The Stroud™ Water Research Center at a Glance

OVERVIEW
Driven by the philosophy that understanding the science of fresh water is fundamental to our ability to protect the integrity of this finite and vital resource, the Stroud™ Water Research Center conducts basic and applied research on freshwater ecosystems throughout the world. The Center seeks to disseminate its research findings to its peers in the scientific and educational communities, as well as to businesses, landowners, policymakers and individuals, to enable informed decision-making that affects water quality and availability in our local communities and the world around us.

We accomplish our goals through our pursuit of scientific research, as well as through research on educational strategies by building effective programs that teach about water resources. Our science staff is internationally recognized for their pioneering research on streams and rivers. Scientists work in interdisciplinary research teams, blending talents in hydrology, chemistry, microbial ecology, invertebrate and fish biology, watershed ecology, and ecosystem modeling to study the physical, chemical, and biological processes of streams and rivers, the life histories of individual organisms, and the ecology of watersheds. Our educational programs serve audiences ranging in age from elementary school students to adults in continuing education programs, undergraduate programs, internships, and graduate and postgraduate studies.

Stroud Water Research Center undertakes applied research projects for public agencies and private corporations in an effort to provide solutions to water resource problems throughout the world.

You can find updates and photos on all of our exciting projects and activities by visiting us online. Go to: www.stroudcenter.org and www.facebook.com/WaterResearch

MISSION
To advance the global knowledge and stewardship of fresh water through research, education, and global outreach and to help businesses, landowners, policymakers, and individuals make informed decisions that affect water quality and availability around the world.

GEOGRAPHICAL LOCATION
The Stroud™ Water Research Center is located in Chester County, Pennsylvania, about 40 miles (65 km) WSW of Philadelphia, and about 60 miles (95 km) NE of Baltimore. The Center is situated adjacent to White Clay Creek in the hilly terrain of the Pennsylvania Piedmont physiographic province. White Clay Creek is a tributary of the Christina River, which flows into the Delaware Bay. In 1981 NSF designated
Stroud™ Water Research Center an Experimental Ecological Reserve and, in 1998, an LTREB site for its dedication to long-term experimental research on an ecosystem that is an outstanding representative of its type. The Center sits along the banks of WCC, a Pennsylvania-designated exceptional value watershed and a part of the National Wild and Scenic Rivers system. The designation affords the stream and its watershed special protection against human induced degradation. Additional protection is afforded by conservation easements in place over much of the watershed.

RESEARCH AND EDUCATION
The Center's research and education efforts span temperate and tropical rivers and streams in North America, Central and South America, Africa, New Zealand, Antarctica, Easter Island, and Papua New Guinea. Our findings have served as the basis for regulatory legislation to protect freshwater resources and contribute to our understanding of the major issues of our day. Our education programs are influencing thousands of citizen scientists, increasing awareness about water issues and providing the knowledge and skills required to address them. Educational products like the Leaf Pack Experiment Kit from the LaMotte Company, the Leaf Pack Network®, and new, collaborative programs and curricula are engendering watershed stewardship everywhere. What follows below are brief descriptions of the many recent research and education projects completed or ongoing at the Stroud Water Research Center.

Developing Best Practices and Providing Data to Support Science-Based Legislation That Protects Freshwater Resources

Our research on the effects of temperature changes on insects and fish provided data for revisiting existing legislation to protect U.S. streams and rivers from thermal pollution discharged by power plants and other operators, ensuring preservation of the ecosystem while enabling more cost-efficient plant operations.

Center scientists have regularly assessed regional stream conditions in Pennsylvania. For example, recognizing biological impairment and sources of stream degradation in the Schuylkill River basin in Pennsylvania affects regulations for the river's ongoing protection and management, greatly improving water quality for the millions of residents who rely on the watershed for clean, fresh water.

Stroud’s expert testimony provided to the U.S. Department of Justice has helped influence the protection of wetlands throughout the United States that both sequester pollutants and reduce dangerous flooding.

