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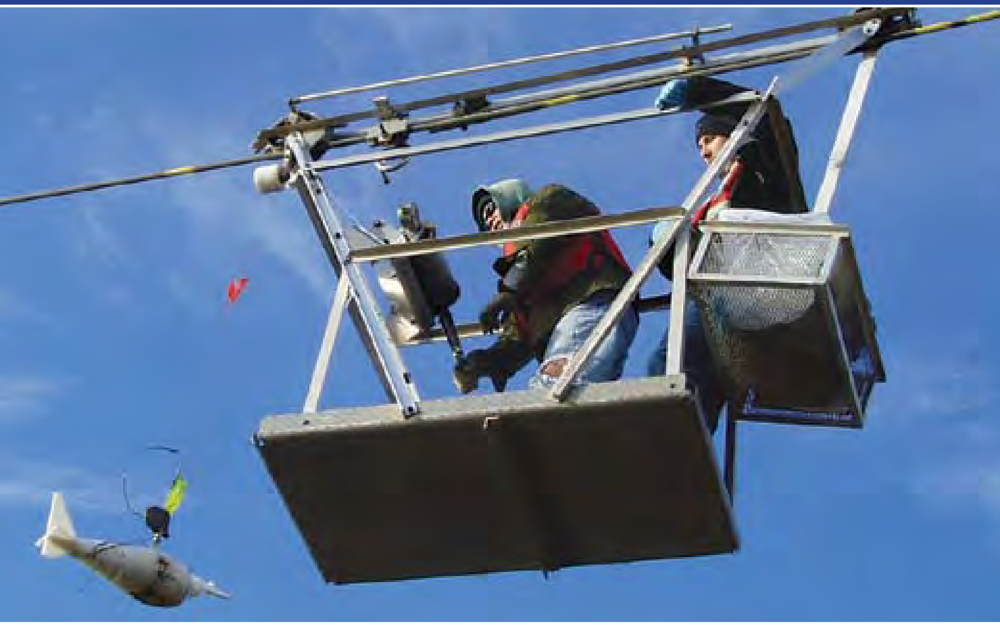
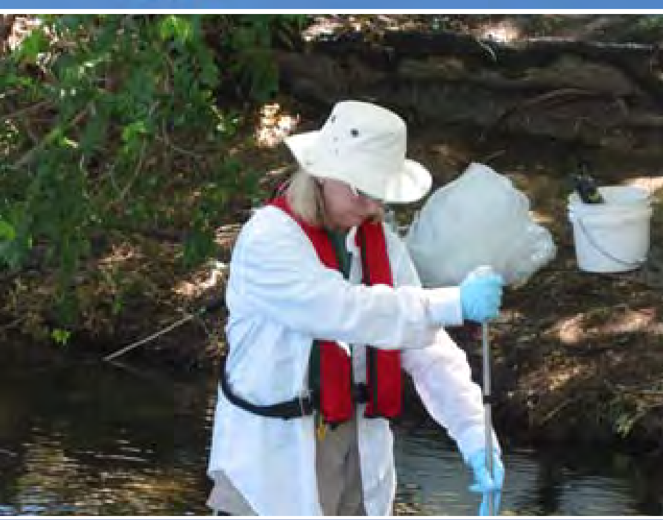
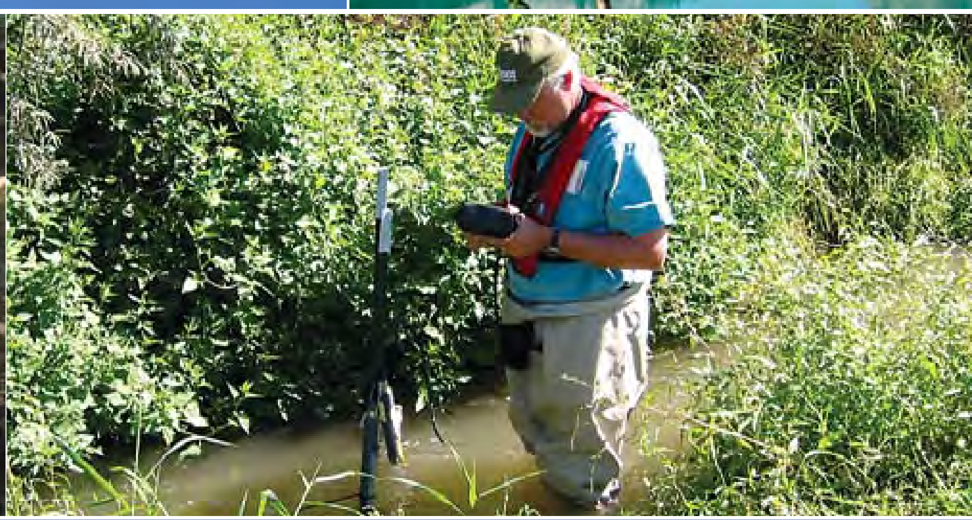
Quality-Assurance Plan for Water-Quality Activities in the U.S. Geological Survey Washington Water Science Center







Open-File Report 2007–1307

U.S. Department of the Interior
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Cover:
Top Left: Photograph of U.S. Geological Survey employees Dwight Copeland and Doug Call collecting water-quality samples from a cable car on the Yakima River at Kiona, Washington. (Photograph by Richard Wager, 2004).

Top Right: Photograph of Green Lake, North Cascade National Park. (Photograph by Roy Zipp, U.S. National Park Service, Sedro Woolley, Washington, 2003).

Bottom Left: Photograph of U.S. Geological Survey employee Sandra Embrey sampling at Ahtanam Creek at Union Gap, Washington. (Photograph by Mark Munn, 2003).

Bottom Right: Photograph of U.S. Geological Survey employee Mark Munn measuring water quality at DR2 near Granger, Washington. (Photograph courtesy of U.S. Geological Survey, 2003).

Quality-Assurance Plan for Water-Quality Activities in the U.S. Geological Survey Washington Water Science Center

Compiled by Richard J. Wagner, Robert A. Kimbrough, and Gary L. Turney

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U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
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Quality-Assurance Plan for Water-Quality Activities in the U.S. Geological Survey Washington Water Science Center

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Abstract

In accordance with guidelines set forth by the Office of Water Quality in the Water Resources Discipline of the U.S. Geological Survey (USGS), this quality-assurance plan has been created for use by the USGS Washington Water Science Center (WAWSC) in conducting water-quality activities. The plan documents the standards, policies, and procedures used by the personnel of the WAWSC for activities related to the collection, processing, storage, analysis, and publication of water-quality data. The policies and procedures that are documented in this quality-assurance plan for water-quality activities are meant to complement the WAWSC's quality-assurance plans for surface-water and ground-water activities and to supplement the WAWSC quality-assurance plan.

1.0 Introduction

The U.S. Geological Survey (USGS) was established by an act of Congress on March 3, 1879, to provide a permanent Federal agency to perform the systematic and scientific "classification of the public lands, and examination of the geologic structure, mineral resources, and products of the national domain." The Water Resources Discipline (WRD) of the USGS is the Nation's principal water-resources information agency. The objectives of the WRD's Basic Hydrologic Data Program are to collect and provide unbiased, scientifically based information that describes the quantity and quality of waters in the Nation's streams, lakes, reservoirs, and aquifers. Water-quality activities in the USGS Washington Water Science Center (WAWSC) are part of the WRD's overall mission of appraising the Nation's water resources.

To address quality-control issues related to water-quality activities, the WRD has implemented policies and procedures designed to ensure that all scientific work conducted by or for the WRD is consistent and of documented quality. The Office of Water Quality (OWQ) is responsible for providing a quality-assurance (QA) plan that documents the policies and procedures that apply to the water-quality activities in each Science Center in the Discipline.

A QA plan is a formal document that describes the management policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation procedures for ensuring quality. Quality assurance, quality control, and quality assessment are all components of a QA plan. The terms are defined as follows:

Quality assurance (QA)—The systematic management of data-collection systems by using prescribed guidelines and criteria for implementing technically approved methods and policies. Quality assurance incorporates a comprehensive plan that outlines the overall process for providing a product or service that will satisfy the given requirements for quality.

Quality control (QC)—The specific operational techniques and activities used to ensure the required quality of data. Quality control consists of the application of technical procedures to achieve prescribed standards of performance and to document the quality of collected data. Quality-control data that do not meet required standards are used to evaluate and implement corrective actions necessary to improve performance to acceptable levels.

Quality assessment—The overall process of assessing the quality of environmental data by (1) reviewing appropriate implementation of QA policies and procedures and (2) analyzing the QC data. Quality assessment encompasses measurable and unmeasurable factors that affect the quality of environmental data. Assessment of these factors may indicate limitations that require modifications to protocols or standard operating procedures for sample collection and analysis, or that affect the desired interpretation and use of the environmental data.

Quality-assurance, quality-control, and quality-assessment systems complement each other to provide a comprehensive QA program that ensures that quality objectives are identified and integrated into all levels of water-quality activities. By integrating these components into a discipline-wide QA guidance document, the OWQ hopes to enhance water-quality data collected by the USGS by providing for the following:

- **Consistency** in data quality across all levels of the WRD;

- **Accountability** to clients, the scientific community, regulatory agencies, and the general public;
- **Comparability** of results among samples, sites, and laboratories;
- **Traceability** from the end product back to its origins, and to all supplementary information, through written records;
- **Application** of appropriate and documented techniques that lead to similar results time and again;
- **Representativeness** of the data in describing the actual chemical composition of the water and biological or physical conditions at a sampling site for a given point or period in time; and
- **Adequacy** of the amount of data obtained to meet data objectives.

1.1 Purpose and Scope

The purpose of this WAWSC QA plan for water-quality activities is to document the standards, policies, and procedures used by the USGS WAWSC, for activities related to the collection, processing, storage, analysis, and publication of water-quality data. This plan identifies responsibilities for ensuring that stated policies and procedures are carried out. The plan also serves as a guide for all WAWSC personnel who are involved in water-quality activities and as a resource for identifying memoranda, publications, and other literature that describe associated techniques and requirements in more detail.

The scope of this QA plan includes discussions of the policies and procedures followed by the WAWSC for the collection, processing, analysis, storage, and publication of water-quality data. Although procedures and products of interpretive investigations are subject to the criteria discussed in this plan, some interpretive investigations may be required to have separate and complete QA plans. The policies and procedures documented in this QA plan for water-quality activities are intended to complement the WAWSC QA plan for surface-water and ground-water activities, and supplement the WAWSC QA plan.

2.0 Organization and Responsibilities

Quality assurance is an active process of achieving and maintaining high-quality standards for water-quality data. Consistent quality requires specific actions that are carried out systematically in accordance with established policies and procedures. Errors and deficiencies can result when individuals fail to carry out their responsibilities. Clear and specific statements of responsibilities promote an understanding of each person's duties in the overall process of ensuring the quality of water-quality data.

2.1 Organizational Chart

The WAWSC organizational structure is similar to those of other science centers in the Discipline, but different program requirements from one science center to another contribute to the uniqueness of these organizational structures. The organization of WAWSC is illustrated in figure 2.1.

2.2 Responsibilities

The ultimate responsibility for the preparation and implementation of and adherence to the QA policies that are described in this QA plan lies with the WAWSC Director (Schroder and Shampine, 1992, p. 7). Following is a list of responsibilities for selected WAWSC personnel who are involved in the collection, processing, storage, analysis, and publication of water-quality data:

The WAWSC Director and management personnel are responsible for:

1. Managing and directing the WAWSC program, including designation of personnel responsible for managing all water-quality activities;
2. Ensuring that water-quality activities meet the needs of the Federal government, cooperating State and local agencies, and the general public;
3. Ensuring that all aspects of this QA plan are understood and followed by personnel. This is accomplished by direct involvement or through clearly stated delegation of this responsibility to other personnel;
4. Providing final resolution, in consultation with the Water-Quality Specialist, of any conflicts or disputes related to water-quality activities within the WAWSC;
5. Keeping subordinates briefed on procedural and technical communications from regional and Headquarters offices, by
    - (a) Coordinating and participating in technical reviews of all water-quality programs on at least a semiannual basis;
    - (b) Ensuring that all publications and other technical communications released by WAWSC personnel are accurate and comply with USGS policy; and
    - (c) Ensuring that all personnel involved in water-quality activities are adequately trained, mentored, and supervised to conduct such activities.

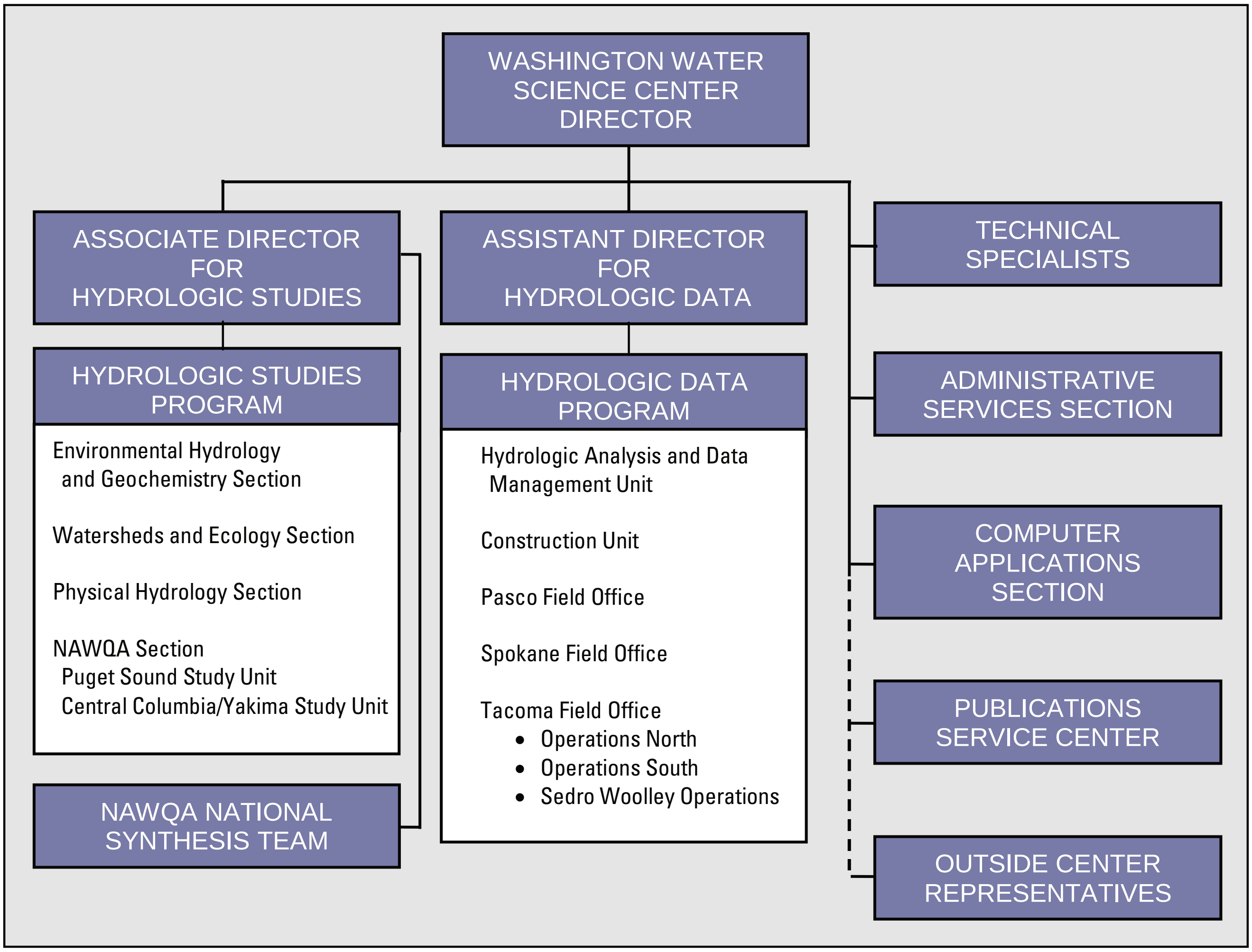


Figure 2.1. U.S. Geological Survey Washington Water Science Center organizational chart, February 2007.

The Water-Quality Specialist or designated representative is responsible for:

1. Ensuring that water-quality activities meet the needs of the Federal government, the cooperating State and local agencies, and the general public;
2. Preparing and implementing the WAWSC water-quality QA plan for water-quality activities;
3. Ensuring that all aspects of this QA plan are understood and followed by WAWSC personnel;
4. Keeping WAWSC personnel briefed on procedural and technical communications from regional and Headquarters offices;
5. Participating in technical reviews of all WAWSC water-quality programs on a semiannual basis;
6. Ensuring that all publications and other technical communications released by the WAWSC that relate to and include water-quality information are accurate and comply with USGS policy;
7. Ensuring that the WAWSC QA plan for water-quality activities is reviewed and revised at least once every 3 years to document current responsibilities, methodologies, and ongoing procedural improvements; and
8. Ensuring that personnel involved in water-quality activities are adequately trained, mentored, and supervised to conduct such activities.

The Project Chief is responsible for:

1. Managing and directing the project's field and laboratory water-quality activities;
2. Ensuring that the project's field and laboratory water-quality activities meet the needs of the Federal government, the cooperating State and local agencies, and the general public;
3. Ensuring that all aspects of this QA plan that pertain to the project's field and laboratory water-quality activities are understood and followed by project personnel;
4. Preparing a project QA plan as part of the proposal or workplan (Shampine and others, 1992);
5. Obtaining guidance, as appropriate, for project quality-assurance/quality-control (QA/QC) activities from the Water-Quality Specialist; and
6. Ensuring that QA/QC activities are properly carried out by the project personnel.

2.3 References Used for Organization and Responsibilities Section

Table 2.3 lists reports and web pages referred to in this section. For a complete citation, refer to Section 13.0 of this report.

