expressed as a percentage and is used in the evaluation of *precision*.

***Relative percent difference (RPD).*** RPD is an alternative to *standard deviation*, expressed as a percentage and used to determine precision when only two measurement values are available.

***Replicate samples.*** See duplicate samples.

***Representativeness.*** A data quality indicator, representativeness is the degree to which data accurately and precisely portray the actual or true environmental condition measured.

***Sensitivity.*** Related to *detection limits*, sensitivity refers to the capability of a method or instrument to discriminate between measurement responses

***Standard Reference Materials (SRMs) are produced by the U. S. National Institute of Standards and Technology (NIST) and characterized for absolute content independent of any analytical method.***

representing different levels of a variable of interest. The more sensitive a method is, the better able it is to detect lower concentrations of a variable.

***Spiked samples.*** Used for quality control purposes, a spiked sample is a sample to which a known concentration of the target analyte has been added. When analyzed, the difference between an environmental sample and the analyte's concentration in a spiked sample should be equivalent to the amount added to the spiked sample.

***Split sample.*** Used for quality control purposes, a split sample is one that has been equally divided into two or more subsamples. Splits are submitted to different analysts or laboratories and are used to measure the precision of the analytical methods.

***Standard reference materials (SRM).*** An SRM is a certified material or substance with an established, known and accepted value for the analyte or property of interest. Employed in the determination of bias, SRMs are used as a gauge to correctly calibrate instruments or assess measurement methods. SRMs are produced by the U. S. National Institute of Standards and Technology (NIST) and characterized for absolute content independent of any analytical method.

***Standard deviation(s).*** Used in the determination of *precision*, standard deviation is the most common calculation used to measure the range of variation among repeated measurements. The standard deviation of a set of measurements is expressed by the positive square root of the *variance* of the measurements.

***Standard operating procedures (SOPs).*** An SOP is a written document detailing the prescribed and established methods used for performing project operations, analyses, or actions.

***True value.*** In the determination of accuracy, observed measurement values are often compared to true, or standard, values. A true value is one that has been sufficiently well established to be used for the calibration of instruments, evaluation of assessment methods or the assignment of values to materials.

***Variance.*** A statistical term used in the calculation of *standard deviation*, variance is the sum of the squares of the difference between the individual values of a set and the arithmetic mean of the set, divided by one less than the numbers in the set.

# Appendix B: EPA REGIONAL CONTACTS

Each of EPA's 10 Regional offices has a volunteer monitoring coordinator and quality assurance officers who can be of assistance to volunteer programs. Listed below are the contact names for each region, as of September 1, 1996. These contacts may change over time.

## EPA Regional Volunteer Monitoring Coordinators

Diane Switzer
USEPA Region 1
(EMS-LEX)
60 Westview Street
Lexington, MA 02173
617-860-4377

Diane Calesso
USEPA Region II
Environmental Services Division
2890 Woodbridge Avenue
Raritan Depot Bldg. 10
Edison, NJ 08837-3679
908-906-6999
calesso.diane@epamail.epa.gov

Pete Weber
USEPA Region III
3WP13
841 Chestnut Bldg.
Philadelphia, PA 19107
215-566-5749

Chuck Kanetsky
USEPA Region III
841 Chestnut Bldg.
Philadelphia, PA 19107
215-566-2735

David Melgaard
USEPA Region IV
Watershed Section
345 Courtland Street
Atlanta, GA 30365
404-347-2126 (x6590)

Tom Davenport
USEPA Region V
77 W. Jackson Blvd.
Chicago, IL 60604
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| | |
|---|---|
| Region 1: | CT, MA, ME, VT, NH, RI |
| Region 2: | NY, NJ, VI, PR |
| Region 3: | DE, DC, MD, PA, VA, WV |
| Region 4: | AL, FL, GA, KY, MS, NC, SC, TN, |
| Region 5: | IL, IN, MI, MN, OH, WI |
| Region 6: | AR, LA, NM, OK, TX |
| Region 7: | IA, KS, MO, NE |
| Region 8: | CO, MT, ND, SD, UT, WY |
| Region 9: | AZ, CA, NV, GU, HI, AS |
| Region 10: | AK, ID, OR, WA |

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# Appendix C:
# REFERENCES


***Directory of Volunteer Environmental Monitoring Programs, 4th Edition***. EPA 841-B-94-001, January 1994. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

***EPA Requirements for Quality Assurance Project Plans (QAPP) for Environmental Data Operations***. EPA/QA/R-5. August 1994. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

***Generic Quality Assurance Project Plan Guidance for Programs Using Community Level Biological Assessment in Wadable Streams and Rivers***. EPA 841-B-95-004, July 1995. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

***Guidance for Data Quality Assessment***. EPA QA/G-9, March 1995. U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC.

***Guidance for the Preparation of Standard Operating Procedures (SOPs) for Quality-Related Documents***. EPA QA/G-6. November 1995. U.S. Environmental Protection Agency, Quality Assurance Division.

***Integrating Quality Assurance into Tribal Water Programs: A Resource Guide for Reliable Water Quality Data Collection***. U.S. Environmental Protection Agency Region 8, Denver, Colorado.


