Summer 2017 (May 21 – July 28, 2017)
Undergraduate Research Fellowships Announcement

National Science Foundation Research Experiences for Undergraduates (REU) Site
INTERDISCIPLINARY WATER SCIENCE AND ENGINEERING
Virginia Tech, Blacksburg, Virginia

Application Deadline March 17, 2017 (5:00 PM, EST)

We will begin reviewing applications on March 13, 2017 and continue to accept submissions through March 17, 2017.

Program Description:
Applications are invited from qualified and motivated undergraduate students (rising sophomores, juniors and seniors) from all U.S. colleges/universities to participate in a 10-week (May 21-July 28, 2017) summer research in interdisciplinary water science and engineering at Virginia Tech. U.S. Citizens or Permanent Residents are eligible to apply. The research program is funded through the National Science Foundation – Research Experiences for Undergraduates (NSF REU) program. The 10-week internship will begin on May 21, 2017 (arrival day) at Virginia Tech and end on July 29, 2017 (departure day). The research internship includes a stipend of $500/week, housing (two persons per room), meals, and travel expenses (limited to a maximum of $500 per student for those working at Virginia Tech and a maximum of $1500 for those travelling internationally to India for a portion of the program). We have already graduated 85 excellent undergraduate researchers representing 55+ institutions in the United States from our prior sites during 2007-09, 2010-2013 and 2014-16.

Successful applicants (hereafter referred to as REU fellows) will join one of the ongoing research projects in interdisciplinary water science and engineering and conduct research under the supervision of Virginia Tech faculty and graduate students. Research projects address interdisciplinary issues related to water science and engineering involving fieldwork, laboratory simulations, literature review, and analysis of data. See Appendices 1 and 2 for list of faculty advisors and typical 2017 summer research projects, respectively. The summer research program is complemented by other professional activities. For example, REU fellows will attend weekly forums and participate in a few field trips. Speakers at these forums will include VT faculty members, graduate students and experts from water industry and government. These weekly forums provide an excellent opportunity to REU fellows to learn about commonalities between their various research projects, interact with each other and with other research mentors. REU fellows will make frequent presentations to their peers about their research progress and ultimately prepare a research report in collaboration with their research mentors suitable for conference presentation and/or publishing in a refereed journal or other appropriate publications.

New this year is an international component: two students will travel to the Indian Institute of Technology Madras (IITM), located in Chennai, India. The selected students will spend one week at Virginia Tech, six weeks at IIT Madras doing research, and then three weeks at Virginia Tech. Applicants must indicate their interest in traveling abroad in their project selection justification essay. Please see Appendix 2 for project details, and if you have any additional questions please contact Dr. Vinod Lohani.

Social interaction and networking is a major goal of the program. Several social activities are organized to encourage informal personal interaction between REU Fellows and the research team and the larger university community. See Appendix 3 for possible recreational activities.

Financial Support: The research internship includes a stipend of $500/week, housing (two persons per room), meals, and travel expenses (limited to a maximum of $500 per student for those working at Virginia Tech and a maximum of $1500 for those travelling internationally to India for a portion of the program).
Application: The deadline to receive all application materials (i.e., items 1, 2, and 3 below) is March 17, 2017 (5:00 PM EST). NOTE: Application review will begin on March 13, 2017, March 17, 2017 at 5:00PM is the latest submissions will be accepted.

Applications should be submitted online via the website: http://www.lewas.centers.vt.edu/index.php/lewas-nsf-reu/nsf-reu-online-application-2017

The application must include:

1. A 300-word essay about your interest in water/environment research and professional goals, and indicate top two choices of summer research project including a brief justification of your choices (see Appendix 2). The justification should be part of your essay. This should be uploaded as a PDF document using the online application form.

2. Unofficial College transcripts, to be uploaded as a PDF document using the online application form.

3. Two letters of reference to be sent by your referees. Recommendations are requested to be sent in a pdf document to Jennifer Cacciola at jcacciola@vt.edu, no later than March 17, 2017. Potential candidates are requested to remind their referees about this requirement, subject line: VT Water REU. Letters should address candidate’s motivation to pursue research, enthusiasm, reliability, teamwork skills and personality.

