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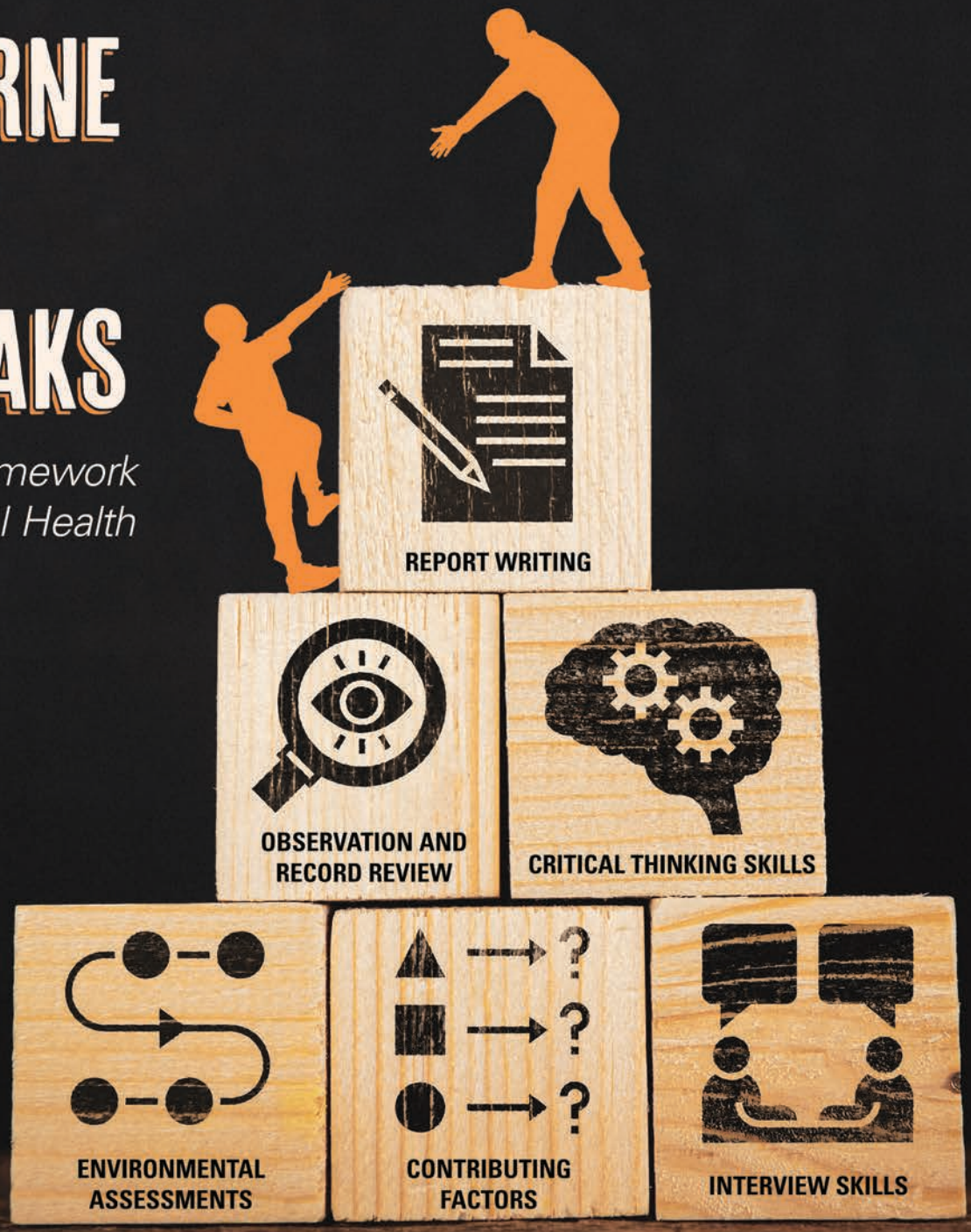
Competency Framework for Environmental Health Professionals



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ABOUT THE COVER

Environmental health professionals are essential to foodborne illness outbreak investigations, although many do not receive formal training in this area. This month's cover article, "Competencies for Environmental Health Professionals Who Detect, Investigate, and Respond to Foodborne Illness Outbreaks," presents a competency framework that reflects the comprehensive set of skills desired for environmental health professionals at state and local health agencies. The study describes the findings of a web-based survey that assessed these competencies and identified training priorities among practicing environmental health professionals, as well as an environmental health competency training road map.

See page 24.

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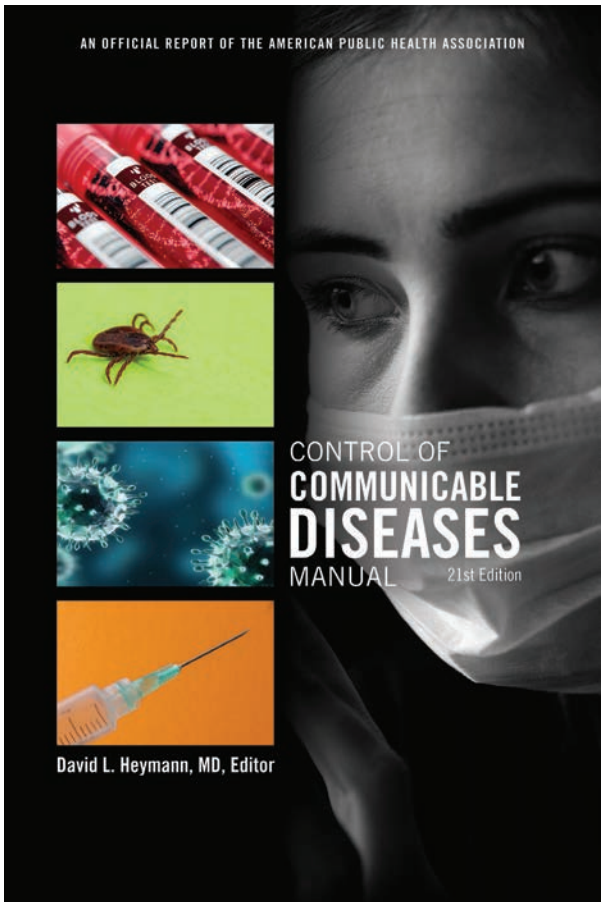

Control of Communicable Diseases Manual, 21st Edition

Edited By: David L. Heymann, MD

2022, SOFTCOVER, 750 PP, 9780875533230

Control of Communicable Diseases Manual, 21st Edition, is the must-have sourcebook on identifying and controlling infectious diseases. The new edition has been heavily updated and includes new chapters on SARS-CoV-2, Zika, and more. Now more than ever this landmark publication is essential for all areas of public health. Available in print, and digital subscription for individuals and institutions.

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PRESIDENT'S MESSAGE

D. Gary Brown,
DrPH, CIH, RS, DAAS

Help Spread the Word—Environmental Health Is Public Health

I want to thank all the environmental health professionals who were the unsung heroes of the COVID-19 pandemic. Environmental health professionals stepped up to the plate and performed a variety of tasks that provided their peers and the public with important insight into the value of our profession. I would be remiss to not thank all of the National Environmental Health Association (NEHA) staff for their hard work. NEHA is lucky to have such a passionate, dedicated, and hardworking staff.

I grew up in Lackawanna, New York, a steel town located in a suburb of Buffalo. At its height of operation, the Bethlehem Steel Plant, known locally as Daddy Bethlehem, was the world's largest steel factory that employed over 20,000 workers. Growing up in a steel town was a wonderful experience with people from all over the world having a shared sense of community.

As I got older, I realized I grew up in a polluted town. I remember as a kid my grandmothers taking clothes off the line so the clothes would not get covered in coal dust when the coke ovens would have their shake out. As a child I would walk along the appropriately named Smokes Creek and helped clean debris out to the creek as a Boy Scout.

I learned firsthand the danger of heavy manufacturing. When I was little, my father received third degree burns on his lower leg. Two of my friends, Michael "Mugsy" Francis Catuzza and Kenneth Pirowski, lost their lives in occupational accidents, which taught me that the true value of environmental and occupational health and safety (EOHS) can never be measured in dollars. My father was a third-generation steel worker and if Bethlehem Steel did not close down in the 1980s, I probably would have been the fourth generation. Later in his career, my father was the union representative who assisted with health and safety at Bethlehem Steel, which helped guide my career.

> *Our communities need us as environmental health leaders to be bold.*

I went to the University of Buffalo, studying premed with the hopes of becoming a veterinarian. Unfortunately, I am allergic to animals and needed to make a career switch. I switched to environmental studies under the assumption I would spend most of my time in nature counting deer. Instead, I was conducting sewer monitoring watching the feces (aka brown trout) float by. My first job after graduation was in a laboratory, which I did not enjoy. No one informed me that the professions in the environmental field making money were engineering or EOHS, a lesson I learned the hard way.

My father told me to look into health and safety. In his infinite wisdom, he stated that people will pay more to save themselves than whales. The only EOHS program in New York at the time was at Hunter College in New York City. I called the EOHS Department at Hunter College to learn more. I ended up speaking with Dr. David Kotelchuck, program director, who spent over one hour enlightening me about this amazing field. Majoring in EOHS was wonderful—I loved my classes that were taught by professors who had practiced in the field for years before coming into academia. My professors at Hunter College are my inspiration through their love teaching and their genuine concern for the success of their students.

I did an internship at an EOHS consulting firm in Buffalo and realized that I had found a home. After graduating, I worked for consulting firms and in the chemical industry. The work was fulfilling but my passion was teaching. Something my grandfather Eli Evanovich, who only finished third grade in Macedonia, resonated with me: "Education is something that can never be taken away from you."

In order to teach EOHS, I knew I had to go back to school to obtain a terminal degree, which led me to the University of Alabama at Birmingham. I have many people to thank who helped me complete my doctor of public health (DrPH) that afforded me a wonderful, fulfilling career, including Dr. Mitchell Zavon and Dr. R. Kent Oestenstad (aka Dr O). There are not enough words to thank my wife Deby, who has been a stalwart in support of my career, dreams, and aspirations, as well as our eventual move to Kentucky.

I started a consulting firm in Buffalo while completing my doctoral research. It was there that I began my journey as a Hawaiian shirt, sneaker wearing fashionista. I hit the lottery when I became a faculty member of the Environmental Health Science Program at Eastern Kentucky University, being mentored by Dr.

Peter (aka "Yoda the Industrial Hygiene Master) Creighton, Dr. Carolyn Harvey, Professor Worley Johnson, Professor Joe Beck, and the other faculty. I started as the baby of the program but after 21 years, I am now the old man. Funny how that happens.

I have found a home in Jamaica teaching with Dr. Norbert Campbell and Dr. Henroy Scarlett in the Occupational and Environmental Safety and Health Department at the University of the West Indies at Mona, Jamaica, along with being a member of the Jamaica Association of Public Health Inspectors for the past 17 years. When not teaching, I consult for government and private entities.

Environmental health is a hidden treasure, providing a world of opportunity that touches all aspects of daily life. In my opinion, one of the greatest challenges we face is a lack of knowledge by the public of our profession. I will be working with NEHA members and staff to increase the visibility of the environmental health profession. Along with the general public, we need to diligently educate the numerous professionals we work with that environmental health is public health.

This increased awareness will also help to reverse the trend of fewer students pursuing a formal education in environmental health. Students are the future of environmental health; therefore, we need to not only increase the number of the younger generation but also get them more involved in NEHA. As a profession, we all need to work together to spread the word far and wide about this exciting, fulfilling, and meaningful career. I believe an increased awareness will also lead to increased diversity in our field, an area that needs improvement.

As the world is reopening from the COVID-19 pandemic, environmental health needs to seize the opportunity to educate the public, policy makers, and key stakeholders of the technical, scientific expertise required to become a Registered Environmental Health Specialist/Registered Sanitarian (REHS/RS). The REHS/RS credential is under appreciated by many, something I will work diligently to rectify. Another priority for myself and the NEHA Board of Directors and staff is to make NEHA more beneficial to our affiliates.

I have a passion for assisting people all over the world to have clean air, food, and water, along with a healthy and safe place to live, work, and play. I believe NEHA can help increase international participation and in turn, we can all learn from each other to help improve environmental health and the overall quality of life on a global scale. We are a cure to many of the world's ills. Environmental health professionals realize this fact but we need everyone else to know it. We are making progress as an association and I hope to help us make even more progress.

This moment is our time to help spread the word—environmental health is public health. Our communities, here and worldwide, need us as environmental health leaders to be bold.

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Occurrence of Nitrate and Indicators of Agricultural and Septic System Contamination in a West Central Wisconsin Sand Aquifer

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Abstract **Fertilizers, manure, and septic effluent are potential sources of nitrate in groundwater. Nitrate can be harmful if ingested above the U.S. Environmental Protection Agency maximum contaminant level of 10 mg/L. In Eau Claire County, located in West Central Wisconsin, approximately one quarter of households rely on private wells. Sources of nitrate in private wells in Eau Claire County have not been researched previously.**

A total of 110 private wells in Eau Claire County were tested for seven agricultural and three septic indicators to identify sources of nitrate contamination. Nitrate contamination risk factor data (e.g., well depth, casing depth) were also collected. Average nitrate concentrations were significantly higher in wells with agricultural indicators, suggesting agriculture is a source of nitrate. Wastewater indicators were identified, but septic systems were not a significant source of nitrate. Well casing depth was the only risk factor associated with elevated nitrate. Funds should be allocated to the Eau Claire City–County Health Department to promote and subsidize point-of-use drinking water treatment in homes with nitrate levels ≥10 mg/L. Further, new well casing depths should be >12 m (40 ft) to avoid infiltration of nitrate and other contaminants.

Introduction

Nitrate is a widespread, highly mobile contaminant of groundwater that is especially common in dense agricultural areas (Spalding & Exner, 1993). Potential sources of nitrate contamination include agricultural or lawn fertilizer application, septic systems, animal feedlots and barnyards, and septage or sludge disposal. The burden of nitrate contamination in groundwater in the Upper Midwest has been widely studied (Bundy et al., 1996; Chern et al., 1999; LeMasters & Baldock, 1997; Shaw, 1994), partly because of the human health effects associated with nitrate exposure. Though nitrate is a naturally occurring compound, it is often found in groundwater at levels that greatly exceed the U.S. Environmental Protection Agency (U.S. EPA) preventive action limit (2 mg/L) or maximum contaminant level (MCL, 10 mg/L) in agricultural and dense unsewered residential areas.

The health-based standards for nitrate were established from the risk of methemoglobinemia, a condition in which the blood's ability to transport oxygen is compromised. Individuals who are pregnant and infants are at greatest risk. Some studies also suggest livestock that drink water with elevated nitrate have poorer pregnancy outcomes (Al-Qudah et al., 2009).

The Wisconsin Department of Natural Resources (WI DNR) has estimated that 90% of nitrate in Wisconsin groundwater is from agricultural activities, approximately 9% is from septic systems, and <1% is attributable to lawn fertilizer or other sources (Shaw, 1994). In addition to the health risks from nitrate, there could be additional risks to private well owners where co-contaminants associated with agriculture and septic systems exceed preventative action limits. Elevated nitrate often is correlated with pesticides, herbicides, viruses, pharmaceuticals, or other constituents of agrichemicals or human wastewater (Burow et al., 1998; Istok et al., 1993; Seiler et al., 1999). One study estimated that 42% of private drinking water wells in Wisconsin contained a detectable level of an herbicide or herbicide metabolite (Wisconsin Department of Agriculture, Trade, and Consumer Protection [WI DATCP], 2017).

In Eau Claire County located in West Central Wisconsin, over 25,000 people (approximately 1 in 4) rely on private wells as their primary source of drinking water. The quality of private well water is of public health concern because private water supplies are not regularly tested or regulated. Over 4,500 nitrate tests have been analyzed at the Eau Claire City–County Health Department (ECC–CHD) since 2005. Approximately 4,500 wells remain untested in Eau Claire County for nitrate. Approximately

1 in 2 wells sampled in Eau Claire County have nitrate that exceeds naturally occurring concentrations (generally presumed to be ≤2 mg/L). Nearly 1 in 20 sampled wells exceed the health-based standard for nitrate.

Until our study, almost no wells had been tested for common nitrate co-contaminants such as pharmaceuticals or agricultural chemicals in Eau Claire County, though other areas of the state have been investigated as early as the 1980s (Rothschild et al., 1982). Aims of our study were to determine nitrate trends and identify nitrate contamination risk factors of private wells in Eau Claire County.

Methods

Site Selection

This study took place from July 2016 through June 2018 and was approved by the University of Wisconsin–Eau Claire Institutional Review Board in 2016. Private well owners with a septic system and past water test containing nitrate levels ≥5 mg/L in the ECC–CHD Certified Public Health Laboratory water quality database were invited to participate. This level was used because it provided a robust number of potential participants (399) and at ≥5 mg/L, the nitrate present was likely from an anthropogenic source (U.S. Geological Survey, 1999). Well owners were mailed a letter describing the study that contained instructions to contact ECC–CHD to participate in the study.

Questionnaire

We developed the questionnaire used in our study in consultation with researchers from a similar study in Hastings, Minnesota, to create an exhaustive list of potential risk factors of nitrate contamination of well water (Dakota County Environmental Management, 2003). Property owners were issued a questionnaire on-site that gathered well contamination risk factor data such as site history and proximity to potential nitrate sources (e.g., septic systems, distance to and type of agricultural fields, fertilizer storage, abandoned wells). Using the questionnaire, researchers also recorded approximate distances from the wellhead to potential sources of nitrate such as animal feedlots, privies, and fertilizer storage. For each well, we gathered construction data—including well depth, construction date, casing depth, and well type—prior to sampling wells that had records available from WI DNR.

Sample Collection and Analysis

We collected samples for nitrate as well as seven agricultural indicators (i.e., atrazine, desethyl atrazine, desisopropyl atrazine, acetochlor, alachlor, metolachlor, and cyanazine) and three septic system indicators (i.e., caffeine, carbamazepine, and carisoprodol). We collected water samples for nitrate in clear, sterilized 250-ml polyethylene bottles. We collected agricultural and septic system indicator samples in 1-L amber glass bottles.

Samples were collected from an outside tap or pressure tank tap (before in-line water treatment systems where present) and after running the source for approximately 2 min. If no water treatment system was present, we also collected water samples from the indoor tap. Samples were transported on ice to the ECC–CHD laboratory, stored at <6 °C, and processed within 24 hr of collection.

Nitrate samples were analyzed using Standard Method 4500D-NO_3. Nitrate standards were prepared from pure potassium nitrate (Fisher Scientific). Nitrate standards and samples were treated with an interference suppressor and then analyzed with a calibrated ion-selective electrode.

Target chemicals for agricultural and septic system indicators were obtained as neat standards and prepared as diluted solutions in ethyl acetate (ChemService). Samples were analyzed using modified U.S. EPA (1995) Method 507. Control spikes were prepared by addition of standard solutions to 1 L of reagent water. Method blanks consisted of 1 L reagent water. To aid in recovery, 50 g of sodium chloride was dissolved in the samples, and 1,2-dimethyl-3-nitrobenzene was added as a surrogate spike. A sample size of 1 L was drawn through a Empore C18 and an SPD-RPD extraction disk (3M). The disks were eluted first with 8 ml ethyl acetate and then with 8 ml methylene chloride. The eluant was dried with sodium sulfate powder then reduced to 5 ml volume by evaporation of the solvent over a hot plate at 100 °C until the volume was reduced to 5 ml. The extract was injected into a calibrated Trace 1300 gas chromatograph with a nitrogen–phosphorus detector to determine the sample concentration (Thermo Fisher Scientific). Both the control spikes and method blanks (one of each per batch) were processed in the same manner as the samples. Hydrocodone, acetaminophen, flumetsulam, mesotrione, saccharin, and sulfamethoxazole were evaluated as potential indicator compounds—but were not amenable to the method.

Statistical Analysis

A student's *t*-test at the 95% confidence level was performed on dichotomous questionnaire responses to determine if the average nitrate concentration differed among sites with agricultural or septic system indicators and risk factors identified on the questionnaire. For example, the average nitrate concentration was compared at sites positive and negative for agricultural indicators to determine if herbicides and pesticides are indicators of nitrate contamination in private wells. Pearson's correlation coefficient was used to explore associations between numerical data collected on the questionnaire. Correlation coefficients (r) > .3 and < .5 indicate a moderate correlation and r > .5 indicates a strong correlation. STATA data analysis and statistical software version 13.1 was used to perform the statistical analysis.

Results

Sample Demographics

There were 399 eligible participants for our study. Of these, 130 households indicated interest (33% response rate) and 110 fully participated by completing the questionnaire and submitting water samples (28% response rate). A total of 108 samples were above the nitrate, agricultural, or septic system indicator detection limits; thus, we included these 108 samples in statistical analysis. Samples were collected from 10 different townships in Eau Claire County, with an additional 3 county townships having no participants. Positive samples of agricultural and septic systems were limited to 3 townships (Table 1). No agricultural or human waste indicators were found in samples from the other 7 townships.

