

**Virginia Water Resources Research Center
Annual Technical Report
FY 2017**

Introduction

The Virginia Water Resources Research Center (VWRRC) was established at Virginia Tech in 1965 as a federally authorized program. In 1982, the Virginia General Assembly authorized the VWRRC as a state agency under the Code of Virginia (§23-135.7:8). In 2005, the VWRRC became an administrative unit in the College of Natural Resources and Environment at Virginia Tech.

Mission

The VWRRC provides research and educational opportunities to future water scientists; promotes research on practical solutions to water-resources problems; and facilitates timely transfer of water-resources information to policy- and decision-makers and the general public.

Mission Elements

Research

1. Assisting university researchers in securing research support funds from public and private sources to address water-resources issues.
2. Assisting university researchers in initiating and executing water-resources research.
3. Conducting research on water-resources issues appropriate for expertise of personnel affiliated with the VWRRC.

Education

Advancing educational opportunities for students in water-resources fields by

1. Helping university researchers provide undergraduate and graduate research experiences in water resources.
2. Coordinating an undergraduate minor and graduate certificate in water resources at Virginia Tech.
3. Coordinating a multidisciplinary undergraduate B.S. degree program in *Water: Resources, Policy, and Management* at Virginia Tech.
4. Connecting students in water-resources fields with internship opportunities.

Outreach

1. Maintaining and frequently updating the VWRRC website and social media outlets to provide access to information on water-resources science, engineering, policy, and management.
2. Publishing *Virginia Water Central*, a newsletter featuring articles on water-related policy and law, summaries of water conditions in Virginia, and news briefs about water issues.
3. Producing *Virginia Water Radio*, a weekly radio show and podcast featuring unique perspectives on water sounds and news, and information involving Virginia's waters.
4. Securing academic advisors to work in an advisory capacity with public and private sectors, as requested.
5. Initiating and participating in development and execution of seminars, conferences, and symposia on Virginia, regional, and national water issues.
6. Developing and maintaining stormwater-, water-monitoring-, and water-education websites for state agencies and associations.

Program Administration

Administrative oversight of the VWRRC is provided by the Dean of the College of Natural Resources and Environment. A Statewide Advisory Board appointed by the Governor advises the VWRRC director on state water-research- and information priorities. Because of its multiple legislative authorities and administrative responsibilities, the VWRRC has a number of reporting requirements. In addition to the annual reporting requirements to the USGS and the National Institutes for Water Resources (NIWR), it presents an annual report to the Virginia Tech administration and the College of Natural Resources and Environment. Five-year reports and reviews are presented to the USGS and the State Council on Higher Education for Virginia (SCHEV).

Programs of the Virginia Water Resources Research Center (VWRRC)

Introduction

Programs are structured to meet strategic goals of the VWRRC and are consistent with the VWRRC mission as authorized by the U.S. Congress through the Water Resources Research Act of 1984 (Public Law 98-242), and Code of Virginia (§23-135.7:8). Programs in research and education are available to students and faculty at all Virginia colleges and universities. Outreach and collaborative programs include information transfer to policy/decision makers and citizens, and collaborative partnerships with state and federal agencies and other water-interest groups.

Research Programs

1. The VWRRC's statewide competitive grants program for students provides research funds to find practical solutions to water problems in Virginia and the region. The grant period begins June 1 and ends May 31 of the following year. Proposals are evaluated with emphasis on intellectual merit, innovation, likelihood of success, broader impacts on Virginians, and alignment with state or regional water-resources needs and challenges. A priority listing of water-research needs for this competitive grants program is updated annually in consultation with the VWRRC State Advisory Board. These grants are designed to support research efforts with a high potential for expanded funding from additional sources.
2. The VWRRC applies for external grants and conducts in-house research.
3. The VWRRC facilitates research team building and interdisciplinary, multi-institute collaborative research.
4. The VWRRC facilitates research opportunities to other university faculty and external contractors through a partnership with federal agencies that provides targeted funding from the USGS.