Stroud's streamside forest research has served as a basis for Pennsylvania's proposed stormwater regulation policy requiring 100-foot-wide riparian forest buffers that will help protect landowners from flooding and improve water quality.
Improving Water Quality Through Monitoring and Testing the Efficacy of Water Treatment Options

The Center is leading the International Barcode of Life project’s Freshwater Surveillance Group, whose work promises to facilitate rapid, inexpensive, and more accurate methods of monitoring water quality as a result of cataloging the world’s freshwater species using DNA barcoding.

Our assessment of the health of the Mississippi, Missouri, and Ohio rivers will determine whether human impacts have increased algal production to levels that affect organic nutrient exports downstream, causing algal blooms, fish kills, and ocean dead zones.

Monitoring programs in the Rio Sierpe and Osa Peninsula of Costa Rica have provided baselines of the health of freshwater ecosystems and data on land-use impacts, enabling the establishment of conservation targets and guidelines which could become the model for other tropical watersheds.

Assessing Results of Remediation and Environmental Regulation to Preserve Water Quality

An analysis of stream and water quality in Bucks County, Pa., by Center scientists after 40 years of protection from the Clean Water Act, have helped to better define the value of efforts to prohibit point source pollution from entering our waterways.

Researchers at the Center recently completed a study about the effects of acid mine drainage (AMD) on the health of streams that flow into the Chesapeake Bay. The study evaluated the remediation of AMD-influenced streams in Pennsylvania to determine the success of restoring the health of an AMD stream and protecting the bay from hypoxic conditions or dead zones.

Research on the effects of elevated levels of dissolved phosphorus in streams using the Center’s experimental streams is helping to untangle the complex relationships between plant nutrients, algal growth, and changes to aquatic insect communities (the primary food items for fish in streams). Results from these...
types of experiments feed information directly to regulators to help develop standards and regulations for both point- and non-point-source pollutants.

**Understanding the Role of Freshwater Systems in the Carbon Cycle and Global Climate Change**

Research on the Fly River in Papua New Guinea will determine whether the combined effects of mountain erosion and deposition in floodplains and estuaries have important consequences for carbon cycling and climate change.

Research in the Andean Amazon explores the role of extreme flood events during La Niña in burying globally significant quantities of carbon.

A study of the attributes of the Congo River’s dissolved organic carbon is calling attention to the significant role of fresh waters in the carbon cycle and climate change.

Research in tropical Costa Rica may yield important data as to how species will respond to changes associated with global climate change.

Stroud scientists and University of Delaware colleagues have established the Christina River Basin Critical Zone Observatory to study large-scale, human-induced erosion and its relationship to the carbon cycle and climate change.

Ongoing research on the changes in forest ecology and soil chemistry caused by exotic earthworms in North American forests will determine whether their presence alters carbon storage in forest soils and impacts climate change.

**Empowering the Next Generation of Freshwater Stewards**

Stroud Water Research Center educators and scientists are inspiring hundreds of thousands of Longwood Gardens visitors to create beautiful, eco-friendly landscapes through a multifaceted education program entitled Cultivating an Ecosystem Esthetic.

An innovative Web 2.0 application and watershed education program entitled, Model My Watershed, is empowering Pennsylvania students to understand the impact of various land-planning options on water quantity and catalyzing interest in science, technology, engineering, and math (STEM) careers.

Cabrini College students are acquiring the skills to deal with water issues and are actively engaging in watershed stewardship activities due to new Watershed Ecology and Watershed Citizenship curricula co-developed by Stroud Water Research Center educators.

Center educators are leading an effort modeled after the highly successful Mountaintop-to-Tap trek...
(through the New York City drinking water source watersheds), to guide high school students from Coatesville, Pa. on a trek through the Brandywine Creek watershed to learn about water resources management and the importance of streams and rivers as drinking water sources.

Center educators continue to partner with Pa. conservation organizations, municipal advisory committees, watershed associations, and citizen action groups to provide technical assistance and training in conducting effective watershed assessments and restoration efforts.

Underserved teachers and students in the Chesapeake Bay watershed were introduced to “boots-in-the-water” water quality monitoring using the Leaf Pack Experiment Kit.

Center educators have helped translate the Leaf Pack Experiment Kit and program into Spanish and offer training in Central and South America with assistance from the Moore Foundation, the National Geographic Society, and the Stroud Endowment.