Agricultural and Septic System Indicators

Agricultural indicators were identified in 15% of samples; septic system indicators were found in 5% of samples. Agricultural indicators detected were desethyl atrazine, desisopropyl atrazine, atrazine, and alachlor. Detected

septic system indicators included caffeine and carbamazepine (Table 2). The most frequent agricultural indicator was desethyl atrazine (13% of samples), followed by atrazine (10% of samples). Of the 108 samples, 16 samples (15%) were positive for atrazine and/or an atrazine metabolite and 1 sample was positive for alachlor. Caffeine was the most frequent septic system indicator (4%). The four sites with caffeine detections were independent from the two sites with carbamazepine detects (the only other detected human waste indicator). Of the sites with atrazine detects, only two did not have atrazine metabolite detects. The four sites with atrazine metabolite detects did not have atrazine present in groundwater at detectable levels.

Nitrate

The nitrate MCL was exceeded in 24 of 108 samples (22%). The maximum detected nitrate concentration was more than double the MCL at 22 mg/L. The average nitrate concentrations in each township are shown in Figure 1. None of the agricultural or septic system indicators was above available enforcement standards. The average nitrate concentration in wells with agricultural indicators present was 10.7 mg/L, which is significantly higher at the 95% confidence level than the average nitrate concentration in wells without agricultural indicators present (6.8 mg/L; $p < .0026$).

The median nitrate concentration was 6.7 mg/L. When comparing the average nitrate concentration in wells positive for atrazine (but no other agricultural indicators) with wells without atrazine, nitrate concentrations were significantly higher in atrazine wells ($p < .0025$). No statistically significant relationship was found between wells with high nitrate concentrations and presence of the septic system indicators analyzed.

Nitrate Contamination Risk Factors

Contrary to our hypothesis, there were weak correlations between nitrate concentration and well age ($r = .08$) and well depth ($r = .17$). Other analyzed variables with weak correlations to nitrate concentration were drillhole depth ($r = .21$), static water level ($r = .22$), and well screen length ($r = .05$). Well construction information was available for 39% of sampled sites. Among these sites, wells with a casing depth <12 m (40 ft) had significantly more nitrate at the 95% confidence level ($p < .032$). A total of 73% of households (52 households) that reported a crop within 91 m (300 ft) of the well stated the crop was corn.

TABLE **1**

Number of Samples Collected and Percentage of Samples Positive for Agricultural and Septic System Indicators, Eau Claire County Townships, Wisconsin

Township	Sample Size	Population	# of Permitted Septic and Holding Tanks	Samples Positive for Agricultural Indicators # (%)	Samples Positive for Septic System Indicators # (%)
Bridge Creek	3	1,902	699	0	0
Brunswick	16	1,713	700	0	0
Clear Creek	1	817	331	0	0
Drammen	2	745	330	0	0
Lincoln	3	1,186	444	0	0
Ludington	1	1,096	479	0	0
Pleasant Valley	27	3,181	1,355	6 (22)	3 (11)
Seymour	8	3,276	1,299	0	0
Union	14	2,736	1,071	10 (71)	1 (7)
Washington	29	7,379	2,278	1 (3)	2 (7)

Note. Population numbers were calculated from 2013–2017 U.S. Census Bureau estimates.

Discussion

Agricultural and Septic System Indicators

Atrazine and desethyl atrazine (an atrazine metabolite) were the most frequent agricultural indicators detected. The frequency of detection was similar to Wisconsin's state average. Throughout Wisconsin, atrazine and atrazine metabolites are present in approximately 23% of private wells compared with 15% in our study (WI DATCP, 2017). The infrequent detection of the other agriculture and septic system indicators could be due to a variety of reasons. Atrazine is a broadleaf herbicide for agriculture, and weed control is responsible for the overwhelming majority of atrazine in the environment. Because atrazine is classified as a restricted-use pesticide, only certified applicators are permitted to purchase or apply it. Atrazine is not very persistent in surface soils after application due to biodegradation. The half-life of atrazine in soil has been reported within a range of 14–109 days. Slow or no biodegradation occurs once atrazine is in groundwater (Agency for Toxic Substances and Disease Registry, 2011). The low number of atrazine detects in groundwater for our study is likely a result of its biodegradation prior to entering the water column.

Caffeine and carbamazepine were the only septic system indicators detected. Caffeine can serve as an effective indicator of groundwater contamination from septic systems because of its widespread use (Seiler et al., 1999). Caffeine might be present in wastewater as unmetabolized caffeine consumed in beverages or via disposal of unconsumed coffee, soft drinks, or tea. Of the sampled wells, four contained caffeine at detectable levels; the maximum concentration of caffeine was 0.36 µg/L, which is slightly higher than other similar studies. For example, Seiler et al. (1999) detected 0.23 µg/L of caffeine below an unsewered Nevada subdivision.

Considering 100% of sampled sites in our study have septic systems, a higher number of detectable concentrations of caffeine or other wastewater indicators was expected. Caffeine

TABLE **2**

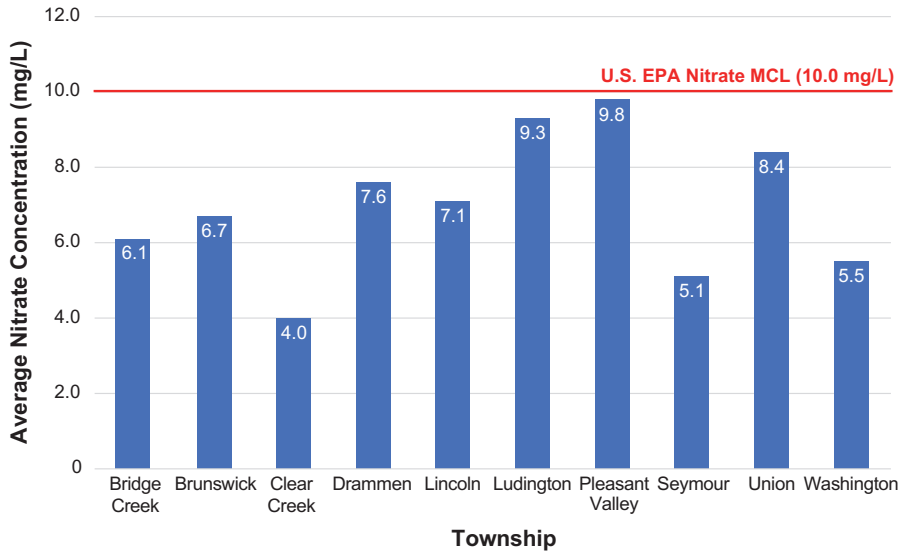
Maximum Concentrations, Frequency, and Detection Limits for the Analysis of Agricultural and Septic System Indicators and Nitrate, Eau Claire County, Wisconsin

Indicator	Chemical	Chemical Purpose	Detection Limit (µg/L)	Maximum Concentration Detected (µg/L)	MCL (µg/L)	# of Detects
Agricultural	Desethyl atrazine	Atrazine metabolite	0.2	0.49	NA	14
	Desisopropyl atrazine	Atrazine metabolite	0.2	0.42	NA	3
	Atrazine	Herbicide	0.1	0.49	3	11
	Acetochlor	Herbicide	0.2	ND	NA	0
	Alachlor	Herbicide	0.2	0.28	2	1
	Metolachlor	Herbicide	0.2	ND	NA	0
	Cyanazine	Herbicide	0.1	ND	NA	0
Septic system	Caffeine	Stimulant	0.2	0.36	NA	4
	Carbamazepine	Anticonvulsant	0.3	0.85	NA	2
	Carisoprodol	Muscle relaxant	0.3	ND	NA	0
	Nitrate	Fertilizer, waste product	0.41 mg/L	22 mg/L	10 mg/L	108

Note. MCL = maximum contaminant level; NA = not applicable; ND = not detected.

FIGURE **1**

Average Nitrate Concentrations in Private Wells, Eau Claire County Townships, Wisconsin



Note. No township's average nitrate concentration in private wells exceeded the U.S. Environmental Protection Agency (U.S. EPA) maximum contaminant level (MCL) for nitrate of 10 mg/L.

is highly biodegradable in soils with strong microbiological communities, however, and is known to sorb to sandy loam and silt loam soils, which are present in Eau Claire County (Karnjanapiboonwong et al., 2010; Knee et al., 2010) and might reduce the presence of caffeine in groundwater.

Conversely, carbamazepine does not degrade or sorb and can survive intact in groundwater for >8 years (Clara et al., 2004; Drewes et al., 2003). These properties make carbamazepine a good option for a wastewater tracer. Carbamazepine, however, is much less ubiquitous in septic systems compared to caffeine due to its overall lower rate of consumption. Seiler et al. (1999) found 1 positive sample for carbamazepine in 16 samples from unsewered subdivisions. Out of 38 groundwater sampling locations in western Montana, 11 locations contained detectable carbamazepine with a maximum concentration of 0.42 µg/L (Miller & Meek, 2006) in comparison with a maximum 0.85 µg/L found in our study.

The relatively low detection rates of caffeine and pharmaceuticals do not confirm that a well has not been impacted by septic effluent, though, especially given the trans-

port barriers of caffeine and potential sporadic use of the pharmaceuticals. In future studies, better indicators of septic system impacts might be a) other chemicals that are less biodegradable and ubiquitous or b) pharmaceutical metabolites.

Nitrate

Across Wisconsin as a whole, 10–11% of private wells on average are above the nitrate MCL (LeMasters & Baldock, 1997; WI DATCP, 2017). Even though the sample population in our study contained wells known to have at least ≥5 mg/L nitrate, the percentage of samples above the U.S. EPA nitrate MCL for drinking water (10 mg/L) that we found (22%) is similar to what other regional studies found. In areas with abundant agriculture in Wisconsin, much like Eau Claire County, 17–26% of private wells contain nitrate above the U.S. EPA MCL (LeMasters & Baldock, 1997). In nearby Hastings, Minnesota, researchers found 25% of private and public drinking water wells had nitrate concentrations above the U.S. EPA MCL (Hastings is 140 km west of Eau Claire County) and deemed these findings as a water quality "problem" for the area (Dakota County Environmental Management, 2003).

For existing private wells in Eau Claire County with nitrate tests >10 mg/L, homeowners are notified and point-of-use or whole-house system installation is recommended by ECC–CHD. Nitrate testing of private wells in Eau Claire County, however, is not required, and there is no funding to help homeowners purchase point-of-use treatment systems.

Results from a statewide study found that 70% of Wisconsin homeowners did not take action to reduce nitrate drinking water exposures (Knobeloch et al., 1997). Among the homeowners who did take action in our study population, the most common solutions were purchasing bottled water and installing a point-of-use nitrate treatment system. The average cost of purchasing bottled water or installing a point-of-use treatment system at the time of the Knobeloch et al. (1997) study was $200/year and $850/year, respectively.

Present-day estimates for bottled water (1 gallon/day) are approximately $475/person/year. Reverse osmosis systems are available currently for a one-time cost of at least $200 plus the cost of installation and replacement filters (additional annual cost estimate of $50–$120, depending on usage), for a total cost of $250–$320. The cost of these mitigation options could be prohibitive for some county residents. To make access to safe, clean drinking water more equitable, affordable nitrate mitigation resources should be made available and advertised to households in areas with nitrate well water levels ≥10 mg/L.

Considering the time, effort, and environmental impact of purchasing bottled water, the cost of installing and maintaining a point-of-use treatment system is the preferable option for households. The efficacy of a private well nitrate remediation program that would offer and aggressively advertise nitrate remediation options to homeowners with well water at or above the U.S. EPA nitrate MCL should be tested in an area that is experiencing nitrate contamination issues (like Eau Claire County). There is also a need for prioritizing education and outreach about the importance of monitoring nitrate levels in at-risk private wells (i.e., 5–9 mg/L nitrate).

Nitrate Contamination Risk Factors

The significantly higher average nitrate concentration in wells with agricultural indicators suggests agriculture is a source of nitrate contamination in private wells in Eau Claire County. Although studies have demonstrated that nitrate from septic system effluent is a contributor to poor well water quality (Shaw, 1994), our findings do not suggest septic systems are a significant source of nitrate in Eau Claire County. Other studies have also indicated that agriculture is the primary source of nitrate contamination compared with septic systems (Chern et al., 1999).

Casing depth was the only risk factor associated with elevated nitrate. Previous research indicates wells with casings less than 12.2 m (40 ft) have significantly more nitrate (Bundy et al., 1996), which is consistent with our study. Well age and depth had been previously identified as nitrate contamination risk factors but did not correlate with nitrate contamination in our study (Dakota County Environmental Management, 2003). The sandy soil, heavy agriculture, and thick sandstone aquifers allow for rapid and deep infiltration of water and water-soluble contaminants. This process and the increased likelihood of denitrification or lower nitrate concentrations in older groundwater at depth (Böttcher et al., 1990; Kraft et al., 2004) are the most likely explanation for higher concentrations of nitrate in wells with shallow casing.

Many of the wells for which records were available (n = 43) are constructed as open boreholes, with highly variable distances between the bottom of the borehole and bottom of the casing (0 up to 48.2 m [158 ft]) borehole depth below casing, median of 5.1 m (17 ft). This finding could explain the lack of correlation between nitrate concentration and well borehole depth in our study.

Conclusion

The frequency of samples with nitrate concentrations above the drinking water MCL in our study is similar to other regional studies where water quality was declared problematic. Agriculture appears to be the primary source of nitrate contamination of private wells in Eau Claire County. Solutions presented to resolve the nitrate problem in Wisconsin have traditionally focused on reducing nitrate fertilizer overuse on crops. Although this strategy is an important part of the solution, direct action is needed to protect homeowners from the adverse health effects associated with consuming water with nitrate ≥10 mg/L.

As most Wisconsin homeowners (70%) do not take action to reduce nitrate exposures from drinking contaminated well water (Knobeloch et al., 1997), local public health authorities must develop and implement interventions. Funds should be allocated to public health authorities in Eau Claire County or other areas experiencing similar nitrate contamination issues to promote and subsidize point-of-use drinking water treatment systems in homes with nitrate levels ≥10 mg/L. The efficacy of this approach could be studied as a pilot for other areas experiencing a similar rate of nitrate contamination in private well water. As casing depth was the only risk factor to have an association with nitrate contamination, private wells should be constructed with a casing depth greater than 12 m (40 ft) where possible to avoid infiltration of nitrate and other contaminants.

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continued on page 14

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Quiz effective date: July 1, 2022 | Quiz deadline: October 1, 2022

1. Potential sources of nitrate contamination in groundwater include
   a. septic systems.
   b. animal feedlots and barnyards.
   c. agricultural or lawn fertilizer application.
   d. all of the above.
   e. none of the above.

2. The U.S. Environmental Protection Agency (U.S. EPA) preventive action limit for nitrate is
   a. 2 mg/L.
   b. 4 mg/L.
   c. 5 mg/L.
   d. 10 mg/L.

3. The Wisconsin Department of Natural Resources has estimated that __ of nitrate in Wisconsin groundwater is from agricultural activities.
   a. 60%
   b. 70%
   c. 80%
   d. 90%

4. Approximately __ wells sampled in Eau Claire County have nitrate levels that exceed naturally occurring concentrations.
   a. 1 in 2
   b. 1 in 3
   c. 1 in 4
   d. 1 in 5

5. Private well owners with a septic system and past water test containing nitrate levels __ in the Eau Claire City–County Health Department Certified Public Health Laboratory water quality database were invited to participate.
   a. ≥2 mg/L
   b. ≥4 mg/L
   c. ≥5 mg/L
   d. ≥10 mg/L

6. A total of __ households fully participated in this study by completing the questionnaire and submitting water samples.
   a. 108
   b. 110
   c. 130
   d. 399

7. Agricultural indicators were identified in __ of samples and septic system indicators were found in __ of samples.
   a. 5%; 10%
   b. 5%; 15%
   c. 15%; 5%
   d. 15%; 10%

8. Of the 108 samples, __ were positive for atrazine and/or an atrazine metabolite.
   a. 14%
   b. 15%
   c. 16%
   d. 17%

9. Caffeine was the most frequent septic system indicator.
   a. True.
   b. False.

10. The U.S. EPA maximum contaminant level for nitrate of 10 mg/L was exceeded in __ of the samples.
    a. 16%
    b. 18%
    c. 20%
    d. 22%

11. Among the homeowners who did take action in this study population, the most common solutions were purchasing bottled water and installing a point-of-use nitrate treatment system.
    a. True.
    b. False.

12. In this study, __ was the only risk factor associated with elevated nitrate.
    a. well depth
    b. casing depth
    c. drillhole depth
    d. well age

JEH Quiz #5 Answers

March 2022

1. d	4. c	7. b	10. d
2. d	5. a	8. d	11. a
3. b	6. b	9. e	12. c

INTERNATIONAL PERSPECTIVES

Effectiveness of London's Ultra Low Emission Zone in Reducing Air Pollution: A Pre- and Post-Comparison of NO_2 and PM_{10} Levels

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Abstract **Air pollution has a detrimental effect on public health. Several policies have been proposed in European cities to tackle emissions, including transport policies. The Ultra Low Emission Zone (ULEZ) was introduced in April 2019 and is an area in London where a fee is charged for polluting vehicles that drive through that area. Our study examined the effects of the ULEZ on local NO_2 and PM_{10} levels. Using secondary data recorded at 16 permanent monitoring stations by continuous ambient air monitoring systems and gathered by London Air, we conducted descriptive analyses of historical trends and inferential pre- and post-comparisons of seasonal levels of emissions. Results show statistically significant reductions of NO_2 levels in every site between spring 2018 and spring 2019, while reductions of PM_{10} levels reached statistical significance in 3 out of 5 sites. Control sites outside the ULEZ did not show statistically significant reductions of NO_2 and PM_{10}. Findings indicate that the ULEZ contributed to a decrease of air pollution and is an effective policy for reducing air pollution, which can also lead to public health benefits. Emission levels remain, however, above European Union legal limits in specific instances and thus further action is needed. Additional research is required to assess these changes in the long term.**

Introduction

Air pollution has been defined as the "new tobacco" by the World Health Organization (Gao et al., 2020). It is estimated that approximately 4.2 million people die every year globally from ambient air pollution; air pollution also increases morbidity, reduces life expectancy, and increases the global burden of diseases (World Health Organization, 2022). Road transport is one of the major contributors to air pollution and is estimated to cause 40% of total nitrogen dioxide (NO_2) emissions. Due to the detrimental impacts of road transport on health, several cities within the UK are starting to implement air pollution reduction strategies, such as clean air zones and traffic management strategies.

The aim of our study was to assess the effectiveness of London's Ultra Low Emission Zone (ULEZ) on local air pollution levels, specifically on particulate matter (PM_{10}) and NO_2. The ULEZ was introduced in 2019. PM_{10} and NO_2 are the two main pollutants that have been associated with having the greatest impact on public health, with road vehicles being one of the largest contributors of particulate matter pollution into the atmosphere (Davidson et al., 2005). Growing epidemiological evidence shows associations between particulate matter pollution and cardiovascular diseases (Gold et al., 2000), and that NO_2 can cause acute respiratory infections, skin and eye irritation, and aggravation of lung diseases—as well as lead to chronic obstructive pulmonary disease (Nuvolone et al., 2018).

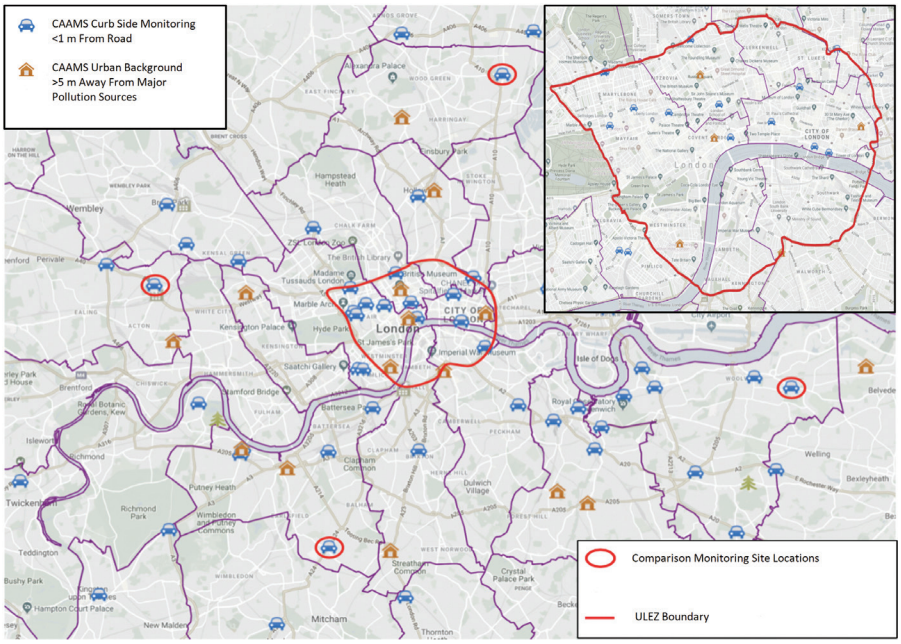
London Ultra Low Emission Zone

London is classed as a global megacity with an official estimated population of 9 million people (Office for National Statistics, 2021). London has had historical problems with hazardous levels of air pollution due to a high level of manufacturing since the Industrial Revolution. Within the last 20–30 years, however, the problems created by high air pollution levels are mostly related to modern transportation (Greater London Authority, 2018). Moreover, pollution has been labeled as the cause of 9,400 premature deaths within Greater London and subsequent increased healthcare costs on the National Health Service between £1.4 and £3.7 billion per year due to extra hospital admissions and treating respiratory illnesses caused by the toxic air (London Councils, 2017).

