Quality-Assurance Plan for Water-Quality Activities in the Kentucky Water Science Center

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U.S. Geological Survey Water Resources Discipline

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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, a quality-assurance plan has been created for use by the Kentucky Water Science Center in conducting water-quality activities. This quality-assurance plan documents the standards, policies, and procedures used by the Kentucky Water Science Center 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 Water Science Center quality-assurance plans for surface-water and ground-water activities and to supplement the Kentucky Water Science Center 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 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 Kentucky Water Science Center are part of the overall WRD mission of appraising the Nation’s water resources.

To address quality-control issues that are 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 Water 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 use of prescribed guidelines and criteria for the implementing technically approved methods and policies. QA incorporates a comprehensive plan that outlines 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 obtain the required quality of data. QC consists of the application of technical procedures to achieve prescribed standards of performance and to document the quality of the data collected. QC 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 reviewing (1) the appropriate implementation of QA policies and procedures and (2) analyzing the QC data. Quality assessment encompasses both the 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 biological or physical conditions at a sampling site for a given point or period in time

Adequacy of the amount of data obtained to meet data objectives

1.1 Purpose and Scope

The purpose of this Water Science Center QA plan for water-quality activities is to document the standards, policies, and procedures used by the Kentucky Water Science Center 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 Water Science Center personnel who are involved in water-quality activities and as a resource for identifying memorandums, 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 Water Science Center 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 Kentucky Water Science Center QA plan for surface-water (Arvin, 1995) and ground-water activities and to supplement the Kentucky Water Science Center QA plan.

2.0 Organization and Responsibilities

QA 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 Kentucky Water Science Center organizational structure is similar to those of other Water Science Centers in the discipline, but different program requirements from one Water Science Center to another contribute to the uniqueness of these organizational structures. The following chart illustrates the organization of the Kentucky Water Science Center (fig.1).

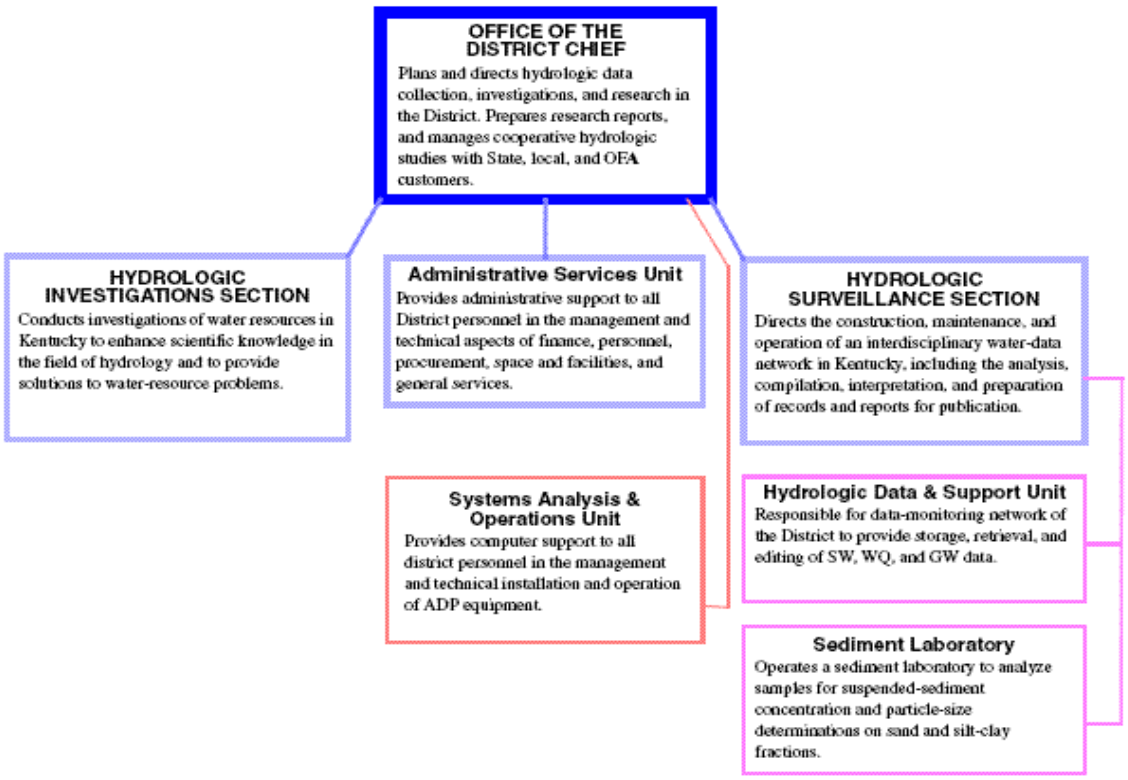


Figure 1. Kentucky District organizational chart, May 2003.

2.2 Responsibilities

The final responsibility for the preparation and implementation of and adherence to the QA policies that are described in this QA plan lies with the Water Science Center Director (Schroder and Shampine, 1992, p. 7).

Following is a list of responsibilities for selected Kentucky Water Science Center personnel who are involved in the collection, processing, storage, analysis, and publication of water-quality data:

The Water Science Center Director and designated management personnel are responsible for the following:

1. Managing and directing the Kentucky Water Science Center program, including designation of personnel responsible for managing all water-quality activities
2. Ensuring that water-quality activities in the Water Science Center meet the needs of the Federal government, the Kentucky Water Science Center, cooperating State and local agencies, and the general public
3. Ensuring that all aspects of this QA plan are understood and followed by Water Science Center personnel. This is accomplished by direct involvement of the Water Science Center Director or through clearly stated delegation of this responsibility to other personnel in the Kentucky Water

Science Center
4. Providing final resolution, in consultation with the Water-Quality Specialist, of any conflicts or disputes related to water-quality activities within the Water Science Center
5. Keeping subordinates briefed on procedural and technical communications from Northeastern Region and discipline offices
6. Participating in technical reviews of all water-quality programs on a quarterly basis
7. Ensuring that all publications and other technical communications released by Water Science Center personnel are accurate and comply with USGS policy

The Water Science Center Water-Quality Specialist or designated representative is responsible for the following:

1. Ensuring that water-quality activities in the Water Science Center meet the needs of the Federal government, the Kentucky Water Science Center, cooperating State and local agencies, and the general public
2. Preparing and implementing the Kentucky Water Science Center water-quality QA plan
3. Ensuring that all aspects of this QA plan are understood and followed by Water Science Center personnel; this is accomplished by direct involvement of the Water-Quality Specialist
4. Keeping Kentucky Water Science Center personnel briefed on procedural and technical communications from Northeastern Region and discipline offices
5. Participating in technical reviews of all Water Science Center water-quality programs on a quarterly basis
6. Ensuring that all publications and other technical communications released by the Water Science Center that relate to and include water-quality information are accurate and comply with USGS policy
7. Ensuring that the Kentucky Water Science Center QA plan is reviewed and revised at least once every 3 years to document current responsibilities, methodologies, and ongoing procedural improvements
8. Ensuring that the Kentucky Water Science Center Chemical Hygiene Plan (U.S. Geological Survey Manual 445-1-H and 445-2-H) is reviewed and revised every year to document the chemical inventories in the Kentucky Water Science Center water-quality and sediment laboratories

The Project Chief is responsible for the following:

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 Kentucky Water Science Center, 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. Obtaining guidance, as appropriate, for project QA/QC activities from the Water Science Center Water-Quality Specialist
5. Ensuring that QA/QC activities are properly carried out by the project staff

The Data Base Manager is responsible for the following:

1. Maintaining the Kentucky Water Science Center data bases including GWSI, ADAPS, and QWDATA
2. Creating site files, entering data, processing incoming sampling results, and tracking data from NWQL, Ocala Water Quality and Research Laboratory (OWQRL) in Ocala, Fla., and USGS approved outside laboratories
3. Answering requests for data from Kentucky Water Science Center staff, other USGS personnel, other governmental entities, and the public

2.3 References Used for the Organization and Responsibilities Section

The following table lists reports and (or) memorandums referred to in this section. For a complete citation, refer to Section 13.0 in this plan.

Table 1. Summary of references for organization and responsibilities related to quality assurance

Reference	Subject
Schroder and Shampine, 1992	Guidelines for preparing a QA plan
Shampine and others, 1992	Integrating QA into project work plans

3.0 Program and Project Planning

The Water Science Center Director has primary responsibility for overall Water Science Center program planning and is responsible for ensuring that Water Science Center projects are supportive of Water Science Center and national priorities. All water-quality projects require review and approval prior to the commencement of work. QA 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 Kentucky Water Science Center or cooperator, or other criteria as described in Shampine and others (1992).

3.1 Project Proposals

Project proposals are developed at the local level in response to requests by cooperating agencies, needs recognized by the WRD in working closely with other agencies or national programs. Water Science Center proposals conform to the format required by the WRD Memorandum 2000.04.

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) relevance and benefit statement, and (4) define the approach— how work will be done to accomplish the objectives. The approach consists of a detailed outline of data-collection activities to be carried out (if new data are needed), QA plans, QC information needed, and analytical techniques to be used. Project report plans, cost estimates, time schedules, and personnel requirements also are addressed. Consultation with regional and discipline 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 Water Science Center discipline specialists, the Administrative Officer, the Assistant Water Science Center Directors, and the Water Science Center Director. Proposals may be sent to other Water Science Centers for review at the discretion of the Water Science Center Director. The Northeastern Region provides final review and approval of all project proposals.

3.2 Project Work Plan

The project chief prepares a detailed work plan that identifies all project work elements and the related technical methods and approaches that are necessary to satisfy project objectives. The work plan 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. Work plans for water-quality programs and projects, including programs and projects with water-quality components, should clearly state how the “Quality-Assurance Plan for Water-Quality Activities in the Kentucky Water Science Center" 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, a description of the sample types and their expected uses, and descriptions of laboratory tests.