Table 2.3. Summary of references for organization and responsibilities related to quality assurance.

References	Subject
Schroeder and Shampine, 1995	Guidelines for preparing a quality-assurance plan
Shampine and others, 1992	Integrating quality assurance into project workplans
Figure 2.1	U.S. Geological Survey Water Science Center organizational chart

3.0 Program and Project Planning

The WAWSC Director has primary responsibility for overall WAWSC program planning and is responsible for ensuring that WAWSC projects are supportive of WAWSC and national priorities. All water-quality projects require review and approval prior to the commencement of work. Quality-assurance requirements should be integrated into the project proposal. Whether or not a separate QA plan will be required for a water-quality project will depend on the complexity of the work, the needs of the cooperator, or other criteria as described in Shampine and others (1992).

3.1 Project Proposals

Project proposals are developed at the local science center level in response to requests by cooperating agencies, needs recognized by the WRD in working closely with other agencies, or national programs. Science center proposals conform to the format required by the Western Region WRD, as described by T. John Conomos, Regional Hydrologist, written commun., September 10, 1999 and WAWSC internal memoranda. Science centers are encouraged to transmit proposals electronically, as described in a memorandum by Keith R. Prince, USGS Assistant Regional Director for Programs, written commun., June 29, 2001.

Each proposal must (l) state the problem or need for the study; (2) define objectives—what will be done to help solve the problem; (3) describe the relevance and benefits—why the USGS should conduct the study and how the work will support the goals of WRD; and (4) define the approach—how work will be done to accomplish the objectives. Relevance and benefits refer to USGS goals as expressed in the USGS Strategic Plan (accessed April 30, 2007, at http://www.usgs.gov/stratplan/), the WRD's Strategic Directions (accessed April 30, 2007, at http://pubs.usgs.gov/circ/2007/1309/pdf/C1309.pdf), or the USGS Federal-State Cooperative Program Priorities (published annually by WRD memorandum). The approach to a proposed study or project consists of a detailed outline of the data-collection activities to be carried out (if new data are needed), the QA plans, the QC information needed, and the analytical techniques to be used. Project report plans, cost estimates, time schedules, and personnel requirements also are addressed. Consultation with regional and divisional specialists is encouraged in the preparation of proposals and in the execution of projects defined in the approach. The approach consists of a detailed outline of the data-collection activities to be carried out (if new data are needed), the QA plans, the QC information needed, and the analytical techniques to be used. Project report plans, cost estimates, time schedules, and personnel requirements also are addressed. Consultation with regional specialists is encouraged in the preparation of proposals and in the execution of projects.

Review of project proposals is given high priority. Project proposals are reviewed by the Section Chief, Associate Director for Hydrologic Studies (or designee), and appropriate science center discipline specialist(s) and, at the discretion of the science center Director, may be sent to other science centers for review. The Western Region provides final review and approval of all project proposals.

The Project Chief identifies all project work elements and the related technical methods and approaches that are necessary to satisfy project objectives. The approach defined in the proposal (or in a separate workplan) links project personnel, tasks, and functions with associated funds and indicates the projected dates for on-time completion of project elements and, ultimately, the project. The approach defined in the proposal or workplan should clearly state how the WAWSC's "Quality-Assurance Plan for Water-Quality Activities" will be implemented.

Descriptions of the methods and approaches to be used to complete the technical elements of the project are required and include, for example, the design of environmental sample collection to meet the study objectives. The plan lists the environmental sampling locations and frequency of sample collection, a description of the sample types and their expected uses, and descriptions of analytical methods.

Proposals or workplans also include a description of the design of QC sampling that is required to document bias and variability in the environmental data. The proposal or workplan lists QC sample types, the frequency of collection, and their intended uses. The types of QC samples that typically are collected include blanks and spikes to estimate bias and replicates to estimate variability (Mueller and others, 1997).

Quality-control samples are to be a part of all water-quality projects. Quality-control samples include, but are not limited to: (1) replicates, (2) field blank samples composed of inorganic- or organic-free water, (3) equipment blanks, and (4) field-matrix spikes. Generally, about 15 percent of samples collected should be quality-control samples. The preparation of project quality-assurance plans is encouraged in order to present and document specific quality-control issues.

Proposals or workplans state anticipated methods for data analysis and presentation, including report plans. Accurate cost estimates are included for personnel, materials, and services related to planned completion dates for accurately budgeting the project. Ensuring the availability of project personnel is often difficult and can impose serious constraints on completing project tasks; therefore, WAWSC management should be consulted to ensure adequate staff resources and to avoid the over-commitment of individuals to multiple projects. The project timeline lists major project elements and planned completion dates.

3.2 Project Workplan

Project workplans are sometimes developed from approved project proposals. The WAWSC requirements for the content, review, and revision of workplans are outlined below. The Project or Field Office Chief prepares a detailed workplan that identifies all project work elements and the related technical methods and approaches that are necessary to satisfy project objectives if that information is not already included in the project proposal. The workplan links project personnel, tasks, and functions with associated funds and indicates the projected dates for on-time completion of project elements and, ultimately, the project. Workplans for water-quality programs and projects, including programs and projects with water-quality components, should clearly state how the WAWSC's "Quality-Assurance Plan for Water-Quality Activities" will be implemented.

Descriptions of the non-standard methods and approaches to be used to complete the technical elements of the project are required. New or unapproved field and laboratory methods that will be used must be described in detail. The plan lists the environmental sampling locations and frequency, a description of the sample types and their expected uses, and descriptions of laboratory tests.

3.3 Project Review

Project reviews are conducted periodically by WAWSC management, technical advisors, or Discipline Specialists to ensure compliance with the project workplan or proposal. Project reviews are used to ensure that data collection, analysis, and reporting are being done in accordance with the workplan and with broader WAWSC policies and requirements. Quality-assurance activities with respect to project reviews are outlined in the following subsections.

3.3.1 Review Schedules

The WAWSC has developed and implemented a review schedule for evaluating the technical development and progress of water-quality programs and projects by use of semi-annual (or more frequent) reviews. Regularly planned reviews ensure that water-quality programs or projects are conducted efficiently to produce quality products on time. Informal reviews are part of ongoing quality assurance, whereby problems and related issues are addressed as they arise.

PROJECT REVIEW FORM		rev. March 2004
Period of Review:		
Date Prepared:		By:
Date Reviewed:		By:
Project Short Title:		Project No.:
Project Chief:	Cooperator(s):	
Project Members:		
FY:	FY Funding: $	Scheduled completion date:

1. What has been accomplished since the last review of this project?

2. What action items were identified at the last project review, and what is the status or outcome of these action items?

3. What are your plans for?

a) the next 3 months:

b) the next year:

4. **Any technical issues that need to be addressed?**

5. Management issues

a) Any changes in goals, objectives, or approach?

b) What reports are planned?

- Target date of first draft:
- Target date of publication:

c) Any timelines missed?

d) Expenditures in accord with funds?

6. Do you have any unresolved problems that are affecting or may hinder the successful completion of this project?

7. Reviewer comments:

Figure 3.3.2. Documentation form for program and project reviews in the USGS Washington Water Science Center.

3.3.2 Review Documentation

The WAWSC has developed a form and procedure for documenting program and project reviews (fig. 3.3.2). The WAWSC archives all review comments that address project progress, status, all resulting actions or recommendations, and the status of these actions or recommendations. WAWSC management holds the review forms until the next review cycle, at which time they note progress made in addressing previously identified project problems or deficiencies. They then submit the previous review forms to the Administrative Services Section for filing into the related project case file, and hold the current review form for the next cycle. Project case files are maintained by the Administrative Services Section until the project completion date, at which time they are marked "completed" and held for 2 years prior to being submitted to the Federal Records Center for archiving. The documentation form for program and project reviews is available to USGS employees.

3.4 References Used in Program and Project Planning Section

Table 3.4 lists reports and memoranda referred to in this section. For complete citations, refer to Section 13.0 of this report

Table 3.4. Summary of references for organization and responsibilities related to quality assurance.

References	Subject
Mueller and others, 1997	Quality control design for NAWQA surface water
Shampine and others, 1992	Integrating quality assurance into project workplans
T. John Conomos, September 10, 1999	Water Resources Division Instructional Memorandum
Standardized proposals, May 24, 2007	Washington Water Science Center Instructional Memorandum
Keith R. Prince, June 29, 2001	Water Resources Division Instructional Memorandum

4.0 Water-Quality Laboratories

Two of the most critical issues for a long-term, national water-quality program are data comparability and data consistency. Because of the inherent variability among laboratories, one of the best ways to provide comparability and consistency is to use a single laboratory as much as is practical.

4.1 Selection and Use of an Analytical Laboratory

The USGS National Water Quality Laboratory (NWQL) was established to meet the needs of the WRD, and is the laboratory required for use in all WRD national water-quality programs (WRD Memorandum 92.036). In some circumstances, however, a laboratory other than the NWQL may be used; such circumstances are applicable to water-quality activities (USGS Memoranda cited in this report are listed in Section 13.1, USGS Memoranda).

4.1.1 Selection

Contract or cooperator laboratories can be used when the cooperative agreement designates a laboratory other than the NWQL, or when analytical services are required that cannot be provided by the NWQL. Research laboratories can be used for developing analytical techniques or to provide data for research purposes, and these laboratories generally are exempt from approval requirements that other laboratories must meet (OWQ Technical Memorandum 98.03). WAWSC laboratories generally can be used when analyses must be completed within a few hours of sample collection and cannot be done conveniently in the field.

4.1.2 Requirements for Use

All laboratories that provide analytical services to the WRD for non-research purposes must meet the requirements of the WRD, as described in OWQ Technical Memorandum 98.03 (supersedes WRD Memorandum 92.035), before any analytical data can be stored in the WRD National Water Information System (NWIS) database (discussed in Section 10) or published by the WRD. Laboratories affected by this policy include those that provide chemical, biological, radiochemical, stable isotope, or sediment analytical services. The Project Chief, with assistance from the WAWSC Water-Quality Specialist, is responsible for assuring that all laboratories providing analytical services to the WAWSC have met the requirements for approval. These laboratories must do the following:

1. Use approved and published analytical methods—Analytical methods must be approved and published by one of the following sources: USGS; U.S. Environmental Protection Agency (USEPA); American Public Health Association, American Water Works Association, and Water Environmental Federation (Standard Methods); or American Society for Testing and Materials (ASTM). The publication of the method must include documentation for the analytical techniques and chemical processes plus the expected data quality. If a specific analytical method not published by one of the sources listed above is requested for a specific project, it is the responsibility of the WRD office requesting the analysis to have the method approved based on requirements specified in OWQ Technical Memorandum 04.01 before the analytical data from this method are published and (or) stored in the USGS national database. (The WAWSC Water Quality Specialist [or Project Chief] also should consult the National Environmental Methods Index [NEMI] for reference to many approved methods [http://www.nemi.gov].)

2. Have standard operating procedures (SOPs) for analytical methods—All analytical methods must have documented SOPs that are approved in accordance with procedures contained in the laboratory QA plan.

3. Have an approved laboratory QA plan—The laboratory must have an approved QA plan that is supplied to WRD customers upon request. The laboratory QA plan should provide internal guidance and documentation that will ensure the laboratory is operating under a standardized, rigorous QA program and is producing analytical results of a known and documented quality. The laboratory QA plan should describe QA activities, QC procedures and requirements, performance acceptance criteria, and required corrective actions that will be taken if the criteria are not met.

4. Have a documented QC program that provides the data necessary to continuously track the bias and variability of analytical data. All QC information, such as QC charts, analysis of laboratory QC samples, calibration records, and analyst bench logs should be maintained for at least 5 years and be available upon request to WRD customers.

5. Demonstrate the ability to provide the analytical services required—Laboratories can demonstrate the ability to provide the required analytical services by participation in existing USGS or non-USGS certification/evaluation/round-robin programs or by documentation of similar projects (OWQ Technical Memorandum 98.03). The USGS Standard Reference Sample (SRS) round-robin program is required for analytes included in the SRS (http://bqs.usgs.gov/srs/) samples.

4.2 Laboratories Used by Washington Water Science Center

The laboratories that have been used for analytical services by WAWSC projects are shown in table 4.2. The table lists the analytical laboratory, type of analyses provided, the person who has been the primary laboratory contact, the project using the laboratory, and the dates the laboratory was used.

Table 4.2. Laboratories used for U.S. Geological Survey Washington Water Science Center projects.

[CHIPS, Coastal Habitats in Puget Sound; NAWQA, National Water-Quality Assessment program; NWQL, National Water Quality Laboratory; OWQRL, Office of Water Quality Regional Laboratory; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; WY, water year; NA, not applicable]

Analytical laboratory	Analyses provided (by general category)	Laboratory contact	Project	Dates used
USGS (NWQL)—Lakewood, CO	Inorganic, organic, biology	Various	Many	1974 to present
USGS (OWQRL)—Ocala, FL	Inorganic	NA	Several	1998–2002 WY
	Organic carbon	NA	Fort Lewis	1998–2002 WY
USGS Vancouver Sediment Laboratory—Vancouver, WA	Sediment size and concentration	Dan Gooding	Several	On-going
USGS Sediment-Trace Element Partitioning laboratory—Atlanta, GA	Inorganic (mercury)	Art Horowitz	Lake Roosevelt	1998 WY
	Suspended-sediment trace elements		NASQAN	1996–99 WY
	Suspended-sediment trace elements		Lake Roosevelt sediment	2001 WY
Econanalysts—Moscow, ID	Biology (taxonomy)	Robert Black	Cedar River	1996 WY

Table 4.2. Laboratories used for U.S. Geological Survey Washington Water Science Center projects.—Continued

Analytical laboratory	Analyses provided (by general category)	Laboratory contact	Project	Dates used
USGS South Carolina District Laboratory—Columbia, SC	Dissolved methane Microcosm experiments	Paul Bradley	Navy Air Station, Whidbey Island	1997–98 WY
	VOCs, major ions, and nutrients			1996–97 WY
	Microcosm experiments		Fort Lewis	2001 WY
Axis Analytical—Moscow, ID	PCBs, dioxins, and furans	Mark Munn	Lake Roosevelt	1998 WY
Severn Trent (formerly Quanterra)	Organics	Several	Fort Lewis	1998–99 WY
USGS—Menlo Park, CA	Isotope analysis	Carol Kendall	PUGET NAWQA	1998 WY
			Yakima	1997–98 WY
Georgia Institute of Technology – Atlanta, GA	Microcosm experiments	Frank Loffler	PUGET NAWQA	1997–98 WY
USGS Washington Water Science Center Laboratory—Tacoma, WA	Inorganics–Chloride	Steve Cox	Lopez Island	1998 WY
	Organics	Steve Cox	Fort Lewis	1998 WY to present
	H_2 gas	Steve Cox		1998 WY to present
USGS Reston Chlorofluorocarbon Laboratory—Reston, VA	CFC and dissolved gasses	Neil Plummer	Fort Lewis	2000–01 WY
			Yakima	2001 WY
Edge Analytical - Moscow, ID	Organics	Several	Jim Creek	2000 WY
WA Department of Ecology—Manchester, WA	Pesticides	Stuart Magoon	Pesticide toxicity in urban streams	2000–02 WY
Pacific Analytical - Moscow, ID	Bacteria enumeration	Chris Holmes-Baker	Fort Lewis	2001 WY
TEG Laboratory—Lacey, WA	Dissolved methane, TCE in tree core material	Sherry Chilcutt	Fort Lewis	2001 WY
	Dissolved methane, ethane, and ethene		Navy–Keyport	2001 WY
Lamont-Doherty – Palisades, NY	Noble gasses	Martin Stute	Fort Lewis	2001 WY
USGS Mercury Research Laboratory—Middleton, WI	Mercury	David Krabbenhoft	NAWQA	2001 WY to present
USEPA Region 10 Laboratory—Manchester, WA	Nutrients	Jennifer Crawford	Umatilla	2004 WY
Bureau of Reclamation—Boise, ID	Nutrient, chlorophyll, and major ions	Bill Stroud	Irrigation return flow; Lower Yakima	2004 WY to present
USGS Columbia Environmental Research Laboratory—Columbia, MO	Bioaccumulation, AVS	Various	Lake Roosevelt CHIPS	2006 WY to present
University of Washington Marine Chemistry Laboratory—Seattle, WA	Nutrients	Katherine Krogslund	Hood Canal, CHIPS	2005 WY to present
USGS Center for Coastal and Marine Geology Laboratory—Woods Hole, MA	Nutrients	Various	CHIPS	2006 WY to present
Oregon State University Laboratory—Corvallis, OR	Nutrients	Cam Jones	Lake Crescent	2006 WY to present

4.3 Documentation for Laboratories Used by the WAWSC

4.3.1 USGS National Water-Quality Laboratory (Lakewood [Denver Federal Center], CO)

1. Methods used—The NWQL uses approved methods for determination of organic, inorganic, and radioactive substances in water, sediments, and biological tissues. The methods used include methods approved by the USGS, USEPA, the American Public Health Association, the American Water Works Association, the Water Environmental Federation, and the ASTM. A list of some analytical methods currently used at the NWQL is available at http://nwql.usgs.gov/Public/ref_list.html.

   Other analytical methods from the USEPA that are currently used at the NWQL are available at http://www.epa.gov/epahome/publications.htm. Analytical methods from the ASTM that are currently used at the NWQL are available at http://www.astm.org.

2. QA plan—The NWQL quality-assurance plan is published in Maloney (2005).

3. QC program—Quality control at the NWQL is monitored by three programs: (1) an internal blind sample program, (2) an external blind sample program, and (3) bench level QC samples. Information about the internal blind sample program and bench level QC samples can be obtained by sending an e-mail request to the NWQL at labhelp@usgs.gov. Information about the external standard reference sample and blind sample program can be found under Branch of Quality Systems (BQS) Projects or is available at http://bqs.usgs.gov/index.html.