Most of the recent legislation implemented to reduce air pollution within the UK are driven by European Union (EU) directives. Limits for NO_2 are 200 µg/m^3 on average per hr (with 18 annual permitted exceedances) and 40 µg/m^3 a year. Limits for PM_{10} are 50 µg/m^3 on average per 24 hr (with 35 annual permitted exceedances) and 40 µg/m^3 a year.

FIGURE **1**

Detailed Map of Central London With Boundaries of Local Authorities Within the Ultra Low Emission Zone (ULEZ) and Continuous Ambient Air Monitoring System (CAAMS) Site Locations



Source: Environmental Research Group, Imperial College London (2022a).

TABLE **1**

Annual Nitrogen Dioxide (NO_2) Spring and Overall Averages From Continuous Ambient Air Monitoring System (CAAMS) Sites, 2014–2018

Location	Average NO_2 Measurements (µg/m³)					
	2014	2015	2016	2017	2018	2019
Sir John Cass School	41.01	38.81	37.32	35.64	28.91	30.28
Walbrook Wharf	129.07	100.02	87.36	93.27	91.23	70.77
Beech Street	94.98	96.52	81.82	86.39	82.21	62.02
Old Street	65.76	62.43	53.80	50.93	48.40	40.57
Marylebone Road	93.66	92.47	83.59	83.58	87.53	59.68
Oxford Street	115.22	133.49	83.93	73.36	62.29	44.86
Horseferry Road	45.42	36.89	36.89	36.46	30.08	26.90
Euston Road	116.75	97.16	97.16	79.35	81.59	67.60
Bloomsbury	48.17	43.87	43.87	32.74	35.70	25.21
Holborn	90.91	77.44	77.44	78.34	71.82	57.87
Elephant and Castle	39.21	42.41	42.41	29.23	31.01	26.83
Average	80.02	74.68	65.96	61.75	59.16	46.60

Note. Measurements were taken from April–July for each year. Data were used from 11 of the 16 CAAMS sites within the Ultra Low Emission Zone.

Several interventions have been implemented already to control and reduce harmful levels of air pollution, including the Low Emission Zone for trucks, additional fees during traffic congestion, and public bus fleet improvements. Previous studies evaluating the effectiveness of these interventions found varying levels of success, but overall, they have not been able to reduce London air pollution to reasonable levels (Atkinson et al., 2009; Beevers & Carslaw, 2005; Ellison et al., 2013).

Intervention and Vehicle Compliance With the Ultra Low Emission Zone

The ULEZ was introduced on April 8, 2019, as a public health intervention to reduce the toxic levels of air pollution caused by vehicle emissions within Central London (i.e., innermost part of Greater London; Figure 1). The ULEZ is enforced 24 hr/day and operates through a punitive charge that applies to the most polluting vehicles.

Any vehicle that enters the ULEZ and does not meet EU standards on vehicle emissions will have to pay a charge of £12.50/day. In addition, a congestion charge within the same area is a fixed price of £11.50 for every vehicle that enters, but vehicles not meeting the EU standards pay a total of £23.50/day. Heavy goods vehicles (i.e., larger trucks) pay a total of £111.50/day. The London government department Transport for London (n.d.) reported that the average compliance rate with ULEZ standards between April and September 2019 was 77%, which was an increase from the 2017 compliance rate.

The aim of our study was to assess if the introduction of the ULEZ had any effect in reducing air pollution in terms of NO_2 and PM_{10} levels in the immediate weeks after implementation of the intervention. To this aim, we conducted descriptive analyses of historical trends and inferential pre- and post-comparisons of seasonal levels of emissions.

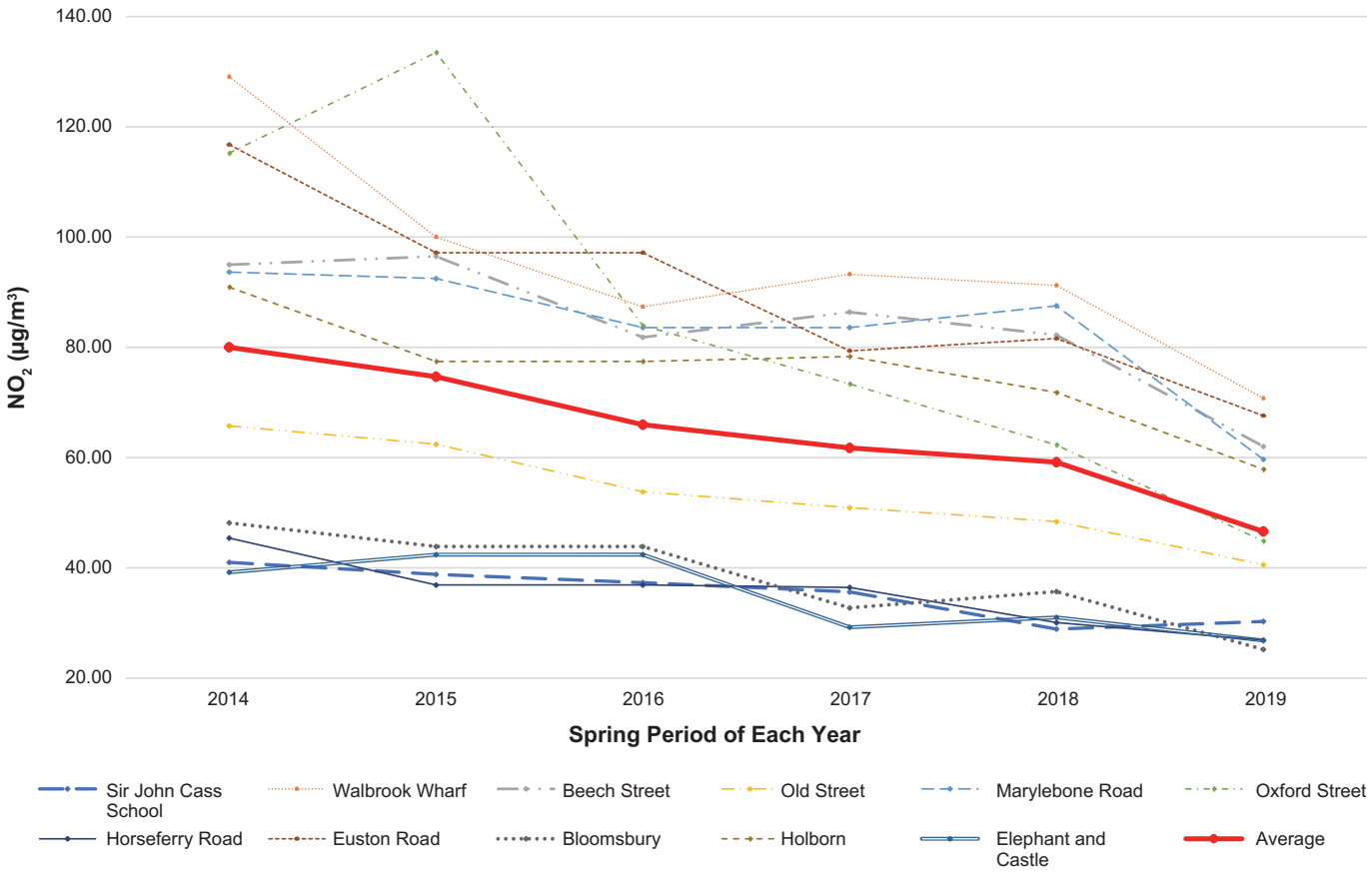
Methods

Data Collection and Analysis

The study design for this project used a descriptive and inferential analysis of NO_2 and PM_{10} measurements gathered on a large scale by a reliable source (Environmental Research Group, Imperial College London, 2022a) and collected continuously by 16 continuous ambient air monitoring systems

FIGURE **2**

Annual Nitrogen Dioxide (NO_2) Spring and Overall Averages From Continuous Ambient Air Monitoring System (CAAMS) Sites, 2014–2018



Note. Measurements were taken from April–July for each year. Data were used from 11 of the 16 CAAMS sites within the Ultra Low Emission Zone.

(CAAMS; Figure 1). In addition, comparisons were also conducted on four CAAMS sites located outside the ULEZ as a comparative check (Figure 1).

The 16 CAAMS measure NO_2 using the chemiluminescence technique and are calibrated using the EU standards method EN14211:2012 for nitrogen oxides. Those stations also measure PM_{10} using a filter dynamics measurement system and are calibrated using the EU standards method EN16450:2017 for automatic PM analyzers. All the downloaded data sets for both pollutants were measured in µg/m^3 of air.

The entire CAAMS network is monitored and the data disseminated by London Air and Imperial College London; the network is maintained to strict guidelines and quality procedures to ensure reliability of results (Environmental Research Group, Imperial College London, 2022b). Furthermore, the CAAMS are calibrated every 2 weeks to ensure efficiency. The air pollution data also undergo a validation and ratification process stipulated by the Department for Environment, Food & Rural Affairs (2017). All the historical and 2018 data sets used within our analysis were validated. The data sets used for the 2019 comparisons, however, were not ratified because the analysis took place before the ratification process was completed.

Completeness criteria were also applied to all the data sets for the descriptive and inferential analysis. CAAMS sites where the daily average data have more than 10% of the total number of days missing were excluded from the analysis. Therefore, if a site had more than 9 separate days without an average for the springtime comparisons, or if the annual data were missing more than 36 separate days, we excluded those sites from the analysis. To compensate for the confounding issue of weather, the paired comparisons were based on seasonal (i.e., spring) averages.

Statistical Analysis

Our analysis included descriptive statistics and paired sample tests. A parametric paired samples *t*-test was used for all data that passed the Shapiro–Wilk test for normality

TABLE **2**

Annual Particulate Matter (PM_{10}) Spring and Overall Averages From Continuous Ambient Air Monitoring System (CAAMS) Sites, 2014–2018

Location	Average PM_{10} Measurements (µg/m³)					
	2014	2015	2016	2017	2018	2019
Sir John Cass School	18.29	22.93	21.71	21.71	24.05	20.36
Upper James Street	33.81	39.31	31.94	31.94	35.38	29.48
Beech Street	24.36	26.24	22.96	22.96	30.16	23.70
Old Street	25.44	26.81	22.28	22.28	25.25	23.18
Bloomsbury	17.56	19.03	17.80	17.80	20.16	19.97
Marylebone Road	22.56	21.47	22.62	21.67	25.60	23.83
Horseferry Road	17.08	15.07	15.16	16.35	21.18	19.93
Elephant and Castle	22.77	24.37	29.09	19.86	23.28	15.95
Average	23.35	24.96	23.11	22.11	25.96	19.60

Note. Measurements were taken from April–July for each year. Data were used from 8 of the 16 CAAMS sites within the Ultra Low Emission Zone.

and a nonparametric Wilcoxon signed-rank test was used for all data that have a departure from normality or were not normally distributed. Many of the data sets were not normally distributed, so the Wilcoxon signed-rank test was used predominantly.

Due to the variability of measurements in most air pollution data sets, almost all the measurement analyses used within our study had at least one outlier. The outliers were not removed within the statistical analysis, as they did not change the results or affect the assumptions of each statistical test. Analyses were conducted with SPSS version 27.

Results

Historical Spring Air Pollution Trends Within the Ultra Low Emission Zone

Long-term trends were assessed descriptively. Data averages (i.e., the spring averages) were used from the same 90-day period (April 8–July 7, 2019) after the introduction of the ULEZ for the last 5 years. The preliminary analysis of these data shows there have been historical air pollution issues with both NO_2 and PM_{10} pollution concentrations within Central London. Furthermore, based on data from 11 of the 16 CAAMS sites, an overall decline in NO_2 air pollution can be identified within the areas now covered by the ULEZ since 2014 (Table 1, Figure 2).

Looking at PM_{10}, based on data from 8 of the 16 CAAMS sites, it seems that there has not been a downward trend of the PM_{10} air pollution data since 2014, with most sites experiencing fluctuating levels. The descriptive data do show, however, that all sites experienced a reduction in PM_{10} pollution measurements from the spring average in 2018 when compared with the spring average in 2019 (Table 2, Figure 3).

Pre- and Post-Comparisons for Spring 2018 and Spring 2019

The second stage of our analysis compared data from spring 2018 and spring 2019, thus mitigating the confounding effects of weather. This analysis was based on available data from the 90-day period after the introduction of the ULEZ (April 8–July 7, 2019) and from the same time period in 2018 from 9 of the 16 CAAMS sites. From this data analysis, the evidence shows there have been substantial decreases in NO_2 pollution levels and only minor reductions in PM_{10}. Table 3 indicates that there has been a drop in NO_2 pollution levels for all sites except Sir John Cass School, which experienced an increase of 1.81 µg/m³.

The decreases in NO_2 pollution have also been statistically analyzed. Overall, five sites indicated a statistical difference between the median of spring 2019 when compared with spring 2018 (Table 1). There was no significant difference in the NO_2 air pollution data at Sir John Cass School.

The comparisons for the PM_{10} air pollution were based on 5 of the 16 CAAMS sites. A significant number of sites (11) were excluded due to failing the study's completeness criteria. The comparison analysis of the means from each site does show, however, that there has been a minor drop in PM_{10} pollution levels when a comparison between spring 2018 and spring 2019 is made (Table 3). There was a statistical difference between the medians of spring 2018 and spring 2019 for Sir John Cass School, Upper James Street, and Beech Street. There was no statistically significant difference in the PM_{10} air pollution data at Bloomsbury or Marylebone Road.

Control Analysis Within Greater London

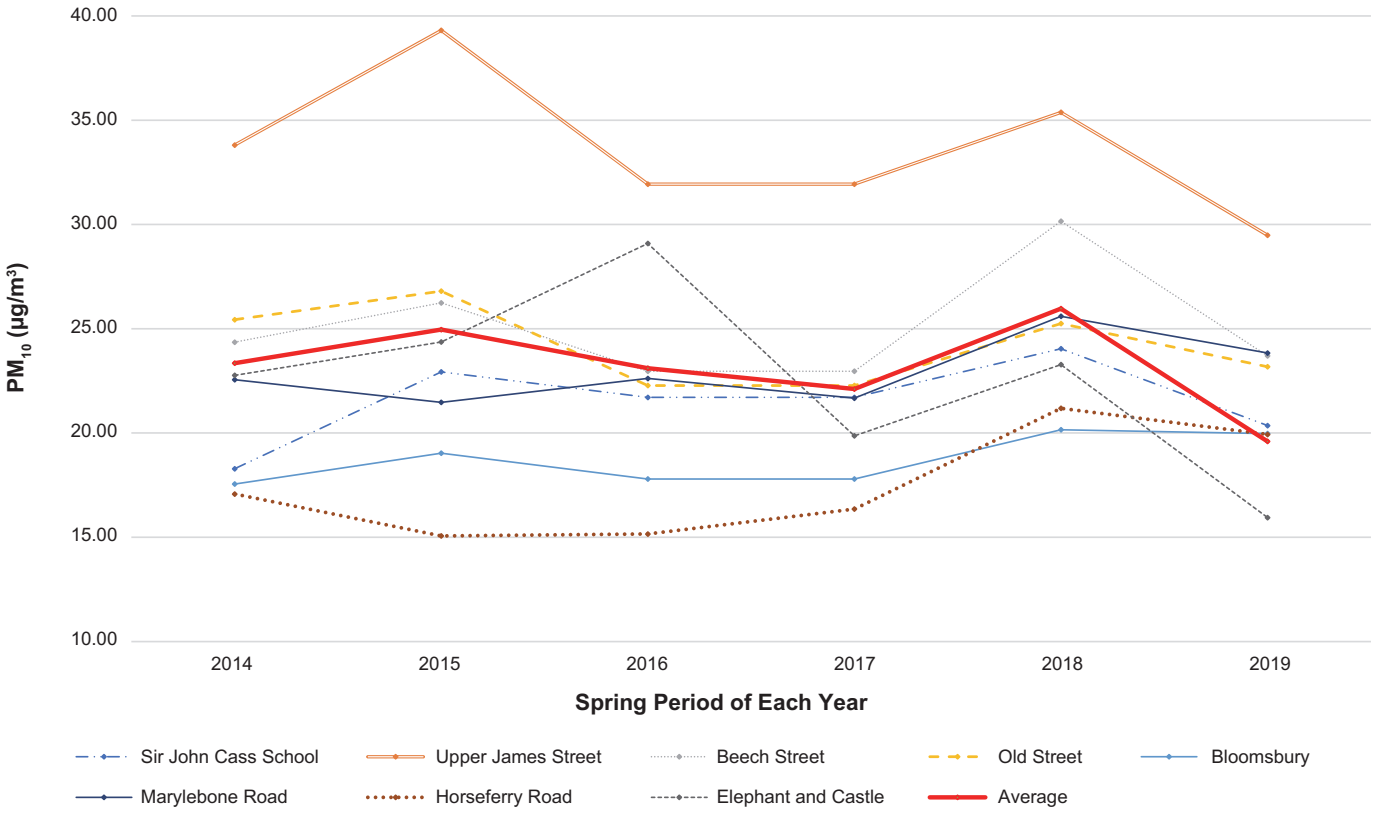
Further comparisons were made from CAAMS sites that are within Greater London but located outside the ULEZ to help clarify if the reductions found in the air pollution levels were due to the ULEZ intervention. In all, 4 sites were chosen for this analysis from around Greater London and all are at least 3 m away from the ULEZ, specifically North, East, South, and West of the ULEZ (Figure 1). Looking at the springtime periods (i.e., the 90 days from April 8–July 7, 2019) after the introduction of the ULEZ for both 2018 and 2019, only minor decreases in both NO_2 and PM_{10} air pollution levels were found. The data within the ULEZ show statistically significant reductions in the NO_2 air pollution levels, whereas the results from Greater London and outside the ULEZ show only minor or no reductions in the NO_2 levels. The inferential tests show that only 1 site (i.e., Ealing) out of 4 reported statistically significant reductions of NO_2 levels and no site had reductions of PM_{10}.

Discussion

The main aim of our study was to assess the effectiveness of whether the ULEZ has been successful or not at reducing the levels of NO_2 and PM_{10} air pollution within Central London immediately after its introduction. Our results show that the ULEZ seemed to contribute to the reduction of NO_2 concentration levels. The data show, however, a less clear trend regarding the concentration lev-

FIGURE **3**

Annual Particulate Matter (PM_{10}) Spring and Overall Averages From Continuous Ambient Air Monitoring System (CAAMS) Sites, 2014–2018



Note. Measurements were taken from April–July for each year. Data were used from 8 of the 16 CAAMS sites within the Ultra Low Emission Zone.

els of PM_{10}. We conducted comparisons in four control sites outside the ULEZ and these showed no statistically significant reductions of NO_2 and PM_{10} levels in most sites, thus reinforcing the notion that the ULEZ is a valid intervention for Greater London for reducing air pollution. Emission levels, however, remained above EU legal limits in specific instances.

Our analysis of NO_2 concentration levels showed that of the 9 CAAMS sites analyzed within the spring comparisons of 2018 and 2019, 8 had a statistically significant reduction in pollution levels. These reductions, while considering the confounding factor of weather, varied from each site and ranged between a minor 3.15 µg/m^3 to a much larger 28.18 µg/m^3. Although there has been a historical trend of NO_2 pollution reduction within London, the control group outside the ULEZ showed that the changes are larger within the new public health intervention zone. The control analyses of the 2018 and 2019 NO_2 data outside of the ULEZ indicate that none of the sites, except Ealing in West London, had a statically significant reduction, thus reinforcing the notion that the ULEZ is contributing to reduced NO_2 levels. While the historical data analysis showed an overall downward trend in NO_2 air pollution concentrations levels within London, our study shows that the ULEZ public health intervention is further contributing to this historical downward trend.

