

# Center for Health Effects of Environmental Contamination (CHEEC) The University of Iowa

## 2017 Annual Report

The University of Iowa (UI) Center for Health Effects of Environmental Contamination (CHEEC) is a multidisciplinary environmental research center that supports and conducts research to investigate possible health outcomes related to exposure to environmental toxins. CHEEC is comprised of faculty from the UI Departments of Civil and Environmental Engineering, Epidemiology, Occupational and Environmental Health, Chemistry, and the State Hygienic Laboratory. Participating areas include the State Hygienic Laboratory, the Iowa Registry for Congenital and Inherited Disorders., and other Centers and Institutes at the University of Iowa. CHEEC works cooperatively with the Iowa Departments of Natural Resources (IDNR), Public Health (IDPH), and Agriculture and Land Stewardship (IDALS).

Center activities include 1) developing and maintaining environmental databases to be used in conducting research, 2) cooperating and collaborating on environmental health research programs and projects, 3) managing a seed grant program to support environmental health research, 4) providing environmental health education programs to the citizens of the state and the region, and 5) serving on state and local committees to provide environmental health expertise.

CHEEC's mission, as described in the 1987 Iowa Groundwater Protection Act, is to "*determine the levels of environmental contamination which can be specifically associated with human health effects.*" This report presents an overview of CHEEC research programs and educational activities during 2017–2018.

### Environmental Databases

CHEEC maintains databases on Iowa water quality, including the *Iowa Historical Municipal Water Treatment and Supply Database*, the *Municipal Analytical Water Quality Database*, and the *Statewide Rural Well Water Survey (SWRL)*. Safe Drinking Water Act data through 2016 were added for all Iowa public water systems to the *Municipal Analytical Water Quality Database*.

#### *Iowa Municipal Water Systems*

The CHEEC Municipal Analytical Water Quality Database contains information from numerous sources including state and federal special surveys, regulatory programs (Safe Drinking Water Act), and various academic studies. This database houses information from the 1950s to the present. The Historical Municipal Water Supply Source and Treatment Database contains information dating back through the early 1900s. This database is updated regularly years by contacting public water utilities across Iowa about changes to their water treatment process and new water sources. The most recent update was completed in 2012.

#### *Iowa Private Drinking Water Wells*

CHEEC maintains data from surveys of Iowa private drinking water wells. The Iowa Statewide Rural Well Water Survey (SWRL, 1988–89) was conducted by CHEEC and the Iowa Geological Survey Bureau as part of the implementation of the Iowa Groundwater Protection

Act. SWRL provided a statistically valid assessment of the proportion of private rural wells and rural residents affected by various water contaminants. A total of 686 wells were sampled for coliform bacteria, nitrate, 27 pesticides and major inorganic ions. A second phase of the SWRL study (SWRL2) was conducted in 2006–08, in which 473 private rural drinking water wells were sampled; 116 of the wells were original SWRL wells; the other wells were randomly selected from the IDNR’s Private Well Tracking System. SWRL2 tested for the same contaminants as the original SWRL, with the addition of arsenic and several pesticide degradates. The Iowa Community Private Well Study (2002–03) includes water quality data for 230 private drinking water wells in 50 incorporated Iowa towns not served by a public water supply system.

## **Research and Data Management**

In 2017, CHEEC staff participated in the following projects as Investigators and through data support.

### **Exposure Assessment for Drinking Water Contaminants and Cancer Risk in the Iowa Women’s Health Study**

*Collaborators:* National Cancer Institute, CHEEC

This project is studying associations between environmental exposures and cancer incidence and mortality among older Iowa women by linking drinking water contaminant data including nitrate, DBPs, and pesticides to the women’s drinking water source to evaluate risk of brain, bladder, kidney, ovarian, thyroid and gastrointestinal cancers.

### **Pesticides in Tap Water and Congenital Heart Defects**

*Collaborators:* University of Texas Health Science Center at Houston; National Birth Defects Prevention Study Centers, CHEEC

This project investigated the possible risk for heart defects in offspring of women who are exposed to atrazine in their drinking water during pregnancy. Atrazine exposure data was collected from EPA for several NBDPS states and added to an exposure assessment approach that was developed by Iowa and Texas for the previous NBDPS study looking at nitrate in drinking water and risk for neural tube defects and other birth defects.

