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ABOUT THE COVER

For the September issue, we have featured "Implications of Hurricane Harvey on Environmental Public Health in Harris County, Texas" on the cover in recognition of National Preparedness Month (www.ready.gov/September). On August 25, 2017, Hurricane Harvey made landfall near Rockport, Texas, as a Category 4 major hurricane. Over the next week, Harvey carved a path of destruction and flooding across Texas. This month's cover article looks at the natural disaster through an environmental health lens. It provides an overview of the historic flooding event, identifies vulnerable populations, highlights the potential environmental public health risks associated with the storm, and provides recommendations for future actions.

See page 24.

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PRESIDENT'S MESSAGE

Vince Radke, MPH, RS,
CP-FS, DLAAS, CPH

Food Safety: Partnering Is Required

September is Food Safety Month. Given that many of our members work in the area of food safety, I thought I would devote this month's column to the importance of food safety in our daily lives and communities.

Occasional we hear that our food in the U.S. is the safest in the world. Is our food the safest in the world? Maybe, maybe not. There are many unknowns in trying to answer that question. As someone who has worked on food safety issues for decades, I am not sure our food is the safest in the world. I do know, however, that it could be safer.

The Centers for Disease Control and Prevention (CDC) estimates every year in the U.S that approximately 48 million people come down with a foodborne illness, 128,000 are hospitalized, and 3,000 die. The U. S. Department of Agriculture's Economic Research Service puts the estimated cost of foodborne illness at $15.6 billion annually. These numbers taken together are a tremendous burden to our nation and the communities where we live and work. Therefore, what are you—or better yet, what are we—doing about it?

Back in 2006, I wrote a column in this journal about the importance of partnership in reducing the burden of foodborne illness in the U.S. and our communities (www.cdc.gov/nceh/ehs/docs/jeh/2006/sept_2006_radke.pdf). As members of the food production/manufacturing/service industry, as members of a regulatory agency, as members of an academic/science institute, and as members of consumer groups involved in food safety, we must gather our resources and collective wit to reduce foodborne illness. The folks in our communities expect nothing less.

> *We must gather our resources and collective wit to reduce foodborne illness.*

We have made progress in some areas of food safety. Illness cause by Shiga toxin-producing *E. coli* O157:H7 have decreased over the past 10 years. Illness caused by certain serotypes of *Salmonella* have been reduced through the efforts of regulatory and industry working together to make food safer.

The Food and Drug Administration's *Food Code* (the 9th edition was just released) has language that states all restaurants must have a certified food protection manager (CFPM). A study conducted by CDC's Environmental Health Specialist Network (EHS-Net) found that restaurants with a CFPM had less foodborne disease outbreaks than restaurants without a CFPM. Another EHS-Net study showed that restaurants with a CFPM had less major violations than restaurants without a CFPM.

The National Environmental Health Association, along with a number of organizations including the Conference for Food Protection, National Association of County and City Health Officials, Association of Food and Drug Officials, National Restaurant Association, International Association of Food Protection, and many others, is working with federal, state, local, and territorial food safety professionals to reduce the burden of foodborne illness.

From an environmental health perspective, we need to understand the underlining causes of foodborne illness. From our laboratory and epidemiology colleagues we can potentially discover the pathogen or chemical that made people sick. As an environmental health specialist or sanitarian, we ask questions to determine the underlining causes: How did the pathogen or chemical get in the food? Who handled the food? When was the food eaten? Why did the food safety system fail to prevent the foodborne illness?

Today, we have some new and powerful tools to help us understand why foodborne illness occurs. Once we understand the why, we can reduce and prevent foodborne illness. One of the new tools is whole genome sequencing. This laboratory tool can determine the complete DNA sequence of a pathogen in a relatively short period of time. In order to take advantage of this new tool, food and environmental samples should be collected when foodborne illness is identified, particularly during foodborne outbreak investigations.

Another tool that environmental health specialist or sanitarians can use is the National Environmental Assessment Reporting System (NEARS). NEARS was developed at CDC to aid environmental health professionals at state and local health departments during foodborne illness outbreak investigations. Combined, these tools can help determine why foodborne illness occurs. Once we understand the why, all partners can use this knowledge to reduce and prevent foodborne illness.

From my years of working on food safety issues and foodborne illness outbreak investigations, I've seen the importance of understanding how food worker behavior, farm and kitchen structure and operation, and food safety management can contribute to decreasing the risk of foodborne illness. It is not an easy task. Industry deals with the issues of high turnover rates, communication barriers, cultural differences, nonuniform regulations, increased imports, and many others. Consumers have the challenges of cooking temperatures, storage and handling of foodstuffs, and properly cleaning hands and work surfaces. Regulators have concerns about adequate training, enough staff to handle all the food safety activities, and inadequate surveillance and data.

Unless we, as partners, pull together in our communities and throughout the U.S., we will not achieve the food safety goal of Healthy People 2020 to reduce foodborne illness in the U.S. by improving food safety related behaviors and practices (www.healthypeople.gov/2020/topics-objectives/topic/food-safety). In a documentary about antibiotic resistance, *Resistance: Not All Germs Are Created Equal*, a scientist makes the following statement, "It is their genes against our wit." To paraphrase that statement, it is our partnership against foodborne illness.

All the best,

Vince

President@neha.org

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The NEHA Endowment Foundation was established to enable NEHA to do more for the environmental health profession than its annual budget might allow. Special projects and programs supported by the foundation will be carried out for the sole purpose of advancing the profession and its practitioners.

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Atlanta, GA

Measuring the Impact of Lead Hazard Control and Healthy Homes Programs: Evaluating Hazard Reduction Using the Healthy Home Rating System

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Abstract **The U.S. Department of Housing and Urban Development's Office of Lead Hazard Control and Healthy Homes (OLHCHH) use the Healthy Home Rating System (HHRS), a tool developed to quantitatively assess the reduction of health-related housing hazards during the implementation of OLHCHH programs. This study evaluated the reduction of home-based hazards in 62 homes after remediation work was completed. The most common hazards identified in all homes were lead-based paint and domestic hygiene, pests, and refuse. The program was successful in reducing a variety of hazards, resulting in 100% reduction of lead-based paint hazards, 69% of water supply issues, 68% of concerns related to entry by intruders, and 60% reduction in hazards related to flames and hot surfaces. Still, other issues in the home could not be addressed due to cost and limitations in funding. While there is utility in using the HHRS, we need to consider changes to improve upon ways in which data are collected and impact is measured.**

Introduction

Numerous studies support a direct link between substandard housing and its direct impact on health and safety, which includes injuries within the home (Folger et al., 2017; Zaloshnja, Miller, Lawrence, & Romano, 2005), asthma (Hughes, Matsui, Tschudy, Pollack, & Keet, 2017), respiratory infections (Howden-Chapman et al., 2007; Wang, Engvall, Smedje, Nilsson, & Norbäck, 2017), mental health issues (Rollings, Wells, Evans, Bednarz, & Yang, 2017), and lead poisonings (Centers for Disease Control and Prevention, 2012), for which the public health system bears a substantial financial cost. In 2011 it was estimated that childhood asthma alone cost the U.S. $56 billion annually (Nunes, Pereira, & Morais-Almeida, 2017).

Effective housing interventions can mitigate the physical and financial outcomes associated with poor housing. Gould (2009) estimated the benefit of all U.S. lead-based paint hazard control efforts in a cohort of 27.97 million children ≤6 years of age in 2006 to be $200 billion–$325 billion. The study found that every dollar invested in lead paint hazard control results in a return of $17–$221.

In 1999, in response to a congressional directive over concerns about children's environmental health, the U.S. Department of Housing and Urban Development (HUD) launched the Healthy Homes Initiative to protect children and their families from housing-related health and safety hazards (HUD, n.d.). As a result of the Healthy Homes Initiative, HUD offered grants from the Office of Lead Hazard Control and Healthy Homes (OLHCHH) to facilitate the identification and correction of housing deficiencies in vulnerable communities.

The City of Henderson, a suburban area of metropolitan Las Vegas, was awarded an OLHCHH grant in 2013 with the University of Nevada, Las Vegas Department of Environmental and Occupational Health as a subgrantee. As a HUD grantee, the Healthy Home Rating System (HHRS) was used to assess hazards in the qualifying target-area housing and prioritize HUD-funded home remediation. The HHRS was adopted from a United Kingdom (UK) tool used to quantify the health impact of poor housing to inform policy and housing improvements (Roys, Davidson, Nicol, Ormandy, & Ambrose, 2010). This new approach identifies the presence of hazards in the home and the risk associated with each hazard (Stewart, 2002).

The purpose of this article is to assess the impact of OLHCHH efforts in a low-income population in Henderson, Nevada, by evaluating the reduction in hazards postremediation. Recommended improvements to the HHRS and challenges of implementing the HHRS will be discussed.

Methods

Data for the Henderson Lead Hazard Control and Healthy Homes Program were collected August 2013–April 2016 on homes in Hen-

TABLE **1**

29 Hazard Categories of the Healthy Home Rating System

1	Damp and mold growth
2	Excess cold
3	Excess heat
4	Asbestos, silica, and other man-made mineral fibers
5	Biocides
6	Carbon monoxide and fuel combustion products
7	Lead
8	Radiation
9	Uncombusted fuel gas
10	Volatile organic compounds
11	Crowding and space
12	Entry by intruders
13	Lighting
14	Noise
15	Domestic hygiene, pests, and refuse
16	Food safety
17	Personal hygiene, sanitation, and drainage
18	Water supply
19	Falls associated with baths, etc.
20	Falling on level surfaces, etc.
21	Falling on stairs, etc.
22	Falling between levels
23	Electrical hazards
24	Fire
25	Flames, hot surfaces, etc.
26	Collision and entrapment
27	Explosions
28	Position and operability of amenities, etc.
29	Structural collapse and falling elements

derson, Nevada. To qualify for the program, participants met housing and occupancy requirements. Homes had to be built before 1978, have at least one bedroom, be a permanent structure, and be located within city limits. Occupants also had to meet HUD's income guidelines, and owner-occupied dwellings had to have either a child <6 years of age living in the home or visiting (at least 6 hr/week) or be the permanent residence of an expectant mother.

If both housing and occupancy requirements were met, homes had to contain a lead-based paint hazard (lead concentration ≥1.0 mg/cm^2 and be in chipping, flaking, or peeling condition) to receive remediation work. Identification of a lead-paint hazard prompted a healthy homes visual assessment. It is important to note that there is no standard visual assessment tool to conduct OLHCHH housing assessments; therefore, each HUD awardee develops their own tool.

A certified healthy homes specialist (HHS) performed all visual assessments. The visual assessment evaluates 29 hazard categories identified in the HHRS (see Table 1 for a complete list of hazards), of which 6 were excluded from analyses because they were not adequately assessed during the healthy homes inspections. The excluded hazards were asbestos, biocides, radiation, uncombusted fuel gas, noise, and explosions.

Each of the 23 hazards retained for analysis were assessed throughout the dwelling's interior and exterior. The number of hazards was determined by 1) the dichotomous presence or absence of the 23 individual HHRS hazards identified in a home and 2) the total number of instances of each hazard identified throughout a home. Further, additional hazards identified during the construction process, which were not marked during the initial assessment, were later added to the visual assessment for that dwelling.

Hazards identified during the visual assessment were inputted into an HHRS scoring tool. The scoring tool computes a Hazard Score and Hazard Band for each of the 29 hazards. National averages for the likelihood and the spread of harm are based on data obtained from the UK. For instance, UK data were used to determine the likelihood of a certain condition in the home based on what you might expect to find considering the age of the home and type (HUD, 2014). The HHRS allows inspectors to make judgments on three factors: 1) the perceived likelihood that the identified hazard will cause harm requiring medical care within the next 12 months in vulnerable age groups, 2) the consistency of the likelihood of harm with the national average, and 3) the severity of possible health outcomes.

Once the inspector made these decisions, the Hazard Score was derived by multiplying the weighted class of harms by the likelihood of occurrence and the spread of harm (Figure 1). The higher the Hazard Score, the more likely and serious the outcome. The Hazard Band is based on the inspector's judgment, however, less emphasis is put on the numerical score, and more emphasis on the Hazard Bands that are derived (A–J), with J being the least dangerous and A being the most dangerous (HUD, 2014).

The Hazard Bands were used to prioritize hazards in need of remediation. After lead and healthy homes rehabilitation work were completed, the City of Henderson program manager performed a postconstruction walk-through of each property to ensure work was completed as described in the scope of work. Finally, to obtain a postremediation assessment of hazard reduction, the scope of work and invoices were evaluated to determine which hazards were fixed. For analysis purposes, all hazards identified were summed for a total preremediation and postremediation hazard count, from which the percent reduction was calculated.

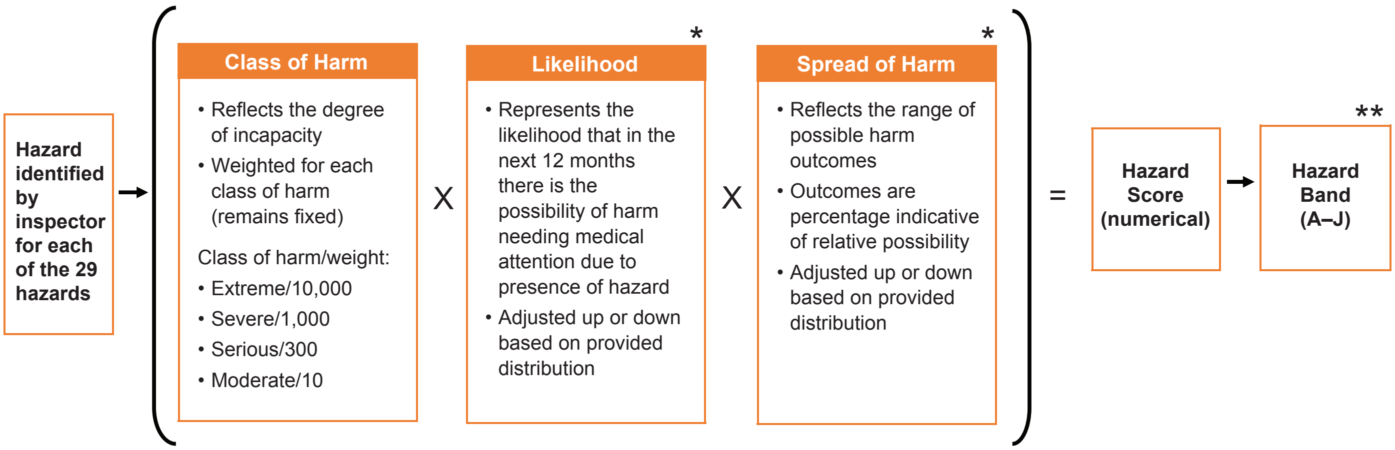
Results

A total of 106 homes contained deteriorated lead-based paint, of which 62 (58%) received both lead and healthy homes rehabilitation work. The most frequently identified hazards found in homes were lead and domestic hygiene, pests, and refuse—these were found in 62/62 (100%) of the homes. Other common hazards included dampness and mold growth, carbon monoxide, and combustion products in 60/62 (97%) of homes. Excess cold or excess heat was found in 58/62 (94%) of the homes. Additionally, fire hazards and danger of structural collapse/falling elements were assessed in 56/62 (90%) of the homes (Table 2).

Table 2 also describes the total number of hazard instances, which could exceed 62 because each individual hazard within a home was counted (e.g., water leaks) in more than one room/location. Also, the percent reduction of hazards within the home is also shown (Table 2). Hazards most commonly remediated included lead-based paint hazards (100%) and water supply issues (69%). Fur-

FIGURE 1

Schematic of How the Hazard Band and Hazard Score Are Generated for Each Hazard



Source: U.S. Department of Housing and Urban Development, 2014.
*Likelihood and spread of harm are adjusted by the inspector to reflect overall likelihood of occurrence and severity of hazard compared with UK national averages.
**Used to prioritize repairs needed to prevent harm.

ther evaluation indicated a 68% reduction in concerns regarding entry into the home by intruders, a 60% reduction in hazards related to flames and hot surfaces, and a 44% reduction in each excess cold, excess heat, and electrical hazards. Although the category of domestic hygiene, pests, and refuse was one of the most frequently identified hazards, totaling 1,147 instances, only 7% of these hazards were fixed. Other identified hazards were not addressed, such as crowding and space, food safety, and collision and entrapment.

