

**STATE OF CALIFORNIA**  
**DEPARTMENT OF WATER RESOURCES**  
**DIVISION OF LOCAL ASSISTANCE**  
**OCTOBER 1993**  
**DRAFT**  
**GUIDELINES FOR PREPARING**  
**QUALITY ASSURANCE PROJECT PLANS**



**Douglas P. Wheeler**  
**Secretary of**  
**Resources Agency**

**Pete Wilson**  
**Governor**  
**State of California**

**David N. Kennedy**  
**Director**  
**Department of**  
**Water Resources**

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**ORGANIZATION**

**State of California  
Pete Wilson, Governor  
The Resources Agency  
Douglas P. Wheeler, Secretary of Resources**

**Department of Water Resources  
David Kennedy, Director**

<b>John Silveira Deputy Director</b>	<b>Robert Potter Chief Deputy Director</b>	<b>Carroll Hamon Deputy Director</b>
<b>L. Lucinda Chipponeri Assistant Director</b>	<b>Susan Weber Chief Counsel</b>	

**DIVISION OF LOCAL ASSISTANCE**

**Carlos Madrid.....Chief, Division of  
Local Assistance**

*This report was prepared by*

**Judith Heath.....Program Manager, Quality  
Assurance/Control Program**

*Under the supervision of*

**Richard Woodard .....Chief, Water Quality Assessment**

*With the assistance of*

**Marvin Yates.....Chemist, U.S. Geological Survey  
(Contract No. B-57658)**

## INTRODUCTION

The purpose of these guidelines is to describe requirements for preparing QA Project Plans involving environmental measurements. A QA Project Plan is necessary for: 1) projects requiring environmental permits; 2) large or complex scientific investigations; 3) politically sensitive projects; 4) monitoring data which will or could be used for regulatory purposes or DWR planning projects.

A detailed QA Project Plan may not need to be developed if the size and scope of the project is small or simplistic in operation. However, QA procedures should still be conducted. The DWR's QA Officer is available for consultation for these special cases.

These guidelines were developed to ensure that a QA Project Plan meets the minimum informational requirements. The Environmental Protection Agency's model was used as the basis for developing this document because it is widely accepted as the basis for an adequate plan. QA Project Plans should also conform with the programs of other non-regulatory agencies in meeting the needs of DWR to adequately document its environmental measurement program activities.

It is no longer acceptable for an agency to simply produce and

disseminate data from monitoring studies without (1) documenting the quality of the data produced and (2) assuring that the data were generated reliably. To meet these requirements, the Department of Water Resources has developed a Quality Assurance/Control Program with a system of methods to ensure reliable data.

This technical document is part of a series of documents which support the QA/QC Program. Other technical documents include the QA Program Plan, QA Protocol for Contract Laboratories and the Sampling Manual for Environmental Measurement Projects.

The QA Program is intended to provide flexibility depending on DWR needs and will not require undue effort to implement as staff become trained and gain experience in preparing QA Project Plans. Incorporating QA/QC practices will help make data collection efforts more selective, reduce the need for resampling and reanalysis when bad data are obtained, and improve the efficiency of resource expenditures.

The objective of a QA Project Plan is to ensure that the quality of the data collected is known and is appropriate for the objectives of the investigation. The QA Project Plan is a document that explains the QA/QC requirements to the sampling team, analytical laboratory, management, and all interested parties. As such, it must be well organized and complete.

Apart from the need to develop QA Project Plans for DWR's purpose, the EPA has issued regulations in 40 CFR Part 30 under the Clean Water Act which stipulate that agencies performing environmental measurement programs must have QA Project Plans for activities that receive federal monies directly or indirectly. In addition, the State Water Resources Control Board has required that contract work, performed by DWR for the State Board, be conducted in accordance with standard operating procedures as described in QA Project Plans.

The Program Manager has the responsibility to ensure that the data collected and analyzed are reliable for end users. Program Managers are responsible for producing the QA Project Plan, although the development of the plan may be delegated to the QC Coordinator or other staff. Once it is complete, the approval by the Program Manager of the QA Project Plan is required. The DWR QA Officer is available for review of the QA Project Plan.

The sixteen elements described in this document should be considered and addressed in each QA Project Plan, although some elements can be combined for convenience. A brief explanation of any element that is not relevant should be included.

In the following pages, the basic elements for consideration in the QA Project Plans are described and criteria are established

for plan preparation, review and approval. Where appropriate, examples are given to aid the QA Project Plan preparer throughout the main body and in the Appendices.

In addition, copies of some existing QA Project Plans are available for reference and are kept with the DWR QA Officer. Examples include the QA Project Plans from the DWR Municipal Water Quality Investigations and other State and federal agency programs.

For convenience, an example of a generic short form for QA Project Plans is included in Appendix H. This format was developed to aid Program Managers in providing documentation for less detailed QA activities where projects do not require a fully developed QA Project Plan. It is also appropriate to cite an existing QA Project Plan if it fits the requirements of the project.

## QUALITY ASSURANCE PROJECT PLAN COMPONENTS

(16 Elements)

### 1. Title and Approval Page

Completion of reviews and approvals should be shown on the title page of the plan. At a minimum, the QA Project Plan must be approved by the Program Manager.

Normally, environmental measurements should not be initiated until the QA Project Plan has received the necessary approvals, unless an emergency situation arises. In such cases, the Program Manager should consult with the QA Officer to identify an appropriate existing QA Project Plan which can be cited.

A copy of the approved QA Project Plan should be distributed to each person who has a major responsibility for the quality of measurement data, including the DWR QA Officer.

### 2. Table of Contents

The table of contents should have a serial listing of components, as well as a listing of figures, tables, and appendices.

### 3. Project Description

This section describes the environmental system or site that is to be evaluated, the project objectives, a summary of the experimental monitoring network design and the proposed project schedule.

A. Objective and Scope

Explain why the project is needed. Briefly summarize the site use, the reason for environmental concern and general conclusions of any relevant studies, including existing data of interest.

B. Data Usage

Describe what data are needed and how they will be used. Describe the adequacy of the existing data, if any, and why new data are needed. The following points should be explained:

- o Intended uses of data in order of importance
- o decisions to be made when data are obtained
- o the decision makers who will use the data.

C. Monitoring Network Design and Rationale

Describe the scope of the project in terms of the geographical area, the environmental medium being investigated and the time period for the study. The description of the site or environmental system could be shown in the form of maps, charts, etc. with sampling locations indicated. Any constraints of time, resources etc. on the measurement project should be listed.

In this section, the Program Manager should also describe how the sampling plan will meet the objectives stated in

parts 3A and 3B including the incorporation of data quality objectives described in part 3E. Include a description of the sampling procedures, where the samples will be collected, and types of matrices to be sampled. Bibliographic references for sampling and field measurements is found in Appendix B. Explain the rationale for the selection of the sampling location, the number of sampling locations and present any statistical approach used to select these sampling locations.

Most sampling protocols should have a statistical design to prove that the samples represent the matrix to be evaluated. Specifically, there should be a discussion to indicate whether the sampling locations were selected on a random, judgmental or systematic basis or a combination of these.

Bibliographic sources for sampling design references are listed in Appendix A. Especially useful are the publications authored by Lawrence H. Keith. Program Managers and their QA Coordinators will develop experience in using these techniques and can be assisted by the QA Officer in their application. Training, incorporating these concepts, is also planned.

Summary information can conveniently be presented in a table similar to the parameter table such as described in part 3D.

Table headings would include sample site, matrix, parameter, type of sample and frequency of collection.

#### D. Parameter Table

Prepare a table listing the parameters, number of samples, sample preservation method, and sample holding times. An example of this information is given in Table 1. The DWR QA Officer or laboratory director can provide assistance in identifying this information. The DWR Bryte Laboratory QA Manual lists analytical method references for many parameters.