We found more mixed results for PM_{10}. All sites that had data available for analysis showed only minor reductions in the PM_{10} pollution levels (ranging from 0.19–5.9 µg/m^3) and only 3 out of the 5 sites had a statistically significant reduction. The comparison analyses showed, however, that the PM_{10} reductions outside of the ULEZ were not statistically significant in any site, thus highlighting that the ULEZ intervention seems to have contributed to reductions in Central London. These results mirror the study by Atkinson et al. (2009), which found that the London congestion charge reduced the levels of NO_2 within Central London but resulted in only minor reductions in PM_{10}. This finding could be because PM_{10} pollution is less dependent on road transport in comparison with NO_2 (Marković et al., 2008). In addition, it should be noted that the lack of available PM_{10} data limited the scope of our analysis, and as a result, 11 of the CAAMS sites failed the completeness criteria test.

TABLE **3**

Nitrogen Dioxide (NO_2) and Particulate Matter (PM_{10}) Mean Comparisons and Statistical Analysis, Spring 2018 and Spring 2019

Site	NO_2 (µg/m³)					PM_{10} (µg/m³)				
	Spring Mean 2018	Spring Mean 2019	Difference (% Change)	Test	*p*-Value	Spring Mean 2018	Spring Mean 2019	Difference (% Change)	Test	*p*-Value
Sir John Cass School	28.45	30.26	1.81 (6.36% increase)	WS	.598	24.05	20.36	-3.69 (15.34% decrease)	WS	.001
Walbrook Wharf	91.23	70.92	-20.31 (22.26% decrease)	WS	.000	–	–	–	–	–
Beech Street	82.23	61.89	-20.34 (24.74% decrease)	TT	.000 95% CI [14.50, 26.85]	30.16	25.34	-4.82 (15.98% decrease)	WS	.009
Old Street	48.38	40.38	-8.00 (16.54% decrease)	TT	.000 95% CI [3.54, 11.15]	–	–	–	–	–
Euston Road	81.86	67.69	-14.17 (17.31% decrease)	TT	.010 95% CI [5.56, 19.47]	–	–	–	–	–
Bloomsbury	35.70	25.35	-10.35 (28.99% decrease)	WS	.000	–	–	–	–	–
Marylebone Road	87.68	59.50	-28.18 (32.13% decrease)	WS	.000	25.60	23.83	-1.77 (6.91% decrease)	WS	.124
Horseferry Road	30.09	26.94	-3.15 (10.47% decrease)	WS	.020	–	–	–	–	–
Elephant and Castle	31.01	26.85	-4.16 (13.42% decrease)	WS	.018	–	–	–	–	–
Upper James Street	–	–	–	–	–	35.38	29.48	-5.90 (16.68% decrease)	WS	.000
Bloomsbury	–	–	–	–	–	20.16	19.97	-0.19 (0.95% decrease)	WS	.293

Note. CI = confidence interval; WS = Wilcoxon signed-rank test (two related samples); TT = two-samples *t*-test.

Our study adds to the evidence on the environmental health benefits of London policies (Beevers & Carslaw, 2005; Ellison et al., 2013) and demonstrates that the ULEZ has further contributed to the reduction of emissions. Although the reduction were not large in some sites, it should be noted that any level of particulate matter and NO_2 pollution reduction can have public health benefits (Gold et al., 2000; Hamra et al., 2015). It should be noted, however, that in some cases emission levels were, as of spring 2019, still above the EU legal limit. This finding held true for 7 NO_2 measuring sites out of 11 that recorded a daily average, based on a 90-day period, that was above the recommended yearly average of 40 µg/m³ set by the EU. Therefore, further action might be needed to improve London's air quality.

Strengths, Limitations, and Future Research

There are some challenges and limitations that we have identified in this study. First, weather conditions can cause significant variations in the data. These conditions, therefore, were factored into the analysis process via analyzing similar time periods in the spring of each year. Despite best efforts

to deal with weather confounders, weather changes daily and thus is not the same from year to year. Future research could make use of regression methods that consider weather variables to increase the reliability of the air pollution measurements (Jhun et al., 2015).

Second, CAAMS location can have a significant confounding effect on air pollution results. Some of the CAAMS sites are on the roadside, and some are in urban settings (>5 m from the roadside), which can affect the measurements due to pollution dispersal. These site differences could also explain why no statistical differences were found in Sir John Cass School and the Bloomsbury monitoring site—as both are monitoring locations in urban settings.

Third, despite the CAAMS being certified and validated, the data sets used for the 2019 comparisons were not ratified because this process can take over 1 year to complete and this time frame did not fit within the scope of our project. This lack of data set validation could create minor inaccuracies within the data analysis, hence future research is needed to confirm our results.

Despite these limitations, this research has several strengths. First, the study was based on analyses conducted on a large quantitative data set that is reliable and validated. Second, the comparative data analyses taken from locations outside of the ULEZ strengthened the evaluation of the intervention. While it is challenging to isolate the single effect of transport policies on public health outcomes when they are part of wider strategies (Bornioli et al., 2020; Ogilvie et al., 2006), the use of control groups helped to isolate the effect of the ULEZ on air pollution concentrations within Central London.

Further avenues for research include comparing the results with analyses that are based on different sources, including the Department for Environment, Food & Rural Affairs air pollution monitoring network, the Greater London Authority's NO_2 diffusion tube data sets, and the Local Authorities and Air Quality Program. Additionally, a study based on longer-term annual trends would more naturally deal with the confounding factors of weather, further improving the robustness of the data and the overall research analysis. And lastly, it is important to identify if specific neighborhoods of London report higher levels of air pollution, with a focus on trends of spatial inequalities and vulnerable groups.

Conclusion

Our exploratory research found that for Greater London, the ULEZ is a valid strategy for contributing to the reduction of NO_2 air pollution levels, even though our analysis found NO_2 air pollution levels remain at or above the EU legal limit. The reduction in NO_2 air pollution levels was also corroborated by the Greater London comparative results. The success of the strategy, however, has not been fully reciprocated in PM_{10} air pollution measurements.

The implication for policy is that the ULEZ can be a valuable tool to contribute to the reduction of air pollutant concentrations, especially NO_2. The importance of the wider strategy of air quality improvement is also evident and suggests that air quality can be tackled with a combination of measures. Additional research, however, is required to substantiate these claims further and create a better understanding of how the ULEZ can improve air pollution over an increased time frame and/or in different contexts. Other findings suggest that cities reporting high levels of air pollution in the U.S. (Liu et al., 2019) could benefit from emission zones such as the Santa Monica zero emissions delivery zone pilot that was implemented in 2020 (National Association of City Transportation Officials, 2021).

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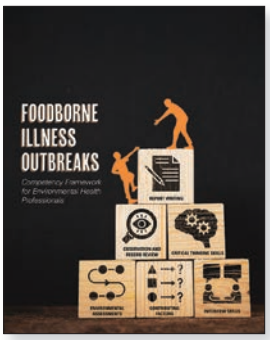

Competencies for Environmental Health Professionals Who Detect, Investigate, and Respond to Foodborne Illness Outbreaks

Abstract **Environmental health (EH) professionals are essential to foodborne illness outbreak investigations, although many do not receive formal training in this area. We present a competency framework that reflects the comprehensive set of skills desired for EH professionals engaged in foodborne illness outbreak detection, investigation, and response at state and local public health agencies. We describe findings of a web-based survey that assessed these competencies and identified training priorities among practicing EH professionals, as well as an EH competency training road map. The competencies were developed with input from EH professionals from academia and local, state, and national EH agencies. Survey results indicate that the competencies are relevant and highlight opportunities for further training. The training road map is a tool to connect EH professionals with a curated list of existing trainings by competency. The competencies and road map are publicly available and free, and can be used for workforce, curricula, and resource development.**

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Introduction

Foodborne illness is common in the U.S., with >800 recognized foodborne outbreaks reported to the Centers for Disease Control and Prevention (CDC) annually (Dewey-Mattia et al., 2018; Scallan et al., 2011). Foodborne illness outbreak detection, investigation, and response is primarily the responsibility of state and local public health agencies, and environmental health (EH) professionals have an integral role in these investigations. EH departments routinely receive foodborne illness complaints from the public and maintain complaint-based surveillance systems to detect outbreaks. Moreover, EH professionals are responsible for conducting environmental assessments at food facilities during investigations to identify the factors contributing to an outbreak (Brown et al., 2017; Selman & Guzewich, 2014). Collaborating with epidemiologists, laboratorians, and other members of the outbreak investigation team, EH professionals work to determine the cause of the outbreak and implement control measures to prevent future outbreaks or illnesses.

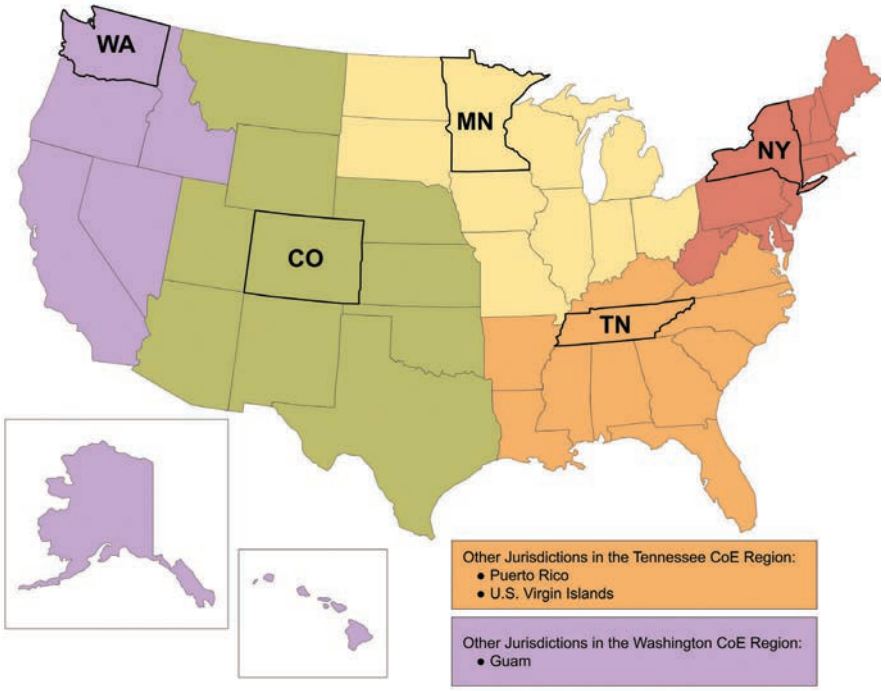
While EH professionals are essential to foodborne illness outbreak investigations, outbreaks can be relatively infrequent occurrences, especially for EH professionals working in smaller public health agencies. Furthermore, the organizational structure of EH departments vary considerably across health agencies, as do the educational backgrounds, credentials, and job titles of EH professionals (Gerding et al., 2019; Selman & Green, 2008). As such, many EH professionals have not received formal training in foodborne outbreak response. This formal training is important because the job skills required for foodborne illness outbreak investigations differ from routine EH activities (Selman & Green, 2008).

The best example of this difference is the distinction between routine EH inspections and environmental assessments. Unlike routine inspections that cover a range of potential food safety violations, environmental assessments focus on the factors contributing to the cause of an outbreak under investigation. EH professionals who lack adequate training, however, may conduct routine inspections as part of an outbreak investigation (National Environmental Health Association [NEHA], 2013; Selman & Green, 2008).

In recent years several organizations—including CDC, the Integrated Food Safety Centers of Excellence (CoEs), and the National Environmental Health Association (NEHA)—have developed trainings and resources for EH professionals on investigating foodborne illness outbreaks, thus filling a significant gap. An overarching competency framework, however, is lacking and is

FIGURE **1**

Designated Sites and Regions for Integrated Food Safety Centers of Excellence (CoE)



Note. CO = Colorado; MN = Minnesota; NY = New York; TN = Tennessee; WA = Washington.

needed if organizations and EH managers are to develop, assess, and maintain the knowledge and skills desirable for EH professionals who are engaged in foodborne illness outbreak detection, investigation, and response.

Here we present a competency framework developed by the CoEs and the findings of a survey that a) assessed these competencies and b) identified training priorities among practicing EH professionals. Lastly, we share an EH competency training road map that links competencies to existing trainings. The competency framework includes 3 professional tiers with 16 competencies in each tier and reflects the comprehensive set of skills desired for EH professionals to detect, investigate, and respond to foodborne illness outbreaks.

Methods

Integrated Food Safety Centers of Excellence

Established by CDC in 2012 under the authority of the Food Safety Modernization Act, the mission of CoEs is to improve the detection and investigation of foodborne illness outbreaks by developing and providing resources, training, and technical assistance to public health professionals (e.g., epidemiologists, laboratorians, EH professionals). CoEs are associated with regions and located at state health departments with at least one academic partner (Figure 1). The 2019–2024 sites for CoEs are Colorado, Minnesota, New York, Tennessee, and Washington. From 2012–2018, sites included Colorado, Florida, Minnesota, Oregon, and Tennessee, with the addition of New York in 2015.

Competency Development

This competency framework was informed by existing competencies and analyses of job skills identified as part of the:

- Foodborne Illness Outbreak Environmental Assessment certificate training developed by the Colorado CoE in collaboration with CDC, NEHA, and the National Network of Public Health Institutes (NEHA, 2022a).
- Environmental Assessment Training Series (Centers for Disease Control and Prevention [CDC], 2021).
- Job skills analyses conducted as part of the NEHA Certified Foodborne Outbreak Investigator credential (NEHA, 2022b).
- Food and Drug Administration (FDA) model *Food Code* (U.S. Department of Health and Human Services, 2017).

Furthermore, these competencies were designed to build on existing competencies for local EH practitioners (American Public Health Association & National Center for Environmental Health, CDC, 2001) and the baseline knowledge and skills required to pass the NEHA Registered Environmental Health Specialist/Registered Sanitarian (REHS/RS) credential exam (NEHA, 2022c).

Recognizing that EH professionals will undertake different activities as part of foodborne outbreak detection, investigation, and control based on experience and responsibility, we mapped competencies to three professional tiers using tier-specific verbiage, which was supported by Bloom's revised taxonomy and the *Core Competencies for Public Health Professionals* developed by the Council on Linkages Between Academia and Public Health Practice (Anderson & Krathwohl, 2000; Council on Linkages Between Academia and Public Health Practice, 2014).

The Colorado and Tennessee CoEs each hosted two focus groups with EH professionals from academia and local, state, and national EH agencies. Focus groups reviewed tiers and competencies for wording, gaps, and relevance. The revised competencies were reviewed by experts at the Association of Food and Drug Officials, CDC, National Association of County and City Health Officials (NACCHO), and NEHA.

Competency Assessment

We surveyed EH professionals at local, state, and territorial health departments to 1) validate the draft competencies, 2) assess competency importance and frequency by tier, and 3) identify training priorities.

The survey instrument included demographic questions (e.g., years of experience, state, agency type, average number of foodborne illness outbreaks investigated by agency each year). To navigate respondents to a specific tier, respondents were asked to choose a position that most closely

described their role in foodborne illness outbreak investigations (Table 1). Survey respondents then rated the importance of each competency in their specific tier to their practice on a 5-point Likert scale (i.e., not at all, somewhat, important, very, and essential). Respondents also ranked how frequently they performed each competency in their practice on a 4-point Likert scale (i.e., never, rarely, sometimes, and often). Competency order was randomized for both questions to minimize the impact of respondent fatigue. Respondents were also asked to identify the five competencies they considered to be their highest training priority. Finally, respondents were asked to identify competencies that were difficult to understand, recommend additional competencies, and provide open-ended feedback.

The online survey was created using Qualtrics and piloted prior to launching. It was active for 36 days beginning on June 14, 2019. Coordinators at the CoEs disseminated the survey to state-level contacts within each center's region (Figure 1). The survey was also disseminated through NEHA and center listservs as well as state EH associations. Respondents had the option to anonymously enroll in a raffle for a $20 gift card.

Frequencies and proportions were used to describe the data. The Pearson's chi-squared test was used to test differences in work characteristics between professional tiers. For data presentation, each competency was assigned a topic area name and number. Survey data were analyzed using SAS software version 9.4.

TABLE **1**

Professional Tiers for Environmental Health Professionals Who Detect and Investigate Foodborne Illness Outbreaks and Corresponding Survey Descriptions for Respondents to Navigate to Tier-Specific Competencies

Tier	Description	Survey Description
1	Practitioners who are new to outbreak investigations (although not necessarily new to regulatory food safety, environmental health [EH], or public health) or who work in jurisdictions with a low outbreak rate. EH professionals in Tier 1 should be able to detect foodborne illness outbreaks and participate in environmental assessments with guidance as part of an investigation.	I participate in environmental assessments conducted as part of a foodborne disease outbreak investigation. I understand the basics of how outbreaks are detected and investigated.
2	Practitioners who routinely participate in foodborne illness outbreak investigations or work in jurisdictions with a moderate to high outbreak rate. EH professionals in Tier 2 should have the knowledge and skills required to conduct all aspects of the outbreak investigation.	I routinely conduct environmental assessments performed as part of a foodborne disease outbreak investigation. I lead different aspects of the outbreak investigation (e.g., sampling and implementing control methods) and represent EH on the outbreak investigation team.
3	Practitioners who are typically in program management, supervisory, or managerial roles, and/or work in jurisdictions with a moderate to high outbreak rate. EH professionals in Tier 3 improve the conduct of outbreak investigations at their agency.	I oversee the EH portion of a foodborne disease outbreak investigation. I advance the applied practice of investigating outbreaks from the EH perspective (e.g., I create model practices and train staff on best investigative methods).

Training Road Map for Environmental Health Competencies

The Tennessee CoE, led by the University of Tennessee Center for Agriculture and Food Security and Preparedness (CAFSP), created a training road map using the EH competencies. First, they developed a logic model containing the inputs, activities, and goals for each competency. Second, they performed a web-based environmental scan of available online and in-person trainings as well as the associated learning objectives. Next, they reached out to professional associations such as NACCHO to identify additional relevant trainings. To learn more about the identified trainings, CAFSP staff sought feedback from EH professionals and when possible, completed the courses themselves. Lastly, they mapped the relevant training courses to the EH competencies.

Results

Competency Development

The competency framework includes three professional tiers (Table 1) with 16 competencies in each tier (Table 2) and reflects the comprehensive set of skills desired for EH professionals to detect, investigate, and respond to foodborne illness outbreaks. A total of six competencies were specific to environmental assessments: environmental assessments (C4), contributing factors (C5), observation and record review (C6), interview skills (C7), specimen testing (C8), and critical thinking skills (C9). The remaining competencies were related to outbreak detection (C1), roles and responsibilities (C2), partnerships and communication (C3), control measures (C10), legal authority (C11), traceback/traceforward investigations (C12), outbreak communication (C13), quality improvement (C14), report writing (C15), and outbreak surveillance reporting (C16).

We developed tier-specific language for each competency. In general, Tier 1 language emphasizes assisting the other tiers, Tier 2 verbs are action oriented, and Tier 3 language emphasizes leadership. For the interview skills competencies (Table 2), during a foodborne illness outbreak environmental assessment:

- Tier 1 investigators list the types of information required when interviewing managers and staff.
- Tier 2 investigators interview managers and staff to obtain relevant information.
- Tier 3 investigators develop interview guides and techniques for interviewing managers and staff.