The following presentation paper topics, specifically relavant to quality assurance and quality control issues, are contained in the proceedings documents from past national volunteer monitoring conferences:

**Proceedings of Third National Citizens' Volunteer Water Monitoring Conference.**

- *Goal Setting and Organizing*
- *Study Design*
- *Training Monitors*
- *Integrated Monitoring Systems*
- *Enforcement and Compliance Monitoring*
- *Procedures for Collecting Quality Data*
- *Meeting Scientific Standards for Biological Monitoring*
- *Deciding Data Objectives*
- *River and Stream Monitoring Techniques*
- *Lake Monitoring Techniques*
- *Wetland Monitoring Techniques*
- *Estuary Monitoring Techniques*
- *Computer Data Management*
- *Data Application and Presentation*

**Proceedings Fourth National Citizens' Volunteer Monitoring Conference.**

- *Designing Your Water Quality Study*
- *Assuring Quality Data*
- *Defining Data Use*
- *Using Your Data to Evaluate Your Volunteer Monitoring Program*
- *Geographic Information Systems and Volunteer Monitoring Data*
- *Managing Your Data: Some Basic Principles*
- *Data Analysis for the Technically Impaired*
- *Macroinvertebrate Monitoring*
- *Bacteria Testing*
- *Monitoring Restoration and Pollution Prevention Activities*

Both of these documents are available upon request from the EPA National Volunteer Monitoring Coordinator.

***Proceedings of the Fourth National Citizen's Volunteer Water Monitoring Conference***. EPA 841/R-94-003, February 1995. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

***Proceedings of the Third National Citizen's Volunteer Water Monitoring Conference***. EPA 841/R-92-004, September 1992. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

***Volunteer Estuary Monitoring: A Methods Manual***. EPA 842-B-93-004, December 1993. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

***Volunteer Lake Monitoring: A Methods Manual***. EPA 440/4-91-002, December 1991. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

***The Volunteer Monitor: Building Credibility***. Volume 4, number 2, Fall 1992. Eleanor Ely, ed. San Francisco, CA.

***The Volunteer Monitor: Managing and Presenting Your Data***. Volume 7, number 1, Spring 1995. Eleanor Ely, ed. San Francisco, CA.

***Volunteer Stream Monitoring: A Methods Manual (Field Test Draft)***. EPA 841 D 95-001. April 1995. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

***Volunteer Water Monitoring: A Guide for State Managers***. EPA 440/4-90-010, August 1990. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

# Appendix D:
# ABBREVIATED QAPP FORM

What follows is an example of an optional abbreviated quality assurance project plan form. You may be able to use it as a model for your project's QAPP. However, be sure to consult your state or EPA regional QA officers to determine if use of this form (or a modified version) is acceptable to them, and for specific information on required elements for your project.

## 1. Title and Approval Page

______________________________
(Project Name)

______________________________
(Responsible Agency)

______________________________
(Date)

| | |
|---|---|
| *Project Manager* Signature | ____________________ |
| Name/Date | ____________________ |
| *Project QA Officer* Signature | ____________________ |
| Name/Date | ____________________ |
| USEPA Project Manager Signature | ____________________ |
| Name/Date | ____________________ |
| *USEPA QA Officer* Signature | ____________________ |
| Name/Date | ____________________ |

## 2. Table of Contents

List sections with page numbers, figures, tables, references, and appendices (attach pages).

## 3. Distribution List

Names and telephone numbers of those receiving copies of this QAPP. Attach additional page, if necessary.

i. ____________________

ii. ____________________

iii. ____________________

iv. ____________________

v. ____________________

vi. ____________________

vii. ____________________

viii. ____________________

ix. ____________________

x. ____________________

## 4. Project/Task Organization

List key project personnel and their corresponding responsibilities.

| Name | Project Title/Responsibility |
|---|---|
| | Advisory Panel (contact) |
| | Project Manager |
| | QA Officer |
| | Field/Sampling Leader |
| | Laboratory Manager/Leader |

## 5. Problem Definition/Background

A. Problem Statement

____________________

____________________

____________________

____________________

____________________

B. Intended Usage of Data

## 6. Project/Task Description

A. General Overview of Project

B. Project Timetable

| Activity | Projected Start Date | Anticipated Date of Completion |
| --- | --- | --- |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

## 7. Measurement Quality Objectives

A. Data Precision, Accuracy, Measurement Range

| Matrix | Parameter | Measurement Range | Accuracy | Precision |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

B. Data Representativeness

C. Data Comparability

D. Data Completeness

| Parameter | No. Valid Samples Anticipated | No. Valid Samples Collected & Analyzed | Percent Complete |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

## 8. Training Requirements and Certification

A. Training Logistical Arrangements

| Type of Volunteer Training | Frequency of Training/Certification |
|---|---|
| | |
| | |
| | |
| | |
| | |

B. Description of Training and Trainer Qualifications

## 9. Documentation and Records

## 10. Sampling Process Design

A. Rationale for Selection of Sampling Sites

B. Sample Design Logistics

| | Type of Sample/ Parameter | Number of Samples | Sampling Frequency | Sampling Period |
|---|---|---|---|---|
| Biological | | | | |
| | | | | |
| | | | | |
| Physical | | | | |
| | | | | |
| | | | | |
| Chemical | | | | |
| | | | | |
| | | | | |

## 11. Sampling Method Requirements

| Parameter | Sampling Equipment | Sampling Method |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

## 12. Sample Handling and Custody Procedures

## 13. Analytical Methods Requirements

## 14. Quality Control Requirements

A. Field QC Checks

B. Laboratory QC Checks

C. Data Analysis QC Checks

## 15. Instrument/Equipment Testing, Inspection, and Maintenance Requirements

| Equipment Type | Inspection Frequency | Type of Inspection |
| --- | --- | --- |
| | | |
| | | |
| | | |
| | | |
| | | |

## 16. Instrument Calibration and Frequency

| Equipment Type | Calibration Frequency | Standard or Calibration Instrument Used |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

## 17. Inspection/Acceptance Requirements

## 18. Data Acquisition Requirements

## 19. Data Management

## 20. Assessment and Response Actions

## 21. Reports

## 22. Data Review, Validation, and Verification

## 23. Validation and Verification Methods

## 24. Reconciliation with DQO's