INTEGRATING QUALITY ASSURANCE INTO TRIBAL WATER PROGRAMS

A RESOURCE GUIDE FOR RELIABLE WATER QUALITY DATA COLLECTION

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Writing & technical review: Chris Lehnertz, EPA Region 8

Additional technical review & editing: Phil Johnson, EPA Region 8
Rick Edmonds, EPA Region 8
David Rathke, EPA Region 8

Special review & comments: Ute Mountain Ute Tribe
Fort Peck Tribes
Southern Ute Tribe

Editing, design, photography & production: ECOS Communications, Inc.
Boulder, Colorado

Cover art work: Norman Lansing
Southern Ute Tribe

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Opening Prayer for the Conference:
"Quality Assurance for Water Quality in Indian Country"
Southern Ute Reservation, September 1992

Heavenly Father, Grandfather, we thank you for this time of day, Grandfather, that we've gathered here in a good way, Grandfather, the participants for this conference on water quality, Grandfather.

We thank you, Grandfather, for all that you've created. We thank you for the water of life, Grandfather, that these professionals are here, Grandfather, that they can take this knowledge they've gained about their individual reservations and their homes, Grandfather, that we can protect all of our water and our water quality, Grandfather.

We ask in a humble way, Grandfather, for good prayers, Grandfather, for the unborn generations, and for the little children, Grandfather. For the teenager generation, Grandfather, we ask your blessings, for the adult generation, Grandfather, for all those from the doorway in to the doorway out, that you can take care of their needs. We thank you, Grandfather, for our elders and our ancestors, Grandfather. Without them we would not be able to do the things that have brought us to where we are right now, Grandfather.

All things, spoken and unspoken, we ask in a humble way that you take care of these things, Heavenly Father, and we put these into your hands, Grandfather. Again, Grandfather, we thank you for the water of life that we can take care of it in a good way for all the generations that will be coming in the future. Amen.

—Nathan Winder
Southern Ute Tribe

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INTRODUCTION

BACKGROUND

In September 1992, the Southern Ute Indian Tribe and the United States Environmental Protection Agency (EPA) Region 8 co-sponsored the workshop "Quality Assurance for Water Quality in Indian Country." The document before you is a result of that workshop. It presents workshop information along with suggested methods for incorporating quality assurance—a process for evaluating data quality—into tribal water quality programs, based on EPA requirements.

Reauthorization of the Clean Water Act (CWA) in 1987 created opportunities for Indian tribes to receive financial assistance from EPA. The Agency now provides funding to Indian tribes for the development of many types of water quality projects, including: water quality program development, lake water quality assessment and remediation, point and nonpoint source pollution control, and wetlands protection. When environmental data are collected by any entity funded through EPA, specific technical requirements must be met in order to ensure that data are of good quality. The system of such quality assurance is commonly known as QA/QC (quality assurance/quality control). QA/QC should be integrated into a tribal water quality monitoring program at the outset of program development.

The QA/QC workshop is one example of technical training available from EPA.

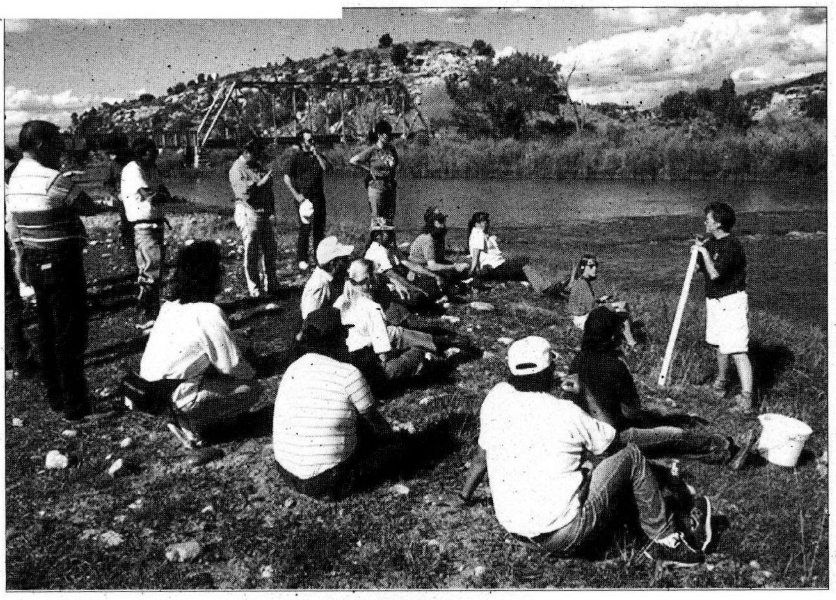
The purpose of this guide is to provide you with the information that you will need to develop a tribal QA/QC program. It also provides instructions for writing the required Quality Assurance Project Plan (QAPP) that must be approved by EPA before monitoring may begin under a CWA grant.

By federal regulation, any entity funded by EPA to collect enviromental data must develop a QAPP which will document how their QA/QC program meets EPA criteria. This is required so that EPA and its grantees can ensure that the data collected are scientifically valid, of known and suitable quality, collected with the best cost-effective technology available, and legally defensible if necessary.

- **By law, you cannot conduct water monitoring under an EPA-funded program until you have an approved Quality Assurance Project Plan.**

- **If a tribe is sampling under a QA/QC program with the pre-1993 format, sampling may continue, but the QAPP must be reformatted by October 1994.**

Many tribal water quality programs have already developed EPA-approved QA/QC programs. Because the QAPP format and contents are new and sampling technology has recently changed, previously-approved QA/QC programs may not reflect current requirements. Sample portions of the new QAPP format are provided in the section of this document entitled "Quality Assurance Project Plans."



Field sessions are part of many EPA training courses.

QA/QC is used when making any environmental measurement, including those for water, air, or soil. But how does QA/QC fit into tribal water quality program development? From evaluating historical data to projecting monitoring costs for a grant proposal, QA/QC considerations must be included. The case study in the next section of this guide illustrates the integration of QA/QC into the development of a tribal program.

HOW TO USE THIS GUIDE

This guide is divided into four sections, each of which can be read and used as a unit, independent of the others. Reading only one section, however, might leave you with an incomplete picture of the process for integrating QA/QC into your tribal water quality program. We suggest that you read through the entire guide in the order presented here. Afterward, you may want to go back to a certain section for further study or clarification.

The "Case Study" section provides a step-by-step overview of the entire process for establishing a water monitoring program, beginning with the tribe's commitment and ending with an evaluation of the data collected. The details for developing your own QA/QC program can be found in the two sections following the case study.

Throughout this guide, informational tips are presented in shaded boxes, while important definitions can be found in bold type in the page's outer margin. (The Glossary, in the "Helpful Resources" section, is another good place to check for definitions.) The "Quality Assurance and Quality Control Working Together" section contains formulas and mathematical computations to better present several technical concepts, and the "Quality Assurance Project Plans" section provides numerous examples shown on ruled or graph paper for you to follow. Sources for additional information are listed under References in the final section. If you are unable to find the answers to your questions in this guide, contact EPA for assistance.

CASE STUDY:
TRIBAL WATER QUALITY PROGRAM DEVELOPMENT

CASE STUDY: TRIBAL WATER QUALITY PROGRAM DEVELOPMENT UTE MOUNTAIN UTE TRIBE

The following is an account of the steps that could be taken by a tribe to develop a water quality protection program that includes adequate QA/QC provisions. Beginning with a stated commitment by the tribe to protect its reservation waters, the Ute Mountain Ute Tribe developed the necessary systems and EPA documents to receive a CWA grant and begin surface water monitoring. Although the timeline and progression of events will vary from tribe to tribe, this case study may help you to plan for the successful integration of QA/QC into your program.

In 1991, the Ute Mountain Ute Tribal Council decided that one of the tribe's priorities was to protect water quality on the Ute Mountain Ute Reservation. The tribe investigated a variety of possibilities for developing a water quality protection program. After applying and being approved for an EPA Clean Water Act Section 106 grant, the tribe initiated program development.

PROGRAM DEVELOPMENT

The first task for the tribe was to hire a Water Quality Specialist with a background in biology and chemistry. The role of the Water Quality Specialist was to provide technical assistance to the tribe by developing and managing a tribal water quality program. The Water Quality Specialist worked closely with the Tribal Council to develop a program objective and long-range goals. Examples of these are:

Objective:

The Ute Mountain Ute Tribe will protect, maintain, and enhance the quality of tribal waters.

Long-Range Goals:

1. To develop a complete set of baseline data on the quality of tribal surface water, groundwater, and wetlands. Monitoring will include chemical, physical, and biological parameters as well as habitat assessments, and will incorporate appropriate quality assurance and quality control measures. The resulting database will: (a) provide an overview of the current quality of reservation waters, (b) assist in classifying waters for the development of water quality standards, (c) help to inventory potential point and nonpoint sources of pollution, and (d) identify areas of special concern that may need immediate attention or further study. Data will be used for long-term monitoring of abatement projects, tracking water quality standards compliance, providing information for assessing environmental impacts from development on the reservation, and prioritizing program activities.

Quality Assurance (QA) ***is a process which ensures that a monitoring program is adequately planned and conducted to provide data of the highest possible quality. QA is a set of operating principles and procedures used for data collection, sample handling, analysis, and data review that can be used in the field and in the laboratory to provide data that are of known quality. Simply put: QA is a way to effectively collect environmental data and determine how believable or reliable they are.***

Quality Control (QC) ***is the set of steps taken during sample collection and analysis to ensure that data quality meets the minimum standards established by a Quality Assurance Project Plan.***

Note: An EPA Section 106 grant can be a cornerstone for developing a tribal water quality program. It can provide funding for a broad range of water pollution control projects, including wetlands protection, nonpoint source pollution control, water quality standards development, permitting and code development, and groundwater, surface water, and lake water quality sampling. Wastewater treatment facility construction and analysis of drinking water are not eligible for funding under the 106 program

Water quality monitoring ***is the collection and analysis of water, organisms living in or adjacent to the water, or physical elements associated with water that may serve to characterize the quality of the water. It may also include data collection on the condition of the physical and biological habitat in and around a body of water. Typical monitoring data can be separated into chemical, physical, biological, and habitat parameters.***

2. To develop a water quality program that will address point and non-point sources of pollution. This will be accomplished through the development of rules and regulations, management and assessment plans, best management practices, and water quality standards.