Educational Programs

1. The VWRRC provides research opportunities to undergraduate students and assistantships to graduate students who participate in sponsored research. Also, numerous graduate and undergraduate students are supported through the VWRRC's competitive grants program in Virginia Tech academic departments, and at Virginia's other colleges and universities.
2. In 1999, the VWRRC established the William R. Walker Graduate Research Fellowship to honor the many contributions of Dr. William R. Walker, the VWRRC's first director. The annual monetary award is intended for individuals preparing for a professional career in water resources and is provided to at least one new graduate student at Virginia Tech each year. Details of the program can be found on the VWRRC website: <http://www.vwrcc.vt.edu/walker-award/>
3. The VWRRC coordinates the interdisciplinary Watershed Management Undergraduate Minor and a Watershed Management Graduate Certificate Program in collaboration with five colleges and ten departments at Virginia Tech. The VWRRC also developed and coordinates an interdisciplinary undergraduate degree program called Water: Resources, Policy, and Management (WRPM) in

collaboration with the Department of Forest Resources and Environmental Conservation at Virginia Tech and nine other departments across five colleges (<http://waterdegree.frec.vt.edu/>) The VWRRC also coordinates Sustainable Water Scholarships and Sustainable Water Research Fellowships as part of the WRPM degree program.

4. The VWRRC has an internship program that provides opportunities for undergraduate students to assist with projects and sponsored research associated with the VWRRC.
5. The VWRRC supports and advises the Virginia Tech Chapter of the American Water Resources Association.

Outreach and Collaborative Programs

1. The VWRRC provides administrative support for the Virginia Water Monitoring Council.
2. The VWRRC publishes research reports, symposia proceedings, and citizen education booklets. It provides funding for the publication of outreach efforts.
3. The VWRRC publishes a newsletter, *Virginia Water Central*, several times each year. It features scientific and educational articles, legislative information, and water news of interest. The newsletter is available to the public at <http://www.vwrcc.vt.edu/water-central-news/> and electronic copies are provided via email to more than 600 people.
4. The VWRRC sponsors or co-sponsors symposia, workshops, and seminars addressing contemporary water-resources issues.
5. The VWRRC facilitates peer reviews of research reports for state programs when requested.
6. The VWRRC website (<http://www.vwrcc.vt.edu/>) serves as a repository of the Center's publications, houses an academic expert database, provides updated news and information relevant to water resources, and manages website links for collaborative partners, including the Virginia Water Monitoring Council, the Virginia Department of Environmental Quality division of public education and outreach, and the Virginia Department of Environmental Quality Stormwater BMP Clearinghouse. A news feed from the website allows users to subscribe to VWRRC updates via email.
7. The VWRRC has Twitter and Facebook sites and a Water News Grouper blog (<http://vawatercentralnewsgrouper.wordpress.com/>) to facilitate information exchange related to water resources and related news at the VWRRC.

National Affiliations

The VWRRC is affiliated with NIWR and the Universities Council on Water Resources (UCOWR).

Research Program Introduction

Research Program

The research program of the Virginia Water Resources Research Center (VWRRC) is supported through

- its annual appropriation from the Commonwealth of Virginia,
- external funding through grants and contracts, and
- a portion of overhead generated by external funding.

The VWRRC's 104B funds are not allocated directly to support research, but are used to support its outreach and information dissemination programs and to provide administrative support.

Through its annual appropriation from the Commonwealth of Virginia, the VWRRC funded three new research projects during the reporting period through allocation of \$5,000 seed grants to graduate students at Virginia Tech in the Department of Biosystems Engineering and the Department of Biological Sciences, and at Christopher Newport University in the Department of Environmental Science.

Information Transfer Program Introduction

The VWRRC supports timely dissemination of science-based information to policy- and decision-making entities and to citizens. The VWRRC used its USGS 104b funds to support expert personnel with responsibilities related to the VWRRC's outreach and collaborative programs. During the reporting period, the USGS 104b funds supported:

1. Preparation and electronic publication of the newsletter *Virginia Water Central*.
2. Partial administrative support for the Virginia Water Monitoring Council.
3. Partial support for production and management of the VWRRC webpage, VWRRC Facebook, VWRRC Twitter, and *Virginia Water Radio*.
4. Preparation and electronic publication of the *Virginia Water Central* Water News Grouper containing annotated links to articles and references relevant to Virginia's water resources. The Water News Grouper is accessed via the VWRRC webpage (<http://vawatercentralnewsgrouper.wordpress.com>).