To illustrate the severity of hazards, a cumulative frequency distribution of hazards, sorted by Hazard Band, is shown in Figure 2. A total of 47 homes had concerns of excess cold with a Hazard Band of C, while an equal number of homes had issues of excess heat with a Hazard Band of G. Level surface issues (tripping hazards, uneven floors or thresholds) were found in 36 homes with a Hazard Band of F. Additionally, 27 homes had concerns with entry by intruders (broken/missing doors, windows, or locks), with a Hazard Band of F.

Discussion

The data collected during this study are the first to use the HHRS in the assessment and remediation of hazards in predominantly low-income housing in Southern Nevada. Our findings have many implications for local housing because they identify commonality of hazards among the housing stock and provide an indication of the severity of these hazards. Knowing the severity of these housing conditions can help local health departments and code enforcement personel establish policies that protect the health and welfare of individuals living in rental units. On a broader scale, OLHCHH programs have facilitated the reduction of lead hazards in pre-1978 housing and consequently have 1) reduced primary pathways by which children are exposed to lead and 2) provided the opportunity to address many other categories of hazards to varying degrees. To reduce the burden of unsafe housing, however, we must continue to devise ways to address hazards that can not be directly resolved through remediation work, particularly those that might be a result of resident behavior, and we must find ways to measure and quantify the impacts on health related to OLHCHH work.

The OLHCHH program fostered the ability to improve housing conditions that have a direct impact on health. One of the most prominent hazards identified in homes was related to the ability or inability to adequately cool or heat one's home, often as a result of inadequate doors, windows, or cooling and heating equipment. This prominent hazard is of particular importance in Southern Nevada, given that temperatures can exceed 100 °F for 5 months of the year. These extreme temperatures are associated with exacerbation of asthma symptoms (Krieger, 2010) and in Nevada have resulted in the highest number of annual deaths due to excess heat (National Weather Service, 2017). The inability to cool or heat a home places a significant burden on many vulnerable populations such as the old, poor, or individuals with pre-existing medical conditions who are at increased risk to experience negative health outcomes if they go unaddressed (Borrell et al., 2006; Bouchama et al., 2007; Sheridan, Kalkstein, & Kalkstein, 2009). In this study, less than 50% of hazards related to excess cold and heat were repaired and, as a consequence, a significant risk to vulnerable communities remains.

Another clear gap identified in the prioritization of hazards to remediate are those that result from resident behavior. Residents play an equally important role in the maintenance of the home. We found this to be particularly true when assessing conditions related to specific hazard categories such as domestic hygiene, pests, and refuse. In this study, 100% of homes had concerns in this category,

TABLE **2**

Number of Homes With Hazards and Percent Reduction of Each Hazard Identified During Initial Assessment and Postremediation

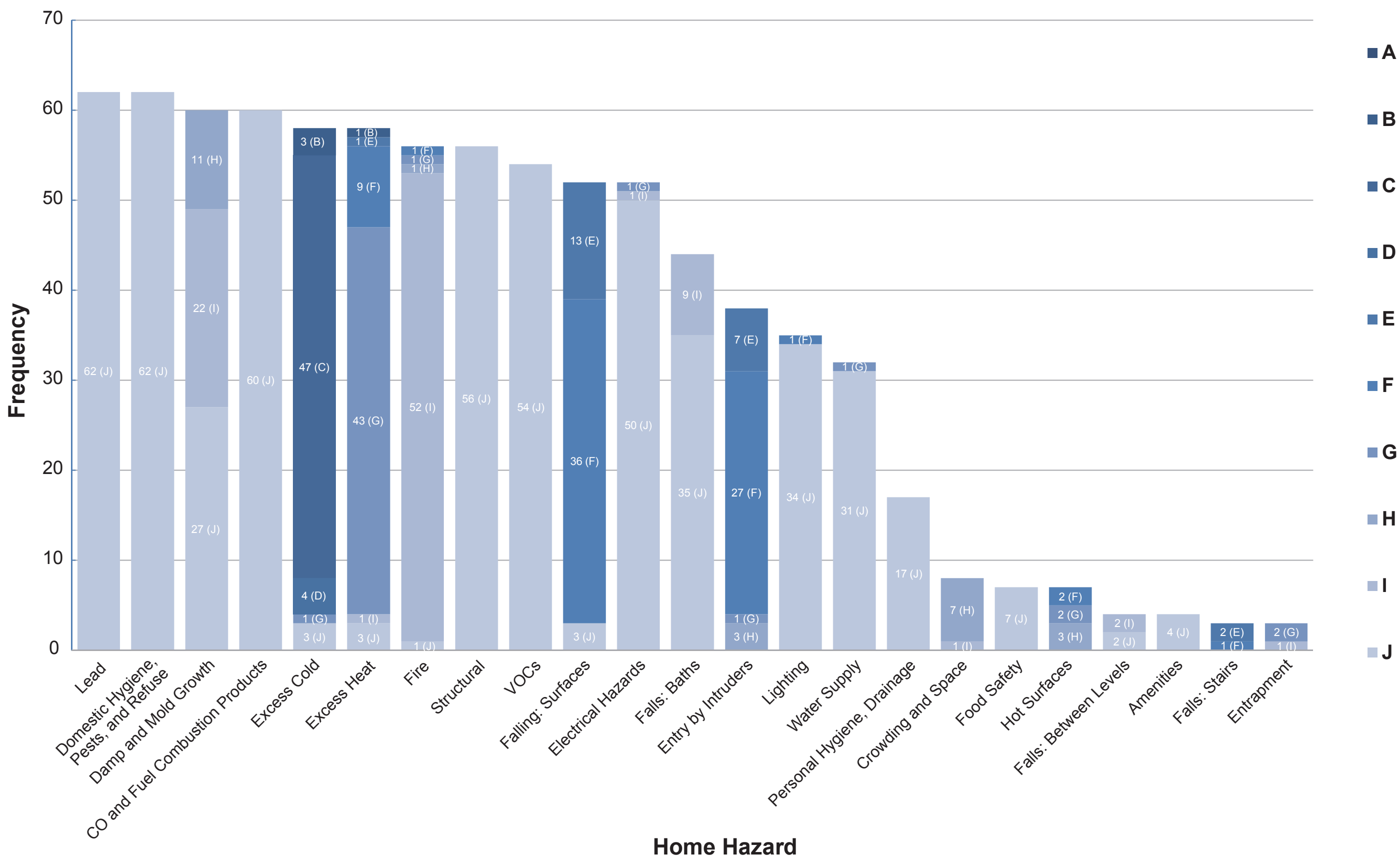
Hazard	Initial Assessment					Postremediation					Percent Reduction by Total Count
	Homes With Hazard Present		Range	Median Score	Total Count*	Homes With Hazard Present		Range	Median Score	Total Count*	
	#	%				#	%				
Lead**	62	100	1–17	5.0	351	0	0	0	0	0	100
Water supply	32	52	0–4	1.0	48	12	19	0–2	0	15	69
Entry by intruders	38	61	0–11	1.0	109	16	26	0–5	0	35	68
Flames, hot surfaces, etc.	7	11	0–4	0	10	4	6	0–1	0	4	60
Excess cold	58	94	0–18	3.0	248	44	71	0–13	1.0	139	44
Excess heat	58	94	0–18	3.0	248	44	71	0–13	1.0	139	44
Electrical hazards	52	84	0–12	2.0	155	31	50	0–9	0.5	87	44
Personal hygiene, sanitation, and drainage	16	26	0–3	0	26	12	19	0–2	0	17	35
Fire	56	90	0–15	4.0	282	44	71	0–15	2.5	206	27
Damp and mold growth	60	97	0–14	5.0	334	55	89	0–14	4.0	262	22
Lighting	35	56	0–18	1.0	121	32	52	0–15	1.0	95	21
Structural collapse and falling elements	56	90	0–14	3.0	261	52	84	0–14	2.0	206	21
Carbon monoxide and fuel combustion products	60	97	0–9	2.0	161	52	84	0–9	2.0	141	12
Falling on level surfaces, etc.	52	84	0–19	4.0	306	48	77	0–19	3.0	270	12
Falls associated with baths, etc.	44	71	0–5	2.0	94	40	65	0–5	1.0	87	7
Domestic hygiene, pests, and refuse	62	100	2–47	17.0	1,147	61	98	0–47	16.5	1,068	7
Volatile organic compounds	54	87	0–12	2.0	172	53	85	0–12	2.0	168	2
Crowding and space	8	13	0–12	0	29	8	13	0–12	0	29	0
Food safety	7	11	0–2	0	8	7	11	0–2	0	8	0
Falling on stairs, etc.	3	5	0–6	0	9	3	5	0–6	0	9	0
Falling between levels	4	6	0–1	0	4	4	6	0–1	0	4	0
Collision and entrapment	3	5	0–2	0	4	3	5	0–2	0	4	0
Position and operability of amenities, etc.	4	6	0–1	0	4	4	6	0–1	0	4	0

*Total count per hazard reflects each hazard counted uniquely within the home.
**All homes contained lead and all lead hazards were remediated/abated per grant requirements. Number of homes with hazards indicates the presence/absence of hazard found within the home (*N* = 62).

usually as a result of cleanliness or clutter issues, but we saw only a 7% reduction in the overall hazard. This finding suggests the need to integrate a systematic approach to address behavioral components within OLHCHH programs to maximize efforts to improve housing conditions and sustain better health. Intervention models based on theoretical frameworks (i.e., Health Belief Model and Transtheoretical Model) have been proved to be effective in improving and sustaining behavior changes (Glanz, Rimer,

FIGURE **1**

Cumulative Frequency Distribution of Hazards and Healthy Home Rating System Hazard Band Score Ranking in Housing, Clark County, Nevada (*N* = 62)



CO = carbon monoxide; VOCs = volatile organic compounds.
Note. Darker colors indicate more severe hazard band scores, indicating a higher risk of severity.

& Viswanath, 2008) and are worth employing to address resident behaviors.

Another area to expand upon is the connection between housing remediation and improvements in health. For instance, it is a common misconception that dry climates are devoid of mold problems. Specifically, 97% of homes evaluated had concerns regarding mold or mildew because of poor ventilation, which creates optimal conditions for growth. Dampness is associated with upper respiratory symptoms, coughing, wheezing, and asthma in sensitized persons. The presence of mold is associated with these symptoms and with the presence of hypersensitivity pneumonitis in susceptible persons (Institute of Medicine, 2000; Shaw, 2004; U.S Department of Health and Human Services, 2009).

It is estimated that 4.6 million out of 21.8 million people who reported having asthma were exposed to dampness and mold in their home (Mudarri & Fisk, 2007). OLHCHH programs are not required to evaluate health indicators such as asthma symptoms and severity; evaluating these data could further quantify the impact of remediation work among OLHCHH participants.

Moving Forward

Although the HHRS provided empirical evidence to enumerate and prioritize hazards, implementation of the HHRS presented challenges concerning operationally defining hazards on the visual assessment tool and evaluating the impact of remediation after work was completed. To overcome these challenges and to maximize the potential benefits of a nationwide data collection system, the authors recommend:

1) development of a standardized, valid, and reliable visual assessment tool;
2) a less subjective approach to adjusting likelihood and outcome calculations;
3) standardization of the Hazard Band score; and
4) development of a data collection, analysis, and evaluation plan.

The HHRS allows grantees the flexibility to use various assessment methods; however, a systematic approach is warranted to reduce the variability that can result from inspector judgments. We support recommendations by Keall and coauthors (2008) for the need of a systematic, reliable, and affordable housing assessment tool that demonstrates inter-rater reliability. The current methodology to identify what hazard in the home might result in the need for medical attention within the next 12 months can produce a great deal of variability between inspectors. A tool that affords inter-rater reliability would provide greater validity to the data collected and make regional comparisons more feasible.

Another area we found challenging was making adjustments to the likelihood and spread of harms based on whether we thought it was above or below the national average. Due to the subjectivity of these adjustments, staff rarely made adjustments to the likelihood and outcomes. Developing a method to adjust rankings based on the frequency (actual count) of all hazards found in a home would increase objectivity. For example, many instances of cockroaches throughout a home would present a reasonable basis for increasing the likelihood of negative health outcomes as opposed to seeing a single cockroach.

We also recommend that the Hazard Band, which currently rates a severe hazard as an A and a less severe hazard as J, should be more intuitive, where an A rating is good and a J rating would imply worse conditions. It is the responsibility of grantees to communicate with individuals and families who participate in the program what hazards were identified and how hazards were prioritized. The current convention does not make it easy to translate program documents into something understandable to the general population.

Additionally, although implementation of the HHRS is occurring nationwide, how these data are to be collected, aggregated, and evaluated for impact is as of yet unclear. The method in which data are collected is essential in analyzing the impact of the program. For instance, dichotomous variables indicating the presence or absence of a hazard by location in a home alone cannot be easily compared postremediation if the total number of specific hazards and locations is not first identified. Also, distinguishing hazards based on resident behaviors versus hazards that are directly tied to the dwelling is essential. If interventions do not include mechanisms to address housing conditions related to occupant behavior, overall hazards might be inflated and thereby diminish the impact of remediation work.

Moreover, to measure the impact of a program, a standard set of health indicators should be tracked throughout the project. This standardization would allow OLHCHH programs to quantify the impacts on health directly related to housing improvements. This type of information could inform funding and policy decisions to enhance housing equity in traditionally underserved populations (Corburn & Cohen, 2012).

Delimitations

A significant limitation of the study included the use of a tool that has not been validated to assess the HHRS hazards identified in a home. Inter-rater reliability "represents the extent to which the data collected in the study are a correct representation of the variables measured" (McHugh, 2012, p. 276). The inability to capture a deficiency in a home resulting in medical attention in the next 12 months could be overestimated or underestimated due to tool reliability. Furthermore, the current assessment tool considered hazards that result from resident behavior, generating larger counts of certain hazards (i.e., clutter, trip and fall hazards, improperly stored food). Subsequently, the reduction of hazards might appear less significant because remediation work is not necessarily behavior specific, and efforts to educate occupants were not quantified.

Conclusion

OLHCHH programs serve as a mechanism to provide equitable housing among disadvantaged populations. The OLHCHH program could be strengthened, however, by capturing data connecting program efforts with health outcomes and cost savings. Ultimately, the HHRS provided a good starting point to capture an unbiased report of housing conditions that exist in our local communities and the ability to influence housing priorities, policies, and funding.

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SPECIAL REPORT

Phosphorus Recovery From Surface Waters: Protecting Public Health and Closing the Nutrient Cycle

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Abstract **Phosphorus (P) pollution of surface waters contributes to hazardous algal blooms, posing a significant public health risk from contact with toxins released by the algae. Replenishing P depleted from agricultural soils poses additional public health risks from pollution associated with fertilizer production and the exhaustion of limited domestic P deposits. Environmental health professional responsibilities can impact sources of P pollution, such as onsite wastewater treatment systems, land use planning, watershed and drinking water protection, and stormwater control. The watershed planning process provides an opportunity for environmental health professionals to become involved in protecting public health by assuring the most cost-effective strategies for P control and recovery.**

This special report reviews the properties of P that provide both opportunities and challenges for P control and recovery, presents progress being made in P recovery from surface waters, and highlights the most promising technologies for the near future. These technologies have significant implications for public health, the environment, and the economy. Environmental health practitioners can play a role in developing and implementing these technologies and in educating the public about the benefits of P recovery.

The Public Health Consequences of Phosphorus Pollution

Phosphorus (P) is essential for plant and animal life. Most of earth's ecosystems, however, evolved under P-limited conditions (Schoumans et al., 2014; Scinto & Reddy, 2003). Even relatively small increases in P can significantly alter an ecosystem. To increase agricultural output for a growing human population, the world has relied increasingly on production of mineral-based P fertilizers. Of the P fertilizer applied to crops, it is estimated that approximately 50% is lost through surface runoff and soil erosion (Rittmann, Mayer, Westerhoff, & Edwards, 2011). Most of the P taken up by crops and consumed by livestock and humans ultimately is excreted in wastes. Sewage and manure treatment systems, even with modern technologies, represent a significant source of P into waterways (Karunanithi et al., 2015).