We request applicants to upload their applications along with other required documents by the deadline (application review will begin on March 13, 2017, applications may continue to be submitted until March 17, 2017, 5:00 pm, EST)

We will begin contacting the successful applicants beginning March 22, 2017. For questions, please contact: Dr. Vinod K Lohani, NSF REU Program Director, E-mail: vlohani@vt.edu; Phone: (540) 231-0019; FAX: (540) 231-0970 or Jennifer Cacciola (phone: (540) 231-5244; E-mail: jcacciola@vt.edu)
## Appendix 1

### REU Site Research Mentors

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
<th>Responsibility</th>
<th>Academic Discipline and Field of Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Carey</td>
<td>Virginia Tech</td>
<td>Research Mentor; Participant Selection</td>
<td>Biological Sciences; Freshwater Ecology</td>
</tr>
<tr>
<td>Dr. Hester</td>
<td>Virginia Tech</td>
<td>Research Mentor; Participant Selection</td>
<td>Civil &amp; Environ Eng.; Ecohydraulics</td>
</tr>
<tr>
<td>Dr. Edwards</td>
<td>Virginia Tech</td>
<td>Research Mentor; Participant Selection</td>
<td>Civil &amp; Environ Eng.; Water Infrastructure</td>
</tr>
<tr>
<td>Dr. Dietrich</td>
<td>Virginia Tech</td>
<td>Research Mentor; Participant Selection</td>
<td>Civil &amp; Environ Eng.; Analytical Chemistry</td>
</tr>
<tr>
<td>Dr. Xia</td>
<td>Virginia Tech</td>
<td>Research Mentor; Participant Selection</td>
<td>Crop &amp; Soil Environ Sciences – Soil Chemistry</td>
</tr>
<tr>
<td>Dr. Lohani</td>
<td>Virginia Tech</td>
<td>Project Director (PI); Program Coordinator; Recruitment &amp; Selection; Assessment; Cohort Experiences/ Professional Development; Dissemination; Research Mentor</td>
<td>Civil and Agricultural Engineering; Watershed Instrumentation, Hydrology, and Engineering Education</td>
</tr>
<tr>
<td>Dr. Pruden</td>
<td>Virginia Tech</td>
<td>Research Mentor; Participant Selection</td>
<td>Civil &amp; Environ Eng.; Environmental Contaminants</td>
</tr>
<tr>
<td>Dr. Vikesland</td>
<td>Virginia Tech</td>
<td>Research Mentor; Participant Selection</td>
<td>Civil &amp; Environ Eng.; Nanomaterials in the Environment</td>
</tr>
<tr>
<td>Dr. Schreiber</td>
<td>Virginia Tech</td>
<td>Research Mentor; Participant Selection</td>
<td>Hydrogeosciences; Chemical Hydrogeology</td>
</tr>
<tr>
<td>Dr. He</td>
<td>Virginia Tech</td>
<td>Research Mentor; Participant Selection</td>
<td>Civil &amp; Env. Engineering; Environmental biotechnology</td>
</tr>
<tr>
<td>Dr. McLaughlin</td>
<td>Virginia Tech</td>
<td>Research Mentor; Participant Selection</td>
<td>Forest Resources and Environmental Conservation</td>
</tr>
<tr>
<td>Dr. Muffo</td>
<td>Independent Assessment Consultant</td>
<td>Evaluation/Assessment</td>
<td>Academic Assessment</td>
</tr>
</tbody>
</table>
Appendix 2

Virginia Tech NSF/REU Site: Interdisciplinary Water Sciences and Engineering
Summer 2017: Research Projects
REU Site Duration: May 21 – July 28, 2017

**Project 1: Design and Implementation of a Robotic System for Sample Gathering of Remote Environmental Data for Hydrologic Analysis; Mentor: Dr. Lohani**

A Learning Enhanced Watershed Assessment System (LEWAS) lab was established on Virginia Tech campus for remotely assessing high frequency water quality and quantity data from a creek that flows through the campus. A water quality sonde provides the capability to sense temperature, conductivity, dissolved oxygen, turbidity, and pH of water. A flow meter and an ultrasonic sensor measure the flow in a real time. In addition, a weather station has also been integrated into LEWAS to allow real-time monitoring of weather parameters like precipitation, temperature, humidity, etc. The data is shared with remote clients via Wireless LAN through a user interface. Thirteen NSF/REU scholars have worked in this lab since 2008.

A single board computer has been implemented to collect and store data from the LEWAS sensors and in a database, which allows users to access the high frequency data from this database through an interactive user interface. The sensor network provides data for numerous variables, and some parameters are difficult to measure in situ. Design and implementation of a robotic sample gathering solution will allow for further laboratory analysis of the water. This work is inspired by planetary science endeavors.