TABLE 1  
EXAMPLE PARAMETER TABLE

PARAMETER	NUMBER OF SAMPLES	MATRIX	SAMPLE PRESERVATION	HOLDING TIME
Arsenic	32	Water	Nitric Acid pH2	6 months
Cadmium	32	Water	Nitric Acid pH2	6 months
Total Chromium	32	Water	Nitric Acid pH2	6 months
Lead	32	Water	Nitric Acid pH2	6 months
Selenium	32	Water	Nitric Acid pH2	6 months
Mercury	32	Water	Nitric Acid pH2	6 months
Arsenic	96	Sediment/Soil	4°C	6 months
Total Chromium	96	Sediment/Soil	4°C	6 months
Lead	96	Sediment/Soil	4°C	6 months
Selenium	96	Sediment/Soil	4°C	6 months
Mercury	96	Sediment/Soil	4°C	6 months
Arochlor 1254	32	Water	GA*/4°C	7/**40 Days
Aldrin	32	Water	GA*/4°C	7/**40 Days
Chlordane	32	Water	GA*/4°C	7/**40 Days
Endosulfan 1	32	Water	GA*/4°C	7/**40 Days
4,4'DDT	32	Water	GA*/4°C	7/**40 Days
Arochlor 1254	96	Sediment/Soil	GA*/4°C	7/**40 Days
Chlordane	96	Sediment/Soil	GA*/4°C	7/**40 Days
4,4'DDT	96	Sediment/Soil	GA*/4°C	7/**40 Days
Toxaphene	96	Sediment/Soil	GA*/4°C	7/**40 Days

\* Glass Amber Bottle with Teflon Lined Cap.

\*\* 7 Days for Extraction. Analysis Within 40 Days.

#### E. Data Quality Objectives

Development of Data Quality Objectives (DQOs) is required in order to determine suitable sampling, analytical, and QA/QC protocols described in the overall QA Project Plan. The DQOs are qualitative and quantitative statements of the quality of data needed to support specific decisions or actions. The project description lays the groundwork for the DQOs by establishing the objectives of the measurement project, the data needed, the intended uses, the data users, and the strategy for achieving the objectives.

The development of the DQOs is a joint responsibility of the Program Manager, QA Officer, technical staff and laboratory staff and occurs in three stages.

- o First, the Program Manager states the purpose of data collection and provides some preliminary guidance on resources, time constraints, and the quality of data needed.
- o Second, the technical staff including the DWR QA Officer, then refines the data quality goals via discussion with the Program Manager. Based on the timeframes, resources, and the technological constraints of methodology to be used for sampling and analysis, the technical staff develops various approaches for the investigation.
- o Third, the Program Manager finally selects the

approach best suited for the project goal.

It is recognized that skill in developing DQOs will have to be acquired by DWR Program Managers and other support personnel working with environmental measurement projects. DWR QA/QC training for the employees will address the techniques for developing DQOs and provide suitable examples to clarify these concepts.

#### F. Schedule of Tasks and Products

Describe the planned progress of the project from conception and implementation through completion and final reports.

#### 4. Project Organization and Responsibility

A table, chart, or flow diagram should be included showing the project organization and line authority. Contractors that are providing analytical services should be shown along with a list of the principal contacts.

List the key individuals who are responsible for the collection and analysis of measurement data and QA/QC functions. Make sure that data provided through contract laboratories are directed to a Program Manager for review and evaluation.

#### 5. Quality Assurance Objectives

Quality Assurance Objectives (QAOs) are specifications of the

level of precision, accuracy, representativeness, comparability and completeness that are necessary to meet the goals of the investigation. These objectives must be defined in terms of project requirements. If they exceed the capabilities of available methods, the methods must be modified to compensate for these deficiencies. Non-standardized methods require validation.

The QAOs are defined in quantitative and qualitative terms:

A. Quantitative QA Objectives

o Method Detection Limit

The method detection limit is defined as the lowest possible concentration of an analyte that can be detected in a sample or a blank with a 99% confidence level. In practice, laboratories usually determine reporting levels, or practical quantitation levels, which are several times higher than the method detection level.

The method detection limit must be reliably lower than the required objectives for quantitation in the project.

o Precision

Precision is the degree to which measurements can be reproduced among duplicate or replicate observations.

It is often expressed as relative percent difference (RPD) between duplicates. Precision is expressed as relative standard deviation (RSD) of the mean with more than two replicates.

- o Accuracy

Accuracy refers to the difference between the measured result and the true value of the parameter being determined. Accuracy can be determined by comparison of the environmental sample results to certified reference samples or as percent recovery of matrix spikes.

- o Completeness

Data completeness refers to the amount of data that are successfully collected and validated with respect to the amount intended in the project design. A certain percentage of the intended data must be successfully determined for valid conclusions to be reached. Completeness is usually expressed in percent.

B. Qualitative QA Objectives

- o Representativeness

Representativeness is the degree to which the data accurately and precisely represent the population (of samples). For example, the most critical factors necessary to achieve representativeness are appropriate

points of sampling, time of sampling, frequency of sampling, and maintenance of the integrity of the sample.

o Comparability

Comparability refers to the similarity of data generated by different groups. If comparability is required, these different agencies or groups should use equivalent sampling procedures and analytical methods.

Sometimes interlaboratory comparison studies can be used to establish comparability of analytical data.

Unless otherwise specified, all data must be calculated and reported in units consistent with usage of other organizations within and without DWR. The DWR QA Officer will be the final arbiter of the reporting units. The QAOs should be presented in a summary table with other information to clarify the details. Example QAOs are shown in Table 2. This format is not rigid and can be adjusted to suit the needs of the project.

TABLE 2.

## EXAMPLE QA OBJECTIVES TABLE

MEASUREMENT PARAMETER	MATRIX	METHOD <sup>1</sup>	CONCENTRATION UNITS	MDL*	REPORTING LEVEL	PRECISION [RPD OF DUPLICATES] <sup>2</sup>	ACCURACY (% RECOVERY)	COMPLETENESS <sup>4</sup>
Arsenic	Water	206.3	mg/l	.0005	.001	12	77-121	95%
Cadmium	Water	213.2	mg/l	.001	.005	5	87-119	95%
Total Chromium	Water	218.2	mg/l	.001	.005	8	86-122	95%
Lead	Water	239.2	mg/l	.001	.005	5	79-121	95%
Selenium	Water	270.3	mg/l	.0005	.001	8	74-121	95%
Mercury	Water	245.1	mg/l	.0002	.001	4	78-121	95%
Arochlor 1254	Water	608	mg/l	.065	.35	10	85-115	95%
Aldrin	Water	608	mg/l	.014	.07	10	85-115	95%
Chlordane	Water	608	mg/l	.014	.07	10	85-115	95%
Endosulfan 1	Water	608	mg/l	.014	.07	10	85-115	95%
4,4' DDT	Water	608	mg/l	.012	.06	10	85-115	95%
Arsenic	Sediment/Soil	7060	mg/kg	5	25	35	75-125	90%
Total Chromium	Sediment/Soil	6010	mg/kg	1	5	35	75-125	90%
Lead	Sediment/Soil	6010	mg/kg	10	50	35	75-125	90%
Selenium	Sediment/Soil	7740	mg/kg	5	25	35	75-125	90%
Mercury	Sediment/Soil	7471	mg/kg	.02	.10	35	75-125	90%
Arochlor 1254	Sediment/Soil	8080	mg/kg	70	350	25	25-140 <sup>3</sup>	90%
Chlordane	Sediment/Soil	8080	mg/kg	20	100	25	25-140 <sup>3</sup>	90%
4,4' DDT	Sediment/Soil	8080	mg/kg	20	10	25	25-140 <sup>3</sup>	90%
Toxaphene	Sediment/Soil	8080	mg/kg	30	150	25	25-140 <sup>3</sup>	90%

1 - USEPA Methodology

2 - Precision is usually related to concentration. The concentration range used to determine precision is defined by the laboratory. RPD is Relative Percent Difference.