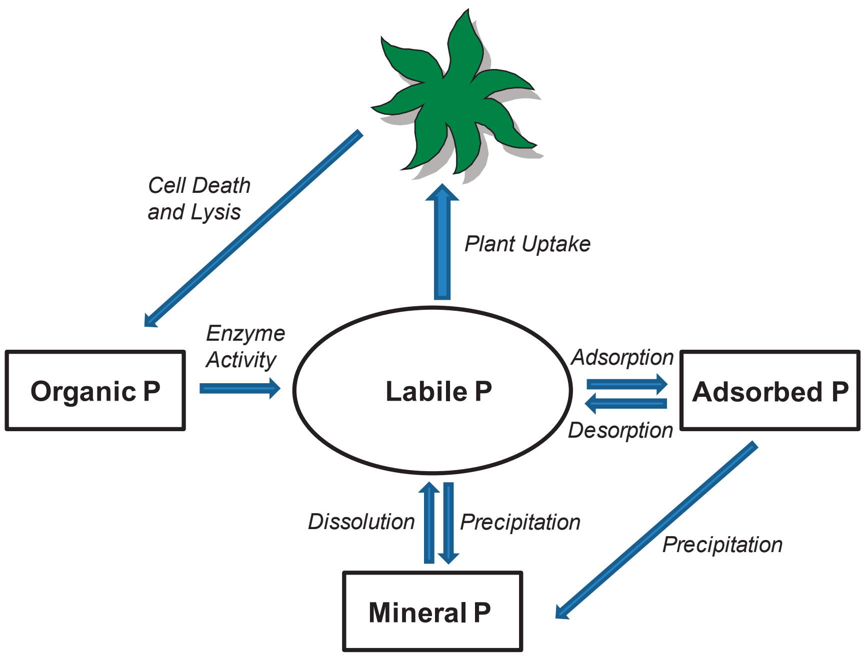
The public health implications of P pollution are significant. Toxins produced by harmful algal blooms (HABs) have been recognized for decades as a threat to human and animal health, but are increasing in frequency and severity, not only across the U.S. but also around the world (Berdalet et al., 2016; Carmichael, 2013; D'Anglada 2015; Erdner et al., 2008). The first recorded instance of HABs in the U.S. was in South Dakota in 1925 when more than 120 hogs were killed after consuming water from a lake that was undergoing an algal bloom (Carmichael, 2013). HABs on the Ohio and Potomac Rivers in 1931 were estimated to have sickened 5,000–8,000 people (Carmichael, 2013).

Seafood taken from waters contaminated by HABs can be harmful, causing numerous outbreaks of paralytic shellfish poisoning and other illnesses (Erdner et al., 2008). Another HAB, red tide in coastal areas, can harm not only aquatic life but also release toxins into the air, producing respiratory problems in humans, especially in individuals with asthma (Erdner et al., 2008). In 2014, HABs in Lake Erie interrupted the supply of drinking water to the city of Toledo (Ho & Michalak, 2015). HABs are caused by a number of algal species and can involve a variety of toxins, but nutrient pollution—particularly from phosphorus and nitrogen (N)—is estimated to be a significant contributing factor in many HABs (Heisler et al., 2008).

Pollution from P also has significant indirect implications for public health due to the need to restore soil fertility where P has been depleted. Production of mineral-based P fertilizer creates a waste product that can be mildly radioactive. Over 1 billion tons of this waste is stockpiled currently in Florida and a number of other states (Cordell & White, 2013). The recent opening of a sinkhole beneath one of these stockpiles resulted in the loss of over 200 million gallons of phos-

FIGURE **1**

Key Phosphorus (P) Compartments and Transformations



Adapted from Karunanithi et al., 2015.

phate- and radionuclide-contaminated water (O'Donnell, 2016).

Phosphate fertilizer is made from phosphate rock, a limited resource that is found in relatively few places in the world. While the U.S. once had rich deposits, world supply is now dominated by Morocco and China (Scholz, Ulrich, Eilittä, & Roy, 2013). World population growth and a shift to greater per-capita meat consumption is predicted to dramatically increase demand for P fertilizer in the coming decades, with higher prices and potential shortages anticipated (Desmidt et al., 2015). Unlike other limited resources, such as fossil fuels, there are no substitutes for phosphate rock. Current reliance on mineral-based P fertilizer is unsustainable and poses a significant food and national-security threat (Desmidt et al., 2015).

The Role of the Environmental Health Professional

The greatest sources of P pollution include runoff from crop production, livestock wastes, urban stormwater, and discharge from sewage treatment plants and septic systems (U.S. Environmental Protection Agency [U.S. EPA], 2017). Environmental health professional responsibilities can influence a number of these sources, including onsite wastewater treatment systems, land use planning, watershed and drinking water protection, stormwater control, and others.

Efforts to reduce nutrient pollution increasingly use watershed-based planning (U.S. EPA, 2013). The stakeholder groups assembled to participate in the planning process offer an opportunity for the environmental health professional to further public health goals and assure that nutrient control is performed through the most cost-effective means. To be most effective, environmental health professionals should be familiar with the range of methods available for P pollution control.

A number of excellent reviews have been published on methods to reduce the flow of P into waterways (Clary, Jones, Strecker, Leisenring, & Zhang, 2017; U.S. EPA, 2007, 2018). Relatively little has been published, however, on the need and methods to remove and recover P already present in surface waters. There are several reasons why P removal and recovery from surface waters is important (Rittmann et al., 2011). First, efforts to reduce P inputs to waterways have progressed slowly, and are likely to be insufficient to control HABs in the near term (Lürling, Mackay, Reitzel, & Spears, 2016).

Second, even if P inputs could be sharply reduced, sediments and vegetation have built up sufficient P stocks from prior contamination to keep aqueous P concentrations high for decades to come (Jarvie et al., 2013; Lürling et al., 2016). And third, recovered P can reduce reliance of commercial P fertilizer, reducing the public health and environmental impact of fertilizer production and improving food security.

In the remaining sections we explain the current technologies for P removal and recovery from wastewater, highlight the challenges of adapting these technologies to surface waters, and note the prospects for recovering P while attaining water quality sufficient to avoid environmental and public health harm. But first we provide a brief explanation of the behavior of P in the natural environment and its implications for removal and recovery.

Phosphorus in the Natural Environment

In the environment, P exists in a number of different forms (Figure 1). Labile P refers to the forms of P readily usable by plants, and is typically dominated by orthophosphate—the ionized forms of phosphoric acid ($H_2PO_4^-$, HPO_4^{2-}, and PO_4^{3-}) (Karunanithi et al., 2015). Plants and bacteria can use P to produce organic compounds, which can then be converted back to labile P through a number of P-metabolizing enzymes.

Labile P can be readily adsorbed on soil and vegetation surfaces. In both surface water and wastewater, most P is associated with solids, and typically only a small fraction is present as dissolved P (Ibarra, 2011). Aluminum (Al), calcium (Ca), iron (Fe), and certain other metal oxides form positively charged surfaces when hydrated. The presence of these compounds in solids often determines the extent to which P is particle bound (Loganathan, Vigneswaran, Kandasamy, & Bolan, 2014). Adsorption on metal oxides is pH dependent, however, and high pH can desorb P, increasing aqueous concentrations (Ibarra, 2011). Under some conditions P can bond to the metal, forming a mineral precipitate. Long contact time and high concentrations of P favor mineral formation (Ibarra, 2011; Karunanithi et al., 2015). Some phosphorus minerals are highly insoluble, but solubility can be affected by pH and redox conditions. For example, many calcium phosphate minerals increase solubility as pH decreases, and iron phosphate minerals can be solubilized under low redox conditions (Ibarra, 2011).

Phosphorus Removal and Recovery From Wastewater

Removal and recovery of P is most advanced in wastewater treatment due to the relatively low volume and high P concentration in comparison to surface water.

Biological Removal and Subsequent Recovery: All municipal and livestock wastewater treatment systems use microorganisms to degrade carbon-containing compounds and reduce pathogens. Under well-controlled conditions, approximately 90% of the wastewater P can be incorporated into these biosolids, which can then be land applied as a fertilizer or composted to produce a soil amendment, returning P to crops and reducing the need for rock-based P fertilizers (Lu, He, & Stoffella, 2012).

Chemical Precipitation: Concentrated solutions of orthophosphate can be directly precipitated using compounds containing Al, Ca, Fe, magnesium (Mg), or some other metals. Anaerobic digestion supernatant can be highly concentrated in P (20–400 mg/L) (Cai, Park, & Li, 2013; Egle, Rechberger, & Zessner, 2015). Under these conditions, Mg can be used to precipitate struvite ($MgNH_4PO_4 \cdot 6H_2O$). Struvite has two advantages over other precipitates. First, it can be used directly as a slow-release fertilizer; and second, it provides some N removal in addition to P removal (Rahman et al., 2014).

Lower P concentrations (5–10 mg/L) are typical of secondary treated effluent (Egle et al., 2015). Al, Ca, and Fe compounds are favored at these lower concentrations due to the lower solubility of their reaction products (Morse, Brett, Guy, & Lester, 1998; Rich, 2005). Alum (aluminum sulfate) and ferric chloride are most common, but the resulting P compounds have no fertilizer value and must be disposed of as a waste sludge (Loganathan et al., 2014; Morse et al., 1998; Wendling, Blomberg, Sarlin, Priha, & Arnold, 2013). Calcium compounds produce a P precipitate that can be substituted for phosphate rock in fertilizer production, but Ca reacts preferentially with dissolved carbon dioxide to produce calcium carbonate solids (U.S. EPA, 1976). Thus, large quantities of precipitate can be produced with a very low overall P concentration.

Phosphorus Removal and Recovery From Surface Water

The concentration at which aqueous P no longer stimulates eutrophic conditions (including HABs) can be difficult to define due to the complexity of local ecologies. Achieving a P concentration of 10–20 µg/L, however, is considered reasonably protective for many ecosystems in the U.S., while achieving levels of 1–2 µg/L can be required to restore oligotrophic conditions for sensitive ecosystems, such as the Everglades (Noe, Childers, & Jones, 2001). Some control methods have demonstrated success in reducing surface water concentrations to 50 µg/L or so. Achieving 10 µg/L, however—much less 1 µg/L—has proved very difficult. This section discusses P removal and recovery down to concentrations of approximately 50 µg/L. The final section explores the prospects for removal and recovery down to oligotrophic concentrations.

Surface water poses a much greater challenge for P removal and recovery than wastewater due to its higher volume (or flow rates) and lower concentrations. This characteristic means chemical reactions, such as precipitation to form struvite or calcium phosphate, require extensive chemical additions or take place very slowly (Ibarra, 2011). Low concentration of carbon-based energy sources (biochemical oxygen demand) means that microorganisms cannot be used for P uptake to biosolids. There are a number of methods, however, for removing, and even recovering, P from surface water.

Settling and Filtration: Reducing water velocity to promote settling and/or forcing flow through a filtration media can remove particulate-bound P. Settling and/or filtration generally are components of the methods discussed below, and can provide a significant fraction of overall P removal.

Chemical Methods: Some adsorption of P from surface waters onto soils containing certain metal oxides is known to occur in natural ecosystems (Lu, Wan, Li, Shao, & Wu, 2016). Over time, P reacts with the adsorbent, creating a more tightly bound P mineral (Ibarra, 2011). In constructed wetlands (see discussion below) this effect can be enhanced by enriching substrates with one or more of these metal oxides (Bays, Knight, Wenkert, Clark, & Gong, 2001; García et al., 2010; Gu & Dreschel, 2008; Kadlec, 2006; Mitsch, Zhang, Marois, & Song, 2015; Scinto & Reddy, 2003; Vohla, Kõiv, Bavor, Chazarenc, & Mander, 2011). Adsorbents also have been used in an attempt to prevent the migration of P from lake sediment back into the water. This in-situ immobilization in sediments has had various levels of success (Huser, Futter, Lee, & Perniel, 2016; Wang & Jiang, 2016). None of the above technologies, however, have incorporated recovery of adsorbed/precipitated P.

Biological Methods: The most common biological method used to reduce P in surface waters is natural or constructed (engineered) wetlands. Thus, P removal in wetlands is the result of a combination of processes including settling and filtration, adsorption/desorption and chemical precipitation on sediments or soils or engineered substrate, and biological uptake (García et al., 2010; Kadlec, 2006). Constructed wetlands have been relatively successful in reducing surface water P concentrations to 50 µg/L or even lower (Chen, Ivanoff, & Pietro, 2015; Kadlec 2006).

Despite the success of P removal in wetlands, however, it cannot be sustained indefinitely because P never truly leaves the wetland (Jarvie et al., 2013), in that P that is incorporated into plant tissue is returned to the water as the plant dies and decomposes. Adsorbed P can be desorbed during normal pH swings as a result of the daily photosynthesis cycle. Even precipitated P can be dissolved due to changes in pH or redox potential, or disturbance of the sediment (Rozan et al., 2002).

Moreover, as progress is made in reducing agricultural runoff and other P inputs, the concentration of labile P in wetlands will decrease, stimulating a shift from other P compartments to increase labile P concentrations (Jarvie et al., 2013). Many ecosystems have accumulated P in adsorbed, organic, and mineral form. Without removal (and potential recovery) of P from the ecosystem, it could take decades of low P inputs to drain this accumulation and return the ecosystem to its original P-limited state.

Biomass harvesting from wetlands is one way to remove P from the ecosystem. Once removed, biomass can be composted or anaerobically digested and returned to fields as a soil amendment or, in some cases, used directly as a fertilizer (Iqbal, 1999; Timmermann & Hoving, 2016). The cost of biomass harvesting, however, can be prohibitive (Vymazal, 2011). A number of alternatives to wetlands have been explored that could reduce the costs of biomass harvesting. In one system, known as algal flow-way treatment (AFT), water is removed from the waterway and allowed to flow by gravity down a long runway upon which algae has been grown (Bott et al., 2015). Under proper conditions, algae grows rapidly, and readily absorbs aqueous orthophosphate (Scinto & Reddy, 2003). Effluent is returned to the waterway. Periodically, algae can be harvested by scraping and collecting it. The cost and effectiveness of AFT systems, however, have not yet been sufficiently demonstrated to support widespread adoption.

Prospects for Phosphorus Recovery and Achieving Oligotrophic Water Quality

If P recovery is not considered, it is likely that extensive use of carefully engineered wetlands, perhaps combined with an adsorption stage, could achieve oligotrophic levels of P. Mitsch and coauthors (1995) reported outflows as low as 11 µg/L from constructed wetlands in Illinois receiving water with P concentrations of 40–176 µg/L. DeBusk and coauthors (2004), using mesocosm-scale experimental wetlands containing limestone, and including a limestone adsorption stage following the wetland, achieved outflow concentrations as low as 8 µg/L from water containing an average of 18 µg/L in south Florida. In another example, an experimental alum-based treatment system following a constructed wetland in Lee County, Florida, achieved outflows as low as 7 µg/L (Aim Engineering & Surveying, Inc., Boylan Environmental Consultants, Inc., & Lee County Division of Natural Resources, 2011). While these data are limited, they suggest that low-flow wetlands that include adsorption materials have the potential to achieve oligotrophic P concentrations in the high single-digit µg/L range, but without P recovery.

We are not aware of any technology implemented on a pilot-scale or larger scale that can reliably achieve oligotrophic P concentrations (≤10 µg/L) while recovering P for economic fertilizer use. In fact, this feat is considered such a daunting technological challenge that the Everglades Foundation has established a $10 million prize to the first organization that can demonstrate such a system (Everglades Foundation, 2016). Known as the Barley Water Prize, this four-stage competition has attracted research teams from around the world.

At the time of this writing, Stage 1 (theoretical) has been completed. The winning technology is a multistep chemical process removing suspended particulate P through flocculation, and then removing dissolved P by reversible adsorption (Everglades Foundation, 2018a). Desorbing P from the adsorbent allows the adsorbent to be reused, and the P to be precipitated as calcium phosphate—an input to existing fertilizer manufacturing.

Similar use of high-capacity, highly selective, reversible adsorbents, particularly those based on Fe, is being investigated by a number of researchers (Awual et al., 2011; Blaney, Cinar, & SenGupta, 2007; Boyer, Persaud, Banerjee, & Palomino, 2011; Liu, Wan, Zhang, & Zhou, 2011; Sengupta & Pandit, 2011; Wu, Lam, Lee, & Lau, 2007; Zhang et al., 2012). Currently, these adsorbents appear to offer the most promising technology for P recovery at low concentrations. The success of recovery will depend upon the cost of the adsorbent and the extent to which it can be regenerated after each cycle.

The two other winning technologies from Stage 1 of the Barley Water Prize also harness adsorption, but the P-loaded adsorbents are used directly as fertilizers (Everglades Foundation, 2018b, 2018c). The success of this approach will depend upon use of a very low-cost adsorbent, short transportation distances to farms, and acceptance of the new fertilizer by farmers.

