2010 IGEP Proposal
Water INTERface: INTERdisciplinary Research Transcending Boundaries of Engineering, Science, and Human Health

A. IGEP Proposal Title: Water INTERface: INTERdisciplinary Research Transcending Boundaries of Engineering, Science, and Human Health.

Table 1. Core and Affiliated Faculty in Water INTERface IGEP

Faculty Name[1,2]	College	Dept	Area of Expertise
Brenda Davy*	CALS	HNFE	Health Behaviors, Obesity Prevention/Treatment
Kevin Davy	CALS	HNFE	Human Integrative Physiology
Andrea Dietrich*	COE	CEE	Drinking Water Chemistry/Aesthetics
Susan Duncan*	CALS	FST	Sensory Science, Food Processing
Marc Edwards*	COE	CEE	Water Treatment and Distribution, Ethics
Paul Estabrooks	CALS	HNFE	Behavioral Science, Community Systems
Joseph Falkinham*	COS	BIOL	Water-Borne Infectious Disease
Dan Gallagher	COE	CEE	Risk Assessment, Statistics
Thomas Grizzard	COE	CEE, NCR	Water Re-use, Public Health
Yanna Lambrinidou	CLAHS	STS, NCR	Public Policy, Sociology, Ethics
Sean O'Keefe	CALS	FST	Analytical Chemistry, Food Chemistry
Amy Pruden-Bagchi	COE	CEE	Environmental Microbiology
Elena Serrano	CAL	HNFE	Community Nutrition, Extension

[1]Core faculty (bold*) email: bdavy@vt.edu; andread@vt.edu; duncans@vt.edu; edwardsm@vt.edu; jofiii@vt.edu; [2]Steven Schoenholtz (CNR, VA Water Resources Research Center) will serve as the liaison with other water research groups on campus and in Virginia.

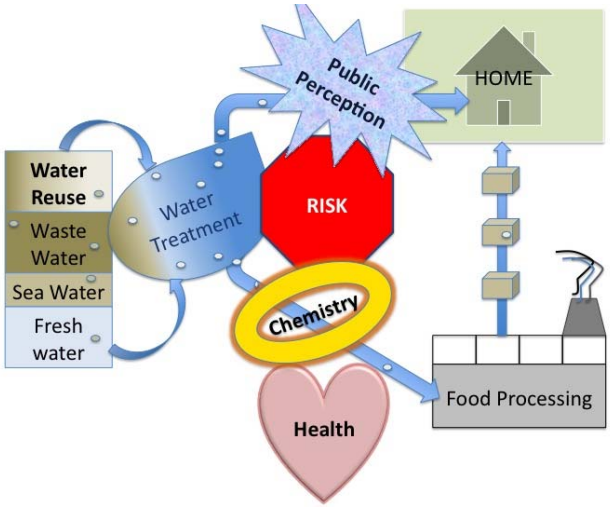
This interdisciplinary faculty group is united by a central focus of water for health, spanning from "pipes to people". Clean water is a common topic discussed in many classrooms and research laboratories around this campus. Yet, the complexity of societal issues related to water shortages, cleanliness, and quality, which influence water consumption and its role in human health, highlights the need for increased interdisciplinary dialogue and problem-solving capabilities. This proposed Interdisciplinary Graduate Education Program (IGEP) unites graduate students and faculty in 4 colleges and 5 departments in addressing technical and societal challenges of transforming low-quality water resources into clean water for healthy living. Four interdisciplinary thematic areas in this education and research program include (Figure 1):

Thematic Areas

- **Public Perception:** public perception of technological options and advancements for providing clean water resources (water treatment);
- **Risks:** risks (perceived or real) associated with contaminants and water-borne infectious diseases in private homes , public water systems, and commercial food processing facilities;
- **Chemistry:** role of water chemistry (e.g. mineral composition) in delivering functional qualities such as flavor and bioavailable nutrients;
- **Health:** role of water consumption in health, wellness, and mitigation of mineral deficiencies and diseases including obesity.