3 - Surrogate recovery range.

4 - Based on the number of valid measurements compared to the total number of measurements. \*MDL is Method Detection Limit

## 6. Sampling Procedures

For each required measurement parameter (or analytical group) provide a description of the sampling procedures to be used.

Where applicable, include the following:

- A. Describe techniques or guidelines used to select sampling stations.
- B. Include a description of specific sampling procedures to be used. Reference the latest DWR Sampling Manual or provide a description of the entire procedure in the case of non-standard procedures.
- C. Where applicable, use charts, flow diagrams or tables to delineate the sampling program operations.
- D. Describe procedures for the cleaning and preparation of sampling equipment and containers to avoid sample contamination. For example, containers for organics should be solvent rinsed. Containers for trace metals should be acid rinsed.
- E. List sample preservation methods, maximum holding times and procedures to transport samples to the laboratory within allowable time limits. An example list is shown in Table 1.
- F. Describe the forms, notebooks, logbooks and procedure to be used to record field analyses, sample history, field equipment problems, sampling conditions, and sample station access information.

## 7. Sample Tracking

Sample tracking procedures require that possession of samples be traceable from the time samples are collected until completion and submittal of analytical results. The following sample tracking procedures should be addressed in the QA Project Plan. Where possible, refer to existing procedures described in the DWR Sampling Manual or the laboratory QA Manuals.

### A. Field Sampling Operations:

- 1) Describe procedures and forms for recording the exact sampling location and specific considerations associated with sample acquisition.
- 2) Indicate any use of pre-prepared sample labels containing all information necessary for effective sample tracking and to meet the contract laboratory requirements.
- 3) Describe the use of standardized field tracking reporting forms to establish sample custody in the field prior to transport. Examples of these forms are found in the Appendices to the DWR Sampling Manual.

### B. Laboratory Operations:

- 1) Identify the person acting as sample custodian at the laboratory authorized to sign for incoming field samples, obtaining documents of shipment (e.g. bill of lading number or mail receipt) and verifying the data entered onto the sample custody records.
- 2) Specify laboratory sample tracking procedures for

sample handling, storage and dispersment for analysis and any provision for sample tracking log. The laboratory SOPs may be referenced.

#### 8. Calibration Procedures and Frequency

Valid scientific measurements require that instruments function properly. This is verified by regular calibrations and maintenance. Both field sampling equipment and laboratory analytical equipment calibration procedures should be documented or referenced. There should be information on various calibration procedures, frequency of re-calibration and sources of calibration standards. Standards should be traceable to a source such as the NIST or EPA certified vendors. Calibration procedures can be referenced in the QA Project Plan.

#### 9. Analytical Procedures

For each measurement parameter, reference the analytical method being used, or provide a written description of the analytical procedures to be used in the case of non-standard methods. Officially approved methods (EPA, ASTM, Standard Methods) will be used unless an equivalent method is available. Bibliographic references of analytical methods are found in Appendix C. The information on laboratory analytical methods can be provided as shown on Table 2. A similar table should be developed for field analytical procedures.

## 10. Data Reduction, Validation and Reporting

After the laboratory provides analytical data to the Program Manager, they must be subjected to a process of data reduction, validation, and be processed for reporting in the appropriate format. The following topics should be addressed in the QA Project Plan:

A. Describe techniques to trace the data from receipt of the data to the use and storage in the final reported form. A flow chart can be used for clarification. Include the record keeping procedures, any document control system, any data control mechanism for detecting and collecting paperwork errors and preventing loss of data, and the means of data storage and retrieval.

Describe the criteria used by the project to review and validate (i.e. accept, reject, or qualify) data. The process can include checks on the following: transmittal errors, field and laboratory QC data, detection limits, instrument calibrations, special sampling or analysis conditions, any performance (or systems) audits conducted during the project and statistical data treatments such as evaluation of outliers (outliers are data which fall into an unexpected and unlikely range).

B. Describe the equations and/or statistical procedures used to calculate the value of the measured parameter and to

convert these values to the final use form. The final form must be compatible with the intended data uses. Include procedures for entry into any computer data base program.

Appendix D contains bibliographic sources for statistical procedures. Most of these publications are available in libraries and some are in the QA Officer's reference library.

C. If not already done in the organization section, identify key individuals who will handle this data flow.

#### 11. Internal Quality Control Checks

Internal quality control is the use of specific types of samples and protocol driven timely activities and procedures to control the precision and recovery of a measurement process. These include periodic calibrations, duplicate analysis, use of spikes, and use of reference materials. These apply to both field and laboratory activities. Quality control checks can include the following:

- Replicates
- Spiked samples
- Split samples
- Control Charts
- Blanks
- Internal standards
- Quality Control Samples
- Surrogate Samples
- Calibration standards and devices
- Reagent checks

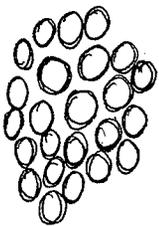
A table, such as the example shown in Table 3 should be included in this section to describe the QC protocols used for each parameter analyzed. In general, the information in the laboratory QA manuals or specific SOPs should be used to reference the laboratory quality control procedures. The QA Project Plan should also describe QC procedures used with field analytical procedures. The DWR QA Officer is available to help in the determination of basic QA protocols

See previous class ppt;

Sample Documentation  
 Sampling Plan  
 Sample Identification  
 Sampling Methodology  
 Chain of Custody

Data Validation  
 precision  
 blanks  
 accuracy  
 validation  
 collection  
 transport  
 dups  
 preservation  
 COC  
 Reference Mat.

{LAB  
 {FIELD



Data Documentation  
 Location of Data  
 Data Reduction  
 Limitations  
 Accuracy  
 Limit of Precision  
 Rec. Series  
 Significant Figures