3. To enhance the technical and administrative expertise of water quality program staff through training and instruction. This will allow the tribe to work as an equal partner with other agencies regarding water quality issues both on and off the reservation.

After the long-range goals were approved by the Tribal Council, short-range activities were translated into a final Section 106 grant workplan.

SECTION 106 GRANT WORKPLAN

The workplan was written to encompass activities to be completed during the one-year grant project period. All of the workplan activities were tied to the long-range goals. While some program activities would be conducted over more than one year, only those tasks that could be accomplished during the grant period were described. Listed here, without details such as specific tasks, budget, or milestones, are some of the activities:

▼ The primary purpose of monitoring is to confirm or deny the presence, amount, and extent of pollutants or contaminants. Keep this in mind when developing a monitoring program.

▼ Remember that your QAPP must be completed and approved before you collect baseline data or perform any monitoring. However, you may begin compiling historic data at any time.

1. Establish a Water Quality Protection Office; purchase office and sampling equipment and supplies; hire a Water Quality Technician to work with the Water Quality Specialist.

2. Compile and review historical data on the quality of reservation waters. Develop format for water quality database and enter data of acceptable quality.

3. Determine gaps in the existing data and outline a surface water quality monitoring program. Before monitoring is performed, the monitoring program details will be sent to EPA as an addition to the workplan.

Seining a stream is one way to collect data about fish populations.

4. Write a Standard Operating Procedures (SOP) manual of monitoring procedures. The SOPs will be used whenever water quality program samples are collected.

5. Write a Quality Assurance Project Plan (QAPP) that will outline the QA/QC requirements for collecting and analyzing data. Submit the QAPP to EPA for approval.

Because the scope of work for this grant was only one year, the tribe focused on surface water only, and planned to monitor groundwater and wetlands at a later date. As soon as the workplan was approved by EPA, work was initiated.

SOPs, if followed correctly, will provide consistency in sampling. All sampling procedures should be contained in one document, and be readily available to provide instruction for anyone conducting field sampling. SOPs frequently consist of the operating manuals from field and laboratory equipment, specific information on how a sample should be extracted from a body of water, and instructions for the handling of sample containers.

Depending on your experience with monitoring and environmental data collection, as well as your workload, the writing of your QAPP and SOP documents could take from one week to several months. The pre-work for collecting equipment operating instructions, contracting with a laboratory, and gathering information on elements for your QAPP typically takes as long as one month.

Many of the activities of the workplan were conducted at the same time. Once a Water Quality Protection Office was established, the program entered into the day-to-day work of implementing other aspects of the workplan and developing the water quality program.

1. The Water Quality Specialist set up the Water Quality Protection Office, hired a Water Quality Technician, ordered office and sampling equipment and supplies, and began performing activities from the workplan.

2. The Water Quality Technician began to compile existing water quality information from organizations that had previously conducted water quality monitoring on surface water, groundwater, and wetlands within or adjacent to the reservation boundaries. Data were limited to information no more than 15 years old. The Technician looked for chemical, physical, and habitat data, as well as data on the plant and animal species found in and around aquatic areas. It was found that each of the four drainages on the reservation had been sampled within the previous 15 years for physical, chemical, and biological parameters.

3. The Specialist performed a review of the water quality data that had been compiled. For three of the four drainages found on the reservation, the water quality data included QA/QC results.

The fourth drainage, the Mancos, had been monitored every year for the

***Standard Operating Procedure (SOP)* manual is a written, step-by-step description of the procedures that should be used for collecting samples and performing analyses. These procedures are designed to ensure that samples are collected, preserved, handled, and analyzed in a proper manner, and that sampling is done consistently from year to year. SOPs also ensure that evaluations on habitat parameters are performed the same way by all water quality personnel, to provide consistency.**

***Quality Assurance Project Plan (QAPP)* is a written plan that outlines the procedures to be used for ensuring high-quality data when conducting sample collection and analysis for environmental monitoring. A QAPP consists of up to 25 elements that comprise a quality assurance system.**

The Southern Ute Tribe developed a tribal water quality laboratory for performing routine analyses. A review of laboratory SOPs was part of the workshop that served as the background for this guide.

previous ten years, but there was no indication that any QA/QC had been used. Because there was no documentation on the use of QA/QC, the quality of this data could not be determined. The Specialist decided that the information from the other three drainages was of good enough quality to be entered into the tribal database as baseline data. The Mancos data, however, were of unknown quality, and could not be used in the database. Thus, the only gap in baseline data was for the Mancos drainage.

4. In order to complete the baseline data collection, the Specialist and the Technician would need to monitor the Mancos River and the seven streams that drained into it. While the Specialist outlined a monitoring program for the Mancos, the Technician began to work on developing the required QAPP and SOP documents.

5. Because there is so much overlap between the SOPs and QAPP, they were developed concurrently. The Technician wrote the QAPP, including the tribe's expectations for the quality of data, how detailed the analysis of the data would be, and how the quality of the results would be determined. The QAPP included information on how many and what types of quality control samples would be used. This would determine the quality of field collection procedures as well as field and laboratory analyses. It also included specific information about how long each sample could be kept before analysis, information on how to preserve samples, the type of container to be used, specifics on how the samples should be shipped, and the analytical methods to be used.

▼ **The QAPP was written to include the necessary information for collecting and analyzing every type of physical and chemical parameter that the tribe might possibly measure. Although the Technician and Specialist knew they would not monitor for every parameter in every sample, they included all possible parameters in the QAPP so that they would only have to write this part of the document once, subject to change only with changes in applicable technology.**

▼ **Keep the SOP and QAPP documents together for quick reference in the field and laboratory. Even when you have collected the same type of sample every day for a month, refer back to these documents periodically to check your sampling procedures.**

▼ Take time to look around you at those things that might influence the rivers that flow into reservation waters. Ask questions of people who may have valuable information (e.g., industry operators, geologists, weather specialists, farmers).

▼ Consider the season of the year when planning monitoring, as this will affect flow, dilution, and other aspects of surface waters. Storms and droughts can also affect your monitoring results. Make sure to indicate current season and weather in your field notebook.

▼ Check your data periodically, not just at the end of the year. Do they appear reasonable? Are there any big surprises? Doing this can help you catch problems early in the sampling season.

To put together the SOPs, the Technician collected all the operating manuals for the field and laboratory sampling equipment that the tribe had purchased. The reference book *Standard Methods for the Examination of Water and Wastewater* (see References, page 35) was reviewed so that the Technician could list the exact procedures that would be used for each type of sample collection. Once the Technician compiled these items, they were put together in one notebook. Because one copy was needed in the laboratory and another was needed in the field, the Technician made two copies (and laminated each page), keeping the original in the office. This way, anyone collecting samples could refer to the SOP notebook for complete instructions.

MONITORING

Water quality monitoring is conducted for a wide variety of reasons. For example, monitoring programs may be established to collect baseline data or to evaluate the effects of road building and maintenance, forest harvest, application of herbicides and pesticides, recreation, grazing, or mining. Each of these programs would necessitate a specific set of monitoring tests. Clearly stating and understanding your objective for monitoring will help you to determine how often and where samples should be collected.

The Specialist outlined a monitoring plan for the Mancos drainage, aimed at providing baseline data, and sent it to EPA as part of the tribal workplan. The QAPP was also sent to EPA for approval, with the SOPs attached for review. Meanwhile, the Specialist and Technician spent time in the field and laboratory, becoming familiar with their equipment and Standard Operating Procedures. The first samples were collected just for practice and were not included in the official water quality database.

▼ Include a statement in your field notebook about land use near and upstream from your sampling sites. Such information might help to explain your results, especially in explaining why certain values turned out higher or lower than expected.

▼ Are you looking for training in monitoring techniques? Local colleges and universities may offer courses in monitoring or environmental science. Additional resources for training include other tribes, state and federal agencies, and a collection of extensive literature on monitoring plans and procedures.

As soon as your QAPP is approved and your SOPs are finalized, you and your sampling staff should read and discuss these documents to become completely familiar with them. Communication between people collecting data is essential; if possible, have them sample together in the field. In addition, sampling personnel should document their procedures (and deviations from procedures) to help identify situations where problems may arise because consistency is not ensured. This way, if program personnel leave the program, new staff will have accurate documentation on how samples have been collected.

Once the monitoring plan and the QAPP were approved by EPA, the Specialist and Technician were able to begin monitoring. They collected the samples that had been identified in the monitoring plan, closely following the SOPs and QAPP. The Specialist was identified as the Quality Assurance Officer, and ensured that the correct methods for sample collection, preservation, storage, and shipment were used. Some of the tests, such as those for temperature, conductivity, hardness, alkalinity, dissolved oxygen, and pH, were conducted in the field or tribal laboratory. Samples to test for constituents such as iron, mercury, and atrazine were collected and then sent to a contract laboratory for analysis. For both types of data, QA/QC procedures were performed regularly.

<u>Data Quality Objectives (DQOs)</u> are the numerical goals that are set for a monitoring project. Based on the objective of the sampling, numbers are defined for the range of data quality that will be acceptable. DQOs reflect the accuracy, precision, and completeness for each parameter that is measured.

Once the data from the monitoring were compiled, the Specialist went back to the QAPP to review the requirements for acceptable data quality. By reconciling the QA/QC sample results with the data quality objectives outlined in the QAPP, the Specialist was able to determine that the overall quality of the data was good. (The procedures for conducting this type of reconciliation are detailed on page 16.) Data not meeting the QA/QC guidelines were discarded. These steps ensured that the data used were likely to represent the actual conditions of the water. At this point, the water quality staff could identify locations of poor water quality and recommend further action.

