

The U.S Geological Survey's National Water Quality Laboratory:

The U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL) is a world-class environmental analysis and research laboratory located on the campus of the Denver Federal Center in Lakewood, Colo. The NWQL recently celebrated its 40th Anniversary of producing water-quality data and was recognized for its key role in describing the quality of water; one of our Nation's most precious resources. The NWQL offers a wide-range of environmental analytical services, including inorganic, organic, and radiochemical constituents, and provides high-quality, reproducible data.

The laboratory specializes in trace- and ultratrace-level chemical analyses of water, sediment, and tissue, and the taxonomic identification and quantitation of benthic invertebrates. Many of the chemical analysis methods are developed specifically for the scientific investigations of the USGS and are not available elsewhere. Several of these methods allow the NWQL to reduce its costs through the reduction of laboratory waste.

PERSONNEL: The NWQL has a diverse staff of scientists and technicians; 98 are permanent Federal employees and 22 are contract employees. These employees are spread across a breadth of organizational units including Research and Development, Analytical Services, Quality Assurance Safety, Health and Environment; Facility Support Services, Support Services, Administration, and Information Technology. Within Research, Quality Assurance, and Analytical Services, expertise includes analytical chemistry and environmental biology.

The work of NWQL scientists is recognized nationally and internationally. For example, NWQL scientist Dr. Edward T. Furlong has been designated a Thomson Reuters Highly Cited Researcher, ranking among the top 1 percent of researchers from 2003 to 2013 for most cited documents in the section on Environment and Ecology. He was listed as one of Thomson Reuters' "The World's Most Influential Scientific Minds" in 2015.

The Scope of Science at the NWQL

Sample analysis at the NWQL is carried out by chemists, physical scientists, aquatic biologists, and technicians in the Analytical Services (AS) section. The AS section has broad environmental analytical capabilities to analyze over 800 inorganic and organic contaminants in surface water, groundwater, waste treatment influent and effluent, biosolids, suspended sediment, aquatic bed sediment, atmospheric precipitation and aquatic plant and animal tissues. Examples of analyte classes determined include trace metals, nutrients, pesticides and their degradates, pharmaceuticals, steroid hormones, surfactants, anthropogenic waste indicators, explosives, fossil-fuel residues and emissions, chlorophyll, chlorinated solvents and other volatile compounds, polychlorinated biphenyls (PCBs), phenols, phthalates, and other chemicals used in industrial processes. Examples of physical properties include color, pH, specific conductance, and turbidity. State-of-the-art techniques are used to determine radon (water matrix only). The NWQL uses commercial laboratories for radiochemistry sample analyses that are not done in-house. The NWQL also identifies and estimates the populations of aquatic invertebrates in samples collected from streams. The presence and number of these organisms provide insight into the health of the aquatic ecosystem and are thus important in our efforts to support the USGS Science Strategy.

Over the last six years, the AS section throughput has ranged from more than one to two million analytical results (data points) per year. The NWQL receives an annual average of almost 39,000 samples and produces about 1.8 million results. The NWQL analyzes from 70 to 80 percent of all water-quality samples collected by the USGS Water Science Centers which are located in every State and in Puerto Rico and the Pacific Island territories.

The Methods Research and Development Program (MRDP) was formed in 1987 to address national-level concerns about toxic contaminants in the nation's water resources for which there were no available analytical methods with adequate performance. The methods developed at the NWQL involve the MRDP research chemists and support chemists and senior technical personnel within AS to transition new methods into the AS fee-for-service capability while retaining method performance and quality.

Current research is focused on emerging national water quality issues, such as addition of new priorities and to broaden the applicable range of sample types. Additionally, the need to lower detection levels, and to reduce bias and variability drive continuous method optimization efforts on existing methods. New technology and methodology are being applied to the identification of unknown compounds to assist program leadership in their efforts to identify new high priority chemical compounds.

The MRDP is also engaged in continuous improvement for existing methods where needs are identified by numerous feedback mechanisms, including technical assistance, input received from USGS Water Quality Specialists, USGS Water Science Center researchers, and others.

NWQL approved and custom methods are validated, as specified in an MRDP Standard Operating Procedure (SOP). Method detection levels are determined using the ASTM Inter-laboratory Detection Estimate. Methods are documented and published in NWQL Tech Memos, Techniques and Methods (T&M) reports and journal articles, as appropriate. Highly specialized detection, quantitation, reporting and data qualification schemes are employed and coded in the laboratory information management system (LIMS) and in NWIS.

Results of MRDP's method development and other research activities are presented at professional meetings, in scientific journals, in 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.

The MRDP unit works closely with USGS leadership to develop methods to address the highest priority water resource and water quality issues facing the Nation. Methods developed by MRDP are recognized internationally for their breadth and scope of chemical compounds, high sensitivity, data quality and applicability to complex types of samples. Most MRDP-developed methods are transferred to the AS group, which provides high quality, high throughput, analysis in support of USGS priorities.

The collective expertise across USGS National Programs and Water Science Center research programs play a key synergistic role in the growth of science and data quality at the NWQL.