This project will engage one REU scholar who will work in the LEWAS lab. The participant will learn to design and implement a robotic system, calibrate the LEWAS sensors and collect data, and conduct hydrologic analysis of high frequency (every 3-5 min) water data and develop case studies to demonstrate use of high frequency data in environmental monitoring. Desired skills for the candidate include computer experience with CAD and programming, as well as physical, mechanical and electrical experience such as soldering.

The REU participants will be mentored by a PhD student along with Dr. Lohani. In addition to the research work, the REU scholar will write a research paper to document his/her research experiences.

**Project 2: Greenhouse Gas Dynamics in a Drinking Water Reservoir; Mentors: Drs. Carey and Schreiber**

For this project, the REU scholar will work with a highly interdisciplinary team of graduate students and faculty to study ecosystem processes affecting carbon dioxide (CO$_2$) and methane (CH$_4$) production and efflux in a drinking water reservoir near Roanoke, VA. The objective is to examine the effects of water quality management techniques, including hypolimnetic oxygenation and epilimnetic mixing, on CO$_2$ and CH$_4$ concentrations in the reservoir. To address the objective, the intern will conduct field sampling at the reservoir (~2 times per week) with graduate students and learn laboratory techniques for gas and water chemistry analysis. The REU will examine how multiple drivers (including light, nutrients, weather, and reservoir morphometry) interact to affect CO$_2$ and CH$_4$. Using the collected data, the interns will conduct calculations to examine carbon and greenhouse gas balance in the reservoir. In addition to conducting this independent research, the interns will assist in other water quality campaigns at the reservoir and will be an integral member of the reservoir sampling team. We seek an REU student that has experience and interest in aquatic field sampling and data analysis, and can work independently while participating in a fun, collaborative team in the field. The REU must be able to swim, be comfortable working on boats, and be able to lift 40 lbs.

**Project 3: Investigation of the occurrence and fate of pharmaceuticals and personal care products (PPCPs) in urban-impacted watersheds; Mentor: Dr. Xia**

Due to rapid urbanization in the State of Virginia and nationwide, many watersheds are increasingly affected by urban activities. Nutrient loading and biological indicators have been the focus for water quality monitoring in the affected watersheds. Limited effort has been devoted to assessing the occurrence of organic contaminants associated with urban activities and storm water runoff. The objective of this project is to assess urban impact on the water quality of Stroubles Creek Watershed and the New River Watershed by monitoring the levels of PPCPs, often used as indicators for urban impact. The REU student will participate in a team effort to assess how leaky sewer systems affect stormwater water quality and Stroubles Creek water quality by investigating the occurrence and levels of PPCPs in the stormwater and receiving surface stream. The REU student will learn latest techniques for the analysis of organic contaminants in environmental samples and will gain hands-on experience with state-of-the-art analytical instruments such as the ultra-performance liquid chromatography-tandem mass spectrometry (UPLC/MS/MS). The REU participants will be working with graduate students under Dr. Xia’s guidance.
Project 4: Water Quality for Humanity and the Environment; Mentor: Dr. Dietrich

Worldwide, increasing population/agriculture/industrial activities cause increased natural and anthropogenic contamination at the food-energy-water-human interface. In projects in my research group, a potential REU student will focus on the effects of water quality and human health/wellbeing. These projects include: 1) modeling human exposure at the air-water interface to contaminants that are volatilized from drinking water and inhaled by humans; 2) integrating inorganic and organic water quality with occurrence of odorants, minerals, and algae in water; and 3) investigating communication strategies for informing the public about water quality.

Project 5: Bacterial Contamination of Water Distribution and Plumbing Pipelines; Mentors: Drs. Edwards and Pruden

*Legionella pneumophila* is an opportunistic pathogen found in building plumbing. *L. pneumophila* can cause Legionnaire’s Disease (severe pneumonia) in immuno-compromised individuals, hospitalizing 8,000 to 18,000 people each year and is responsible for a majority of the waterborne disease deaths in the U.S. Recently, our group exposed one of the worst Legionella outbreaks in U.S. history associated with the Flint, MI water crisis. As society strives to become more energy and water sustainable, low-flow (and lower) faucets are increasingly installed in hospitals, schools, and homes around the country. Limited sampling to date has raised concern about these new “green” faucets, because they seem to have much higher levels of *L. pneumophila* than normal faucets. This research would be amongst the first to systematically study this issue. In addition to operating a plumbing rig to generate samples and explore the relationship between *L. pneumophila*, flow rates, and flow volumes, the REU student will monitor *L. pneumophila* levels via qPCR and agar plating. Temperature, TOC, ICP, and 16S rRNA genes (total bacteria) will also be quantified. The overall goal is to determine if prior sampling results correctly indicated a systemic problem with low-flow faucets causing higher *L. pneumophila*, and to consider what can be done about it. Several rigs have been running to study this problem, allowing students to jump in and examine a system with established biofilms. In this project, the REU scholar will oversee operation of the rigs, make physical/chemical measurements of temperature and disinfectant, and correlate those results to the growth of *L. pneumophila* as determined by culturing or molecular methods. The REU student will write up the results and be encouraged to present this work at conferences.