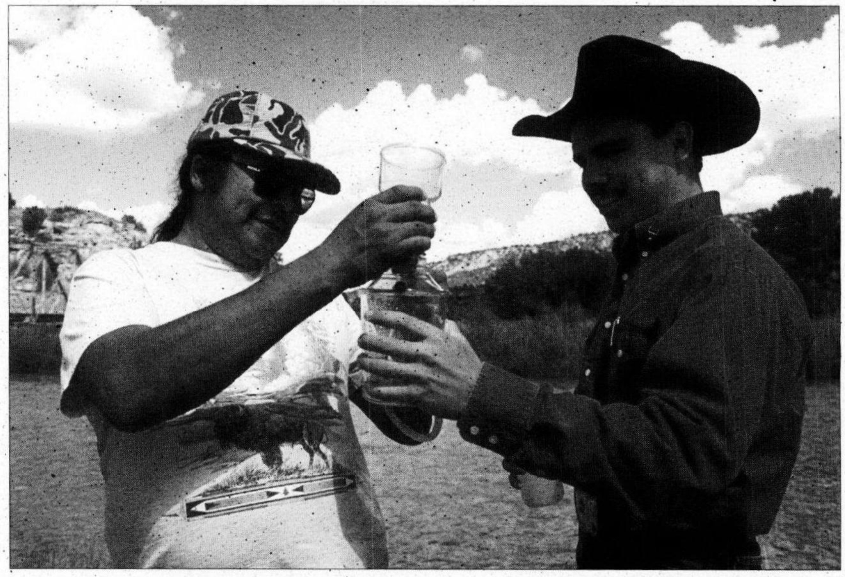
This case study is just one example of how QA/QC can be successfully incorporated into a tribal water quality program. It illustrates the importance of developing the QAPP and SOP documents early in the process. By becoming familiar with the procedures in these documents, and using them regularly in the field and laboratory, the tribe was able to determine the quality of the data collected.

When choosing a laboratory for analyzing your water quality samples, it is best to conduct interviews. Provide the laboratory with a list of questions regarding the analyses you anticipate having done, and talk directly with the laboratory manager. When you develop the contract, include a specific period of time that your contract will cover, the scope of work (including materials the laboratory will furnish), terms for payment, a provision giving both the tribe and EPA the right to audit the laboratory, and other terms and conditions as required or recommended by the tribal program. Make sure to agree on turnaround time in advance.

QUALITY ASSURANCE
AND QUALITY CONTROL
WORKING TOGETHER

QUALITY ASSURANCE AND QUALITY CONTROL WORKING TOGETHER

While quality assurance, quality control, and SOPs are separate components of a monitoring program, they work together to provide data of known quality. Together, they minimize the error that is introduced in sampling, and allow the tracking of errors that may occur. From failing to add the necessary preservative to a metals sample to inadvertently using contaminated glassware, the possibilities for system or human error in monitoring are extensive. Regular control sampling is an integral element in a system for water quality monitoring.



Filtered samples can be easily contaminated during transfer from filtration reservoir to sample bottle. Getting assistance from other members of the field crew can help you to minimize contamination.

▼ QC samples should be labeled with the same type of sample identification number as other samples, and submitted to the laboratory without indication that they are QC samples. However, these identification numbers should be noted in your field sample notebook, and tracked within your system as QC samples.

▼ In order to determine the quality of the laboratory analyses, at least 10% of the samples you submit to the laboratory should be QC samples. At least 5% of your samples analyzed in the field should be QC samples. For a new monitoring program, however, it would be appropriate to have as many as 50% of all samples as QC samples, until the system is finely tuned.

QUALITY ASSURANCE AND QUALITY CONTROL

QA/QC includes planning, assessment, reporting, and making necessary changes to the water monitoring program to ensure quality data. The system defined in your QAPP will outline what is acceptable for your monitoring objectives. If the results of your quality control samples fall outside the acceptable levels, these samples are rejected. In addition, corrections may be needed in your SOPs to ensure that data are collected properly. Evaluation of quality control samples allows you to determine the quality of the overall data.

Quality control (QC) samples are collected to determine precision and accuracy, and can be collected or prepared

***Precision** is a measurement of the closeness of data values to each other. This is determined by comparing the results of several measurements taken at one location. Statistically, precision is expressed as a range of concentration units, using relative percent difference or standard deviation.*

in the field or laboratory. Field QC samples are used to evaluate data collection methods and field or laboratory procedures and analyses. Laboratory QC samples are used solely to determine the quality of laboratory procedures and analyses.

PRECISION AND ACCURACY SAMPLING AND CALCULATIONS

There are five basic types of QC samples, numbered 1-5 on the pages that follow. In determining precision and accuracy, the use of basic statistics is required. Each type of QC sample listed below includes an example of how the QC results would be analyzed to determine precision or accuracy.

Samples to Determine Precision

Precision gives information about how consistent your methods are. It does not mean that the sample results actually reflect the true value of the parameter measured, but rather that your sampling is giving similar results under similar conditions.

1. A split sample is the result of taking one sample collected in accordance with SOPs and splitting the sample into two bottles. The measurement of agreement between the samples will represent the precision. A sample may be split in either the field or in the laboratory.

EXAMPLE:

Precision Calculation for a Split Sample

If a sample is split into two subsamples, or if a replicate sampling results in only two samples, the following calculation may be used to determine precision:

Relative Percent Difference =

$$RPD = \frac{\frac{x_1 - x_2}{x_1 + x_2}\ (100)}{2}$$

For example, if: $x_1 = 22$

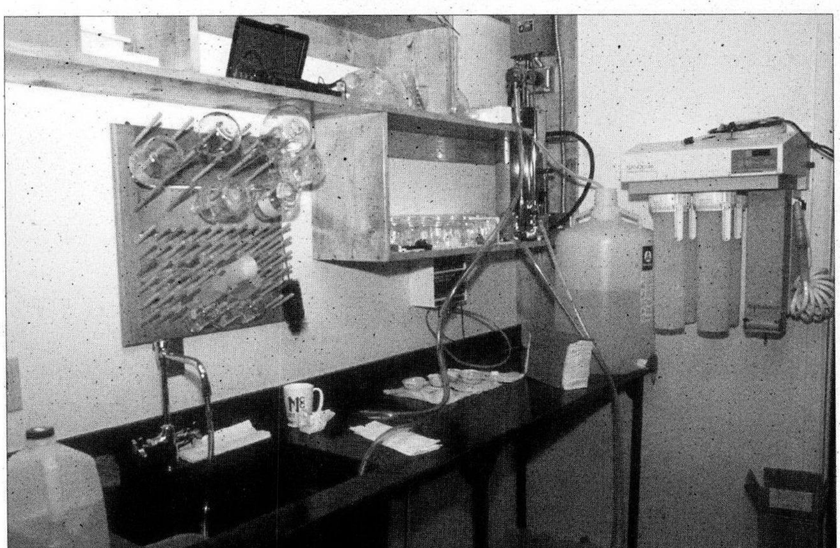
$x_2 = 18$

$$RPD = \frac{\frac{22 - 18}{22 + 18}\ (100)}{2}$$

$$= \frac{\frac{4}{40}\ (100)}{2}$$

$$= 5\%$$

2. A replicate sample is obtained by collecting two or more samples from the same site, with the same methods, one immediately after the other. Such samples are considered representative sub-samples of the same environment. Replicate samples are processed normally through the entire measurement



A tribal water quality laboratory can be developed as part of the Section 106 grant program. Equipment can be purchased with grant funds and installed by a tribal program to perform routine laboratory analyses.

system. While analysis results will never be exactly the same for any two samples due to natural variation, the degree of difference will allow you to assess the variability caused by field sampling methods.

EXAMPLE:

Precision Calculation for a Replicate Sample

In order to assess the precision of a replicate set where three or more samples are obtained from the same environment, the standard deviation must be determined. If four replicate samples were obtained consecutively from one location to determine precision, the following calculations would be made:

Sample results from laboratory:

Sample #	Concentration (mg/l)
x_1	48
x_2	51
x_3	50
x_4	45

The equation for standard deviation (s) is:

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

where $\sum_{i=1}^{n}(x_i - \bar{x})^2$

is the sum of the concentration values for each of the sample results $(x_1 \ldots x_n)$ when the average concentration is subtracted from each result and the total value is squared.

Breaking the equation into its components makes the calculations simple.

First, $\bar{x}$ is the average concentration, found by:

$$\bar{x} = \frac{(x_1 + \ldots x_n)}{n}$$

In this case:

$$\bar{x} = \frac{(48 + 51 + 50 + 45)}{4}$$

$$\bar{x} = 48.5$$

Then, $\sum_{i=1}^{n}(x_i - \bar{x})^2$ means the sum of

$(x_1 - \bar{x})^2$ for all values of x from i to n.

$$(x_1 - \bar{x})^2 + (x_2 - \bar{x})^2 + (x_3 - \bar{x})^2 + (x_4 - \bar{x})^2$$
$$= (48 - 48.5)^2 + (51 - 48.5)^2 + (50 - 48.5)^2 + (45 - 48.5)^2$$
$$= (-0.5)^2 + (2.5)^2 + (1.5)^2 + (-3.5)^2$$
$$= 0.25 + 6.25 + 2.25 + 12.25$$
$$= 21$$

By placing these values in the original equation, the result is:

$$s = \sqrt{\frac{21}{4-1}}$$

$$s = \sqrt{\frac{21}{3}}$$

$$s = \sqrt{7}$$

$$s = 2.6$$

The smaller the value of s, the better the precision. The standard deviation reflects the scatter of the values around the average value. The results of this calculation should be compared with the data quality objectives defined in your QAPP. (See Element #6 in the section "Quality Assurance Project Plans.")

If a relationship between the standard deviation and the concentration level is clearly evident, use the coefficient of variation (cv) to determine precision.

$$cv = \frac{s}{\bar{x}}(100)$$

In this example:

$$cv = \frac{2.6}{48.5}(100)$$

$$cv = 5.4$$

When conducting an extensive sampling event (collecting samples at different locations during one trip), plan ahead for the types and number of QC samples that you will need to collect. You will want to meet the minimum of 10% laboratory QC samples for every sampling event, and compose the precision and accuracy makeup based on the needs of your sampling. If you want to evaluate the precision of the analysis for an entire sampling event, you could collect either a series of split samples or a series of replicate samples. The following example is for an event using a series of split samples.