Work plans also include a description of the design of QC sampling that is required to document bias and variability in the environmental data. The work plan 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).

Work plans state anticipated methods for data analysis and presentation, including report plans. Accurate cost estimates are needed for personnel, materials, and services related to planned completion dates for properly budgeting the project. Assuring the availability of project personnel is often difficult and can impose serious constraints on completing project tasks; therefore, Water Science Center 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.

3.3 Project Review

Project reviews are conducted quarterly by Kentucky Water Science Center management, technical advisors, or discipline specialists to ensure compliance with the project work plan or proposal. Project reviews are used to ensure that data collection, analysis, and reporting are being done in accordance with the work plan and with broader Water Science Center policies and requirements. QA activities with respect to project reviews are outlined in the next section.

3.3.1 Review Schedules

The Kentucky Water Science Center has developed and implemented a review schedule for evaluating the technical development and progress of water-quality programs and projects, such as quarterly reviews or the 10-, 40-, 70-percent (10/40/70) project-completion milestones. 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 QA, whereby problems and related issues are addressed as they arise.

3.3.2 Review Documentation

The Kentucky Water Science Center has developed a review template and method for documenting program and project reviews. The following information should be included in program and project review documentation:

- Date of review
- Type of review (quarterly, 10/40/70, discipline)
- Names of reviewers and (or) attendees
- Responses to recommended action items from the last review
- Status, plans, and problems with data collection, data analysis, and report writing
- Major findings
- Cooperator/customer contacts
- Project-related training needs
- Concerns or special issues
- Recommended follow-up or action items

The Water Science Center archives all review comments that address the presence or absence of project deficiencies, all actions or recommendations for fixing deficiencies, or documentation explaining why a fix cannot be made.

The Kentucky Water Science Center archives all review comments that address the presence or absence of project deficiencies, all actions or recommendations for fixing deficiencies, or documentation explaining why a correction cannot be made. The files relating to review documentation are maintained by the Water Science Center Director's Secretary and are stored in the filing cabinet in the Secretary's office.

3.4 References Used in the Program and Project Planning Section

The following table lists reports and (or) memorandums referred to in this section. For a complete citation, refer to Section 13.0 in this plan.

Table 2. Summary of references for program and project planning

Reference	Subject
Mueller and others, 1997	Example of QC sample design used by NAWQA for surface-water sampling
Shampine and others, 1992	Integrating QA into project work plans

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 National Water Quality Laboratory (NWQL) was established as the laboratory to meet the needs of the WRD, and it is the required laboratory for use in all WRD national water-quality programs (WRD Memorandum 92.036). However, there are conditions for selecting a laboratory other than the NWQL.

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 are generally exempt from approval requirements that other laboratories must meet (WRD Memorandum 92.035; OWQ Technical Memorandum 98.03). Water Science Center laboratories generally can be used when analyses must be done 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 Memorandum 98.03 (supersedes WRD 92.035), before any analytical data can be stored in the WRD National Water Information System (NWIS) data base (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 Water-Quality Specialist is responsible for assuring that all laboratories providing analytical services to the Water Science Center 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 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 Memorandum 98.05 (supersedes WRD 82.028) before the analytical data from this method are published and (or) stored in the USGS national data base.

2. Have standard operating procedures (SOP's) for analytical methods—All analytical methods must have documented SOP's 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 samples (see *http://btdqs.usgs.gov/srs/*).

4.2 Laboratories Used by the Kentucky Water Science Center

The laboratories used for analytical services by Kentucky Water Science Center projects that were not provided by the NWQL or the OWQRL are shown in table 3. The analyses provided, the dates used, and the person who has been the primary contact at the laboratory also are provided in the table. The USGS Reston and Menlo Park research laboratories are used to provide data for research purposes. These laboratories are generally exempt from approval requirements that other laboratories must meet (OWQ Technical Memorandum 2007.01).

Table 3. Laboratories used for Kentucky Water Science Center projects (2008)

Project	Analytical laboratory	Laboratory contact	Dates used
Various	USGS Reston isotope fractionation	Tyler Coplen	1980's to present
Various	USGS Menlo Park	Carol Kendall	1990's to present
Rock Creek	Kentucky Geological Survey	Henry Francis	Oct. 2001 to Sep. 2003 (in process of USGS-BQS approval, FY 2003)
Floyds Fork	Microbac Laboratories, Inc.	Ken Ford	May 2007 to present (in process of USGS approval, FY07 for *E. coli*)
Floyds Fork and Pennyroyal Nutrient Criteria	Kentucky Centralized Lab Facility	Gleason Wheatley	May 2007 to present

4.3 Documentation for Laboratories Used by the Kentucky Water Science Center

The methods used, laboratory QA plan, and QC program can be obtained from the laboratory contact list in table 3.

4.3.1 National Water-Quality Laboratory

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 USGS, USEPA, American Public Health Association, American Water Works Association, Water Environmental Federation, and ASTM. A list of some published reports on analytical methods currently used at the NWQL can be found at *http://owqrl.er.usgs.gov/*. Analytical methods from the USEPA that are currently used at the NWQL can be found at *http://www.epa.gov/epahome/publications.htm*. Analytical methods from the ASTM that are currently used at the NWQL can be found at *http://www.astm.org/*.
2. QA plan—The NWQL QA plan is contained in Pritt and Raese (1995). A copy of this report can be obtained by sending an e-mail request to *nwqlqc@usgs.gov*.
3. QC program—QC at the NWQL is monitored by three programs: (1) the internal blind-sample program, (2) the 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 *nwqlqc@usgs.gov*. Information about the external blind-sample program can be found at *http://btdqs.usgs.gov/bsp/Fact.Sheet.html.*
4. Performance evaluation studies and certification programs—The NWQL participates in performance evaluation studies and laboratory certification programs. Information on NWQL evaluation studies can be obtained at *http://wwwnwql.cr.usgs.gov/USGS/Performance/perf_eval.html*.
5. Laboratory reviews—External agencies and customer organizations audit the NWQL to assess analytical methods and QA/QC programs. Information on NWQL audits can be found by USGS employees on the World Wide Web inhouse home page *http://wwwnwql.cr.usgs.gov/USGS/Performance/perf_eval.html*.
6. Miscellaneous services—Information about and access to other services offered by the NWQL can be found at *http://wwwnwql.cr.usgs.gov/USGS/USGS_gen.html*. The services offered include but are not limited to the following:

    Biological unit
    Chain-of-custody procedures
    Contract services
    External performance evaluations
    Laboratory services catalogue
    Methods Research and Development Program
    Organic spike kits
    Publications
    QA of selected field supplies
    SPiN (schedules, parameters, and network record)
    Technical memorandums

4.4 References Used for the Water-Quality Laboratories Section

The following table lists reports and (or) memorandums referred to in this section. For a complete citation, refer to Section 13.0 of this plan.

Table 4. Summary of references for selecting and using water-quality laboratories

Reference	Subject
OWQ Technical Memorandum 98.03 (USGS)	Policy for the evaluation and approval of production analytical laboratories
Pritt and Raese, 1995 (NWQL)	QA/QC manual
WRD Memorandum 82.028 (USGS)	Acceptability and use of water-quality analytical methods
OWQ Technical Memorandum 98.05 and *http://btdqs.usgs.gov/srs/*	Policy for approval of all laboratories providing analytical services to the WRD for non-research purposes
WRD Memorandum 92.036 (USGS)	quality programs
WRD Memorandum 2000.02	Policy for the reimbursement of costs for QA and water-quality analytical laboratories

5.0 Field Service Units, Laboratories, and Field Vehicles

The Kentucky Water Science Center maintains laboratory facilities, such as Field Service Units, mobile labs, and field vehicles for use in preparing equipment for field activities, processing samples, performing sample analysis, and preparing samples for shipment to analytical laboratories. This section documents the Kentucky Water Science Center criteria for maintaining and operating these facilities.

5.1 Field Service Units and Laboratories

The KY Water Science Center "laboratory" system consists of a field services unit (FSU) in each of the WSC offices (Louisville, Paducah, and Williamsburg). The WSC Water-Quality Specialist has overall fiscal and operations responsibilities for the FSUs, and is actively assisted by a representative from each field office. Each FSU supports water-quality activities by providing space for certain equipment, field instrumentation checks/calibration, preparations for sample collection, and QA for these activities. The FSU maintains a supply of laboratory glassware, deionized water, and expendable supplies needed by field personnel for water-quality sample collection analysis.

5.1.1 Facility

The FSUs, contain laboratory benches, glassware, sinks, chemical storage cabinets, deionized water, and other equipment and instruments listed in table 5. A hydrologic technician in each field office has the responsibility for day-to-day maintenance of this unit, and QA of hand-held thermometers provided. The FSU in Williamsburg has not been involved with the collection of water-quality data and is virtually inactive. The FSUs are maintained in accordance with standards set forth in the Kentucky Water Science Center chemical-hygiene plan last updated in 2003-04 and Branch of Operations Technical Memorandum 91.01.

Table 5. Equipment and instruments provided by Louisville Field Preparation Laboratory and quality assurance

Laboratory equipment	Quality assurance
Refrigerator at 4°C	Temperature monitored approximately every 2 weeks
Fume hood	Checked annually
Supply of deionized water	Maintained per OWQ Technical Memorandum 92.01
Ventilated acid cabinets	[Not applicable]
Wash sink with drying rack	[Not applicable]
Metering pump, valveless, piston type	[Not applicable]
Hand-held thermometer	Calibrated per TWRI, Book 1, Chap. D1
Lab pH and specific conductance meter	Calibrated before and after each use

5.1.1.1 Procedures

The Louisville Field Preparation Laboratory is managed by the Laboratory Manager. This person is responsible for maintaining the laboratory space, supplies, and equipment listed above. The unit maintains QA records of laboratory equipment and supplies, such as calibration standards, chemical reagents, sample preservatives, and sample bottles that are provided to field personnel. The Water-Quality Specialist and project chiefs (or their designees) are responsible for repair and maintenance of project water-quality equipment and instruments. The Collateral Duty Safety Program Coordinator and the Collateral Duty Environmental Program Coordinator oversee the Kentucky Water Science Center waste-disposal practices to ensure that procedures are in compliance with State and Federal regulations. The unit operations comply with the Kentucky Water Science Center chemical-hygiene plan. The operation of the unit is reviewed annually by the Water-Quality Specialist and every 3 years by the OWQ.