4. Performance evaluation studies and certification programs—The NWQL participates in performance evaluation studies and laboratory certification programs. A list of the current programs and a description of each can be found by sending an e-mail request to labhelp@usgs.gov.

5. Laboratory reviews—External agencies and customer organizations audit the NWQL to assess analytical methods and QA/QC programs. A table of audits that shows the year reviewed, reviewing agency, and purpose of the review can be obtained by sending an e-mail request to labhelp@usgs.gov.

6. Miscellaneous services—Information about and access to other services are available through the NWQL.

   The services offered include but are not limited to the following:

Biological unit	Methods Research and Development Program
Chain-of-custody procedures	Organic spike kits
Contract services	Publications
External performance evaluations	Quality assurance of selected field supplies
Laboratory services catalogue	Technical memoranda and Rapi-Notes

4.3.2 USGS Ocala Water Quality and Research Laboratory (Ocala, FL)

NOTE: The Ocala Water Quality and Research Laboratory was closed in September 2004. Laboratory archives are available at the NWQL.

1. Methods used—Prior to closure, the laboratory specialized in analysis of environmental waters using methods approved by USGS, USEPA, ASTM, or American Public Health Association.

2. Laboratory QA plan — Laboratory quality assurance/quality control (QA/QC) is monitored by internal review, external audits, and programs of the USGS Branch of Quality Systems.

3. QC program—Quality control at the OWQRL is monitored by three programs: (1) an internal blind sample program, (2) an external blind sample program, and (3) bench level QC samples. Information about the internal blind sample program and bench level QC samples can be obtained by sending an e-mail request to the OWQRL. Information about the external standard reference sample and blind sample program under BQS Projects is available at http://bqs.usgs.gov/index.html.

4. Certification/evaluation/round-robin programs—The laboratory maintains certification by the state of Florida, which requires annual approval of a Comprehensive Quality Assurance Plan.

5. Miscellaneous services—OWQRL formerly operated the National Field Quality (NFQA) program in cooperation with the BQS. The laboratory's QA Programs Section also provides training in Safety and Chemical Waste Management.

4.3.3 USGS Vancouver Sediment Laboratory (Vancouver, WA)

1. Methods used—Concentrations and sizes of sediment are measured following standard methods described by Guy (1969) and ASTM D3977-97 (2007).
2. Laboratory QA plan—The laboratory's Quality Control and Quality Assurance Plan is available upon request.
3. QC program—Quality control is monitored by practices specified for individual analyses as described in the laboratory's Quality Control and Quality Assurance Plan.
4. Certification/evaluation/round-robin programs—The laboratory regularly participates in analyses of single-blind and double-blind reference samples distributed by the BQS as part of the Sediment Laboratory Quality Assurance Project (see http://bqs.usgs.gov/slqa/).
5. Dates and participants of laboratory reviews— Every 3 years by the USGS Office of Surface Water.
6. Miscellaneous services—Not available.

4.3.4 USGS Sediment-Trace Element Partitioning Laboratory (Atlanta, GA)

1. Methods used—The laboratory is approved for analysis of Ag, As, Ba, Be, Cd, Co, Cr, Cu, Hg, Li, Mo, Ni, P, Pb, Sb, Sr, Tl, V, Zn, TC, TOC, TS in sediments utilizing various digestates with appropriate instrumentation. Analytical methods used are WRD-approved methods and are referenced to USGS analytical methods. Total mercury in fish tissue is analyzed by the cold vapor atomic adsorption method (Elrick and Horowitz, 1986).
2. QA plan— Laboratory QA Plan exists and meets BQS approval.
3. QC program—The QA/QC mandated for laboratory analyses is inclusive.
4. Certification programs—At present, BQS does not provide sediment samples for analysis. The laboratory has participated in the annual National Oceanic and Atmospheric Association (NOAA) round-robin program for sediment and tissue analyses.
5. Laboratory reviews—Approval for the above analyses was extended by BQS for fiscal year 2005.
6. Miscellaneous services—Not available.

4.3.5 Ecoanalysts (Moscow, ID)

1. Methods used—Taxonomic identification of macro invertebrates.
2. Laboratory QA plan—Available from Robert Black, USGS Project Chief.
3. QC program—Re-identification of 10 percent of samples.
4. Certification programs—Not available.
5. Dates and participants of laboratory reviews—Not available.
6. Miscellaneous services—Not available.

4.3.6 USGS South Carolina Water Science Center Laboratory (Columbia, SC)

1. Methods used— Samples for dissolved methane, ethane, and ethene were analyzed by gas chromatography as described by Kampbell and others (1989); hydrogen in ground water was sampled using the bubble-strip method of Bradley and Chappelle (1996) and analyzed using a field gas chromatograph with a reduction gas detector. Microcosm experiments are described by Chapelle and others (1997).
2. QA plan—Available from Paul Bradley, USGS Hydrologist.
3. QC program—Available from Paul Bradley, USGS Hydrologist.
4. Certification programs—Not available.
5. Laboratory reviews—Not available.
6. Miscellaneous services—Not available.

4.3.7 Axis Analytical Laboratory (Victoria, B.C., Canada)

1. Methods used—Rainbow trout and mountain whitefish were analyzed for dioxins and furans using USEPA Method 1613B (U.S. Environmental Protection Agency, 1994), and rainbow trout samples were analyzed for PCB arochlors using USEPA Method 8082A (U.S. Environmental Protection Agency, 1998), and "dioxin-like" PCB congeners using USEPA Method 1668 (U.S. Environmental Protection Agency, 1995).

2. QA plan—Available from Mark Munn, USGS Project Chief.
3. QC program—Available from Mark Munn, USGS Project Chief.
4. Certification programs—Not available.
5. Laboratory reviews—Not available.
6. Miscellaneous services—Not available.

4.3.8 Severn Trent Laboratory (formerly Quanterra) (Arvada, CO)

1. Methods used—Analysis of VOCs by USEPA Method 8260B.
2. QA plan—Yes (not available locally).
3. QC program—Yes (not available locally).
4. Certification programs—Certified by USEPA.
5. Laboratory reviews—By NWQL—contract laboratory for DODEC projects.
6. Miscellaneous services —http://www.stl-inc.com/.

4.3.9 USGS Carol Kendall (Menlo Park, CA)

1. Methods used— Stable isotopes: none of the methods are USGS-approved, but most of the time the same methods as the USGS Reston Stable Isotope Laboratory (RSIL) are used, which are USGS-approved methods.
2. QA plan—Available from Carol Kendal.
3. QC program—QA/QC protocols are used for all stable isotope analyses, and even have written documentation of some of them (sometimes as journal articles, sometimes just as QA/QC documents written for collaborators). Routinely run more than 10 percent duplicates, 5–10 percent reference standards, and some unknowns in each batch of samples. All data and QA/QC info are kept in laboratory databases.
4. Certification programs—Participate in occasional sample “round-robins” with the USGS RSIL, or other laboratories.
5. Laboratory reviews—None.
6. Miscellaneous services—Not available.

4.3.10 Georgia Institute of Technology (Atlanta, GA)

1. Methods used—Series of microcosm experiments to evaluate the effect of aquifer material and electron donors on the anaerobic degradation of dichloropropane (DCP), as described by Loffler and others (1997).
2. Laboratory QA plan—not available.
3. QC program—not available.
4. Certification/evaluation/round-robin programs—Not available.
5. Dates and participants of laboratory reviews—Not available.
6. Miscellaneous services—Not available.

4.3.11 USGS Washington Water Science Center Laboratory (Tacoma, WA)

1. Methods used—(**Chloride**: Ferric thiocyanate method was used for colorimetric analysis of chloride concentrations (Fishman and Friedman, 1989) in samples from the Lopez Island project.

   Organics: Modified USEPA Method 8015 for analysis of trichloroethene (TCE).

   Hydrogen: (H_2) gas: Bubble-strip method.
2. Laboratory QA plan—The quality-assurance plan for the analysis of chloride concentration is archived at WAWSC (/snld13/qwspec/Lopez_QA.doc).

   Organics: Not available.

   H_2 gas: Not available.
3. QC program—The quality-control program for analysis of chloride consisted of daily calibration using standards of known concentration, the use of continuing-calibration standards, and the regular analysis of replicates, blanks, and reference standards. Replicate and blank samples were analyzed every six samples and inter-laboratory replicates were submitted to the OQWRL for every 11 samples analyzed. One reference standard was analyzed for every six samples.

   Organics: Replicates, blanks, and spikes every five or six samples.

   H_2 gas: Replicates, blanks, and spikes every five or six samples.

4. Certification/evaluation/round-robin programs—None.

5. Dates and participants of laboratory reviews—None.

6. Miscellaneous services—Not available.

4.3.12 USGS Reston Chorofluorocarbon Laboratory (Reston VA)

1. Methods used—Chlorofluorocarbon (CFC) concentrations (CFC-12, CFC-11 and CFC-113) are determined in the laboratory using a purge-and-trap gas chromatography procedure with an Electron Capture Dector (ECD) (Bullister, 1984; Bullister and Weiss, 1988; Busenberg and Plummer, 1992).

2. Laboratory QA plan—Not available.

3. QC program—Gas and water blanks are used extensively. The instrument is calibrated with Standard Marine Oregon Air (Oregon Graduate Center) and Niwot Ridge Colorado Air (CMDL of NOAA). The primary standard is an Oregon air sample that was calibrated by Ray Weiss at the Scripps Institution of Oceanography (SIO). Other standards are secondary standards intercalibrated on the SIO scale.

4. Certification programs—Certification/evaluation/round-robin programs.

5. Dates and participants of laboratory reviews—not available.

6. Miscellaneous services—Not available.

4.3.13 Edge Analytical Laboratory (Burlington, WA)

1. Methods used—USEPA 515.1 for analysis of triclopyr; Standard Methods 2540C for analysis of total dissolved solids and 2540B for analysis of total suspended solids.

2. QA plan—Available upon request from laboratory manager at (800) 775-9295.

3. QC program—Analysis of laboratory blanks, replicates, surrogates, laboratory spikes and matrix spikes.

4. Certification programs—Certified by the Washington State Department of Health and accredited by the Department of Ecology. Available upon request from laboratory manager at (800) 775-9295.

5. Laboratory reviews—Available upon request from laboratory manager at (800) 775-9295.

6. Miscellaneous services—Not available.

4.3.14 Washington Department of Ecology Manchester Environmental Laboratory (Port Orchard, WA)

1. Methods used—Pesticide screening and compound-independent elemental quantitation by gas chromatograph with atomic emission detection (AED), USEPA Method 8085.

2. QA plan—Available at /snld13/qwspec/Manchester_laboratory and also from Stuart Magoon, Department of Ecology (360) 871-8801.

3. QC program—Minimal quality control requirements are analysis of laboratory blanks, initial demonstration of capability, determination of surrogate compound recoveries, and determination of matrix spike or fortified blank compound recoveries.

4. Certification programs—Performance evaluations samples are described at http://www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html. The laboratory participates in the USGS Standard Reference Program.

5. Laboratory reviews—The laboratory received approval by BQS in February 2002 for the following constituents:

Method 8085	Silver	Aluminum	Arsenic	BOD
Beryllium	Calcium	Cadmium	Cobalt	BTEX
Chromium	Fluoride	Iron	Mercury	VOCs[1]
Potassium	Magnesium	Molybdenum	Sodium	Copper
Ammonia	Nickel	Nitrate	Lead	TOC
Orthophosphate	Antimony	Selenium	Sulfate	Zinc
Thallium	Total P			

[1]Analysis of volatile organic compounds by U.S. Environmental Protection Agency Method 8260. The reporting level is less than 1.0 µg/L for most analytes, much greater than U.S. Geological Survey method reporting levels.

Unapproved analytes based on performance in the autumn 2001 Standard Reference Sample program				
Boron	Chloride	Vanadium	Manganese	Lithium
Total Kjeldahl Nitrogen (TKN)	Silica (SiO^2)	Strontium	Uranium	

6. Miscellaneous services—not available.

4.3.15 Pacific Analytical Laboratory (Corvalis, OR)

1. Methods used—Enumeration of bacteria by epifluoresence.
2. QA plan—Not available.
3. QC program—Not available.
4. Certification programs—Oregon Drinking Water program.
5. Laboratory reviews—Not available.
6. Miscellaneous services—Not available.

4.3.16 TEG Laboratory (Lacey, WA)

1. Methods used—Analysis of TCE in tree core material by gas chromatography.
2. QA plan—Available from Steve Cox, USGS hydrologist.
3. QC program—Available from Steve Cox, USGS hydrologist.
4. Certification programs—Accredited by Washington Department of Ecology.
5. Laboratory reviews—Not available.
6. Miscellaneous services—Not available.

4.3.17 Lamont-Doherty Laboratory (Palisades, NY)

1. Methods used—Isotope analysis of noble gasses.
2. QA plan—Not available.
3. QC program—Not available.
4. Certification programs—Analysis of helium and tritium for NWQL.
5. Laboratory reviews—By NWQL contract office.
6. Miscellaneous services—Not available.

4.3.18 USGS Mercury Research Laboratory (Middleton, WI)

1. Methods used—Mercury sampling and analytical methods used by the USEPA.

   Low-level collection techniques (Olson and DeWild, 1999; DeWild and others, 2002; 2004; Olund and others, 2004).
2. QA plan—Contact Dave Krabbenloft, USGS Research Hydrologist.
3. QC program—Not available.
4. Certification programs—Not available.
5. Laboratory reviews—Not available.
6. Miscellaneous services—Support includes training of personnel in proper sample-collection techniques, providing sampling equipment, development of new collection and analytical methods, analysis and reporting of high quality results from various matrices and mercury species, and consultation in project development and interpretation of results.

4.3.19 USEPA Region 10 Laboratory (Manchester, WA)

1. Methods used—USEPA, ASTM, and Standard Methods.
2. QA plan—Available from Jennifer Crawford, USEPA Head Chemist.
3. QC program—Not available.
4. Certification programs—NELAC certification in December 2005.
5. Laboratory reviews—Not available.
6. Miscellaneous services—Not available.

4.3.20 Bureau of Reclamation Laboratory (Boise, ID)

1. Methods used—USEPA and ASTM methods.
2. QA plan—Not available.
3. QC program—Participates in USGS Standard Reference Sample (SRS) program.
4. Certification programs—Not available.
5. Laboratory reviews—Reviewed by USGS BQS in February 2004.
6. Miscellaneous services—Not available.

4.3.21 USGS Columbia Environmental Research Laboratory (Columbia, MO)

1. Methods used—USEPA, ASTM, and USGS methods.
2. QA plan—Not available.
3. QC program—Not available.
4. Certification programs—Not available.
5. Laboratory reviews—Not available.
6. Miscellaneous services—Not available.

4.3.22 University of Washington Marine Chemistry Laboratory (Seattle, WA)

1. Methods used—USEPA and ASTM methods.
2. QA plan—Not available.
3. QC program—Not available.
4. Certification programs—Not available.
5. Laboratory reviews—Not available.
6. Miscellaneous services—Analysis of nutrients in marine waters.

4.3.23 USGS Center for Coastal and Marine Geology Laboratory (Woods Hole, MA)

1. Methods used—USEPA, ASTM, and USGS methods.
2. QA plan—Not available.
3. QC program—Not available.
4. Certification programs—Not available.
5. Laboratory reviews—Not available.
6. Miscellaneous services—Not available.

4.4 References Used for the Central Chemical Analytical Water-Quality Laboratories Section

Table 4.4 lists reports and memoranda referred to in this section. For a complete citation, refer to Section 13.0 of this report.

Table 4.4. Summary of references for selecting and using water-quality laboratories.