Measurement Documentation  
 Methodology  
 Apparatus  
 Calibration  
 Operator

QA Documentation  
 Control Charts  
 Demonstration of Statistical Control

TABLE 3

## EXAMPLE QUALITY ASSURANCE PROTOCOLS IN THE LABORATORY

MEASUREMENT PARAMETER	SAMPLE MATRIX	QA PROTOCOL (PRECISION, ACCURACY, BLANKS)
Arsenic	Water	1 Duplicate per 10 Samples, 1 Spike per 10 Samples, 1 Method Blank per Set
Cadmium	Water	1 Duplicate per 10 Samples, 1 Spike per 10 Samples, 1 Method Blank per Set
Chromium	Water	1 Duplicate per 10 Samples, 1 Spike per 10 Samples, 1 Method Blank per Set
Lead	Water	1 Duplicate per 10 Samples, 1 Spike per 10 Samples, 1 Method Blank per Set
Selenium	Water	1 Duplicate per 10 Samples, 1 Spike per 10 Samples, 1 Method Blank per Set
Mercury	Water	1 Duplicate per 10 Samples, 1 Spike per 10 Samples, 1 Method Blank per Set
Arochlor 1254	Water	1 Blank per Set, 1 Surrogate Spike per Sample, 1 Surrogate Spike recovery from Blank per Set, Recovery and Precision of LCS* duplicates for each series
Aldrin	Water	1 Blank per Set, 1 Surrogate Spike per Sample, 1 Surrogate Spike recovery from Blank per Set, Recovery and Precision of LCS* duplicates for each series
Chlordane	Water	1 Blank per Set, 1 Surrogate Spike per Sample, 1 Surrogate Spike recovery from Blank per Set, Recovery and Precision of LCS* duplicates for each series
Endosulfan 1	Water	1 Blank per Set, 1 Surrogate Spike per Sample, 1 Surrogate Spike recovery from Blank per Set, Recovery and Precision of LCS* duplicates for each series
4, 4' DDT	Water	1 Blank per Set, 1 Surrogate Spike per Sample, 1 Surrogate Spike recovery from Blank per Set, Recovery and Precision of LCS* duplicates for each series
Arsenic	Sediment/Soil	1 Duplicate per 10 Samples or Batch or Matrix, 1 Spiked Sample per 10 Samples or Batch or Matrix, 1 Method Blank per Set or Matrix
Chromium	Sediment/Soil	1 Duplicate per 10 Samples or Batch or Matrix, 1 Spiked Sample per 10 Samples or Batch or Matrix, 1 Method Blank per Set or Matrix
Lead	Sediment/Soil	1 Duplicate per 10 Samples or Batch or Matrix, 1 Spiked Sample per 10 Samples or Batch or Matrix, 1 Method Blank per Set or Matrix
Selenium	Sediment/Soil	1 Duplicate per 10 Samples or Batch or Matrix, 1 Spiked Sample per 10 Samples or Batch or Matrix, 1 Method Blank per Set or Matrix
Mercury	Sediment/Soil	1 Duplicate per 10 Samples or Batch or Matrix, 1 Spiked Sample per 10 Samples or Batch or Matrix, 1 Method Blank per Set or Matrix
Arochlor 1254	Sediment/Soil	1 Method Blank per Set, 1 Surrogate Spike Recovery per Sample, 1 Surrogate Spike Recovery from Method Blank, Recovery and Precision of LCS* Duplicates for each Series
Chlordane	Sediment/Soil	1 Method Blank per Set, 1 Surrogate Spike Recovery per Sample, 1 Surrogate Spike Recovery from Method Blank, Recovery and Precision of LCS* Duplicates for each Series
4, 4' DDT	Sediment Soil	1 Method Blank per Set, 1 Surrogate Spike Recovery per Sample, 1 Surrogate Spike Recovery from Method Blank, Recovery and Precision of LCS* Duplicates for each Series
Toxaphene	Sediment/Soil	1 Method Blank per Set, 1 Surrogate Spike Recovery per Sample, 1 Surrogate Spike Recovery from Method Blank Recovery and Precision of LCS* Duplicates for each Series

\*LCS is "Laboratory Control Sample" which is a standard reference solution or a spiked clean sediment, prepared and utilized by the laboratory.

## 12. Performance Evaluations

Performance evaluations help to assess the capability and performance of a measurement system and to identify problems which warrant correction. Performance evaluations can occur by physically auditing the field and laboratory procedures and by providing reference samples, split samples and blind samples to the contract laboratory. The DWR "QA Protocol for Contract Laboratories" explains performance evaluation methods. The QA Project Plan should describe any performance evaluation to be conducted over the lifetime of the project.

The two types of audits normally employed are performance and system audits. In a performance audit, data are collected using performance evaluation samples. These samples are certified reference samples obtained from sources such as the National Institute of Standards and Technology, National Research Council of Canada, United States Geological Survey, and from EPA certified vendors. The Program Manager can obtain appropriate reference samples from the Department QA Officer. Performance audits are often used to evaluate contract laboratories prior to awarding of the contract. They may be used during the life of the project to monitor analytical performance, and are especially useful when QC problems arise.

A system or management audit is more extensive than a performance

audit. It consists of a review of the total data production process. It usually involves on-site reviews by a qualified auditor, of the laboratory's operational systems, physical facilities and evaluation of sampling, calibration and measurement protocols. The DWR QA Officer will periodically audit the DWR Bryte Laboratory facilities. Field audits can be accomplished by knowledgeable project persons, or outside agency auditors with appropriate experience. System audits should be periodically conducted at contract laboratories, particularly for long term investigations. The major responsibility for arranging systems audits and for obtaining qualified auditors will be with the DWR QA Officer.

### 13. Preventive Maintenance

Preventive maintenance applies to both the field and laboratory operations. Descriptions of the laboratory preventive maintenance procedures is usually in the laboratory QC manuals and can be referenced in the QA Project Plan. The following types of preventive maintenance items should be considered:

- A schedule of important preventive maintenance tasks that must be carried out to minimize downtime. Preventive maintenance tasks can include inspections, testing and repair procedures.
- Information on critical spare parts and contingency plans for equipment back-up in case of failure.

#### 14. Procedures to Assess Data Precision, Accuracy, and Completeness

The QA Project Plan should describe the routine procedures to assess the precision, accuracy and completeness of the measurement data. Any equations for determining these data characteristics should be presented such as those shown in Appendix F. The DWR QA Officer can be consulted if assistance is needed.

#### 15. Corrective Action

Corrective action is necessary if bad data or incorrect procedures occur. For example, corrective action would be warranted if bad data are obtained or as a result of audits, interlaboratory comparison studies, etc. Each QA Project Plan must incorporate a corrective action plan. Procedures must be described when data results fall into the range that is determined to be unacceptable. Identify the project personnel responsible for implementing the corrective action. Routine QC activities are normally successful in eliminating most data quality problems before data are received by the project. A flowchart showing step-by-step procedures for handling problem data is in Appendix I.

#### 16. Quality Assurance Reporting Procedures

QA Project Plans should describe the procedure to be used to report on the performance of measurement systems and data

quality. The reporting mechanism may be in the form of a section in the project investigation report to management.

QA sections in project investigation reports to management should include:

- A. Results of the assessment of measurement data accuracy, precision, and completeness.
- B. Results of performance and system audits.
- C. Significant QA problems and documentation of solutions.

The DWR QA Officer is available to review QA sections of investigative reports to management. A final copy of these reports should be sent to the DWR QA Officer so that tracking of QA procedures can occur.

APPENDIX A

BIBLIOGRAPHIC SOURCES FOR SAMPLING DESIGN REFERENCES

- 1) Green, R.H..1979. Sampling Design and Statistical Methods for Environmental Biologists. John Wiley and Sons, New York.
- 2) Keith, L.H., ed. 1988. Principles of Environmental Sampling. American Chemical Society.
- 3) Keith, L.H. 1991. Environmental Sampling and Analysis. Lewis Publishers Inc. 121 South Main Street, Chelsea, MI 48118.
- 4) Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold Company Inc. 115 Fifth Ave. New York, NY 10003
- 5) U.S. Environmental Protection Agency. Test Methods for Evaluating Solid Waste, SWA 846, Volume 2, Part III, Chapter Nine-Sampling Plan 1986.
- 6) U.S. Environmental Protection Agency, 1982. Handbook for Sampling and Sample Preservation of Water and Waste Water. EPA 600\ 4-82-029, Chapter 4: Statistical Approach to Sampling.

APPENDIX B

BIBLIOGRAPHIC SOURCES FOR SAMPLING AND FIELD MEASUREMENTS

- 1) American Society for Testing and Materials. ASTM Annual Book of Standards- Part 31 "Water". 1916 Race street, Philadelphia, PA 19103. (215) 299-5400. Revisions are issued annually.
- 2) APHA, AWWA, WPCF. 1989. Standard Methods for the Examination of Water and Wastewater. 17th Edition.
- 3) CA Dept. of Health Services. July 1, 1985. Collection, Pretreatment, Storage and Transportation of Water and Wastewater Samples.
- 4) California Department of Water Resources, 1991. State Water Project Water Quality Field Manual. California Department of Water Resources. Sacramento, CA 95814.
- 5) California Department of Water Resources. Expected release December, 1993. Sampling Manual for Environmental Measurement Projects. California Department of Water Resources, Sacramento CA, 95814.
- 6) 40 CFR Part 136. October 26, 1984. Guidelines for Test Procedures, 500 series for drinking water.