Many of today's calculators perform the standard deviation calculation. Consider purchasing this type of equipment under your Section 106 grant.

EXAMPLE:
Precision Calculation for a Sampling Event Using Splits

For a sampling event involving 80 samples and a QC scheme of 10% of all samples being analyzed for precision, every 8th sample could be split. The following measurements and calculations could be made to determine QA/QC. The results of each pair (x_1 and x_2) are listed in the table below. Also listed are the calculations that could be made for average concentration ($\bar{x}$), standard deviation (s), and coefficient of variation (cv).

The precision of the individual measurements for this sampling event could be estimated to be: (0.07) (x)

More complicated calculations may be necessary for results where a constant relationship does not exist. Such calculations are not included here, but can be found in most statistics texts.

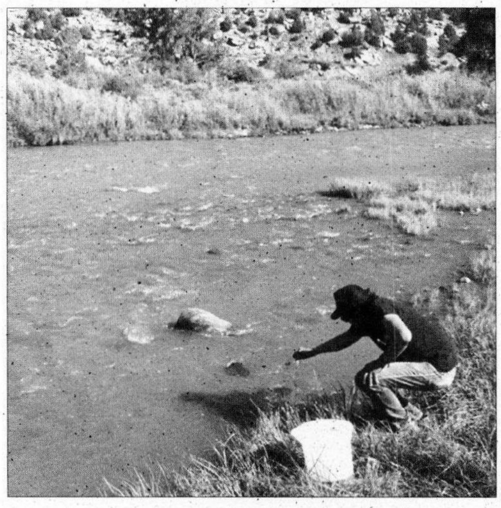
x_1	x_2	$\bar{x}$	s	cv (%)
1.5	1.7	1.60	.14	9
1.7	1.6	1.65	.07	4
2.0	2.1	2.05	.07	3
2.4	2.1	2.25	.21	9
2.7	2.4	2.55	.21	8
3.9	4.3	4.10	.28	7
5.0	4.5	4.75	.35	7
5.2	4.7	4.95	.35	7
				average cv = 7%

Samples to Determine Accuracy

In order to determine the accuracy of samples, they must be compared to a reference material which is of a known concentration. There are two types of QC samples which determine accuracy.

3. A <u>spike sample</u> is a sample that has a known amount and concentration of a constituent, such as a metal or pesticide, added to it. By introducing a known quantity into a regularly collected sample, and determining the percent of material that is recovered in analysis, an evaluation of accuracy can be made. Samples can be spiked either in the field or in the laboratory.

By spiking a sample in the field and determining the percent recovery of the substance added, the results will reflect effects associated with preservation, shipping, laboratory preparation, and analysis. A spike added in the laboratory will incorporate effects associated only with preparation and analysis.



Always remember safety considerations when sampling during high run-off.

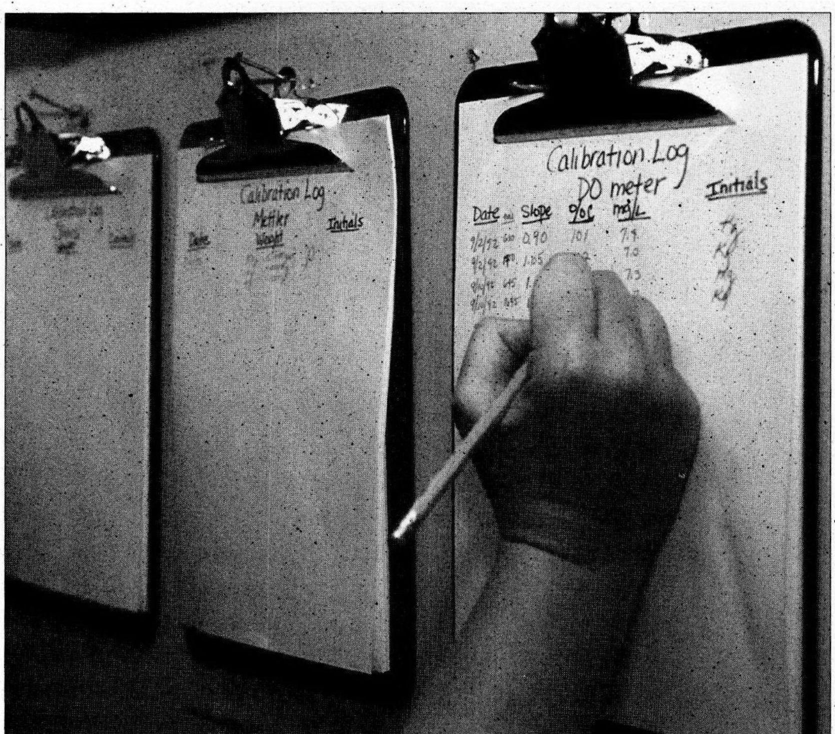
EXAMPLE:

Accuracy Calculation for a Spike Sample

A sampling event collects 100 samples. To meet QA/QC requirements of 10%, 10 samples were selected to be spiked and evaluated for accuracy. (Note: When creating spike samples, a sample is split. One resulting sub-sample is spiked; the other is left unspiked.)

<u>Accuracy</u> is the agreement between the measured amount of a constituent and the amount of that constituent that is actually present. This is determined by averaging several samples with a known value added, and determining how close they are to the true value.

Unspiked Sample (B_i)	Spike Value (T_i)	Spiked Sample (A_i)	Recovery ($A_i - B_i$)	% Recovery/Bias $\frac{A_i + B_i}{T_i}$ (100)
4.0	20.0	22.8	18.8	94.0
7.9	20.0	26.2	18.3	91.5
4.5	20.0	25.4	20.9	104.5
1.3	20.0	21.2	19.9	99.5
17.3	50.0	66.7	49.4	94.8
26.3	100.0	128.0	101.7	101.7
5.7	20.0	24.8	19.1	95.5
5.0	20.0	24.8	19.8	99.0
62.5	200.0	260.5	197.8	98.9
34.5	100.0	135.3	100.8	100.8



Equipment calibration logs should be kept in the tribal and contract laboratories. Documenting the calibration trends for each piece of equipment will help you to identify any damaged or broken equipment. When evaluating results, calibration logs can help you to determine the system bias of laboratory equipment.

<u>Bias</u> is the difference between a true value and a measured value, due to the laboratory equipment's "normal" skew.

Average percent of recovery is:

$$\bar{P} = \frac{P_1 + \ldots P_n}{n}$$

$$\bar{P} = \frac{980.2}{10}$$

$$\bar{P} = 98.0\%$$

To express accuracy for the data set, take the standard deviation:

$$s = \frac{\sqrt{\sum_{i=1}^{n}(P_i - \bar{P})^2}}{n - 1}$$

$$s = \sqrt{\frac{142.58}{9}}$$

$$s = \sqrt{15.84}$$

$$s = 4.0$$

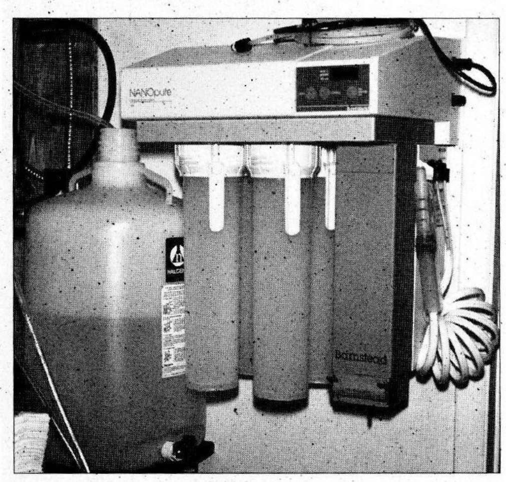
This means that statistically, if the percent recovery is + or - two standard deviations, it is 98.0% ± 2 (4.0), and will fall between 90% and 106% recovery 95% of the time. Accuracy is generally reported as a percentage (%) of bias.

$$\% \text{ Bias} = \bar{P} - 100$$

In this case:

$$\% \text{ Bias} = 98 - 100$$
$$= 2$$

4. A <u>blank sample</u> consists of a sample container that is filled with distilled or deionized water rather than water taken from the stream or lake being sampled. A blank can be used to test the accuracy of field or laboratory equipment, or to let you know whether constituents are being carried over from one sample to another through problems with equipment or procedure. If any constituent is recovered during analysis of a blank sample, it is an indication that some procedure is allowing for contamination or error. Some blanks are prepared before going into the field, some are prepared in the field,



Deionized water is used in the laboratory and the field to rinse sample containers, equipment, and laboratory ware. The unit shown here transforms regular tap water into deionized water.

and some are prepared in the laboratory. The preparation will depend on the purpose for using a blank.

Samples to Evaluate Equipment Performance

5. A calibration check is used to check equipment performance with laboratory-prepared standards, or in accordance with manufacturers guidelines, to ensure that equipment is operating properly. A reference sample of known concentration is used to measure accuracy. Percent bias can be determined using the following equation:

$$\% \text{ Bias} = \frac{100\ (\text{average value} - \text{true value})}{\text{true value}}$$

Measurements for such parameters as pH, alkalinity, hardness, dissolved oxygen, and even temperature should also include a component of quality control. Such QC will allow you to evaluate the accuracy and precision of both your methods and your equipment.

Another measure of QA/QC is to evaluate the bias of the system. Bias is the amount of difference between a measured value and a true value that is due solely to analysis system sources.

EXAMPLE: System Bias Calculation

A sample of a known concentration (50 mg/l) is analyzed four times to determine the bias. The results of the analyses are:

x_1 = 48 mg/l
x_2 = 51 mg/l
x_3 = 50 mg/l
x_4 = 45 mg/l

First, the average concentration is determined by the formula:

$$\bar{x} = \frac{(x_1 + \ldots + x_n)}{n}$$

or, in this case:

$$\bar{x} = \frac{(48 + 51 + 50 + 45)}{4}$$

$$\bar{x} = \frac{194}{4}$$

$$\bar{x} = 48.5 \text{ mg/l}$$

Next, the bias is determined by subtracting the true concentration from the average concentration.