[**Abbreviations:** USGS, U.S. Geological Survey; OWQ, Office of Water Quality; WRD, Water Resources Discipline; NWQL, National Water Quality Laboratory; EPA, U.S. Environmental Protection Agency]

Reference	Subject
OWQ Technical Memorandum 98.03 (USGS)	Policy for the evaluation and approval of production analytical laboratories.
OWQ Technical Memorandum 04.01 (USGS)	Revised policy
Pritt and Raese, 1995	Quality assurance/quality control manual—NWQL.
WRD Memorandum 82.028 (USGS)	Acceptability and use of water-quality analytical methods.
WRD Memorandum 92.036 (USGS)	Policy of the WRD on the use of laboratories by national water-quality programs.
ASTM D3977-97, 2007	Standard test method for determining sediment concentration in water samples: ASTM International, 6 p.
Bradley and Chapelle, 1996	Anaerobic mineralization of vinyl chloride in Fe(III)-reducing aquifer sediments. Environmental Science and Technology, v. 30, no. 6, p. 2084-2086
Bullister, 1984	Atmospheric chlorofluomethanes as tracers of ocean circulation and mixing: Studies in the Greenland and Norwegian Seas: Ph.D. Dissertation, University of California, San Diego, La Jolla, 172 p.
Bullister and Weiss, 1988	Determination of CCL_3F and $CCLF_2$ in seawater and air: Deep Sea Resources, v. 35, no. 5, p. 839-854.
Busenberg and Plummer, 1992	Use of chlorofluorocarbons (CCL_3F and CCL_2F_2) as hydrologic tracers and age-dating tools: The alluvium and terrace system of Central Oklahoma: Water Resources Research, v. 28, no. 9, p. 2257-2283.
Chapelle and others, 1997	Practical considerations for measuring hydrogen concentrations in groundwater: Environmental Science and Technology, v. 31, no. 10, p. 2873-2877.
DeWild and others, 2002	Determination of methyl mercury by aqueous phase ethylation, followed by gas chromatographic separation with cold vapor atomic fluorescence detection: U.S. Geological Survey Open-File Report 01-455, 14 p.
DeWild and others, 2004	Methods for the preparation and analysis of solids and suspended solids for methylmercury: U.S. Geological Survey Techniques and methods Report 5-A7, 21 p.
Elrick and Horowitz, 1986	Analysis of rocks and sediments for mercury, by wet digestion and flameless cold vapor atomic adsorption: U.S. Geological Survey Open-File Report 86-596, 12 p.
Fishman and Friedman, 1989	Methods for determination of inorganic substances in water and fluvial sediments: Techniques of Water-Resources Investigations of the U.S. Geological Survey, Book 5, Chapter A1, 545 p.
Guy, 1969	Laboratory theory and methods for sediment analysis: Techniques of Water-Resources Investigations of the U.S. Geological Survey, Book 5, Chapter C1, 58 p.
Kampbell and others, 1989	Dissolved oxygen and methane in water by a GC headspace equilibrium technique: International Journal of Environmental Analytical Chemistry, v. 36, p. 249-257.
Loffler and others, 1997	Complete reductive dechlorination of 1,2-dichloropropane by anaerobic bacteria: Applied and Environmental Microbiology, v. 63, no. 7, p. 2870-2875.
Olson and DeWild, 1999	Techniques for the collection and species-specific analysis of low levels of mercury in water, sediment, and biota: Water-Resources Investigations 99-4018-B, 11 p.
Olund and others, 2004	Methods for the preparation and analysis of solids and suspended solids for total mercury: U.S. Geological Survey Techniques and Methods Report 5-A8, 23 p.
U.S. Environmental Protection Agency, 1994	Method 1613—revision B, tetra-through octa-chlorinated dioxins and furans by isotope dilution HRGC/HRMS: U.S. Environmental Protection Agency, Office of Water, 48 p.
National Environmental Methods Index http://www.nemi.gov	Reference to many approved analytical methods.
U.S. Environmental Protection Agency, 1995	Toxic polychlorinated biphenyls by isotope dilution high resolution gas chromatography/high resolution mass spectrometry: U.S. Environmental Protection Agency, Office of Water, 48 p.
U.S. Environmental Protection Agency, 1998	EPA Method 8082A—polychlorinated biphenyls (PCBs) by gas chromatography, revision 1—EPA test methods for evaluating solid wastes, physical/chemical methods: SW-846, 48 p.

5.0 Field Service Units and Laboratories, Mobile Laboratories, and Field Vehicles

The WAWSC maintains laboratory facilities, such as Field Service Units (FSUs), mobile laboratories, and field vehicles for use in preparing equipment for field activities, processing and analyzing samples and preparing samples for shipment to analytical laboratories. This section documents the WAWSC's criteria for maintaining and operating these facilities.

5.1 Field Service Units and Laboratories

The WAWSC maintains FSUs in Tacoma, Pasco, and Spokane. In addition, a laboratory research unit is maintained in Tacoma. The FSU assists and supports water-quality activities by providing field instrumentation maintenance and calibration, preparations for sample collection, and QA for these activities. The FSU maintains a supply of instruments, equipment, and expendable supplies needed by field personnel for water-quality sample collection and analysis.

5.1.1a Tacoma Facility

The WAWSC maintains a Field Service Unit (FSU) and a laboratory research unit in Tacoma. The Tacoma FSU is managed by the FSU Manager, who is funded at 40 percent by the WAWSC. The FSU contains laboratory benches, glassware, sinks, chemical storage cabinets, and other equipment and instruments listed in table 5.1.1a. The FSU Manager is responsible for maintenance of the FSU and QC of the equipment and instruments provided by the FSU or laboratory. The facility is maintained in accordance with standards set forth in the WAWSC chemical-hygiene plan (Wagner and others, written commun.) and Branch of Operations Technical Memorandum 91.01.

Table 5.1.1a. Equipment, instruments, and quality assurance provided by the Tacoma Field Service Unit.

[**Abbreviations:** OWQ, Office of Water Quality; NA, not applicable; °C, degrees Celsius; RO, reverse osmosis]

Laboratory equipment	Quality assurance
Laboratory balances	Calibration checked annually
Refrigerators at 4°C	Temperature monitored weekly
Fume hoods	Calibrated annually
Ventilated acid cabinets	NA
Wash sinks with drying racks	NA
Vacuum pump	NA
Drying ovens	Calibration monitored annually
Autoclave	Maintained per manufacturer's instructions
Incubators	Calibration monitored biannually
Freezer	Temperature monitored monthly
Emergency safety showers	Operation checked monthly
Emergency eye washes	Operation checked monthly
Lab pH and specific conductance meters	Calibrated before each use
Ion chromatograph	Calibrated before each use
Gas chromatograph	Calibrated before each use
Spectrophotometers	Calibrated before each use
Fluorometers	Maintained per OWQ Technical Memorandum 92.01; Calibrated before each use
Siemens RO water system	Continuous readout of resistivity of water
Turbidimeters	Calibrated before each use
Microscopes	Calibrated periodically

5.1.1b Pasco and Spokane Facilities

The WAWSC also maintains FSUs in Pasco and Spokane under the direct responsibility of the Field Office Chiefs, who assign managers on an as-needed percentage of their time. The Pasco and Spokane FSUs contain laboratory benches, glassware, wash sinks with drying racks, chemical storage cabinets, and other equipment and instruments listed in table 5.1.1b. The FSU Manager at each facility has responsibility for maintenance of the FSU and QA of the equipment and instruments provided by the FSU. Each facility is maintained in accordance with standards set forth in the WAWSC chemical-hygiene plan (Wagner and others, written commun.) available upon request and Branch of Operations Technical Memorandum 91.01.

Table 5.1.1b. Equipment, instruments, and quality assurance provided by the Pasco and Spokane Field Services Units and quality assurance.

[**Abbreviations:** OWQ, Office of Water Quality; NA, not applicable; °C, degrees Celsius]

Laboratory equipment	Quality assurance
Refrigerator at 4°C	Temperature monitored weekly
Fume hood	Calibrated annually
Supply of deionized water	Maintained per OWQ Technical Memorandum 92.01
Ventilated acid cabinets	NA
Emergency eye wash	Operation checked monthly
Wash sink with drying rack	NA
Freezer	Temperature monitored monthly
Lab pH and specific conductance meter	Calibrated each use

5.1.2 Procedures

The FSU at each facility is managed by the FSU Manager. This person is responsible for maintaining the laboratory space, supplies, and equipment listed above, as described in the WAWSC Instructional Memorandum, “Functions of the Washington District Water-Quality Field Service Units”. The unit maintains QC records of laboratory equipment and supplies, such as calibration standards, chemical reagents, sample preservatives, and sample bottles that are provided to field personnel. The project staff personnel, in consultation with the WAWSC water-quality specialist and FSU Manager, are responsible for repair and maintenance of project water-quality equipment and instruments. The Chemical Hygiene Officer, in consultation with the WAWSC Safety Officer, WAWSC Water-Quality Specialist, and Field Office Chiefs, oversees the WAWSC waste-disposal practices to ensure that procedures are in compliance with State and Federal regulations. The unit operations comply with the WAWSC chemical-hygiene plan. The operation of the unit is reviewed annually by the WAWSC Water-Quality Specialist and every 3 years by the OWQ.

5.1.3 Equipment and Supplies

It is the responsibility of the FSU manager to maintain a common pool of field instruments and equipment and to order, store, and quality assure the field equipment and supplies described in table 5.1.3. The FSU stock of supplies is generally intended for short-term, small-scale usage for WAWSC purposes. It is the responsibility of the Project Chief or designated project personnel to determine the need for field equipment and supplies. If large quantities of supplies are needed, projects must purchase these directly. If multiples sets of meters or equipment are needed, or if meters and equipment are needed for longer periods, special accommodations must be made through the FSU Manager.

Table 5.1.3. Summary of information on supplies, equipment, and instruments in the U.S. Geological Survey Washington Water Science Center Field Service Units.

[**Abbreviations:** FSU, Field Service Unit; QA, quality assurance; RO, reverse osmosis]

Supplies, equipment, and instruments	Source and guidelines for QA	Responsible party
Sample bottles	Purchase from One-Stop Shopping	FSU Manager or Project Chief (for large quantities)
Coolers/shipping containers	Local vendors	FSU Manager or Project Chief (for large quantities)
Sample preservatives	Purchase from One-Stop Shopping	FSU Manager or Project Chief (for large quantities)
pH calibration standards	Purchase from One-Stop Shopping	FSU Manager or Project Chief (for large quantities)
Specific conductance calibration standards	Purchase from One-Stop Shopping	FSU Manager or Project Chief (for large quantities)
Blank water for QA	Purchase from One-Stop Shopping as described in NWQ Technical Memorandum 92.01	FSU Manager or Project Chief (for large quantities)
Deionized water	Millipore Milli-Q or RO system used for District operations as described in OWQ Technical Memorandum 92.01	FSU Manager
Isokinetic water-quality samplers	Purchase from One-Stop Shopping	FSU Manager or Project Chief (for long-term use)
Splitting devices	Purchase from One-Stop Shopping	FSU Manager or Project Chief (for long-term use)
Specific conductance meters	Manufacturers. Routine calibrations and participation in National Field Quality Assurance tests are required	FSU Manager or Project Chief
pH meters	Manufacturers. Routine calibrations and participation in National Field Quality Assurance tests are required	FSU Manager or Project Chief
Dissolved oxygen meters	Manufacturers. Routine calibrations and participation in National Field Quality Assurance tests are required	FSU Manager or Project Chief
Barometers	Purchase from One-Stop Shopping Routine calibrations	FSU Manager or Project Chief

5.2 Mobile Laboratories and Water-Quality Field Vehicles

Mobile laboratories and field vehicles refer to all vehicles that are designed, designated, and outfitted for use during water-quality sample-collection and processing activities at or near sample-collection sites. The WAWSC maintains vehicles designated for water-quality sample collection and processing. If a non-designated vehicle must be used for water-quality work, portable processing and preservation chambers are used for sample processing, and extra QC samples are collected to document that the data have not been compromised. Refer to the National Field Manual for the Collection of Water-Quality Data (U.S. Geological Survey, variously dated) for guidelines on procedures for collecting and processing water-quality data.

A field vehicle is designated as a water-quality field vehicle when it meets criteria to maintain a non-contaminating environment for the constituents being sampled. The work area must be maintained to eliminate sources of sample contamination. Specifications for vehicles used when sampling for water-quality constituents are discussed by Horowitz and others (1994) and in the National Field Manual (Lane and others, 2003) and include the following:

- Materials used for cabinets, storage, and work surfaces must be easy to maintain, made of or covered with non-contaminating materials, and such that they can be cleaned with water or solvents as appropriate.
- Cargo must be restricted to equipment and supplies related to water-quality sample collection unless stored in a separate compartment.
- No potentially contaminating equipment or supplies, such as sounding weights, solvents, fuel, etc., may be transported in the interior compartment of the vehicle.
- A dust barrier must be installed between the cab and work area of the vehicle.

The FSU Manager or project personnel assigned by the WAWSC Water-Quality Specialist are responsible for vehicle maintenance, for maintaining the suitability of the vehicle for water-quality sample collection, and for keeping the vehicle stocked with necessary equipment and supplies.

5.3 References Used for Field Service Units and Laboratories, Mobile Laboratories, and Field Vehicles Section

Table 5.3 lists reports, web pages, and (or) memoranda referred to in this section. For a complete citation, refer to Section 13.1 of the report.

Table 5.3. Summary of references for Field Service Units and laboratories, mobile laboratories, and field vehicles.

[**Abbreviations:** USGS, U.S. Geological Survey; NWQL, National Water Quality Laboratory; TWRI, Techniques for Water Resources Investigations]

References	Subject
Branch of Operations Technical (OP) Memorandum 91.01 (USGS)	Safety—Chemical Hygiene Plan
Horowitz and others, 1994	Protocol for collecting and processing samples for inorganic analysis
NWQL Memorandum 92.01 (USGS)	Availability of equipment blank water for inorganics and organics
OWQ Technical Memorandum 92.01 (USGS)	Distilled/deionized water for Water Science Center operations
OWQ Technical Memorandum 92.06 (USGS)	Recommended guidelines for shipping samples to the NWQL
Wagner and others, written commun.	USGS WAWSC, Chemical Hygiene Plan
Lane and others, 2003 (National Field Manual, TWRI book 9, chap. A2.3)	Guidelines for field vehicles.

6.0 Water-Quality Instruments

The WAWSC complies with the WRD policy of providing personnel with high-quality field instruments and equipment that are safe, precise, accurate, durable, reliable, and capable of performing required tasks (WRD Memorandum 95.35). Accordingly, appropriate instruments for use in water-quality projects in the WAWSC will be selected based on the specifications described in the USGS "National Field Manual for the Collection of Water-Quality Data" (U.S. Geological Survey, variously dated) and the requirements of the project. The Hydrologic Instrumentation Facility (HIF), which provides analyses of precision and bias for water-quality instruments, also will be consulted for recommendations when appropriate. The WAWSC Water-Quality Specialist will be done if project personnel need assistance with the selection or use of equipment.

All instruments used by WAWSC personnel for water-quality measurements will be properly operated, maintained, and calibrated. For correct operation of any field or laboratory equipment, the manufacturer's operating guidelines will be carefully followed. Most instruments will be calibrated in the field prior to making the sample measurements, as described below. Information regarding the preparation and storage of calibration standards is provided in Section 5.1.2 of this QA plan.

Thorough documentation of all calibration activities associated with water-quality data collection is a critical element of the WAWSC QA program. Calibration and maintenance records of field equipment, including the manufacturer, make, model, and serial or property number are kept in permanent instrument-specific log books. Similar records for WAWSC laboratory equipment are kept by the FSU Manager. Information that is required to be included with the calibration and maintenance records includes the date, initials and last name of the individual performing the activity, results of calibration or equipment check, and any actions taken. Calibration and maintenance records are checked for completeness and accuracy on an annual basis by the WAWSC Water-Quality Specialist and every 3 years by the OWQ.

Calibration, repair, and maintenance of all single or multiparameter water-quality monitors for continuous monitoring also should be recorded in permanent instrument-specific log books. Standard procedures for the installation and operation of such monitors are described by Wagner and others (2006).

6.1 Calibration of Water-Quality Instruments

Table 6.1 provides summary information regarding the calibration methods, acceptance criteria, calibration frequency and location, responsible persons, and references for specific instructions for the calibration and use of water-quality instruments to measure selected parameters in the WAWSC.

Table 6.1. Summary of calibration information for water-quality instruments used to measure selected parameters in the U.S. Geological Survey Washington Water Science Center.

[**Abbreviations:** NIST, National Institute of Standards and Technology, ºC, degrees Celsius; FAA, Federal Aviation Administration; FSU, Field Services Unit; TWRI, Techniques for Water Resources Investigations; µS/cm, microsiemens per centimeter at 25 ºC; ±, plus or minus; DO, dissolved oxygen; mg/L, milligram per liter; mm, millimeter; µm, micrometer]

Parameter	Calibration method used	Acceptance criteria and response if not acceptable	Calibration frequency and location	Responsible person	Reference for calibration and use
Temperature	NIST-certified thermometer	Calibrated accuracy within ±0.2 ºC, otherwise return to supplier or discard.	Annual 5-point calibration at the Tacoma FSU, with additional 2-point calibrations twice annually	Annual 5-point calibration by the FSU manager and additional calibrations by field personnel	Wilde and Radtke (ver. 2, 2006)
Specific conductance	At least two standards, bracketing expected values	Acceptable range is within ±3 percent or ±5 percent for values less than 100 µS/cm; and response, such as cleaning or replacement of probe.	Daily in field, if appropriate, prior to taking measurements	Field personnel	Radtke and others (2005)

Table 6.1. Summary of calibration information for water-quality instruments used to measure selected parameters in the U.S. Geological Survey Washington Water Science Center.—Continued

[**Abbreviations:** NIST, National Institute of Standards and Technology, ºC, degrees Celsius; FAA, Federal Aviation Administration; FSU, Field Services Unit; TWRI, Techniques for Water Resources Investigations; TWRI, Techniques for Water Resources Investigations; µS/cm, microsiemens per centimeter at 25 ºC; ±, plus or minus; DO, dissolved oxygen; mg/L, milligram per liter; mm, millimeter; µm, micrometer]

Parameter	Calibration method used	Acceptance criteria and response if not acceptable	Calibration frequency and location	Responsible person	Reference for calibration and use
pH	Two-point calibration, bracketing expected values	Electrode slope response must be greater than 95 percent of theoretical slope. If not, ensure that electrode filling solution is sufficient. Clean the probe according to manufacturer's instructions, if necessary, and recalibrate. Return probe to FSU and use backup probe if not successful. Temperature should be within ±0.2 ºC of NIST-calibrated thermistor if automatic temperature calibration feature is used.	Daily in field, if appropriate, prior to taking measurements	Field personnel.	Wilde and others (2006)
Dissolved oxygen	Air calibration in water (preferred)	Zero-DO check should read no more than 0.2 mg/L using a fresh zero-DO solution and meter should calibrate and hold steady at constant temperature and pressure. If the zero-DO check or saturation cannot be achieved, replace the membrane and recalibrate or replace the probe. Temperature recorded by meter should be within ±0.5 ºC of the NIST-calibrated thermistor, otherwise the probe should be replaced.	Twice daily in field prior to taking measurements	Field personnel	Lewis, M.E. (2006)
Barometric pressure	Mercury barometer	Calibrate against reference barometer to within 1 mm Hg at Tacoma FSU, National Weather Service, or FAA station.	Annually or more frequently if needed	FSU Manager or field personnel	Wilde, F.D., variously dated
Turbidity	At least two standards, bracketing expected values	Zero turbidity standard (deionized water passed through a 0.2 µm filter) should be calibrated along with a standard higher than the expected value. Acceptance criteria is the greater of 5 percent or ±0.5 turbidity units.	Daily in field, if appropriate, prior to taking measurements	Field personnel	Anderson, C.W. (2005)

6.2 References Used for Water-Quality Instruments Section

Table 6.2 lists reports and memoranda referred to in this section. For a complete citation, refer to Section 13.1 of the report.

