Kentucky Water Resources Research Institute
University of Kentucky

Annual Technical Report
2019

Products

2017KY264B:

Ebrahimi, M., Gerber, E. L., & Rockaway, T. D. (2017). Temporal performance assessment of wastewater treatment plants by using multivariate statistical analysis. *Journal of environmental management*, *193*, 234-246. https://doi.org/10.1016/j.jenvman.2017.02.027

2017KY266B:

Zhang, X., Wendroth, O., Matocha, C., Zhu, J., & Reyes, J. (2020). Assessing field-scale variability of soil hydraulic conductivity at and near saturation. *Catena, 187*, 104335. https://doi.org/10.1016/j.catena.2019.104335

2017KY268B:

Brion, G., Currens, B. J., Fryar, A. E., & Hall, A. (2019, December). Use of Acetaminophen and Sucralose as Co-analytes to Differentiate Sources of Human Excreta in Surface Waters. In *AGU Fall Meeting Abstracts* (Vol. 2019, pp. H33D-06). 2019AGUFM.H33D..06B

Currens, B. J., Hall, A. M., Brion, G. M., & Fryar, A. E. (2019). Use of acetaminophen and sucralose as co-analytes to differentiate sources of human excreta in surface waters. *Water Research*, 157, 1-7. https://doi.org/10.1016/j.watres.2019.03.023

2017KY270B:

Bernard, M. M. (2018). *Ecophysiological Analysis of Yield Determination in Soybean of Different Relative Maturities* (108). Master's Thesis, University of Kentucky, Department of Plant and Soil Sciences. https://doi.org/10.13023/etd.2018.373

2018KY275B:

Amirsoleimani, A., Brion, G. M., Diene, S. M., François, P., & Richard, E. M. (2019). Prevalence and characterization of Staphylococcus aureus in wastewater treatment plants by whole genomic sequencing. *Water Research*, *158*, 193-202. https://doi.org/10.1016/j.watres.2019.04.035

Amirsoleimani, A. (2020). *Investigation into the Presence, Persistence, and Fate of S. Aureus, and its Mobile Genetic Elements, in Wastewater and the Surrounding Environment*. Master's Thesis, University of Kentucky, Department of Civil Engineering. https://doi.org/10.13023/etd.2020.452

2018KY282B:

Matocha, C. J., Karathanasis, T. D., Murdock, L. W., Grove, J. H., Goodman, J., & Call, D. (2018). Influence of ryegrass on physico-chemical properties of a fragipan soil. *Geoderma*, 317, 32-38. https://doi.org/10.1016/j.geoderma.2017.12.004

Smith, K., McNear, D. H., Wendroth, O., & Matocha, C. J. (2019, January). The Impact of Root Exudates on Element Release in a Fragipan Soil. In *SSSA International Soils Meeting Abstracts* (2019). ASA-CSSA-SSSA. https://scisoc.confex.com/scisoc/2019sssa/meetingapp.cgi/Paper/115769

Smith, K. P. (2020). *The Impact of Ryegrass on a Fragipan Soil*. Master's Thesis, University of Kentucky, Department of Plant and Soil Sciences https://uknowledge.uky.edu/pss_etds/132

2018KY283B:

Lee, B. D., Edwards, D., & Munshaw, G. C. (2019, January). Canine Nutrient Contributions to the Urban Environment: Implications for Municipal Separate Storm Sewer System Communities. In *SSSA International Soils Meeting Abstracts* (2019). ASA-CSSA-SSSA. https://scisoc.confex.com/scisoc/2019sssa/meetingapp.cgi/Paper/115390

2019KY287B:

Alvarez Villa, Cristopher. (2020). *Identification of the Causes and Extent of Elevated Methane Concentrations in the Groundwater of Eastern Kentucky*. Master's Thesis, University of Kentucky, Department of Earth and Environmental Sciences. https://doi.org/10.13023/etd.2020.486

2019KY290B:

Hughes, S.E., and Marion, J.W. (2021). Cyanobacteria growth in a nitrogen- and phosphorus-spiked water from a hypereutrophic reservoir in Kentucky, USA. *Journal of Environmental Protection* 12(2):75-89. https://doi.org/10.4236/jep.2021.122006

2019KY291B:

Lovence, A. (2019). *Incorporation of Metal Oxide into a Polymer Substrate for Buoyant Photocatalysts for Water Remediation*. Master's Thesis, Western Kentucky University, Department of Chemistry.

