USGS
science for a changing world

National Water Quality Laboratory—A Profile

"Changing water into data"

Leadership

The U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL) is a full-service laboratory that specializes in environmental analytical chemistry. The NWQL's primary mission is to support USGS programs requiring environmental analyses that provide consistent methodology for national assessment and trends analysis.

This mission directly supports the USGS, which, in part, is charged with providing the Nation with reliable, impartial earth-science information to help decisionmakers manage the Nation's water resources. To contribute to this information base, the NWQL provides the following:

- High-quality chemical data
- Consistent, published, state-of-the-art methodology
- Extremely low-detection levels
- High-volume capability
- Biological unit for identifying benthic invertebrates
- Quality assurance for determining long-term water-quality trends
- Professional staff

The NWQL has a highly trained and talented work force, and a history of quality and leadership in development of analytical methods for water, sediment, and tissue. The NWQL offers comprehensive services through a modern facility designed for efficient and safe operation. It was moved into a new building in spring 1999 on the Denver Federal Center campus.

Front view shows north wing of the National Water Quality Laboratory, Denver, Colorado.

The NWQL provides environmental analyses to meet a variety of water-quality objectives for the USGS and its customers. Some USGS customers have data-quality objectives that require routine methods of analysis, such as inductively coupled plasma—mass spectrometry for trace metals. Other customers ask the NWQL to detect minute quantities (low levels) of organic compounds, thus requiring more advanced methods of sample preparation and analysis. These "trace" and "ultratrace" concentrations require methods of analysis that, in some instances, are more stringent than that required for many present standards of water quality and include compounds that are not available from any standard analysis. Detections of even trace amounts of compounds can be important when classifying or

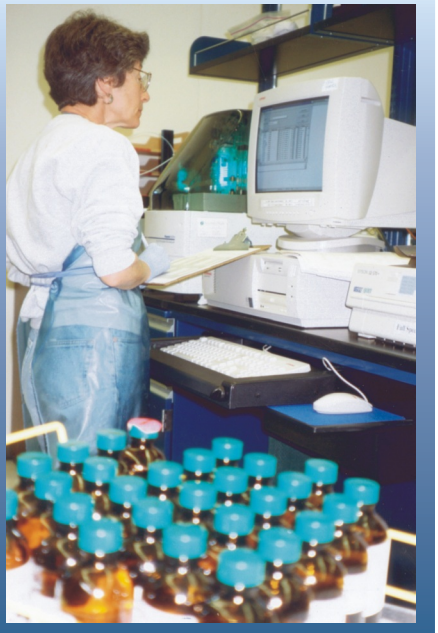
Glass-walled center module connects the north and south wings.

defining the environment in which water quality might be changing.

Whatever the need—chain-of-custody requirements, development of new analytical methods for emerging contaminants, custom methods, or biological assessment—the NWQL is prepared to meet the request for analytical services. NWQL data are used by the USGS to describe and understand the earth's hydrology through the professional application of science and technology to physical, chemical, and biological analyses of water, river and lake sediment, and aquatic biota.

Unique Capability

The high volume of analyses, accuracy and reliability, low-detection levels, and new applied research mark the NWQL as a unique part of the USGS. At present (2001), about 60,000 samples collected with USGS field protocols are sent to the NWQL each year, making it one of the largest environmental water-testing laboratories in the United States. More than 2.3 million individual chemical determinations are made each year from these samples through agreements with USGS offices relating to national assessment and cooperative programs with other Federal, State, and local agencies. Analytical work destined for the NWQL flows through these USGS offices throughout the United States.



Dissolved organic carbon samples are analyzed on an ultraviolet persulfate total organic carbon analyzer.

Sample login area is conveniently located near shipping and receiving. Samples are unpacked and bar-code labels are applied for identification and tracking.

Funding a cooperative program by USGS is considered when a research study or project is mutually advantageous to the USGS and the cooperating agency. This arrangement ensures that the work the USGS does is of national, regional, and local interest. The USGS State offices are listed on the World Wide Web at **http://www.usgs.gov/**. Click on "Contact Us" for a map of the United States, its protectorates, and Puerto Rico. The map provides the addresses of all USGS offices.

The NWQL produces scientifically and legally defensible data that are supported by its own approved and published USGS analytical methods, and by U.S. Environmental Protection Agency (USEPA) methods, along with three levels of chain-of-custody procedures. The high degree of proficiency required in determining substances to the microgram-per-liter level or lower and the requirement for long-term consistency for contaminant reporting are hallmarks of the NWQL. It takes an investment in instrumentation and professional staff to make the NWQL successful in meeting customer needs.

A primary role of the research chemists at the NWQL is to develop new analytical methods. These methods are validated, approved, documented, published, and added to NWQL's analytical capabilities. In addition, NWQL chemists develop custom methods and offer analytical design consulting. Current research is focusing on emerging national water-quality issues, the need for even lower detection levels than those already in use, identification of new compounds, and improvement in accuracy (low bias and low variability) for present methods. Recent new methods, for example, have been developed to determine polar pesticides and pesticide degradates (compounds that are breakdown products from the original pesticide) in surface- and ground-water samples at concentrations as low as 0.002 microgram per liter.