Table 6.2. Summary of references for water-quality instruments.

[**Abbreviations:** TWRI, Techniques of Water Resources Investigations; USGS, U.S. Geological Survey]

Reference	Subject
Wilde, ed., chapter sections, variously dated (TWRI book 9, chap. A6)	Field measurements
WRD Memorandum 95.35 (USGS)	Instrumentation plan for the WRD and the hydrologic field instrumentation and equipment policy and guidelines
Wagner and others (2006)	Continuous water-quality monitors

7.0 Site Selection and Documentation

Deciding where to sample is an important initial step toward achieving project objectives and meeting WAWSC QA/QC requirements. Once a site is selected, thorough documentation is required, usually in the form of a station description.

7.1 Site Selection

Site selection for sampling is important to the validity of water-quality data. Selection of a suitable site is made only after considering a number of factors, including the need for information of a particular location, the suitability of a site for sampling, and its accessibility and safety. Specific guidelines for site selection are contained in Wilde (2005). The Project Chief is responsible for the selection of sampling sites, after consultation with the Water-Quality Specialist and the Surface-Water or Ground-Water Specialist, as appropriate.

7.1.1 Surface Water

If possible, water-quality stations are located at or near streamflow-gaging stations. If this is not possible, the water-quality station is located where the stream discharge can be measured and water samples can be collected at all stages of flow to be monitored. If the water-quality station is located too close downstream from either the confluence of two or more streams or a point source of pollution, the collection of a representative sample is difficult because of incomplete mixing. Under such conditions, the required minimum number of vertical transects sampled should be increased and lateral mixing documented with cross-sectional surveys at various stages of flow. Surface-water sites are documented with a station description and photographs, as described in the “Surface-Water Quality-Assurance Plan for the Washington District” (Kresch and Tomlinson, 2004).

7.1.2 Ground Water

The selection of wells for ground-water sampling is dependent on many variables, including location, depth and accessibility of the well, type of well completion, availability of geologic and water-use information, and sampling purpose(s). Details for the selection and inventory procedure of wells for sampling ground water are described in the “Quality Assurance Plan for Ground-Water Activities, U.S. Geological Survey, Washington District” (Drost, 2005). If suitable existing wells cannot be found, new wells will need to be installed.

7.2 Site Documentation

The Project Chief constructs a site file containing descriptive information on location, conditions, purpose, and ancillary information for all new water-quality data-collection sites (Schroder and Shampine, 1995). Much of this information also is stored electronically in computerized site files maintained by the Data Management Section. The Field Office or Project Chief is responsible for assuring that the site file is maintained for each data-collection site. Archiving of this information is discussed in Section 10.4 of this document.

To standardize and facilitate the processing of water-quality data in Washington, and to assure that water-quality data are entered into the proper database in a timely manner, the following procedures are followed:

- Site-file records will be established for each new site at which water-quality samples will be collected or have been collected; it is very important that a site-file record exist before the return of analytical data from the NWQL. The site files, as well as the resulting water-quality data, will be stored in the NWIS water-quality database of the WAWSC in which the samples were collected. The responsibility for the maintenance of the site-file records will rest with the WAWSC Database Manager (DBM)—either the surface-water or ground-water database manager, depending on the site. The entry of the site-file records will be completed by the DBM or designee, but the pertinent information that makes up the site-file record will be furnished by the Field Office or Project Chief (or designee). The entry of site-file records for surface-water sites is the responsibility of the Surface-Water Database Manager (SW-DBM), and information for surface-water site must be submitted to the SW-DBM by the Field Office or Project Chief (or designee) in a timely manner. The entry of site file records for ground water sites is the responsibility of the Field Office or Project Chief (or designee). The Field Office or Project Chief (or designee) will generally enter ground water site records into NWIS or submit surface-water site file data to the SW-DBM before samples are collected, but in all cases within 10 days of sample shipment to the analyzing agency.

- The Analytical Services Request (ASR) form will be completed by the Field Office or Project Chief or designee and submitted to the NWQL, and a copy retained in a station file as part of the sample tracking documentation.

- Project and Field Office Chiefs will be responsible for maintaining a comprehensive station file, either physical or electronic, that tracks all pending samples that are submitted for analysis.

7.2.1 Surface Water

A station description is prepared for each water-quality station that is sampled on a regular or periodic basis. Sites established at existing surface-water gaging stations commonly will need only supplemental information to complete the description. Other surface-water sites, such as lakes, estuaries, and coastal waters, may require varying amounts of supplemental information to complete the station descriptions. Normally, the minimum electronically stored information required for a surface-water station record is dictated by the NWIS software used by the WAWSC. The minimum information required for establishing electronic files in NWIS for surface water is listed in Wilde 2005, table 1-1). For continuous water-quality monitoring sites, station-description requirements are presented by Wagner and others (2006).

Creation of surface-water sites in NWIS is the responsibility of the WAWSC Automated Data Processing System (ADAPS) database manager. Project or data personnel should provide the ADAPS database manager with the requirements for a new surface-water site: (1) a 1:24,000 topographic map with location(s) marked; (2) latitude and longitude, and source (for example map or global positioning system [GPS]); (3) elevation and source (for example, map, barometer, or survey); (4) drainage area, if calculated. The ADAPS database manager will determine the station number and update the site file in NWIS and provide the project with the new station(s) information.

7.2.2 Ground Water

A well file (analogous to a surface-water station description) is prepared for each well that is sampled on a regular or periodic basis. Normally, the minimum electronically stored information required for a ground-water-quality site is dictated by the NWIS software used by the WAWSC. The minimum information required for establishing electronic files for a ground-water site in NWIS is listed in Wilde (2005, table 1-4). Paper documents, such as agreements for use of the well between the well owner and the USGS, also should be stored in the well file.

To standardize and facilitate the processing of water-quality data in the WAWSC, and to assure that water-quality data are entered into the proper database in a timely manner, the following procedures will be used:

- Site-header records will be established for each new site at which water-quality samples will be collected or have been collected. Header record must exist in the NWIS site file before the return of analytical data from the NWQL. New site-header data must be checked by Project or Field Office personnel. These verified records, as well as the resulting water-quality data, will be stored in the NWIS water-quality database for the WAWSC. The responsibility for entry of the site-header records and maintenance of the site-header records file currently rests with the Project Chief (or designee). The pertinent information that comprises the header must be entered into the system within 10 days after sample collection.

- For each sample that will be sent to the NWQL for analysis, an ASR form will be completed by the Project or Field Office Chief (or designee) with a copy (or facsimile) retained in a project file as part of the sample tracking system. The Project or Field Office Chief (or designee) is responsible for tracking all pending samples submitted for analysis. Sample status at the NWQL can be tracked from login to completion of analysis (see Section 9.0).
- For continuous water-quality monitoring sites, station-description requirements are presented by Wagner and others (2006).

Required information about the well that is mandated by WAWSC policy is described in the “Quality Assurance Plan for Ground-Water Activities in the Washington District” (Drost, 2005). The required data about the well that is gathered during the site-selection phase of the project is recorded on the ground-water site inventory form and specific information about sampling conditions is recorded on the ground-water-quality field form.

7.2.3 Other Sites

Project or Field Office Chiefs will establish station files for all miscellaneous sites (such as lakes, estuaries, or wet and dry deposition collectors). All data-collection activities will be recorded on appropriate field forms and in notebooks. These forms and notebooks will be kept with station files and, upon completion of the project, all documents will be appropriately archived according to the WAWSC files maintenance and disposition plan.

7.3 References Used for Site-Selection and Documentation Section

Table 7.3 lists reports and memoranda referred to in this section. For a complete citation, refer to Section 13.0 of the report.

Table 7.3. Summary of references for site selection and documentation for water-quality programs.

Reference	Subject
Schroder and Shampine, 1995	Guidelines for documenting new water-quality data-collection sites.
Wilde, 2005 (TWRI book 9, chap. A1)	Establishing electronic NWIS files for surface- and ground-water data.
Drost, B.W., 2005, Quality assurance plan for ground-water activities in the Washington District.	Washington Water Science Center Ground Water Quality Assurance Plan
Kresch and Tomlinson, 2004, Surface-Water Quality-Assurance Plan for the Washington District	Washington Water Science Center Surface-Water Quality-Assurance Plan

8.0 Sample Collection and Processing

Water-quality data collected by the USGS are used by agencies at Federal, State, and local levels to guide their decisions concerning the appropriate and efficient management of water resources for the Nation. Water-quality data are collected as part of Federal programs such as the National Water-Quality Assessment (NAWQA) Program, as well as cooperative projects jointly funded by local or State agencies, and are a vital component of water-resources activities performed by the USGS and the WAWSC.

The primary objective in collecting a water-quality sample is to obtain environmental data that are representative of the system that is being studied. Sampling and processing techniques for specific constituents may vary according to the general class of compound, such as inorganic or organic chemicals. If incorrect sampling procedures produce a non-representative sample, or if the sample is contaminated or degraded before analysis can be completed, the value of the sample is limited and the data are questionable. Therefore, compliance with documented and technically approved sample-collection and processing protocols is critical to ensuring the quality of water-quality data.

It is the policy of the WAWSC that all personnel involved in collecting and processing water-quality data will be adequately informed and trained regarding water-quality data-collection and processing procedures established by the WRD. Because of rapid changes in technology, however, new and improved methods for sample collection and processing are continually being developed. All WAWSC personnel who are involved in water-quality sampling must be aware of changing requirements and recommendations. The Project or Field Office Chief , with the assistance of the WAWSC Water-Quality Specialist, is responsible for providing current information to field personnel on the correct protocols in collecting and processing water-quality samples.

Project or Field Office Chiefs are responsible for ensuring that personnel collecting and processing samples are qualified, trained, and experienced. The Project or Field Office Chief also is responsible for seeing that field personnel take the following steps to ensure the quality and integrity of the WAWSC’s water-quality data:

Instantaneous Water-Quality Data

- Samples must be collected and processed according to prescribed WRD protocols, as described and referenced later in this section.
- All samples must be shipped to the laboratory from the field in an expedient manner, within the required holding times for each analysis.
- Samples that are chilled or time-dependent should be shipped overnight.
- All samples should be logged into NWIS (usually within 7 days of sample collection) prior to the completion of analysis and transmittal of the results back to the WAWSC.
- All analytical data must be reviewed in a timely manner (usually within 2 weeks after release by the NWQL) and within the required holding times for each analysis (to allow time for re-analysis), and fully documented in the station analysis file.

Continuous Water-Quality Data

- The water at the site should be vertically and horizontally well mixed in the cross section.
- Location of the sensors should be fully documented.
- All pertinent information regarding the site, cross-section, equipment maintenance, and data corrections should be fully documented and included in the station analysis file.
- Monitors must be inspected and calibrated as frequently as required to obtain as complete a record as possible. Site should be operated as described in Wagner and others (2006).

8.1 Constituents in Water

Most studies that are designed to evaluate the water quality of an aquatic system are based upon analyses of physical and chemical parameters associated with the water. Physical properties generally are measured in the field, whereas most chemical parameters require laboratory analysis. This section of the QA plan includes an overview of relevant WAWSC and WRD policies, as well as references for specific procedures pertaining to the measurement of field parameters and the collection and processing of samples for water-quality analysis. Information in this section is drawn primarily from the National Field Manual—a Techniques of Water Resources Investigations (TWRI) that describes in greater detail the recommended and required policies and procedures for collecting and processing water-quality samples in the WRD. Additional sources of information include manuals published by the NAWQA Program (Koterba and others, 1995). The project proposal and workplan also should be consulted for specific guidelines for field personnel regarding details of sample collection and processing.

8.1.1 Field Measurements

Routine field measurements include temperature, dissolved-oxygen (DO) concentration, specific conductance (conductivity), pH, and alkalinity. Other types of measurements that also may be necessary for specific projects include acid neutralizing capacity, reduction-oxidation potential (Eh), and turbidity. WAWSC procedures for collecting field measurements in surface- and ground-water systems are provided in chapter A6 of the National Field Manual (Wilde, 2005a). Field measurements should represent, as closely as possible, the natural conditions of the system at the time of sampling. To ensure quality of the measurements, calibration within the range of field conditions at each site is required for most instruments.

Field-measurement data are recorded while in the field, including methods, equipment, and calibration information. Field-measurement data can be stored either electronically or on paper field forms, which may be national forms (fig. 8.1.1), and may be customized for a particular project. The Field Office or Project Chief is responsible for reviewing field records for completeness. To avoid the loss of data because of possible instrument malfunction, field personnel should ensure that backup sensors and (or) instruments are readily available and in good working condition.

To document the quality of field measurements, all WAWSC personnel involved in the collection of water-quality data are required to participate in the National Field Quality Assurance (NFQA) Program (Stanley and others, 1992). Results of the NFQA Program are reviewed by the Regional Water Quality Specialist and the WAWSC Water-Quality Specialist. Staff receiving an unsatisfactory rating will be required to participate in additional QC checks administered by the WAWSC Water-Quality Specialist.

November 2006

U. S. GEOLOGICAL SURVEY SURFACE-WATER QUALITY NOTES

Station No. ____________

NWIS Record No. ____________

Station No. ____________ Station Name ____________________ Field ID ____________

Sample Date ________ Mean Sample Time ______ Time Datum ______ (eg. EST, EDT, UTC) End Date ________ End Time ______

*Sample Medium: 9 (SW) Q (QC-SW) ________ *Sample Type: 9 (regular) 7 (replicate) 2 (blank) 1 (spike) ________

*see last page for additional codes

*Sample Purpose (71999): 10 (routine) 15 (NAWQA) 20 (NASQAN) 30 (Benchmark) ____________

*Purpose of Site Visit (50280): 1001 (fixed-frequency SW) 1003 (extreme high flow SW) 1004 (extreme low flow SW) 1098 (NAWQA QC) ______

QC Samples Collected? Y N Blank Replicate Spike Other____________

Project No. ________ Project Name____________ Project No. ________ Project Name____________

Sampling Team ____________ Team Lead Signature ____________ Date ________

START TIME ______ GAGE HT ______ TIME ______ GHT ______ TIME ______ GHT ______ TIME ______ GHT ______ END TIME ______ GHT ______

FIELD MEASUREMENTS

Property	Parm Code	Method Code	Result	Units	Remark Code	Value Quali-fier	Null Value Quali-fier	NWIS Result-Level Comments
Gage Height	00065			ft				
Discharge, instantaneous	00061			cfs				
Temperature, Air	00020	THM04 (thermister) THM05 (thermometer)		°C				
Temperature, Water	00010	THM01 (thermister) THM02 (thermometer)		°C				
Specific Conductance	00095	SC001 (contacting sensor)		µS/cm				
Dissolved Oxygen	00300	MEMBR (amperometric) LUMIN (luminescent)		mg/L				
Barometric Pressure	00025			mm Hg				
pH	00400	PROBE (electrode)		units				
ANC, unfiltered, incr.	00419	TT001		mg/L				
Alkalinity, filtered, incr.	39086	TT013		mg/L				
Carbonate, flt, incr.	00452	TT019		mg/L				
Bicarbonate, flt, incr.	00453	TT017		mg/L				
Hydroxide, flt, incr.	71834	TT023		mg/L				
Turbidity [see attachment for codes]								
Other								
Other								

SAMPLING INFORMATION

Parameter	Pcode	Value	Information
Sampler Type	84164	3044 DH-81; 3045 DH-81Teflon; 3051 DH-95 Teflon; 3052 DH-95 Plastic; 3053 D-95 Teflon; 3054 D-95 Plastic; 3055 D-96 Bag Sampler; 3057 D-99 Bag Sampler; 3058 DH-2 Bag Sampler; 3060 Weighted-Bottle Sampler; Other (see last page for codes) ________	Sampler ID: Sampler bottle/bag material: plastic teflon other ________ Nozzle material: plastic teflon other ______ Nozzle size: 3/16" 1/4" 5/16"
Transit Rate, minimum	50014	ft/sec	
Transit Rate	50015	ft/sec	
Transit Rate, maximum	50016	ft/sec	
Sampler Splitter Type	84171	10 Churn, plastic, 8 L, cooler-type spigot; 20 Churn, plastic, 14 L, cooler-type spigot; 30 Churn, plastic, 8 L, cubitainer-type spigot; 40 Churn, plastic, 14 L, cubitainer-type spigot; 60 Churn, Teflon 14 L, US SS-1; 80 Cone splitter, Teflon; Other (see last page for codes) ________	Splitter ID:
Sampling Method	82398	10 EWI; 20 EDI; 30 single vertical; 40 multiple vertical; other ____________	Filter type(s): capsule disc 142mm 25mm GFF membrane
Stream Velocity	81904	ft/sec estimated measured	
Hydrologic Condition	N/A	A Not determined; 4 Stable, low stage; 5 Falling stage; 6 Stable, high stage; 7 Peak stage; 8 Rising stage; 9 Stable, normal stage	
Observations [codes: 0=none; 1=mild; 2=moderate; 3=serious; 4=extreme]		Oil-grease (01300) ___ Detergent suds (01305) ___ Atm. Odor (01330) ___ Fish kill (01340) ___	Floating garbage (01320) ___ Floating algae mats (01325) ___ Floating debris (01345) ___ Turbidity (01350) ___

COMPILED BY: ________ DATE ______ CHECKED BY: ________ DATE: ______ LOGGED INTO NWIS BY: ________ DATE ______

1 SW Form version 8.0

Figure 8.1.1. Example first page of a national field form for use in recording field-measurement data.