5.1.1.2 Equipment and Supplies

It is the responsibility of project chiefs (or their designees) to order, store, and quality assure the following field equipment and supplies as needed by field personnel.

Table 6. Summary of information on supplies, equipment, and instruments in the Kentucky Water Science Center

Supplies, equipment, and instruments	Source and guidelines for QA	Responsible party
Sample bottles	Purchased from NWQL	WQ Specialist or project chief
Coolers/shipping containers	Purchased commercial suppliers	WQ Specialist or project chief
Sample preservatives	Purchased from NWQL or commercial supplier	WQ Specialist or project chief
pH calibration standards	Commercially prepared buffers, traceable to NIST Standard Reference Material	WQ Specialist or project chief
Specific conductance calibration standards	Purchased from NWQL	WQ Specialist or project chief
Blank water for QA	Purchased from NWQL	WQ Specialist or project chief
Deionized water	Made using deionizing columns as per OWQ Technical Memorandum 92.01	WQ Specialist or project chief
Sample filters	Purchased from NWQL.	WQ Specialist or project chief
Isokinetic water-quality samplers	Purchased from FISP	Project chief
Point samplers	Purchased from FISP	Project chief
Bailers, teflon	Purchased from commercial supplier using guidelines outlined in Koterba and others (1995)	Project chief or field person
Splitting devices	Purchased from FISP	Project chief
Pumps	Purchased from commercial supplier using guidelines	Project chief
Specific conductance meters	Purchased from commercial supplier	Project chief or field person
Dissolved oxygen meters	Purchased from commercial supplier	Project chief or field person
pH meters	Purchased from commercial supplier	Project chief or field person
Thermometers	Purchased from commercial supplier	Project chief or field person

5.2 Water-Quality Field Vehicles

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 Kentucky Water Science Center 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, 1997-present) for guidelines on procedures for collecting and processing water-quality data [USGS Techniques of Water-Resources Investigations (TWRI), Book 9, Chaps. A1-A9].
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 (Wilde and others, eds., 1998a, TWRI book 9, chap. A2.3) and include the following:

Materials used for cabinets, storage, and work surfaces must be easy to maintain, made up 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.

The project chiefs (or their designees) are responsible for vehicle maintenance, for maintaining the suitability of the vehicle for water-quality-sample collection, and for keeping the vehicle supplied.

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

The following table (table 7) lists reports and (or) memorandums referred to in this section. For a complete citation, refer to Section 13.0 in this plan.

Table 7. Summary of references for Field Service Units, laboratories, and field vehicles

Reference	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 District operations
Survey Manual 445-2-H, Chapter 21	Industrial Hygiene-Laboratory Protection Program
OWQ Technical Memorandum 92.06 (USGS)	Recommended guidelines for shipping samples to the NWQL
Wilde and others, eds., 1998a (National Field Manual, TWRI book 9, chap. A2.3)	Guidelines for field vehicles
29 Code of Federal Regulations (CFR), 1910-1450	Laboratory Chemical Hygiene Plan
USGS, 1997-present	National Field Manual for the Collection of Water-Quality Data chaps. A1-A9

6.0 WATER-QUALITY INSTRUMENTS

The Kentucky Water Science Center 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 Water Science Center should be selected based upon the specifications described in the USGS "National Field Manual for the Collection of Water-Quality Data" (TWRI book 9, chaps. A1-A9) and the requirements of the project. The Hydrologic Instrumentation Facility (HIF), which provides analyses of precision and bias for water-quality instruments, also should be consulted for recommendations when appropriate. Consultation with the Hydrologic Instrumentation Facility, the National Water-Quality Laboratory, and the Quality of Water Service Unit should be done if project personnel need assistance with the selection or use of equipment.

All instruments used by Kentucky Water Science Center personnel for water-quality measurements are to be properly operated, maintained, and calibrated. For correct operation of any field or laboratory equipment, the manufacturer’s operating guidelines should 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 5.0 of this QA plan.

Documentation of all calibration activities associated with water-quality-data collection is a critical element of the Water Science Center QA program. Calibration and maintenance records of field equipment, including the manufacturer, make, model, and serial or property number are to be kept. Information that is recorded on field sheets and (or) permanent log books are used for storing calibration information. Similar records for Kentucky Water Science Center laboratory equipment are to be kept by the Water-Quality

Specialist. 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 annually for completeness and accuracy by the Water-Quality Specialist.

Recommended procedures for the use of single or multiparameter continuous monitoring have been outlined in a report by Wagner and others, 2000. This document covers all aspects of such monitoring, including guidelines for site selection, installation, frequency of inspection and servicing, and documentation required. Site selection and installation are based on purpose of data collection. Installation guidelines are similar to those for selecting a gage site. The maintenance and servicing frequency is governed by the sensor stability. Inspection of the site includes (1) recording initial sensor reading, (2) servicing sensor; (3) recording "cleaned" sensor readings, and (4) recording final sensor reading. All information should be carefully noted on field sheets or in a field notebook.

Table 8 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 Kentucky Water Science Center.

6.1 Calibration of Water-Quality Instruments

Table 8 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 Kentucky Water Science Center.

Table 8. Summary of calibration information for water-quality instruments used to measure selected parameters in the Kentucky Water Science Center

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	Thermometers must be within 0.2 degrees Celsius of calibration at 3 points from 0 to 40 degrees Celsius, thermistors must be 5 points; if not, replace	Every 3-6 months using 2-points; annually using 5 points	Field personnel	Wilde and Radtke, eds., 1998 (TWRI book 9, chap. A6.1); see manufacturer's instructions
Specific conductance	At least two standards, bracketing expected values	Acceptable range is within 5 percent; if not then clean or replace probe	Daily in field, if appropriate, prior to taking measurements	Field personnel	Wilde and Radtke, eds., 1998 (TWRI book 9, chap. A6.3); see manufacturer's instructions
pH	Two-point calibration, bracketing expected values	Acceptable range, calculated slope must be within 5 percent of theoretical slope; if not, clean or replace probe	Daily in field, if appropriate, prior to taking measurements	Field personnel	Wilde and Radtke, eds., 1998 (TWRI book 9, chap. A6.4); see manufacturer's instructions

Dissolved oxygen	Air calibration in water for zero dissolved oxygen check	Acceptable range; zero should be <0.2 mg/L; +/- 0.3 mg/L is the stabilization criteria; if not, change membrane, batteries, or probe	Prior to taking measurements at each sampling site in field or laboratory, as appropriate	Field personnel	Wilde and Radtke, eds., 1998 (TWRI book 9, chap. A6.2); see manufacturer's instructions
Barometric pressure	Mercury barometer	Acceptable range is within 5 millimeters Hg; if not, replace	Annually	Field personnel	See manufacturer's instructions
Turbidity	Formazin calibration or other approved primary standard calibration	Acceptable range is within 5 percent or 2 NTUs; if not, clean or replace probe	Daily in field, if appropriate, prior to taking measurements	Field personnel	See manufacturer's instructions

6.2 References Used for the Water-Quality Instruments Section

The following table (table 9) lists reports and (or) memorandums referred to in this section. For a complete citation, refer to Section 13.0 in this plan.

Table 9. Summary of references for water-quality instruments

Reference	Subject
Wilde and Radtke, eds., 1998 (TWRI book 9, chap. A6)	Calibration of water-quality instruments
WRD Memorandum 95.35 (USGS)	Instrumentation plan for the WRD and the hydrologic field instrumentation and equipment policy and guidelines
USGS, 1997-present	National Field Manual for the Collection of Water-Quality Data, chaps. A1-A9
Wagner and others, 2006	Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Station Operation, Record Computation, and Data Reporting

7.0 Site Selection and Documentation

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

7.1 Site Selection

Site selection for sampling is important to the validity of water-quality data. Selection of a suitable site can be made only after considering a number of factors, including the need for information in a particular location, the suitability of a site for sampling, and its accessibility and safety. Specific guidelines for site selection are contained in Wilde and others, eds. (1998a, chap. A1). The project chief is responsible for the selection of sampling sites, after consultation with the Water-Quality Specialist and the Surface- 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 should be 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 may be difficult because of incomplete mixing. Under such conditions, the criteria for the minimum number of vertical transects sampled may need to be increased, and lateral mixing should be documented with cross-sectional surveys at various stages of flow.

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). If suitable existing wells cannot be found, new wells will need to be installed.

7.1.3 Other Sites

The selection of sites for lake and reservoir sampling is dependent on many variables, including project and sampling objectives, location, size, depth of lake or reservoir, accessibility, and safety. Specific guidelines for site selection are available in Ward and Harr, 1990, and Arvin, 1995.

Guidelines for selection and establishment of sites for wet and dry deposition can be found in the report documenting protocols for establishment of sites for the National Atmospheric Deposition Program (Dossett and Bowersox, 1999).

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 project chief and supervisor are responsible for assuring that the site file is maintained for each data-collection site. Archiving of this information is discussed in Section 10.4.