$B = \bar{x} - T$

or:

$B = 48.5 \text{ mg/l} - 50 \text{ mg/l}$

$B = -1.5 \text{ mg/l}$

This is the average amount of bias that the process of system analysis may contribute to each sample in this analysis run, for the samples that this machine is running, until it is calibrated again.

✓ Laboratories conduct their own quality control checks — including collocated samples (those that are arranged or organized in a certain manner), replicates, splits, and spikes — to determine their own quality. When contracting with a laboratory, be sure to get a copy of their QA/QC plan and include it as an appendix to your QAPP. Also, discuss how frequently the laboratory will analyze quality control samples, and be certain that the results from the laboratory's internal quality control samples are included in the report on your data.

*__Completeness__ **is a measure of the number of samples intended to be taken compared to the number of samples actually taken, expressed as a percentage. If a study defines 80% completeness, then 80 out of 100 samples must be acceptable as valid samples. A sample may be determined to be invalid and rejected from the study because it was contaminated or destroyed somewhere in the sampling process.***

EVALUATING RESULTS AND DETERMINING QUALITY

Once you have completed sampling, sent the samples to the laboratory for analysis, and received the results, you will need to determine the quality of your data. Procedures for determining this should be covered in the "Validation and Verification" section of your QAPP. (See Element #14 in the following section.) But, how do you actually evaluate the data?

Compare the results of your data with the information from your field notebook. From this, you may be able to identify errors (if any), and the source of these errors. Use the precision and accuracy equations outlined above to evaluate the quality of your data. Additional methods which are more technical and statistical in nature may also be used. (Consult *Standard Methods.*)

After a determination of the precision, accuracy, and completeness of the data is made, you will be able to do one of the following: Completely accept the data that you collected, accept them with restrictions, or reject them. If you must reject a portion of the data, you should go back and review the procedures that were used both in field collection and laboratory analysis to determine where errors were introduced into the system, and how these errors can be avoided in the future.

▼ When conducting environmental monitoring, be sure to document all of the procedures and changes in procedures that you make, both in the field and in the laboratory. Along with the SOP manual and QAPP, keep waterproof field and laboratory notebooks available to use at every location. Record information such as current weather, recent storm events, specific site location descriptions, deviations from SOPs, sample ID numbers, and the type of QC samples taken. Before going into the field, make sure your equipment is working properly, and take spare parts with you in case you need to repair or replace something that breaks while you are out.

Some water quality samples will be collected directly from a water body and analyzed for total concentration of a constituent. Others, such as the sample shown here, will be filtered in the field and analyzed for dissolved concentrations.

QUALITY ASSURANCE PROJECT PLANS

QUALITY ASSURANCE PROJECT PLANS

A QAPP is a document that provides specific information on how QA/QC is applied to the collection of data. It includes information on data collection, planning, implementation, and assessment. If used properly, a QAPP provides the best tool for evaluating the results of monitoring. Because the information contained in a QAPP varies greatly from tribe to tribe, there is no standard form to be completed. Rather, the examples included here should serve as a guideline for your tribe's unique QAPP. For more detailed information on developing a QAPP, refer to the document *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations* (see References, page 35).

A QAPP may consist of as many as 25 different elements. For tribal QAPPs, only 16 of these elements are required.

▼ Each year, review your approved QAPP. If there have been changes to field or analytical methodologies, revise the plan to reflect these changes. Your QAPP must be current.

▼ Hiring an independent consulting firm to complete your tribal QAPP is allowed, but EPA encourages tribes to write it themselves. Because the QAPP document will be used by tribal personnel in sampling, its contents must be very familiar to those individuals. An outside contractor may not be able to provide the details specific to your tribal program as well as tribal staff can.

All 25 possible elements are listed below; an arrow indicates those required for tribal programs in EPA Region 8.

- ➤ Title and Approval Sheet
- ➤ Table of Contents
- Distribution List
- ➤ Project/Task Organization
- ➤ Problem Definition/Background
- ➤ Project/Task Description
- ➤ Data Quality Objectives for Measurement Data
- Project Narrative
- Special Training Requirements/ Certification
- Documentation and Records
- ➤ Sampling Process Design
- ➤ Sampling Methods Requirements
- ➤ Sample Handling and Custody Requirements
- ➤ Analytical Methods Requirements
- ➤ Quality Control Requirements
- Instrument Testing, Inspection, and Maintenance
- ➤ Instrument Calibration and Frequency
- Inspection Requirements for Supplies
- Data Acquisition Requirements
- Data Quality Management
- ➤ Assessments and Response Actions
- Reports to Management
- ➤ Data Review, Validation, and Verification Requirements
- ➤ Validation and Verification Methods
- ➤ Reconciliation with Data Quality Objectives

This section describes, gives examples of, and lists the requirements for the 16 elements that are necessary for tribal water quality programs.

1 TITLE AND APPROVAL SHEET

This element must include (1) title of the QAPP, (2) name of the tribe and tribal organization implementing the plan, and (3) names, titles, signatures, and approval dates for the Tribal Project Manager, Tribal Quality Assurance Manager, EPA Project Officer, and EPA Quality Assurance Manager.

2 TABLE OF CONTENTS

Lists the sections, figures, tables, references, and appendices. A complete document control number should be included at the top right corner of every page.

Section________
Revision No. ___
Date _________
Page___ of ___

ELEMENT #2-Table of Contents

This method of document control is advantageous. If you need to make minor changes, document control will eliminate the need to resubmit a revised QAPP; such changes to the plan can be inserted on a page-by-page basis. Major revisions to the plan, however, must be submitted to EPA for review and approval.

3 PROJECT/TASK ORGANIZATION

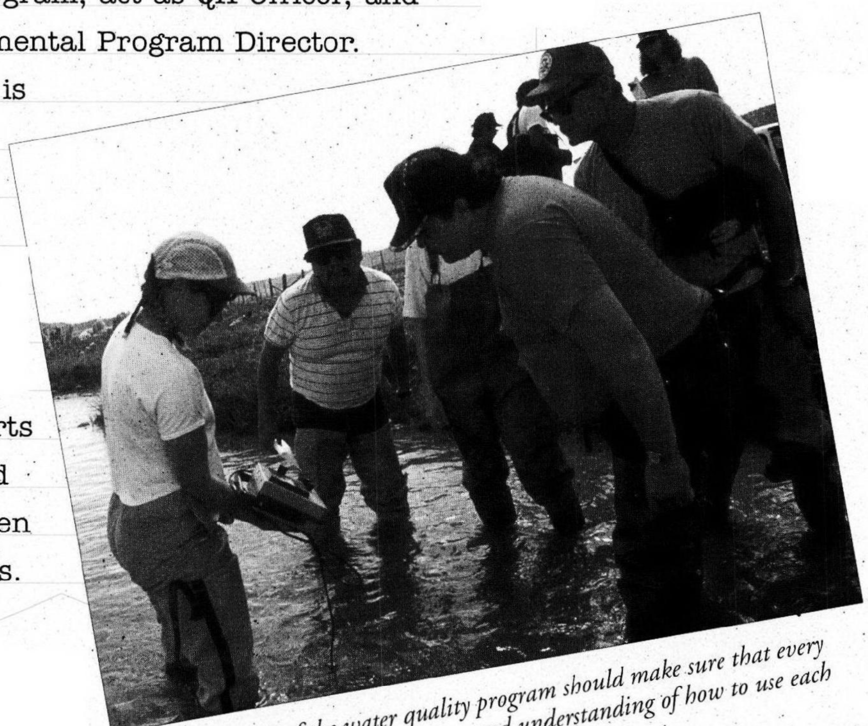
Identifies the personnel and departments within the tribe that will use the data and make decisions associated with them. Includes an organizational chart showing the relationship of these individuals and departments. Do not use specific names, but rather job titles. Include at least one paragraph which describes the responsibilities of each position, how the QA/QC activities will be performed, and who will be responsible for performing which QA/QC activities.

ELEMENT #3-Project/Task Organization

Organizational Chart

Tribal Members
Tribal Council
Tribal Chair
Environmental Committee Chair
Environmental Program Director
Water Quality Specialist (QA Officer)
Water Quality Technician

The Water Quality Technician will be responsible for the field collection and tribal laboratory analysis of samples, and reports to the Water Quality Specialist. The Specialist will oversee the water quality monitoring program, act as QA Officer, and report to the Environmental Program Director. The Program Director is responsible for reviewing the work performed and making recommendations to the Environmental Committee. The Committee Chair reports to the Tribal Chair and Tribal Council, who then inform Tribal Members.



The coordinator of the water quality program should make sure that every member of the sampling crew has a good understanding of how to use each piece of equipment.

4 PROBLEM DEFINITION/BACKGROUND

Briefly states the specific problem to be addressed in the water quality monitoring project. Includes brief background information on the project. Includes a description of the EPA program that is funding the monitoring program. The QAPP may reference this information from the annual workplan.

ELEMENT #4-Problem Definition/Background

The Ute Mountain Ute Tribe is developing a water quality program with funding from the EPA Clean Water Act Section 106 program. The tribe is establishing a baseline water quality monitoring program for surface water chemistry. The purpose of collecting data is to support the tribe's long-range goals of developing tribal rules and regulations and water quality standards, and creating an overview of the quality of reservation waters. See the Section 106 grant workplan for specifics on the problems to be addressed in water quality monitoring.

Macroinvertebrates (insects) can be collected from the stream bottom and then transported to the laboratory for accurate identification.

5 PROJECT/TASK DESCRIPTION

Provides a description of the work that will be performed. This description should be as thorough as possible. If appropriate, maps and other descriptive figures are helpful to describe the data collection location. Because this portion of the QAPP is most likely to change from year to year, the most effective way to provide this information is by referencing the tribal workplan. (Certain other parts of the QAPP will remain constant because procedures such as sample preservation and handling for certain constituents are unlikely to change.)