During 2018, 23 EH practitioners from across the U.S. who were working at local and state health agencies, state agricultural departments, national EH organizations, and an academic institution participated in four separate focus groups held using bidi-

TABLE **2**

Competencies for Environmental Health Professionals Engaged in Foodborne Illness Outbreak Detection, Investigation, and Response

Topic area	Tier 1 [a]	Tier 2 [b]	Tier 3 [c]
C1: Outbreak detection	Describes the role of surveillance systems in detecting foodborne illness outbreaks	Uses surveillance systems to detect foodborne illness outbreaks	Improves surveillance systems to make foodborne outbreak detection timelier and more efficient
C2: Outbreak investigation team: Roles and responsibilities	Explains the role of environmental health (EH) professionals, epidemiologists, microbiologists, and other members of the outbreak investigation team [d] during an outbreak investigation	Collaborates with other members of the outbreak investigation team on activities undertaken as part of an outbreak investigation	Leads activities undertaken as part of an outbreak in collaboration with partners at local, state, and federal agencies
C3: Outbreak investigation team: Partnerships and communication	Describes the importance of partnerships and ongoing communication with epidemiologists, microbiologists, and other professionals engaged in outbreak detection and response	Maintains partnerships and ongoing communication with epidemiologists, microbiologists, and other professionals engaged in outbreak detection and response	Builds partnerships with local, state, and federal agencies engaged in outbreak detection and response
C4: Environmental assessments	Describes the components of an environmental assessment	Performs foodborne illness outbreak environmental assessments	Continuously improves the process for conducting foodborne illness outbreak environmental assessments
C5: Contributing factors	Lists types of contributing factors by causative agent or food vehicle	Uses available information to develop hypotheses about the causative agent, implicated food, and contributing factors in preparation for a site visit	Mentors others on the use of epidemiological, laboratory, and other data when developing hypotheses about the causative agent, implicated food, and contributing factors in preparation for a site visit
C6: Observation and record review	Lists processes, practices, and records to observe and review during a site visit	Selects appropriate processes and practices to observe and records to review during a site visit given a specific outbreak scenario	Mentors others on appropriate processes and practices to observe and records to review during a site visit given a specific outbreak scenario
C7: Interview skills	Lists the types of information required when interviewing managers and staff during a foodborne illness outbreak environmental assessment	Interviews managers and staff during a foodborne illness outbreak environmental assessment to obtain relevant information	Develops interview guides and techniques for interviewing managers and staff during a foodborne illness outbreak environmental assessment
C8: Specimen testing	Lists the types of sampling, sampling tools, and other equipment used as part of a foodborne illness outbreak environmental assessment	Collects food, environmental, and clinical samples during a foodborne illness outbreak environmental assessment and describes different testing methods	Develops and improves sampling guides and model practices, requests appropriate tests and test methods, and interprets test results
C9: Critical thinking skills	Summarizes multiple sources of information from a foodborne illness outbreak environmental assessment	Analyzes information from a foodborne illness outbreak environmental assessment to identify contributing factors and root causes or environmental antecedents	Mentors others on the use of critical thinking skills and systems theory to identify contributing factors and root causes or environmental antecedents
C10: Control measures	Lists appropriate short- and long- term control measures	Recommends appropriate short- and long-term control measures given a specific outbreak scenario	Evaluates the impact of short- and long-term control measures
C11: Legal authority	Describes the legal authority of state and local agencies during a foodborne illness outbreak	Carries out the legal authority of state and local agencies during a foodborne illness outbreak	Evaluates the need to use state and local legal authorities during a foodborne illness outbreak, in consultation with other local, state, and federal agencies
C12: Traceback/traceforward investigations	Explains the purpose of traceback and traceforward investigations and the roles of local, state, and federal agencies	Conducts traceback and traceforward investigations in collaboration with state and federal partners	Facilitates and advises on traceback and traceforward investigations in collaboration with other state and federal agencies
C13: Outbreak communication	Recognizes the importance of communicating with external partners and stakeholders	Communicates results of the environmental assessment to external partners and stakeholders	Responds to requests from the media, external partners, and stakeholders for information on the outbreak investigation

continued ▸

TABLE **2** *continued*

Competencies for Environmental Health Professionals Engaged in Foodborne Illness Outbreak Detection, Investigation, and Response

Topic area	Tier 1 [a]	Tier 2 [b]	Tier 3 [c]
C14: Quality improvement	Explains the importance of evaluation and continuous quality improvement	Implements strategies for evaluation and continuous quality improvement	Develops strategies for evaluation and continuous quality improvement
C15: Report writing	Lists the items that would be included in a written summary of a foodborne illness outbreak environmental assessment	Prepares a foodborne illness outbreak environmental assessment report	Mentors staff on effective report writing during a foodborne illness outbreak investigation
C16: Outbreak surveillance reporting	Describes the importance of reporting outbreaks to national surveillance	Assists in the reporting of outbreaks to national surveillance	Improves the quality and completeness of outbreak data reported to national surveillance

[a] Tier 1 competencies apply to entry-level EH professionals or EH professionals who do not routinely participate in outbreak investigations. EH professionals in Tier 1 should understand how foodborne illness outbreaks are detected and investigated, and participate in an environmental assessment with guidance.

[b] Tier 2 competencies apply to EH professionals who routinely participate in outbreak investigations. EH professionals in Tier 2 should have the knowledge and skills required to conduct all aspects of the outbreak investigation.

[c] Tier 3 competencies apply to EH professionals in program management, supervisory, or managerial roles. EH professionals in Tier 3 improve the conduct of outbreak investigations at their agency.

[d] Outbreak investigative teams are made up of a variety of professionals from local, state, territorial, and federal levels, including epidemiologists, laboratorians, EH professionals, regulatory compliance officers and inspectors, and health communication specialists. A team can add other professionals as the investigation proceeds.

rectional video. Participants agreed that all 16 competencies were relevant to the role of an EH practitioner. Several changes to the wording of the competencies were suggested and incorporated to improve clarity and better distinguish differences between tiers. The only potential gaps noted were baseline knowledge of foodborne pathogens and epidemiological skills. Upon further discussion, it was determined that these competencies were included by other competency sets such as the *Foodborne Illness Outbreak Detection, Investigation, and Response: Competencies for Epidemiologists*, which can be used by EH professionals who are involved in foodborne disease outbreak investigations (Colorado Integrated Food Safety Center of Excellence, 2020).

Competency Assessment

There were 271 survey respondents from 29 states and territories. Just over one half of respondents selected professional Tier 1 (54%), followed by Tier 2 (26%), and Tier 3 (20%). Of the respondents, 51% had ≥10 years of experience and 72% worked at a local public health agency (Table 3). Respondents who self-selected Tier 1 were more likely to have ≤2 years of experience and to work at an agency that investigated few outbreaks each year. In contrast, respondents who self-selected Tier 3 were more likely to have ≥10 years of experience and to work at an agency that investigated ≥5 outbreaks per year.

The percentage of respondents rating each competency as important, very important, or essential ranged from 82–97% in Tier 1, 69–97% in Tier 2, and 67–98% in Tier 3 (Table 4). A total of 10 competencies in Tier 1 and 8 competencies in Tiers 2 and 3 were rated as important, very important, or essential by ≥90% of respondents. Of the 10 highly rated competencies, 6 were common across tiers: roles and responsibilities (C2), partnerships and communication (C3), environmental assessments (C4), observation and record review (C6), interview skills (C7), and critical thinking skills (C9). Tier 1 respondents also highly rated contributing factors (C5) and outbreak communication (C13). Tiers 1 and 2 highly rated control measures (C10); Tiers 1 and 3 highly rated quality improvement (C14). Tier 2 highly rated legal authority (C11); Tier 3 highly rated report writing (C15).

The percentage of respondents who stated that they performed a competency often or sometimes ranged from 30–73% in Tier 1, 24–90% in Tier 2, and 33–84% in Tier 3. A total of 9 competencies in Tier 1, 13 in Tier 2, and 14 in Tier 3 were often or sometimes performed by ≥50% of respondents. All nine competencies that were often or sometimes performed by ≥50% of Tier 1 respondents were also common to Tier 2 and 3 respondents: roles and responsibilities (C2), partnerships and communication (C3), environmental assessments (C4), contributing factors (C5), observation and record review (C6), interview skills (C7), critical thinking skills (C9), control measures (C10), and quality improvement (C14).

Additionally, four competencies were common to Tiers 2 and 3: outbreak detection (C1), legal authority (C11), outbreak communication (C13), and report writing (C15). Most (≥50%) Tier 3 respondents also reported performing outbreak surveillance reporting (C16) often or sometimes. Moreover, nine competencies in Tier 1 and eight in Tiers 2 and 3 were both highly rated in terms of importance and frequency (Table 4).

The competencies most frequently reported as being difficult to understand were traceback/traceforward investigation (C12) (14%, mostly Tier 2 respondents) and quality improvement (C14) (12%, mostly Tier 3 respondents). Several additional competencies were suggested: foodborne illness outbreak training coinciding with an emergency preparedness or natural disaster response, understanding food flows, and predictive modeling for food safety risk.

TABLE **3**

Workforce Characteristics of Survey Respondents by Professional Tier

Characteristic	Respondents (*N* = 271) # (%)	Tier 1 (*n* = 147) # (%)	Tier 2 (*n* = 70) # (%)	Tier 3 (*n* = 54) # (%)	*p*-Value
Experience investigating foodborne disease outbreaks (years)					<.0001
0–2	47 (17)	40 (27)	6 (9)	1 (2)	
3–9	86 (32)	47 (32)	25 (36)	14 (26)	
≥10	138 (51)	60 (41)	39 (56)	39 (72)	
Average number of foodborne disease outbreaks that the agency investigates per year					.05
0–1	97 (36)	63 (43)	23 (33)	11 (20)	
2–4	89 (33)	42 (29)	26 (37)	21 (39)	
≥5	85 (31)	42 (29)	21 (30)	22 (41)	
Type of public health agency					.54
Local	194 (72)	40 (27)	16 (23)	15 (28)	
State	71 (26)	103 (70)	54 (77)	37 (69)	
Federal/other	6 (2)	4 (3)	0	2 (4)	

Training Priorities

Respondents were asked to identify five competency training priorities. When training priorities were ranked in the order of frequency, the highest ranked competencies by tier were observation and record review (C6) and contributing factors (C5) for Tier 1, and environmental assessments (C4) for Tiers 2 and 3 (Table 5). All three tiers identified environmental assessments (C4), interview skills (C7), and observation and record review (C6) in their top-5 ranked training priorities. Critical thinking skills (C9) was ranked highly for Tiers 2 and 3. The remaining highly ranked training priorities were: control measures (C10) for Tier 1, specimen testing (C8) for Tier 2, and report writing (C15) for Tier 3. All the highly ranked training priorities in Tiers 1 and 3 and four of the five highly ranked training priorities in Tier 2 were highly rated for importance and frequency.

Training Road Map for Environmental Health Competencies

Reviewers identified 90 online and in-person trainings from state and national organizations including CDC, CoEs, FDA, NEHA, and state health departments, as well as academia. We included both free and for-purchase trainings. Trainings were mapped to the EH competencies using logic models, training learning objectives, training goals, and descriptions. Reviewers assigned trainings to basic, intermediate, or advanced categories that paralleled EH competencies tiers.

The training road map is a visual guide that lists available trainings by tier for each EH competency (Tennessee Integrated Food Safety Centers of Excellence, 2018). The road map legend indicates if the training is online or in-person and if there is an associated fee, as well as includes a hyperlink to each training. Two supplementary documents accompany the road map that provide resource information for each training and cross-reference the competencies that are covered by each training.

Discussion

The competencies presented here represent the knowledge and skills desirable for EH professionals engaged in foodborne illness outbreak detection, investigation, and response at state and local public health agencies. Developed with both qualitative and quantitative feedback from a nationally representative sample of practicing EH professionals and experts from national agencies, these competencies fill an important gap in EH workforce development. Specifically, competencies can be used by institutions and programs designing and developing curricula for the current and future EH workforce and by EH managers for workforce development for existing and new employees.

Our survey results highlight opportunities for training and skills development among EH professionals. Several competencies related to environmental assessments were highly ranked for importance and frequency and listed as a training priority for all tiers. Environmental assessments require knowledge of systems theory concepts, an understanding of the outbreak-specific farm-to-fork continuum, and identification of the outbreak environmental antecedents and contributing factors (Selman & Guzewich, 2014). Given the unique and multifaceted nature of environmental assessments, EH professionals could require ongoing training, beginning with foundational skills and concepts—including observation, record review, and contributing factors—and progressing to skill-building exercises that apply these skills in different multiple outbreak scenarios.

Interview skills were highly ranked for importance, frequency, and training by all tiers. Conducted as part of an environmental assessment, good interviewing skills are essential for understanding food handling processes and practices within the kitchen and identifying recent illnesses or notable events that occurred around the time of the outbreak. Interviewing, however, can be challenging, as the interviewer might encounter staff who are fearful of losing their job or uncooperative managers who are reluctant to share information (Hedberg, 2013; Selman & Green, 2008). Trainings for EH professionals on conducting successful interviews should emphasize skills such as building rapport and cultural competency—and allow for practice-based learning opportunities that involve role-playing and specific outbreak scenarios.

Critical thinking skills were highly rated for importance and frequency by all tiers and listed as a training priority for Tiers 2 and 3. This finding aligns with a previous study of EH professionals in which 82% of respondents reported critical thinking and problem solving on a routine basis (Gerding et al., 2019). Skills involved in critical thinking include the ability to shift perspective, consider situations in an unbiased manner, seek evidence, and make inferences (Willingham, 2008). For EH professionals involved in foodborne disease outbreak investigations,

TABLE **4**

Importance and Frequency of Competencies by Professional Tier

Competency	Tier 1		Tier 2		Tier 3	
	Essential, Very Important, or Important (%)	Performed Often or Sometimes (%)	Essential, Very Important, or Important (%)	Performed Often or Sometimes (%)	Essential, Very Important, or Important (%)	Performed Often or Sometimes (%)
Observation and record review (C6)	**97**	**73**	**97**	**80**	**96**	**84**
Control measures (C10)	**97**	**69**	**95**	**77**	85	**73**
Interview skills (C7)	**95**	**62**	**95**	**84**	**92**	**70**
Contributing factors (C5)	**94**	**67**	88	**79**	84	**73**
Partnerships and communication (C3)	**93**	**59**	**95**	**87**	**94**	**79**
Critical thinking skills (C9)	**93**	**51**	**92**	**73**	**90**	**80**
Environmental assessments (C4)	**91**	**57**	**94**	**81**	**94**	**82**
Roles and responsibilities (C2)	**91**	**56**	**95**	**90**	**98**	**77**
Quality improvement (C14)	**90**	**58**	86	**53**	**92**	**73**
Outbreak communication (C13)	**90**	48	85	**54**	77	**50**
Report writing (C15)	89	44	88	**65**	**92**	**79**
Legal authority (C11)	88	46	**92**	**73**	87	**74**
Outbreak surveillance reporting (C16)	87	30	71	24	77	**59**
Traceback/traceforward investigations (C12)	87	31	69	29	79	41
Specimen testing (C8)	82	35	80	43	67	33
Outbreak detection (C1)	82	38	71	**51**	88	**57**

Note. Bolded numbers indicate competencies with a) ≥90% of respondents rating the competency as essential, very important, or important or b) ≥50% of respondents reporting performing the competency often or sometimes.

proficiency in critical thinking is essential during an environmental assessment, including identifying which observations to make based on the current outbreak, using the establishment's records to identify issues or hints to further form a hypothesis for the outbreak, and identifying relevant contributing factors and root causes or environmental antecedents in environmental assessments.

Traceback/traceforward investigations (C12) was the only competency across all tiers that was not highly rated for importance, frequency, and training, which could reflect the fact that many local EH agencies do not routinely conduct traceback or traceforward investigations (NEHA, 2013). Having jurisdictions know how to conduct efficient traceback or traceforward investigations is important, and these results suggest that consideration should be given to how groups receive this training, as well as which groups receive this training.

The training road map is a tool to connect EH professionals with a curated list of existing trainings that support each competency, saving agencies and professionals time and energy. In the future, we plan to evaluate the alignment of existing resources and training needs to prioritize resource development. For example, for three of the five training priorities identified by Tier 3 EH professionals (environmental assessments [C4], interview skills [C7], and critical thinking skills [C9]), only one training resource was identified in the training road map, and for one competency (report writing [C15]), no resources were identified.

Quality improvement (C14) is another area in which training development could be focused. All tiers rated this competency high for importance. Of the five trainings identified, none were directed toward Tier 3 professionals, who rated this competency highest for importance and frequency among the tiers. Only one training was directed toward Tier 2 professionals.

Other competencies, such as sampling (C8) and legal authority (C11), will require state-specific training in addition to general trainings. Given the diversity of educational and experiential background among EH professionals (Gerding et al., 2019; NEHA, 2013) as well as the distinct desired skills by professional level, careful attention must be paid to the development and delivery of training resources. To ensure resources are effective and engaging, newly developed resources should have measurable outcomes and be based on instructional design methods geared toward adult learners using multiple technological modalities (Drehobl et al., 2014; Koo & Miner, 2010).

The competencies should be used in conjunction with other resources including the FDA (2022) Voluntary National Retail Food Regulatory Program Standards, specifically Standard 5 (Foodborne Illness and Food Defense Preparedness and Response), and the EH investigation focus area of the *Guidelines for Foodborne Disease Outbreak Response Toolkit* (Council to Improve Foodborne Outbreak

TABLE **5**

The Five Most Frequently Chosen Competency Training Priorities by Professional Tier

Tier 1	Tier 2	Tier 3
Environmental assessments (C4)	Environmental assessments (C4)	Environmental assessments (C4)
Interview skills (C7)	Interview skills (C7)	Interview skills (C7)
Observation and record review (C6)	Observation and record review (C6)	Observation and record review (C6)
Contributing factors (C5)	Critical thinking skills (C9)	Critical thinking skills (C9)
Control measures (C10)	Specimen testing (C8)	Report writing (C15)

Response, 2018). While the FDA Standard 5 self-assessment tool provides a mechanism for evaluating agency procedures, the competency framework provides expectations for individual-level knowledge and skills, as well as road maps to existing trainings.

In addition, the competency framework presented here is specific to foodborne outbreak investigations; these activities are likely a small, albeit crucial, component of most EH professional job duties. As such, they are intended to build on the general knowledge required for EH positions, including the baseline knowledge and skills required to pass the NEHA REHS/RS credential exam. EH professionals also can work on epidemiological aspects of the outbreak investigation. For these skills, EH professionals are encouraged to consult *Foodborne Illness Outbreak Detection, Investigation, and Response: Competencies for Epidemiologists* (Colorado Integrated Food Safety Center of Excellence, 2020).

Conclusion

EH professionals play a vital role in foodborne illness detection and control and thus require a specialized set of knowledge and skills that can vary by job. The CoEs 1) developed and evaluated a tiered competency framework to support EH professionals working in enteric and foodborne illness and 2) created a training road map linking competencies to existing trainings. During 2021 and 2022, the Tennessee CoE was working to streamline the existing training road map to enable EH professionals to more easily identify trainings needed to master the EH competencies. Once completed, this updated resource will be made available via the CoE All Products website (Integrated Food Safety Centers of Excellence, 2021). The competencies and road map are free and can be used for workforce development by individuals and managers to identify and address knowledge and skill gaps. These resources are also valuable to institutions designing related training curricula and resources. The CoEs also plan to assess gaps in available competency trainings to help prioritize the development of new trainings.

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continued on page 32

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Did You Know?

NEHA has researched and carefully crafted a series of policy statements in response to concerns from the environmental health profession. Each statement has been vetted by NEHA and adopted by the NEHA Board of Directors as official statements of the association. The statements include topics on food freedom operations, body art, vector control, well water quality, mosquito control, the role of environmental health in preparedness, food safety, point-of-service food inspection disclosure, onsite wastewater systems, and more. You can find these policy statements at www.neha.org/policy-statements.

DIRECT FROM CDC ENVIRONMENTAL HEALTH SERVICES

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Resources and Tools for Emergencies

Editor's Note: The National Environmental Health Association (NEHA) strives to provide up-to-date and relevant information on environmental health and to build partnerships in the profession. In pursuit of these goals, NEHA features this column on environmental health services from the Centers for Disease Control and Prevention (CDC) in every issue of the *Journal*.

In these columns, authors from CDC's Water, Food, and Environmental Health Services Branch, as well as guest authors, will share tools, resources, and guidance for environmental health practitioners. The conclusions in these columns are those of the author(s) and do not necessarily represent the official position of CDC.

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In 2021, 20 weather or climate disasters, each causing over $1 billion in damage, affected the U.S. and its territories. These disasters included droughts, flooding events, severe storms, wildfires, and winter storms. Overall, they impacted human quality of life and had significant economic effects on the affected areas (Smith, 2020). State, territorial, local, and tribal health departments play an important role in responding to emergencies and disasters. Both during and after these events, it can be challenging for environmental health professionals to conduct the traditional functions of environmental health, such as safeguarding drinking water supplies, controlling disease-causing vectors, conducting food safety inspections, and ensuring safe and healthy building environments.

The Water, Food, and Environmental Health Services Branch within the Centers for Disease Control and Prevention (CDC) supports environmental health professionals with tools and resources to help build their capacity to respond to emergencies and disasters (CDC, 2022). The Response and Recovery Activities for Environmental Health (RRA) webpage highlights key resources for environmental health professionals that are useful in preparing for, responding to, and recovering from emergencies and disasters (Figure 1). The RRA webpage provides tools for conducting assessments, guidance on how to communicate with the public during and after a disaster, and links to partner resources that support recovery.

CDC assessment tools assist environmental health professionals by providing guidance after wildfires and flooding (CDC, 2021a). After a wildfire, environmental health professionals might be tasked with conducting assessments and evaluating drinking water wells. The rapid assessment form from CDC (2021a) can help environmental health professionals quickly conduct assessments to identify well damage and the risk associated with using damaged well infrastructure. In turn, environmental health professionals can provide guidance to well owners on well water testing and taking action to repair damaged wells.