7.2.1 Surface Water

A station description is prepared for each water-quality station that is sampled on a regular or periodic basis. All continuous, daily, weekly, monthly, quarterly, and twice-yearly stations require a station description. All stations sampled on a seasonal or flow basis (flood, low-flow, or water-use basis) or some other basis where data are collected repeatedly and intended to be comparable. No description is required for one-time synoptic surveys, time-of-travel, or reconnaissance operations. These types of sampling can be adequately described in field notes and project reports. 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 National Water Information System (NWIS) software used by the Water Science Center. The minimum information required for establishing electronic files in NWIS for surface water is listed in table 1-1 in Wilde and others, eds. (1998a, chap. A1).

The following information is required for a water-quality station description:

Location: A brief description of the station location that is clear and concise so other persons can find the sampling site with little or no difficulty. Important geographic features should be included in the location. The name of the recent 7.5-inch topographic map should also be provided in the location of the station.

Sampling site: The site or cross-sections where samples are collected during low and high flow conditions for chemical quality, suspended sediment, bottom material, and biological material are adequately described. A sketch map showing pools, shoals, bottom material deposits, biological sampler supports, or other pertinent features is required.

Hydrologic characteristics: Runoff characteristics such as time, magnitude, and occurrence of flood and low flows are important to water-quality operations and should be noted. Climate, such as air temperatures, precipitation characteristics, freezing possibility, and other features are important for the record.

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 Water Science Center. The minimum information required for establishing electronic files in NWIS is listed in table 1-4 in Wilde and others, eds. (1998a, chap. A1). 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. The first page of the ground-water site schedule form for recording general site data is shown in figure 2. Additional guidelines are used for the National Water-Quality Assessment (NAWQA) program and are fully outlined in Lapham and others (1995).

7.2.3 Other Sites

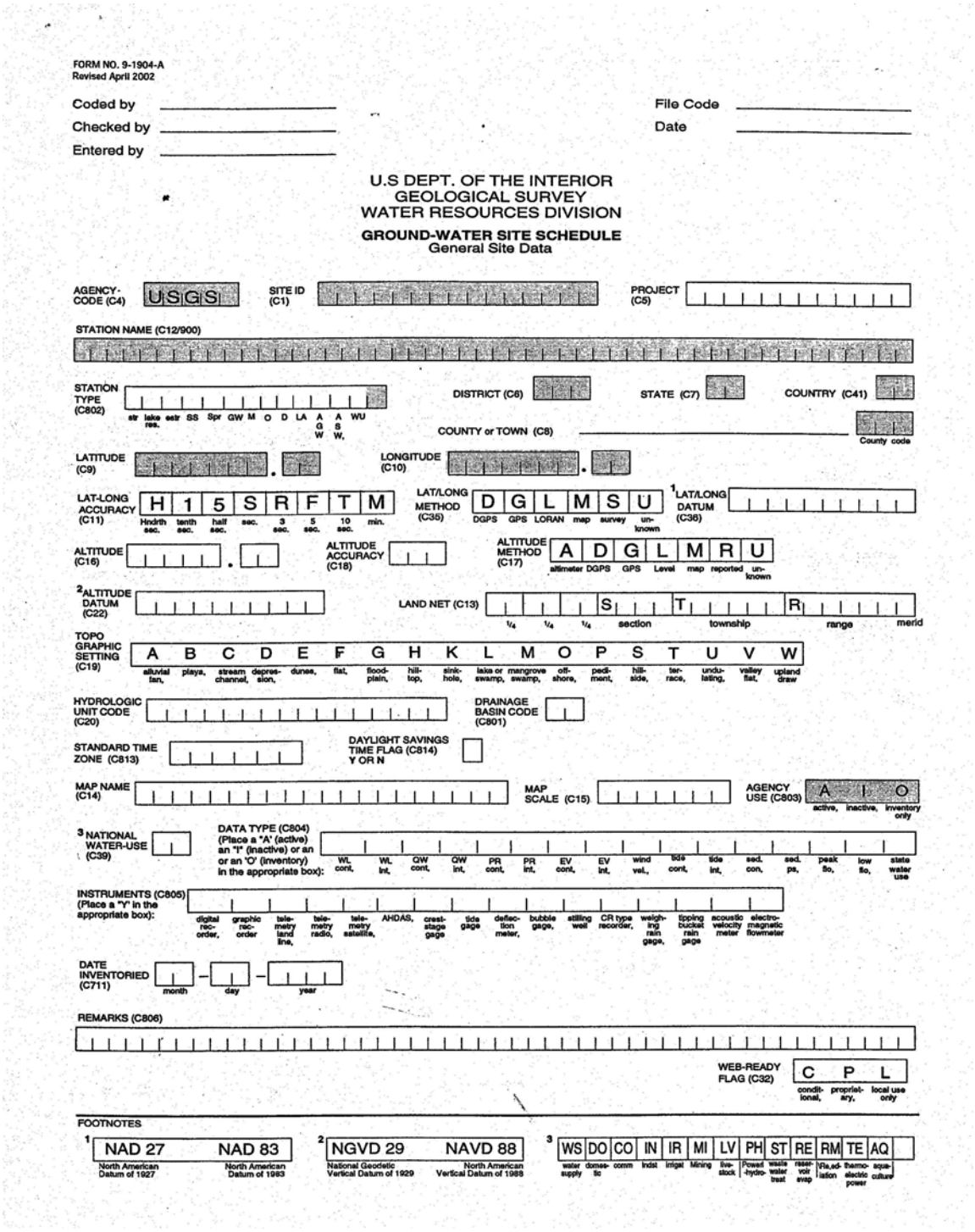
The site description for continuous water-quality monitor collection sites in lakes and reservoirs includes: location of station, station history, equipment used at the site, relation to adjacent benchmarks, cross-sectional measurements, purpose of site, maps, photographs, permits, and safety hazards (Wagner and others, 2006). Documentation of precipitation collection sites for the National Atmospheric Deposition Program is described in Dossett and Bowersox (1999). All sites established according to these guidelines are required to use specific monitoring and collection equipment.

7.3 References Used for the Site-Selection and Documentation Section

The following table (table 10) lists reports and (or) memorandums referred to in this section. For a complete citation, refer to Section 13.0 in this plan.

Table 10. Summary of references for site selection and documentation for water-quality programs

Reference	Subject
Dossett and Bowersox, 1999	National trends network site operation manual for the National Atmospheric Deposition Program
Lapham and others, 1995	Ground-water-data collection protocols and procedures for the NAWQA Program: Collection and documentation of water-quality samples and related data
Schroder and Shampine, 1995	Guidelines for documenting new water-quality data-collection sites
Wagner and others, 2006	Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Station Operation, Record Computation, and Data Reporting
Wilde and others, eds., 1998a (TWRI book 9, chap. A1)	Establishing electronic NWIS files for surface- and ground-water data



FORM NO. 9-1904-A
Revised April 2002

Coded by _____ File Code _____
Checked by _____ Date _____
Entered by _____

U.S DEPT. OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

GROUND-WATER SITE SCHEDULE
General Site Data

AGENCY CODE (C4) USGS | SITE ID (C1) | PROJECT (C5)

STATION NAME (C12/900)

STATION TYPE (C802): str, lake res., estr, SS, Spr, GW, M, O, D, LA, AGW, ASW, WU | DISTRICT (C6) | STATE (C7) | COUNTRY (C41)

COUNTY or TOWN (C8) | County code

LATITUDE (C9) | LONGITUDE (C10)

LAT-LONG ACCURACY (C11): H 1 5 S R F T M — Hndrth sec., tenth sec., half sec., sec., 3 sec., 5 sec., 10 sec., min.

LAT/LONG METHOD (C35): D G L M S U — DGPS, GPS, LORAN, map, survey, unknown

[1] LAT/LONG DATUM (C36)

ALTITUDE (C16) | ALTITUDE ACCURACY (C18)

ALTITUDE METHOD (C17): A D G L M R U — altimeter, DGPS, GPS, Level, map, reported, unknown

[2] ALTITUDE DATUM (C22)

LAND NET (C13): ¼ ¼ ¼ S section T township R range merid

TOPO GRAPHIC SETTING (C19): A B C D E F G H K L M O P S T U V W — alluvial fan, playa, stream channel, depression, dunes, flat, flood-plain, hill-top, sink-hole, lake or swamp, mangrove swamp, offshore, pediment, hillside, terrace, undulating, valley flat, upland draw

HYDROLOGIC UNIT CODE (C20) | DRAINAGE BASIN CODE (C801)

STANDARD TIME ZONE (C813) | DAYLIGHT SAVINGS TIME FLAG (C814) Y OR N

MAP NAME (C14) | MAP SCALE (C15) | AGENCY USE (C803): A I O — active, inactive, inventory only

[3] NATIONAL WATER-USE (C39)

DATA TYPE (C804) (Place a "A" (active) an "I" (inactive) or an or an "O" (inventory) in the appropriate box): WL cont, WL int, QW cont, QW int, PR cont, PR int, EV cont, EV int, wind vel., tide cont, tide int, sed. con, sed. ps, peak flo, low flo, state water use

INSTRUMENTS (C805) (Place a "Y" in the appropriate box): digital rec-order, graphic rec-order, telemetry land line, telemetry radio, telemetry satellite, AHDAS, crest-stage gage, tide gage, deflection meter, bubble gage, stilling well, CR type recorder, weighing rain gage, tipping bucket rain gage, acoustic velocity meter, electromagnetic flowmeter

DATE INVENTORIED (C711) – month – day – year

REMARKS (C806)

WEB-READY FLAG (C32): C P L — conditional, proprietary, local use only

FOOTNOTES

[1] NAD 27 (North American Datum of 1927) NAD 83 (North American Datum of 1983)

[2] NGVD 29 (National Geodetic Vertical Datum of 1929) NAVD 88 (North American Vertical Datum of 1988)

[3] WS DO CO IN IR MI LV PH ST RE RM TE AQ — water supply, domestic, comm, Indst, irrigat, Mining, livestock, Powerhydro, waste water treat, reservoir evap, Recreation, thermoelectric power, aquaculture

Figure 2. First page of ground-water site schedule form for recording field general site data.