The description in the workplan should include an identification of all measurements that will be performed during the project. All measurements should be classified as either critical (required for the project) or non-critical (informational).

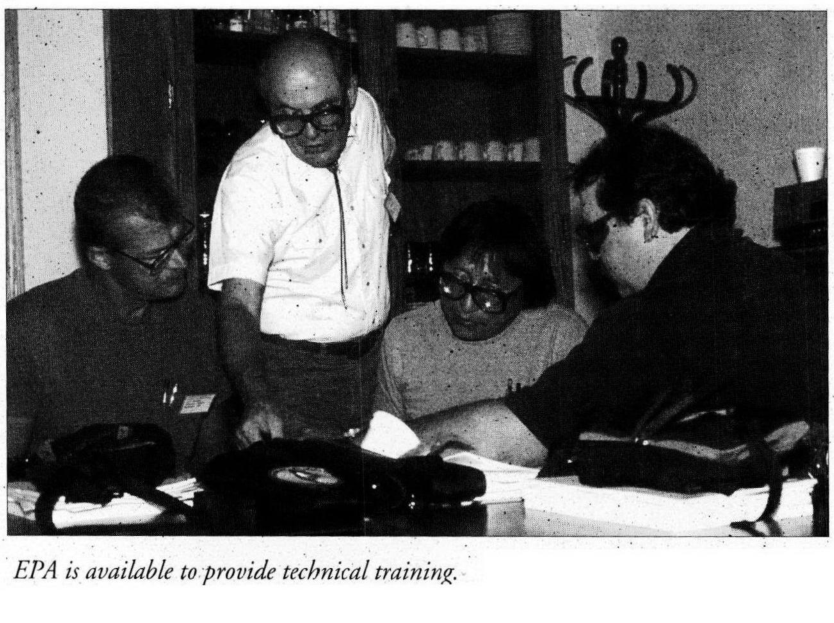
Equipment and personnel that will be used should be included. Performance and calibration requirements, as well as the methods and procedures to be used for field and laboratory sampling, may be cited from the tribal Standard Operating Procedures manual.

ELEMENT #5-Project/Task Description

The Ute Mountain Ute Tribe is located in extreme southwest Colorado, with portions extending into Utah and New Mexico. The reservation covers approximately 500,000 acres. Four drainages traverse the reservation, including the Mancos River, San Juan River, Mc Elmo Creek, and Navajo Creek. Some of the surface water bodies serve as irrigation water, and are also important to fish and wildlife resources. Included are numerous groundwater wells used for construction and livestock water. Selection of monitoring sites was based on historical monitoring data. Measurements which will be made are listed in the approved Section 106 grant workplan under Task #4, "Monitoring Program."

6 DATA QUALITY OBJECTIVES FOR MEASUREMENT DATA

State the project objective, or reference it from the workplan. The objective must be described in numerical terms. This allows you to know what measurements must be taken and with what frequency. By establishing numerical goals to support the objective, you will be able to determine how many samples to collect and what analytical methods to use to give results at the sensitivity required.



EPA is available to provide technical training.

In this section you will identify the scope of the project, including the time frame for conducting the monitoring, and the constraints on the project. List why the data are needed and for what they will be used. Being very specific, list what compounds are being measured, the detection levels of the compounds, the reporting units, the acceptable level of confidence for each (standard deviation and percent bias), and the citation for the source(s) of this information (CFR or *Standard Methods*). The easiest way to do this is to present the information in a table that specifies the quality of the data needed to achieve the project objective.

ELEMENT #6-Data Quality Objectives for Measurement Data

Parameter	Detection Level	Reporting Units	Precision (std. dev.)	Accuracy (% bias)	Method	Completeness (%)
pH	0.01-14.0	SU	0.13	0.05	Std Met	80
conductivity	0-10,000	mhos/cm	8.2	4.8	Std Met	80
iron	0.02	mg/l	16.5	0.06	Std Met	80
zinc	0.005	mg/l	8.4	0.4	Std Met	80

Precision, accuracy, and completeness should be expressed in terms of numbers. Representativeness and comparability are not numerical but are descriptive evaluations of items such as sampling locations and the sampling scheme.

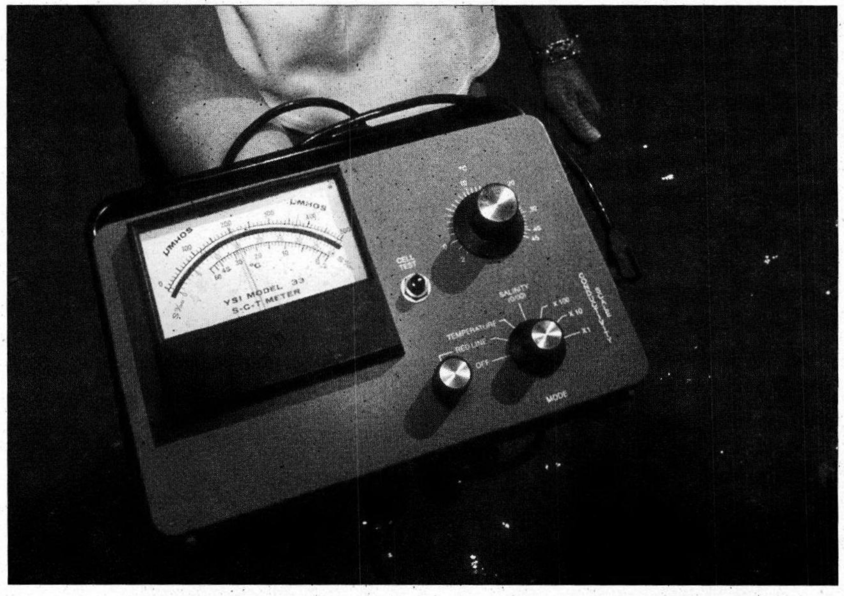
Representativeness is the expression of the degree to which data accurately and precisely represent a characteristic of a population, parameter variation, process condition, or environmental condition. The Ute Mountain Ute Tribe's water quality monitoring program is set up to delineate the water quality of the reservation by drainage.

Comparability is the confidence with which one data set can be compared to another. Consistency of reporting units, standardized analytical methods, and standardized data formatting will ensure comparability.

Note: The levels selected for acceptability depend entirely on the objective(s) of your monitoring program. For instance, the accuracy and precision used when monitoring for legally-defensible data for an Environmental Impact Statement would need to be much higher than those used when monitoring for baseline data to classify reservation waters.

7 SAMPLING PROCESS DESIGN (EXPERIMENTAL DESIGN)

Outlines, in general terms, the experimental design of the project and the anticipated project activities. Includes sample design, sample frequencies, matrices, and a schedule of milestones. It is recommended that a map be included that identifies sampling locations. This section describes how sampling locations and frequency of sampling were determined; it will vary with each monitoring plan that you design. The best way to address this requirement is to reference this information from the grant workplan.



Hand-held conductivity meter with probe attached. Equipment such as this can be taken into the field to perform on-site analysis.

8 SAMPLING METHODS REQUIREMENTS

This is a specific list of the constituents for which you will be sampling and the methods you will use to do the sampling. A good way to illustrate this is by developing a table of the constituents and then listing details regarding the containers, sample preservation methods, maximum holding times, and procedures. This information comes directly from the methods in 40 CFR 136 or *Standard Methods*, or from the analytical laboratory. It is best to include in the table all possible constituents found on the reservation, even if you do not anticipate monitoring for all of them immediately.

ELEMENT #8-Sampling Methods Requirements

Parameter	Procedure *	Container	Preservative	Hold Time
pH	Meter	Poly/Glass	None	0
iron	Atom Abs	Poly	IINO3	6 months

* Analytical Method Requirement from Element #10

9 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

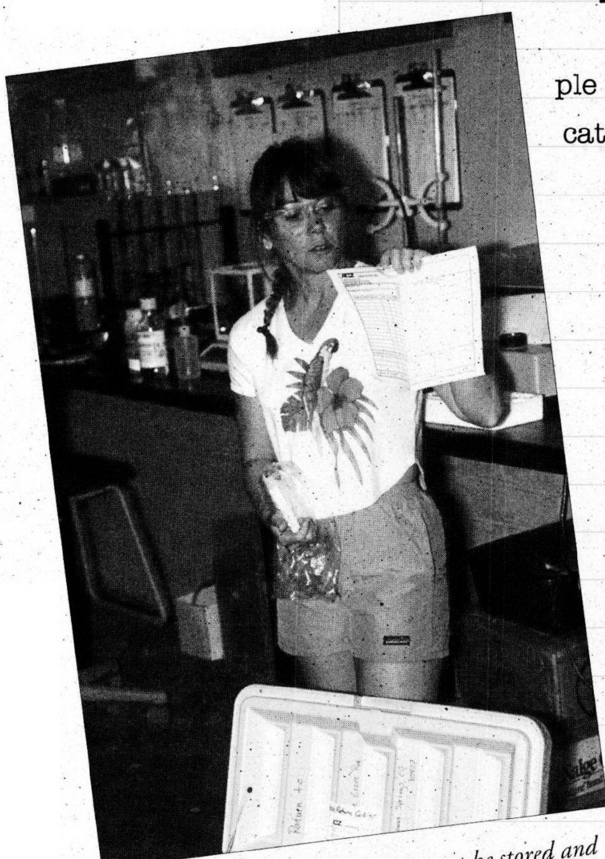
Describes the procedure that will be used for keeping track of and shipping or delivering samples to an outside laboratory for analysis. Describes the chain of custody for both the field and the laboratory.

ELEMENT #9-
Sample Handling & Custody Requirements

Samples will be labeled in the field at the sample location. Minimum information on the identification labels will include

- sample location
- sample number
- date and time of collection
- sample type
- sampler's name
- preservation method

Samples will be sealed and preserved appropriately for shipment, and be accompanied by a chain of custody (COC) form. Upon receipt by the lab, the receiver will sign the COC form and return it to the Water Quality program staff. A copy of the final COC form will accompany the data results in the report from the laboratory.