### **Implementation of a Novel Bioassay as a Global Indicator of Endocrine Disruption in Public Drinking Water Supplies for Epidemiologic Studies of Cancer**

*Collaborators:* National Cancer Institute, State Hygienic Laboratory at UI, CHEEC

Epidemiologic literature suggests that endocrine disrupting compounds (EDCs) play a role in human health. It is unknown whether drinking water is a source of human exposure to EDCs. This project used a new assay to characterize global EDC activity in samples from ten Iowa public water systems. The project evaluated the feasibility for developing an exposure model that relates measured EDC activity in water samples to characteristics of the water systems, including levels of regulated contaminants, water source and treatment methods.

## **Seed Grant Program**

CHEEC administers a Seed Grant Program that supports pilot level research across a range of environmental research topics. Seed grant projects are small-scale studies designed to test new and unusual hypotheses, develop innovative methodologies in laboratory and field settings, or perform initial statistical analyses to support efforts to acquire federal or private

grants for larger studies. The funding provides graduate level research opportunities, which strengthens graduate programs, creates innovative research, and fosters interdisciplinary development of research opportunities.

CHEEC awards about one-third of its annual budget to seed funding. Since 1989, this investment has generated almost ten dollars in external funding for every dollar invested by the program; seed grants projects have attracted over twenty-four million dollars in external funding for additional research. Seed grant funding provides hands-on learning opportunities for undergraduate and graduate students, enhancing their educational experience and preparing them for their professional lives. To date, over sixty graduate degrees have resulted from seed grant projects, and over one hundred and ten articles describing seed grant projects have been published in peer-reviewed journals.

In FY 2017, CHEEC awarded the following seed grants:

**Endocrine disrupting compounds in water sources: Development of a functionalized silicon nanowire biosensor for detection and quantification in complex mixtures**

*Investigators:* F. Toor, UI Department of Electrical and Computer Engineering; G. LeFevre, UI Department of Civil and Environmental Engineering

*Summary:* Endocrine disrupting compounds (EDCs) in water negatively affect aquatic organisms and expose human consumers. This project develop a novel silicon (Si) nanowire (NW) biosensor to detect EDCs, specifically estrogenic substances, *in-situ* for complex environmental mixtures. This biosensor will contain NWs functionalized with human estrogen receptors (ERs) that generate a change in recorded electrical signal when chemical compounds with estrogenic bioactivity bind to the ERs, such as natural (estrone, E1) or synthetic (ethinylestradiol, EE2) hormones. This project is an innovative advancement of a compact, low-cost and high sensitivity optoelectronic sensing technology that facilitates real-time detection of EDCs in complex, unknown mixtures present in the environment. Our biosensor will detect compounds that bind to receptors as organisms “see” EDCs rather than simply measuring chemical presence. Investigators propose two novel sensor designs and will test sensitivity and robustness against current technologies. This work will facilitate deeper understanding of detecting EDC water sources.

**Predictive model of the fate and transport of antibiotic resistant genes in Iowa rivers**

*Investigators:* K. Ikuma, C Rehmann, Department of Civil, Construction and Environmental Engineering, Iowa State University

*Summary:* The aquatic environment can act as a reservoir for antibiotic resistance genes (ARGs) and therefore contribute to human health risk. Effluent discharges from wastewater treatment plants (WWTPs) provide a constant and significant point source of environmental ARGs even in agricultural areas like Iowa. As the first step towards accurate risk assessment of the environmental dissemination of antibiotic resistance, a predictive and quantitative model of ARG persistence in Iowa rivers will be constructed and evaluated. The tasks of the proposed work involve constructing and evaluating a model that accounts for physical, chemical, and biological mechanisms of fate and transport of ARGs. Modeling will start with mass balances applied to the water column, suspended particles, sediment bed, and biofilms. The model will be evaluated by comparing with measurements in controlled laboratory microcosms and field measurements in the Ames, IA WWTP and its receiving river.