With flooding events, it is important to understand when outdoor areas can be safe to use after flood waters subside. Wastewater treatment plants, sewer lift stations and collection systems, and individual or community septic systems can contaminate public spaces like ball fields, playgrounds, and residential yards (U.S. Environmental Protection Agency, 2001). Floodwater and standing water can be dangerous, making humans and animals more vulnerable to infectious diseases, chemical hazards, and injuries (CDC, 2020). CDC (2021b) guidance on reopening outdoor spaces after flooding outlines a risk assessment approach that environmental health professionals can use to determine when it is acceptable to use a public outdoor space again.

Clear and effective communication is a crucial life-saving component in public health emergency response. Because misinformation can spread quickly, it is especially important to speak, communicate, and engage with your audience during a response (Khan et al., 2021). The Crisis and Emergency Risk Communication (CERC) program describes

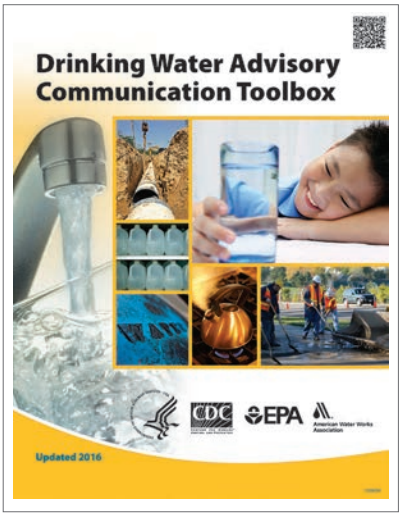
FIGURE **1**

Response and Recovery Activities for Environmental Health

Find response activities by environmental health mission to help you fulfill important roles in all-hazards emergency preparedness, response, recovery, and mitigation at www.cdc.gov/nceh/ehs/rra/index.html.

FIGURE **2**

Drinking Water Advisory Communication Toolbox



Use this toolbox at www.cdc.gov/healthywater/emergency/dwa-comm-toolbox/index.html to plan, develop, implement, and evaluate drinking water advisories.

evidence-based principles to successfully communicate during emergencies (CDC, 2018). The CERC program was developed from past public health emergencies and research in the fields of public health, psychology, and emergency risk communication. The CERC program provides trainings, tools, and resources for health communicators, emergency responders, and leaders of organizations to help with effective communication during emergencies.

Environmental health disasters pose a risk for foodborne and waterborne disease outbreaks. To assist with outbreak investigations, CDC developed the National Hypothesis Generating Questionnaire, which is a set of questions for public health officials to use to interview sick people in the early stages of a multistate foodborne or gastrointestinal disease outbreak investigation (CDC, 2021c). The CDC Drinking Water Advisory Communication Toolbox provides information on how to plan, develop, implement, and evaluate communication activities with the public and stakeholders during drinking water emergencies (Figure 2). A water main break, a drop in pressure in the water system, flooding, a hurricane, or intentional contamination can prompt the need for a drinking water notification or advisory.

For example, Houston, Texas, experienced in 2020 a catastrophic 96-in. water main break. As a result, 95% of the city was under a boil water notice, affecting 13,000 food service establishments. The Houston Health Department and Houston Health Authority used the CDC Drinking Water Advisory Communication Toolbox as a framework for their response. The approach in the toolbox recognizes the differences in scope, scale, and severity of situations that trigger advisories and notifications, and describes the best communication methods for those situations. Both tools provide a streamlined process for environmental health professionals to prevent and mitigate foodborne and waterborne diseases.

To learn more about how CDC helped to rebuild and increase the capacity of several jurisdictional environmental health programs after a natural disaster, see our stories about recovery at www.cdc.gov/nceh/ehs/rra/stories/index.html. The tools and resources are geared toward the needs and interests of environmental health professionals to help them build capacity, reduce exposures, and improve public health in their communities after an emergency or disaster.

Explore Other Resources for Response Recovery

- Centers for Disease Control and Prevention Disaster Shelter Assessment: https://emergency.cdc.gov/shelterassessment/
- Community Assessment for Public Health Emergency Response (CASPER): www.cdc.gov/nceh/casper/default.htm
- Comprehensive Disaster Assessment and Readiness Tools (CDART): www.atsdr.cdc.gov/CDART.html
- Emergency Water Supply Planning Guide for Hospitals and Healthcare Facilities: www.cdc.gov/healthywater/emergency/ewsp.html
- Environmental Health Training in Emergency Response (EHTER): www.cdc.gov/nceh/ehs/elearn/ehter.htm
- Third Edition of the Council to Improve Foodborne Outbreak Response (CIFOR) *Guidelines for Foodborne Disease Outbreak Response:* http://cifor.us/clearinghouse/cifor-guidelines-for-foodborne-disease-outbreak-response
- Food and Drug Administration Food Defense Resources: www.fda.gov/food/food-defense
- Waterborne Disease Outbreak Investigation Toolkit: www.cdc.gov/healthywater/emergency/pdf/waterborne-disease-outbreak-toolkit-h.pdf
- Foodborne Disease Outbreak Investigation and Surveillance Tools: www.cdc.gov/foodsafety/outbreaks/surveillance-reporting/investigation-toolkit.html

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References on page 36

continued from page 35

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Did You Know?

NEHA is a partner of the Retail Food Safety Regulatory Association Collaborative, a group of agencies and associations working to reduce the incidence of foodborne illness at the retail level. The Collaborative has posted a variety of resources including a toolkit to help jurisdictions adopt the latest editions of the Food and Drug Administration *Food Code*, an assessment of the impact of active managerial control incentive programs, an interactive map of *Food Code* adoption, and more. Check it out at www.retailfoodsafetycollaborative.org.

Did You Know?

World Mosquito Day is celebrated each year on August 20. The date marks the anniversary of the discovery that mosquitoes transmit the parasite that causes malaria. On August 20, 1897, Sir Ronald Ross discovered the malaria parasite in the stomach tissue of an *Anopheles* mosquito. His work later confirmed that mosquitoes are the vector that carries this parasite from human to human.

DIRECT FROM ecoAmerica

Nicole Hill, MPH

Robert Perkowitz

Climate Changes Mental Health

Editor's Note: The National Environmental Health Association (NEHA) strives to provide up-to-date and relevant information on environmental health and to build partnerships in the profession. In pursuit of these goals, we feature this column from ecoAmerica whose mission is to build public support and political resolve for climate solutions. NEHA is an official partner of ecoAmerica and works closely with their Climate for Health Program, a coalition of health leaders committed to caring for our climate to care for our health. The conclusions in this column are those of the author(s) and do not necessarily represent the official position of NEHA.

Nicole Hill is the research and marketing manager at ecoAmerica. Robert Perkowitz is the founder and president of ecoAmerica.

When you think about climate change, how do you feel? If you are overwhelmed with fear or feeling depressed or despondent, you are not alone. In 2020, 67% of people in the U.S. surveyed by the American Psychiatric Association said they were somewhat or extremely anxious about climate change. More than one half said they were anxious about the impact of climate change on their mental health (American Psychiatric Association, 2020).

The chronic fear of environmental doom is termed "eco-anxiety" and it reaches beyond environmental and public health spaces (Clayton et al., 2021). In 2022, eco-anxiety and climate change have been covered in diverse publications, including *Elle*, *The New York Times*, *Good Housekeeping*, and *Teen Vogue*. The National Environmental Health Association (NEHA) has long recognized the mental and environmental health implications of climate change. These implications are synthesized in the ecoAmerica and American Psychological Association report, *Mental Health and Our Changing Climate* (Clayton et al., 2017).

Severe weather, for example, can create personal struggles with mental health, including trauma and shock, post-traumatic stress disorder, anxiety, depression, and strains on social relationships. These disaster events that we often think of, such as hurricanes and floods, also impact us on the community level. Weakened community cohesion, increased vulnerability to stress, community displacement, and a threatened sense of belonging can occur as a result of climate change impacts. And, as with the physical impacts, the mental health impacts of climate change most heavily burden people who are oppressed by historical and present power dynamics (Clayton et al., 2021).

Beyond acute impacts of climate change, mental health and well-being are threatened by chronic, long-term changes to our environment. Heat, drought, and declining air quality can lead to mood and anxiety disorders, lower happiness and life satisfaction, and loss of personally important places, to name a few. Impacts on communities include mental distress, diminished self-worth, intergroup hostility, and depression (Clayton et al., 2021).

While it is true that climate change has a myriad of impacts on mental health and well-being, it is also true that solutions are at hand. Environmental health professionals are poised to take meaningful action. Health professionals are highly trusted messengers when it comes to communicating about climate change. In 2021, 68% of people in the U.S. said they trusted health professionals as a source for climate change information. That percentage is up from 57% in 2015 (ecoAmerica, 2021). Equipped with information from NEHA and ecoAmerica's Climate for Health program, you can make a difference in your organization and community.

Mental Health and Our Changing Climate provides direction for building community resilience to the mental health impacts of climate change and for accelerating climate solutions (Clayton et al., 2021). Some examples include:

1. **Expanded response and resiliency plans can play a significant role in mitigating mental health concerns**. Environmental health professionals should invite mental health professionals and affected community members into the planning process to incorporate short- and long-term mental health implications of climate change
2. **Increase and maintain social cohesion**. Following climate disasters and weather-related events, community leaders, including environmental health professionals, should support one another. Social cohesion and social networks provide community members with much-needed support
3. **Address disparities to advance mental health equity**. Environmental injustices have impacted communities for decades and all other resilience-building actions need to be paired with addressing inequities. A good place to start at the community level

is conducting a vulnerability assessment. The results can then inform preparedness efforts such as prevention of climate disasters, reduction of exposure to disasters, and allocation of resources following a disaster.

You cannot take care of others if you do not take care of yourself. As you bring forth climate solutions and mental health resiliency in your organization and community, remember to also care for yourself. Spend time often with supportive people in your life (Bekkar, 2021). Providing solutions and helping to empower climate change solutions today will help counter distress (Clayton et al., 2021). We are, certainly, in this fight together.

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> *"There are some solutions that require our collective action. One of them is acknowledging that there are important mental health impacts [of climate change] and that we have to take that into consideration as we think about this issue."*
>
> Arthur C. Evans, Jr., PhD, Chief Executive Officer, American Psychological Association (ecoAmerica, 2022, 16:03)

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Did You Know?

Thank you to all that attended the NEHA 2022 Annual Educational Conference (AEC) & Exhibition in Spokane, Washington, on June 28–July 1. Over 1,000 people attended either in person or virtually, taking advantage of the all the educational and networking opportunities. A wrap-up of the 2022 AEC will be published in the October *Journal of Environmental Health*.

EH CALENDAR

UPCOMING NATIONAL ENVIRONMENTAL HEALTH ASSOCIATION (NEHA) CONFERENCE

July 31–August 3, 2023: NEHA 2023 Annual Educational Conference & Exhibition, Hilton New Orleans Riverside, New Orleans, LA, https://www.neha.org/aec

NEHA AFFILIATE AND REGIONAL LISTINGS

California
August 15–18, 2022: Annual Educational Symposium (AES), hosted by the Central Chapter of the California Environmental Health Association, Clovis, CA, https://www.ceha.org

Colorado
September 13–16, 2022: 66th Annual Education Conference, Colorado Environmental Health Association, Crested Butte, CO, http://www.cehaweb.com

Florida
July 31–August 6, 2022: 2022 Annual Education Meeting, Florida Environmental Health Association, Howey in the Hills, FL, https://feha.wildapricot.org

Georgia
July 26–28, 2022: Annual Educational Conference, Georgia Environmental Health Association, Savannah, GA, https://geha-online.wildapricot.org

Illinois
November 7–8, 2022: IEHA Annual Educational Conference, Illinois Environmental Health Association (IEHA), Utica, IL, https://ieha.coffeecup.com/calendar.html

Indiana
September 19–21, 2022: Fall Educational Conference, Indiana Environmental Health Association, Nashville, IN, https://www.iehaind.org/Conferences

Iowa
October 12–13, 2022: Fall Conference, Iowa Environmental Health Association, West Des Moines, IA, https://www.ieha.net

Kansas
September 13–15, 2022: Annual Fall Conference, Kansas Environmental Health Association, Topeka, KS, https://kansasenvironmentalhealthassociation.org

Texas
October 19–21, 2022: 66th Annual Educational Conference, Texas Environmental Health Association, Round Rock, TX, https://myteha.org/Annual-Education-Conference

Wisconsin
October 26–28, 2022: WEHA Educational Conference, Wisconsin Environmental Health Association (WEHA), Lake Geneva, WI, https://weha.net/events

PEOPLE ON THE MOVE

NEHA Board Member Receives John J. Guzewich Award

The National Environmental Health Association (NEHA) is pleased to announce that Michele DiMaggio, NEHA Region 2 vice-president, was selected as the recipient of the 2022 John J. Guzewich Environmental Public Health Award. DiMaggio was nominated by Vince Radke, who stated on the nomination application that "Michele DiMaggio is the embodiment of what Jack Guzewich worked toward and accomplished in his professional life to improve food safety and prevent foodborne illness."

DiMaggio holds a bachelor's degree in biological science from California State University East Bay and is a California Registered Environmental Health Specialist. She has worked at the national level on the Centers for Disease Control and Prevention's Board of Scientific Counselors Food Safety Modernization Act Surveillance Work Group during the past 4 years. She has also participated in the Council to Improve Foodborne Outbreak Response committee working on the third edition of the *Guidelines for Foodborne Disease Outbreak Response*.

DiMaggio's experience is extensive, ranging from being a subject matter expert on the Training and Certification and Surveillance, Response, and Post-Response work groups of the Partnership for Food Protection; participating on the Advisory Council for Training Compilation and Certification Program for Environmental Assessments of Foodborne Illness Outbreaks at the Colorado Integrated Food Safety Center of Excellence; and being a technical advisor and instructor for food safety and shelter assessment at the California Department of Public Health. DiMaggio also previously taught the Epi-Ready Foodborne Illness Response course for NEHA.

Since August 2013, DiMaggio has been a supervising environmental health specialist within the Environmental Health Division at the Contra Costa County Health Services Department. She shares management responsibility for the retail food safety program and is also an associate supervisor for the division's Foodborne Illness Outbreak Response and Emergency Response Team. She has coordinated and conducted numerous foodborne illness outbreaks investigations in conjunction with the Public Health Communicable Disease and Laboratory Divisions.

The award is named for John J. Guzewich who retired from the Center for Food Safety and Applied Nutrition within the Food and Drug Administration in 2011. He was senior advisor for environmental health in the Office of Food Defense, Communication, and Emergency Response. Guzewich worked on a number of special projects to enhance relationships with federal, state, and local government partners responsible for food safety. The award aims to recognize the role of individuals and local, state, tribal, and territorial environmental public health departments in protecting their communities and the national food safety system from foodborne illness, as well as to encourage innovative programs and best practices to prevent the occurrence of foodborne illnesses.

The award was presented at the 2022 Integrated Foodborne Outbreak Response and Management (InFORM) Conference in April.

People on the Move is designed to keep NEHA members informed about what their peers in environmental health are up to. If you or someone you know has received a promotion, changed careers, or earned a special recognition in the profession, please notify Kristen Ruby-Cisneros at kruby@neha.org. It is our pleasure to announce the achievements and new directions of our members. This feature will run when we have material to print—so be sure to send in your announcements!

RESOURCE CORNER

Resource Corner highlights different resources the National Environmental Health Association (NEHA) has available to meet your education and training needs. These resources provide you with information and knowledge to advance your professional development. Visit the NEHA online Bookstore for additional information about these and many other pertinent resources!

NEHA BOOKSTORE
www.neha.org/store

Management and Supervisory Practices for Environmental Professionals: Basic Principles, Volume I (4th Edition)

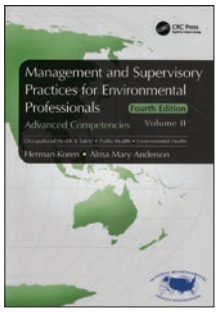
Herman Koren and Alma Mary Anderson (2021)

The 4th edition of this bestseller provides up-to-date information for newly promoted or management-aspiring professionals and engineers in the fields of environmental health, occupational health and safety, water and wastewater treatment, public health, and other environmental professions. The book is also an excellent resource for students interested in learning management skills prior to entering the workforce. Through nine sets of tools, the first volume explains the basic principles supervisors need to understand the structure of their organization, what leadership is, how to effectively plan and budget, how to manage other people, and best practices for achieving success in a management position.

258 pages / Paperback
Member: $49 / Nonmember: $56

Management and Supervisory Practices for Environmental Professionals: Advanced Competencies, Volume II (4th Edition)

Herman Koren and Alma Mary Anderson (2021)

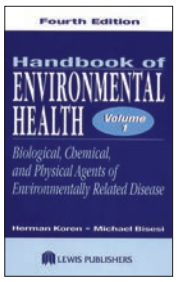


The 4th edition of this bestseller provides up-to-date information for newly promoted or management-aspiring professionals and engineers in the fields of environmental health, occupational health and safety, water and wastewater treatment, public health, and other environmental professions. The book is also an excellent resource for students interested in learning management skills prior to entering the workforce. The second volume explains the advanced principles that supervisors need to understand the art of communication and resolving communication problems, as well as the role of supervisors or managers in teaching, counseling, and managing employee performance, health, and safety.

276 pages / Paperback
Member: $49 / Nonmember: $56

Handbook of Environmental Health, Volume 1: Biological, Chemical, and Physical Agents of Environmentally Related Disease (4th Edition)

Herman Koren and Michael Bisesi (2003)

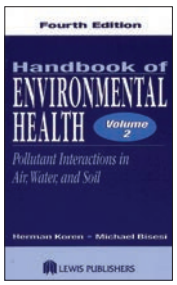


A must for the reference library of anyone in the environmental health profession, this book focuses on factors that are generally associated with the internal environment. It was written by experts in the field and copublished with the National Environmental Health Association (NEHA). A variety of environmental issues are covered such as food safety, food technology, insect and rodent control, indoor air quality, hospital environment, home environment, injury control, pesticides, industrial hygiene, instrumentation, and much more. Environmental issues, energy, practical microbiology and chemistry, risk assessment, emerging infectious diseases, laws, toxicology, epidemiology, human physiology, and the effects of the environment on humans are also covered. Study reference for NEHA's Registered Environmental Health Specialist/Registered Sanitarian credential exam.

790 pages / Hardback
Member: $215 / Nonmember: $245

Handbook of Environmental Health, Volume 2: Pollutant Interactions With Air, Water, and Soil (4th Edition)

Herman Koren and Michael Bisesi (2003)



A must for the reference library of anyone in the environmental health profession, this book focuses on factors that are generally associated with the outdoor environment. It was written by experts in the field and copublished with NEHA. A variety of environmental issues are covered such as toxic air pollutants and air quality control; risk assessment; solid and hazardous waste problems and controls; safe drinking water problems and standards; onsite and public sewage problems and control; plumbing hazards; air, water, and solid waste programs; technology transfer; GIS and mapping; bioterrorism and security; disaster emergency health programs; ocean dumping; and much more. Study reference for NEHA's Registered Environmental Health Specialist/Registered Sanitarian credential exam.