Project 6: Recovery of Nutrients and Water from Wastewater Using an Integrated Osmotic Bio-electrochemical System; Mentor: Dr. He

Sustainable wastewater treatment should significantly clean polluted water while it minimizes energy consumption of the treatment process and decreases the carbon footprint. Wastewater contains more energy contents than what is required for treatment process, and extracting such contents from contaminants will help accomplish sustainable wastewater treatment. In addition, water and nutrients are valuable resources that can be recovered from wastewater. An innovative system based on synergistic cooperation between microbial electrolysis cells (MECs) and forward osmosis (FO) has been developed at VT. MECs oxidize organic matters in wastewater for electricity generation, which drives the recovery of ammonia. Ammonia is then used as a draw solute in FO for recovering high-quality water from the treated wastewater from MECs. The developed system will be examined for treating the effluent from anaerobic digesters. In this project, a potential REU participant will work with a graduate student and obtain hands-on experiences in reactor setup and operation and in chemical analysis. The participant will be part of a multidisciplinary team and will learn knowledge in engineering, electrochemistry, materials, and biotechnology. The results will be presented in major conferences, and a research paper will be highly desired.

Project 7: Effects of Hydrology on Ecosystem Processes and Water Quality of Streams and Rivers; Mentor: Dr. Hester

This research aims to understand how water moves between streams/rivers and groundwater. Its goal is to better understand how human activities affect this interaction and, in turn, affect aquatic ecosystems and water quality. This project will allow better informed ecological stream and river restoration design, pollutant attenuation by natural processes, and watershed planning. Example projects include laboratory experiments to evaluate exchange processes across riverbeds and effects on pollutant migration in rivers, field measurements of exchange across riverbanks, and groundwater flow through coal-mined landscapes and how that contributes to downstream pollutant loading. The REU participant’s role will vary but typical laboratory roles include assisting with setup and monitoring of water and tracer dye movement through a laboratory sediment tank, and typical field roles that include measuring water movement across riverbeds or banks and using geophysical imaging techniques to track water in mined areas. REU scholars will also assist with data analysis and will present results in a written report or oral presentation.
Project 8: Hydrologic Controls on Wetland Function at the Great Dismal Swamp; Mentor: Dr. McLaughlin

The Great Dismal Swamp (the Swamp) represents one of the largest (ca. 200,000 acres) forested wetlands in the continental U.S., providing functions at local (e.g., water quality and quantity, habitat) and global (e.g., carbon sequestration) scales. However, the Swamp has been hydrologically impaired, resulting in shifted habitats, decreased water storage capacity, increased fire frequency, and loss of stored carbon. To help guide current large-scale restoration efforts, this REU project will link wetland ecosystem and hydrologic monitoring to elucidate the hydrologic effects on wetland function. In this project, a potential REU student will conduct field research at the Swamp to monitor metrics of ecosystem function (e.g., carbon and water storage, habitat, fire resistance) and hydrologic regime, as well as laboratory analysis of field-collected samples.

Research Projects for REU Scholars in India

Virginia Tech is the lead institution on an NSF Partnership in International Research and Education (PIRE) project (PI: Vikesland, co-PI: Pruden) focused on Halting Environmental Antibiotic Resistance Dissemination (HEARD). This 5-year program (2015-2020) provides opportunities for students to visit foreign labs and field sites and engage in research collaboration. The objective is to track and compare the occurrence of antibiotic resistance genes (ARGs) in wastewater treatment plants (WWTPs) along a global transect of countries representing various antibiotic use and water treatment practices. India is a key partner as a country currently developing its water infrastructure while also battling population pressure and cited as being a hot-spot for the emergence of antibiotic-resistant superbugs.