Quality Assurance Section:

The NWQL assures the reliability, reproducibility, and high quality of its data and information through adherence to USGS Fundamental Science Practices for publications. The NWQL has an extensive Quality Management System (QMS) that defines internal quality system processes and requirements. The NWQL also develops and revises a wide variety of Standard Operating Practices to assure consistency and comparability in results over time. The use of comprehensive internal and external QA/QC (Quality Assurance and Quality Control) processes to monitor method and analyst performance insures that NWQL meets its commitment to publish high quality data of known and documented quality. External, independent oversight is provided by the USGS Branch of Quality Services as well as accrediting agencies such as the NELAC Institute.

The NWQL's Quality Assurance Section (QAS) provides oversight of all quality programs documented in the lab's comprehensive Quality Management System. The QAS coordinates the NWQL's internal and external QA/QC processes and performance testing. The QAS staff has expertise in modern analytical science that is leveraged with their quality systems expertise to provide a powerful and highly valued assessment of the NWQL's published results.

Laboratory Proficiency Testing: The NWQL demonstrates exceptional proficiency in testing for a wide range of constituents in various sample matrices by participating in inter-laboratory testing and certification programs administered by third-party agencies. The NWQL takes part in national and international proficiency testing studies coordinated by the following organizations: Environment Canada, New York State Department of Health for the Environmental Laboratory Approval Program (ELAP), and the USGS Branch of Quality Systems (BQS). Results of such studies offer an independent check of performance and capability while providing a means for laboratories to be uniformly evaluated. Proficiency testing results are posted on the NWQL's Public Web site at http://nwql.usgs.gov/Public/perf_eval.shtml.

Certifications and External Audits. Since the early 1990s, the National Environmental Laboratory Accreditation Program (NELAP) has promoted national standards for quality procedures that relate to laboratory certification. 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 NELAC Institute (TNI). The NWQL is currently accredited through the States of New York, Florida, Texas, and North Carolina. These standards apply to all NWQL procedures used to obtain analytical data of known quality, a thorough and complete Quality Assurance Manual, and on-site audits.

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 in one place at one point in time or gathered as multiple samples at many locations and analyzed over years for use in developing long-term trends in water quality. The rigorous techniques and protocols used by USGS personnel in the collection of samples are essential to the success of NWQL in analyzing samples on-site. Quality Assured Supplies,

proficiency testing, and two levels of chain-of-custody procedures to support regulatory needs of others.

Support Infrastructure:

The Safety, Health and Environment (SHE) program not only insures that the workplace is safe but also provides for safe, regulation-compliant disposal of toxic waste. The SHE group is continually recognized by various industry regulators for setting a high standard in the environmental field.

The NWQL's Support Services (SS) unit operates the lab's sample login facility which is critical to insure the integrity of incoming environmental samples and therefore the resulting published data. The SS unit also operates the lab's warehouse facility and provides support for general facility operational needs. The SS unit also operates the National Field Supply Service (NFSS) to ensure quality assured field supplies are available to samplers for use in their sample collection programs.

The NWQL's Information Technology (IT) group is staffed with highly skilled specialists capable of system design and maintenance for an infrastructure of networked computer systems. These systems house numerous databases and associated system and application software to support the lab's data management activities. The system is fully certified and accredited to FISMA standards by IT Security of USGS. 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 database of all samples received by the NWQL, and an archive of actions taken with each 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. A Business Intelligence system is used to monitor analytical processes. 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 NWIS Web: <http://water.usgs.gov/nwis>. These data are used by scientists in universities, Federal, State, and local agencies, and public and private sectors.

Impact:

The NWQL has had major impact across USGS Water, providing the bulk of the data used by the National Water Quality Assessment (NAWQA) program through two completed decadal programs and a third that is ongoing. The NWQL's collaborations with the USGS Toxics Substances Hydrology Program (Toxics) have led to an industry-leading reputation in the field of Emerging Contaminants. The NWQL's support for USGS Water Science Center research have empowered the USGS to leverage sophisticated analytical methodology for limited-scope state, county and city-level water quality issues that have no other avenue for investigation. This reputation for excellence has made the NWQL a very in-demand facility as evidenced by sample

submissions: over the last six years, submissions have averaged nearly 39,000 annually resulting in approximately 1.8 million results reported per year.

The NWQL's reputation for excellence has led to numerous opportunities to respond to national disasters, chemical spills and involvement in large scale inter-agency research. One example is the EPA Drinking Water Study, where NWQL methods provided analysis of pharmaceuticals and waste indicators to a high-value national level interagency study. Other examples include:

-The MRDP collaborated with NOAA scientists to determine ocean water levels of the surfactant used to disperse crude oil during the Deepwater Horizon spill in the Gulf of Mexico in 2010.

-Supported by state WSCs from West Virginia and Kentucky, MRDP collaborated with state and federal agencies and university researchers to quickly develop a method and analyze river water following a spill of methyl-cyclohexane methanol (MCMH) in the Elk River.

-The NWQL competed and won an A-76 process, which is a thorough, real-world test of value. See attached summary for additional details.

Summary:

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. The need for a national laboratory with broad environmental analytical capabilities using standardized field protocols and laboratory methods, in combination with extensive 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.