8.1.2 Cleaning of Sampling and Processing Equipment

Procedures for cleaning equipment used for water-quality sampling and processing are described in chapter A3 of the National Field Manual (Wilde, 2004). All new equipment acquired for water-quality sampling, as well as equipment that has been in long-term storage, must be cleaned in the office before being used in the field. Similarly, equipment must be cleaned as soon as possible after sample collection and before being used again to avoid cross-contamination between sampling sites. The field rinsing of equipment only with site water just prior to sample collection is not a substitute for proper cleaning.

Equipment blanks are a particular type of blank sample that is used to verify that cleaning procedures used by the field personnel are adequate for removing contamination. These blanks ensure that individual pieces of sampling equipment are not sources of detectable concentrations of constituents to be analyzed in environmental samples. An annual equipment blank, processed in the office laboratory, is required for each set of equipment used to collect water-quality samples (Horowitz and others, 1994; Wilde, 2004). Annual equipment blanks that indicate detectable levels of constituents require submission of blanks for individual components of the equipment to isolate the source of contamination. When the source of contamination has been determined, the necessary maintenance must be performed to eliminate contamination, or the equipment must be replaced. The WAWSC Water-Quality Specialist monitors the results of annual equipment blanks and ensures compliance with WAWSC standards.

8.1.3 Surface-Water Sampling

Collecting surface-water samples that accurately represent the physical and chemical characteristics of the aquatic system requires the appropriate use of sampling equipment and methods in order to describe environmental variability and to prevent contamination or bias in the sampling process. All WAWSC personnel who are involved in water-quality studies must be well informed of the various factors that must be considered to ensure the collection of representative samples. The choice of sampling equipment and method of sample collection are based on established protocols and guidelines, depending upon the characteristics of the target constituents, study objectives, hydrologic conditions, and sampling logistics.

8.1.3.1 Equipment Selection

Guidelines for selecting equipment for sampling surface water are provided in Horowitz and others (1994) and in chapter A2 of the National Field Manual (Lane and others, 2003). Review of equipment selection by WAWSC technical specialists occurs during proposal and workplan review and during periodic project reviews.

8.1.3.2 Sample Collection

Guidelines for the collection of surface-water samples are provided in chapter A4 of the National Field Manual (U.S. Geological Survey, 2006). Field personnel are responsible for examining the sampling site carefully and choosing the most appropriate sampling method to collect the most representative sample possible under the conditions at the time of sampling. The standard procedure for stream sampling is to collect the sample through the entire depth of the water column at multiple vertical transects by either the equal-discharge or equal-width increment method. These procedures generate a representative cross-sectional sample that is both flow-weighted and depth- and width-integrated (Edwards and Glysson, 1999; Ward and Harr, 1990). Occasionally, the use of non-integrated or non-flow-weighted methods may be appropriate because of hydrologic, climatic, or safety conditions, or specific project objectives. The use of non-standard sampling methods, such as dip samples from the centroid may be acceptable when extreme flood or other conditions preclude the collection of the standard sample. Thorough documentation of sampling equipment and methods that are used is required to be documented in field records and by use of NWIS fixed-value codes associated with water-quality samples. The Project Chief or Field Office Chief is responsible for timely review of field records.

Specific procedures employing two-person sampling teams with specific, designated roles in sample collection and handling are required when sampling for trace inorganic constituents with ambient concentrations at or near 1 microgram per liter (μg/L), or when aluminum, iron, and manganese ambient concentrations are up to about 200 μg/L, as described in chapter A4 of the National Field Manual (U.S. Geological Survey, 2006). The two-person sampling protocol may be modified, upon consultation with the WAWSC Water-Quality Specialist, as appropriate for studies in which low-level trace elements are not measured.

Review of surface-water sampling procedures for WAWSC water-quality projects is performed upon request by the Project or Field Office Chief for each project actively involved in water-quality data collection. Reviews are conducted in the field or laboratory by the WAWSC Water-Quality Specialist and is documented with a memorandum to the appropriate Field Office or Project Chief and the WAWSC Director. An independent review of field methods, for at least one WAWSC project, is conducted once every 3 years during the Office of Water Quality WAWSC technical review.

8.1.4 Ground-Water Sampling

WAWSC ground-water sampling procedures are designed to ensure that the samples collected are representative of water in the aquifer and are not contaminated by well construction material or sampling equipment, and that the composition of the samples is not altered by physical or chemical processes during sampling. It is critical that field personnel be aware of all factors that can compromise the integrity of ground-water samples and implement consistent strategies to protect sample integrity.

8.1.4.1 Equipment Selection

Guidelines for selecting appropriate equipment for ground-water sampling are provided in chapter A2 of the National Field Manual (Lane and others, 2003). All project personnel involved in ground-water sampling for water-quality studies must understand the advantages and disadvantages of available equipment with respect to study objectives. Because of the wide range of factors involved, the ideal equipment for sample collection under some circumstances may not exist. When compromise decisions are required, the field team must thoroughly document with field notes the compromises that are made. Equipment selection is required during proposal and workplan review and during periodic project reviews by WAWSC technical specialists.

8.1.4.2 Sample Collection

Guidelines, which prevent or minimize loss of sample integrity, for collecting representative water-quality samples from ground water are provided in chapter A4 of the National Field Manual (U.S. Geological Survey, 2006). The standard procedure for ground-water sampling is to purge the well to remove at least three well volumes of standing water while monitoring field measurements for stabilization. Exceptions to the three-well-volume rule can be made under some circumstances, however, depending on project objectives or site characteristics. The Field Office or Project Chief is responsible for timely review of field records.

As a rule, field personnel are required to follow a prescribed order of sample collection, described in the National Field Manual (U.S. Geological Survey, 2006), to help ensure the quality of the data collected. In addition, two-person sampling teams are to implement coordinated clean-handling techniques when collecting samples for analyses of trace inorganic constituents with ambient concentrations at or near 1 µg/L, or when ambient concentrations of aluminum, iron, and manganese are up to about 200 µg/L, as described in U.S. Geological Survey, 2006. The two-person sampling protocol may be modified, upon consultation with the WAWSC Water-Quality Specialist, as appropriate for studies in which low-level trace elements are not measured.

Review of ground-water data collection activities is conducted upon request by the Project or Field Office Chief for each water-quality project involved in water-quality data collection. Reviews are conducted by the WAWSC Water-Quality Specialist and documented with a memorandum to the appropriate Field Office or Project Chief and the WAWSC Director. An independent review of field methods, for at least one WAWSC project, is conducted once every 3 years during the Office of Water Quality WAWSC technical review.

8.1.5 Precipitation Sampling

Specific procedures in the WAWSC for collecting precipitation samples are based primarily on the study objectives. Major factors that must be considered in sampling for precipitation quality include the location of the sampling station relative to human influences, the choice of sampling equipment, and special sample-handling procedures that may be necessary. Precipitation-quality sampling equipment should be composed of inert, nonabsorbent material that will not affect the typically low concentrations of ions in solution.

Guidelines regarding the collection of precipitation samples are provided in the following references:

1. Dossett and Bowersox (1999) for guidance in field and laboratory procedures in the WRD;

2. Peden and others (1986) for procedures for collecting precipitation samples recommended by the USEPA; and

3. Willoughby (1995) for a case study discussing methods of precipitation sampling and analysis.

The project proposal and workplan should be consulted for specific guidelines regarding the factors that must be considered in choosing the sample location, the sampling equipment and frequency, and the special sample handling procedures that may be necessary. For specific questions related to precipitation sampling that are not addressed by these references, contact the WAWSC Water-Quality Specialist or the appropriate unit chief at the NWQL.

8.1.6 Sample Processing

All samples collected for water-quality analysis must be processed according to procedures in chapter A5 of the National Field Manual (Wilde and others, 2004) as soon as possible following collection. The constituents of interest and study objectives determine the specific processing procedures that are necessary, which must be described in the project workplan.

All WAWSC water-quality studies that include the analysis of trace elements in concentrations less than or near 1 µg/L, or when ambient concentrations of aluminum, iron, and manganese are up to about 200 µg/L must use the protocols for sample processing as described in U.S. Geological Survey, 2006. These techniques require the use of processing and preservation chambers to reduce the potential for contamination from the surrounding environment during sample splitting, filtration, and preservation. Sample processing procedures for all water-quality projects are reviewed during proposal and workplan review and during periodic project reviews by the WAWSC Water-Quality Specialist.

8.1.6.1 Sample Compositing and Splitting

Guidelines for using sample compositors and splitters are in chapter A2 of the National Field Manual (Lane and others, 2003). Two types of sample splitters currently in use in the WRD are the churn splitter, which also serves as a compositing device, and the cone splitter, which requires a separate compositing vessel. Each splitter has specific advantages and disadvantages, as described in OWQ Technical Memorandum 97.06. Either splitting method can be applied to samples collected for analysis of inorganic and organic constituents within the technical design limits of the device and so long as the equipment is constructed of appropriate materials.

8.1.6.2 Sample Filtration

Water-quality samples may have to be filtered in order to separate particulates from the water and constituents in solution. Selection of the appropriate filter unit and filter characteristics to be used depends on the constituent class of interest and is based on guidance provided in the National Field Manual (Wilde and others, 2004). Guidelines for filtration procedures for specific constituent groups and specific details about filtration are provided in the National Field Manual (Lane and others, 2003). For surface water, the most common filtration system consists of a reversible, variable-speed battery-operated peristaltic pump and 0.45-µm pore size disposable capsule filter. For ground water, the sample is generally pumped directly from the well through a 0.45-µm pore-size disposable capsule filter. Samples for analysis of trace elements in concentrations less than or near 1 µg/L, or when ambient concentrations of aluminum, iron, and manganese are as much as about 200 µg/L must be filtered in a processing chamber that encloses the filtering unit and sample bottles in a protected environment.

8.1.6.3 Sample Preservation

Samples collected for analyses of some constituent groups must be preserved to prevent reduction or loss of target analytes and to stabilize analyte concentrations for a limited time. Guidelines for sample preservation are provided in the National Field Manual (Wilde and others, 2004), and the NWQL Services Catalog. Because some samples have a very limited holding time even when preserved, field personnel must ensure that all water-quality samples are shipped to the laboratory as quickly as possible and that time-sensitive samples are received in good condition within the appropriate holding time. To ensure that samples arrive at the NWQL in good condition and in a timely manner, a return postcard is enclosed with the samples so that NWQL personnel can report the date received and temperature of samples in the cooler. For details on sample shipping requirements, refer to Section 9.3 of this QA plan.

8.2 Other Types of Water-Quality Samples

Many water-quality studies in the WRD are beginning to employ a multidisciplinary approach that relies on data from a range of sampling media. Various types of biological, sediment, and radiochemical samples may be incorporated into a water-quality project to provide multiple lines of evidence with which to evaluate a particular aquatic system. This section of the QA plan includes an overview of standard WAWSC QA procedures and references for detailed instructions that describe the collection of biological, sediment, and radiochemical samples.

8.2.1 Biological Samples

WAWSC water-quality activities include the collection of biological samples as part of NAWQA studies and specific WAWSC projects. Biological samples may include those for analysis of bacteria, viruses, or protozoa; biological oxygen demand; chlorophyll, and algae, including phytoplankton or periphyton; benthic invertebrates; fish; and contaminants in biological tissues. Measurements related to biological condition also may include evaluations of stream habitat. Guidelines for documentation and QA and specific references to personnel who can answer questions regarding various kinds of biological sampling is included in the summary of references for collecting and processing biological samples (table 8.2.1).

Table 8.2.1. Summary of references for collecting and processing biological samples.

Reference	Subject
Crawford and Luoma, 1994	Contaminants in tissues
Cuffney and others, 1993	Benthic invertebrates
Delzer and McKenzie, 2003 (TWRI book 9, chap. A7, section 7.0)	5-day Biochemical Oxygen Demand
Meador and others, 1993a	Fish
Meador, and others, 1993b	Stream habitat
Myers and Wilde, 2003	Biological bacteria
Porter and others, 1993	Algae

8.2.2 Suspended-Sediment and Bottom-Material Samples

WAWSC water-quality activities include the collection of suspended-sediment and bottom-material samples. Guidelines for the collection of sediment samples are described in selected WRD publications and in WRD Office of Surface Water (OSW) memoranda, which are referenced below (table 8.2.2). Suspended-sediment samples are typically analyzed by the Vancouver sediment laboratory for concentration and either sand and silt distribution or complete particle-size distribution. Samples for both suspended sediment and bottom sediment may be analyzed at the NWQL for chemical constituents, including trace elements or hydrophobic organic compounds.

Field personnel must be familiar with the factors involved in the selection of sediment-sampling equipment that are based on the type of analyses to be performed and hydraulic conditions, as well as special cleaning procedures that may be required when sampling sediment chemistry. The project workplan should be consulted for specific guidelines for sediment sampling, depending on project objectives.

Individuals who have questions regarding the collection, handling of sediment samples, or quality assurance should contact the USGS Cascades Volcano Observatory sediment laboratory manager (http://vulcan.wr.usgs.gov/Projects/SedLab/framework.html). For particular questions concerning sediment chemistry samples, contact the WAWSC Water-Quality Specialist.

Table 8.2.2. Summary of references for collecting and processing sediment samples.

Reference	Subject
ASTM D3977-97 (2007), Standard test method for determining sediment concentration in water samples: ASTM International, 6 p.	ASTM standards.
Cascades Volcano Observatory sediment laboratory QA plan (Vancouver, WA) , Dan Gooding, U.S. Geological Survey, oral commun.	Laboratory procedures used in processing and analyzing sediment samples.
Edwards and Glysson, 1999	Field methods for measurement of fluvial sediment.
Guy, 1969 (TWRI book 5, chap. C1)	Laboratory theory and methods for sediment analysis.
Knott and others, 1993	Quality-assurance plan for collecting and processing sediment data.
OSW Memorandum 93.01 (USGS)	Instrumentation and field methods for collecting suspended-sediment data.
Radtke, 2005	Collecting and processing bottom-sediment samples.
Shelton and Capel, 1994	Collecting and processing streambed-sediment samples.
Wilde, 2004	Cleaning equipment for sampling suspended-sediment chemistry.
Lane and others, 2003	Selection of equipment for sampling suspended-sediment chemistry.

8.3 Quality-Control Samples

Quality-control (QC) samples must be collected as integral components of all WAWSC water-quality studies to determine the acceptability of performance in the data-collection process and provide a basis for evaluating the adequacy of procedures that were used to obtain data. Guidelines for the collection of specific types of QC samples and the use of QC data are provided in chapter A4 of the National Field Manual (U.S. Geological Survey, 2006). Issues of QC sample design are addressed in Section 3.1 of this plan. Specific guidelines for the collection and processing of QC samples must be included in the project workplan. The Field Office or Project Chief is responsible for reviewing QC data in a timely manner and implementing necessary modifications, when appropriate, to sampling and processing techniques. The WAWSC Water-Quality Specialist has the responsibility for advising WAWSC personnel regarding the collection and interpretation of QC samples.

8.4 Safety Issues

Because the collection of water-quality data in the field can be hazardous at times, the safety of field personnel is a primary concern. Field teams often work in areas of high traffic, remote locations, and under extreme environmental conditions. Field work involves the transportation and use of equipment and chemicals and commonly requires working with heavy machinery. Additionally, field personnel may come in contact with waterborne and airborne chemicals and pathogens while sampling. Beyond the obvious concerns regarding unsafe conditions for field personnel, such as accidents and personal injuries, the quality of the data also may be compromised when sampling teams are exposed to dangerous conditions.

So that personnel are aware of and follow established procedures and protocols that promote all aspects of safety, the WAWSC communicates information and directives related to safety to all personnel. Training is provided by contract trainers (for example, Hazardous Waste Operation, 40-hour training) or by in-house training classes (for example, hazard communication and laboratory safety). In addition, periodic safety presentations are made on specific topics utilizing video tapes, memoranda, or guest speakers as appropriate. Specific policies and procedures related to safety is available to USGS employees in WAWSC Instructional Memoranda. Additional information is available to USGS employees on the WRD Safety web page.

An individual has been designated as collateral-duty Safety Officer by the WAWSC Director. The duties of the Safety Officer include serving as a primary focal point for all safety issues, coordinating and conducting training and inspections, identification and abatement of hazardous conditions, and promoting safety throughout the WAWSC. Personnel who have questions or concerns pertaining to safety, or who have suggestions for improving some aspects of safety, should direct those questions, concerns, and (or) suggestions to their immediate supervisor or the Safety Officer, as appropriate.

Guidelines pertaining to safety in field activities are provided in chapter A9 of the National Field Manual (Lane and Fay, 1997).

8.5 References Used for Sample Collection and Processing Section

Table 8.5 lists reports, web pages, and memoranda referred to in this section. For a complete citation, refer to Section 13.1 of the report.

Table 8.5. Summary of references used for collecting and processing water-quality samples.