Information Transfer

Basic Information

Title:	Information Transfer
Project Number:	2017VA191B
Start Date:	3/1/2017
End Date:	2/28/2018
Funding Source:	104B
Congressional District:	9th
Research Category:	Not Applicable
Focus Categories:	None, None, None
Descriptors:	None
Principal Investigators:	Stephen H. Schoenholtz

Publications

- Rodriguez, N.B., K.J. McGuire, and J. Klaus. 2018. Time-varying storage water age relationships in a catchment with a Mediterranean climate, *Water Resources Research*, doi: 10.1029/2017WR021964.
- Lang, A.J., W.M. Aust, M.C. Bolding, K.J. McGuire, and E.B. Schilling. 2017. Forestry best management practices for erosion control in haul road ditches near stream crossings, *Journal of Soil and Water Conservation*, 72(6):607-618, doi: 10.2489/jswc.72.6.607
- Gannon, J.P., K.J. McGuire, S.W. Bailey, R.R. Bourgault, and D.S. Ross. 2017. Lateral water flux in the unsaturated zone: a mechanism for the formation of spatial soil heterogeneity in a headwater catchment, *Hydrological Processes*, 31(20):3568–3579, doi: 10.1002/hyp.11279.
- Bourgault, R.R., D.S. Ross, S.W. Bailey, K.J. McGuire, and J.P. Gannon. 2017. Redistribution of soil metals and organic carbon via lateral flowpaths at the catchment scale in a glaciated upland setting, *Geoderma*, 307:238–252, doi: 10.1016/j.geoderma.2017.05.039.
- Jensen, C. K., K.J. McGuire, and P.S. Prince. 2017. Headwater stream length dynamics across four physiographic provinces of the Appalachian Highlands. *Hydrological Processes*, 31(19): 3350–3363, doi: 10.1002/hyp.11259.
- Evenson, G.R., H. Golden, C. Lane, D.L. McLaughlin, and E. D. Amico E. 2018. Depressional Wetlands Affect Watershed Hydrological, Biogeochemical, and Ecological Functions. *Ecological Applications*: doi:10.1002/eap.01701.
- Jones, C.N., D.L. McLaughlin, K. Henson, C.A. Hass, and D.A. Kaplan. 2018. From salamanders to greenhouse gases: does upland management affect wetland function? *Frontiers in Ecology and the Environment* 16(1): 14-19, doi:10.1002/fee.1744. [cover feature]
- Jones, C.N., G.R. Evenson, D.L. McLaughlin, M. Vanderhoof, M. Lang, G. McCarty, H. Golden, C. Lane, and L. Alexander. 2018. Estimating restorable wetland water storage at landscape scales. *Hydrological Processes*. doi: 10.1002/hyp.11405.
- Creed, I.F., et al. (McLaughlin). 2017 Enhancing protections for vulnerable waters. *Nature Geoscience* 10: 809-815, doi: 10.1038/NGEO3041. [featured in a special focus collection on inland waters]
- Golden, H.E., et al. (McLaughlin). 2017. Scientific tools for integrating geographically isolated wetlands into land management decisions. *Frontiers in Ecology and the Environment*: doi: 10.1002/fee.1504
- MacDonald, M.C., L. Juran, S. Srinivasan, J. Jose, S.I. Ali, P. Rajagopalan, and K. Hall.