- 7) Keith, L.H., ed. 1988. Principles of Environmental Sampling. American Chemical Society.
- 8) Keith, L.H., ed. 1991. Compilation of EPA's Sampling and Analysis Methods. Lewis Publishers Inc., 121 South Main Street, Chelsea, MI 48118.
- 9) Krotochvil, B. and Taylor, J.K. .1981. Sampling for Chemical Analysis. Anal. Chem. 53:924A-938A
- 10) Meson, B.J. August 1983. Preparation of Soil Sampling Protocol: Techniques and Strategies. EPA-600/4-83-020. NTIS PB-83-206979
- 11) U.S. EPA. March 1979. Handbook for Analytical Quality Control in Water and Wastewater Laboratories. EPA - 600/4-79-019 PB-297451
- 12) U.S. EPA. January 1980. Samplers and Sampling Procedures for Hazardous Waste Streams. EPA-600/2-80-018. NTIS PB-80-135353
- 13) U.S. EPA. 1982. Handbook for Sampling and Sample Preservation of Water and Wastewater. Environmental Monitoring and Support Laboratory. Cincinnati, OH. EPA-600/4-82-029 NTIS Publication No. PB-83-120503

14) U.S. EPA. November 1984. Sampling for Hazardous Materials. Office of Emergency and Remedial Response. , Cincinnati, OH.

15) U.S. EPA. 1985. Sediment Sampling Quality Assurance Users Guide. EPA/600/4-85/048. July 1985. NTIS PB85233542

16) U.S. EPA. December 1988. Methods for the Determination of Organic Compounds in Drinking Water. EPA 600/4-88-039 NTIS PB-89-220461

17) U.S. Geological Survey, 1989. Methods for Collection and Analysis of Aquatic Biological and Microbiological Samples. Technologies of Water Resources Investigations of the U.S. Geological Survey. Book 5, Chapter A-4. U.S. Government Printing Office, Washington D.C.

18) U.S. Geological Survey, Western Region, Sacramento, CA 95814. 1990. Guidelines for the Collection, Treatment and Analysis of Water Samples.

APPENDIX C

BIBLIOGRAPHIC SOURCES FOR ANALYTICAL PROCEDURES

- 1) American Society for Testing and Materials. 1991. ASTM Annual Book of Standards- Part 31 "Water". American Society for Testing and Materials. 1916 Race street. Philadelphia, PA 19103. Revisions are issued annually.
- 2) APHA, AWWA, WPCF. 1989. Standard Methods for the Examination of Water and Wastewater. 17th Edition.
- 3) Association of Official Analytical Chemists. 1980. Methods Manuals of the Association of Official Analytical Chemists. 15th Edition.
- 4) Plumb, R.H., Jr. 1981. Procedures for Handling and Chemical Analysis of Sediment and Water Samples. Technical Report EPA CE 81-1. U.S. Army Engineers Waterways Experiment Station. Vicksburg, Mississippi.
- 5) Taylor, J.K.. 1983. Validation of Analytical Methods. Anal. Chem. 55: 600a - 608a
- 6) U.S. EPA. March 1983. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020 NTIS PB-84-128677

7) U.S. EPA. 1986. Test Methods for Evaluating Solid Waste.  
EPA- SW 846

8) USGS. 1989. Methods for Determination of Inorganic  
Substances in Water and Fluvial Sediments. Techniques of Water  
Resources Investigation. Book 5, Chapter 41. U.S. Government  
Printing Office, Washington D.C..

9) Verschueren, K. 1983, Handbook of Environmental Data on  
Organic Chemicals, Second Edition. Van Nostrand Reinhold and Co.  
New York.

APPENDIX D

BIBLIOGRAPHIC SOURCES FOR STATISTICAL PROCEDURES

- 1) American Society for Testing and Materials. 1985. Quality Assurance for Environmental Measurements: a symposium sponsored by ASTM Committee D-19 on Water and Committee D-22 on Sampling and Analysis of Atmospheres, Denver, CO, 8-12 Aug, 1983. ASTM special publication #867
- 2) American Society for Testing and Materials, 1991. Annual Book of ASTM Standards, Section II, Water and Environmental Technology. Section 1, Definitions, Specifications and Reporting Results.
- 3) Bauer, E.L. 1971. A Statistical Manual for Chemists, Second Edition. Academic Press, Inc. 111 Fifth Ave. New York, NY 10003
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- 5) Green, R.H..1979. Sampling Design and Statistical Methods for Environmental Biologists. John Wiley and Sons, New York.
- 6) Friedman, Linda C. and Erdmann, David E. 1982. Quality Assurance Practices for the Chemical and Biological Analyses of

Water and Fluvial Sediments. Techniques of Water Resources Investigations of the United States Geological Survey, Book 5, Chapter A6. U.S. Government Printing Office, Washington D.C.

7) Taylor, J.K. Sept. 1985. Handbook for SRM Users. National Bureau of Standards. NBS Special Publication 260-100. Available through U.S. Government Printing Office.

8) Sokal, Robert R. and F. James Rohlf. 1981. Biometry. The Principles and Practice of Statistics in Biological Research. Second Edition, W. H. Freeman and Company, New York.

9) Standard Methods for the Examination of Water and Wastewater. 17th Edition 1989. Part 1000 General Information (This section includes statistics, quality assurance, data quality, method validation and collaborative testing.)

10) Taylor, J.K.. 1986. A Collection of Abstracts of Selected Publications related to quality assurance of chemical measurements. National Technical Information Service No. NBSIR 86-3352

11) Taylor, J.K. 1987. Quality Assurance of Chemical Measurements. Lewis Publishers, Inc. 121 South Main Street, Chelsea, MI 48188.

12) Taylor, J.K. 1990. Statistical Techniques for Data Analysis. Lewis Publishers, Inc. 121 South Main Street, Chelsea, MI 48188.

13) Youden, W.J. and Steiner, E.H. 1975. Statistical Manual of the Association of Official Analytical Chemists. AOAC 1111 N. Nineteenth St. Suite 210, Arlington, VA 22209

14) Youden, W.J. 1969. Statistical Techniques for Collaborative Tests. Association of Official Analytical Chemists. Washington D.C.

APPENDIX E

BIBLIOGRAPHIC SOURCES FOR BIOLOGICAL SAMPLING REFERENCES

- 1) Sokal, R.R. and Rohlf, F.J., 1981. Biometry, Second Edition. W.F. Freeman and Co. New York.
- 2) U.S. Environmental Protection Agency, May 1988. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms. EPA 600/4-87-028
- 3) U.S. Environmental Protection Agency, September 1988. Methods for Aquatic Toxicity Identification Evaluations: Phase I - Toxicity Characterization Procedures. EPA 600/3-88-034
- 4) U.S. Environmental Protection Agency, February, 1989. Methods for Aquatic Toxicity Identification Evaluations: Phase II - Toxicity Identification Procedures. EPA 600/3-88-035
- 5) U.S. Environmental Protection Agency, February, 1989. Methods for Aquatic Toxicity Identification Evaluations: Phase III - Toxicity Confirmation Procedures
- 6) U.S. Environmental Protection Agency, March 1989. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms Second Edition. EPA

600/4-89-001

7) U.S. Geological Survey, 1989. Methods for Collection and Analysis of Aquatic Biological and Microbiological Samples. Techniques of Water Resources Investigations of the U.S. Geological Survey, Book 5, Chapter A-4. U.S. Government Printing Office, Washington D.C.

precision:

$$RPD = \frac{(C_1 - C_2)}{(C_1 + C_2)/2} \quad (1)$$

where: RPD = relative percent difference  
C<sub>1</sub> = larger of the two observed values  
C<sub>2</sub> = smaller of the two observed values.