Conclusion

Technologies for P removal from surface waters, such as constructed wetlands and in-situ immobilization, have the potential to reduce P concentrations to near oligotrophic levels, limiting the development of HABs. These technologies, though, are not designed to facilitate P recovery. Biomass harvesting from wetlands and other surface waters could lead to P recovery, but significant progress must be made in lowering costs.

Technologies designed specifically for P recovery from surface waters are only recently emerging. The most promising seem to involve both removal of particulate-bound P and adsorption of aqueous P. Potentially, P can be recovered either through direct land application, or by desorption and concentration—producing a renewable P fertilizer. The success of this approach will depend upon development of low-cost, P-selective adsorbents.

Environmental health professionals have the opportunity to participate in watershed planning to optimize their own efforts in onsite wastewater treatment systems, land use planning, watershed and drinking water protection, stormwater control, and other activities. Additionally, they have the opportunity to assure implementation of the most cost-effective P-control strategies and advocate for P recovery.

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Implications of Hurricane Harvey on Environmental Public Health in Harris County, Texas

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Abstract **Hurricane Harvey, a Category-4 hurricane, dropped more than 40 in. of rain across Harris County, Texas, over 4 days, inundating the third-most populous county in the U.S. and damaging an estimated 136,000 structures. Most major roadways were flooded, impeding rescue and recovery efforts. An estimated 120,000 customers in the Houston area experienced power outages; many were without power for several days. The heavily industrialized area experienced accidental releases of numerous air pollutants from the petrochemical industry, and several Superfund sites were underwater for days, delaying assessment of the potential chemical contamination to nearby waterways. The purpose of this article is to 1) provide an overview of the historic flooding event, 2) identify vulnerable populations, 3) highlight the potential environmental public health risks associated with the storm, and 4) provide recommendations for future action.**

Introduction

On Friday, August 25, 2017, at approximately 10 p.m. local time, Hurricane Harvey made landfall near Rockport, Texas, as a Category 4 major hurricane (National Weather Service, 2017). Over the next 7 days, the slow-moving storm caused widespread, intense rainfalls throughout southeast Texas, with Houston receiving 24 in. of rain in 48 hr (Di Liberto, 2017). Storm totals across the region ranged from 20–40 or more inches of rain (Figure 1), with a record amount of 49.6 in. reported near Clear Creek at Interstate Highway 45 in Houston and over 1 trillion gallons of water falling in Harris County (Di Liberto, 2017; Harris County Flood Control District [HCFCD], 2017). The rainfall led to record flooding, closing major roads throughout the area, flooding an estimated 136,000 structures in Harris County, and resulting in 38 storm-related deaths (HCFCD, 2017; Houston Recovers, 2017).

The devastation was not limited to Houston. According to the Federal Emergency Management Agency (FEMA) summary, across southeast Texas nearly 80,000 homes had at least 18 in. of floodwater in them, and 23,000 had more than 5 ft of water. More than 780,000 individuals evacuated, with more than 42,000 Texans temporarily housed in 692 shelters. First responders rescued 122,331 people in addition to pets (Federal Emergency Management Agency [FEMA], 2017a). The rescue numbers might not include the countless numbers of people and animals rescued by individual residents.

Geography of Harris County, Texas

Harris County is located on the Gulf of Mexico in southeast Texas, and is comprised of 1,777 mi^2, 4.1% (72.5 mi^2) of which are covered by water (U.S. Census Bureau, 2017a). Most of the waterways are in the eastern portion of the county, including Lake Houston and the multiple smaller lakes and bays formed at the mouth of the San Jacinto River. The area also has numerous bayous, or slow-moving coastal rivers or streams. Several small creeks are not actively monitored, while 22 named waterways are actively monitored by the Harris County Flood Control District (HCFCD, 2017). Approximately 25% of Harris County lies within the 100-year flood plain, including low-lying areas near the creeks and bayous, as well as coastal areas (Harris County, 2007).

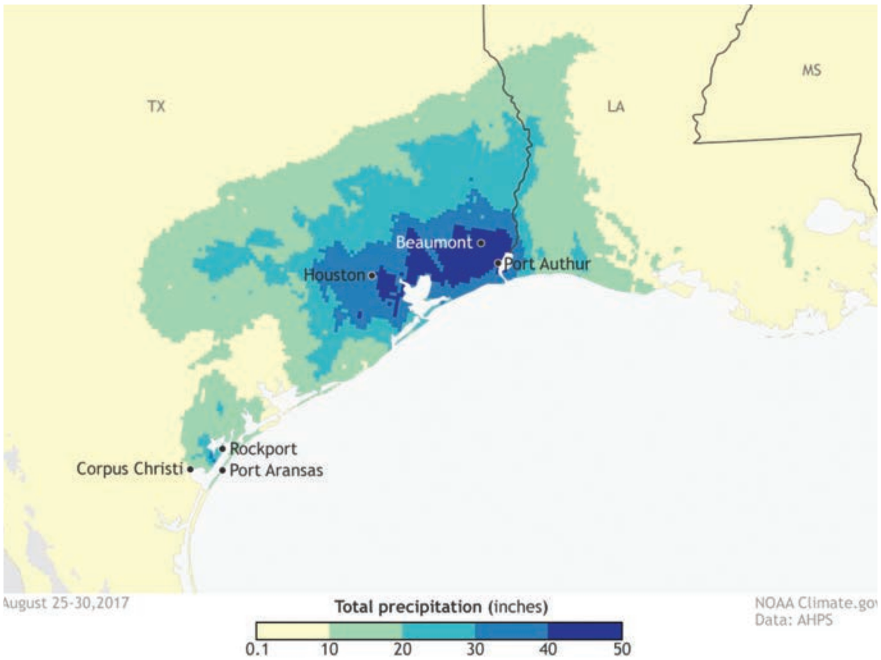
Buffalo Bayou forms part of Port Houston, a 25-mile complex of diversified public and private land that includes the Houston Ship Channel. In 2016, Port Houston was the largest U.S. port for foreign tonnage and third-largest U.S. port for total foreign cargo value (Port Houston, n.d.). In addition to shipping-related facilities, Harris County is also home to numerous industrial complexes, including a number of petrochemical facilities. The county has 16 current and former federally designated Superfund sites in addition to 9 other sites identified by the Texas Commission on Environmental Quality (TCEQ) as in need of cleanup and remediation (TCEQ, 2013).

Community Overview

Harris County is the third-largest county in the U.S. by population; the county seat

FIGURE **1**

Rainfall Totals Across Southeast Texas, August 25–30, 2017



Source: National Oceanic and Atmospheric Administration (www.climate.gov/news-features/event-tracker/reviewing-hurricane-harveys-catastrophic-rain-and-flooding).

is Houston, the fourth-largest city in the U.S., with a 2016 estimated population of 2,303,482 (U.S. Census Bureau, 2016). Table 1 presents a community overview of both Harris County and Houston. Only 1.2% of the county is considered rural (Texas Association of Counties, 2015). Many parts of Texas, and in particular Harris County, have experienced a rapid, ongoing population increase since 2000. From 2010–2016, Houston is estimated to have grown by 9.7%, while Harris County has grown by 12.1% (U.S. Census Bureau, 2016). In the wake of Hurricane Katrina in September 2005, Harris County experienced an influx of displaced people from Louisiana, and many people made Houston their permanent residence. While estimates vary, one report indicated that approximately 250,000 Katrina evacuees came to Houston in 2005, with an estimated 100,000 living there 10 years later (Dart, 2015).

Harris County residents are more mobile than the state or national averages. In 2010, 44% of people living in Harris County had moved within the past 5 years, and 18% had moved within the past year. Among Harris County residents who had moved during the past 5 years, 71% had moved from another house in the same county, 12% from elsewhere in Texas, 12% from another state, and 5.4% had moved from abroad (Harris County, 2007).

Harris County has high income inequality, which continues to increase. In 2015, the ratio of mean income for the top quintile of earners compared with the bottom quintile was 17.3, up from 16.1 in 2010 (U.S. Census Bureau, 2017b). Numerous neighborhoods experience social vulnerability due to high poverty/low income rates, high unemployment rates, and low high school graduation rates (Figure 2). Another measure of social vulnerability is defined by housing and transportation (Figure 3). According to FEMA, there are only 245,249 flood insurance policies in force in Harris County through the National Flood Insurance Program, meaning that only 15.3% of housing units in Harris County have flood insurance (FEMA, 2017b).

Disaster Response Planning for Vulnerable Populations

Houston's population is diverse, and as such, there are several identifiable vulnerable populations. Specifically, individuals with disabilities, noncitizens, the poor, and older and pediatric populations each present unique challenges in the face of disaster.

People With Disabilities

Due to differing transportation requirements, disabled individuals face difficulties in evacuating, and they also pose potential challenges for rescuers if they choose to stay. For example, the morbidly obese and those in wheelchairs both affect the weight limitations that are in place for boat and helicopter rescue units, which can slow rescue times for others and subject those with decreased mobility to a longer exposure to flood waters and risk of drowning. Following Hurricane Sandy, disabled New Yorkers sued Mayor Bloomberg, citing the city's failure to offer people with disabilities meaningful access to New York's emergency preparedness program.

The Court identified the following failures of New York's plan and specified a need to 1) modify evacuation transportation to meet the needs of the disabled, 2) make shelter provisions for the disabled, 3) canvass buildings and neighborhoods for the disabled who might not be able to notify rescue workers of their locations, 4) notify disabled individuals of shelters with resources for them, 5) educate and encourage disabled people to form their own emergency preparedness plans, and 6) confirm the existence and location of accessible services for disabled people in an emergency (*Brooklyn Ctr. for the Independence of the Disabled v. Bloomberg,* 2013).

Houston's disabled population encountered many of the same issues during and after Harvey. It should be noted that the State of Texas Emergency Assistance Registry maintains a free, voluntary special-assistance registry for residents of the Gulf Coast who might need assistance during a general evacuation (dial 2-1-1), but individuals must register in advance and services vary by community (Texas Department of Public Safety, 2018).

Noncitizens

Noncitizens face unique healthcare challenges, especially in regard to insurance. For instance, Houston's large refugee population has access to refugee medical assistance coverage for 9 months after arrival, and then they are eligible for several different public health insurance programs through the Affordable Care Act (ACA), but many of them require language translation services that are not widely available (Siskin & Lunder, 2016). Despite public insurance options for refugees and those granted asylum, "Dreamers" under the Deferred Action for Childhood Arrivals (DACA) provision is the only legally deferred action group that is ineligible for ACA coverage (Siskin & Lunder, 2016). Therefore, their only option for healthcare is to pay out of pocket or obtain health insurance coverage through private insurance, which is often unaffordable, leaving many DACA recipients uninsured. Even more problematic, several DACA recipients contributed to Harvey rescue efforts, which exposed them to increased risk of injury (Lavandera, Morris, & Kopan, 2017).

Low-Income Housing Recipients

Many impoverished noncitizens and citizens living in Houston avail themselves of low-income housing. Houston, however, has suffered from a shortage of affordable residences in recent years, and during Harvey, many of these units flooded (Schaper, 2017). Low-income residents are more likely to live in flood-prone areas, and therefore faced increased challenges during and after Harvey (Graif, 2016). Moreover, rental prices increased after Harvey, as available properties within the city are so scarce. Not only has this trend resulted in a rise in the homeless population in Houston, but it will also likely slow repatriation of the city because there are fewer safe and cheap locations available (Graif, 2016; Schaper, 2017).

Age-Based Vulnerability

Age can also be a source of vulnerability during disasters. Those individuals who are in the very young or very old age groups are at an increased risk of adverse health effects from environmental exposures (Hersher & Schaper, 2017; Morello-Frosch, Zuk, Jerrett, Shamasunder, & Kyle, 2011). Additionally, age-related dependency might necessitate additional assistance with meeting basic needs and with evacuation planning.

TABLE **1**

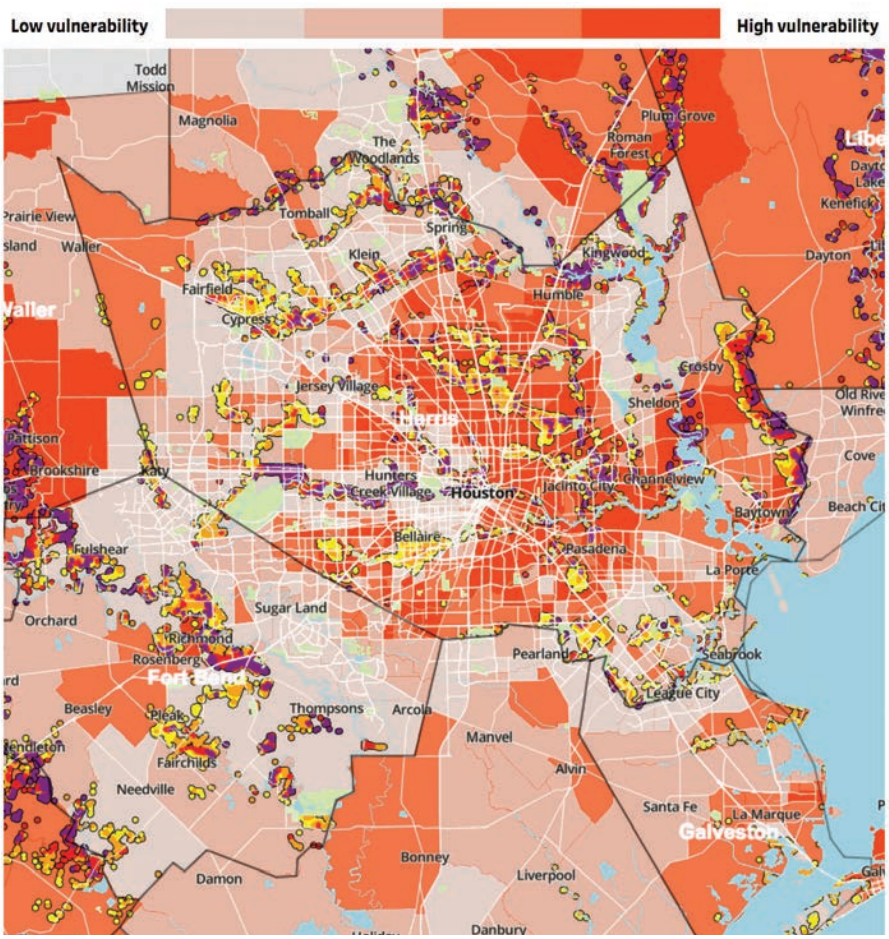
Characteristics of Harris County and Houston, Texas

Population Characteristic	Harris County	Houston
Geography[a]		
Land mass (mi^2)	1,703.5	599.6
Population density (persons/mi^2)	2,402.4	3,501.5
Population[a]		
Total population (2016 estimate)	4,589,928	2,303,482
Total population (2010 census)	4,092,459	2,099,451
Age and sex[b]		
Median age (year)	32.2	32.1
<18 years old	28.0%	25.9%
≥65 years old	8.1%	9.0%
Female	50.2%	49.8%
Race[b]		
White	56.6%	50.5%
Black	18.9%	23.7%
American Indian and Alaska Native	0.7%	0.7%
Asian	6.2%	6.0%
Other	14.4%	15.8%
≥2 races	3.2%	3.3%
Hispanic or Latino[b] (any race)	40.8%	43.8%
Foreign born[a]	25.4%	28.5%
Language other than English spoken at home for persons >5 years of age[a]	43.1%	47.1%
Housing[b]		
Total units	1,598,698	892,646
Owner occupied	51.0%	39.8%
Renter occupied	38.8%	47.9%
Vacant	10.2%	12.3%
Residential stability[a] (persons >1 year of age living in the same house 1 year ago)	82.6%	79.6%
Highest educational attainment[a] (% of population ≥25 years of age)		
High school graduate or equivalent	79.6%	76.7%
Bachelor's degree or higher	29.5%	30.4%
Income and poverty[a]		
Median household income	$54,457	$46,187
Persons in poverty	16.6%	22.5%

[a]U.S. Census Quick Facts, 2016 (www.census.gov/quickfacts/fact/table/harriscountytexas,houstoncitytexas,US/PST045216).
[b]American Fact Finder, 2010 Census Summary for Harris County and Houston city, Texas (https://factfinder.census.gov/faces/nav/jsf/pages/community_facts/xhtml?src=bkmk).