Samples of inorganic trace elements are prepared for analysis by inductively coupled plasma-mass spectrometry.

Sample vials of ambient water in a scintillation cocktail are loaded into a liquid scintillation system for radon detection.

One new method determines wastewater compounds in response to concerns over the effects of endocrine-disrupting chemicals on aquatic organisms. Selected compounds that are identified include food additives, fragrances, antioxidants, flame retardants, plasticizers, industrial solvents, disinfectants, fecal sterols, polycyclic aromatic hydrocarbons, and high-use domestic pesticides. In another new method, the first unequivocal confirmation of the presence of benzalkonium chloride (an active ingredient in cleaning and disinfection products) in water samples provides a useful tool in the trace-level monitoring of wastewater samples.

Analytical Services. The NWQL determines organic and inorganic constituents in samples of ground and surface water, river and lake sediment, aquatic plant and animal tissues, and atmospheric precipitation collected in the United States and its protectorates. The NWQL determines about 600 unique constituents in multiple matrices; the majority of these determinations are made from water samples. These analytical determinations are used in the interpretation of hydrological and chemical data to provide an integrated approach to monitoring water quality.

Gas chromatographic mass spectrometer is set up for determining presence and concentrations of volatile organic compounds.

The NWQL performs the following types of environmental analytical testing:

Organic Chemistry. State-of-the-art techniques are used to separate and analyze complex organic compounds present in water, sediment, and tissue samples. Examples of compounds determined include explosives, fossil-fuel residues and emissions, pesticides and their degradates, pharmaceuticals, chlorophyll, chlorinated solvents and other volatile compounds, polychlorinated biphenyls (PCBs), phenols, phthalates, and other chemicals used in industrial processes. Instrumentation includes carbon analyzers, liquid and gas chromatographs, and mass spectrometers.

Inorganic Chemistry. Selected major anions and cations, metals, nutrients, and physical properties are determined in water, sediment, and tissue samples. Examples of physical properties include color, pH, specific conductance, and turbidity. Instrumentation includes

A spike is pipetted into a distilled water sample in the carbon lab.

Sample extracts are prepared for loading into autosampler for analysis by high-performance liquid chromatography.

graphite furnace, atomic absorption spectrophotometer, ion chromatograph, colorimeter, inductively coupled plasma, and inductively coupled plasma—mass spectrometer.

Radiochemistry. State-of-the-art techniques are used to determine gross alpha, gross beta, and radon (water matrix only). The NWQL uses an extensive network of other laboratories (both commercial and USGS) to determine radiochemical and stable isotopes.

Benthic Invertebrates. The NWQL also identifies and estimates the populations of aquatic invertebrates in samples collected from streams. Benthic invertebrates (aquatic insects, mollusks, and aquatic worms) routinely are collected in bioassessment studies of water quality and physical habitat. Samples from freshwater habitats in the United States are processed by NWQL taxonomists, who use published protocols and taxonomic keys and monographs to provide data and population estimates of invertebrates at stream sites. The presence and number of these organisms provide insight into the health of the aquatic ecosystem.

Methods Research and Development

The Methods Research and Development Program (MRDP) provides new chemical-methods development and transition into the NWQL's capabilities, methods improvement, custom methods, and specialized support for NWQL Analytical Services and USGS national programs. Results of MRDP's method development and other research activities are presented at professional meetings, in scientific journals, USGS publications, and on the Web. The activities of the MRDP are critical to fostering scientific excellence at the NWQL and maintaining its success in supporting USGS water-quality assessment programs nationwide.

Fish-tissue samples are prepared for Soxhlet extraction.