B. Introduction: Training Program Rationale. There is a critical need for scientists (physical, biological, health and social) and engineers to evaluate and implement cost-effective technical solutions to global potable water challenges with consideration of health, safety, and public perception issues. Shortages of fresh water for drinking are projected to occur around the world as illustrated by this quote: "….global water consumption is doubling every 20 years, and the United Nations expects demand to outstrip supply by more than 30% come 2040" (Newsweek, October 2010). This will necessitate taking poor quality water – waste water (industrial, agricultural, municipal) or sea water- and processing it to meet drinking water standards. Technical solutions exist to provide potable water to meet regulatory standards. Yet, changes in chemical, nutritional and palatability characteristics influence water use, safety, consumption, and health and risk of chronic diseases. In addition, public perception and acceptance of feasible engineering solutions for solving water shortages play important roles in societal adoption of technologies. The "interfacial tensions" related to technological feasibility versus societal fears of water treatment options and regulatory standards versus public acceptance of water quality can be overcome with a new Water INTERface approach.

Figure 1. Water INTERface Program explores technical, societal challenges facing water reuse for public and private drinking water and effect on human health.



Education and Research Goals. We will create a community of doctoral students and faculty that incorporate Blacksburg and Northern Capitol Region (NCR) campuses. This community will integrate knowledge of potable water treatment processes with the implications of those processes on water quality, safety and health. IGEP program participants will engage in interdisciplinary research projects to address the four thematic areas described above. Coursework and research experiences will transcend traditional disciplinary boundaries of engineering, science, and human health. This program will enable all Water INTERface participants to:

- understand complex societal issues related to water treatment, cleanliness and quality, water consumption and use, and the role of water in human health;
- develop professional skills for engaging in interdisciplinary research to address the scientific, technical and societal issues associated with these thematic areas;
- engage in ethical thinking and action in relation to the practice of engineering, science, public policy and health pertaining to water.

C. Description: Long Term Goals & Intellectual Focus. Our goal is to create an internationally recognized integrated graduate education and research training program for addressing the challenges of delivering water for healthy living in the 21st century. The initial IGEP seed money will increase the connectivity of the nationally and internationally recognized individuals within the Water INTERface faculty in Blacksburg and NCR. Together with IGEP funding, faculty can join forces to expand water and health research at VT through competitive pursuit of funding from NSF, NIH, EPA research and training grants, and private funding sources. The Water INTERface program will attract students who desire to contribute to public and personal health and well-being and that international government agencies will send/fund students to participate in this program. The connection of NCR and Blacksburg programs is a key to the IGEP success. An NCR-STS to Blacksburg-CEE faculty teaching interaction (Edwards/Lambrinidou; CEE 5984) currently operates and will expand under IGEP. These two VT locations also have been connected for the past 30+ years through CEE. Each semester CEE students in both locations enroll in classes that are simultaneously delivered to both sites through point-to-point polycom or the Commonwealth Graduate Engineering Program (CGEP). CEE Blacksburg and NCR graduate students/faculty meet weekly through a "polycom" seminar; the programs share research collaborations and advising. IGEP will allow Blacksburg HNFE, FST, and BIOL programs to "capitalize" on existing STS and CEE Blacksburg-NCR connections.

Intellectual Research Focus: Research and educational foci that integrate the four thematic areas (public perception, risk, chemistry, and health) include:

- **Emerging Water Technologies:** Large scale and on-site water treatment is changing from traditional and accepted methods that minimally altered mineral and nutritional content, to water reuse, membranes, desalination, and storage that greatly alter water quality and public perception. Research will address societal impacts of emerging technologies on safe and palatable drinking water, risks, water quality for intended use, and public perception.
- **Water Aerosols, Pathogen/Contaminant Distribution, and Human Exposure:** Aerosolization/microdroplets are recognized sources of contaminants and pathogen distribution in homes (e.g., showers) and food processing (e.g., steam processing, cleaning protocols). Research will address differing water chemistries and biological makeup on water aerosolization and real/perceived risks of personal and processing use of water.
- **Water Consumption, Disease Prevention and Quality of Life:** The epidemic of obesity and related comorbidities (i.e., diabetes, cardiovascular diseases) underscores the need for effective lifestyle interventions that are translatable to large-scale settings (e.g., medical systems, worksites, communities). Increasing water consumption is an effective strategy to manage body weight, yet research must determine how individual (i.e., taste preferences, metallic flavor perception) and social/ecological factors (i.e., consumption patterns of friends/family, public perception, water availability) influence water consumption. Such information assists development of interventions with large-scale translation potential. We will also address the use of a water-based system for reducing metallic flavor perception in cancer patients, which has important health and quality of life implications.