Information Transfer

2018. Assessing participant compliance with point-of-use water treatment: an exploratory investigation. *Public Works Management & Policy* 23(2): 150-167.
12. Aksha, S.K., **L. Juran**, and L.M. Resler. 2018. Spatial and temporal analysis of natural hazard mortality in Nepal. *Environmental Hazards* 17(2): 163-179.
 13. **Juran, L.**, M.C. MacDonald, N.B. Basu, S. Hubbard, R. Rajagopal, P. Rajagopalan, and L. Philip. 2017. Development and application of a multi-scalar, participant-driven Water Poverty Index in post-tsunami India. *International Journal of Water Resources Development* 33(6): 955-975.
 14. **Juran, L.** and K. Lahiri-Dutt. 2017. Waterscapes in transition: changing uses and perceptions of water in middle class homes in Kolkata, India. *Water History* 9(4): 433-451.
 15. Bandzuh, J.T., **L. Juran**, K.N. Kolivras, and A.B. Wallis. 2017. Local perceptions of measures to control Aedes mosquitoes and mosquito-borne diseases in Puntarenas and San José, Costa Rica. *Journal of Latin American Geography* 16(2): 139-162.
 16. Timpano, A.J., **S.H. Schoenholtz**, D.J. Soucek, and C.E. Zipper. 2018. Benthic macroinvertebrate community response to salinization in headwater streams in Appalachia USA over multiple years. *Ecological Indicators* 91:645-656. doi.org/10.1016/j.ecolind.2018.04.031
 17. Timpano, A.J., C.E. Zipper, D.J. Soucek, and **S.H. Schoenholtz**. 2018. Seasonal patterns of anthropogenic salinization in temperate forested headwater streams. *Water Research* 133: 8-18. doi.org/10.1016/j.waters.2018.01.012.
 18. Peer-Reviewed Research Publication from VWWRC Seed Grant Program: **Adadevoh, J.S.T.**, O. Sassan, B. Wood, and R.M. Ford. 2017. Modeling transport of chemotactic bacteria in granular media with distributed contaminant sources. *Environ. Sci. Technol.* 51(24): 14192-14198. Doi: 10.1021/acs.est.7b04443.
 19. Peer-Reviewed Research Publications from VWWRC Seed Grant Program: **Jensen, C. K.**, **K.J. McGuire**, and P.S. Prince. 2017. Headwater stream length dynamics across four physiographic provinces of the Appalachian Highlands. *Hydrological Processes*, 31(19): 3350-3363, doi: 10.1002/hyp.11259.
 20. Peer-Reviewed Research Publications from VWWRC Seed Grant Program: **Ziegler, B.A.**, M.E. Schreiber, I.M. Cozzarelli, and G.H.C. Ng. 2017. A mass balance approach to investigate arsenic cycling in a petroleum plume. *Environmental Pollution* 231(2): 1351-1361, doi.org/10.1016/j.envpol.2017.08.110

Outreach and Information Transfer Accomplishments

Newsletter *Virginia Water Central*

Virginia Water Central is distributed via email to approximately 600 recipients. It is also announced and available on the VWRRC website. One issue of *Virginia Water Central* was published during the reporting period.

Notifications to *Virginia Water Monitoring Council*

The VWRRC provides administrative support to the *Virginia Water Monitoring Council* (VWMC). The VWMC was formed to promote and facilitate coordination of water monitoring programs throughout the Commonwealth of Virginia. Membership in the VWMC is open to any person or organization with responsibility for or interest in water monitoring in Virginia. Weekly water-related announcements via list server are provided to 670 members (representing more than 250 different organizations) of the VWMC. Announcements include information about conferences, workshops, total maximum daily load (TMDL) public meetings in Virginia, job openings, newly published reports, information posted on Web sites, and other pertinent information.

1. Distributed 57 sets of general announcements (1,200 individual announcements) as e-mail messages to the VWMC membership; each message contained at least a dozen informational announcements, including: calls for papers, conference announcements, job openings, training opportunities, recently published reports, information posted on websites, total maximum daily load (TMDL) public meetings in Virginia, and other pertinent information.
2. Developed 15 sets of special announcements and distributed these as e-mail messages to the VWMC membership for a total of 101 unique announcements; these announcements pertained to VWMC-sponsored activities, information about beach-monitoring and water recreation as specified in grants from the Virginia Department of Health (VDH), job opportunities, stormwater management training opportunities and upcoming conferences.
3. Collaborated with VDH to develop special beach monitoring announcements for distribution to the VWMC membership and beyond.
4. Weekly announcements are posted on the VWRRC (<https://www.vwmc.vwrrc.vt.edu/>) and VWMC (www.VirginiaWMC.org) websites.

VWRRC Website

(www.vwrrc.vt.edu)

The VWRRC website is updated at least weekly and supports a *Water News Grouper* blog page, which is updated several times each week. During the reporting cycle there were approximately 300 posts listed on the *Water News Grouper* blog page and approximately 9,000 page views (~30/day). The VWRRC website also serves as the portal for two other websites that the VWRRC manages:

1. Virginia Water Monitoring Council (<http://www.vwmc.vwrrc.vt.edu/>)
2. Virginia Department of Environmental Quality Stormwater BMP Clearinghouse (<http://www.vwrrc.vt.edu/swc/>)

