

Science.

Technology.

Innovation.

### *What We Do For Our Clients*

- *Ultra-trace level metal and organic analysis in water, sediment, and tissue*
- *Risk-based organic contaminant analysis*
- *Specialized analytical methods development*
- *Historical/temporal trends of contaminants in sediment cores*
- *Long-term contaminant monitoring programs*
- *Sediment accumulation rates/contaminant loading in recent sediments*
- *Sea-surface microlayer sampling and analysis*
- *Specialized ultra-clean sampling techniques for water, suspended particulates, and bottom sediments*
- *Chemical fate-and-effects studies*
- *Radionuclide dating of sediment.*

## Pacific Northwest National Laboratory

Operated by Battelle for the  
U.S. Department of Energy



# Marine and Environmental Chemistry

At Pacific Northwest National Laboratory (PNNL), we focus on the fate and transport of potentially toxic and hazardous chemicals in the marine environment. Emphasis is placed on

- Ultra-low detection of environmental contaminants
- Chemical speciation of metals
- Analytical methods development
- Chemical fate of contaminants.

Analytical chemistry support also is provided to other research areas through analysis of contaminants in water, sediment, and tissues of marine organisms.

## Metals Chemistry

The Trace Metals group provides expertise, state-of-the-art equipment, and a wide range of analytical capabilities in all areas of environmental metals chemistry. PNNL was instrumental in the development of the EPA 1600 series methods for sampling analysis of trace-level metals. PNNL has also developed field sampling and analytical methods for the analysis of acid volatile sulfides and simultaneously extracted metals in marine and freshwater sediments. In addition, the laboratory is developing methods for the speciation of selenium.



*At the Marine Sciences Laboratory, contaminated groundwater is pumped through ion exchange columns to concentrate toxic chemicals for identification by research scientists.*

## Interlaboratory Comparison Studies

PNNL participates in validation exercises for metals in river water, seawater, and public-owned treatment wastewater effluent. Methods include those for methylmercury, arsenic, and “clean” sampling techniques. The Chemistry group also participates in several chemistry laboratory intercomparison and certification programs that require analysis of performance evaluation samples. These have included those for the National Research Council of Canada and the National Oceanic and Atmospheric Administration/National Research Council Intercomparison Studies (for which the Marine Sciences Laboratory has received a superior rating since its inception), U.S. Environmental Protection Agency Validation and Performance Evaluation studies, the National Water Research Institute of Canada Intercomparison Study, and several other programs.

## Capabilities in Metals Analyses

- Ultra-low detection limits
- Radionuclide dating of sediments
- Arsenic speciation
- Specialized mercury analysis
- Specialized sulfide analysis.

## Organic Chemistry

PNNL’s organic chemists use gas and liquid chromatographic techniques to determine the concentrations of pesticides, polychlorinated biphenyls (PCBs), organotin compounds, polynuclear aromatic hydrocarbons (PAHs), and other contaminants and their metabolites in various environmental matrices.



*Alpha and gamma counters are used by PNNL researchers to measure lead-210, beryllium-7, and cesium-137 to date core sediments.*

PNNL uses Semipermeable Membrane Devices to monitor concentrations of hydrophobic organic compounds, such as PAHs and PCBs, in marine and aquatic systems and to predict how they will bioaccumulate in aquatic organisms. Semipermeable Membrane Devices provide time-integrated samples, sample large volumes of water, detect low hydrophobic organic compound concentrations in water, and identify bioavailable hydrophobic organic compounds in water. These devices allow researchers to avoid using live animals for testing and reduce costs of sampling and analysis.

*Located on 125 acres on the shores of Sequim Bay, Washington, the Marine Sciences Laboratory has provided cutting-edge expertise in trace contaminant analysis, ecotoxicology, and coastal assessment and restoration for more than 30 years. New focus areas include environmental biotechnology and coastal security applications. The MSL is part of PNNL Sequim Marine Research Operations, the only marine sciences facility within the U.S. Department of Energy national laboratory system. PNNL Sequim Marine Research Operations also includes the Coastal Security Institute.*

## Laboratories

**Specialized Mercury Analysis Laboratory** is used for ultra-trace level, that is, picogram per liter, analysis of mercury in water samples, and parts per trillion analysis of total and methylmercury in water, tissue, and sediment. Unique methods and instrumentation can be developed or modified to accommodate unusual matrices and specific client needs.

**Specialized Sulfide Analysis Laboratory** is used for trace-level determination of inorganic sulfur compounds in water and acid volatile sulfides in sediment using gas generation, purge and trap, and colorimetry.

**Arsenic Speciation Laboratory** is used to determine arsenite ( $As^{+3}$ ), arsenate ( $As^{+5}$ ), methylated arsenic at parts-per-billion level in water, and sediment by selective hydride generation.

**Radiation Laboratory** is used for radionuclide dating of sediment using alpha and gamma counting techniques for dating cores by lead-210, cesium-137, and beryllium-7.

### **Organic Wet Chemistry**

**Laboratories** are used to prepare sample extracts for gas chromatography and mass spectroscopy (GC/MS), and to analyze the physical properties of sediment. Specialized cleanup procedures and analyses are conducted for oil and grease, PAHs, phenols, PCBs by congener or Aroclor, pesticides, and organotins.