- **Chemistry/Biology of Water Infrastructure Materials and Biofilms:** "Pipes to People" describes producing water in one location then transporting it through large and small pipes to consumers. Critical research is needed to investigate alterations in water quality or water distribution infrastructure and proliferation of pathogenic/nonpathogenic species that impact health, risk of contamination, water and material's chemistry, and public perception.

Students will increase knowledge and comprehension of the four thematic areas (public perception, risk, chemistry, health) through the core coursework. Students will explore critical thinking of the thematic areas in literature reviews and meeting research objectives in their course discussions, research activities, and dissertations. The core courses, which have been developed and taught at least once (CEE 5984 in Fall 2010; CEE/FST/HNFE/BIOL 5984 for Spring 2011), include:

- Ethics in Engineering, Science and Public Policy (CEE 5984);
- Water for Health Seminar (CEE/FST/HNFE/BIOL 5984);
- Interdisciplinary Research (GRAD 5134);
- Independent Research Study (GRAD 5974).

A coursework timeline, course descriptions and syllabi topics (5984 courses) are in Appendix 1.

Anticipated Pitfalls and Challenges: How They Will Be Addressed. This program was developed to overcome anticipated pitfalls of interdisciplinary research (Rhoten, 2004), which include: 1) conducting research in "disciplinary silos" as opposed to at the disciplinary interface; 2) a lack of well-defined unifying research problems, leading to loose connections among faculty; and 3) medium/large program size (> 20 faculty) which can lead to fewer knowledge-creating connections among faculty and graduate students. Our faculty has a significant history and future plan for engaging in collaborative research activity (Appendix 2, 3). During the past decade, groups of 2-5 faculty successfully competed for governmental (NSF, USDA) and industrial research agency funding that resulted in multi-author interdisciplinary presentations, publications, and additional funding. In the past two years, they (1) received funding from two VT Institutes (ICTAS, Fralin) to support early stages of their interdisciplinary water and health center; (2) co-presented a symposium at the 2010 American Chemical Society meeting on water and health; and (3) served together on current doctoral students committees (Hedrick, HNFE PhD candidate; Mirlohi, Wang, and McKinney CEE PhD candidates). The faculty participated in an interdisciplinary research workshop in May 2010 to consolidate their relationships and expand their research collaborations. Engaging students and faculty in the Water INTERface core courses will serve to further enhance cross-departmental research collaborations.

To address the second challenge, the courses CEE/FST/HNFE/BIOL 5984 Water for Health Seminar and GRAD 5134 Interdisciplinary Research will be used to identify gaps in existing literature related to pertinent research questions. Faculty and students will participate in both courses, thus facilitating interactions among individuals in different departments and colleges, and promoting a sense of community among those involved with this program. Finally, attention to program size (< 20 affiliated faculty) will increase the likelihood of developing meaningful connections within the group.

Student Recruitment & Retention: Reaching a Steady and Sustainable Student Stream. Recruitment for 2011 will take place using the following mechanisms:

1) Local recruitment within existing graduate and undergraduate (UG) programs at VT including Water INTERface faculty home departments, with a combined total UG enrollment exceeding 3400 students, VT's summer undergraduate research fellowship/programs participants (i.e., Fralin Life Science Institute's SURF program; Chemistry SURP), and MAOP and McNair programs.
2) Program announcements on VT Institute's websites (Institute for Critical Sciences and Applied Technologies [ICTAS], Fralin Life Science Institute, and the Institute for Society, Culture and Environment [ISCE]), Water INTERface faculty home department webpages, and National Capital Region campus homepages.
3) National recruitment through postings to the IGERT Resource Center website (digest@igert.org) and website and email announcements, brochures, and attending student receptions at meetings of professional societies (e.g., American Chemical Society, Institute of Food Technologists, Obesity Society, American Dietetic Association, Association of Environmental Engineering and Science Professors, American Society of Civil Engineering, American Water Works Association, Virginia Branch of the American Water Works Association, International Water Association).
4) Program announcements on recruiting websites for minorities and underrepresented groups (www.pathwaystoscience.org).
5) Beyond 2011, faculty and students will use the above mechanisms and add site visits to/from other institutions using funding from IGEP to attract excellent students.

Retention will be facilitated by including an (1) active mentoring program by the core faculty group; (2) developing a community network through collegial interactions, both professional and social; and (3) openly engaging all students within the Water INTERface program in open discussion of program activities, planning, and solutions to challenges. A Scholar Working Group Site will be established to provide a Water INTERface community network.