Samples for certain constituents must be stored and shipped at specific temperatures. Coolers should be filled and lowered to the proper temperature, then closed securely for shipment to the contact laboratory. Chain of custody forms and data sheets should accompany the samples, enclosed in a waterproof bag in the cooler.

10 ANALYTICAL METHODS REQUIREMENTS

This element is a list of the analytical methods that will be used. These can easily be included in the table developed for Sampling Methods Requirements (see Element #8, on previous page).

11 QUALITY CONTROL REQUIREMENTS

Discusses the quality control procedures that will be used for each analysis or measurement technique. This refers to the five different types of QC samples that can be used to determine error in sampling, listed in the previous section "Quality Assurance and Quality Control Working Together." These QC requirements should be determined when creating the monitoring plan. It is best to present this information in table form. Also, reference the contract laboratory's QA/QC plan.

ELEMENT #11-
Quality Control Requirements

Sample Type	QC Frequency
Field	5%
Laboratory	10%

12 INSTRUMENT CALIBRATION AND FREQUENCY

This element describes how all of the instruments (field and tribal laboratory) are calibrated, along with the type of standards that will be used. Specific procedures for calibrating equipment will not be listed in this section; rather, these procedures should be included in the tribal SOP document. A simple reference to the tribal SOP will fulfill the requirements of this element.

If the tribe is using a contract laboratory, it is acceptable to reference the laboratory's QA/QC plan as it pertains to the laboratory's instrument calibration, frequency, and traceability.

ELEMENT #12-Instrument Calibration & Frequency

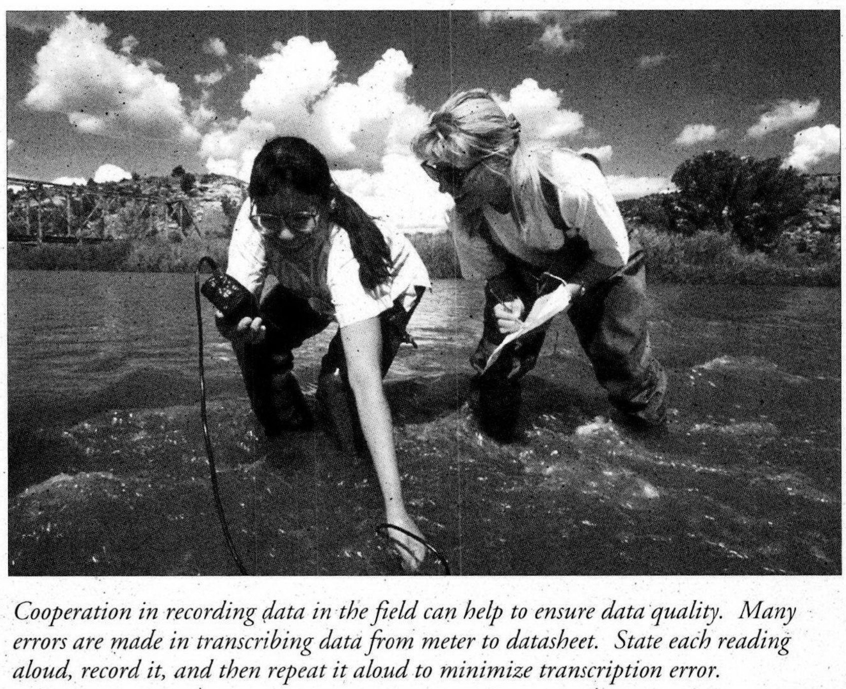
All of the field instruments will be calibrated according to the manufacturer's recommendations. Any deviation from these recommendations due to specific peculiarities with certain instruments will be documented in the monitoring program of the grant workplan. All standards will be traceable to a nationally-recognized standard and documented in field logbooks. All instrument calibration information can be found in the tribal Standard Operating Procedures.

The calibrations, frequency, and traceability of laboratory instrumentation are conducted in accordance with Section #__ of (laboratory's name) QA/QC Plan. A copy of the reference is included as Appendix A.

13 ASSESSMENTS AND RESPONSE ACTIONS

This element identifies the type of assessment activities that are to be conducted during the length of the project. Assessments are formal evaluations of organizations and individuals performing activities for the project. This usually includes, but is not limited to, the following:

Performance Evaluations: evaluations of the individuals or organizations (including water quality programs or laboratories participating in the project) involved in sampling, analysis, and/or interpretation of data. Performance for any or all of these entities can be studied and outlined in a written report or performance review.



Cooperation in recording data in the field can help to ensure data quality. Many errors are made in transcribing data from meter to datasheet. State each reading aloud, record it, and then repeat it aloud to minimize transcription error.

System Audits: audits of the equipment, personnel, and procedures by tribal or EPA personnel to determine the adequacy of the analytical measurement system, data collection, and other system components. The audit may consist of a field or laboratory audit that evaluates operations against the requirements of the approved QAPP and procedures. System audit reports note problems and allow corrective actions to be taken to protect the validity of collected data. When contracting with a laboratory, a tribe should include a requirement that both the tribe and EPA may conduct system audits on the laboratory at any time.

Management System Reviews: allow for reviews of the tribal management system associated with project oversight.

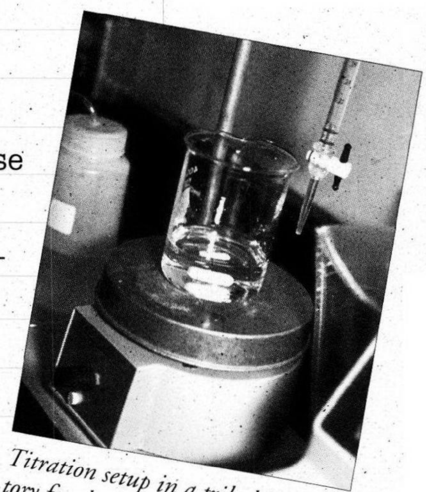
Data Quality Audits: provide an opportunity for tribal and EPA representatives to review data results and compare them with project quality objectives.

Inspections: site inspections allow for evaluation of conditions and procedures in field and laboratory settings.

This element also discusses what action(s) will be taken if sample results indicate a problem in the data collection and/or data analysis aspect of the project.

ELEMENT #13-Assessments & Response Actions

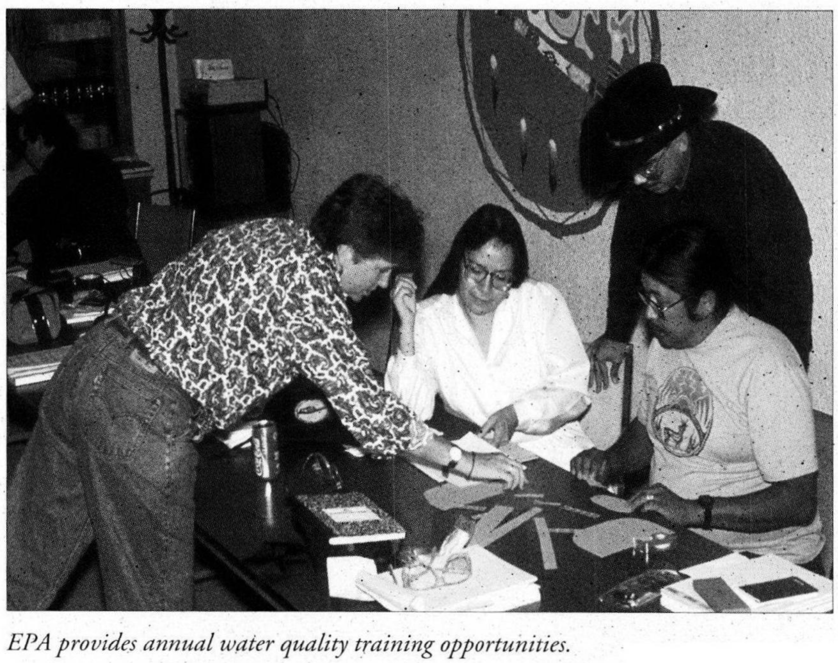
In order to identify any problem(s), the tribe will conduct a self-assessment of the sampling and analysis of the data collected—at least once a year during the project. If a major problem exists, corrective action will be immediately taken and documented. In those situations where independent expertise is needed to assess a certain aspect of the project, the tribe will request technical assistance from the U.S. EPA. The U.S. EPA Project Officer or Regional Quality Assurance Officer may conduct any type of assessment at any time during the length of the project. This includes conducting assessments of any contractor or sub-contractor performing sampling, analysis, or any other activity directly related to the program.



Titration setup in a tribal laboratory for determining hardness or alkalinity.

14 DATA REVIEW, VALIDATION, AND VERIFICATION REQUIREMENTS

This section states the criteria that will be used to review the data that were collected and to decide whether they will be accepted, rejected, or qualified. A statement of what will be done, and by whom, is all that is needed. A description of how this will be done should be provided in the QAPP "Validation and Verification Methods," Element #15.



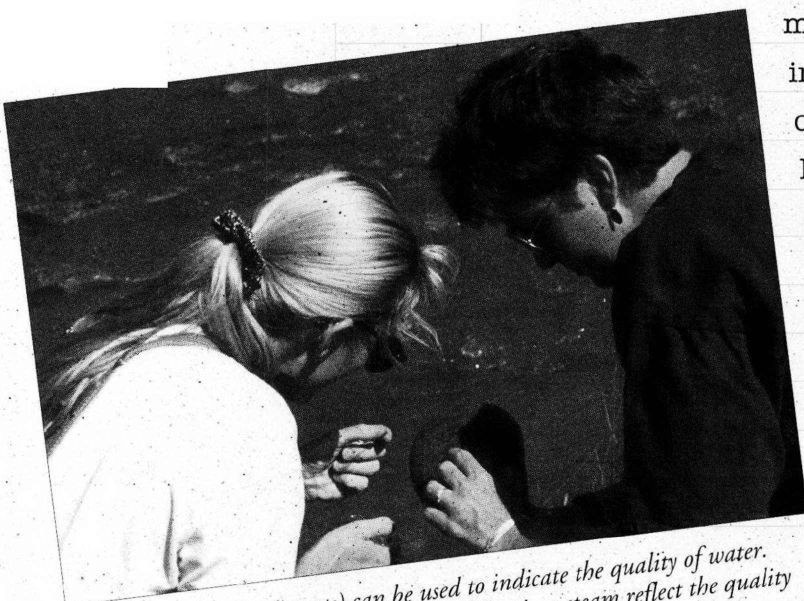
EPA provides annual water quality training opportunities.