FIGURE **2**

Hurricane Harvey Damage by Socioeconomic Status Vulnerability



Source: Federal Emergency Management Agency damage model and the Centers for Disease Control and Prevention's Social Vulnerability Index (https://svi.cdc.gov).

Environmental Public Health Concerns

Electricity-Dependence

According to the U.S. Department of Health and Human Services (HHS) Public Health Surveillance website, 15,192 of the 456,577 Medicare beneficiaries residing in Harris County as of the end of 2016 were considered electricity-dependent for medical and assistive devices such as ventilators, oxygen, in-home dialysis, IV pumps, and mobility devices (HHS, 2017). Center Point Energy reported an estimated 120,000 customers in the Houston area experienced a power outage during Harvey; as of August 30, 2017, approximately 80,000 customers were still without power due to street flooding impeding restoration efforts (Handy & Alfonso, 2017). In addition to the vulnerable populations requiring electricity for medical devices, lack of electricity also potentially contributed to health problems due to lack of refrigeration for certain medications and food spoilage.

Air Quality

Even under normal conditions, air quality in Houston is problematic—particularly for individuals in the very young or very old age groups—due to emissions (Hersher & Schaper, 2017; Morello-Frosch et al., 2011). Harvey created unplanned industrial releases of hazardous chemicals due to petrochemical plant shutdowns, restarts, and damaged facilities (Hersher & Schaper, 2017). Accidentally released airborne chemicals included more than an estimated 1 million pounds of benzene, ethylbenzene, ethylene, 1,3-butadiene, hexane, toluene, xylene, and other volatile organic compounds (Environmental Defense Fund, 2017; Hersher & Schaper, 2017). In addition, a fire at the Arkema chemical plant in Crosby, Texas, led to mandatory evacuations. When the evacuation was lifted, residents living within 1.5 miles of the site remained under a health advisory to use protective clothing and surgical masks and drink bottled water due to the ongoing health concerns (Harris County Public Health [HCPH], 2017a).

Many of the city's air monitoring sites were not operational during and immediately after the storm, as stations were shut down during hurricane preparations to prevent damage to the equipment and many stations were inaccessible due to flooding in the immediate aftermath (Hersher & Schaper, 2017; TCEQ, 2017).

Contaminated Flood Waters

As previously mentioned, Harris County has numerous Superfund sites. The extent of contamination spread due to the flooding is unknown because several sites were inaccessible immediately following Harvey and water quality testing is ongoing. The Associated Press reported that at least seven sites were underwater in the days after Harvey, and the company overseeing cleanup at U.S. Oil Recovery, a former hazardous waste treatment plant in Pasadena, made at least three reports of spills affecting Vince Bayou (Biesecker & Bajak, 2017). After the flooding began to recede, the U.S. Environmental Protection Agency (U.S. EPA) identified 14 Superfund sites that needed additional testing to determine potential leakages (Ebbs, 2017). While testing will continue, the U.S. EPA already confirmed that the Superfund site known as the San Jacinto River Waste Pits leaked dioxins as a result of Harvey. Additionally, U.S. EPA found dioxin levels as high as 70,000 ng/kg, substantially more than the 30 ng/kg that is the standard acceptable level for the site (Ebbs, 2017). Dioxins are known carcinogens, hormone disruptors, and can also cause developmental and reproductive problems, as well as damage to the immune system (World Health Organization, 2018).

Superfund sites were not the only source of contamination in the flood waters. Other sources included household and industrial chemicals and sewage. In Harris County, 65 releases resulted in 20.7 million gallons of raw sewage contaminating the floodwaters during the hurricane. Three weeks after Harvey, six plants in the Houston area remained inoperable and the total amount of release was unknown (Stuckey, 2017). Water and sediment testing also found elevated levels of heavy metals including lead and arsenic (Kaplan & Healy, 2017). Footage during Harvey revealed the very young and very old navigating the floodwaters, and each of these groups face an increased susceptibility to contaminants and injury (Kaplan & Healy, 2017; Morello-Frosch, et al., 2011).

Drinking Water

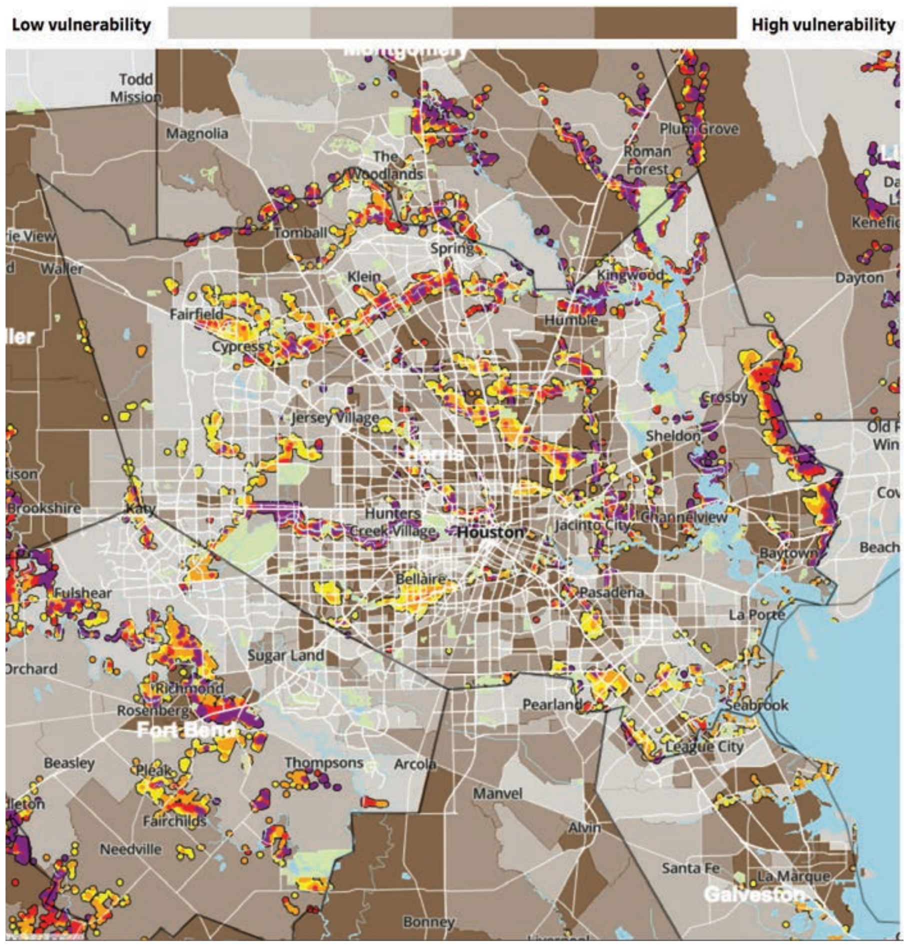
Although most municipal drinking water supplies in Harris County were unaffected by the flooding, multiple locations received boil water notices due to compromised systems. Harris County Public Health (HCPH) provided daily updates via written notices and an interactive map on its website. Any well heads that were covered by floodwater were potentially contaminated with bacteria and/or toxic chemicals including gasoline, oil, and industrial pollutants. HCPH issued a private well water advisory on September 5, 2017, and offered free well water testing through September 22, 2017 (HCPH, 2017a). It should be noted that boiling water only redresses biological contaminants and does not eliminate chemicals present in the water.

Storm Debris Assessment and Cleanup

The sheer number of damaged homes and businesses has created a massive, ongoing cleanup effort. As of the end of September 2017, 48,415 residential and commercial structures had been assessed as damaged and more than 900,000 yd^3 of debris had been collected in Houston (Houston Recovers, 2017). While storm debris collection continues, the city of Houston suspended curbside recycling and yard waste collection until further notice (City of Houston, 2018). Mold growth was extensive and occurring even before the floodwaters receded (Kaplan & Healy, 2017).

FIGURE **3**

Hurricane Harvey Damage by Housing and Transportation Vulnerability



Source: Federal Emergency Management Agency damage model and the Centers for Disease Control and Prevention's Social Vulnerability Index (https://svi.cdc.gov).

Hospital Impacts

Of the 80 licensed hospitals in Harris County, only nine evacuated patients and a majority of these continued to operate in some capacity (Fink & Blinder, 2017; Pulsinelli, 2017; Texas Department of State Health Services, n.d.). Together these nine facilities account for over 2,100 inpatient beds, including 213 intensive care unit (ICU) beds and 87 neonatal intensive care unit (NICU) beds, or 14.6% of the county's overall bed capacity (Texas Department of State Health Services, n.d.).

Ben Taub Hospital, a public facility and one of the only two Level I trauma centers in the city of Houston, initiated evacuations when the facility's basement flooded on August 27, 2017 (Harris Health System, n.d.). Inundated streets surrounding the hospital meant that only three ambulances were able to get through to transfer patients to other facilities. In the end, most of the 350 patients stayed in the facility, and the hospital had to make a call to the public for emergency resupply of food because the food preparation and medical supply storage areas were located in the flooded basement. The facility returned to normal operations and began accepting new patients on August 31, 2017 (Goldstein & McGinley, 2017).

The healthcare delivery community was generally well prepared to function during the flooding, in large part due to lessons learned from Tropical Storm Allison in 2001, which caused power outages and flooding. The facilities at Texas Medical Center (TMC) relocated critical functions and services such as back-up generators and fuel supplies (water contaminated fuel systems), water supply lines (water contamination), pharmacy, blood bank, laboratories, medical supplies, and sterile processing to higher ground (Berger, 2001; Nates, 2004). Floodgates and submarine doors were installed at TMC to prevent basement water penetration. Ride-out and recovery teams up to twice the normal staffing size and emergency supplies prepared each hurricane season to be delivered prior to the arrival of large storms became standard operating policies. Above all, however, Harris County and the surrounding region also came together and created a Catastrophic Medical Operations Center to coordinate resources to safely transfer patients to facilities that have the capabilities to meet patient needs (Texas Department of State Health Services, 2013).

Discussion

Overall, the greatest environmental public health impacts from Harvey were directly related to the pre-existing industrial nature of Harris County. Air monitoring stations were shut down to protect the equipment from wind damage, but street flooding prevented the stations from being reactivated quickly while hazardous chemicals were being released from petrochemical facilities. Water quality throughout the area also suffered from the large-scale flooding and multiple Superfund sites were inundated by water—which in at least one case caused a breach of toxic chemicals.

Residents might not be fully aware of the potential health hazards posed by these sites, as evidenced from a media report of children swimming in flooded retention pools downstream from the Brio Refinery site (Guarino, 2017). Active, ongoing monitoring of the sites, as well as the long-term health of residents across the affected areas, is necessary to determine the long-term effects of these pollutants. Long-term health monitoring, however, is potentially complicated by the high mobility within Harris County and the need to have accurate residential address history to link to potential exposure sites.

Emergency preparedness requires long-term fiscal and collaborative devotion, as successful investments require ongoing maintenance to ensure trust and competency (Katz, Staiti, & McKenzie, 2006). Unfortunately, a zero sum mentality prevails in the allocation of public health budgets, and when funding is diverted towards emergency preparedness or recovery efforts, it is often diverted from other vital public health programs and initiatives (Lurie, Wasserman, & Nelson, 2006). While substantial funding has been diverted to Harvey recovery efforts, the Texas General Land Office and other state and federal agencies are offering grants to support continued resiliency and improvement of local emergency preparedness programs.

Environmental Public Health Response

HCPH created a webpage with resources related to Harvey on which they posted a variety of public notices and information sheets (HCPH, 2017b). Flood advisory sheets indicated potential hazards in the floodwater including snakes and insects, debris, oil and industrial waste, raw sewage, and downed powerlines. A flood recovery tip sheet covered the following topics: proper attire for cleanup, mold, food safety, proper ventilation when using generators, mosquitoes, and drinking water. The tip sheet also recommended frequent hand washing, making sure tetanus shots were up to date (dose every 10 years), and pacing cleanup efforts.

Due to the intensity of the flooding, the capacity of local public health departments to respond was exceeded, and the Texas Department of State Health Services (DSHS) intervened. In their after-action report, DSHS disclosed that 689 staff members were involved in the Harvey response, and staff engaged in 990 medical response missions, 3,200 medical patient evacuations, the treatment of 1,800 patients by mobilized medical units, the transfer of 142 patients, the distribution of 70,000 vaccines, and the treatment of 6,765,971 acres for mosquito control (Hellerstedt, 2017).

Furthermore, the role of volunteers in the rescue efforts led to the organization of a Harris County Volunteer Disaster Response Team conceived of by Constable Sherman Eagleton (Zaveri, 2017). The sheriff's after-action report and Constable Eagleton's response team plans are still being finalized; however, both recognized the inability to fully prepare for a natural disaster as extreme as Harvey and in turn acknowledged the importance of calling on spontaneous volunteer aid and collaboration with DSHS (Zaveri, 2017).

Planning for Vulnerable Populations

As suggested in the New York lawsuit, better education is needed to protect vulnerable populations. Children, the very old, the impoverished, noncitizens, and the disabled all would substantially benefit from emergency plans tailored to their unique requirements. Admittedly, tailoring emergency preparedness plans for different groups costs additional time and resources. Training community health workers who are already mobilized to communicate with diversified patient groups in emergency preparedness, however, could potentially cut costs and provide for an increased reception and comprehension of the emergency preparedness materials appropriate for each subset of the population (Freudenberg & Tsui, 2011).

Flood Insurance and Residential Flooding Risk

Given that the majority of residents impacted by flooding in Harvey did not have flood insurance, greater efforts are needed to accurately inform the public of their flooding risks. In a recent study of the flood plains in East Texas (1999–2009), researchers noted that the vast majority of flood damage occurred outside the FEMA-designated 100-year flood plain (Blessing, Sebastian, & Brody, 2017). This gap might be due in part to the fact that several years passed in between FEMA's map updates.

Houston is a fast growing urban environment, and alterations to the topography such as new building developments and other changes to the built environment change the locations where flooding occurs after a major weather event. Newly updated FEMA flood risk maps for Houston, Texas, went into effect in January 2017, and 8,000 more Houstonians were listed at risk; however, a National Flood Insurance Program insurance specialist explained that homeowners have an entire year to decide whether or not to update their coverage (Pitman, 2016). The extended timeline provided to reevaluate flood insurance coverage under the new maps likely contributed to poor flood insurance coverage in Houston. The authors of the 1999–2009 study suggest that recent advances in hydrologic models that focus on spatial distribution can improve FEMA's accuracy of the flood risk assessment (Brody, Highfield, Blessing, Makino, & Shepard, 2017). This proffered improvement in flood zone identification and risk assessment will require a substantial federal investment, but would likely improve resident confidence in purchasing flood insurance.

Many Houstonians impacted by Harvey flooding were not in a 100-year flood plain and were not informed of the potential risk of flooding due to a close proximity to reservoirs, bayous, and other flood pools. In fact, due to resulting flooding after Harvey, impacted homeowners not informed of this risk are suing the U.S. Army Corps of Engineers for their failure to inform homeowners of their need for flood insurance due to their proximity to flood pools (Olsen, 2017).

The state of Texas and the U.S. Army Corps of Engineers have no statutes or regulations, however, requiring notice to homebuyers informing them of the risk posed by reservoir pools (Olsen, 2017). While writing legislation requiring that homeowners be advised of these risks is feasible, such legislation would likely face fierce opposition in the state legislature due to lobbying efforts by real estate developers. Nonetheless, transparency to homebuyers is ethically responsible and would likely improve flood insurance purchasing and retention, which would ultimately benefit taxpayers. Similarly, researchers correlated an increase in flood insurance purchasing and retention during FEMA's 2004 Floodsmart public awareness campaign (Michel-Kerjan, Lemoyne de Forges, & Kunreuther, 2012). Despite the effect transparency regarding flood risk might have on the real estate market, informing residents of their risks through new legislation or advertising campaigns would not only better protect individual property owners but also in turn protect county tax dollars.

Conclusion

Hurricane Harvey dropped more than 40 in. of rain across Harris County, Texas, over 4 days, inundating the third-most populous county in the U.S. and damaging an estimated 136,000 structures. The historic nature of this extreme weather event precluded the ability to fully plan for such an emergency, but environmental health practitioners can still gain insight from the response and recovery efforts. As a heavily industrialized area built in low-lying areas, Harris County experienced numerous accidental releases of air- and waterborne chemical pollutants, with flooding often delaying the ability to fully assess the damage.