Plan for Securing Funds for Assistantships. This group is collaborating on developing an NSF IGERT application. The research team assembled in May of 2010 to develop the theme and goals of the IGERT application. If successful, this IGERT would fund 20, 24-month doctoral assistantship positions with a stipend of $30,000 per year each. The group also has discussed developing a training program grant through NIH. Funding for three graduate research assistants is currently being provided through a $300,000 award from ICTAS to this Water for Health research initiative (PI: A. Dietrich) and an additional GRA has been received from the College of Agriculture and Life Sciences Integrated Proposal initiative (PI: S.E.Duncan).

Plan for Program Assessment, Outcomes and Benchmarks. Progress toward meeting program goals will be assessed by the core faculty on a semi-yearly basis and will be entered and evaluated in the university WEAVE assessment site. Both program faculty *and* graduate students will be held accountable for achieving program goals, through an assessment of the program outcomes (Appendix 4).

Appendix 1. Water INTERface Coursework Timeline, Course Descriptions, 5984 syllabi topics

Year 1 (2011-12)	Year 2 (2012-13)	Year 3 (2013-14)
FALL: CEE 5984 Ethics in Engineering, Science and Public Policy (3 cr.)	**FALL:** GRAD 5134 Interdisciplinary Research (3 cr.)	GRAD 7994 Dissertation
SPRING: CEE/FST/HNFE/BIOL 5984 Water for Health Seminar (1 cr.)	**SPRING:** GRAD 5974 Independent Study (1-3 cr.)	GRAD 7994 Dissertation
Both Semesters: Departmental Core Coursework Complete training course in Human Research Participant Protections	**Both Semesters:** Departmental Core Coursework	

GRAD 5134 Interdisciplinary Research (3 cr) **Instructors:** Core Faculty. Description: In-depth coverage of significant research questions and topics including social/ ecological aspects of water consumption, role of water in controlling disease and promoting optimal health, public perceptions of water quality, and water re-use; all topics require interdisciplinary expertise, methodologies, and analysis. Students will work in interdisciplinary teams to identify, discuss, and prepare a "white paper" on the engineering, scientific, social and ethical technologies and issues involved in reclaiming water from a tributary that filters municipal waste for endpoint use as potable water and implications to chemical and biological safety, health and palatability of this potable water source.

CEE 5984 Ethics in Engineering, Science and Public Policy (3 cr) **Instructors**: Edwards (CEE), Lambrinidou (STS). *This course was first offered in the Fall of 2010.* Description: Drawing from case studies at the intersection of engineering, science, and public policy, this course examines the cultural and moral dimensions of engineering and scientific practice through the prism of ethical theory. It explores professional, institutional, and political values underlying the production of knowledge and shaping regulatory solutions to real-life problems, and identifies tensions that can arise between "expert" and "non-expert" perspectives on matters that can have serious and large-scale societal consequences.

CEE/FST/HNFE/BIOL 5984 Water for Health seminar (1 cr). **Instructors**: Dietrich (CEE), Duncan (FST), Davy (HNFE), Falkinham (BIOL). *This course is offered Spring 2011.* Description: Through interactive presentations and discussions of articles from disciplinary and interdisciplinary sources, students and faculty will explore potable water treatment, factors influencing water-borne infectious diseases, the need of the human body for water, nutrients present or absence from tap and bottled water, choices consumers make in selecting waters or other beverages, and implications of engineering treatments and consumer choices for promoting human health.