**Chemical Repository** uses the Battelle Standards-Based Management System for logging in reagents, chemicals, and solutions into a Chemical Management System for inventory as well as tracking storing, and disposing chemicals. This laboratory is currently supporting the Endocrine Disruptor Program for the U.S. Environmental Protection Agency.



*PNNL staff are using marine algae to enhance sequestration of carbon dioxide in climate change studies.*

### **Environmental Biotechnology**

**Laboratory** is used for innovative research, such as hydrocarbon bioremediation, ocean carbon sequestration, biofixation of carbon dioxide from flue gases by marine microalgae, and photosynthetic biohydrogen production.

**Preparation Laboratory** is used for preparing samples for metals and organic analyses and determining basic chemical and physical properties of samples, such as pH, salinity, grain size, total volatile solids, and percentage dry weight.

**Sample Receipt/Login Laboratory** provides 15 linear feet of chemical-resistant bench top for handling receipt of samples.

## **Laboratory Features**

### **Air Filtration**

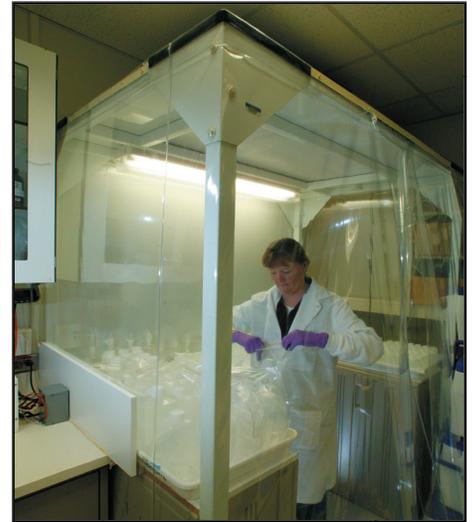
The laboratories are well ventilated with filtered air that is replaced approximately every 6 minutes through exhaust hoods.

### **Balance Control**

Analytical balances are in temperature-controlled laboratories and protected from drafts. Balance calibration is verified daily.

### **Class 100 Clean Rooms**

Reagents and standards are prepared in Class-100 “Clean Rooms.” These rooms have no exposed metal. An all-plastic acid digestion fume hood is provided where samples can be prepared without contamination from airborne metals, including mercury vapor.



*Ultra-trace level analyses of mercury are performed using methods developed at the Marine Sciences Laboratory.*

### **Cold Storage Area**

Sufficient space is available to maintain samples at -20°C for at least 365 days after data submission. The 672-cubic-foot walk-in freezer is checked for proper temperature twice a day, seven days a week. Samples, extracts, and standards are stored separately and away from organic vapors to prevent cross contamination.

### **Deionized Water Supply**

Laboratories are equipped with a continuously circulating deionized water supply system, with a 500-gallon backup supply tank. Resistivity is monitored and recorded daily.

## Quality Assurance

PNNL provides a high level of quality assurance to ensure the defensibility of all data. This commitment to quality helps PNNL's clients meet regulatory requirements and make critical decisions in environmental management programs.

Primary certification is provided through the Washington Department of Ecology. Certifications in other states are under reciprocity programs. The Marine Sciences Laboratory also holds accreditation from the National Environmental Laboratory Accreditation Program (NELAP) for metals and mercury in sediment, tissue, and water, as well as NELAP certifications for toxicological testing.

## Real Solutions for Real Problems

PNNL's programs frequently address the following issues and needs:

- Sediment evaluations in ports and harbors
- Risk assessments: evaluations of contaminant exposure potential from organic compounds and toxic speciated forms of metals
- Endocrine disruptor studies
- Watershed monitoring
- Sediment core dating
- Mine waste evaluations
- Deepwater oil and gas exploration studies
- Energy production research
- Bioremediation technology development
- Climate change studies
- Stormwater evaluations
- Effluent sampling and analysis/wastewater compliance for industry and municipalities
- Water quality monitoring



*Using the Chemical Repository, Marine Sciences Laboratory researchers are developing tests and screens for identifying chemicals that alter or impair the endocrine systems in humans and wildlife.*

- Instrument and method development
- Early detection of trace-level contaminants (including chemical, biological, and nuclear materials)
- Coastal security issues.

## Analytical Chemistry Laboratories

PNNL's fully equipped laboratories include

- Inductively-coupled plasma mass spectrometers (ICP-MS) and atomic emission spectrometer (ICP-AES) for ultra-low-level metals analyses
- Atomic absorption spectrometer (AAS), including graphite furnace atomic absorption (GFAA) for metals speciation
- Cold vapor atomic fluorescence (CVAF) units for mercury and methylmercury analysis
- Ion chromatographs for analysis of nutrients and speciation of arsenic and other metals

- Gas chromatographs for organic analyses of tributyltin, PAHs, PCBs, and other compounds
- High performance liquid chromatographs (HPLC) for specialized sample preparation
- Liquid scintillation analyzer for radionuclides and analysis of C-14 labeled material
- Gamma counter for radionuclide dating of sediment and analysis of isotopes
- Alpha counter for radionuclides and dating of sediments
- Liquid Chlorolab system for determination of photosynthetic oxygen production and dark respiration rates.

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