[Abbreviations: NAWQA, National Water Quality Assessment program; USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; ppb, parts per billion]

Reference	Subject
ASTM D3977-97 (2007), Standard test method for determining sediment concentration in water samples: ASTM International, 6 p.	ASTM standards.
Crawford and Luoma, 1994	Collecting samples of contaminants in tissue (NAWQA).
Cuffney and others, 1993	Collecting benthic invertebrate samples (NAWQA).
Delzer and McKenzie, 2003	Five-day biochemical oxygen demand
Dossett and Bowersox, 1999	Precipitation
Edwards and Glysson, 1999	Representative sampling techniques for surface water.
Guy, 1969	Laboratory theory and methods for sediment analysis.
Horowitz and others, 1994	Protocol for collecting and processing inorganic constituents at ppb concentrations.
Knott and others, 1993	Quality-assurance plan for collecting and processing sediment data.
Koterba and others, 1995	Collecting and processing ground-water samples (NAWQA).
Lane and Fay, 1997	Safety in field activities.
Lane and others, 2003	Selection of equipment used to collect and process water-quality samples.
Meador and others, 1993a	Characterization of streambed habitat (NAWQA).
Meador and others, 1993b	Collecting fish samples (NAWQA).
Myers and Wilde, 2003	Collecting biological samples.
OSW Memorandum 93.01 (USGS)	Instrumentation and field methods for collecting suspended-sediment data.
OWQ Memorandum 97.06 (USGS)	Comparison of splitting capabilities of the churn and cone splitters.
Peden and others, 1986	Procedures for collecting precipitation samples, recommended by USEPA.
Porter and others, 1993	Collecting algal samples (NAWQA).
Radtke, 2005	Collecting and processing bottom-sediment samples.
Shelton and Capel, 1994	Collecting and processing streambed-sediment samples (NAWQA).
Stanley and others, 1992	National field quality-assurance program.
U.S. Geological Survey, 2006	Collecting water-quality samples from surface and ground water.
Ward and Harr, 1990	Representative sampling techniques for surface water.
Wilde, variously dated	Field measurements.
Wilde, 2004	Cleaning equipment used to collect and process water-quality samples.
Wilde and others, 2004	Processing water-quality samples.
Willoughby, 1995	Case study discussing methods of precipitation sampling and analysis.

9.0 Water-Quality Sample Handling and Tracking

All water-quality samples must be uniquely identified, documented, handled, shipped, and tracked appropriately. Following proper protocols for sample handling, shipping, and tracking ensures that samples are processed correctly and expeditiously to preserve sample integrity between the time of collection and the time of analysis. This section describes the procedures used by the WAWSC for handling, shipping, and tracking samples from collection through transfer of the samples to an analytical facility. Receipt of analytical data from laboratories is covered in Section 10.0 (Water-Quality Data Management).

9.1 Preparation for Sampling

Ensuring that field personnel have the correct equipment and supplies on hand to perform the necessary sampling activities saves time and labor costs associated with repeated sampling trips that result from inadequate planning. Therefore, before commencing field activities, the Field Office or Project Chief is responsible for ensuring that the following preparations have been completed:

- Review the sampling instructions for each site and the list of sample types required.
- A field folder must be compiled with pertinent information for the site, including appropriate field sheets.
- Ensure that the station site file is current.
- Prepare bottle labels for samples.
- Obtain field sheets or notebooks and analytical services request forms (ASRs).
- All personnel must use a checklist in preparing for a trip to ensure field preparedness. Backup instrumentation, extra probes and batteries should be part of the checklist.
- Ensure that necessary supplies are available, such as bottles, standards, filters, preservatives, meter batteries, waterproof markers, shipping containers, etc. (see Section 5.1.2 (Equipment and Supplies).
- Ensure that all sampling equipment is thoroughly cleaned and prepared.
- Check meters and sensors for proper performance.

9.2 Onsite Sample Handling and Documentation

During a sampling trip, it is imperative that accurate notes be taken and that sample bottles be labeled and handled appropriately for the intended analysis. Otherwise, bottle mix-ups or other errors may occur, and the samples may be wasted. Field personnel are responsible for ensuring that all of the following sampling requirements are implemented (Wilde and others, 2004):

- Label each bottle with the site identification, date and time of sample collection, bottle type, and lab codes (if necessary), using a permanent, waterproof marker or preprinted labels that will remain securely adhered to the bottle, even when wet.
- Field sheets are completed before leaving the site, including any instrument calibration information and documentation of all sampling circumstances and any deviation from normal protocol.

9.3 Sample Shipment and Documentation

Upon completion of a sampling trip, samples should be packaged and shipped to the laboratory for analysis as soon as possible. Generally, the shorter the time between sample collection and processing and sample analysis, the more reliable the analytical results will be. Before shipping samples to the laboratory, field personnel should complete the following:

1. Check that sample sets are complete and that sample bottles are labeled correctly, with all required information (see Section 9.2).
2. Complete the ASRs for all samples being sent to the NWQL. If samples are being sent to a different, approved laboratory, information similar to that required on the ASRs should be provided to the laboratory.
3. Pack samples carefully in shipping containers to avoid bottle breakage, shipping container leakage, and sample degradation. Check that bottle caps are securely sealed.
4. Line all shipping containers, including those without ice, with doubled heavy-duty plastic bags.
5. Follow the packing and shipping protocols established by the USGS and the receiving laboratory. Refer to NWQL Technical Memorandum 02.04 and chapter A5 of the National Field Manual (Wilde and others, 2004) for additional information. USGS employees can access NWQL Rapi-Notes 01-013, 01-023, 01-033, 01-0034, 02-015, 02-018, 02-020, 03-020, 03-032, and 03-041.
6. Ship samples on the same day as collected, whenever possible.

9.4 Sample Tracking Procedures

The Field Office or Project Chief maintains a record of all samples collected and shipped to a laboratory for analysis to ensure the complete and timely receipt of analytical results. Field personnel have the responsibility for recording the required information. The Field Office or Project Chief (or designee) has responsibility for reviewing the tracking log to determine if analyses are missing and for taking corrective action(s) if necessary. The following is a summary of the WAWSC tracking system:

- Field office or project personnel are to complete the NWIS login procedure within 10 days of sampling (1) to determine if site-file records are available for sites sampled; (2) to facilitate the entry of new sites into NWIS; and (3) to facilitate the efficient entry of NWQL analytical data into NWIS. The Project or Field Office Chiefs will ensure that samples are logged into NWIS immediately after samples are shipped to the NWQL. Field data will usually be entered at this time.

- The project or Field Office Chief (or designee) will keep track of the status of completion of water-quality analyses to ensure that analytical holding times are not exceeded and that necessary reruns are requested in a timely manner. The NWQL provides an online “Sample Status” report that is available to USGS personnel. See Section 10.2.2 for details.

- The Project or Field Office Chief (or designated personnel) will maintain files of original water-quality and sediment data. Sediment size and concentration data are analyzed by the Vancouver Sediment Laboratory. Data are retrieved periodically and manually entered into NWIS.

- Field Office or Project Chiefs and the Database Manager will keep an electronic file of NWQL analyses until data can be verified (and corrected if necessary). Data that is rejected from NWIS (BADQW) will be corrected immediately and reloaded into NWIS. Hard-copy analyses of laboratory data will be kept in Field Office or WAWSC project files, along with field sheets and other original data, as described by the WAWSC files maintenance and disposition plan.

- Only data that has been published or reviewed by the Field Office or Project Chief and Water-Quality Specialist can be transmitted to the public or cooperators as certified data. Data that are not yet published, must be labeled as “Provisional—subject to revision”.

The Water-Quality Database Manager will regularly perform the following:

1. Ensure that the biweekly retrieval of analytical data from NWQL has run successfully, retrieving data and entering it into NWIS using the GETLAB and QWCARDSIN program. Data will be separated into analytical report (WATLIST) files for the primary and quality-assurance database as well as corresponding BADQW files for data which could not be entered into NWIS.

2. Split and distribute the WATLIST and BADQW files by project accounts. It is the responsibility of the Field Office or Project Chief, in consultation with the WAWSC Water-Quality Specialist, to determine if analytical reruns of constituents are required.

3. Compile a monthly report of necessary corrections to laboratory billings (charges to default overhead accounts or wrong projects) and provide the report to the WAWSC Budget Analyst and appropriate Field Office or Project Chiefs, along with instructions or indications for any adjustments that should be made in the billing details.

9.5 Chain-of-Custody Procedures for Samples

When chain-of-custody procedures are appropriate or required (for example, when data may be used in legal proceedings), the Field Office or Project Chief should establish, maintain, and document a chain-of-custody system for field samples that is commensurate with the intended use of the data. A sample is in custody if it is in actual physical possession or in a secured area that is restricted to authorized personnel. Every exchange of a sample between people or places that involves a transfer of custody should be recorded on appropriate forms that document the release and acceptance of the sample. Each person involved in the release or acceptance of a sample should keep a copy of the transfer paperwork. The Field Office or Project Chief, or designee, is responsible for ensuring that custody transfers of samples are performed and documented according to the requirements listed below:

- The means for identifying custody should be clearly understood (use of forms, stickers, etc.);

- Instructions for documenting the transfer of samples and the person responsible for this documentation must be clearly defined; and

- A plan must be in place for maintaining records in a specific location for a specific period of time (for example, in the site folder).

Because laboratories should have their own internal chain-of-custody requirements, it is probably not necessary to include information on their procedures. Individual projects may need laboratory chain-of-custody documentation, however, and this should be documented in the project workplan.

9.6 References Used for Sample Handling and Tracking Section

Table 9.6 lists reports and memoranda referred to in this section. For a complete citation, refer to Section 13.0 of the report.

Table 9.6. Summary of references used for handling and tracking water-quality samples.

Reference	Subject
Wilde and others, 2004	Processing water samples.
NWQL Rapi-Notes 01-013	Sample Shipping Reminder
NWQL Rapi-Notes 01-023	Shipping time-sensitive samples to the NWQL for radiochemical analysis
NWQL Rapi-Notes 01-033	Shipping Reminder from the Central Region Safety Officer
NWQL Rapi-Note 01-034	Update to 01-033, Safe Shipping Reminder
NWQL Rapi-Note 02-015	Change in Saturday Pick-up Instructions
NWQL Rapi-Note 02-018	Shipping schedule for Independence Day and Warm Sample Reminder
NWQL Rapi-Note 02-020	Warm samples and Labor Day Closure
NWQL Rapi-Note 03-020	NWQL Holiday Shipping schedule
NWQL Rapi-Note 03-032	FedEx tags on coolers
NWQL Rapi-Note 03-041	Sending hazardous samples to the NWQL

10.0 Water-Quality Data Management

Water-quality data that are collected for hydrologic investigations are recorded on paper and electronically. Data recorded on paper include chemical, physical, biological, and ancillary data collected in the field. This information is documented on standard USGS field forms (fig. 8.1.1) and stored in site files. Data recorded electronically include analytical results and continuous monitoring data transmitted over the computer network or stored by electronic data logger. Data recorded on paper and electronically typically are stored either in the NWIS QWDATA database or in NWIS-ADAPS database (Bartholoma, 1997). The NWIS is the storage medium for water-quality, streamflow, well, and water-use information collected by the USGS. Data that cannot be stored in these national databases may be stored in other databases, such as project databases.

10.1 Processing Data

Sampling information, field determinations, and ancillary information are recorded on a set of water-quality field notes that are considered original record. These data are combined with analytical data from the laboratory in computer data files and paper files.

10.1.1 Continuous Monitoring Data

Continuous monitoring data are water-quality records collected onsite by electronic sensors and data loggers. Two methods for electronically recording data are by (1) transmitting data from a remote location by satellite telemetry to a central location where they are recorded on magnetic tape, disk, or solid-state memory device, and (2) recording data at a remote location on a solid-state memory device. All sites for which data are transmitted by satellite telemetry are backed up with data stored on a solid-state memory device.

Initial data processing in the office is for the purpose of obtaining a copy of the original data for archiving (see Section 10.4). Data are not manipulated by the field instrument or a computer except to convert recorded signals into data in commonly used units or to display data in a convenient format. The transfer of data from the electronic storage medium to NWIS requires thorough checking to ensure that the data have transferred successfully or that as much data as possible have been recovered and errors identified (WRD Memorandum 87.085). Continuous water-quality data are processed as described by Wagner and others (2006). Data processing procedures for continuous monitors in the WAWSC are as follows:

- Data are downloaded to a field computer from the data logger at the field site and the data is graphically screened to detect any problems.
- Data are transferred from the field computer into the WAWSC database at the office., or in the case of real-time satellite telemetry, the data are processed through the real-time data collection system directly into the data base.
- A copy of the raw data file is permanently stored in the appropriate Field Office or Project directory, and this directory is backed up regularly according to WAWSC computer policy.
- A copy of the raw data is processed using DECODES to enter the data into an NWIS-compatible form, and the processed DECODES file is stored in NWIS.
- All data corrections are applied as described by Wagner and others (2006).
- A station analysis is written (or updated) annually to describe the instrumentation, methods, shifts, missing records, and record quality.
- The station analysis is filed with field notes and hard copy of the NWIS processing tables.

10.1.2 Analytical Data

Analytical data are results of field and laboratory chemical, physical, or biological determinations. Most water-quality samples are analyzed either in the field or at the NWQL. In some cases, samples may be analyzed by research laboratories or by laboratories outside of the USGS (see Section 4.1).

To enter analytical data into the NWIS database, a site identification number must first be assigned and entered into the WAWSC site file (see Section 7.2). Field measurements and NWIS fixed-value codes are entered into the NWIS database by field personnel as soon as possible after returning from the sampling field trip. The record number assigned by NWIS is recorded on the field form (fig. 8.1.1). Sample logging is required for data from the NWQL to successfully transfer the data into the database. Environmental sample data are entered into the WAWSC NWIS QWDATA database 01; QA data are entered into the WAWSC NWIS QWDATA database 02.

All data from the NWQL are electronically transferred to the appropriate WAWSC database by automatic batch jobs at least once per week. Electronic copies of the analytical reports (WATLISTs) are forwarded to Field Office or Project Chiefs by the WAWSC Water-Quality Database Manager for storage of hard copies in project files The NWIS QWDATA database receives daily incremental backup and weekly full backup.

Data analyzed by laboratories other than the NWQL must be entered into NWIS, if possible (Hubbard, 1992), and identified according to the analyzing laboratory and appropriate fixed-value codes and comments. Data entry is the responsibility of the Field Office or Project Chief, with the cooperation of the Water-Quality Database Manager. Data are entered and stored according to procedures already described for processing NWIS analytical data. Appropriate codes are used to identify the data as originating from non-USGS sources.

10.1.3 Non-National Water Information System Databases

Sometimes data collected by project personnel cannot be entered into the WAWSC NWIS QWDATA database because the data are proprietary (such as data collected for some military projects) or because NWIS cannot accept the type of data that are generated by the project (for example, taxonomic data). In these cases, project databases may be established to accommodate the data storage requirements and formats. Project databases that are the sole repository for project data should have a written procedure for data entry, storage, and long-term backup and archival. The Field Office or Project Chief, in consultation with the Water-Quality Database Manager, has the responsibility for developing and implementing management of project databases.

10.2 Validation (Records Review)

Data validation is the process whereby water-quality and associated data are checked for completeness and accuracy. Data validation is the responsibility of the Field Office or Project Chief (or designee). After validation, data records are finalized in the WAWSC database and the record is submitted to the Water-Quality Specialist (or designee) for approval prior to publication.

10.2.1 Continuous Monitoring Data

Records of continuous water-quality data for temperature, specific conductance, pH, dissolved oxygen, and turbidity are processed and reviewed as described by Wagner and others (2006). Following the entry of continuous monitoring data into NWIS, raw data or graphs of raw data are reviewed by field personnel for anomalous values, dates, and times, and preliminary updating is done. A second check of all data entry, computations, shifts, missing record, and deleted values is made by an experienced hydrographer, and the record is reviewed for accuracy and completeness by Field Office or Project Chief. Once the data are edited, the record is submitted to the WAWSC Water-Quality Specialist (or designee) for final review and approval.

10.2.2 Analytical Data

All field notes and field measurements are reviewed for completeness and accuracy within 7 days or as soon as possible after returning from the field trip by the Field Office or Project Chief or designated personnel. All chemical analyses are reviewed for completeness, and questionable values are noted. Prompt review is necessary to allow analytical re-analysis to be performed before sample holding times have been exceeded. Project and Field Office personnel will perform a first-level review of analytical data. Every data analysis entered into NWIS QWDATA results in output (WATLIST) that includes a copy of the analysis and a report of general validation checks, including but not limited to the following:

- Comparison of determined and calculated values for dissolved solids,
- Comparison of dissolved constituents and total constituents,
- Comparison of specific conductance with dissolved solids,
- Comparison of constituents with relevant Federal drinking-water standards, and
- Comparison of sum of cations with sum of anions (ion balance).

Field and laboratory analyses, such as pH, specific conductance, and alkalinity, are compared to confirm agreement of independent measurements. If data from more than one sample are available for a site, the analysis also is compared with previous analyses within a hydrologic context to identify any obvious errors, such as decimal errors, and possible sample mix-ups or anomalies warranting analytical re-analysis. Additional graphical tools that can assist the data review process are:

- Time-trend plots of concentrations
- Plots of discharge versus analyte (concentration)
- Boxplots of analyte concentrations or physical properties, and
- Regressions of field parameters against major ion concentrations.