8.0 Sample Collection and Processing

Water-quality data collected by the USGS are used by agencies throughout the 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 such Federal programs as the National Stream-Quality Accounting Network (NASQAN) and the 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 Kentucky Water Science Center.

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 nonrepresentative 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. Compliance with documented and technically approved sample-collection and processing protocols is therefore critical to ensuring the quality of water-quality data.

It is the policy of the Kentucky Water Science Center 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 Water Science Center personnel who are involved in water-quality sampling must be aware of changing requirements and recommendations. The Water-Quality Specialist or appropriate designee is responsible for providing current information to field personnel on the correct protocols to follow in collecting and processing water-quality samples.

8.1 Constituents in Water

Most studies designed to evaluate the water quality of an aquatic system are based upon analyses of physical and chemical parameters associated with the water. Physical parameters generally are measured in the field; whereas, most chemical parameters require laboratory analysis. This section of the QA plan includes an overview of relevant Kentucky Water Science Center 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 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 (Shelton, 1994; Koterba and others, 1995; and Francy and others, 1998). The project proposal and work plan 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 (E_h), and turbidity. Water Science Center procedures for collecting field measurements in surface- and ground-water systems are provided in Chapter A6 of the National Field Manual (Wilde and Radtke, eds., 1998). 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 must be 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 standardized forms (figs. 3 and 4) or customized for a particular project. The project

chief or their designee is responsible for reviewing field records for completeness. To avoid the loss of data because of possible instrument malfunction, the project chief or designee should ensure that backup sensors or instruments are readily available and in good working condition.

To document the quality of field measurements, all Water Science Center 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 Hydrologist and the Water Science Center Water-Quality Specialist and project chief. Staff receiving an unsatisfactory rating will need to recheck the conditions of equipment, including probes, batteries, and calibration techniques. An additional sample also can be requested from the NFQA program to recheck.

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 and others, eds., 1998b). 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 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, collected in the office laboratory, is required for each set of equipment used to collect water-quality samples (Horowitz and others, 1994; Wilde and others, eds., 1998b, chap. A3). 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 project chief and Water-Quality Specialist monitor the results of annual equipment blanks and ensure compliance with Kentucky Water Science Center standards.

November 2006

USGS

U. S. GEOLOGICAL SURVEY GROUND-WATER QUALITY NOTES FIELD ID _____

NWIS RECORD NO _____

Station No._____ Station Name _____ Field ID _____

Sample Date _____ Mean Sample Time (watch) _____ Time Datum _____ (eg. EST, EDT, UTC)

Sample Medium _____ Sample Type _____ Sample Purpose (71999) _____ Purpose of Site Visit (50280) _____ QC Samples Collected? Y N

Project No. _____ Proj Name_____ Project No. _____ Proj Name_____

Sampling Team _____ Team Lead Signature _____ Date _____

FIELD MEASUREMENTS

Property	Parm Code	Method Code	Result	Units	Re-mark Code	Value Quali-fier	Null Value Quali fier	NWIS Result-Level Comments
Water Level (see p. 8 for codes and units)								
Flow Rate	00059			gal/min				
Sampling Depth	78890 00003			ft blw msl ft				
Depth to top of sampling interval	72015			ft blw lsd				
Depth to bottom of sampling interval	72016			ft blw lsd				
Temperature, Air	00020	THM04 (thermistor) THM05 (thermometer)		°C				
Temperature, Water	00010	THM01 (thermistor) 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, incremental	00419	TT001		mg/L				
Alkalinity, filtered, incremental	39086	TT013		mg/L				
Carbonate, filtered, incremental	00452	TT019		mg/L				
Bicarbonate, filtered, incremental	00453	TT017		mg/L				
Hydroxide, filtered, incremental	71834	TT023		mg/L				
Turbidity [see attachment for codes]								
Redox potential (Eh)	63002			mvolts				
Hydrogen sulfide odor detected?	71875	SNIF1 (sniff test, acidified sample) SNIF2 (sniff test, unacidified sample)	#	Yes No	M detect U non-detect			Sample acidified beforehand? yes no
Hydrogen sulfide, unfiltered, measured	99119	ISE01 (electrode) KIT01 (Chemetrics) KIT02 (Hach)		mg/L				
Other								
Other								
Other								

SAMPLING INFORMATION

Parameter	Pcode	Value
Sampling Condition*	72006	
Sampling Method*	82398	
Sampler Type*	84164	
*see p. 8 for values		

Information

Sampler/Pump Type (make/model): _____

Pump/Sampler ID: _____

Sampler Material: stainless steel pvc teflon other _____

Tubing Material: teflon plastic tygon copper other_____

Filter type(s): capsule disc 142mm 25mm GFF membrane

COMPILED BY:_____ DATE _____ CHECKED BY:_____ DATE _____ LOGGED INTO NWIS BY: _____ DATE _____

Figure 3. Example first page of a field form for use in recording surface-water field measurements.

November 2006

USGS

U. S. GEOLOGICAL SURVEY GROUND-WATER QUALITY NOTES

FIELD ID _____

NWIS RECORD NO _____

Station No._____ Station Name _____ Field ID _____

Sample Date _____ Mean Sample Time (watch) _____ Time Datum _____ (eg. EST, EDT, UTC)

Sample Medium _____ Sample Type _____ Sample Purpose (71999) _____ Purpose of Site Visit (50280) _____ QC Samples Collected? Y N

Project No. _____ Proj Name_____ Project No. _____ Proj Name_____

Sampling Team _____ Team Lead Signature _____ Date _____

FIELD MEASUREMENTS

Property	Parm Code	Method Code	Result	Units	Re-mark Code	Value Quali-fier	Null Value Quali fier	NWIS Result-Level Comments
Water Level (see p. 8 for codes and units)								
Flow Rate	00059			gal/min				
Sampling Depth	78890 00003			ft blw msl ft				
Depth to top of sampling interval	72015			ft blw lsd				
Depth to bottom of sampling interval	72016			ft blw lsd				
Temperature, Air	00020	THM04 (thermistor) THM05 (thermometer)		°C				
Temperature, Water	00010	THM01 (thermistor) 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, incremental	00419	TT001		mg/L				
Alkalinity, filtered, incremental	39086	TT013		mg/L				
Carbonate, filtered, incremental	00452	TT019		mg/L				
Bicarbonate, filtered, incremental	00453	TT017		mg/L				
Hydroxide, filtered, incremental	71834	TT023		mg/L				
Turbidity [see attachment for codes]								
Redox potential (Eh)	63002			mvolts				
Hydrogen sulfide odor detected?	71875	SNIF1 (sniff test, acidified sample) SNIF2 (sniff test, unacidi-fied sample)	#	Yes No	M detect U non-detect			Sample acidified beforehand? yes no
Hydrogen sulfide, unfiltered, measured	99119	ISE01 (electrode) KIT01 (Chemetrics) KIT02 (Hach)		mg/L				
Other								
Other								
Other								

SAMPLING INFORMATION

Parameter	Pcode	Value
Sampling Condition*	72006	
Sampling Method*	82398	
Sampler Type*	84164	
*see p. 8 for values		

Information

Sampler/Pump Type (make/model): _____

Pump/Sampler ID: _____

Sampler Material: stainless steel pvc teflon other _____

Tubing Material: teflon plastic tygon copper other_____

Filter type(s): capsule disc 142mm 25mm GFF membrane

COMPILED BY :_____ DATE _____ CHECKED BY :_____ DATE _____ LOGGED INTO NWIS BY: _____ DATE _____

GW Form version 8.0

Figure 4. Example first page of a field form for use in recording ground-water field measurements.

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 Water Science Center personnel 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 (Wilde and others, eds., 1998a). Review of equipment selection by Kentucky Water Science Center technical specialists occurs during proposal and work plan 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 (Wilde and others, eds., 1999a). Field personnel are responsible for examining the sampling site carefully and choosing the most appropriate sampling method to generate the best 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. Dip samples from the centroid are acceptable when extreme flood or other conditions preclude the collection of the standard sample. Thorough documentation of sampling equipment and methods used is required in field records associated with water-quality samples. The project 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, or when aluminum, iron, or manganese ambient concentrations are up to about 200 micrograms per liter, as described by Wilde and others, eds. (1999a). The two-person sampling team protocol may be modified as appropriate for studies in which low-level trace elements are not measured.

Review of surface-water sampling procedures for each Water Science Center water-quality project is done at least annually by the Water-Quality Specialist. An independent review of field methods, for at least one Water Science Center project, is conducted once every 3 years during the Office of Water Quality Water Science Center technical review.

8.1.4 Ground-Water Sampling

Kentucky Water Science Center 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 the National Field Manual (Wilde and others, eds., 1998a, chap. A2). 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 made. Review of equipment selection occurs during proposal and work plan review and during periodic project reviews by Water Science Center 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 (Wilde and others, eds., 1999a). 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. However, exceptions to the three-well-volume rule can be made under some circumstances, depending upon project objectives or site characteristics. The 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 (Wilde and others, eds., 1999a, chap. A4, table 4-5), 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 trace elements with concentrations at or near 1 microgram per liter, or when aluminum, iron, or manganese ambient concentrations are up to about 200 micrograms per liter, as described by Wilde and others, eds. (1999a).

Review of ground-water sampling procedures for each Water Science Center water-quality project is performed at least annually by the Water-Quality Specialist. An independent review of field methods for at least one Water Science Center project is conducted once every 3 years during the Office of Water Quality Water Science Center technical review.