In preparation for future disasters, it is essential that public health officials assist vulnerable populations—including people with disabilities, noncitizens, low-income housing recipients, and those vulnerable due to youth or advanced age—to create a plan for individual and community response tailored to the population's needs. Special attention might need to be focused on residential areas in the vicinity of industrial sites. The ability to quickly mobilize and organize volunteer efforts is another lesson learned from this experience. Grant funding is currently available to support continued resiliency and improvement of local emergency preparedness programs, but such efforts will require long-term fiscal and collaborative input. Further, environmental health practitioners must continue to monitor the affected communities looking at the long-term effects of the storm on the health status of Harris County.

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Building Capacity by Staffing for Data Operations

Darryl Booth, MBA

Editor's Note: A need exists within environmental health agencies to increase their capacity to perform in an environment of diminishing resources. With limited resources and increasing demands, we need to seek new approaches to the business of environmental health.

Acutely aware of these challenges, NEHA has initiated a partnership with Accela called *Building Capacity*. *Building Capacity* is a joint effort to educate, reinforce, and build upon successes within the profession, using technology to improve efficiency and extend the impact of environmental health agencies.

The *Journal* is pleased to publish this bimonthly column from Accela that will provide readers with insight into the *Building Capacity* initiative, as well as be a conduit for fostering the capacity building of environmental health agencies across the country.

The conclusions of this column are those of the author(s) and do not necessarily represent the views of NEHA.

Darryl Booth is senior vice president and general manager of environmental health at Accela and has been monitoring regulatory and data tracking needs of agencies across the U.S. for almost 20 years. He serves as technical advisor to NEHA's information and technology section.

Technology Plans

A technology plan is a multiyear strategic planning document conceived to assess gaps and goals that lays down a framework for data infrastructure, technology changes, upgrades, software, and staffing. It presses the question, "Where will we be in 5 years and how do we get there?"

We often work with larger local health departments on technology plans. It's a welcome invitation to align the software product's roadmap (the prioritized list and timing of future enhancements) with the health department's goals. For example, when the health department aspires to deploy a new and inventive mobile app to its inspectors, operators, or residents, then the underlying plans must shift to support that particular initiative.

While it's routine to set timelines and budgets for updated tablet computers, servers, and storage, the following question can be a head-scratcher: "Once a technology plan is deployed, how many people will I need to support it?"

Data Operations

In this column I use the phrase "data operations" to refer to the nonpolicy, nonhealth, and noninspection activities that are essential to local health departments of a certain size. Examples of data operations include help desk, computer training, information technology (IT) department and vendor coordination, configuration changes, security, and report writing.

I also qualify health departments of a certain size because most health department workforces are small, where everybody does a bit of everything. This column applies to the largest health departments, those that serve a population of ≥250,000 and have a workforce of ≥100 employees. At this scale, optimizing data operations (computer systems and support) has an amplifying effect. What follows is a model for ideal data operations staffing of a local health department.

Functions of Local Health Department Data Operations

This model proposes several high-level functions (Figure 1). Obviously, a single staff member might fill multiple roles, as well as have other unrelated duties. The model is really a portfolio of contributors, with individuals flexing their involvement with the current needs of the health department.

These functions include:

- Power user/lead: Power users are typically embedded, contributing to day-to-day transactions. Yet, due to their special skills and leadership, they often emerge as first-line resources to their colleagues.
- Help desk: The help desk takes routine questions to keep workers productive throughout the day. Lost passwords and quick directions do not require full administrative training.
- System administrator: System administrators can be responsible for creating new user accounts, setting security privileges, adding or changing configuration settings, and working with IT departments and vendors to maintain uninterrupted operations.

TABLE 1

Local Health Department Data Operations Staffing Model for Different Population Sizes

Population Served	Estimated Full-Time Employees*	Power User	Help Desk	System Administrator**	Trainer	Report Writer
250,000–499,000	124	2.0	1.0	1.0	0.5	0.5
500,000–999,999	230	5.0	2.0	1.5	1.0	1.0
>1,000,000	>486	10.0	3.0	2.0	2.0	1.5

**Source:* 2016 National Profile of Local Health Departments, National Association of County and City Health Officials (http://nacchoprofilestudy.org/wp-content/uploads/2017/10/ProfileReport_Aug2017_final.pdf).
**Position requires cross-training and a succession plan.

FIGURE 1

Job Function Model of Local Health Department Data Operations

Power User/Lead
- Power users are typically embedded, contributing to day-to-day transactions. Yet, due to their special skills and leadership, they often emerge as first-line resources to their colleagues.

Help Desk
- The help desk takes routine questions to keep workers productive throughout the day. Lost passwords and quick directions do not require full administrative training.

System Administrator
- System administrators can be responsible for creating new user accounts, setting security privileges, adding/changing configuration settings, and working with information technology departments and vendors to maintain uninterrupted operations.

Trainer
- New employees need training. New functionality and system upgrades will prompt training, and everybody needs a refresher now and then.

Report Writer
- Whether creating dashboards or automated/e-mailed reports, individuals who take system data and turn them into actionable information are extremely valuable.

- Trainer: New employees need training. New functionality and system upgrades will prompt training, and everybody needs a refresher now and then.
- Report writer: Whether creating dashboards or automated/e-mailed reports, individuals who take system data and turn them into actionable information are extremely valuable.

2016 National Profile of Local Health Departments

I want to draw your attention to the National Association of County and City Health Officials' (NACCHO) 2016 National Profile of Local Health Departments (http://nacchoprofilestudy.org/wp-content/uploads/2017/10/ProfileReport_Aug2017_final.pdf). This scholarly resource reflects survey responses from 2,533 local health departments and includes a chapter that solely addresses workforce numbers, changes, and occupations.

In the NACCHO survey, we find instances of dedicated "information systems specialists" at local health departments serving populations ≥250,000. At the largest segment (serving populations >1,000,000), we see 3.5 full-time equivalent positions dedicated to information systems.

Small health departments, one might conclude, advance data management goals without a named or dedicated resource. Instead, these health departments advance data management goals through individual contributions of other staff and leaders. In other instances, small health departments might rely more heavily on their software vendors.

A Model for Staffing Data Operations

As with all staffing challenges, the individual's aptitude, toolset, leadership, and processes weigh heavily on the ratios. Furthermore, the complexity of the local health department's systems and its initiatives that leverage technology must also be factored.

Table 1 reflects a commercial off-the-shelf (COTS) solution in a software as a service (SaaS) configuration. On premises and custom solutions might require an upward adjustment or additional roles (e.g., a programmer to fix bugs in a custom solution).

Conclusions and Next Steps

Local health departments are resilient and staffing models are just a starting point. We see how individual leaders rise and respond, flex and accommodate.

From the above, we should expect a healthy infrastructure for routine support, as well as a margin for aspirational projects that will advance department goals.

Continue the conversation in the Building Capacity in Environmental Health Group on LinkedIn (www.linkedin.com/groups/6945520).

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DIRECT FROM AEHAP

It's About Communities: The Commitment to Promoting a Culturally Competent Environmental Health Workforce



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Editor's Note: In an effort to promote the growth of the environmental health profession and the academic programs that fuel that growth, NEHA has teamed up with the Association of Environmental Health Academic Programs (AEHAP) to publish two columns a year in the *Journal*. AEHAP's mission is to support environmental health education to ensure the optimal health of people and the environment. The organization works hand in hand with the National Environmental Health Science & Protection Accreditation Council (EHAC) to accredit, market, and promote EHAC-accredited environmental health degree programs.

This column will provide AEHAP with the opportunity to share current trends within undergraduate and graduate environmental health programs, as well as their efforts to further the environmental health field and available resources and information.

Clinton Pinion is the current president of AEHAP and an assistant professor of environmental health at Eastern Kentucky University. Leslie Mitchell is the executive director of EHAC. Jason Marion is an associate professor of environmental health at Eastern Kentucky University.

"Environmental health and public health are profoundly local." This expression is frequently spoken by Dr. David Dyjack, executive director of the National Environmental Health Association. The Association of Environmental Health Academic Programs (AEHAP) firmly agrees and for this reason, it is important to have local environmental health experts who know the pulse of their communities. AEHAP believes in supporting the advanced scientific education of environmental health in these communities through people from these communities. Accordingly, AEHAP has sought to promote and support accredited environmental health programs among a diverse cross-section of the U.S. higher education landscape. AEHAP's students are diverse in many ways, including socioeconomically, racially, ethnically, and culturally. We still have further to go to enhance diversity within our member programs. We remain proud, however, of our people, our programs, and the communities our programs serve.

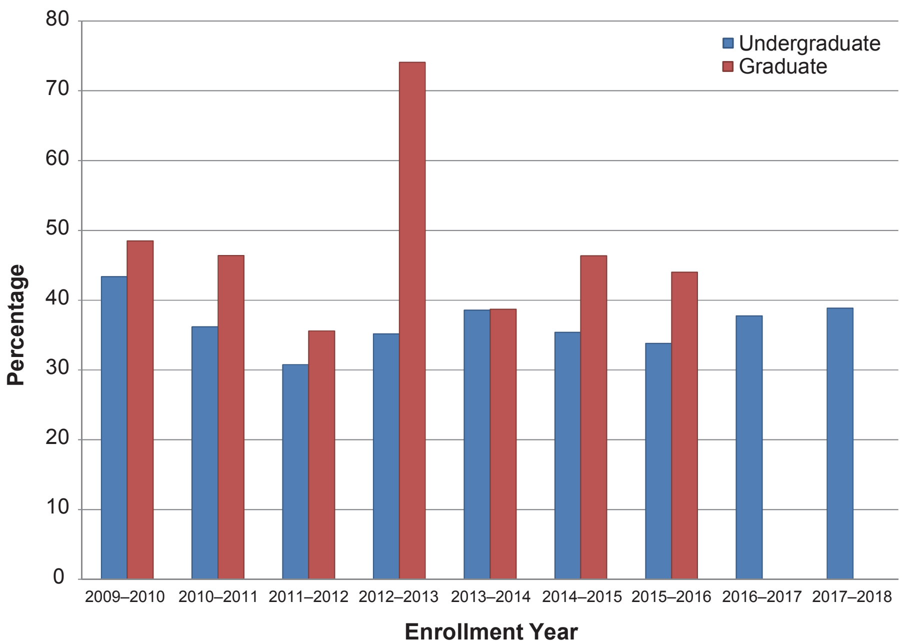
Summarizing the annual undergraduate and 3-year graduate program survey data provided by the National Environmental Health Science & Protection Accreditation Council (EHAC), racially and/or ethnically diverse students represent 37% and 48% of enrolled undergraduate and graduate students, respectively. For the 2017–2018 enrollment year, 39% of undergraduates were described as contributing to diversity (Figure 1). A more detailed description of student racial and ethnic groups is provided in Tables 1 and 2. In addition, 56% of the student population from the undergraduate and graduate programs is female. Female students have been the majority since 2008.

AEHAP's mission is to advance a 21st century science-based educational model that develops culturally competent environmental health scientists. The mission is aligned with current efforts by higher learning institutions to ensure college graduates are competent members of local, national, and global communities. College students are now expected to not only traverse a rigorous curriculum to gain foundational knowledge but also acquire practical skills to enable them to identify and address current and emerging issues.

Graduates from environmental and public health programs often will work in communities that are culturally different from the cities and towns in which they were raised (Galea, 2015). Working with diverse populations is essential as environmental and public health practitioners aim to tackle issues of social injustice and work toward health equity for all

FIGURE 1

Racial and Ethnic Diversity Enrollment Among Programs Accredited by the National Environmental Health Science & Protection Accreditation Council



community members, regardless of disposition. Ensuring college graduate preparedness, according to the Association of American Colleges & Universities (AAC&U), requires colleges and universities to implement four learning outcomes in all majors: 1) cultural and global awareness (i.e., cultural competency), 2) mastery of knowledge-based and applied skills, 3) integrative learning, and 4) personal and social responsibility (Kilgo, Ezell Sheets, & Pascarella, 2015). The aforementioned learning outcomes, especially cultural competency, are crucial if graduates are expected to thrive in the current workforce, which is evolving and becoming increasingly global.

Many colleges and universities have adopted high-impact educational practices (HIPs) in an attempt to infuse AAC&U-recommended learning outcomes into their curricula. Implementation of HIPs increases student engagement and assists colleges and universities in retaining students through graduation. Kilgo and coauthors (2015) highlight 10 HIPs that can positively benefit college students if implemented by institutions of higher education:

1. first year seminars,
2. learning communities,
3. collaborative assignments and projects,
4. diversity and global learning,
5. common intellectual experiences,
6. writing-intensive courses,
7. undergraduate research,
8. service and community-based learning,
9. capstone courses and projects, and
10. internships.

Through implementation of HIPs, more U.S. college students are being instructed on the importance of diversity and cultural competency. One could question if college graduates are, however, culturally competent through classroom instruction alone.

The U.S. population is becoming more ethnically and racially diverse (Duffus et al., 2014; Galea, 2015; Valentine, Wynn, & McLean, 2016). As such, the U.S. will ultimately be considered a plurality nation (i.e., no race or ethnicity exceeds 50% of a nation's total population) (Galea, 2015). In fact, more than 39% of the U.S. population in 2018 identifies as non-White (Kaiser Family Foundation, 2018). The diversity of the U.S. population is expected to increase to 57% by 2060, with the Hispanic population alone expected to grow from 18% of the total U.S. population in 2016 to 31% by 2060 (Duffus et al., 2014). Smaller, but notable, increases will occur in the African-American, Asian, and American Indian populations. Why does this population increase among the aforementioned groups matter?

Compared to individuals of the populous majority, minority and low socioeconomic groups have higher rates of not being insured, infant mortality, negative public health outcomes from preventable diseases, and inadequate access to healthcare (Jackson & Gracia, 2014). In fact, African-Americans typically have higher age-adjusted death rates for HIV/AIDS, cancer, heart disease, and diabetes (Duffus et al., 2014; Jackson & Gracia, 2014). Additionally, life expectancy is shorter for marginalized populations. The average life expectancy for African-Americans in 2009 was 74.6 years compared to 78.9 years among White Americans. Environmental and public health issues faced by marginalized populations are often attributed to health disparities associated with housing quality, access to clean food and water, and education (Jackson & Gracia, 2014).

Public health practitioners have made great strides over the past century to address emerging and existing preventative health issues (Jackson et al., 2014). Unfortunately, public health issues among marginalized populations are not only persistent but also continue to rise in prevalence. AEHAP and EHAC have actively explored the collaborative role they will play in addressing the public health issues of marginalized populations. Keeping in mind the localized nature of environmental and public health, our role is to not only continue the promotion of cultural competent practitioners but also help our accredited institutions graduate classes similar to the populations and communities they serve.

Our approach is aligned with the U.S. Department of Health and Human Services' strategy for health disparity reduction among marginalized populations. This strategy includes supporting initiatives that increase diversity of healthcare workers and increasing cultural competency of the healthcare workforce to ensure better service is provided to individuals with linguistic, cultural, and social backgrounds (Jackson & Gracia, 2014).

TABLE **1**

Total Enrollment Among Undergraduates in Programs Accredited by the National Environmental Health Science & Protection Accreditation Council and Percent Representation by Various Racial and Ethnic Groups

Year	Total Enrollment (*N*)	Native American[a] (%)	Asian (%)	Black or African-American (%)	Hispanic or Latino (%)	Pacific Islander[b] (%)	Other[c] (%)	Overall Diversity (%)
2010	1,423	1.6	13.2	14.5	10.8	0.4	3.0	43.4
2011	1,561	0.8	10.8	11.9	7.8	0.9	4.0	36.2
2012	1,365	1.0	8.6	11.5	7.5	0.3	1.8	30.8
2013	1,401	1.4	8.1	13.5	7.1	0.4	4.7	35.2
2014	1,415	1.2	7.7	13.1	8.7	0.4	7.5	38.0
2015	1,458	0.5	7.8	13.0	9.1	0.5	4.5	35.4
2016	1,506	0.5	7.7	9.7	11.1	0.6	4.1	33.8
2017	1,428	0.8	7.6	11.1	12.1	0.4	5.9	37.7
2018	1,338	1.0	8.4	11.2	11.7	0.4	6.1	38.9

[a]Group includes Native Alaskan.
[b]Group includes Native Hawaiian.
[c]Other is the term used on the survey for people not described by the previous terms or White/non-Hispanic.