Two REU scholars will have the opportunity to travel to India and conduct research in the laboratory of Dr. Indumathi Nambi at the Indian Institute of Technology Madras (IITM), a member of the HEARD NSF PIRE network. Pruden and Vikesland (faculty mentors), along with three graduate students, conducted the first site visit and sampling campaign in Chennai (old name Madras), India, in March 2016 and now are continuing the collaboration with the exchange of samples, protocols, and students. REU scholars will stay on the campus of IIT, Madras, during their visit. Apart from working on their projects, the REU scholars will spend time visiting environment related project sites in India and attend the guest lectures along with other scholars at IITM.

Also, Virginia Tech has established a VT India Research and Education Forum (VTIREF) in Chennai, India, and PI Lohani is a member of a leadership team that’s overseeing development of research and education activities at VTIREF. The VTIREF has 4 staff members stationed in India who will provide logistical support and organize professional and social field trips for the REU scholars.

India-bound scholars will spend the first week of the program at VT and will undergo orientation activities along with their peers and will work with their faculty mentors to get familiar with the proposed work in India. At the end of week 1, these scholars will leave for India and will begin their research activities at IITM under the joint mentorship of Drs. Vikesland, Pruden, and Nambi. These scholars will return to VT in the 8th week of the program and will spend last 3 weeks at VT and participate in VT’s undergraduate symposium and the concluding ceremony of the site activities along with their 8 peers.

Project 9*: Chemical and Microbial Water Quality in India; Mentors: Drs. Peter Vikesland and Pruden (VT, USA) and Dr. Nambi (IITM, India)

The REU scholar will work with graduate student mentors and faculty both in the U.S. and in Chennai, India, to evaluate the chemical and microbial quality of surface, ground, and drinking waters in the city of Chennai with the explicit goal to quantify factors responsible for antibiotic resistance dissemination in this highly urban environment. The student will learn appropriate sampling protocols for chemical and microbial contaminants as well as general water quality parameters. The student engaged in this project will gain intracultural expertise by working in a highly stimulating environment as an integral member of a large international consortium examining the growing threat of antibiotic resistance. At the conclusion of this international research experience, the student will have gained valuable life skills while simultaneously developing scientific expertise in chemical and microbial sampling.

Project 10*: PIRE research opportunity; Mentors: Drs. Vikesland and Pruden (VT, USA) and Dr. Nambi (IITM, India)

The REU scholar will travel to Chennai to collect samples and to extract, sequence, and analyze DNA in order to identify ARGs of clinical concern and compare profiles to those of other WWTPs being monitored as part of the PIRE network. Important water chemistry and physico-chemical data will also be collected to aid in interpretation of the data.

*REU scholars will spend first and last three weeks of the 10-week program at VT and the remaining six weeks at IITM.
Appendix 3

Recreational Activities around Blacksburg, Virginia

Virginia Tech is located in Blacksburg, Virginia and surrounded by the Blue Ridge Mountains. The Appalachian Trail runs through the area and affords many hiking trails. Other hiking trails off the Appalachian Trail include a 2-mile hike to the Cascades Waterfall and Wind Rock, which affords panoramic views of nearby mountain ridges. The New River is located nearby providing kayaking, canoeing, inner tube floating, and fishing during the summer. Other outdoor activities include mountain biking at Pandapas Pond, road biking the Blue Ridge Parkway, and walking, running or biking the Huckleberry trail. The Salem Avalanche, a Class A Affiliate of the Houston Astros, play in nearby Salem, VA.

Live music in both indoor and outdoor venues is available. Friday Night Jamboree in Floyd, VA has been listed as one of the two best places to hear bluegrass music in the United States. Friday nights on Henderson Lawn (located on campus and next to downtown) is an opportunity to hear live music free during the summer. Several restaurants provide live music throughout the week such as Jazz and Bluegrass. Unique eating experiences include local eateries such as Mike’s Grill (burgers and fries), More than Coffee (Mediterranean cuisine), Cabo Fish Taco, Boudreaux’s (Cajun style food), The Cellar (Greek cuisine), Gillie’s (vegetarian fare), Excellent Table (Ethiopian fare) as well as numerous coffee shops located next to campus. Next to campus is The Lyric, a non-profit venue that shows weekly movies and with occasional live performances and a large IMAX movie theater, bowling alley, and arcade is located just a few miles away in North End Center on Main Street in Blacksburg. This is just a sample of the wide varieties of things to do and see in and around Blacksburg.
Pictures from summer 2014 – 2016 sites

FIELD TRIPS

Wastewater treatment plant

NOAA National Weather Service forecast station

Marc Edwards Seminar 2016
SOCIAL EVENTS

End of summer cookout at Claytor Lake

Enjoying Lane Stadium

Fun at Claytor Lake

Photo shoot

Group photo