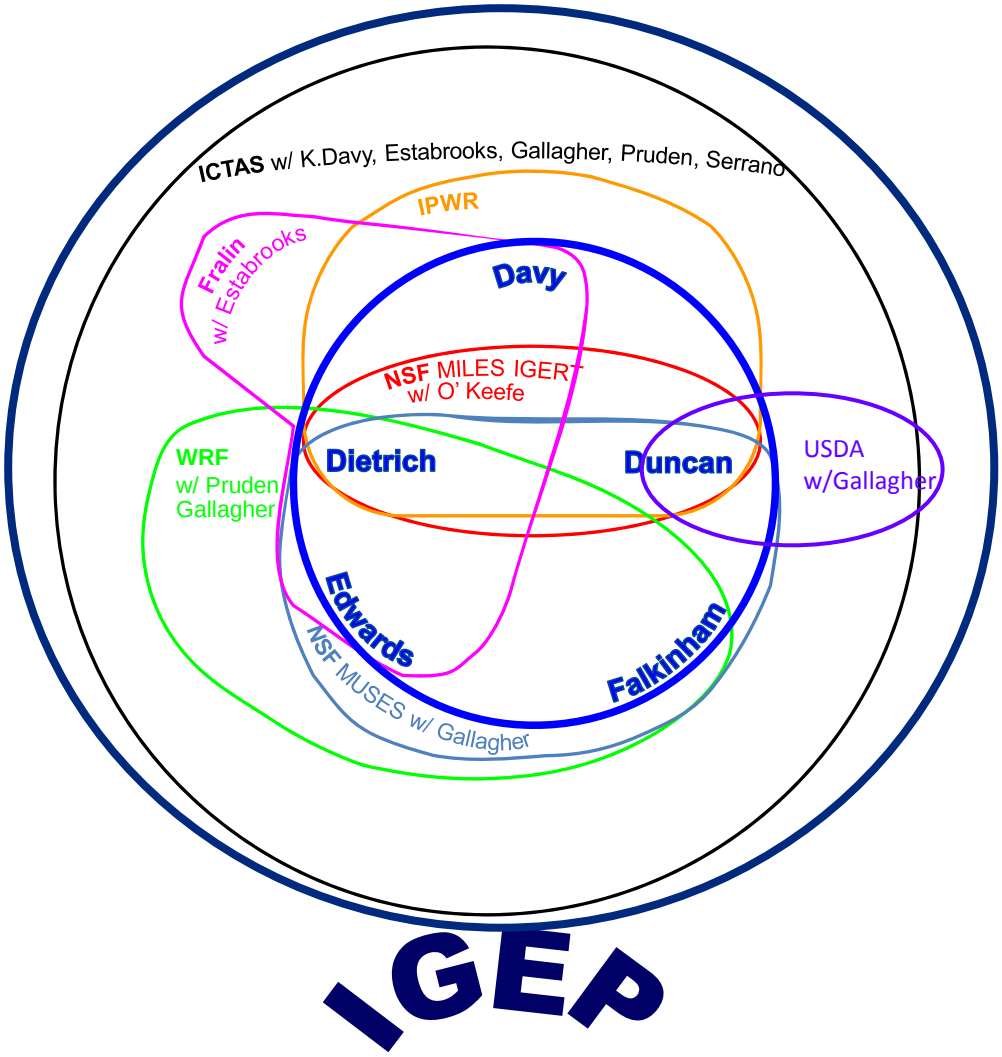
GRAD 5974 Independent Study (1-3 cr). **Instructors**: Any Water INTERface affiliated faculty may supervise this independent study laboratory experience. The course is designed to build skills and knowledge in water research methodology exploration in a discipline outside the student's primary discipline.

Appendix 1 (continued). Syllabi topics for Ethics in Engineering, Science and Public Policy (CEE 5984) and Water for Health Seminar (CEE/FST/HNFE/BIOL 5984)

Ethics in Engineering, Science and Public Policy (CEE 5984; 3 cr)	Interdisciplnary Seminar: Water for Health -CEE/FST/HNFE/BIOL 5984; 1cr
• Professionalism and moral responsibility: History of engineering in the US and professional codes of ethics • Working for others: Organizational culture and organizational loyalty • Witnessing wrongdoing: Dissent and whistleblowing • Assessing harm: Public health, public health ethics, and government responsibility • Communicating risk: Community "right to know" and public education • Multidirectional learning: Public participation, knowledge and advocacy • Responsibility in scientific research: Obligation of scientists and scientific journals • Scientific credibility and public trust: Conflicts of interest and scientific misconduct • Reassessing science: Accountability, transparency, and the ability of science to "self-correct" • Scientists and the media: Communicating science to the public • Science, policy and the law: Expert advocates, litigation, and public policy	• Water quality and availability • Human nutrition and need for water • The flavor of water • Water as a preventative to disease • Water treatment processes • Microbiological species in water distribution systems • Role of water in food processing and food safety • Individual Class Presentations

Appendix 2. Examples of planned proposals for pursuing additional funding

Agency	RFP/RFA Title	PIs	Due Date
NSF	Integrative Graduate Education and Research Traineeship	Dietrich Duncan	Limited submission to VT in 2011
NIH	R. L. Kirschstein NRSA Institutional Research Training Grants (T32) – PA-10-036	Davy Estabrooks	May 2011 or later
EPA or NIEHS	Showering as a Route of Inhalation Exposure to Contaminant Vapors and Particulates of Pathogens and Chemical Precipitates"	Falkinham Gallagher Dietrich	open
WRF	Quality, Flavor and Nutritional Alterations from Storage of Drinking Water in Abandoned Quarries	Dietrich Grizzard	May 2011
NIH	NIDCD Research Grants for Translating Basic Research into Clinical Tools for Human Health; (R01) PAR-07-128	Duncan Dietrich Davy LesserWFU	May 2011 or later



Appendix 3. Previous and Current **Water INTERface** faculty collaborations; circles engulf participating faculty and list the funding agency.