A BRIEF HISTORY AND FUNDING

The Center is a product of a 45-year history involving the Stroud family (principally William Bolton Dixon Stroud and Joan Milliken Stroud), Dr. Ruth Patrick of the Academy of Natural Sciences of Philadelphia (ANSP), the Stroud Water Research Center (an independent non-profit 501(c)3 corporation since October 1, 1999), charitable foundations, and individual donors. The Center was the vision of Dr. Patrick, who as chairman and curator of the Limnology Department of the ANSP began the Center as a field station of the ANSP in 1966. The Center was initially housed in a garage near the present location until Dick and Joan Stroud funded the construction of a laboratory building along White Clay Creek dedicated to freshwater research and education. At 3,005 square feet, the original building, completed in early 1968, housed seven research laboratories, a library-seminar room, offices, and storage space. Since then, the building has gone through two large-scale renovations. The first renovation occurred in 1975-1976 and was financed by the Stroud Foundation, other private donations, and a construction grant from the Kresge Foundation. That expansion (to 6,005 square feet) included four new laboratories, a large wet lab, a teaching lab, more office and storage space, and a lecture hall. In the 1990s, the Center set up its own Education Department to interpret the Center’s freshwater research to a diverse audience including policy and natural resource managers, primary and secondary education groups, and the general public. It soon became clear that the programs at the Center had again outgrown their space and the Center embarked on a capital campaign to raise funds for another building expansion and to grow endowment for its programs. In 1995-1996, the Stroud Water Research

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Joan Milliken Stroud       W.B. Dixon Stroud         Dr. Ruth Patrick
Founders of the Stroud Water Research Center.
Center expanded to its current size of 24,820 square feet by building new laboratories for invertebrate biology and toxicology, storage areas for biological collections, office space, a teaching lab, a lunch room, and an expanded lecture room to accommodate 175 people. This last major renovation was completed in 1999, with the dedication of a “streamhouse”; a glass house attached to the main research facility that has recently housed 10 indoor experimental streams and several other experimental and biological rearing/culturing systems. The final step toward the Center’s current configuration occurred in 1999 when the ANSP trustees authorized the Stroud Water Research Center to become an independent not-for-profit organization and gave title of all land, buildings, and equipment to the Center.

Since the Center’s founding by Dr. Ruth Patrick in 1966, interdisciplinary research teams of scientists and educators have conducted pioneering research on streams and rivers throughout the world and have designed and lead innovative education programs about freshwater issues to a broad audience both locally and around the world. Sites have included the United States, Costa Rica, Bolivia, Peru, Brazil, Cambodia, Thailand, the Democratic Republic of the Congo, Papua New Guinea, New Zealand, Easter Island, and Antarctica). While much of the research is done in streams and rivers all over the world, the Center’s facility includes the White Clay Creek experimental watershed with a 40-plus-year research and monitoring record and the unique aspect of indoor “wet” laboratories and streamside flumes fed by flowing water pumped in from the creek. This exceptional combination of facilities enables Center scientists, educators, and visiting researchers to carry out ecosystem simulations over a range of physical scales and thereby bridge the gap between laboratory and field studies, test hypotheses, and refine methods locally and then deploy that knowledge to benefit studies on streams, rivers, and watersheds throughout the world.

BUILDING FOR A SUSTAINABLE FUTURE

In 2008 the Center started on an ambitious project to expand its campus as a direct and proactive way to support its mission of research and education on freshwater ecology. The cornerstone of the project is the construction of an 18,180-square-foot Leadership in Energy and Environmental Design (LEED)-certified Environmental Education building on the Center’s now 55-acre campus. The “green” building will provide improved and expanded space for the Center’s educational program, while freeing space in the existing buildings for enhanced freshwater research. The driving principal of this project is to “Get the Water Right” on the Center’s campus. That requires the design and execution of an integrated water management system and a set of best management practices (BMPs) to: (i)
restore the natural hydrology of the site; (ii) document and monitor the changes; and (iii) use both the information we generate and our new green campus to create environmental education programs for a variety of audiences.