Information Transfer Program

The Kentucky Water Resources Research Institute's information transfer program includes 4 ongoing components: (1) an annual symposium, (2) the institute's website, (3) other electronic distribution of information, and (4) technical presentations and workshops. Planning and preparation for the 2020 Kentucky Water Resources Annual Symposium began in the fall of 2019. On March 11, 2020, just twelve days before the symposium was to be held, the decision was made to cancel the symposium due to the COVID-19 pandemic. Maintenance of KWRRI's website is ongoing throughout the year. Throughout the grant period, KWRRI continued to increase its social media presence via Twitter which is demonstrated by the acquisition of 67 new followers, 431 profile visits, and over 25,000 tweet impressions. KWRRI produces a semiannual electronic newsletter that spotlights KWRRI's research, highlights 104b supported water research, announces upcoming events and shares other relevant information. The newsletter is distributed to 782 subscribers- 36% academia (faculty and staff); 30% local, state or federal government; 15% students; 12% private sector; and 7% NGOs/non-profits. During the reporting period, KWRRI produced three editions of its semi-annual newsletter (Summer 2019, Winter 2020, Summer 2020). On February 22, 2020, KWRRI hosted an interactive exhibit at the UK College of Engineering's annual Engineering Day that was attended by over 3,000 people. KWRRI also participated in the Kentucky Geological Survey's virtual open house on October 16, 2020. Institute staff members continue to serve in a variety of support roles on technical committees and advisory panels for agencies and volunteer organizations.

Student Support

Undergraduate	**11**
Graduate	**3**
Post-Doc	**0**

Notable Achievements and Awards

2019KY287B: PI Andrea Erhardt was awarded the College of Arts and Sciences Outstanding Graduate Mentor Award, recognizing the success of her students, including Cris Alvarez.

2019KY287B: MS Student Cris Alvarez was recognized with an American Association of Petroleum Geologists Grant-in-Aid award and a Geological Society of America Southeastern Section Society Grant. The success of his thesis work positioned Cris Alvarez for his current full-time position as a GC chemist at ETS Laboratories in Napa, California.

2019KY290B: Swade Barned and Austin Mills received one of four "Outstanding Student Research Awards" from the Association of Environmental Health Academic Programs which included a $1,000 prize divided evenly between each.

2019KY290B: Amber Turner and Lana Sexton received one of four "Outstanding Student Research Awards" from the Association of Environmental Health Academic Programs which included a $1,000 prize divided evenly between each.

2019KY290B: Swade Barned was accepted to a fully funded M.S. program in the University of Cincinnati College of Medicine's Department of Environmental and Public Health Sciences. Swade is pursuing a M.S in Environmental & Industrial Hygiene.

2019KY290B: Amber Turner was accepted with funding support from NIOSH for her Master of Public Health in Environmental and Occupational Health and Sustainability at Eastern Kentucky University.

2019KY291B: Lovence Ainembabazi received the College Heights Foundation Excellence Scholarship (2018/2019) and the Ogden College of Science and Engineering's Dean's Excellence scholarship (2019).

2019KY291B: Connor Schulte received second place in the Chemistry (Organic/Inorganic) Section at the 106th Annual Meeting of the Kentucky Academy of Science in November 2020 for his presentation, *Polydimethylsiloxane as a substrate to facilitate the use photocatalysts in the breakdown of organic water pollutants*.

2019KY291B: Connor Schulte was a Session winner at Western Kentucky University's 50th Annual Student Research Conference in May 2020. His virtual presentation, *Effectiveness of Polydimethylsiloxane Beads with Photocatalysts at Addressing Organic Pollution*, is available online, https://www.youtube.com/watch?v=wEkIwAjUZH4.

2019KY295B: *Appalachian Community Technical Assistance and Training Program (ACTAT)*, Rural Utilities Service, USDA, $105,461 (10/1/20 – 9/30/21).

Identification Of The Causes And Extent Of Elevated Groundwater Methane Concentrations In Eastern Kentucky

Project Type: Annual Base Grant
Project ID: 2019KY287B

Project Impact:

Across Eastern Kentucky, methane is observed in groundwater wells at concentrations above the immediate action level (>1 mg/L) as outlined by the Environmental Protection Agency. These concentrations pose clear health and safety issues for households. In many rural areas, groundwater is the only potable water source, making identification of the controls of methane contamination important for mitigation efforts. In this study, groundwater from 24 wells in Eastern Kentucky were analyzed for methane, trace metals, alkalinity, sulfide, sulfate, ferrous iron, and water quality parameters. The sample locations, spanning three counties, build off previous studies in the northeastern and southeastern corners of the state. Mining, along with oil and gas extraction, occur throughout the region. By combining a complete water chemistry profile with methane concentrations and isotopes, we identified if the methane was controlled by oil and gas exploration, natural bacterial processes, and/or influenced by local mining activity.

We found that while most of the methane is naturally derived, areas with a high density of oil and gas wells appear to be more likely to introduce isotopically distinct thermogenic methane in groundwater. Interestingly, proximity to extensive coal mining appeared to suppress methane production. We hypothesize this is the result of an increase in sulfur, limiting methanogenesis. Overall, these results suggest that anthropogenic activities directly and indirectly influence geochemical conditions and methane distribution in groundwater in eastern Kentucky. Similar effects would be expected throughout the Appalachian Basin and in areas with different levels of mining and oil and gas development.