876 pages / Hardback
Member: $215 / Nonmember: $245

Corresponding Author and Subject Index

Code	Corresponding Author/Title	Volume/Issue	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5
1	**Muge Akpinar-Elci, MPH, MD** Climate Change, Dust Storms, Vulnerable Populations, and Health in the Middle East: A Review	84.3 Oct 2021 Pages: 8–15	Ambient Air	International	Meteorology/ Weather/ Climate	Public Health/ Safety	
2	**Gina Bare, RN** Environmental Health Innovations During the COVID-19 Pandemic	84.4 Nov 2021 Pages: 32–39	Disaster/ Emergency Response	Management/ Policy	Workforce Development		
3	**Brenden A. Bedard, MPH** Hepatitis A Vaccination of Food Service Workers in Genesee County, New York	84.2 Sept 2021 Pages: 26–28	Emerging Pathogens	Epidemiology	Food	Management/ Policy	Public Health/ Safety
4	**Laurel Berman, PhD** An Overview of Brownfields Redevelopment in the United States Through Regulatory, Public Health, and Sustainability Lenses	84.9 May 2022 Pages: 8–14	Environmental Justice	Hazardous Materials/Toxic Substances	Land Use Planning/ Design	Sustainability	
5	**William J. Brazile, PhD, CIH, CSP** The Effect of Ice Hockey Official Helmet Visor Length on Exposure to Whistle Noise	84.3 Oct 2021 Pages: 16–21	Noise	Occupational Health/Safety	Recreational Environmental Health		
6	**Michael G. Bruce, MPH, MD** Acceptability of Household Practices to Prevent Boils in Rural Alaska	84.1 July/Aug 2021 Pages: 26–34	Emerging Pathogens	Epidemiology	Microbiology	Public Health/ Safety	
7	**Jinkyung Choi, PhD, RD** Consumer Perception of Novel Restaurant Hygiene Certificates and Evaluation Criteria for Food Safety	84.8 April 2022 Pages: 18–24	Food	International	Public Health/ Safety		
8	**Elizabeth R. Daly, MPH, DrPH** Community Outbreak of Legionellosis Associated With an Indoor Hot Tub, New Hampshire, 2018	84.10 June 2022 Pages: 16–24	Emerging Pathogens	Epidemiology	Microbiology	Pools/Spas	Public Health/ Safety
9	**Christopher Eddy, MPH, REHS, CP-FS** Part 1: The Zika Virus Threat and Prevention Challenges: An All-Hazards and One Health Approach to Pandemic and Global Epidemic Prevention and Mitigation	84.2 Sept 2021 Pages: 8–18	Disaster/ Emergency Response	Emerging Pathogens	Environmental Justice	Terrorism/ All-Hazards Preparedness	Vector Control
10	**Christopher Eddy, MPH, REHS, CP-FS** Part 2: Public Health Professional Perspectives on Justice and Zika Virus Preparedness: The Human Right to Health	84.2 Sept 2021 Pages: 20–24	Disaster/ Emergency Response	Emerging Pathogens	Environmental Justice	Terrorism/ All-Hazards Preparedness	Vector Control
11	**Kieran Fogarty, PhD** Governmental Food Safety Professional Workforce Estimation Model	84.8 April 2022 Pages: 26–31	Education/ Training	Food	Workforce Development		
12	**Julia Gohlke, PhD** Healthcare Visits and Summertime Heat Index in Virginia: An Analysis of Syndromic Surveillance Data Collected From 2015–2020	84.10 June 2022 Pages: 26–32	Disaster/ Emergency Response	Epidemiology	Meteorology/ Weather/ Climate	Public Health/ Safety	Risk Assessment

Code	Corresponding Author/Title	Volume/Issue	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5
13	**Nicole D. Hedeen, MS, RS** Tools and Techniques to Promote Proper Food Cooling in Restaurants	84.7 March 2022 Pages: 8–11	Education/ Training	Epidemiology	Food	Microbiology	
14	**Daniel E. Ho, JD, PhD** Improving the Reliability of Food Safety Disclosure: Restaurant Grading in Seattle and King County, Washington	84.2 Sept 2021 Pages: 30–37	Food	Management/ Policy	Public Health/ Safety		
15	**Patrick Irwin, PhD** Spatial Analysis of the Impact of "Do Not Spray" Areas on Mosquito Adulticiding in the Suburbs of Northwest Chicago, Illinois	84.9 May 2022 Pages: 22–28	Public Health/ Safety	Technology	Vector Control		
16	**James D. Johnston, MSPH, PhD, CIH** Factors Influencing Radon Mitigation Behaviors Among Utah Residents	84.3 Oct 2021 Pages: 22–30	Indoor Air	Public Health/ Safety	Radiation/ Radon		
17	**Jason W. Marion, MS, PhD** Carbon Monoxide Exposure Potential Associated With the Use of Recreational Watercraft	84.1 July/Aug 2021 Pages: 8–14	Ambient Air	Hazardous Materials/Toxic Substances	Public Health/ Safety	Recreational Environmental Health	Risk Assessment
18	**Edmore Masaka, MPH, PhD** Awareness of Business Owners and Environmental Health Officers Regarding Health Risks Associated With the Use of Water Mist Systems in Australia	84.10 June 2022 Pages: 8–14	Ambient Air	International	Microbiology	Public Health/ Safety	Water Pollution Control/Water Quality
19	**William A. Mase, DrPH** Association Between Equipment Maintenance Violations in Food Service Establishments and Their Risk Level According to the Ohio Administrative Code in Cincinnati, Ohio	84.9 May 2022 Pages: 16–21	Food	Management/ Policy	Public Health/ Safety		
20	**Cezar Morar, PhD** Sustainable Brownfields Redevelopment in the European Union: An Overview of Policy and Funding Frameworks	84.4 Nov 2021 Pages: 24–31	International	Land Use Planning/ Design	Management/ Policy	Public Health/ Safety	Sustainability
21	**Brian A. Nummer, PhD** Retail Risk Assessment and Lethality of *Listeria monocytogenes* and *E. coli* O157 in Naturally Fermented Sauerkraut	84.5 Dec 2021 Pages: 8–12	Food	Microbiology	Risk Assessment		
22	**Brian A. Nummer, PhD** Vegetable Lactic Acid Fermentations Under the Food and Drug Administration Model *Food Code*: Risk Analysis and Safe Processing Guidance	84.5 Dec 2021 Pages: 14–18	Education/ Training	Food	Microbiology	Risk Assessment	

Corresponding Author and Subject Index

Code	Corresponding Author/Title	Volume/Issue	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5
23	**Paschal Nwako, MPH, PhD, REHS, DAAS** Understanding Public Health Worker Beliefs About Radon Gas Exposure	84.6 Jan/Feb 2022 Pages: 22–29	Ambient Air	Indoor Air	Management/ Policy	Radiation/ Radon	Workforce Development
24	**Caroline R. Pharr, PhD and John G. Rowley, PhD** Quantifying the Rate Copper Leaches From a Copper Drinking Vessel Into Simulated Beverages Under Conditions of Consumer Use	84.6 Jan/Feb 2022 Pages: 8–13	Food	Hazardous Materials/Toxic Substances	Public Health/ Safety	Research Methods	Risk Assessment
25	**Clint Pinion, Jr., MA, DrPH, RS, CIT** Isolation of Antimicrobial-Resistant Enterobacteriaceae and Nonfermenting Bacteria From Livestock-Associated Ambient Particulate Matter	84.4 Nov 2021 Pages: 18–22	Ambient Air	Microbiology	Research Methods		
26	**Athena K. Ramos, MBA, MS, PhD, CPM** A Rapid-Response Survey of Essential Workers in Midwestern Meatpacking Plants: Perspectives on COVID-19 Response in the Workplace	84.1 July/Aug 2021 Pages: 16–25	Disaster/ Emergency Response	Emerging Pathogens	Food	Occupational Health/Safety	Public Health/ Safety
27	**Dhitinut Ratnapradipa, MSc, PhD, MCHES** Extreme Winter Storms: Environmental Impacts of Public Utility Policies on Vulnerable Populations	84.7 March 2022 Pages: 12–19	Disaster/ Emergency Response	Environmental Justice	Management/ Policy	Meteorology/ Weather/ Climate	Public Health/ Safety
28	**Stephanie L. Richards, MSEH, PhD** Horse Owner Practices and Equine and Human Arboviral Encephalitis in North Carolina	84.7 March 2022 Pages: 20–26	Epidemiology	Risk Assessment	Vector Control		
29	**Kirstin E. Ross, PhD, GradDipEnvH** The COVID-19 Pandemic and Environmental Health: Lessons Learned	84.5 Dec 2021 Pages: 20–25	Disaster/ Emergency Response	Education/ Training	International	Management/ Policy	Workforce Development
30	**Derek G. Shendell, MPH, D.Env** Built Environment Attributes and Preparedness for Potential Gun Violence at Secondary Schools	84.4 Nov 2021 Pages: 8–16	Children's Environmental Health	Disaster/ Emergency Response	Institutions and Schools	Public Health/ Safety	Terrorism/ All-Hazards Preparedness
31	**Denise A. Smart, MPH, DrPH, RN** Application of Haddon's Matrix in the Exploration of Factors Related to Exertional Heat Illness in Disaster Responders in the U.S. National Guard	84.8 April 2022 Pages: 8–17	Disaster/ Emergency Response	Occupational Health/Safety	Research Methods	Risk Assessment	Terrorism/ All-Hazards Preparedness
32	**Alexander C. Ufelle, MBBS, MPH, PhD** Health Effects and Factors Affecting Formaldehyde Exposure Among Students in a Cadaver Laboratory	84.6 Jan/Feb 2022 Pages: 14–21	Education/ Training	Hazardous Materials/Toxic Substances	Indoor Air	Institutions and Schools	Risk Assessment

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CROSS-REFERENCE

Subject	Author/Title Code
Ambient Air	1, 17, 18, 23, 25
Children's Environmental Health	30
Disaster/Emergency Response	2, 9, 10, 12, 26, 27, 29, 30, 31
Education/Training	11, 13, 22, 29, 32
Emerging Pathogens	3, 6, 8, 9, 10, 26
Environmental Justice	4, 9, 10, 27
Epidemiology	3, 6, 8, 12, 13, 28
Food	3, 7, 11, 13, 14, 19, 21, 22, 24, 26
Hazardous Materials/Toxic Substances	4, 17, 24, 32
Indoor Air	16, 23, 32
Institutions and Schools	30, 32
International	1, 7, 18, 20, 29
Land Use Planning/Design	4, 20
Management/Policy	2, 3, 14, 19, 20, 23, 27, 29
Meteorology/Weather/Climate	1, 12, 27
Microbiology	6, 8, 13, 18, 21, 22, 25
Noise	5
Occupational Health/Safety	5, 26, 31
Pools/Spas	8
Public Health/Safety	1, 3, 6, 7, 8, 12, 14, 15, 16, 17, 18, 19, 20, 24, 26, 27, 30
Radiation/Radon	16, 23
Recreational Environmental Health	5, 17
Research Methods	24, 25, 31
Risk Assessment	12, 17, 21, 22, 24, 28, 31, 32
Sustainability	4, 20
Technology	15
Terrorism/All-Hazards Preparedness	9, 10, 30, 31
Vector Control	9, 10, 15, 28
Water Pollution Control/Water Quality	18
Workforce Development	2, 11, 23, 29

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NEHA **NEWS**

NEHA Government Affairs Activities

By Doug Farquhar, JD (dfarquhar@neha.org)

The National Environmental Health Association (NEHA) Government Affairs has been working hard in 2022 to represent and advocate for the environmental health profession. Here is a list of our recent activities. You can also visit the Government Affairs website at www.neha.org/government-affairs to access NEHA-approved policy statements, letters and sign-ons, the Your Insider in Government Affairs Blog, and other information about our activities to inform policy makers on the importance of a well-supported and well-funded environmental health workforce.

Fifth Annual Hill Day

NEHA's fifth annual Hill Day was held on Thursday, March 3, 2022. The NEHA Board of Directors met virtually with 37 congressional offices to discuss the environmental health profession, federal funding of environmental health, and inclusion of environmental health within the Prepare for and Respond to Existing Viruses, Emerging New Threats, and Pandemics Act (PREVENT Pandemics Act). The visits focused on members of the House of Representatives and Senate Appropriations committees, both Democrat (21 office visits) and Republican (16 office visits). This all-day event allowed the board to advocate for the profession, highlighting the challenges it is facing due to COVID-19, the need for support from the nation's federal policy makers, and the decimation of trained staff due to funding cuts and overwork.

The focus this year was on Food and Drug Administration (FDA) and Centers for Disease Control and Prevention (CDC) appropriations, highlighting the importance of federal funding for food safety and other environmental health objectives to the state and local environmental health profession. NEHA work is vital as we are the only association that advocates solely for environmental health and the environmental health profession before Congress.

Support for Federal Partner Funding

NEHA has been active in requesting funding for our federal partners regarding environmental health. Letters from NEHA President Roy Kroeger, along with letters from the CDC Coalition, have been submitted to the congressional appropriations subcommittees covering budgets for CDC, the Agency for Toxic Substances and Disease Registry (ATSDR), and FDA for fiscal year 2023 (FY 2023).

National Center for Environmental Health

NEHA sent letters signed by NEHA President Kroeger to both the House of Representative and Senate appropriations subcommittees, as well as signed-onto letters from the CDC Coalition, that cover CDC requesting $401.85 million in funding for the National Center for Environmental Health (Table 1). One of the foremost line items NEHA supports is the "all other" environmental health activities, which the Biden Administration would like to increase from $28 million to $45 million (a 164% increase) to address environmental threats that cause cancer as part of the President Joe Biden Cancer Moonshot initiative. This increase will expand the discretionary funding available to the National Center for Environmental Health.

TABLE **1**

Federal Agency Funding Requested for Fiscal Year (FY) 2023

Federal Agency	FY 2022 Enacted	FY 2023 Requested
Centers for Disease Control and Prevention	$8,401,000,000	$11,000,000,000
National Center for Environmental Health	$228,350,000	$401,850,000
Climate change	$10,000,000	$110,000,000
"All other" environmental health activities	$17,000,000	$45,000,000
Asthma	$30,500,000	$34,000,000
Lead poisoning prevention	$41,000,000	$90,000,000
Environmental Health Tracking Network	$34,000,000	$50,000,000
Environmental Health Laboratory	$68,750,000	$72,750,000
Food and Drug Administration	$1,111,237,000	$1,231,960,000
Center operations	$344,869,000	$420,833,000
Field operations	$766,368,000	$811,127,000
New Era for Food Safety	–	$20,200,000
Healthy Safe Food for All	–	$13,500,000
Emerging chemical and toxicological issues (food)	–	$19,500,000
Center for Food Safety and Applied Nutrition	–	$39,000,000
Office of Regulatory Affairs	–	$9,400,000

Agency for Toxic Substances and Disease Registry

NEHA signed-on to a joint letter with the CDC Coalition to request funding for ATSDR in the FY 2023 Interior, Environment, and Related Agencies budget at $100 million. The letter is addressed to the Senate and House of Representatives Interior-Environment Appropriations Subcommittee leadership.

Food and Drug Administration

NEHA sent letters signed by NEHA President Kroeger to the chairs of the House of Representatives and Senate Subcommittees on Agriculture, Rural Development, Food and Drug Administration, and Related Agencies supporting a $510 million budget (not including field operations) in FY 2023 (Table 1). The funding would go toward the food safety needs of FDA and would include new money for the New Era for Food Safety and Healthy Safe Food for All initiatives.

Additional Advocacy Efforts Before Congress

Government Affairs Director Doug Farquhar (left) and Executive Director Dr. David Dyjack (right) represent the National Environmental Health Association during a meeting with Senator Patty Murray's office in Washington, DC. Photo courtesy of Doug Farquhar.

PREVENT Pandemics Act

In addition to supporting CDC, NCEH, ATSDR, and FDA environmental health efforts, NEHA is also engaged in other congressional bills.

As part of ongoing advocacy to strengthen and support the public health workforce, NEHA reached out to Senators Patty Murray (D-Washington) and Richard Burr (R-North Carolina), the cosponsors of the PREVENT Pandemics Act (S. 3799), to ensure that environmental health and the profession are recognized in the act.

The act covers many things, including loan forgiveness for public health workers. NEHA wants to ensure that environmental health is included in that section of the act. NEHA also advocated for environmental health to be recognized within sections addressing public health infrastructure and rebuilding the public health workforce.

NEHA Executive Director Dr. David Dyjack and NEHA Director of Government Affairs Doug Farquhar spoke with staff from Senator Murray's office about the importance of including environmental health in the PREVENT Pandemics Act, as well as funding for NCEH. This discussion was important as Senator Murray serves as chair of the subcommittee that oversees the budget for CDC. Dr. Dyjack is scheduled to meet with staff from Senator Burr's office in June.

Environmental Health Workforce Act

It appears that the Environmental Health Workforce Act, a longstanding NEHA objective, will possibly be passed this year, with Representative Brenda Lawrence (D-Michigan) including language within the House of Representatives appropriations bill requesting a study on the environmental health workforce to be performed by the U.S. Department of Health and Human Services. With the appropriations bill being a "must pass" bill, the addition of this language guarantees that the study will be funded.

Other sections of the Environmental Health Workforce Act, including the national environmental health credential, cannot be included in the appropriations bill. NEHA will continue to work to ensure the environmental health workforce remains at the forefront of congressional efforts to reform public health.

Representative Rob Wittman Visits Harris Teeter Store

Representative Rob Wittman (second from the right) tours a Harris Teeter grocery store in Virginia to learn about current food safety practices. Photo courtesy of Doug Farquhar.

NEHA organized a site visit for Representative Rob Wittman (D-Virginia) at a local Harris Teeter grocery store in Williamsburg, Virginia, on Friday, April 22. Representative Wittman, cochair of the Congressional Public Health Caucus, worked with NEHA to include the environmental health workforce within the congressional resolution that recognized and commended public health professionals for their work during the pandemic. During that work, Representative Wittman's office asked if he could visit a retail food facility to learn about and discuss food safety.

After some searching, Harris Teeter came forward and agreed to host the visit. Their Lightfoot Marketplace store in Williamsburg provided the perfect opportunity for Representative Wittman to tour a retail store in his district and learn about current food safety practices. As a former dairy stocker and grocery clerk, Representative Wittman knows and appreciates the retail food safety business and he remembers the effort it took to ensure foods were properly shelved and remained fresh. The dairy case at Harris Teeter gets restocked 3 times each day—it takes many professionals to ensure that milk comes from the processing facility to retailers to consumers in a safe, efficient manner each day.

The store was fully stocked, unlike last year during the pandemic. Harris Teeter noted that an increase in local sourcing from farmers and food processers ensured that products were available. Retailers across the county had trouble restocking imported items

due to the pandemic and local sources aided in keeping food products on the shelves.

Representative Wittman has a particular interest in seafood. As a former seafood inspector for Virginia, he recognizes the importance of safe packaging of meat products and spoke of biofilm on meats that leads to spoilage. Prior to Congress, Representative Wittman worked with the Food and Drug Administration on its seafood hazard analysis critical control point (HACCP) program. He was involved with the testing of seafood to learn how norovirus, *Listeria*, or other foodborne pathogens emerge and spread in seafood processing facilities.

Representative Wittman has shown a keen interest in ensuring that the nation's retail food safety system remains safe, well stocked, and provides a wide variety of foods to consumers in the U.S. NEHA looks forward to working with Representative Wittman on future public health and food safety efforts.

NEHA Starts Work to Update the Certified in Comprehensive Food Safety Credential

By Eileen Neison (eneison@neha.org)

The subject matter experts working on the job task analysis for the Certified in Comprehensive Food Safety credential take a moment away from all the hard work to capture a group photo. Photo courtesy of Eileen Neison.

NEHA has begun the process to update and overhaul its Certified in Comprehensive Food Safety (CCFS) credential. The CCFS credential is NEHA's food safety manufacturing credential. The CCFS credential is a mark of distinction for more seasoned food safety professionals who aim to demonstrate expertise in the manufacturing and processing areas, whether in a regulatory or oversight role or in a food safety management or compliance position within the private sector. A CCFS credential holder is prepared to manage and evaluate food safety plans in food manufacturing and processing facilities to assure a safe food supply. They are accomplished in understanding and implementing preventative controls, conducting risk assessments, observing and training staff, assessing the physical facility, and assuring corrective measures are applied to control hazards and prevent foodborne illness.

In mid-April 2022, 12 subject matter experts from around the country flew to the NEHA office in Denver to attend and assist with the job task analysis of the CCFS credential. A job task analysis is the process of studying a job to determine its activities and responsibilities, qualifications necessary for performance of the job, and conditions under which the work is performed. NEHA is doing a complete overhaul of the CCFS credential and this first step will help us develop a blueprint of basic competencies for someone working in or evaluating food manufacturing. This knowledge will then be used to inform the updates needed for the current CCFS credential exam.

Thank you to our amazing volunteers:

- William "Bill" Barriger, Safety Solutions Group, LLC
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- Rashelly Bland, Virginia Department of Agriculture and Consumer Services
- Robert Buckley, Coca-Cola
- Anne Cooper, Eagle
- Martin Guy Ethy, Sodexo
- Jasmine Hagan, First Watch Restaurants
- Taryn Horr (Polera), Exponent
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- Edward Suttmiller, Stahmann's Pecans
- Terrin Thomas, Coca-Cola

To learn more about the CCFS credential, please visit www.neha.org/ccfs.

NEHA Staff Profiles

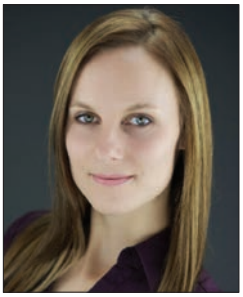
As part of tradition, NEHA features new staff members in the *Journal* around the time of their 1-year anniversary. These profiles give you an opportunity to get to know the NEHA staff better and to learn more about the great programs and activities going on in your association. This month we are pleased to introduce you to three NEHA staff members. Contact information for all NEHA staff can be found on pages 48 and 49.

Dillon Loaiza

I obtained a degree in economics in 2016 from Colorado State University, which lead me to a few different accounting positions and a labor and employment job before coming to NEHA in August 2021 as an accounts payable specialist. My specialization was in international development but over the last few years, I have become very invested in the effects climate change is having on our environment and how to avoid the worst of it.