8.1.5 Precipitation Sampling

Specific procedures in the Kentucky Water Science Center 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 for the National Atmospheric Deposition Program
2. Peden and others (1986) for procedures for collecting precipitation samples recommended by the USEPA
3. Willoughby (1995) for a case study discussing methods of precipitation sampling and analysis

The project proposal and work plan 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 based upon the study objectives. For specific questions related to precipitation sampling that are not addressed by these references, contact the USGS coordinator for the National Atmospheric Deposition Program.

8.1.6 Sample Processing

All samples collected for water-quality analysis must be processed according to procedures in the National Field Manual (Wilde and others, eds., 1999b, chap. A5) 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 work plan.

All Kentucky Water Science Center water-quality studies that include the analysis of trace elements in concentrations less than 10 ppb must use the protocols for sample processing as described in Wilde and others, eds. (1999-2002). 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. Review of sample processing procedures for all water-quality projects occurs during proposal and work plan review and during periodic project reviews by the Water Science Center Water-Quality Specialist.

8.1.6.1 Sample Compositing and Splitting

Guidelines for using sample compositors and splitters are in the National Field Manual (Wilde and others, eds., 1998a, chap. A2). Two types of sample splitters presently 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 inorganic and organic constituents within the technical design limits of the device and as long as the equipment is constructed of appropriate materials (Capel and Larson, 1996)

8.1.6.2 Sample Filtration

Filtration is required for many water-quality samples 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, eds., 1998a, chap. A1). Guidelines for filtration procedures for specific constituent groups are provided in the National Field Manual (Wilde and others, eds., 1999b, chap. A5). For surface water, the most common filtration system consists of a reversible, variable-speed battery-operated peristaltic pump and 0.45-micron pore-size disposable capsule filter. For ground water, the sample is generally pumped directly from the well through a 0.45-micron pore-size disposable capsule filter. Filtration of samples for analysis of trace elements in concentrations less than 10 ppb must be done in a processing chamber that encloses the filtering unit and sample bottles in a protected environment (Wilde and others, eds., 1999-2002).

8.1.6.3 Sample Preservation

Sample preservation techniques are required for some constituent groups 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, eds., 1999b, chap. A5), and the NWQL Services Catalog (see section 4.3.1 for location). Since 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. For details on sample shipping requirements, refer to the next section of this plan. Procedures for shipping samples to the NWQL and ensuring samples arrive in good condition are described in Wilde and others, eds. (1999b, chap. A5).

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. A variety of different types of biological, sediment, and

radiochemical samples may be incorporated into a water-quality project in order 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 Water Science Center QA procedures and references for detailed instructions that describe the collection of biological, sediment, and radiochemical samples.

8.2.1 Biological Sampling

Kentucky Water Science Center water-quality activities include the collection of biological samples for specific projects. Biological sampling in the Kentucky Water Science Center may include bacteria, biological oxygen demand, chlorophyll, algae, including phytoplankton or periphyton; benthic invertebrates, fish, and contaminants in biological tissue. Documentation and specific references for this procedure and for other procedures are included in the reports referenced in table 11.

Table 11. Summary of references for collecting and processing biological samples

Reference	Sample type
Crawford and Luoma, 1994	Contaminants in tissues
Cuffney and others, 1993	Benthic invertebrates
Meador and others, 1993	Fish
Meador, Hupp, and others, 1993	Stream habitat
Myers and Sylvester, 1997 (TWRI book 9, chap. A7, section 7.1)	Fecal-indicator bacteria; biological oxygen demand
Delzer and McKenzie, 1999 (TWRI book 9, chap. A7, section 7.2)	5-day biochemical oxygen demand
Porter and others, 1993	Algae

8.2.2 Suspended-Sediment and Bottom-Material Samples

Water Science Center 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) memorandums, which are referenced below (table 12). Suspended-sediment samples are typically analyzed by the Kentucky 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 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 work plan should be consulted for specific guidelines for sediment sampling, depending on project objectives. Individuals who have questions regarding the collection and handling of sediment samples should contact the project chief and the sediment laboratory manager. For particular questions concerning sediment chemistry samples, contact the project chief.

Table 12. Summary of references for collecting suspended-sediment samples

Reference	Subject
Sholar and Shreve, 1998	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	QA plan for collecting and processing sediment data
OSW Memorandum 93.01 (USGS)	Instrumentation and field methods for collecting suspended-sediment data
Radtke, 1998 (TWRI book 9, chap. A8)	Collecting and processing bottom-sediment samples
Shelton and Capel, 1994	Collecting and processing streambed-sediment samples
Wilde and others, eds., 1998b (TWRI book 9, chap. A3)	Cleaning equipment for sampling suspended-sediment chemistry
Wilde and others, eds., 1998a (TWRI book 9, chap. A1)	Selection of equipment for sampling suspended-sediment chemistry

8.3 Quality-Control Samples

QC samples must be collected as integral components of all Water Science Center 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 the National Field Manual (Wilde and others, eds., 1999a, chap. A4). Issues of QC sample design are addressed in section 3.2 of this plan. Specific guidelines for the collection and processing of QC samples must be included in the project work plan. The project chief, or designee, is responsible for reviewing QC data in a timely manner, and when appropriate, implementing necessary modifications to sampling and processing techniques. The Kentucky Water Science Center Water-Quality Specialist has the responsibility for advising Kentucky Water Science Center 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 Kentucky Water Science Center communicates information and directives related to safety to all personnel. This information is communicated through in-house training, memorandums, videotapes, and other appropriate means. Specific policies and procedures related to safety can be found in the Kentucky Water Science Center safety plan.

An individual has been designated as Collateral Duty Safety Program Coordinator (CDSPC) by the Kentucky Water Science Center. The duties of the CDSPC include disseminating safety guidelines of the USGS to supervisors, coordinating safety training, and reviewing and maintaining vehicle accident reports. 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 the Kentucky CDSPC. Individuals who have questions regarding chemical use in the Kentucky Water Science Center Water-Quality Laboratory or questions regarding hazardous communications should contact the Kentucky CDSPC and the Kentucky Collateral Duty Environmental Program Coordinator (CDEPC) and (or) refer to the Kentucky Water Science Center Laboratory Chemical Hygiene Plan (2003-04) and Kentucky Water Science Center Hazards Communications Plan (2003-04). Guidelines pertaining to safety in field activities are provided in the National Field Manual (Lane and Fay, 1998, chap. A9) and at the USGS web site for safety (*http://1stop.usgs.gov/safety*).

8.5 References Used for the Sample Collection and Processing Section

The following table lists reports and (or) memorandums referred to in this section. For a complete citation, refer to Section 13.0 in this plan.

Table 13. Summary of references for collecting and processing water-quality samples

Reference	Subject
Crawford and Luoma, 1994	Collecting samples of contaminants in tissue (NAWQA)
Cuffney and others, 1993	Collecting benthic invertebrate samples (NAWQA)
Edwards and Glysson, 1999	Field methods for measurement of fluvial sediment
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, 1992	QA plan for collecting and processing sediment data
Koterba and others, 1995	Collecting and processing ground-water samples (NAWQA)
Lane and Fay, 1998 (TWRI book 9, chap. A9)	Safety in field activities
Meador and others, 1993	Collecting fish samples (NAWQA)
Meador, Hupp, and others, 1993	Characterization of streambed habitat (NAWQA)
Myers and Sylvester, 1997 (TWRI book 9, chap. A7, section 7.1)	Measuring fecal indicator bacteria
Delzer and McKenzie, 1999 (TWRI book 9, chap. A7, section 7.2)	Five-day biochemical oxygen demand test
OSW Memorandum 93.01 (USGS)	Instrumentation and field methods for collecting suspended-sediment data
OWQ Memorandum 81.07 (USGS)	Field and laboratory procedures for precipitation samples
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, 1998 (TWRI book 9, chap. A8)	Collecting and processing bottom-sediment samples
Shelton, 1994	Collecting and processing stream-water samples (NAWQA)
Shelton and Capel, 1994	Collecting and processing streambed-sediment samples (NAWQA)
Stanley and others, 1992	National field quality-assurance program
Ward and Harr, 1990	Representative sampling techniques for surface water
Wilde and Radtke, eds., 1998 (TWRI book 9, chap. A6)	Well-purging procedures
Wilde and others, eds., 1998b (TWRI book 9, chap. A3)	Cleaning equipment used to collect and process water-quality samples
Wilde and others, eds., 1999a (TWRI book 9, chap. A4)	Collecting water-quality samples from surface and ground water
Wilde and others, eds., 1999b (TWRI book 9, chap. A5)	Processing water-quality samples
Wilde and others, eds., 1998a (TWRI book 9, chap. A2)	Selection of equipment used to collect and process 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. 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 Kentucky Water Science Center 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 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
- Ensure that the station site file is current
- Prepare bottle labels for samples
- Obtain field sheets or notebooks and analytical services request forms (ASR's) (see OWQ Technical Memorandum 2000.09)
- Ensure that necessary supplies are available, such as bottles, standards, filters, preservatives, meter batteries, waterproof markers, shipping containers, etc. (see Section 5.1.3)
- Ensure that all sampling equipment is thoroughly cleaned and field rinsed, if necessary (table 14)
- Check meters and sensors for proper performance
- Ensure that appropriate safety-related items are available for use

Table 14. Directions for field rinse of bottles used to contain samples for inorganic constituents [from Wilde and others, eds., 1999b, chap. A5, table 5.2]

Bottle Preparation
If bottles were previously rinsed and half-filled with deionized water[a], discard deionized water and rinse only once with the water to be sampled.
If bottles were not previously rinsed with deionized water, rinse twice with deionized water on site, followed by one field rinse with the water to be sampled (use only 25-mL filtrate for bottle rinse for the filtered sample[a,b]).
Field-Rinse Technique
1. Put on disposable, nitrile, powderless gloves.
2. Fill sample bottle about 1/10 full of rinse water. Cap bottle.
3. Shake the bottle vigorously to rinse all interior surfaces.
4. Discard rinse water by swirling the solution out of the bottle.
5. Shake off adhering water droplets.