VWRRC is on **Twitter** at <http://twitter.com/VaWaterCenter> and **Facebook** (<http://www.facebook.com/pages/Blacksburg-VA/Virginia-Water-Resources-Research-Center/186479556264?v=wall>)

Virginia Water Radio

(www.viriniawaterradio.org)

The VWRRC produces and hosts a weekly 5-minute radio show featuring summaries of recent water news, upcoming water events, and water-related sounds or music. The radio show also includes relevance to specific Virginia science and social studies standards of learning for Virginia public schools for each episode. *Virginia Water Radio* is broadcast on two campus stations: WECH at Emory & Henry College and WVRU at Radford University. During the past year, 52 weekly episodes were produced and the Water Radio Web site had approximately 2,300 page views (~8/day).

Coordination of Studies

The VWRRC chaired the *Water Quality Academic Advisory Committee*, which serves an advisory role for the Virginia Department of Environmental Quality to establish and evaluate water-quality criteria and standards for freshwater resources in the Commonwealth of Virginia. During the reporting period, the VWRRC coordinated a study of development of aquatic life use assessment protocols for Class VII waters in Virginia. The report is currently being prepared as a VWRRC publication.

International Outreach Activities

1. VWRRC Faculty serve as referees for numerous international journals.
2. Associate Director McGuire serves as Associate Editor of *Hydrological Processes*, *Journal of Environmental Quality*, and *Water Resources Research*, which publish international research.
3. Associate Director McGuire is North American chair for the international Gordon Research Conference on Catchment Science.
4. Director Schoenholtz serves as sub-editor of *Current Forestry Reports*, an international journal and as Associate Editor of *Journal of American Water Resources Association*, which publishes international research.
5. Assistant Professor Juran led a three-week study abroad course on Sustaining Human Societies and the Natural Environment in New Zealand.
6. Assistant Professor Juran served as a consultant on Fulbright program impacts and communication, Fulbright Commission, Bureau of Cultural and Educational Affairs, U.S. Department of State.

USGS Summer Intern Program

Basic Information

Start Date:	5/1/2016
End Date:	5/31/2017
Sponsor:	USGS Virginia & West Virginia Water Science Center, Richmond, Virginia
Mentors:	Jennifer L Rapp
Students:	Jared Goldbach Ehmer

Internship Evaluation

Question	Score
Utilization of your knowledge and experience	Very Good
Technical interaction with USGS scientists	Good
Treatment by USGS as member of a team	Very Good
Exposure and access to scientific equipment	Good
Learning Experience	Very Good
Travel	About Right
Field Experience Provided	About Right
Overall Rating	A

Additional Remarks

Student Support					
Category	Section 104 Base Grant	Section 104 NCGP Award	NIWR-USGS Internship	Supplemental Awards	Total
Undergraduate	6	0	1	0	7
Masters	3	0	0	0	3
Ph.D.	10	0	0	0	10
Post-Doc.	0	0	0	0	0
Total	19	0	1	0	20

Notable Awards and Achievements

The new interdisciplinary undergraduate degree in Water: Resources, Policy, and Management at Virginia Tech had its first cohort of students enrolled in August 2015 and currently has an enrollment of more than 60 students. The first 11 students graduate from this program between May 2017 and May 2018. The VWRRC coordinates curriculum and advising for this degree program. See <https://frec.vt.edu/students/undergraduate/water-resources-policy-and-management.html> for more information.

VWRRC Director Stephen Schoenholtz served as President and Past-president of NIWR during the reporting period.

The VWRRC supported two student interns, four undergraduate students, eleven graduate students, and two post-doctoral research associates during the reporting period.

The VWRRC acquired \$629,278 in external funding, which supported 10 new and ongoing projects.

The VWRRC funded three new research projects through allocation of \$5,000 seed grants to graduate students at Virginia Tech in the Department of Biological Systems Engineering and Department of Biological Science, and at Christopher Newport University in the Department of Environmental Science.

VWRRC faculty published 17 peer-reviewed papers.

The VWRRC coordinated research and reporting on a study of development of aquatic life use assessment protocols for Class VII waters in Virginia in its role as manager of the Academic Advisory Committee to Virginia Department of Environmental Quality.

The VWRRC helped coordinate the 2017 Mid-Atlantic Water Research Conference in Shepherdstown, WV. This conference involved all eight mid-Atlantic NIWR water institutes.