Hemond Professional Statement

The practice of engineering now requires consideration of the environment, which is the source of materials and fuels, the sink for waste, and the physical and chemical background shared by man, machines, and the biological world. Yet, present knowledge is not adequate to predict how engineered systems and the world's ecosystems will behave collectively. New knowledge is needed to address the environmental issues of coming decades.

My work focuses on the interactions that control the movement and fate of chemicals, both natural and man-made, in the environment. The goals are (i) to understand the environment at a level adequate to support engineering solutions to a host of contemporary environmental problems, and (ii) to help educate a future generation of environmental engineers.

My approach to teaching and research emphasizes the "big picture" as it emerges from the interaction of chemical, physical, and biotic processes. Input from many disciplines is required. Hydrology is a controlling influence throughout the environment. Aquatic chemistry is essential to the interpretation of chemical data, while analytical chemistry establishes chemical pool sizes. Biology is central, as vascular plants and microbes provide chemical reducing power, catalyze chemical transformations, and create environmental structure and productivity. The great temporal and spatial
variability of the environment creates data needs which require new tools based on microelectronics, new sensor technology, and remote sensing.

This work has a strong experimental and field orientation. Data must often be gathered from the real world, where key chemicals may be dilute, unstable, inaccessible, and/or toxic. My students become proficient with sophisticated analytical instruments as well as with drilling tools, mosquito repellent and the other paraphernalia of fieldwork. A few highlights include:

¥ Major contributions to understanding the cycling of water and major elements in wetlands, and thus to managing them more effectively as pollutant sinks.

¥ Documentation, quantification, and modeling of the role of natural organic acids in stream acidity, contributing to the NAPAP (National Acid Precipitation Assessment Program) acid rain assessment.

¥ Advancement of an instrumental approach to help overcome limitations on chemical measurements in ground waters and hazardous waste sites, by providing in-situ, real-time measurement of vapors.

¥ Research on atmospheric trace gases (e.g., methane and nitrous oxide), which are crucial to climate change prediction and thus to formulating the world's technological response to climate issues.

¥ Improving the fundamental basis of Pb-210 dating, crucial to establishing the pollution history of many lakes and reservoirs and to designing management programs.

Teaching is central to my work. I involve many UROP students as well as graduate students in both field and laboratory. I have developed part or all of several successful environmental subjects in limnology (1.75), groundwater quality (1.723), an undergraduate laboratory subject (1.107), and, most recently, an institute-wide subject (1.725/TPP51J) which introduces to M.I.T. students from all departments the principles controlling the environmental fate and transport of man-made chemicals. The goal is to help broadly educate future engineers and societal decision-makers about the processes that operate in the environment, processes that must in the future be considered a part of many engineered systems. Receipt of the 1989 Graduate Student Council Teaching Award for Course 1 was a gratifying recognition of my interest in teaching the fundamentals of the environment.

I intend to continue environmental teaching and research with a focus on interactions between water movement and chemical transformations, controls of critical atmospheric trace gases, and in-situ chemical measurements. Toxic chemicals, applications of remote sensing, and the interface with human health effect studies will receive increased emphasis. I have also started a textbook specifically for use with subjects such as Chemical Fate and Transport (1.725/TPP51J) as part of a long-term commitment to helping equip engineers with adequate tools to address environmental problems.