Example: Results from analysis of selenium in a water sample and its field duplicate are given as 5.9 and 7.4 ug/L. Calculation of RPD by equation 1 gives the following result:

$$RPD = \frac{7.4 - 5.9}{(7.4 + 5.9)/2} \times 100\% = 22.5\%$$

Better values for precision can be obtained using more replicates. If precision is calculated from 3 or more replicates, determine the standard deviation and use the relative standard deviation (RSD) rather than RPD :

$$RSD = (s / \bar{x}) \times 100 \quad (2)$$

where: RSD = relative standard deviation  
s = standard deviation  
 $\bar{x}$  = arithmetic mean (average) of replicate measurements.

Standard deviation is defined as follows:

$$s = \sqrt{\frac{\sum_{i=1}^n [X_i - \bar{X}]^2}{n - 1}} \quad (3)$$

where: s = standard deviation  
 $X_i$  = measured value of the ith replicate  
 $\bar{x}$  = arithmetic mean (average) of replicate measurements  
n = number of replicates.

Example: A laboratory measures three replicates of a water sample to evaluate the in-laboratory precision for selenium. The replicate values are 7.4, 5.9 and 6.6. The mean value is 6.6. The standard deviation is:

$x_i$	$(x_i - \bar{x})$	$(x_i - \bar{x})^2$
7.4	0.8	0.64
5.9	-0.7	0.49
<u>6.6</u>	0.0	<u>0.00</u>
$\bar{x} = 6.6$		$\Sigma = 1.13$
		n = 3

$$s = \sqrt{\frac{1.13}{2}} = 0.75$$

$$\text{RSD} = \frac{0.75}{6.7} \times 100\% = 11.4\%$$

For measurements, such as pH, where the absolute variation is more appropriate, precision is usually reported as the absolute range of duplicate measurements. Range is often used as an index of precision:

$$D = |m_1 - m_2| \quad (4)$$

where:        D = absolute range  
               $m_1$  = first measurement  
               $m_2$  = second measurement

### Accuracy

Accuracy is the degree of agreement of a measured value with the true or expected value of the constituent of concern. Accuracy is normally measured using matrix spikes or standard reference materials (SRM). The analytical laboratory is required to provide spike recovery data as part of its in-laboratory QC

procedures. Spike recoveries must fall into an established acceptable range. Standard reference materials can be used as performance samples to evaluate the analytical capabilities of a laboratory.

Where matrix spikes are used calculate percent recovery as follows:

$$\%R = \frac{S - u}{C_{sa}} \times 100$$

(5)

where:      %R = percent recovery  
              S = measured concentration in spiked aliquot  
              u = measured concentration in unspiked aliquot  
              C<sub>sa</sub> = actual concentration of spike added.

Example: The laboratory spiked a duplicate environmental sample to measure the matrix effects and quantitative recovery of selenium in water. The concentration of Se in the unspiked sample was 3.2 ug/L. A 10 ug/L spike was added to the duplicate and the measured value of this sample for Se was 12.3 ug/L:

$$\%R = 100 \times \frac{12.3 - 3.2}{10} = \frac{9.1}{10} = 91\%$$

When a standard reference material (SRM) is used:

$$\%R(\text{or Certified Value}) = \frac{C_m}{C_{\text{SRM}}} \times 100$$

(6)

where:        %R = percent recovery or percent of certified value  
               $C_m$  = measured concentration of SRM  
               $C_{\text{SRM}}$  = certified concentration of SRM

Example: A NIST certified water sample (SRM) contains 9.7 ug/L selenium. The laboratory measures 8.7 ug/L selenium in an analysis of the SRM. The %R value is

$$\frac{8.7}{9.7} \times 100 \text{ or } 89.6\%$$

### Completeness

Completeness is a measure of all information necessary to validate a scientific study. A useful way to evaluate completeness is to compare the project objectives with the data acquired. If this indicates incomplete valid data then the

completeness requirement is not met. In many cases, this will mean re-sampling and analysis to obtain valid data. Completeness can be defined as the number of measurements judged valid compared to the total number of measurements taken. Often it is not useful to try to measure completeness in quantitative terms for water monitoring projects. A simple equation for completeness is defined as:

$$\%C = \frac{V}{T} \times 100$$

where:            %C = percent completeness  
                  V = number of measurements judged valid  
                  T = total number of measurements.

#### Method Detection Limit (MDL)

The method detection level (MDL) is defined as the minimum concentration that can be measured with a 99% confidence that the analyte concentration is greater than zero. Values for MDL's are required to define the limitations of the method and instrumentation being used. MDL's should be from 5 to 10 times lower than the environmental values being measured. Ideally, the laboratory should establish and periodically re-evaluate its own MDL for each matrix type by analysis of seven or more replicates

of spiked matrix samples. More often the laboratory establishes on a one time basis the MDL for a given parameter. MDL is defined as follows:

$$\text{MDL} = t_{(n-1)} \text{ at the 99\% confidence level } \times s \quad (8)$$

where:

- MDL = method detection limit
- s = standard deviation of the replicate measurements
- t = Students' t-value for a one-sided 99% confidence level and a standard deviation estimate with n-1 degrees of freedom.
- n = number of samples
- n-1 = degrees of freedom

Example: A laboratory is evaluating the MDL for a parameter at the .02 mg/L level. Eight spikes were measured giving values of .032, .016, .021, .022, .024, .017, .025, and .019 mg/L. The arithmetic mean of these samples is .022 mg/L with a standard deviation of .005 ug/L (calculated using Equation #3). Going to a table of "t" values, for a 99% confidence level and 8 analyses (7 degrees of freedom) the "t" value is 2.998.

The MDL estimate is  $2.998 \times 0.005 = 0.015$  mg/L

APPENDIX G

Laboratory Quality Assurance Evaluation Form

Project Name:

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---

DWR Program Manager:

---

signature

DWR QA Officer:

---

signature

Laboratory Name:

---

Location:

---

Director:

Phone Number:

---

Laboratory QA Officer:

Phone Number:

---

Review Dates:

---



Comments:

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3. Preventive Maintenance

	Yes	No
Equipment manual available near each instrument	___	___
Fume hoods quarterly inspections (up-to-date)	___	___
Log books documenting equipment maintenance available	___	___
Includes:		
date, description of routine maintenance	___	___
all corrective actions documented	___	___
entry signed by technician	___	___
Trouble-shooting SOPs available	___	___
Service contracts available for:		
Most _____ Some _____ Few _____		

Comments:

---

---

4. Chain-of-Custody Procedures

Sample Security            Adequate \_\_\_\_\_ Inadequate \_\_\_\_\_

Custody forms include:	Yes	No
Project name/Manager	___	___
Laboratory name	___	___
Field/Lab ID	___	___
Matrix type	___	___
Number of containers	___	___
Analyses requested	___	___
Adequate signature space	___	___

Comments:

---

---

5. Sample Receipt

	Yes	No
Written SOPs available	___	___
Sample transport methods documented	___	___
Condition of samples recorded	___	___
Information on container documented	___	___
Lab ID assigned	___	___