[a] Required for filtered trace-element samples (Horowitz and others, 1994)

[b] Refer to Wilde and others, eds. (1999b) for detailed guidance for surface-water and ground-water samples

9.2 On-site 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. The project chief is responsible for ensuring that all of the following sampling requirements are implemented:

1. Station identification
2. Station name
3. Date and time of sample collection
4. Bottle code (table 15) [For more complete bottle codes, see Wilde and others, eds. (1999-2002), NWQL Technical Memorandum 95-04, and the NWQL web page at *http://wwwnwql.cr.usgs.gov/servlets_u/SampleContainersTreatments?srchCntrType=All*]
5. Appropriate laboratory schedule(s) or laboratory codes

Table 15. Common organic-compound and inorganic-constituent sample designation codes for the National Water-Quality Laboratory of the U.S. Geological Survey [modified from Wilde and others, eds., 1999b, chap. A5, p. 17]

Organic-compound samples	
GCV	40-mL amber, glass septum vials, laboratory cleaned and baked, for analysis of volatile organic compound samples (VOC or VOA); sample chilled to or below 4°C without freezing.
GCC	1-L amber, glass bottle, laboratory cleaned and baked, for various types of pesticides and organic compound samples other than VOCs; sample chilled to or below 4°C without freezing.
TOC, DOC	125-mL amber, glass bottle, laboratory cleaned and baked, for total (TOC) or dissolved (DOC) organic carbon; sample chilled to or below 4°C without freezing.
Inorganic-constituent samples	
RA, FA	250-, 500-, 1000-mL polyethylene bottles, acid-rinsed, capped, to be filled with raw (RA) or filtered (FA) samples and treated with nitric acid to pH < 2.
RU, FU	250-, 500-, 1000-mL polyethylene bottles, acid-rinsed, uncapped, to be filled with untreated raw (RU), or filtered (FU) samples (through 0.45 micron filter)
FCC	125-mL brown polyethylene bottles, uncapped, to be filled with filtered sample for nutrient analysis, and chilled to or below 4°C without freezing.
WCA, FCA	125-mL polyethylene bottles, uncapped, to be filled with raw (WCA, uncolored bottle) or filtered (FCA, brown bottle) sample for nutrient analysis, treated with sulfuric acid, and chilled to or below 4°C without freezing.

9.3 Sample Processing

The sequence of sample processing is dependent on the type of constituents being sampled and analyzed. The most current guidelines (1999) for processing samples are listed in table 16.

Table 16. Recommended sequence for processing samples [from Wilde and others, eds., 1999b, chap. A5, table 5-1, p. 20]

Sequence of processing
1. Organic compounds—Raw (whole-water or unfiltered) samples first, followed by filtered samples. **Do not field rinse bottles.** Chill immediately. a. Volatile organic compounds (VOCs) b. Pesticides, herbicides, polychlorinated biphenyls (PCBs) and other agricultural and industrial organic compounds
2. Total organic carbon (TOC)[a], dissolved organic carbon (DOC)[a], and suspended organic carbon (SOC). Chill immediately.
3. Inorganic constituents, nutrients, radiochemicals, isotopes: For ground water, filtered samples first, followed by raw samples. For surface water, raw samples first, followed by filtered samples. (Field rinse each sample bottle, as required). a. Trace metals b. Separate-treatment constituents (such as mercury, arsenic, selenium) and major cations. c. Major anions, alkalinity, and nutrients. Chill nutrients immediately. d. Radiochemicals and isotopes. Bottle-rinse, filtration, and preservation requirements depend on analysis to be performed (see section 5.6 and app. A5-C of Wilde and others, eds., 1999b). USGS employees also can access NWQL Rapi-Notes 01-013, 01-023, 01-033, and 01-034.
4. Radon and chlorofluorocarbons[b] Do not rinse bottle.
5. Microorganisms

[a] TOC and DOC samples can be collected whenever most appropriate for the specific field operation.

[b] Radon and chlorofluorocarbons and most isotope samples are collected outside of the processing chamber.

9.4 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, the 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 ASR's 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 ASR's 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. Follow the packing and shipping protocols established by the USGS and the receiving laboratory (NWQL Technical Memorandum 95.04 and Wilde and others, eds., 1999b).
4. Ship samples after sample collection and the same day whenever possible.

9.5 Sample Tracking Procedures

The projects each maintain a record of all samples collected and shipped to a laboratory for analysis to ensure the complete and timely receipt of analytical results. The project chief has responsibility for recording the required information. The project chief has responsibility for reviewing the tracking log to determine if analyses are missing and for taking necessary corrective action(s).

9.6 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 project chief should establish, maintain, and document a chain-of-custody system for field samples 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 project chief, or designee, is responsible for ensuring that custody transfers of samples are performed and documented according to the requirements listed below. (NOTE: Most laboratories have their own chain-of-custody forms which can be used for project documentation.)

9.7 References Used for the Sample Handling and Tracking Section

The following table lists reports and (or) memorandums referred to in this section. For a complete citation, refer to Section 13.0 in this plan.

Table 17. Summary of references for handling and tracking water-quality samples

Reference	Subject
NWQL Memorandum 02.04	Requirements for the proper shipping of samples to the NWQL
OWQ Technical Memorandum 2000.09	Mandatory use of new Analytical Services Request (ASR) form
Wilde and others, eds., 1999-2002 (TWRI book 9, chap. A5)	Processing water samples
NWQL Rapi-Notes 01-013, 01-023, 01-033, 01-034	USGS employees can access Rapi-Notes through the NWQL in-house Web site

10.0 Water-Quality Data Management

Water-quality data that are collected for hydrologic investigations are recorded on paper and electronically. Data that are recorded on paper include chemical, physical, biological, and ancillary data measured in the field. This information is documented on standard USGS field forms 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 that are recorded on paper and electronically are typically stored either in the NWIS QWDATA data base (Hoopes, 2001) or in NWIS-ADAPS data base (Bartholoma, 1997). Both of the preceding references are available at *http://wwwnwis.er.usgs.gov/conversion/nwisdocs4_1/index.html*. 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 data bases may be stored in other data bases, such as project data bases.

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 records. 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 on site by electronic sensors and data loggers. Two methods for electronically recording data are by (1) transmitting data from a remote location

by land line or radio telemetry to a central location where they are recorded on disk or solid-state memory device, and (2) recording data at a remote location on disk or 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). Water-quality data recorded at the field site are automatically transmitted, real-time via a Geo-Operational Environmental Satellite (GOES) to a down link site located at the Kentucky Water Science Center office. When the site is visited by a hydrologic technician, data are down-loaded to a computer hard drive or a handheld computer. Continuous water-quality data are processed as described in Wagner and others (2006).

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 data base, a site identification number must first be assigned and entered into the Water Science Center site file (see Section 7.2). Field measurements are entered into the NWIS data base by the data base manager as soon as possible after returning from the sampling field trip. A record number is assigned by the system and is recorded on the field forms and on the analytical services request form (see Section 9.4). Sample logging is required for data from the NWQL or Ocala Water-Quality and Research Lab (OWQRL) to successfully transfer the data into the data base. Environmental sample data are entered into the Water Science Center NWIS QWDATA data base number 01; QA data are entered into the Water Science Center NWIS QWDATA data base number 11.

Figure 5. Example page of a Kentucky Water Science Center sample-collection log book.

Station number	Date/time	Schedules requested	NWIS record number	Lab ID number
0208500	Sept. 21, 1993	1043	993000025	
"	"	542	"	
0209754	Oct. 4, 1993			

All data from the NWQL are electronically transferred to the appropriate Kentucky Water Science Center data base by the Kentucky Water Science Center Water-Data Base Manager at least once per week. Hard copies of the analytical reports (WATLIST's) are forwarded to the project chief for storage in project files. The NWIS QWDATA data base 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. Data entry is the responsibility of the Data Base 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 Data Bases

Where project data collected by project personnel cannot be entered into the Water Science Center NWIS QWDATA data base because NWIS cannot accept the type of data that are generated by the project, project data bases may be established to accommodate the data storage requirements and formats. Project data bases that are the sole repository for project data should have a written procedure

for data entry, storage, and long-term backup and archival. Project chiefs have the responsibility for developing and implementing management of project data bases.

10.2 Validation (Records Review)

Data validation is the process whereby water-quality and associated data are checked for completeness and accuracy. After validation, data records are finalized in the Kentucky Water Science Center data base.

10.2.1 Continuous Monitoring Data

National guidelines for site selection, sensor test methods, field procedures, error correction, and data computation, review, and publication process are given in "Guidelines for Continuous Water-Quality Monitors" (Wagner and others, 2006). Following the entry of continuous monitoring data into NWIS, raw data and (or) graphs of raw data are reviewed by the project chief for anomalous values, dates, and times, and preliminary updating is done. Once the data are edited, the record is submitted to someone other than the person who computed the record for a second check. A designated project person (field office chief or lead technician) are responsible for final review. The Kentucky Water Science Center's Water-Quality Specialist is responsible for approval and consultation for unresolved questions regarding the computation of continuous water-quality record.

10.2.2 Analytical Data

All field notes and field measurements are reviewed for completeness and accuracy within 14 days or as soon as possible after returning from the field trip by the project person. 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 for accuracy and precision. The Kentucky Water Science Center review procedure requires that analysis results be reviewed early enough that the samples will not be destroyed at the laboratory prior to requests for reanalysis, for example within 7 days of receipt of nutrient results and less than 21 days from sample collection, or when all analytical results have been returned but less than 6 months holding time for major ions. 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 (Hoopes, 2001), 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
- 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 obvious errors, such as decimal errors, and possible sample mix-ups or anomalies warranting analytical re-analysis. These reports and comparisons are reviewed and noted on the analytical report (WATLIST). If necessary, corrections or re-analysis may be requested by the project chief.