These reports and comparisons are reviewed and noted on the analytical report (WATLIST). If necessary, corrections or re-analysis may be requested by the Field Office or Project Chief or designated personnel. Additional resources for review and interpretation of analytical data are:

1. Methods for determination of inorganic substances in water and fluvial sediments (Fishman and Friedman, 1989);
2. Standard methods for the examination of water and wastewater (American Public Health Association, 1998);
3. Quality assurance practices for the chemical and biological analyses of water and fluvial sediments (Friedman and Erdmann, 1982); and
4. Study and interpretation of the chemical characteristics of natural water (Hem, 1985).
5. Quality control sample design and interpretation (USGS Training course QW2034TC)
6. Water Quality data toolbox for NWIS users (USGS Training course QW1297TC)

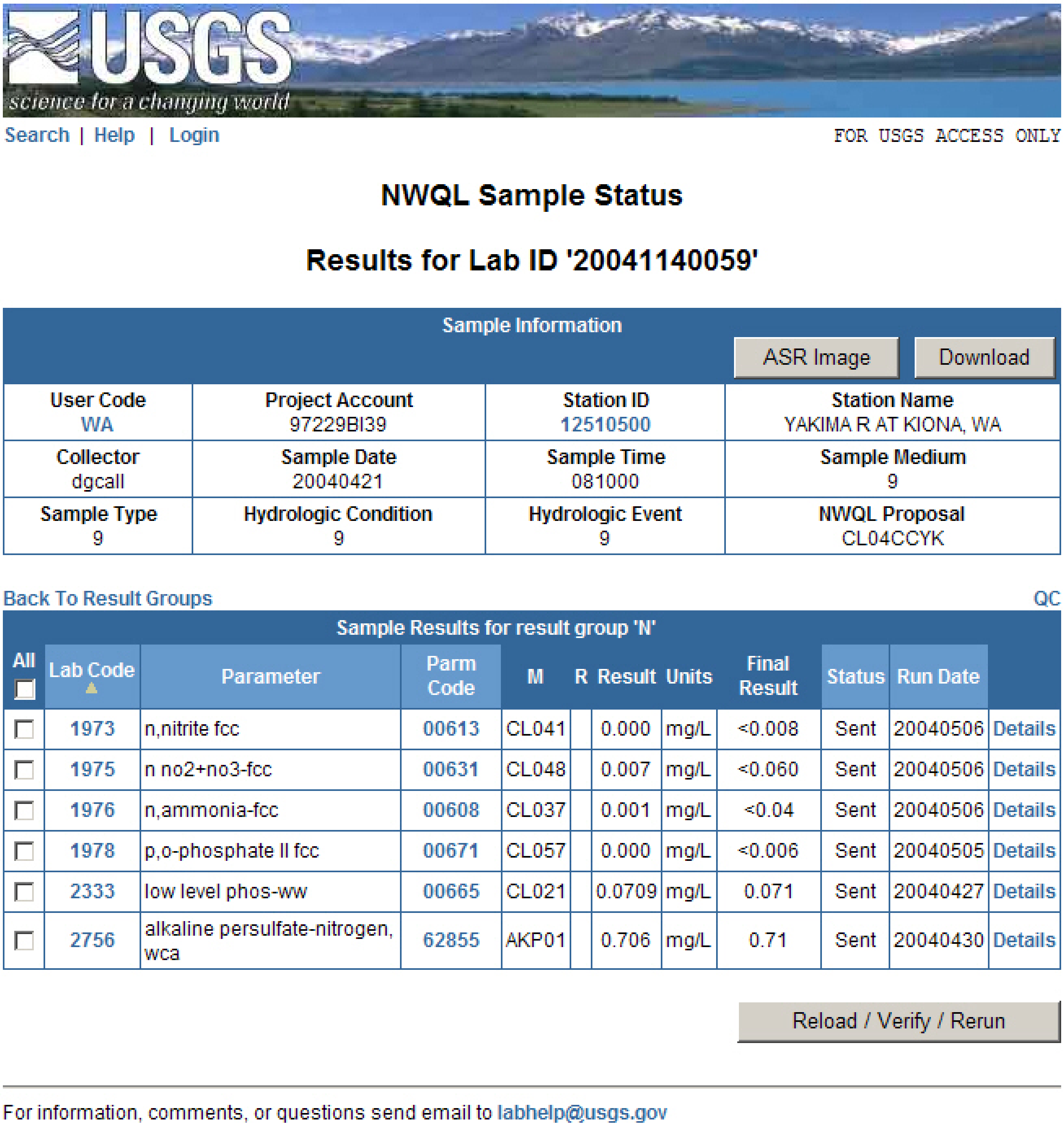
Requests to the NWQL for re-analysis, confirmation, or reload are made by USGS employees through the NWQL "Sample Status" (fig. 10.2.3). Re-analysis (if possible), verifications, or sample reloads can be requested from this page. Requests for re-analysis are the responsibility of the Field Office or Project Chief, but are commonly made by designated field office or project personnel. Notification of re-analysis requests and results should also be sent or forwarded to the WAWSC Water-Quality Database Manager.

Re-analysis requests are logged and tracked by recording the pertinent information in a spreadsheet for rerun analysis information (fig. 10.2.2). All re-analysis requests and results should be recorded in the annual station analysis. Corrections to NWIS resulting from reruns by the NWQL must be made to the laboratory database as well as to the WAWSC database. These corrections are initiated by e-mail request to LabHelp (labhelp@usgs.gov) from the Field Office or Project Chief (or designee) requesting an update to the laboratory database and subsequent NWIS reload of data. Policies for reanalysis with other laboratories should be stipulated in the laboratory contract. Project QC data, such as blanks, replicates, blind standards, and matrix spikes, periodically are tabulated or graphed by the Project Chief to facilitate identification of inaccuracies or systematic bias that may not be discernible when reviewing an individual analysis. If upon review of data by the Project Chief, it is discerned that environmental samples may have been contaminated, the environmental data should be remarked with a V-code as described by (OWQ Memorandum 97.08). The Data Quality Indicator (DQI) describes the review status of a result, the ability of a batch input program to overwrite a value, and affects the inclusion of a result in output as described in OWQ Memorandum 2002.15 and QWDATA documentation, section 2. The default DQI for individual sample results is "presumed satisfactory", but review by the Project or Field Office Chief may lead to the conclusion that analytical result(s) should be rejected. In such cases, the DQI may be set to "reviewed and rejected." No data are deleted from the database without the consent of the WAWSC Water-Quality Database manager and Water-Quality Specialist.

All personnel responsible for sample collection and field analysis participate in the NFQA Program and process an equipment blank once per year. WAWSC QC data, including NFQA sample results and annual equipment blanks, are reviewed by the WAWSC Water-Quality Specialist.

Date requested	Lab ID number	Station number	Date	Time	Parameter number	Parameter name	Old value	New value	Update No update/ Delete

Figure 10.2.2. Example of re-analysis request tracking form.



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NWQL Sample Status

Results for Lab ID '20041140059'

Sample Information			
			ASR Image Download
User Code WA	Project Account 97229BI39	Station ID 12510500	Station Name YAKIMA R AT KIONA, WA
Collector dgcall	Sample Date 20040421	Sample Time 081000	Sample Medium 9
Sample Type 9	Hydrologic Condition 9	Hydrologic Event 9	NWQL Proposal CL04CCYK

Back To Result Groups

QC

Sample Results for result group 'N'

All	Lab Code	Parameter	Parm Code	M	R	Result	Units	Final Result	Status	Run Date	
	1973	n,nitrite fcc	00613	CL041		0.000	mg/L	<0.008	Sent	20040506	Details
	1975	n no2+no3-fcc	00631	CL048		0.007	mg/L	<0.060	Sent	20040506	Details
	1976	n,ammonia-fcc	00608	CL037		0.001	mg/L	<0.04	Sent	20040506	Details
	1978	p,o-phosphate II fcc	00671	CL057		0.000	mg/L	<0.006	Sent	20040505	Details
	2333	low level phos-ww	00665	CL021		0.0709	mg/L	0.071	Sent	20040427	Details
	2756	alkaline persulfate-nitrogen, wca	62855	AKP01		0.706	mg/L	0.71	Sent	20040430	Details

Reload / Verify / Rerun

For information, comments, or questions send email to labhelp@usgs.gov

Figure 10.2.3. Example of the web interface National Water Quality Laboratory Rerun Request form.

10.3 Data Storage

In accordance with WRD policy, all water data collected as part of routine data collection by the WRD are stored in the NWIS computer database. Data collected by others, such as cooperators, universities, or consultants, which are used to support published USGS documents and are not published or archived elsewhere, also should be entered into NWIS; however, these data must be flagged with the appropriate DQI code and identified according to analytical laboratory and collection organization. Other outside data may be entered into the database at the discretion of the WAWSC Water-Quality Specialist if data-collection methods and quality have been reviewed and found acceptable. Electronically stored data that cannot be entered into NWIS are stored in project databases online or offline. The Database Administrator has responsibility for maintaining backups of data stored electronically in NWIS or online. Data stored electronically offline are maintained by the Field Office or Project Chief.

In addition to electronically stored data, other project data and information, including field notes, ASRs, WATLISTs, NWIS primaries, station descriptions, and station analyses are retained in station folders and maintained by the Field Office or Project Chief or designee while the project is active.

10.4 Records Archival

According to WRD policy, all original data that are published or that support published scientific analyses shall be placed in archives (WRD Memorandum 92.059; Hubbard, 1992). Original data—from automated data-collection sites, laboratories, outside sources, and non-automated field observations—are unmodified data as collected or received and in conventional units (engineering units, generally with a decimal). Original data should be preserved in this form, no matter how they may be modified later (Hubbard, 1992). Original data on paper include field notes, field measurements, ASRs, WATLISTs, continuous water-quality monitoring records, and calibration notes. These data are archived according to the WAWSC Files Maintenance and Disposition plan. It is the responsibility of the Field Office or Project Chief to ensure that project files entered into the WAWSC archive are organized and complete.

10.5 References Used for Water-Quality Data Management Section

Table 10.5 lists reports, web pages, and memoranda referred to in this section. For a complete citation, refer to Section 13.1 of the report.

Table 10.5. Summary of references used for managing water-quality data and records.

Reference	Subject
American Public Health Association, 1998	Standard methods for the examination of water and wastewater,
Bartholoma, 1997	NWIS ADAPS user's guide, Open-File Report 97-635
Fishman and Friedman, 1989	Methods for determination of inorganic substances in water and fluvial sediments: Techniques of Water-Resources Investigations of the U.S. Geological Survey, Book 5, Chapter A1, 545 p.
Friedman and Erdmann, 1982	Quality assurance practices for the chemical and biological analyses of water and fluvial sediments
Hem, 1985	Study and interpretation of the characteristics of natural water
Hubbard, 1992	Policy recommendations for managing and storing hydrologic data.
OWQ Memorandum 2002.15	Use of the new data-quality-indicator (DQI) field in NWIS 4_1.
WRD Memorandum 87.085 (USGS)	Policy for collecting and archiving electronically recorded data.
WRD Memorandum 92.059 (USGS)	Policy for the management and retention of hydrologic data.
OWQ Memorandum 97.08	Policy for use of V remark code.
Wagner and others, 2006	Guidelines and standard procedures for continuous water-quality monitors

11.0 Publication of Water-Quality Data

Water-quality data are published in hydrologic data reports, interpretive reports, or on NWISWeb (http://waterdata.usgs.gov/wa/nwis/qw). The selection of the appropriate publication outlet for water-quality data will be the responsibility of the Field Office or Project Chief. A summary of USGS and WRD policies pertaining to the publication of data and interpretive reports is contained in the WRD Publications Guides (Alt and Iseri, 1986, p. 382-385; U.S. Geological Survey, 1995). Other references that should be consulted when writing reports include "Suggestions to Authors ..." (Hansen, 1991) and the U.S. Government Printing Office Style Manual (U.S. Government Printing Office, 2000).

The report review process in the WAWSC includes the following steps: (1) supervisor's review for technical and editorial adequacy and readiness for technical review; (2) technical review for technical adequacy by two colleague reviewers (generally outside of WAWSC); (3) editorial review for adequacy of organization, rhetoric, grammar, audience level, consistency, and for verification; (4) Report Specialist review for completeness, adherence to policy, and readiness for approval; and (5) WAWSC Director's review for approval of non-interpretive and data reports; or, forwarding to Western Region for approval of interpretive reports.

11.1 Hydrologic Data Reports

All non-proprietary water-quality data collected during the water year are published in the WRD annual data report, "Water Resources Data, Washington", or in individual project data reports or publicly through a project website. Hydrologic data reports make water-quality data available to users, but without interpretations or conclusions. Approval of hydrologic data reports is by the WAWSC Director, as described in Office of Water Information Technical Memorandum 2003.01.

The review process for all data reports in the WAWSC includes the following steps: (1) raw data or graphs of raw data are reviewed by field personnel for completeness, anomalous values, dates, and times, and preliminary updating is done; (2) a second check of all data entry, computations, missing record, and deleted values is made by an experienced hydrographer; (3) the record is reviewed for accuracy, completeness, and readiness for technical review by the Field Office or Project Chief; (4) the record is submitted to the WAWSC Water-Quality Specialist for final review; and (5) final approval for publication by the WAWSC Director.

11.2 Interpretive Reports

Interpretive reports include such USGS outlets as Circulars, Professional Papers, Fact Sheets, Scientific Investigations Reports, Open-File Reports, and Data Series Reports, as well as non-USGS outlets, such as scientific journals, books, and proceedings of technical conferences. The WAWSC Water-Quality Specialist, project supervisor, and outside technical specialists will provide guidance in ensuring that each water-quality report meets the highest technical standards. Approval of interpretive reports is in accordance with applicable USGS policy.

11.3 Other Data Outlets

Article 500.14.1 of the Department of the Interior Geological Survey Manual (U.S. Department of the Interior, 1992) states that data and information are released through publications; however, publication is not limited to paper media (U.S. Department of the Interior, 1993). Electronic outlets include the internet (NWISWeb at http://waterdata.usgs.gov/wa/nwis/qw) and computer storage media, such as CDROM.

The term "data" refers to uninterpreted observations or measurements, usually quantitative measurements resulting from field observations and laboratory analyses of water, sediment, or biota. Data can be released to the public after preliminary review for accuracy by appropriate WRD personnel. Concentrations of constituents in water samples collected by or for the USGS that exceed USEPA drinking water maximum contaminant levels (MCLs), as specified in the National Primary Drinking Water Regulations, are promptly reported by the Field Office or Project Chief to appropriate agencies that have a need to know (WRD Memorandum 90.38).

The term "information" refers to interpretations of data or conclusions of investigations. Interpretive results or conclusions require colleague review and Director's approval for publication. Release of preliminary interpretations to the general public prior to final approval is prohibited to avoid disseminating incomplete or incorrect conclusions, which are subject to change as a result of subsequent technical and policy reviews.

11.4 References Used for Publication Section

Table 11.4 lists reports, web pages, and memoranda referred to in this section. For a complete citation, refer to Section 13.1 of the report.

Table 11.4. Summary of references used for managing water-quality data and records.

Reference	Subject
Hansen, 1991	Suggestions to authors of USGS reports.
U.S. Department of the Interior, 1992	Safeguard and release of USGS information.
U.S. Department of the Interior, 1993	Policy for release of computer databases and computer programs.
U.S. Geological Survey, 1995	Guidelines on writing hydrologic reports.
U.S. Government Printing Office, 2000	Style manual for printed government documents.
WRD Memorandum 90.038 (USGS)	Policy for reporting maximum contaminant level exceedances.
WRD Memorandum 92.005 (USGS)	Extended delegation of authority to approve reports of certain categories for open-file release.
WRD Memorandum 95.18 (USGS)	Redelegation of Director’s report approval authority to Regional Hydrologists.

12.0 Water-Quality Training and Reviews

Periodic reviews of data-collection procedures are used to evaluate the effectiveness of training programs and to determine if technical work is being conducted correctly and efficiently. Such reviews also are used to identify and resolve problems before they become widespread and potentially compromise the quality of the data.

12.1 Training

Employee training is an integral part of water-quality activities, allowing current employees to maintain and enhance their technical knowledge and new employees to gain the specific skills needed to adequately perform their job. A well-documented training program not only ensures that samples are collected correctly by technically competent personnel, but also lends legal credibility to data and interpretations. Training is accomplished according to the following policies and protocols.

Individual training plans are developed by the supervisor and employee at least annually as part of the performance review process. The WAWSC Training Officer is responsible for informing WAWSC staff about the availability of training—in-house, USGS, U.S. Government, and other sources. The WAWSC Water-Quality Specialist provides recommendations and advice to supervisors and their staff as needed. The WAWSC Director has authority and responsibility for approving training opportunities. In addition, staff are responsible for taking full advantage of the training provided.

Primary sources of water-quality training are USGS courses, usually taught at the National Training Center at the Denver Federal Center; Regional training; cyber seminars, and WAWSC seminars or in-house training courses. The WAWSC Water-Quality Specialist plays an important role in providing in-house training. Training documents are maintained by the Training Officer in WAWSC personnel files and by the Personnel Office in Western Region.

12.2 Reviews

Reviews of water-quality data-collection activities are conducted upon request by the Project or Field Office Chief for each project actively involved in water-quality data collection. Reviews are conducted in the field or laboratory by the WAWSC Water-Quality Specialist.

Reviews are completed in a timely manner, and comments are documented by the reviewer in a memorandum to the immediate supervisor with a copy to the employee and the WAWSC Director. Reviews address sample collection and processing techniques, compliance with WRD, OWQ, and WAWSC policies, the condition of the work environment (for example, the field vehicle), and any other activities pertaining to the collection of high quality data. When deficiencies are noted, the reviewer, in consultation with the Water-Quality Specialist, is responsible for identifying corrective actions. The immediate supervisor is responsible for ensuring that, once identified, corrective actions are implemented and completed in a timely manner.

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13.1 USGS Memoranda Applicable to Water-Quality Activities

The following USGS memoranda are available electronically on the Internet at the following site address (URL) http://water.usgs.gov/admin/memo/.

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National Water-Quality Laboratory Memorandum 92.01, March 25, 1992, Availability of equipment blank water for inorganic and organic analysis.

National Water-Quality Laboratory Memorandum 02.04, September 23, 2002 Requirements for the Proper Shipping of Samples to the National Water Quality Laboratory

Office of Surface Water Technical Memorandum 93.01, October 8, 1992, Summary of documentation that describes instrumentation and field methods for collecting sediment data.

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Publishing Service Center, Tacoma, Washington
Bill Gibbs
Deb Grillo
Bobbie Jo Richey
Sharon Wahlstrom
Chet Zenone

For more information concerning the research in this report, contact the
Director, Washington Water Science Center
U.S. Geological Survey, 934 Broadway — Suite 300
Tacoma, Washington 98402
http://wa.water.usgs.gov

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