Quantifying The Source Of Dissolved Reactive Phosphate In Karst Drainage Of The Inner-Bluegrass Using Oxygen Isotopes

Project Type: Annual Base Grant
Project ID: 2019KY288B

Project Impact:

In the Midwestern U.S., seasonal hypoxia experienced in the Gulf of Mexico and harmful algal blooms in inland freshwater ponds, lakes, and rivers are fueled by dissolved orthophosphate loadings from disturbed landscapes. Efforts to reduce dissolved reactive phosphorus (DRP) loadings have had varying levels of success and have led to insufficient water quality improvements. Inefficiencies in conservation strategies can stem from poor understanding of phosphate source and flow pathway dynamics. This study focused on monitoring sources and flow pathways of dissolved reactive P in a karst agroecosystem with phosphatic limestone. Preliminary oxygen isotope results for orthophosphate suggest significant differences in isotope signatures at high and low flows, despite similar concentrations, likely reflecting differences in connectivity to anthropogenic and ambient P sources. Storm-event analysis suggests variable DRP hysteresis, that varies as a function of flow pathway. Our study adds to a limited database of PO4 isotope studies and is applied for the first time to our knowledge in the karst landscape.

Predicting Harmful Cyanobacteria Blooms In Central Kentucky Lakes

Project Type: Annual Base Grant
Project ID: 2019KY290B

Project Impact:

A total of 81 water samples were evaluated across eight central Kentucky lakes and one university pond in the late summer and early fall of 2019. The study aimed to evaluate the risk factors for the various lakes to have harmful blue-green algae blooms. The five students who worked on the project observed significant amounts of total phosphorus in several lakes, making these lakes particularly at-risk for harmful blue-green algae blooms. Additionally, the study observed two cyanotoxins (microcystins and anatoxins) occurring in trace amounts in nearly 20% of the samples. Cylindrospermospin was also observed, but not as frequently. Although these toxins are relatively common in these lakes, the levels observed were typically less than 1 part per billion (ppb), which is below advisory recommendations provided by the U.S. EPA and World Health Organization for school-age children and adults. Given that these toxins are present, the results do indicate that the underlying conditions and species of toxin-producing cyanobacteria are common in Kentucky lakes. Under the right conditions for the blue-green algae species producing these toxins, they may be able to bloom and produce higher toxin levels than observed or detected in this study. Some toxin measurements were done with a new dipstick test kit and meter. Continued monitoring and determining how to best predict these toxins is recommended. Citizen scientists may be able to use some of the methods evaluated in this study to help with early detection and monitoring lake health with respect to harmful cyanobacteria bloom prevention.

Development Of Buoyant Photocatalysts For Cleaning Contaminated Streams And Water Bodies

Project Type: Annual Base Grant
Project ID: 2019KY291B

Project Impact:

The project objectives from the original proposal were accomplished. Briefly, the proposal was to incorporate the photocatalysts ZnO and WO3 into a polymer substrate to test these materials for use to remove model pollutants from water. Testing involved both characterization of the material properties (crystal structure, porosity, morphology) and their effectiveness at degrading methylene blue in aqueous solution. It was found that, compared to our previous work on TiO2, both ZnO and WO3 formed superior photocatalytic materials: they were able to degrade methylene blue faster, while showing that our methods can be applied more generally. Graphene oxide was also tested as a potential photocatalyst for incorporation into our substrate, but it did not appear to incorporate well into the polymer. Further explorations will expand to more sophisticated photocatalysts and more biodegradable polymers for use as support substrates. This work will be shared with appropriate state-level environmental agencies once the complications of the current pandemic have resolved.

Comparison Of Water Loss Audit Methodologies In High Loss Kentucky Utilities

Project Type: Annual Base Grant
Project ID: 2019KY295B

Project Impact:

While all drinking water utilities have water losses, excessive water loss can negatively impact the financial health of the utility. Currently there is no statewide policy concerning water loss though the Kentucky Public Service Commission, one of two regulatory agencies in the state, regulates water loss using a 15% unaccounted-for water threshold. Though the PSC uses unaccounted-for water, the American Water Works Association (AWWA) has been urging the use of nonrevenue water to be more encompassing and has further developed a water audit methodology for analyzing utilities' water loss. As part of this study, we worked with three Appalachian utilities identified by the PSC as having greater than 35% loss, where we taught them the AWWA Water Audit methodology through an onsite 6-hour workshop. During the onsite interaction we were able to learn about each utility's current operational and management practices, give them insight into industry wide practice and standards, and gave them an enhanced tool for assessing their practices and operations of their system. In addition, all three utilities gained immense knowledge as to the role of various key personnel and support staff in fulfilling the new Water Audit tool. Finally, we modified the new software so that Kentucky PSC regulated utilities could use it for compliance reporting to the PSC, specifically includes water loss calculations. In the ongoing discussion with PSC, we are proposing that once utilities report their operating status, we can use the data to draw comparisons between water loss and AWWA key performance indicators.