Requests to the NWQL for re-analysis of all inorganic and organic constituents are made using LIMS Sample Status at *http://nwql.cr.usgs.gov/usgs/sampstatus/index.cfm* or by e-mail to *labhelp@usgs.gov.* Requests for re-analysis of constituents from other laboratories are made as stipulated in the laboratory contract. Re-analysis requests are logged and tracked by the data base manager (fig. 6). Corrections to NWIS resulting from reruns by the NWQL must be made to the laboratory data base as well as to the Kentucky Water Science Center data base and are made by the data base manager by e-mail request to

labhelp@usgs.gov.

Figure 6. Example page of a Kentucky Water Science Center re-analysis log book.

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

Project QA data, such as blanks, replicates, blind standards, and matrix spikes, are periodically 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. Questionable values or values in error are deleted by the Data Base Manager, in consultation with the Water-Quality Specialist, from the data base upon approval by the responsible party (usually the project chief). All personnel responsible for sample collection and field analysis participate in the NFQA program and process an equipment blank once per year. Kentucky Water Science Center QA data, including NFQA sample results and annual equipment blanks, are reviewed by the Water-Quality Specialist.

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 data base. 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 Data Quality Indicator (DQI) code, and identified according to analytical laboratory and collection organization. Other non-USGS data may be entered into the data base at the discretion of the project chief, the supervisor, and the NWQL Branch of Quality Assurance 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 data bases online or offline. The Kentucky Water Science Center Computer Specialist has responsibility for maintaining backups of data stored electronically in NWIS or online. Data stored electronically offline are maintained by the project chief.

In addition to electronically stored data, other project data and information, including field notes, ASR's, WATLIST's, and site information records are retained in station folders and maintained by the project chief in the project office while the project is active.

10.4 Records Archival

According to WRD policy, all original data that are published or 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, ASR's, WATLIST's, continuous water-quality monitoring records, and calibration notes. These data are archived when the project is completed or terminated, or if data are more than 7 years old. It is the responsibility of the project chief and the supervisor to ensure that project files entered into the Kentucky Water Science Center archive are organized and complete. The Kentucky Water Science Center archive is located in the warehouse of Kentucky Water Science Center office, 9818 Bluegrass Parkway, Louisville, Kentucky, and is maintained

by the Kentucky Water Science Center Archivist. Data from the Kentucky Water Science Center archives are transferred to the national archive as needed.

10.5 References Used for the Water-Quality Data Management Section

The following table lists reports and (or) memorandums referred to in this section. For a complete citation, refer to Section 13.0 in this plan.

Table 18. Summary of references for managing water-quality data and records

Reference	Subject
Bartholoma, 1997	NWIS ADAPS user's guide, Open-File Report 97-635
Hubbard, 1992	Policy recommendations for managing and storing hydrologic data
Hoopes, 2001	NWIS QWDATA user's guide
NWQL Memorandum 92.06 (USGS)	Water Science Center rerun requests
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
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 or interpretive reports. The selection of the appropriate publication outlet for water-quality data will be the responsibility of the project chief and the supervisor. 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).

Report approval was delegated in 1995 from the Director to the Regional Hydrologists (WRD Memorandum 95.18). In the Northeastern Region, reports are approved by the Regional Reports Specialist. The Northeastern Region has delegated approval authority for some reports to teams through the team review approach. The approving official on the team is the Regional Reports Specialist, unless otherwise arranged. The WRD team approach is outlined in a document available at *http://water.usgs.gov/usgs/report_processing*. The Kentucky Water Science Center Director has the authority to approve abstracts and some reports for publication, such as non-interpretive Open-File and Data Reports (WRD Memorandum 92.005).

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, Kentucky, Water Year xx," or in individual project data reports. Hydrologic data reports make water-quality data available to users, but without interpretations or conclusions. Approval of hydrologic data reports is in accordance with applicable WRD, Region, and Kentucky Water Science Center policy (Alt and Iseri, 1986).

11.2 Interpretive Reports

Interpretive reports include such USGS outlets as Circulars, Professional Papers, Fact Sheets, Water-Resources Investigations Reports, and Open-File Reports, as well as non-USGS outlets, such as scientific journals, books, and proceedings of technical conferences. The Water Science Center 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 WRD, Region, and Water Science Center policy (WRD Memorandum 95.18) and is more technically rigorous than the required approval for non-interpretive data reports. The process for reviewing, processing, and submitting reports for approval in the Kentucky Water Science Center program office is shown in figure 7.

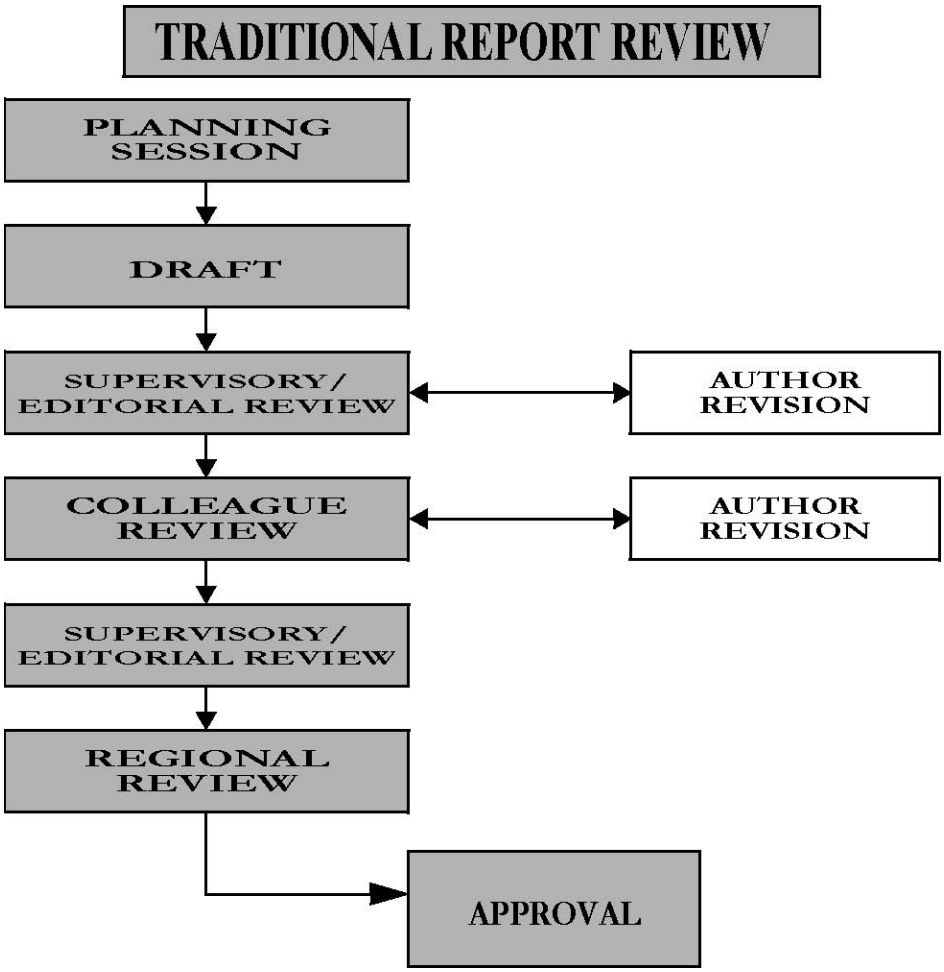


Figure 7. Report review process for the Kentucky Water Science Center office.

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 (WRD Memorandum 90.030; U.S. Department of the Interior, 1993). Electronic outlets include the internet (NWISWeb at http://waterdata.usgs.gov/nwis/) and computer storage media, such as CD-ROM.

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 (WRD Memorandum 90.030). Constituents in water samples collected by or for the USGS that exceed USEPA drinking water maximum contaminant levels (MCL's), as specified in the National Primary Drinking Water Regulations, are promptly reported by the project chief to appropriate agencies that have a need to know (WRD Memorandum 90.038).

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 prior to final approval is prohibited to avoid disseminating incomplete and (or) incorrect conclusions, which are subject to change as a result of subsequent technical and policy reviews.

11.4 References Used for the Publication Section

The following table lists reports and (or) memorandums referred to in this section. For a complete citation, refer to Section 13.0 in this plan.

Table 19. Summary of references for publishing data

Reference	Subject
Alt and Iseri, 1986	Guide for publishing WRD reports
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 data bases 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 90.030 (USGS)	Policy for release of digital data
WRD Memorandum 90.038 (USGS)	Policy for reporting maximum contaminant level exceedances
WRD Memorandum 97.002 (USGS)	Modification to the reports processing system
WRD Memorandum 95.18 (USGS)	Redelegation of Director's report approval authority to Regional Hydrologists
http://waterdata.usgs.gov/nwis/	Water-quality-data site

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 Water Science Center Training Officer is responsible for informing Water Science Center staff about the availability of training-in-house, USGS, U.S. Government, and other sources of training. The Water-Quality Specialist provides recommendations and advice to supervisors and their staff as needed. The Kentucky Water Science Center Training Officer 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; Northeastern Region training; Cyberseminars; and Kentucky Water Science Center seminars or in-house training courses. The Water-Quality Specialist plays an important role in providing in-Water Science Center and in-house training. Training documents are maintained by the Training Officer in Kentucky Water Science Center personnel files and by the USGS Personnel Office.

12.2 Reviews

Reviews of water-quality data-collection activities are conducted annually for each individual in the Water Science Center actively involved in water-quality data collection. Reviews are conducted in the field or laboratory by the 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 project chief, the supervisor, and the Kentucky Water Science Center Director. Reviews address sample collection and processing techniques, compliance with WRD, OWQ, and Water Science Center 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 corrective actions, once identified, are implemented and completed in a timely manner.

13.0 REFERENCES

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