TABLE **2**

Total Enrollment Among Graduates in Programs Accredited by the National Environmental Health Science & Protection Accreditation Council and Percent Representation by Various Racial and Ethnic Groups

Year	Total Enrollment (*N*)	Native American[a] (%)	Asian (%)	Black or African-American (%)	Hispanic or Latino (%)	Pacific Islander[b] (%)	Other[c] (%)	Overall Diversity (%)
2010	255	0.2	16.1	17.6	13.3	0	1.2	48.5
2011	244	0.5	16.0	16.8	4.9	4.5	3.7	46.4
2012	245	0.5	14.3	14.3	5.7	0	0.8	35.6
2013	231	0.5	19.5	18.6	4.3	2.6	28.6	74.1
2014	260	0.2	7.7	14.6	3.1	0	13.1	38.7
2015	289	0	7.2	15.6	3.8	0	19.7	46.4
2016	409	1.5	5.4	28.6	2.7	0.2	5.6	44.0

[a]Group includes Native Alaskan.
[b]Group includes Native Hawaiian.
[c]Other is the term used on the survey for people not described by the previous terms or White/non-Hispanic.

Public health issues of marginalized populations are more likely to be addressed by practitioners who are from underrepresented groups (Duffus et al., 2014; Valentine et al., 2016). Valentine and coauthors (2016) note a strategic push by health agencies to have a workforce reflective of the population and community served. The socioeconomic background, race, ethnicity, and linguistic abilities of healthcare workers are cited as being important in bridging the public health gap between marginalized and nonmarginalized populations in the U.S. (Harper, 2007; Valentine et al., 2016). Having a diverse public health workforce enables local health departments to better educate community members, increases preventative healthcare access for marginalized populations, and bolsters research activities that explore the health disparities that lead to chronic public health issues (Duffus et al., 2014).

In closing, the demographics of EHAC-accredited program graduates are closely aligned with the current U.S. population; however, demographics will change as our nation becomes pluralistic. AEHAP and EHAC will continue to promote cultural competency of graduates and assist accredited environmental health programs in producing cohorts reflective of the needs of their local communities.

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Did You Know?

September is National Preparedness Month. This year's theme is "Disasters Happen. Prepare Now. Learn How." Make a plan to participate in this year's events and visit www.ready.gov/september for more information and resources.

DIRECT FROM ATSDR

Land Reuse Site Screening Tool Cohorts: Creating Land Reuse Site Inventories

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Editor's Note: **As part of our continued effort to highlight innovative approaches to improve the health and environment of communities, the *Journal* is pleased to publish a bimonthly column from the Agency for Toxic Substances and Disease Registry (ATSDR) at the Centers for Disease Control and Prevention (CDC). ATSDR serves the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. The purpose of this column is to inform readers of ATSDR's activities and initiatives to better understand the relationship between exposure to hazardous substances in the environment, its impact on human health, and how to protect public health.**

The conclusions of this column are those of the author(s) and do not necessarily represent the official position of ATSDR or CDC.

Introduction

The Agency for Toxic Substances and Disease Registry (ATSDR) first highlighted the Brownfields/Land Reuse Site Tool (Site Tool) in 2012 (Perlman, Berman, & Lemly Bing, 2012). The Site Tool helps environmental health professionals rapidly inventory and characterize land reuse sites with a public health lens. Inventorying of land reuse sites like brownfields is a common practice. For example, the U.S. Environmental Protection Agency (U.S. EPA) requires a reporting inventory that will sync with its Assessment, Cleanup, and Redevelopment Exchange System (U.S. EPA, 2018). This inventory database, however, was developed based on environmental regulation for redevelopment partners and might focus less on public health and chemical and physical exposure risks. This column demonstrates the utility of the Site Tool in addressing public health needs around redevelopment.

Updates to the Site Tool

ATSDR updated the Site Tool to include a comparison value viewer. The comparison value viewer allows environmental health professionals to screen available environmental data to determine if there are cancer or noncancer exposures that need further assessment. Comparison values (CVs) are concentrations of a substance in air, water, or soil that are unlikely to cause harmful health effects at levels at or below the CV in exposed people. If we find substances in amounts greater than their CVs, we can select them for further evaluation in the public health assessment process. Other federal and state agencies have developed similar types of health-based guidelines for concentrations of substances in water, soil, air, and food, such as U.S. EPA's residual contaminant levels (RCLs) for soil (U.S. EPA Region 4, 2014). In the absence of a CV, we can use these health-based guidelines for a particular environmental media.

The Site Tool can be used on any type of potentially contaminated site including brownfields, landfills, or Superfund sites, and as such, we changed its name to the ATSDR Land Reuse Site Screening Tool (Site Tool). Currently, the Site Tool has been downloaded approximately 2,500 times and is used throughout the U.S. and in four other countries.

Site Tool Cohorts: Example Uses

In 2018, we created four examples from Site Tool users to offer guidance to others who could benefit from using the Site Tool to create land reuse site inventories. Our Site Tool cohorts featured in this column are using the Site Tool in creative ways. Each cohort has provided a brief overview of their use of the Site Tool. For reader interest, we have also created more detailed fact sheets about their Site Tool projects at www.atsdr.cdc.gov/sites/brownfields/site_inventory.html.

FIGURE 1

Examples of Brownfields Mapped in Baker City, Oregon

FIGURE 2

Land Reuse Sites in Health Zone 1

Source: Florida Department of Health in Duval County, 2016.

Baker City, Oregon: High School Students Create a Brownfields Inventory and Engage in Brownfields Assessment and Cleanup

In a small, rural town in eastern Oregon, high school students are using the Site Tool to collect data on brownfields in their community. The data quality was part of an overall learning objective for the students. Initiated by the school's receipt of a donated property that was actually a brownfields, Baker School District's Baker Technical Institute (BTI) hosts the only high school-run brownfields program in the country. Students raised brownfields awareness and used the Site Tool to help the city write a U.S. EPA community-wide assessment grant.

Using the Site Tool, students mapped dozens of potential brownfields in their community, collated data on contaminants of concern, and presented their findings to the city council. Their presentation was key in convincing the city to support and submit a U.S. EPA community-wide assessment grant—with the help of the BTI brownfields class—focused on assessing 25 brownfields sites in 30 blocks (Figure 1). These assessments will help the city understand the depth and breadth of the contamination in their business corridors and will provide property owners with a valuable step in making their properties business ready.

Chicago, Illinois: Master of Science Project to Inventory Land Reuse Sites for Energy Innovation Potential

Erica Arias, Master of Science in Sustainable Management candidate, identified land reuse sites throughout Chicago's south side, including south and west Cook County. Arias researched dozens of sites and used the Site Tool to create an inventory to meet the request of a local Chicago community leader, Bruce Montgomery, executive director of Urban Energy Innovation, to identify land reuse sites greater than 10 acres that could be reused for energy innovation projects (i.e., solar farms) as economic drivers in distressed communities. Arias provided an inventory of 10 sites, including an old hospital, landfill, and several industrial sites to Montgomery, who investigated reusing these sites for energy innovation projects. This project was presented to the community. As a result, local development organizations are focusing on the landfill as a redevelopment opportunity.

Jacksonville, Florida: Florida Department of Health in Duval County Inventory of Land Reuse Sites in Health Zone 1

Grazyna Pawlowicz inventoried 138 known land reuse sites in Duval County, of which 101 (76%) are located within Health Zone 1, an area with elevated adverse health outcome rates and more distressed properties and vacant lots than the county's other five health zones (Florida Department of Health in Duval County, 2016). Pawlowicz inventoried 33 Superfund sites, 2 hazardous waste sites, 58 waste cleanup sites, 2 dump sites, and 10 dry cleaner sites and detailed the chemical contaminants of concern. Pawlowicz also mapped the sites using GIS and overlaid the sites with other local environmental and community data to provide stakeholders and potential developers with a clearer understanding of environmental conditions, as well as help to identify potential priority issues to address (Figure 2). While this project is still in progress, planning for a community citizen science project to engage the public in remediation plans at one Superfund site is underway.

TABLE **1**

Maximum Soil Concentrations and Residual Contaminant Levels (RCLs) of Select Compounds From Five Brownfields/Land Reuse Sites, Washington County, Wisconsin

Contaminant	Unit	Soil Direct Contact RCL		Brownfields/Land Reuse Site (Slated Reuse Category)				
		Non-Industrial	Industrial	Petroleum Distributor (Commercial, Industrial)	Downtown Multi-Use (Residential, Commercial)	Machine Shop (Industrial)	Metal Plating (Unknown)	Rail Yard (Residential)
Metals								
Arsenic	mg/kg	0.613	2.390	**9.3**	**15.0**	n/v	**10.8**	n/v
Barium	mg/kg	15,300	100,000	190	110	114	191	114
Cadmium	mg/kg	70	798	n/v	0.96	n/v	0.72	n/v
Chromium	mg/kg	n/v	n/v	100.0	9.1	31.6	33.8	31.6
Lead	mg/kg	400	800	470	**580**	11	234	11
Mercury	mg/kg	3.13	3.13	0.081	0.110	0.024	0.075	0.017
Selenium	mg/kg	391	5,110	1.70	0.76	n/v	0.96	n/v
Silver	mg/kg	391	5,110	1.50	0.18	n/v	0.96	n/v
Volatile organic compounds (chlorinated)								
1,1,1-trichloroethane	µg/kg	n/r	640	n/v	n/v	0.129	n/v	n/v
Trichloroethylene	µg/kg	n/r	8.41	n/v	n/v	**19.70**	n/v	**7,600**
cis-1,1-dichloroethene	µg/kg	n/r	2,340	n/v	n/v	3.54	n/v	**17,000**
trans-1,1-dichloroethene	µg/kg	n/r	1,850	n/v	n/v	0.0131	n/v	4.1000
Volatile organic compounds (nonchlorinated)								
Benzene	µg/kg	1,490	7,410	170	n/v	n/v	n/v	**12,000**
Ethylbenzene	µg/kg	7,470	3,700	980	n/v	n/v	0.0149	**23,000**
Toluene	µg/kg	818,000	818,000	1,500	n/v	n/v	0.0599	670
Xylene (total)	µg/kg	260,000	260,000	3,100	n/v	n/v	0.1024	24,000
Polycyclic aromatic hydrocarbons								
Benzo[a]anthracene	µg/kg	147	2,100	1,300	**1,600**	n/v	**1,660**	n/v
Benzo[a]pyrene	µg/kg	14.8	211.0	**1,200**	**2,500**	n/v	**1,500**	n/v
Benzo[b]fluoranthene	µg/kg	148	2,110	**2,700**	**3,700**	n/v	**3,750**	n/v
Chrysene	µg/kg	1,480	21,100	2,200	**3,000**	n/v	**2,630**	n/v
Dibenz(a,h)anthracene	µg/kg	14.8	211.0	**340**	**290**	n/v	**264**	n/v
Indeno[1,2,3-cd]pyrene	µg/kg	148	2,110	710	**910**	n/v	**1,040**	n/v

Note. Numbers in bold indicate concentrations above the RCL. RCLs are considered by the U.S. Environmental Protection Agency to be protective for humans (including sensitive groups) over a lifetime. Contaminant values are most often obtained from licensed environmental site professionals.
n/r = not reported; n/v = no value.

West Bend, Wisconsin: Graduate Student Creates a Site Inventory to Characterize Brownfields Sites in Terms of Contaminant Exposures and Site Risks

For her Master of Public Health requirements, Dr. Elizabeth Yogerst is connecting brownfields sites and potential health outcomes by applying the Site Tool to existing data and following Washington County's future activity. Yogerst researched 24 sites and profiled 5 representative sites for this column to emphasize which contaminant levels exceed RCL soil standards in Wisconsin for metals, volatile organic compounds, and polycyclic aromatic hydrocarbons (Table 1). Yogerst obtained contaminant data from reports from the licensed environmental professional who completed the sampling following U.S. EPA and/or state methods (U.S. EPA Region 4, 2014).

Conclusion

The Site Tool's dual capacity of a searchable, customizable inventory and the ability to quickly review sampling data enhanced the capabilities of the cohort communities to ensure public health has a seat at the redevelopment decision table. In addition, the cohorts were able to avoid or reduce consultant costs typically levied for site inventory creations.

We are grateful to our coauthors for sharing their hands-on experiences using the Site Tool. If you would like assistance in creating your own inventory, please contact Gary Perlman at gap6@cdc.gov. In addition, if you use the Site Tool and want to let us know how you used it, we would be happy to add you to our list of Site Tool users so that we can continue to provide guidance to other communities.

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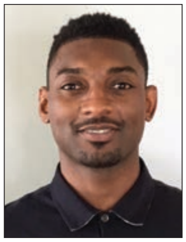
Did You Know?

Beginning October 1, NEHA will introduce a simplified and inclusive membership structure. The new membership categories are Professional, Emerging Professional, Retired Professional, International, and Life. Questions about NEHA's new membership structure can be directed to membership@neha.org.

DIRECT FROM CDC ENVIRONMENTAL HEALTH SERVICES



Erik W. Coleman, MPH

Laura Brown, PhD

Environmental Assessment Training Series (EATS): Practical Training for Food Safety Officials Hungry to Enhance Environmental Assessment Skills

Editor's Note: **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 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 insights and information about environmental health programs, trends, issues, and resources. The conclusions in these columns are those of the author(s) and do not necessarily represent the official position of CDC.

Erik Coleman is a health scientist (informatics) and Laura Brown is behavioral scientist. Both work in the Water, Food, and Environmental Health Services Branch of the Division of Environmental Health Science and Practice at CDC's National Center for Environmental Health.

FIGURE **1**

The Environmental Assessment Training Series (EATS) Helps Food Safety Officials Learn to Conduct Environmental Assessments

Foodborne illness is a significant public health problem in the U.S. Annually, more than 800 foodborne illness outbreaks are reported to the Centers for Disease Control and Prevention (CDC) and most of these occur in retail food service establishments (e.g., restaurants) (Gould et al., 2013). State and local health department investigations of outbreaks collect information valuable in preventing future outbreaks. Of particular value are the data collected during environmental assessments.

Environmental assessments are focused on identifying the environmental causes of outbreaks (also known as contributing factors and environmental antecedents). In other words, the goal is to describe how and why the environment contributed to the introduction or transmission of agents that cause illness (Selman & Guzewich, 2014). For example, an environmental assessment could determine that the contributing factor to an outbreak was an ill worker who transmitted illness to customers (i.e., how the outbreak occurred). The assessment could further determine that the ill worker was working because neither they nor their manager understood that the worker could spread illness through food (i.e., why the outbreak occurred). Findings from environmental assessments can be used to recommend effective interventions that stop ongoing foodborne illness outbreaks and prevent future outbreaks.

Environmental assessments are typically conducted by food safety program officials. They visit the outbreak establishment and conduct a thorough review of the processes and practices used with the suspected outbreak food items. This review could include interviewing staff about food safety policies and practices, observing food preparation practices, and reviewing records. These assessments can be viewed as forensic-type investigations in which investigators reconstruct past events in the outbreak establishment along with other members of an investigation team.

From a local food safety program perspective, foodborne illness outbreaks might not happen very often. So, opportunities to conduct outbreak environmental assessments

FIGURE **2**

Environmental Assessment Training Series (EATS) Users Can Practice Interviewing a Kitchen Manager and Other Restaurant Workers

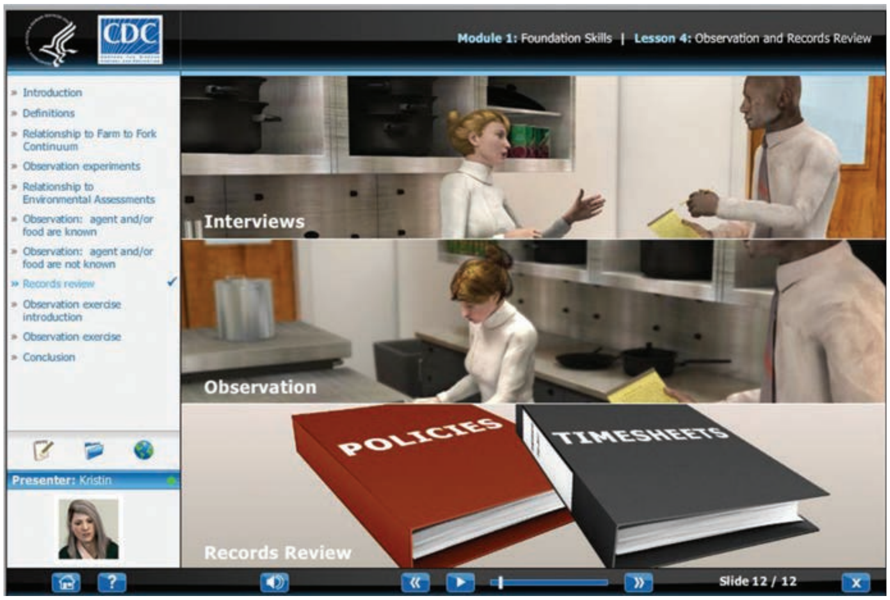


FIGURE **3**

The Environmental Assessment Training Series (EATS) Includes Virtual Outbreak Scenarios

are limited and food safety program officials might not have much experience conducting them. Thus, their outbreak investigation activities can more closely resemble routine inspections, which are less likely to identify environmental causes of outbreaks than environmental assessments. Additionally, there are few training opportunities focused on outbreak environmental assessments. To address these issues, CDC developed the Environmental Assessment Training Series (EATS) (Figure 1). CDC's goal was to provide free online training that uses cutting edge e-learning technology to improve competency with conducting environmental assessments as part of foodborne illness outbreak investigations.