Matrix identified \_\_\_\_\_

Comments: \_\_\_\_\_  
\_\_\_\_\_

6. Sample Preparation (digestion/extraction)

Written SOPs available

Yes No  
\_\_\_\_

Comments: \_\_\_\_\_

7. Calibration Procedures

Reagents

Yes No

Date or receipt or preparation shown \_\_\_\_\_

Analyst preparing reagents identified \_\_\_\_\_

Proper storage \_\_\_\_\_

Vendor source identified \_\_\_\_\_

Written SOPs for calibration documented \_\_\_\_\_

Analytical range \_\_\_\_\_

Frequency of blank/calibration standard analysis \_\_\_\_\_

Blanks and standards prepared using same reagents as for production samples \_\_\_\_\_

Acceptance criteria documented for analyst \_\_\_\_\_

Corrective action documented \_\_\_\_\_

Initial and final calibration of standards within 15% \_\_\_\_\_

Blanks less than the detection limit \_\_\_\_\_

Control charts used \_\_\_\_\_

Calibration problems documented in analyst notebook \_\_\_\_\_

Storage \_\_\_\_\_

Range of standards appropriate \_\_\_\_\_

Comments: \_\_\_\_\_  
\_\_\_\_\_

8. Analytical Methods

Written SOPs of methodology available at each

Yes No

analyst station \_\_\_\_\_  
 Have methods been modified \_\_\_\_\_  
 Validation information on file \_\_\_\_\_

Detection limits \_\_\_\_\_  
 Average sample backlog \_\_\_\_\_  
 Analysis conducted within \_\_\_\_\_ days of receipt

Analysts notebooks available  
 entries made in ink \_\_\_\_\_  
 corrections crossed through \_\_\_\_\_  
 analysts identified \_\_\_\_\_  
 date documented \_\_\_\_\_  
 raw data on file \_\_\_\_\_  
 Weights, volumes recorded \_\_\_\_\_  
 Date, time, procedure entered \_\_\_\_\_  
 Instrument parameters recorded \_\_\_\_\_  
 Technicians initial or sign \_\_\_\_\_  
 Calibration run referenced \_\_\_\_\_  
 Notes on SOP modifications recorded \_\_\_\_\_

Comments:  
 \_\_\_\_\_  
 \_\_\_\_\_

9. Lab Safety

	Yes	No
Lab coats worn	_____	_____
Safety glasses worn	_____	_____
Walkways clear	_____	_____
Work areas clean	_____	_____
Safety data sheets filed	_____	_____

Comments:  
 \_\_\_\_\_  
 \_\_\_\_\_

10 Quality Control (Internal)

	Yes	No
Written SOPs available	_____	_____
Control charts available for:		
blanks	_____	_____
duplicates	_____	_____
spikes	_____	_____
standard reference material	_____	_____

calibration standards \_\_\_\_\_  
other \_\_\_\_\_

Blanks/Duplicates/Spikes  
Frequency of each \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Acceptance criteria available to analyst Yes No  
Corrective action known by laboratory personnel \_\_\_\_\_  
obtained \_\_\_\_\_

Estimated percent passed on first run

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Percent of sample loads: standards \_\_\_\_\_  
blanks \_\_\_\_\_ duplicated \_\_\_\_\_  
spikes \_\_\_\_\_ blind reference samples \_\_\_\_\_

Completeness Yes No  
Acceptance criteria available \_\_\_\_\_  
Corrective action available \_\_\_\_\_

Comments:  
\_\_\_\_\_  
\_\_\_\_\_

11 External Quality Assurance Yes No  
Inter-laboratory duplicates \_\_\_\_\_  
Percent of external QA samples per batch \_\_\_\_\_  
Acceptance criteria (obtained) \_\_\_\_\_  
Corrective action (obtained) \_\_\_\_\_

QA program participation

Sponsoring Agency Samples Types Performance

Reports available \_\_\_\_\_

Laboratory certified by \_\_\_\_\_

Comments:

---

---

12 Reporting

Data checked by second analyst  
QA reports prepared and problems documented  
in writing  
QA reports reviewed by Program Manager prior to  
submittal of Research report

Yes No

\_\_\_\_

\_\_\_\_

\_\_\_\_

13. Sample Storage and Archiving

Proper storage techniques  
Samples stored for 90 days following submittal  
of data  
Sample tags attached

Yes No

\_\_\_\_

\_\_\_\_

\_\_\_\_

Comments:

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APPENDIX H  
SHORT FORM FOR QA PROJECT PLANS

1. Project Name  
Responsible Agency  
Project QA Coordinator
2. Project Description
  - A. Objective and Scope
  - B. Data Usage (e.g. compliance, baseline data etc.)
  - C. Network Design and Rationale (list sampling locations, justify design of network, include other factors in sampling)
  - D. Monitoring Parameters and Frequency of Collection  
Set up a table with the following headings:  
Site location  
Sample matrix  
Parameter to be analyzed  
Sampling frequency or total number of samples
  - E. Parameter Table  
Set up a table with the following headings:  
Matrix  
Analytical method reference  
Maximum sample holding time  
Sample preservation requirements  
(attach or describe non-standard methods and validation documentation)
  - F. Schedule of Tasks  
List anticipated dates for products (reports) covering from date of initial request through the date for the final report
3. Project Organization and Responsibilities  
Identify key individuals and the responsibilities (e.g. an organizational chart)
4. Data Quality Requirements  
Include a brief description of the project data quality

objectives.

5. Procedures for Data Quality Calculations

Indicate that this information is available in "Guidelines for Preparation of Quality Assurance Project Plans" or reference other existing QA Project Plans. List the basic calculation techniques used.

6. Sampling Procedures

Outline the basic sampling procedures for each parameter or group of parameters, covering different matrices such as water, sediment, biota, etc. Cite the appropriate sections in the "Sampling Manual for Environmental Measurement Projects" for complete information.

7. Sample Custody and Tracking Procedures

Make reference to the "Sampling Manual for Environmental Measurement Projects" for detailed procedures and SOPs on:

Tracking samples and maintaining custody records and  
Preparation of sample containers

8. Calibration and Preventive Maintenance

Cite appropriate references in the laboratory QC Manuals (Bryte Laboratory and contractors) for procedures and SOPs on calibration techniques and preventive maintenance protocols. Reference the "Sampling Manual for Environmental Measurement Projects" for the same information on field equipment.

9. Documentation - Data Reduction - Reporting

Reference existing procedures (SOPs), and describe the type of data records to be used and how data is to be stored. The QC of these processes should be described in the SOPs.

10. Data Validation

Cite an existing SOP or refer to the validation section in the "Guidelines for Preparing Quality Assurance Project Plans" for data validation protocol. Validation includes review of:

QA/QC Data  
Sample Results  
Associated Sample Data  
Checks for Transmittal Errors

11. Audits (performance and system)

Describe any use or proposed use of performance evaluation samples for laboratory evaluation, pre-contract or with ongoing contracts. Indicate any need for system audits during the life of the project and how this will be done. Reference any system audits accomplished with laboratories presently being used.