ELEMENT #14-
Data Review, Validation, & Verification Requirements

It is the responsibility of the Water Quality Specialist to evaluate raw data generated by the tribal or contract laboratory for appropriate numeric reduction, data quality, and accuracy. All data will be reviewed and reported in units specified at the detection level of the analytical methods used.

To reduce data point loss, data that are reported as "less than" detection level will be incorporated at a value of 1/2 the detection level.

Once data are generated, they will be compiled in a database file. During this data transfer, the information will be reviewed and verified in accordance with the data quality objectives. Data generated in the laboratory will be validated by performance checks such as duplicate sample analysis, linear regression curve fitting for standards, spike recovery, inter-laboratory sample exchange, and unknown sample analysis reports.



Macroinvertebrates (insects) can be used to indicate the quality of water. Both the number and types of insects that live in a steam reflect the quality of the water. Turn over a rock and see what you find!

Data units will be systematically reported in milligrams per liter (mg/l), unless otherwise noted, for all parameters except pH and conductivity. Scientific notation will be used, and significant figures will correlate with detection levels. Both graphing and narrative conclusions will be used to describe the water quality results and trend variations.

15 VALIDATION AND VERIFICATION METHODS

This section describes the process used for validating and verifying data. It should describe how errors, if detected, will be corrected, and how the analysis of quality control data, detection limits, instrument calibrations, and special conditions will be performed.

ELEMENT #15-Validation & Verification Methods

The Water Quality Specialist will be responsible for receiving the data sheets and field/laboratory notebooks, checking for errors in identification numbers, decimal placement, dates, times, units reported, and comments. Personnel collecting data will be contacted immediately if there are data gaps or if scheduled sampling times were missed. The Water Quality Specialist will make every attempt to screen inaccurate data before they are entered in the database by analyzing all quality control data, including chain of custody, spikes, replicates, sample holding times, blanks, equipment calibrations, and sampling conditions.

Quality control sample results will be evaluated individually by performing appropriate mathematical analysis for precision or accuracy for each sample.

Only the Water Quality Specialist and Water Quality Technician will be allowed to access project data and submit reports to data users. All data will be accompanied by QA/QC information.

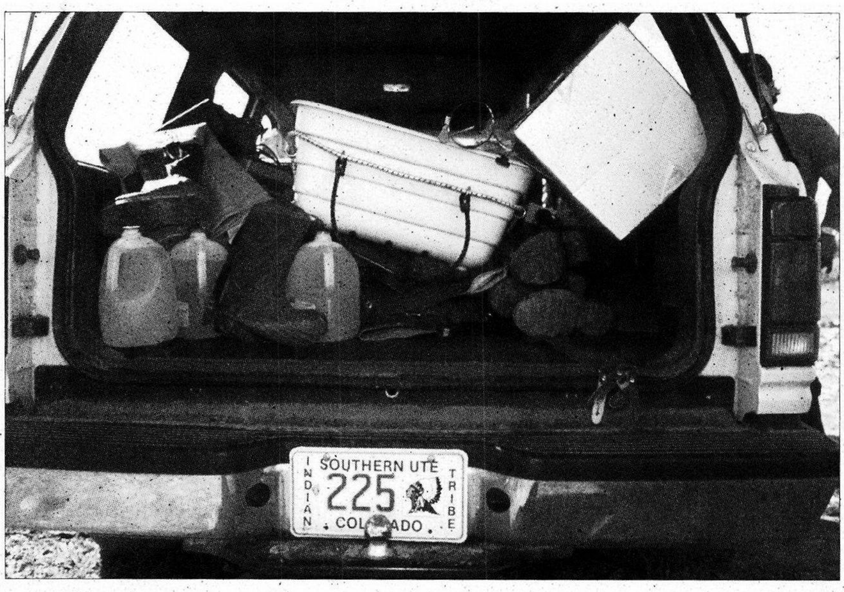
Data will be printed out in lists and graphs, with lists checked against original data sheets. The Water Quality Technician will be responsible for correcting data entry errors. A second examination will verify that corrections are completed. Inaccurate data will be discarded, and data anomalies will be evaluated on a case-by-case basis.

16 RECONCILIATION WITH DATA QUALITY OBJECTIVES (DQOs)

This activity is conducted once the data results are compiled to determine whether the data collected for the project really meet the objectives of the project. If the data quality objectives have not been met, the problem can be addressed either by correcting errors in the system, or by adjusting the objectives. To meet this requirement, simply describe the process that the program will use to evaluate whether the DQOs have been met.

ELEMENT #16-
Reconciliation with Data Quality Objectives (DQOs)

Established DQOs will be compared with the results of all QA/QC samples. Data that do not meet DQOs will be discarded from the analysis and not re-sampled. Completeness, accuracy, precision, representativeness, and comparability will be evaluated by the Water Quality Specialist.



Make a checklist of all the equipment you will need to take into the field. Check it as you pack your vehicle. Always remember spare equipment parts.

The 16 elements described here are those that must be covered in a tribal QAPP. Any of the additional nine elements may also be covered, as a tribe wishes. EPA staff is available to assist tribes throughout the development of the QAPP. Project specific changes should be made annually to the monitoring program described in your grant workplan. Changes in your QAPP must be sent to EPA for approval.

HELPFUL RESOURCES

GLOSSARY

Abatement: The reduction of water pollution sources.

Accuracy: The closeness of a measured value to the true value.

Aliquot: A fraction of a sample prepared for the analysis of particular constituents, sent in a separate container to the analytical laboratory.

Analytical Laboratory: A laboratory under contract with a tribe or state to analyze water samples collected from the field.

Analytical Laboratory Duplicates: Aliquots from a sample that is split in the analytical laboratory. The aliquots are analyzed in the same batch.

Anion: A negatively-charged ion.

Assessment: An evaluation of sources of water pollution, describing the nature, extent, and effect of pollution.

ASTM Type I Reagent-Grade Water: Deionized water which meets American Society for Testing and Materials specifications for Type I reagent-grade water, that has a measured conductance of less than 1 S/cm at 25^0 C.

Bias: The systematic difference between a measured value and a true value.

Blank Sample: A sample of ASTM Type I reagent-grade water analyzed as a quality control sample.

Calibration Blank: A solution used in standardizing or checking the calibration of analytical instruments; also used to determine instrument detection limits.

Cation: A positively-charged ion.

Comparability: A measure of data that expresses the confidence with which one data set can be compared to another.

Completeness: A measure of the number of samples intended to be taken compared to the number of samples actually taken, expressed as a percentage.

Conductance: A measure of the electrical conductance or total ionic strength of a water sample expressed as S/cm at 25^0 C.

Confidence Interval (95%): A set of possible values within which the true value will lie within a probable chance of 95%.

Constituent: A component which is part of a whole. For example, zinc may be one constituent of a water sample that has many types of heavy metals in it.

Database: Computerized results of a survey, which include the raw, verified, validated and final data sets as well as back-up and historical data sets.

Data Quality Objectives: Qualitative and quantitative specifications used to design a study that will limit uncertainty to an acceptable level:

Detection Limit: The lowest concentration or amount of the component of interest that can be determined by a single measurement at a stated confidence level.

Field Audit Samples: A standardized water sample submitted to a field laboratory to check overall performance in sample analysis by field and analytical laboratories.

Field Replicate Sample: An additional sample collected at the same location immediately after the first sample. It is possible to have more than two replicate samples.

Holding Time: The time during which a sample is collected, preserved, and analyzed.

Matrix: The physical and chemical composition of a sample being analyzed.

Parameter: A quantity whose value varies, used interchangeably with "constituent."

Percent Recovery: The amount of constituent recovered from a known added concentration.

pH: The negative logarithm of the hydrogen-ion activity. The pH scale runs from 1 (most acidic) to 14 (most alkaline or basic); the difference of 1 pH unit indicates a 10-fold change in hydrogen-ion activity.

Precision: A measurement of the closeness of data values to one another.

Quality Assurance: A set of operating principles and procedures used to effectively collect environmental data and determine how believable or reliable they are.

Quality Control: The set of steps taken during sample collection and analysis to ensure that the data quality meets the minimum standards established by a Quality Assurance Project Plan.

Reagent: A substance added to water to determine the concentration of a specific analyte.

Remediation: The act of correcting a problem; returning a situation to its proper condition.

Representativeness: A measure of data quality; the degree to which sample data accurately and precisely reflect the characteristics of a population.

Sample: An environmental substance (e.g. water, air, soil) that is measured for specific parameters.

Sample ID: The numeric identifier given to each sample and quality control sample.

Spike: A known concentration of an analyte introduced into a sample or aliquot.

Standard Deviation: The square root of the variance of a given statistic, used in determining the error of sampling.

Systematic Error: A consistent deviation from an expected or known value in the results of sampling and/or analytical processes. Such an error commonly results in biased estimations.

Turbidity: A measure of light scattering by suspended particles in an unfiltered water sample.

Validation: Process by which data are evaluated for quality with reference to the intended data uses; includes evaluation of the potential for error after data verification.

Verification: Process of ascertaining the quality of the data in accordance with the minimum standards established by the Quality Assurance Project Plan.

LIST OF ACRONYMS

CFR	Code of Federal Register
COC	Chain of Custody
CWA	Clean Water Act
DQO	Data Quality Objective
EPA	Environmental Protection Agency
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
SOP	Standard Operating Procedure

REFERENCES

For information about how to obtain the references listed below, or if you have questions about further references, contact: Tribal Water Quality Coordinator, EPA Region 8, 999 18th Street, Suite 500, Denver, CO 80202; (303) 293-1570 or (800) 227-8917.

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

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This guide has been reviewed by EPA and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.