NEHA's work in environmental health was very appealing to me and I knew that I could help make a difference by joining the team. Now I help manage our financial relationships with vendors and try to keep the flow of funds going as efficiently as possible for NEHA and our many partners.

I also volunteer with climate action groups, such as the Sierra Club's Beyond Coal Campaign and Citizens Climate Lobby, to help us transition to a carbon neutral future. I love being outdoors, especially when I am rock climbing or snowboarding. When not outside or volunteering, I spend most of my free time researching alternative energies and energy storage technologies such as iron air batteries. I also enjoy reading lots of science fiction and fantasy. I am currently working through *The Hitchhiker's Guide to the Galaxy* and hope that by working with NEHA, I can help prevent any world ending events like we see in the book.



Amber Potts

I became a NEHA member in 2011 when I started my environmental health career. After graduating with a bachelor's degree in chemistry from The University of Texas at Dallas, I was hired by the Garland Health Department as an environmental health specialist. I received my Registered Environmental Health Specialist/Registered Sanitarian (REHS/RS) and Certified Professional–Food Safety (CP-FS) credentials from NEHA the following year! Along with doing health inspections, I helped run a mobile laboratory where my team responded to emergency situations of unknown chemical substances. I worked there until 2013 when I temporarily moved to Dubai, United Arab Emirates. On my return to the U.S. in 2014, I went back to work for the Garland Health Department.

In 2019 I became the environmental health supervisor for the Environmental Health & Sustainability Department in Plano, Texas. I assisted a team of eight to navigate through COVID-19 obstacles, provided forward momentum in the department's work on the Food and Drug Administration's Voluntary National Retail Food Regulatory Program Standards, and helped host the first Food Safety Summit in Plano. While I thoroughly enjoyed my career at Plano, I was recruited by NEHA in August 2021, where I am a senior project coordinator in food safety.

This position within NEHA has afforded me the opportunity to serve on several committees, including cochair of the Promote Development Team for the Council to Improve Foodborne Outbreak Response (CIFOR) and a voting member for the Conference for Food Protection's (CFP) Allergen Committee. I also get to work on projects such as Epi-Ready, the National Environmental Health Assessment Reporting System (NEARS), and Integrated Foodborne Outbreak Response and Management (InFORM) Conference. I have recently been accepted into the School of Law at Texas A&M University to pursue a master of jurisprudence in energy and environmental law. I will begin in fall 2022.

I have been trained by the U.S. Department of Homeland Security's Center for Domestic Preparedness and my favorite training was the CBRNE (i.e., chemical, biological, radiological, nuclear, and explosive) training at Dugway Proving Ground in Utah. I have conducted thousands of food safety inspections, hundreds of swimming pool inspections, dozens of day care inspections, and a few foster home inspections. I have sprayed miles and miles of roads in the middle of night for vector control, abated numerous stagnant swimming pools, and served as an expert witness in food safety litigations.

I thank Richard Briley, Rachel Patterson, and my friend, the late Jim Dingman, for their support and guidance throughout my career. My love and passion for all things environmental health runs deep.

Alyssa Wooden

I joined NEHA in July 2021 as a project coordinator in Program and Partnership Development. My responsibilities involve managing projects ranging from implementing Health in All Policies programs at state and local health departments to developing an environmental health land reuse training course to improving the use of environmental health data in the U.S. Virgin Islands.

I am passionate about promoting public health at a community level and advocating for environmental justice and health equity, and my role at NEHA has allowed me to fulfill those passions. Over the past year, I have loved working with public health professionals across the country and helping to provide solutions to some of the most pressing environmental health challenges they face.

Prior to starting at NEHA, I received my bachelor's degree in public health from Johns Hopkins University and a master's in environmental health from the Johns Hopkins Bloomberg School of Public Health. I am originally from the Boston area but have lived in Baltimore, Maryland, for the past 6 years. I love exploring my city's diverse neighborhoods, restaurants, shops, and parks. In my free time you can find me running, cycling, trying new recipes, watching horror movies, or writing short stories. Reach out if you are interested in learning more about NEHA's Health in All Policies work.

Did You Know?

Interested in learning more about our staff? Visit the NEHA Employee Anniversaries page that shares these important milestones of our staff. We have also posted the staff profiles for each staff member listed. Check it out at www.neha.org/about-neha/work-neha/employee-anniversaries.

NEHA **NEWS**

Find Your Community With the Private Water Network

The Private Water Network (PWN) is a free, virtual community of practice for anyone working to protect communities from contaminants in private drinking water sources. Through a virtual, easy-to-use platform, PWN provides a place to exchange ideas and solutions with professionals working on similar issues and facing similar barriers. The goal is to build a sustainable community for those working to support private water programs to connect with their peers and share experiences, insights, and resources to ultimately build capacity to protect private water quality.

The virtual community platform includes a discussion forum, comprehensive resource library, educational events and webinars on private water issues, newsletters focused on private water issues, and member directory with a community-wide search option. We hope to expand membership to include individuals from every state and territory in the country. We are particularly interested in new members working at state, tribal, local, and territorial governmental public health agencies, federal agencies, national associations, certified laboratories, and academic and extension partners.

Membership to PWN is free. While NEHA membership is not required to be a PWN member, a MyNEHA account (https://neha.users.membersuite.com/auth/portal-login) is needed to log in. Learn more and join PWN by visiting https://pwn.neha.org.

NEHA History Project Update

By Kristen Ruby-Cisneros (kruby@neha.org)

Back in 2020, NEHA President Dr. Priscilla Oliver (2019–2020) appointed the NEHA History Project Task Force to study and review the rich history of NEHA and the environmental health field. The NEHA History Project Task Force was charged with making the important history of NEHA and environmental health available to all NEHA members, as well as other practitioners, students, and the general public. The task force, made up of luminaries from across the environmental health field, has convened since March 2020 to assess the history we have recorded, gather data and historical documents, collect historical artifacts, and review records. We wanted to highlight the work completed by the task force and the endeavors currently underway.

Spotlight on Several Items From the NEHA Virtual Museum

The NEHA History Project Task Force has put together a virtual museum of artifacts, instrumentation and tools, publications, and miscellaneous items from NEHA's and environmental health's past. Thanks to Dr. Robert Powitz, who has provided photos and descriptions from his personal collection, almost 50 different items are now displayed in the NEHA Virtual Museum at www.neha.org/virtual-museum. The following are just a few of the items on display.

Don't Spit on the Sidewalk Brick

Dr. Samuel J. Crumbine (1862–1954) of Dodge City, Kansas, was one of the leading figures in the field of public health in the early 20th century. Beginning in 1904, he served as secretary of the Kansas State Board of Health for 20 years. Dr. Crumbine was concerned about the spread of tuberculosis and other diseases and campaigned for their prevention. He became particularly concerned after observing tuberculosis patients spitting on the floor of a train. As part of his public health campaign, he convinced brick manufacturers to imprint the slogan, "Don't Spit on the Sidewalk," on their products.

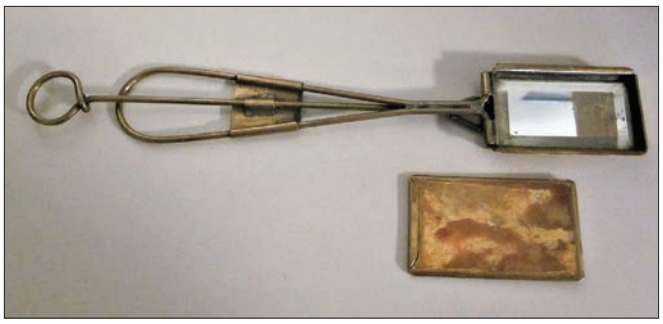
Dr. Crumbine's public health crusade argued for pure food and drugs, the elimination of houseflies and rats, water and sewage sanitary control, and the prevention of tuberculosis. He succeeded in abolishing the common drinking cup, the common or "roller" towel, and spitting in public places. He promoted these campaigns with simple and easy to remember slogans, such as "Bat the Rat," "Swat the Fly," and "Save the Baby."

The Samuel J. Crumbine Consumer Protection Award was established in 1955 in his memory and is awarded each year to local environmental health jurisdictions that demonstrate unsurpassed achievement in providing outstanding food protection services to their communities.

Food Inspection Set

The Food Inspection Set, Veterinary was issued to members of the U.S. Army Veterinary Corps who were charged with ensuring food safety. The set contained the essential tools to examine packaged foods upon delivery such as a hammer and pry bar, tin snips, awl, two bimetal thermometers, and a pocket ruler. The tools in the set allowed the veterinarian in charge of food safety to inspect food for freshness, temperature, quality, and sanitation before accepting food deliveries. This set dates from the Vietnam War era.

Inspection Mirror



The mirror is an absolute essential in the inspection toolkit. Before the development of the ball hinge, lever hinge mirrors were the available inspection tool. It is a two-handed device where the mirror is articulated using the looped lever-type hinge mounted on the back of the beveled mirror. This meticulously crafted inspection mirror is made of brass (manufacturer unknown) and has a brass sliding cover to protect the mirror. It is probably from the post-World War I era and was salvaged from equipment discarded by the Detroit Health Department.

Chicago Inspection Badges

Chicago, Illinois, had some of the most ornate inspector badges of any large city. The Chicago Health Department was overseen by a board of health and created several first-of-their-kind ordinances in the U.S., including the mandating of milk pasteurization in 1909. The unsanitary conditions of the stockyards and meatpacking plants in Chicago prompted Upton Sinclair to write his exposé, *The Jungle*, which resulted in the 1906 Meat Inspection and Pure Food and Drug Acts.

The gold badge with the Swiss cross (top left) is from 1900. The badge with the stylized Celtic cross (top right) is from the 1940s. The star badge (bottom middle) is from 1920.

NEHA AEC History

The NEHA Annual Educational Conference (AEC) & Exhibition is the premier environmental health conference that brings together professionals from around the globe to learn and discuss current and emerging environmental health topics and issues. Each AEC highlights how local agencies, industries, and levels of government work to ensure the safety of the public and environment, and how they contribute to the advancement of the profession.

The first NEHA AEC was held on June 25, 1937, in Long Beach, California. Since that time, NEHA has held over eight decades of AECs in 30 different states, Canada, and Washington, DC. The most AECs have been held in California (14), followed by Colorado (5), Florida (5), Nevada (5), Ohio (4), and Texas (4).

The NEHA History Project Task Force has created a listing of past AECs by decade at www.neha.org/past-aecs. Links to past AEC summaries published in *The Sanitarian* or *Journal of Environmental Health* have also been included. These summaries provide a rich history of the evolution of the AEC, relevant topics within the profession and association, award winners and notables, and images from our past.

Other Projects Underway

The NEHA History Project Task Force is currently working on posting the stories of several "giants" in the environmental health field, including Larry Gordon, Walter S. Mangold, Jerrold M. Michael, P. Walton Purdom, Walter F. Snyder, John G. Todd, and Henry Vaughn. These stories were researched and written by Dr. Herman Koren. As part of his research, Dr. Koren connected with family and friends of these individuals to learn more about their lives and to request review of each story to ensure their accuracy.

The task force also presented at the NEHA 2022 AEC & Exhibition in Spokane, Washington, on June 29. The panel presentation, "Your Profession's History: Updates From Environmental Health Mentors," was moderated by Dr. Leon Vinci, chair of the task force, and featured several task force members who shared milestones, stories, and other key developments of the environmental health profession.

The task force is also working on:

- A history of the NEHA affiliates to share their rich stories and impact at the state and local levels.
- A thorough history of NEHA and the environmental health profession from its origins to the present.
- Biography webpages for the past presidents of NEHA to document their achievements and success in making NEHA what it is today, as well as to honor their service and dedication to NEHA and the environmental health profession.

Please visit the NEHA History Project webpage at www.neha.org/neha-history-project for all the resources and information currently posted. You can also find a listing of task force members and how to get involved in this endeavor. Thank you to the task force members for their continued contributions to discover, record, and preserve our history!

See you next year in jazzy New Orleans!

SAVE THE DATE

2023 Annual Educational Conference (AEC)
& Exhibition
July 31–August 3
New Orleans, Louisiana

NATIONAL ENVIRONMENTAL HEALTH ASSOCIATION

NEHA.ORG/AEC

DirecTalk
continued from page 58

health enterprise should drink deeply from that chalice of wisdom.

About the time you are reading this column, we will have or will soon release our new mission, vision, and values statements. We will showcase our new logo—the first new one in over 40 years—at our Annual Educational Conference & Exhibition in Spokane, Washington. These developments, in aggregate, are manifestations of our continued organizational growth and maturity. They reflect the best thinking of our staff and representatives of the association—your elected board of directors. We embark on the next step of our journey with one dose of excitement, one half dose of fear, and three doses of adrenaline. A powerful concoction of emotion and hormones. We hope you can feel this energy and ambition from your hometown.

In a few months we plan to release training and templates that you can use to promote the environmental health profession at the local level. This project is intended to provide the tools and resources you need to speak effectively on behalf of our profession and community health. We are threading this effort with our national initiatives to speak with one voice in Washington, DC; Atlanta; and your local agency or company. This is our moment.

A sample of environmental health faces in Iowa. Photo courtesy of David Dyjack.

The experiences and developments I describe within this column give me pause. I reflect on their meaning and the messages they send me about the state of our profession. While I desire NEHA to be part of the next great thing, there is ample greatness already at our fingertips. We, as a profession, have the commitment, courage, and character of Summer Beard. We have the local relationships to confront and dispatch misinformation and disinformation at their source. Our partners desire to share their insight and collaborate to advance our common health.

One of our primary purposes as an association is to give the environmental health profession a voice and a face. To honor those who do so much and often receive so little in return. Our job is to remind the world that our profession is populated with noble, committed professionals like Beard, and like you.

Life is fragile. Let us value and support each other while we value and support those who comprise the environmental health profession.

Dave

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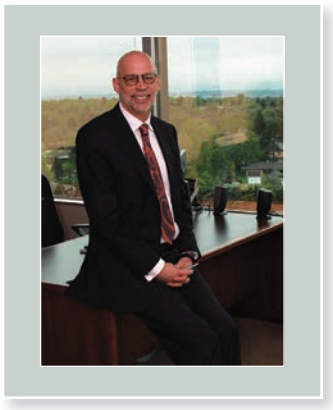
Did You Know?

You can stay in the loop every day with NEHA's social media. Find NEHA on

- Facebook: www.facebook.com/NEHA.org
- Twitter: https://twitter.com/nehaorg
- LinkedIn: www.linkedin.com/company/national-environmental-health-association

DirecTalk



David Dyjack, DrPH, CIH

Summer in Iowa

On Friday, April 29, 2022, a public health environmentalist with the Alabama Department of Public Health died in a tragic incident that occurred while performing the basic duties of her job. Jacqueline (Summer) Beard, an environmental supervisor with the department for 17 years, was conducting a basic public health follow up of a substantial dog bite situation that had occurred the previous day. Beard reportedly went alone for the visit, seemingly had no response from anyone at the residence, and was attempting to leave a public health notice when she was attacked and killed by a pack of dogs. By all accounts, these animals were the same dogs that had serious injured another individual the previous day.

Summer Beard personifies the spirit of our members and profession. People in our professional network are often abstract to us. We hear the names, read the email messages, and might encounter them at a virtual or in-person event. They are the personalities behind the figures—6,700 NEHA members. That is 6,700 stories. That is 6,700 struggles. That is 6,700 individuals who work tirelessly to protect the health, safety, and economic prosperity of their communities. And in some cases, like Beard, people who literally give their lives to make a difference.

Making a difference is the central driving force of our organization. Our members are for the most part modestly compensated, largely invisible, public servants. They are part of complex political or corporate systems that discourage them from claiming credit for a job well done, speaking up, or speaking out. I feel that is where our association should step in and step up.

We hope you can feel this energy and ambition from your hometown.

You rely on us to do that for you. You rely on us for training, capacity building, and validation. It has been my experience that you rely on us for a safe harbor to share your fears, celebrate your successes, and express your insights. We desire to be that place for you.

I shared my profound grief about Beard during a presentation I delivered in Ames, Iowa, at the joint American Public Health Association–National Environmental Health Association (NEHA) affiliate conference in early May. While you have been relentlessly pummeled with my impressions over the localness and emotional attributes of environmental public health during my time at NEHA, it was rewarding to hear those sentiments being echoed by professionals anchored in data science. For example, Dr. Katelyn Jetelina, an epidemiologist from Texas, spoke to the issues of misinformation and disinformation related to the pandemic. Dr. Jetelina has approximately 50,000 Twitter followers and a newsletter (Your Local Epidemiologist) that is read by millions worldwide.

I was impressed by Dr. Jetelina's observations and at the same time, was unsurprised by her disclosures. A handful of families control most social media in the U.S., and thus have a disproportionate strangle hold on the news and information most people consume. She encouraged the audience to play an active role in combating disinformation and misinformation, and to recognize the complex dimensions to our profession. People have an emotional relationship with data. She also made patently clear that our journey in explaining data starts with family and friends. How much more local does an issue get?

This idea of localness also strikes a chord with me in my role as a member on a federal advisory committee. I am appointed to the U.S. Environmental Protection Agency (U.S. EPA) Federal Advisory Committee on North America Environmental Cooperation, a national advisory group that convenes to provide input and guidance to U.S. EPA Administrator Michael Regan. In that capacity, my respect and appreciation of Native American people has trebled. The concept of traditional ecological knowledge, that is, the value represented by the hyper-local insight and understanding of the environment by Native Americans is proving valuable in our challenges with addressing climate change and extreme natural calamities. Their recommendations reflect ages of observation and understanding of resource management, coupled with a deeply held reverence for the world around us. Those of us in the public

continued on page 57

Get Funding for Your *Food Safety Program*

"The training grants have been vital to our food inspection program, as we have seen 100% turnover in our inspection staff over the past 9 years. All but one of our new inspectors have started as trainees, and all have benefitted greatly from these grants."
-Year 1 grantee

The **NEHA-FDA Retail Flexible Funding Model Grant Program** is kicking off its second year in August 2022, offering multiple 1-year grants including Development base funding as well as Mentorship, Special Projects, and Training grants. NEHA, in partnership with FDA, offers a people-centered grant management process with an emphasis on simplicity and accessibility as well as the opportunity to experience professional growth and recognition while joining an elite group of retail food safety specialists.
Application period is August 17-October 12.

NEHA-FDA RFFM Grant Program Support Team
retailgrants@neha.org
1-833-575-2404 (toll-free)

Visit our Retail Grants webpage for the latest information, resources, and training.

www.neha.org/retailgrants

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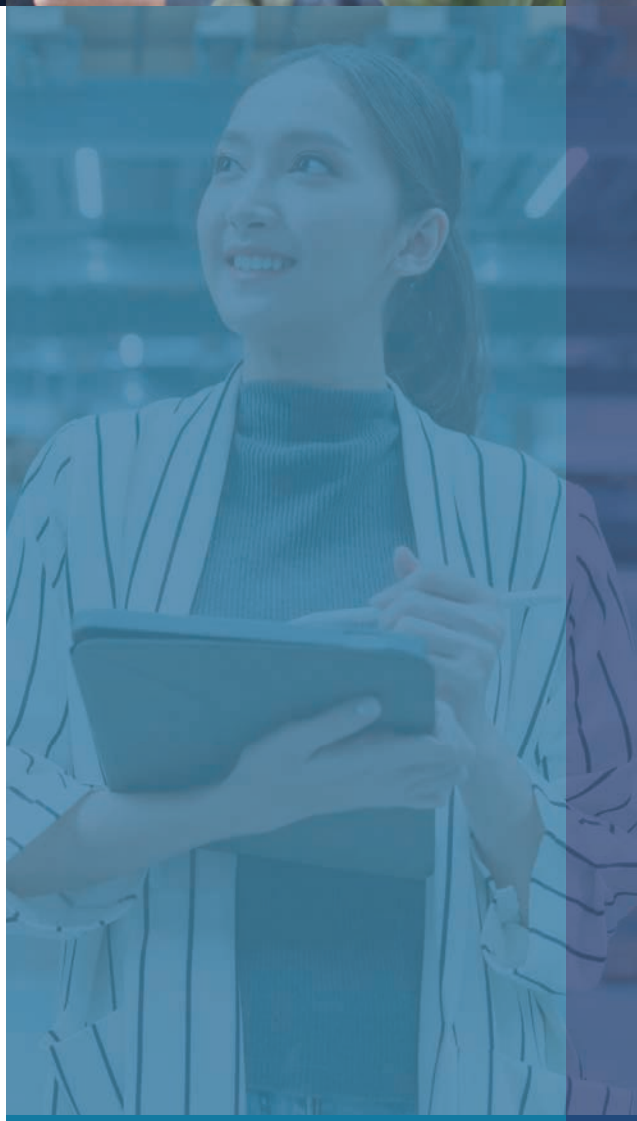

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