12. Corrective Action

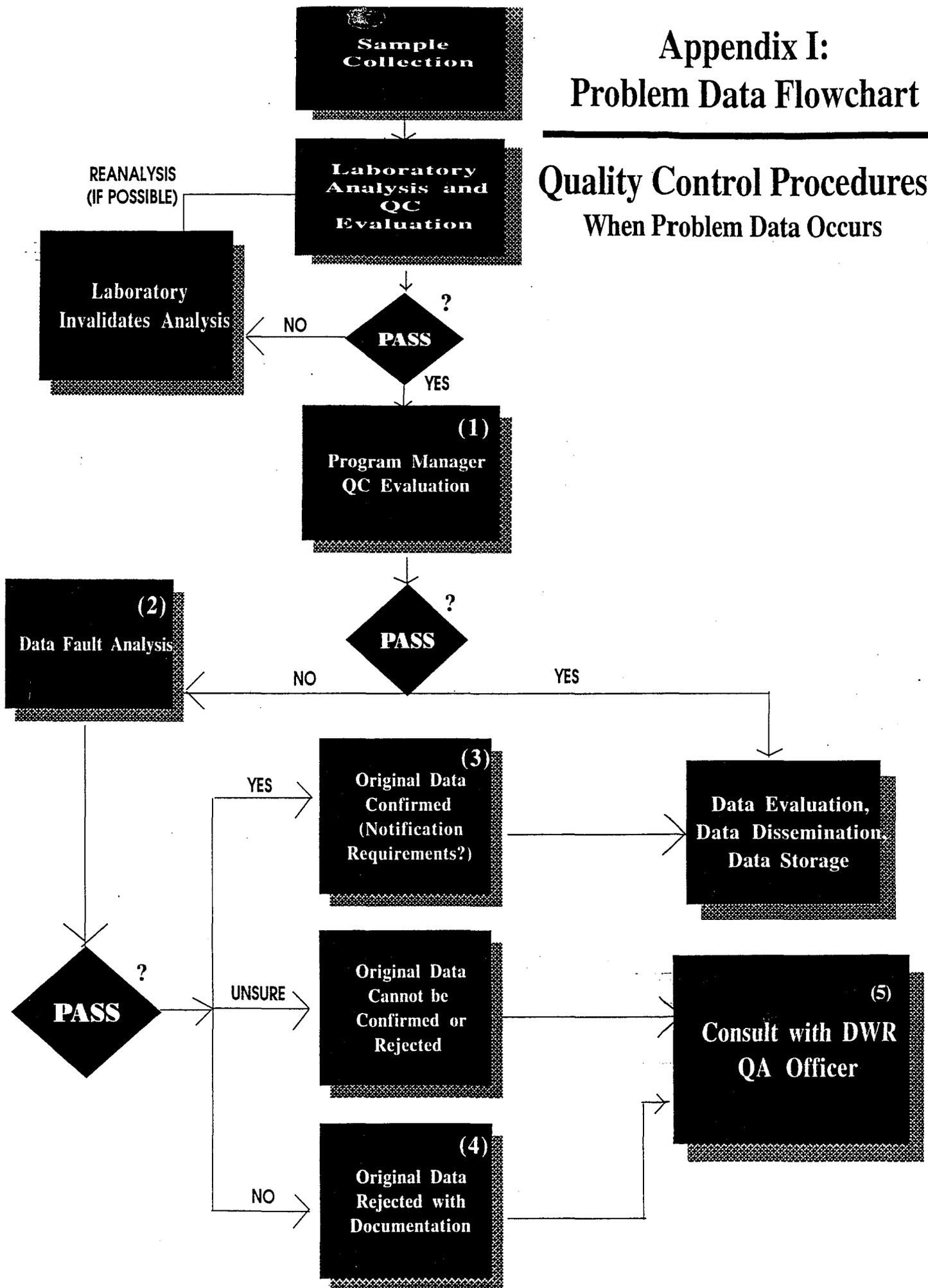
Reference an existing SOP for corrective action or briefly describe the procedure the project will use. Corrective action determines the errors in data, traces the errors to a source and develops the correction needed, along with the documentation of the process. Identify the project person responsible for this activity.

13. Reports

Briefly list the types, frequency and distribution of QA/QC reports to management. Information included will cover such types as status of data accumulation, QA problems observed, corrective actions and data quality assessment.

# Appendix I: Problem Data Flowchart

## Quality Control Procedures When Problem Data Occurs



# Footnotes To Problem Data Flowchart

(1) Program Manager QC Evaluation:

- Compares data with historical data
- Verifies correct data entry
- Checks reasonableness of results

(2) Data Fault Analysis:

- Reviews other data for corroboration
- Evaluates possible sources of sample contamination
- Evaluates possible sampling, preservation, transportation, and holding time error
- Performance evaluation of laboratory
- Re-analysis of original sample (if possible)
- Collect and analyze new sample

Note: If original data indicates a public health threat, notification requirements may be necessary

(3) Notification Requirements:

- If upon re-analysis, the original data is confirmed and the data indicate a public health threat, notification requirements may be necessary.

(4) Original Data Rejected:

- Re-analysis indicates original value cannot be confirmed
- Contamination is identified
- Holding time error was found

Note: If data is verified to be in error, it should be rejected with documentation, and not entered into the database. If data remains questionable even after the validation procedure, it should be tagged and a footnote entered into the database. Data should not be rejected until the verification and validation procedures occur.

(5) Consult with DWR QA Officer: (options for corrective action)

- Sample analysis by independent laboratory
- Increased frequency of monitoring
- Replacement of equipment
- Independent QC audit of field and/or laboratory

APPENDIX J  
PROJECT PLAN GLOSSARY

Accuracy: The degree of agreement of a measured value with the true or expected value of the quantity of concern.

Analyte: The specific component measured in a chemical analysis.

Bias: The systematic or persistent distortion of a measurement process in which the expected sample measurement is different than the samples true value. Bias can be both positive and negative.

Blank: A clean sample of sample/matrix processed so as to measure artifacts in the sampling and analysis process.

Comparability: The degree to which different methods, data sets, and decisions agree or can be represented as similar.

Completeness: A measure of the amount of data that is successfully collected and validated compared to the amount intended in the project design.

Data Reduction: The process of transforming raw data by arithmetic statistical calculations, standard curves, or concentration factors into the final use form.

Data Validation: A systematic process of reviewing a body of data against a set of established criteria to establish the usefulness of the data for a specific purpose.

Data Quality Objectives (DQO): Qualitative and quantitative statements developed by data users to specify the quality of data needed from a particular data collection activity.

Duplicate (sample): A second sample randomly selected from a population of interest to assist in the evaluation of sample variance. duplicate samples are often taken from the same container to measure analytical precision.

Holding Time: The maximum amount of time that can elapse between obtaining the sample and laboratory analysis before significant deterioration occurs.

Internal Standard: A known reference material added to the matrix in order to calculate the concentration of an analyte. The calculation is based on the ratio of the internal standard response to that of the analyte.

Method Detection Limit: The lowest concentration of an analyte that can be measured in the matrix or a blank, by a single

measurement with a stated level of confidence (usually 99%).

Performance Audit: An examination of the ability of an analytical system to obtain reliable data. This examination or audit obtains measurement data using performance evaluation samples.

Precision: The degree of mutual agreement characteristic of independent measurements as the result of repeated application of the process under specified conditions. It is concerned with how close together are the measurements.

QC Sample: A sample of known composition or concentration used to evaluate the quality of field or laboratory measurements.

Reference Sample: A material or substance, one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method or for assignment of values to materials.

Replicate: A counterpart of another, usually referring to an analytical sample or measurement.

Representativeness: The degree to which the data accurately and precisely represent the frequency distribution of a specific variable in the population.

Sample Matrix: The component or substrate (e.g. surface water, groundwater, soil, or sediment) which contains the analyte of interest.

Spiked Samples: A sample to which a known amount of standard material is added (spiked), prior to sample preparation and analysis, to document the precision and bias of a method in a given sample matrix.

Split Samples: A subsample of a total sample.

Standard Operating Procedures (SOP): Procedures adopted for repetitive use when performing a specific measurement or sampling operation. It may be an existing standard procedure or one developed by the user.

Surrogate Sample: A compound (usually organic) which is similar to the target analyte(s) in chemical composition and behavior in the analytical process, but which is not normally found in environmental samples.

System Audit: An examination of the total data production process of a laboratory or field activity. It includes on-site reviews of laboratory and field operational systems and physical

facilities for sampling, calibration, and measurement protocols.