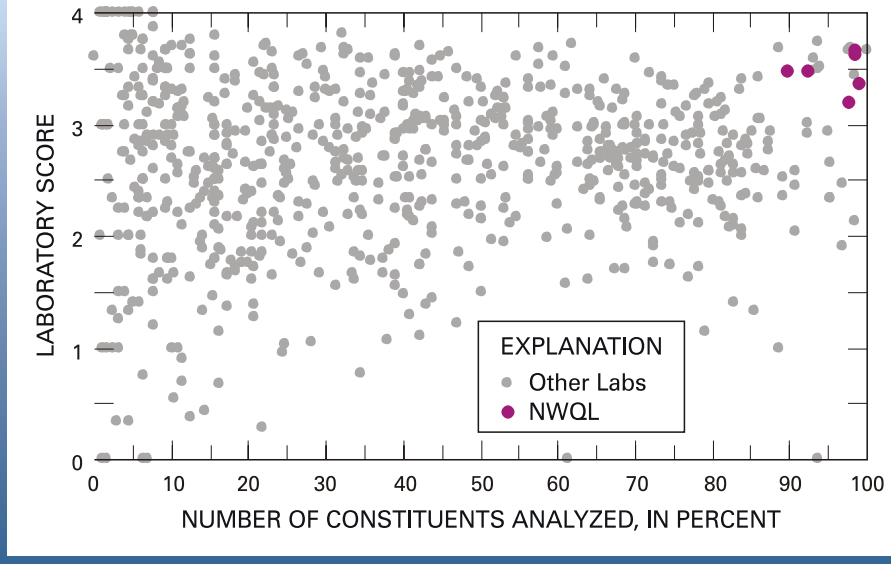
Quality Assurance

Performance Evaluation. The NWQL demonstrates exceptional performance in testing for a wide range of constituents in various sample matrices by participating in interlaboratory and certification programs administered by third-party agencies. The NWQL takes part in national and international performance evaluation studies coordinated by the following organizations: Environment Canada, National Environmental Laboratory Accreditation Program, National

Robotic liquid sample-handling system is configured for automatic, simultaneous preparation of digests for dissolved Kjeldahl nitrogen and dissolved low-level phosphorus determinations.

Institute of Standards and Technology, National Research Council of Canada, and the USGS Branch of Quality Systems (BQS).

The NWQL consistently has received overall ratings between 3 (good) and 4 (excellent) in the BQS evaluations, which include organic and inorganic blind samples. The NWQL analyzed a high percentage of the selected constituents from Fall 1997 to Spring 2000 (see graph). Results of such studies offer an independent check of performance and capability while providing a means for laboratories to be uniformly evaluated. Performance evaluation results are posted on the NWQL's Web site at **wwwnwql.cr.usgs.gov/USGS/Performance/perf_eval.html**



Results of National Water Quality Laboratory performance in relation to more than 100 participating laboratories in the inorganic sample-evaluation studies administered by the U.S. Geological Survey Branch of Quality Systems from Fall 1997 through Spring 2000.

Accreditation and External Audits. The Branch of Quality Systems audits the NWQL to ensure that services comply with USGS requirements. In addition, the NWQL is certified to analyze drinking-water samples by the USEPA Drinking-Water Program (under the Clean Water and Safe Drinking Water Acts) through the Colorado Department of Public Health and Environment.

Chemist analyzes data from liquid chromatograph.

The USEPA has supported a National Environmental Laboratory Accreditation Program (NELAP) since the early 1990s to promote national standards for quality procedures that relate to laboratory certification. These standards apply to a "quality system" at NWQL that includes all procedures used to obtain analytical data of known quality, a thorough and complete Quality Assurance Manual, and on-site audits. The NWQL has taken part in the NELAP process since 1995, and the NWQL's quality systems have been redesigned to comply with standards developed by the National Environmental Laboratory Accreditation Conference (NELAC).

Consistency. Validating the consistency of analytical data nationwide is one goal of the NWQL's participation in the NELAP process. Consistent data lend credence to the data for all samples, whether collected as one-time "grab" samples or gathered as multiple samples and analyzed over years for

Biological technician prepares slides of invertebrates for identification.

use in developing long-term trend analysis. The rigorous techniques and protocols used by USGS to collect samples onsite are essential to the success of NWQL in analyzing samples.

Data Management

An Information Technology infrastructure of networked computer systems with numerous data bases and associated system and application software is available to support NWQL activities. The Laboratory Information Management System (LIMS) is a special-purpose application that monitors the progress of a sample from original entry in the system, through analysis and review to the final release of results to the customer. The system includes a sample data base and archive of actions taken with the sample. USGS personnel may use the data base to design an analytical request or may track the progress of their samples and retrieve intermediate results by using Web applications that query the data base.

Analytical results are transmitted to the customer for review and automatic entry into the USGS National Water Information System (NWIS). Once results are finalized, anyone can retrieve information on where and when a sample was collected, as well as accurate concentrations of chemicals found in the sample and the method of analysis through NWISWeb:
http://water.usgs.gov/nwis

These data are used by scientists in universities, Federal, State, and local agencies, and public and private sectors.

History of Leadership

The NWQL was formed in 1986 by consolidating various USGS laboratories. The need for a full-service national laboratory with standardized laboratory methods, in combination with standardized field protocols for collecting samples, quality assurance, and an infrastructure of trained personnel across the Nation, enable the USGS to collect, manage, and disseminate scientifically based information that describes the quantity and quality of the Nation's water. The NWQL is dedicated to fulfilling its responsibility in supporting the mission of the USGS and U.S. Department of the Interior.

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Banner photo on page 1 courtesy of **John Fielder**. Photo taken in the Raggeds Wilderness Area, Colorado.

Inquiries

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(1-866-275-6975)
Customer Service
E-mail: **LabHelp@usgs.gov**, or call toll-free number

Web Sites —
Public site
http://wwwnwql.cr.usgs.gov/Public

NWQL/USGS site
(for internal USGS use only)
http://wwwnwql.cr.usgs.gov/USGS

U.S. DEPARTMENT OF THE INTERIOR
GALE A. NORTON, Secretary

U.S. GEOLOGICAL SURVEY
Charles G. Groat, Director

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