### **Identification of antibiotic resistance and virulence genes in Legionella found in hospital water using next generation sequencing**

*Investigators:* W. Hottel, UI Department of Epidemiology; N. Hall, V. Reeb, L Desjardin, State Hygienic Laboratory at The University of Iowa *Executive*

*Summary:* *Legionella* bacteria, a cause of pneumonia, are ubiquitous in the freshwater environment and man-made water systems. The majority of human disease is caused by *L. pneumophila* serogroup 1, although other strains and *Legionella* species can cause disease. *Legionella* species have a relatively high genetic diversity and the mobile transfer of genetic material is a mechanism for environmental *Legionella* to acquire virulence and antibiotic resistance genes, potentially increasing their pathogenicity. SHL has an extensive *Legionella* isolate collection from Midwest hospital water supplies providing a unique opportunity to look for antibiotic susceptibility and virulence genes in these isolates by whole genome sequencing using Next Generation Sequencing. The presence of virulence and antibiotic resistance genetic markers in environmental *Legionella* isolates cultured from hospital water could provide important information on the potential risks resulting from infection with these bacteria and whether water control measures are indicated to prevent hospital-acquired Legionnaires' disease.

### **Prairie strips for retaining antimicrobial resistant organisms**

*Investigators:* AC Howe, ML Soupir, M. Helmers, Department of Agricultural and Biosystems Engineering, Iowa State University; LA Schulte, Department of Natural Resource Ecology and Management, Iowa State University; T. Moorman, National Laboratory for Agriculture and the Environment, USDA-ARS

*Summary:* Antimicrobial resistance is a serious threat to both animals and humans. The large number of farm animals receiving antibiotics and their close contact with soil and water resources pose a public threat to the increasing emergence of antimicrobial resistance and ineffective drug treatments. Consequently, methods to mitigate the transport and spread of antimicrobial resistance are critically needed. Prairie strips are a conservation practice that uses strategically placed native prairie plantings in crop fields and have been shown to reduce the movement of soil and water from the agricultural environment. The study hypothesis is that prairie strips can also mitigate the spread of antimicrobial resistance genes and bacteria to the environment. This project develops a pilot system to test the retention of manure-associated resistance genes and bacteria in installed prairie strips and evaluates its benefits for surrounding soils and waters.

### **Colorimetric sensing of environmental fluoride contaminants using chemically reactive triamidoborane ligands**

*Investigator:* S. Daly, UI Department of Chemistry

*Summary:* Developing molecular sensors that can accurately detect elevated fluoride concentrations in groundwater is an important, but challenging goal. Fluorosis – a health condition that stems from chronic consumption of excess fluoride from mineral deposits and industrial pollution – results in severely debilitating bone deformations and other life-threatening ailments in many parts of the world. Optical sensors that change color in response to aqueous fluoride would offer an inexpensive method to detect high fluoride levels in drinking water, but there are two challenges that have yet to be fully addressed: (1) selectivity for fluoride over competing analytes, and (2) high binding affinity for fluoride in water. Previous research

demonstrated that metal-bound triamidoborane ligands (TBDPhos) can selectively bind fluoride while bound to transition metals. Here we propose to chemically modify our colorless TBDPhos ligands to produce an optical change in response to fluoride binding so they can be used in fluoride sensing applications.

## **Cooperative Research Projects**

The CHEEC Cooperative Research Program seeks to leverage research funds from university, state, and federal entities to conduct research in areas of mutual interest; the collaboration requires matching funds from participating entities. Like the Seed Grant Program, it seeks to establish innovative lines of environmental health research leading to preliminary results that may be used in seeking further larger grant funding from federal and private sources. Since the Program began in 1999, 14 projects have been funded. Over the life of the Cooperative Research Program, there has been an average of a 5 dollar match from Cooperators for every dollar CHEEC has invested. Cooperators have included the U.S. Geological Survey, the U.S. Department of Agriculture, the U.S. Department of Energy, the U.S. Environmental Protection Agency, the National Institutes of Health, the Iowa Department of Natural Resources, the Iowa Department of Public Health, the Leopold Center for Sustainable Agriculture at Iowa State University, Iowa County Health Departments, and Departments in the UI Colleges of Public Health, Engineering, Medicine, and Liberal Arts and Sciences.

