RESOURCE & ECOSYSTEMS MANAGEMENT

A Technical Resource for Government and Private Industry

Infrastructure and Research Supporting

Environmental Exposure, Fate and Effects Analysis

The Pacific Northwest National Laboratory (PNNL) serves a variety of clients in the area of environmental exposure, fate and effects studies. PNNL's unique facilities and highly-experienced staff have been used to conduct both basic and applied research for a variety of clients concerned with chemical releases to water, land, and air; and physical disruptions of the environment. Problems we have addressed include fate and transport of chemicals, toxicological analyses with a broad array of biological systems and endpoints, testing and validating new generations of monitoring instrumentation, and development and testing of remediation systems. Our studies have provided clients with the documentation needed to effectively communicate with regulators and the public.

Aerosol Wind Tunnel Research Facility. The PNNL Aerosol Wind Tunnel Research Facility provides a combination of special capabilities for simulating natural environments where dynamics of atmospheric transport, transformation, and deposition are important. Factors under experimental control or measurement include:

- Influences of sunlight, humidity, temperature, or other parameters on aerosol aging
- Deposition of airborne particles to various test subjects such as plants, soils, and water surfaces, as a function of wind speed and flow fields within plant canopies or abiotic surfaces
- Fate of particles deposited to surfaces, including the rate of transfer of chemical contaminants from the surface to the interior of plants and soils as influenced by deposition rate, temperature, humidity, and wind speed.

Greenhouses. PNNL maintains a number of greenhouses to support long-term studies of plants and animals under semi-natural conditions. Research includes toxicological studies of plants, mammals, and birds; chemical uptake, transformation, and biological transport; and bioremediation design.

Controlled Environment Chamber. PNNL's self-contained environmental chambers provide controlled lighting, temperature, and humidity along with treated- and river-water for use in aquatic studies. The facility is used to grow and conduct tests on aquatic plants and insects. Toxicological studies, bioassays, and pharmacokinetic studies are the focus of research.

Aquatic Research Facility. PNNL operates an aquatic facility that supports a variety of research on fish and other aquatic life, supporting toxicology, bioengineering, and biosensor development. Waters from the Columbia River and a groundwater well are delivered to the lab and conditioned to meet specific research needs. Inside the lab, temperature and lighting control are used to simulate seasonal and diurnal cycles. The lab is used for prototype aquatic tool development and to conduct tests to answer questions that are difficult to resolve in the field.

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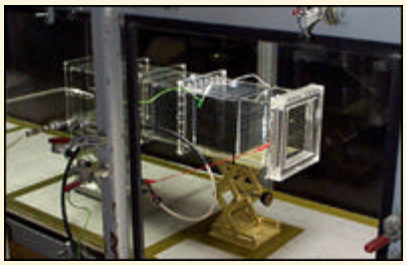
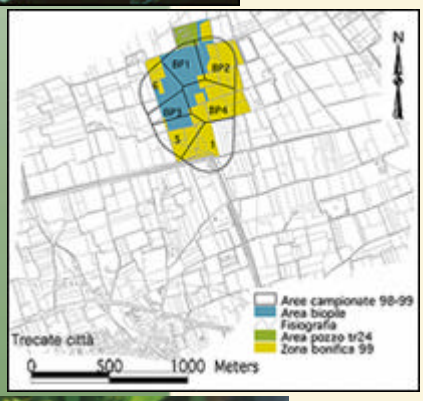
Experience



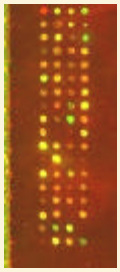
Biological Aerosol Collector/Detector Test Bed: This program aids bioaerosol collector/detector developers in assessing the performance of their devices under a variety of environmental conditions in a short time frame, thereby minimizing client time spent testing while maximizing performance data returned. This work also allowed testing of particulate and aerosol emissions on plants and animals under realistic environmental conditions.

Pesticide Route-of-Exposure: This project was performed to study the importance of five potential routes of pesticide exposure by wildlife (quail). Pesticides were sprayed on cotton canopies in the wind tunnel using procedures representative of actual field applications. Resuspended respirable pesticide and toxic photochemical reaction products attached to dust particles were characterized. Routes of exposure included oral, dermal, percutaneous, respiratory, and preening.



Ecotoxicity of Degradation Products from Crude Oil Spill: This project examined the toxicity and mutagenicity of residuals and breakdown products from biopile remediation of soil contaminated by a crude oil spill for AGIP oil company. Tests included both acute and chronic exposures and toxicity assessment for plants and animals, mutagenicity testing using the Ames protocol, developmental abnormality tests in field and laboratory using a modified *Xenopus* assay, and food chain transfer quantification. The results of the study supported release of the soils for unrestricted use.

Adaptive Pharmacokinetics of Contaminants in Aquatic Biota: Biological systems are capable of adapting uptake and depuration kinetics upon exposure to a wide variety of contaminants. This adaptation can significantly modify both the toxicological response to contaminants as well as the potential for food chain transfer. This project is quantifying adaptive pharmacokinetics in periphyton, aquatic insect larvae, and rainbow trout for a broad set of contaminants of concern for the US Department of Energy and the US Environmental Protection Agency for use in pharmacokinetic models of exposure and toxicokinetic models of effect.



Biological Monitoring Systems: PNNL is developing molecular biological tools to quantify in-situ exposure and effects of contaminants in biological receptors in natural environments. These tools make use of DNA microarray technology and image analysis developed by PNNL for the US Department of Energy's Office of Science. The environmental monitoring systems are capable of reliably detecting a broad spectrum of chemical and physical conditions using bacteria, insects, and fish as the environmental sampling media.

Uptake and Fate of Petroleum-Derived Compounds in a Terrestrial Food Web: These studies investigated the chemical and biological fate of chemicals such as oils, analine, phenol, quinoline, indole, and others in various soils and crops, and an insect/avian food web. These determined initial toxicity plus potential food chain availability.

Studies on Environmental Effectiveness of Novel Microbial Bioremediation Strains on Fresh and Aged Petroleum Spills in Soils: In conjunction with investigators from the former Soviet Union and under a USDOE program studies have been conducted on the development and testing of novel soil microflora for the rapid remediation of petroleum spills and industrially contaminated sites in the US and Russia.