For many years, the impact of the Center’s current infrastructure has (1) impeded stormwater infiltration (thus reducing groundwater recharge in increasing storm flow in nearby White Clay Creek), (2) impacted nearby groundwater quality because the campus utilizes an old wastewater treatment technology (the Center is located in rural Pennsylvania and utilizes a traditional septic tank/drain field system), and (3) has resulted in a dependency on groundwater and imported bottled water to meet gray water and potable water demands. This new building, along with modifications to our existing campus infrastructure, aims to fix many of these problems in order to “Get the Water Right.” To this end, improvements will incorporate state-of-the-art solutions including a wetland waste treatment and drip irrigation system to handle wastewater; composting toilets to reduce wastewater production and clean water use; new stormwater management infrastructure such as rain gardens, bioswales, pervious pavement surfaces, and native vegetation to increase infiltration and reduce stormwater runoff and related nonpoint source pollution; and rainwater capture from our new building’s metal roof to feed grey water and science laboratory systems that will reduce and eventually eliminate the need to withdrawal groundwater. The project has the support of the Pennsylvania Department of Environmental Protection in the form of a grant to help construct the wetland and rainwater capture systems.

INCORPORATING GREEN SOLUTIONS

- **Sustainable Water Use and Treatment**
  - The use of rainwater capture will reduce and eventually eliminate groundwater withdrawal.
  - Wetland waste treatment and drip irrigation system will reduce nitrate discharges, improving water quality of the local aquifer.
  - Composting toilets and a water-reuse system for flush toilets will reduce water use by more than 40 percent over conventional systems.

- **Stormwater Management**
  - Natural landscaping will increase infiltration, and reduce runoff and related nonpoint source pollution; features will include bio-swales, rain gardens, pervious surfaces, and native vegetation.

- **Overall Energy Efficiency**
  - Geothermal heat pumps and a green roof will boost energy efficiency and reduce operational heating and cooling costs by more than 35 percent.
  - Natural ventilation will reduce cooling costs and improve indoor environmental air quality.
  - Solar power will provide a carbon-free source of more than 12 percent of the new building’s energy needs.
• High-efficiency fiberglass windows by Serious Windows will reduce energy loss.
• Sunshades will reduce the air conditioning requirements of the building and minimize glare.

**Recycled and Locally Sourced Materials**
• At least 10 percent of materials will be regionally sourced; for example, locally quarried stone and at least 10 percent of building materials will be recycled.

**Indoor Environmental Quality**
• Low-emitting versions of materials such as carpet, paint, and adhesives will be used throughout.
• Natural ventilation and lighting will be maximized.
• Lighting will be efficient and task-specific.

**Educational Opportunities**
• Educational and interpretive signage will appear on all innovative building and landscaping solutions.

The Stroud Water Research Center is committed to this project for the long term: The new facility is being designed with a 100-year life expectancy, and the site and stormwater improvements are designed to restore and regenerate conditions, with a goal of coming as close as possible to a “natural woodland” in terms of environmental impact. This, in turn, complements — and will provide a demonstration site for — the conservation activities of organizations such as the White Clay Watershed Association, the Chester County Conservation District, and West Marlborough Township.

**SOURCES OF FUNDING (2010)**

Funding for research and education at the Stroud™ Water Research Center comes from competitive grants and contracts (~65 percent), from an institutional endowment (~25 percent), and from annual fundraising efforts (~10 percent). The funding sources in 2010 are listed here in abbreviated form: US NSF (8 projects from 3 directorates), U.S. NASA (1), USDA (1), U.S. Department of Justice (1), Pennsylvania Department of Environmental Protection (4), Kent County, Delaware (1), city of Philadelphia Water Department (1), William Penn Foundation (1), Blue Moon Fund (1), Marsden Fund of New Zealand (1), National Institute for Water and Atmospheric Research, Ltd. in New Zealand (1), Proctor and Gamble Company (2), and Pennsylvania Power and Light (1). Historically, other sources of funding have included the U.S. Department of Energy, U.S. EPA, U.S. National Park Service, Gordon and Betty Moore Foundation, Campbell Foundation, National Fish and Wildlife Foundation, and Chesapeake Bay Foundation.