CHEEC awarded the following cooperative research grant in FY 2017.

### **Iowa statewide small community drinking water survey of lead, copper and arsenic**

*Investigators:* M. Scherer, D. Latta, D. Cwiertny, UI Department of Civil and Environmental Engineering; S. Dai, State Hygienic Laboratory at the University of Iowa

*Cooperators:* Iowa Institute for Hydraulic Research-Hydroscience and Engineering; Sustainable Water Development Graduate Program, UI Department of Civil and Environmental Engineering

*Summary:* This project will address the issue of lead, copper, and arsenic in small community drinking water systems. Lead, copper, and arsenic are regulated in drinking water under the Safe Drinking Water Act (SDWA) due to their toxicity to human health. Over the last five years, 41 water systems in Iowa have exceeded the action level for Pb in their drinking water and 22 have exceeded the maximum contaminant level (MCL) for arsenic (impacted population = 23,393). This project will be a collaboration of CHEEC, the State Hygienic Laboratory, and IIHR-Hydroscience & Engineering to collect, analyze and map available Pb, Cu and As data from small community drinking water systems in Iowa, as well as identify twenty small communities to survey and measure Pb, Cu, and As, water quality parameters, and treatment methods. The goal is to make Pb, Cu, and As data easily accessible to communities and to provide recommendations to communities on how to avoid future Pb, Cu, and As releases to their water.

## **Education Programs**

CHEEC participates in environmental health education activities through organizing, funding and hosting educational programs, and giving presentations at conferences, workshops and public meetings across the state. In 2017, CHEEC participated in a number of programs on drinking water quality in Iowa, focusing on the importance of a public health perspective on the importance of safe drinking water, and in protecting the drinking water sources, both surface water and groundwater, across the state. Talks were presented at an Iowa Association of Water

Agencies meeting, the Iowa Governor's Conference on Public Health, the University of Iowa Science Café, the Des Moines Water Works Citizen Water Academy, and a National Water Quality Monitoring Council webinar. CHEEC also co-hosted the Iowa Public Health Association Workshop titled Iowa's Water Quality: A Public Health Perspective, and co-hosted the Symposium on Challenges to Providing Safe Drinking Water in the Midwest.

## **Education grants**

CHEEC Education Grants provide funding for education programs with a public health and environmental education focus that demonstrates a link to environmental health issues. Awards are for **partial support** for projects related to exposure prevention, assessment and awareness, and improvement of environmental health. .

In 2017, CHEEC awarded a grant to the Iowa Public Health Association.

### ***Iowa's Water Quality: A Public Health Perspective Workshop***

Iowa Public Health Association

## **Who We Are**

### **Staff**

Peter Weyer, PhD, Interim Director

### **Executive Committee**

David Cwiertny, PhD, UI Department of Civil and Environmental Engineering

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Sarah Larsen, PhD, UI Department of Chemistry

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Paul Romitti, PhD, UI Department of Epidemiology

Donald Simmons, PhD, State Hygienic Laboratory

Richard Valentine, PhD, UI Department of Civil and Environmental Engineering

Peter Weyer, PhD, CHEEC

Michael Wichman, PhD, State Hygienic Laboratory

### **Advisory Committee**

Trudy Burns, PhD, UI Department of Epidemiology

Jon Carlson, JD, UI College of Law

Margaret Carrel, PhD, UI Department of Geography

Chad Fields, Iowa Department of Natural Resources

Laurence Fuortes, MD, UI Department of Occupational and Environmental Health

Craig Just, PhD, UI Department of Civil and Environmental Engineering

Mark Lohafer, Iowa Dept. of Agriculture & Land Stewardship

David Osterberg, UI Department of Occupational and Environmental Health

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Ken Sharp, MPA (Chair), Iowa Department of Public Health

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