- NSF MILES IGERT (2004-2010, $3.2 Million)
- NSF MUSES (2003-2010, $1.75 Million)
- IPWR (Institute for Public Health and Water Research (2006-2008, $0.25 Million)
- WRF (Water Research Foundation) (ongoing since 2000; $2 Million)
- Fralin Life Science Grant (2010, $0.01 Million)
- ICTAS (Institute for Applied and Critical Technologies) (2009-2012, $0.3 Million)
- USDA (2009-2011, $0.1 Million)

Appendix 4. Outcomes Assessment for Water INTERface IGEP

All Years:

Outcome: Compared to initial baseline, Water INTERface faculty *and* graduate students will progressively increase interdisciplinary research activity related to water and health through their publications, presentations, and grant submissions and a yearly social network analysis.

Year One

Outcome 1: Students will complete training in the ethical conduct of research, and understand ethical conduct related to issues surrounding water and health.

Benchmark 1a: 100% of first-year students will obtain verification of training in Human Research Participant Protections (i.e., Certificate of Completion).

Benchmark 1b: 100% of first-year students will receive a grade of B or better in CEE 5984 Ethics in Engineering, Science and Public Policy, and CEE/FST/HNFE 5984 Water for Health Seminar.

Year Two

Outcome 2: Students will participate as members of a team engaged in joint research and education.

Benchmark 2a: 100% of students will assemble a dissertation advisory committee that includes at least two Water INTERface faculty, at least one of which will be a core faculty member.

Benchmark 2b: 100% of students will complete coursework that includes interdisciplinary group assignments (GRAD 5134 Interdisciplinary Research).

Benchmark 2c: 100% of students will complete GRAD 5974 Independent Study, which entails a research experience in the laboratory of a Water INTERface faculty member.

Benchmark 2d: The four IGEP students will participate in at least one outreach activity of their choice (e.g., 4H, Engineers Without Borders)

Year Three

Outcome 3: Students will have evidence of successful engagement in interdisciplinary research, related to water and health.

Benchmark 3a: 75% of students will have submitted two or more manuscripts for publication, on a topic related to water and health.

Benchmark 3b: 100% of students will give at least one presentation at a national or international scientific meeting, related to water and health research.

VirginiaTech

College of Agriculture and Life Sciences
College of Engineering
College of Science
College of Liberal Arts and Human Sciences

December 1, 2010

Dr. Karen DePauw
Vice President and Dean of the Graduate School

Re: Water INTERface: INTERdisciplinary Research Transcending Boundaries of Engineering, Science and Human Health Interdisciplinary Graduate Education Program (IGEP) proposal

Dear Karen:

We endorse the proposed IGEP proposal, submitted by Drs. Brenda Davy (PI; HNFE), and Co-PIs Susan Duncan (FST), Andrea Dietrich and Marc Edwards (CEE), and Joe Falkinham III (BIOL). Consideration of the technological, scientific, and social issues of using poor quality water sources for providing safe and healthy water for societal health and well-being is needed. This interdisciplinary program addresses critical issues and challenges current paradigms for providing sufficient clean, safe drinking water to private, public, and commercial sectors. We recognize this interdisciplinary education and research program as important to our disciplines and colleges and encourage the core (PI and Co-PIs) and affiliated faculty to shift the water paradigm with this program. We believe this will be an effective IGEP program because many within this faculty group are leaders in their disciplines and are already engaged in interdisciplinary research and education activities associated with this concept.

Sincerely,

Alan Grant, Dean, CALS

Joseph E. Marcy, DH, FST

Susan Hutson, DH, HNFE

Richard Benson, Dean, COE

W. Samuel Easterling, DH, CEE

Lay Nam Chang, Dean, COS

Brenda S. Winkel, BIOL

Sue Ott Rowlands, Dean, CLAHS

Ellsworth Furman, STS