EATS 101: Foundation Skills

In 2014, CDC launched EATS 101: Foundational Skills (initially titled e-Learning on Environmental Assessment of Foodborne Illness Outbreaks). This course provides guidance on conducting environmental assessments in retail food service establishments. Through simulated exercises, participants learn how to use critical thinking, interviewing, sampling, and establishment observation data to identify an outbreak's contributing factors (Figure 2). Participants also learn how to properly summarize these data for reporting to CDC's National Environmental Assessment Reporting System (NEARS).

EATS 102: Skill Building

In 2018, CDC launched EATS 102: Skill Building. This course expands on the foundational skills taught in EATS 101 by giving participants additional practice with conducting virtual environmental assessments within an outbreak investigation team comprised of regional, state, and federal partners. Participants practice applying environmental assessment skills in multiple outbreak scenarios (Figure 3), including a private school, local catering establishment, grower and distributor of organic herbs, and cheese manufacturer.

EATS Benefits

Since the launch of EATS, more than 6,700 participants from multiple government agencies, as well as from scientific, industry, and consumer groups, have enrolled in the training. Average scores of participants who have completed EATS 101 (N = 2,609) show an increase of 25 percentage points in knowledge about environmental assessments from pretraining to posttraining (61% to 86%). These data indicate that the training is meeting its goal. Further analysis of these data indicates that whether participants have been

Access the Centers for Disease Control and Prevention's (CDC) Environmental Assessment Resources

- Environmental Assessment Training Series (EATS) (www.cdc.gov/nceh/ehs/eLearn/eats): EATS helps you practice skills in an interactive virtual environment and learn to conduct environmental assessments as part of foodborne illness outbreak investigations.
- National Environmental Assessment Reporting System (NEARS) (www.cdc.gov/nceh/ehs/nears): NEARS is a companion surveillance system to CDC's National Outbreak Reporting System (NORS) and is used to capture environmental assessment data from foodborne illness outbreak investigations.

a food safety program official for 1 year or 10 years, they gain new knowledge from EATS.

As an incentive to EATS participants, CDC offers continuing education units for completion of each course. Because EATS is comprehensive and provides many opportunities to apply knowledge learned, completion requires a significant time commitment. It takes an average of 9 hr and 6 hr to complete EATS 101 and EATS 102, respectively. The exercises, however, are self-paced and do not have to be completed in one sitting. Participants report that the training is engaging and effective in improving foodborne illness investigator skills. For example, a Minnesota Department of Health staff member noted that they use some of the questioning tactics presented in NEARS in the field and that EATS can help any inspector conducting outbreak investigations.

CDC is dedicated to promoting the importance of conducting environmental assessments as part of foodborne illness outbreak investigations. EATS helps to improve the ability of food safety programs to prepare for, respond to, and prevent foodborne illness outbreaks. This improvement can ultimately assist in reducing foodborne illness.

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References

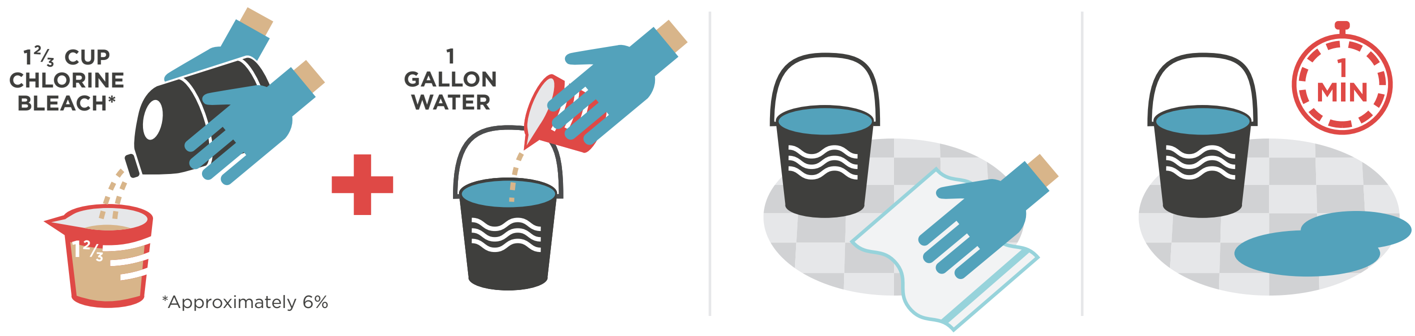
Gould, L.H., Walsh, K.A., Vieira, A.R., Herman, K., Williams, I.T., Hall, A.J., & Cole, D. (2013). Surveillance for foodborne disease outbreaks—United States, 1998–2008. *Morbidity and Mortality Weekly Report*, 62(SS02), 1–34.

Selman, C.A., & Guzewich, J.J. (2014). Public health measures: Environmental assessment in outbreak investigations. In Y. Motarjemi (Ed.), *Encyclopedia of food safety, volume 4* (pp. 98–106). Waltham, MA: Academic Press.

Help Prevent the Spread of Hepatitis A

1: CLEAN UP SURFACES

2: DISINFECT SURFACES



*Approximately 6%

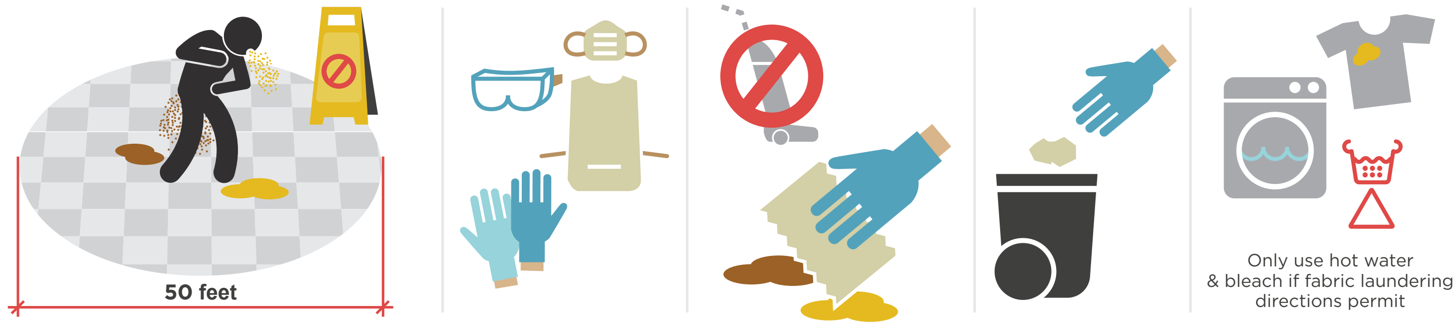
3: WASH YOUR HANDS

Scientific experts from the U.S. Centers for Disease Control and Prevention (CDC) helped to develop this poster. For more information on Hepatitis A prevention, please see https://www.cdc.gov/hepatitis/hav/

NEHA EDUCATION & TRAINING
WATER QUALITY & HEALTH COUNCIL
American Chemistry Council
HEALTH DEPARTMENT

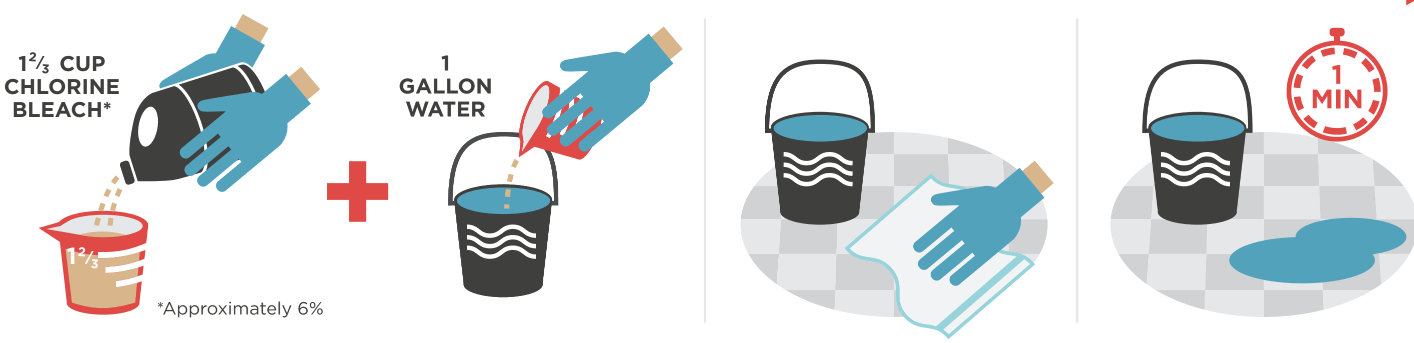
Clean Up & Disinfect for Hepatitis A

1: WIPE UP SURFACES



2: CLEAN UP SURFACES

3: DISINFECT SURFACES



4: WASH YOUR HANDS

Scientific experts from the U.S. Centers for Disease Control and Prevention (CDC) helped to develop this poster. For more information on Hepatitis A clean up, please see https://www.cdc.gov/hepatitis/hav/

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WATER QUALITY & HEALTH COUNCIL

American Chemistry Council

HEALTH DEPARTMENT

CAREER OPPORTUNITIES

Food Safety Inspector

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Eugene, OR
Eureka, CA
Fresno, CA
Galveston, TX
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Grand Rapids, MI
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Idaho Falls, ID
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Long Beach, CA
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- Twitter: https://twitter.com/nehaorg
- LinkedIn: www.linkedin.com/company/national-environmental-health-association

Follow us, like us, and join in on the conversation!

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EH CALENDAR

UPCOMING NEHA CONFERENCES

July 8–11, 2019: NEHA 2019 Annual Educational Conference & Exhibition, Nashville, TN. For more information, visit www.neha.org/aec.

July 13–16, 2020: NEHA 2020 Annual Educational Conference & Exhibition, New York, NY.

July 12–15, 2021: NEHA 2021 Annual Educational Conference & Exhibition, Spokane, WA.

NEHA AFFILIATE AND REGIONAL LISTINGS

Alabama
October 17–19, 2018: 2018 AEHA Conference, hosted by the Alabama Environmental Health Association, Lake Guntersville, AL. For more information, visit www.aeha-online.com.

Alaska
October 10–12, 2018: Annual Educational Conference, hosted by the Alaska Environmental Health Association, Anchorage, AK. For more information, visit https://sites.google.com/site/aehatest.

California
October 12, 2018: CEHA Update, hosted by the Southwest Chapter of the California Environmental Health Association, San Diego, CA. For more information, visit www.ceha.org.

Colorado
September 18–21, 2018: 63rd Annual Education Conference, hosted by the Colorado Environmental Health Association, Fort Collins, CO. For more information, visit www.cehaweb.com.

Indiana
September 24–26, 2018: Fall Educational Conference, hosted by the Indiana Environmental Health Association, Evansville, IN. For more information, visit www.iehaind.org/Conference.

Iowa
October 3–4, 2018: Fall Conference, hosted by the Iowa Environmental Health Association, Des Moines, IA. For more information, visit www.ieha.net.

Kansas
September 12–14, 2018: Fall Conference, hosted by the Kansas Environmental Health Association, Salina, KS. For more information, visit www.keha.us.

Maine
September 19–21, 2018: 56th Annual Yankee Conference on Environmental Health, in conjunction with the Food and Drug Administration's Northeast Annual Food Protection Seminar, South Portland, ME. For more information, visit https://ceha.wildapricot.org/event-2966235.

Montana
September 18–19, 2018: Fall Educational Conference, hosted by the Montana Environmental Health Association, Helena, MT. For more information, visit www.mehaweb.org.

Nebraska
October 3, 2018: Annual Education Conference, hosted by the Nebraska Environmental Health Association, Ashland, NE. For more information, visit www.nebraskaneha.com.

North Carolina
September 19–21, 2018: Fall Educational Conference, hosted by the North Carolina Public Health Association, Charlotte, NC. For more information, visit https://ncpha.memberclicks.net.

North Dakota
October 22–24, 2018: Fall Education Conference, hosted by the North Dakota Environmental Health Association, Bismarck, ND. For more information, visit http://ndeha.org/wp/conferences.

Texas
October 22–26, 2018: Annual Educational Conference, hosted by the Texas Environmental Health Association, Austin, TX. For more information, visit www.myteha.org.

Utah
September 25–27, 2018: Fall Conference, hosted by the Utah Environmental Health Association, Provo, UT. For more information, visit www.ueha.org/events.html.

Wisconsin
September 19–21, 2018: Educational Conference, hosted by the Wisconsin Environmental Health Association, Onalaska, WI. For more information, visit https://weha.net/events.

Wyoming
September 17–20, 2018: Annual Education Conference, hosted by the Wyoming Environmental Health Association, Cheyenne, WY. For more information, visit www.wehaonline.net.

TOPICAL LISTINGS

Recreational Waters
October 10–12, 2018: 15th Annual World Aquatic Health Conference, hosted by the National Swimming Pool Foundation, Charleston, SC. For more information, visit http://thewahc.org.

Vectors and Pest Control
September 11–14, 2018: 15th International Conference on Lyme Borreliosis and Other Tick-Borne Diseases, hosted by the Centers for Disease Control and Prevention, National Institutes of Health, and National Environmental Health Association, Atlanta, GA. For more information, visit www.neha.org/iclb2018.

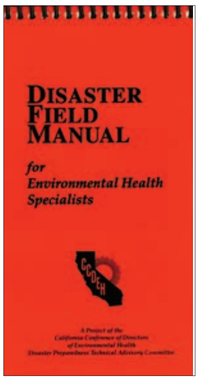
RESOURCE CORNER

Resource Corner highlights different resources that NEHA has available to meet your education and training needs. These timely resources provide you with information and knowledge to advance your professional development. Visit NEHA's online Bookstore for additional information about these, and many other, pertinent resources!

NEHA BOOKSTORE
www.neha.org/store

Disaster Field Manual for Environmental Health Specialists

California Association of Environmental Health Administrators (2012)

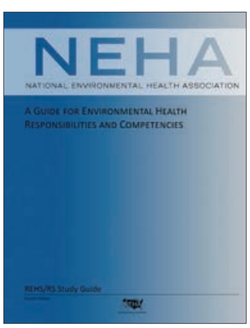


This manual serves as a useful field guide for environmental health professionals following a major disaster. It provides an excellent overview of key response and recovery options to be considered as prompt and informed decisions are made to protect the public's health and safety. Some of the topics covered as they relate to disasters include water, food, liquid waste/sewage, solid waste disposal, housing/mass care shelters, vector control, hazardous materials, medical waste, and responding to a radiological incident. The manual is made of water-resistant paper and is small enough to fit in your pocket, making it useful in the field. Study reference for NEHA's Registered Environmental Health Specialist/Registered Sanitarian credential exam.

224 pages / Spiral-Bound Hardback
Member: $37 / Nonmember: $45

REHS/RS Study Guide (4th Edition)

National Environmental Health Association (2014)

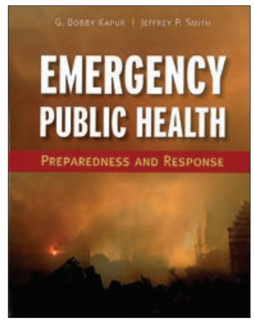


The Registered Environmental Health Specialist/Registered Sanitarian (REHS/RS) credential is NEHA's premier credential. This study guide provides a tool for individuals to prepare for the REHS/RS credential exam and has been revised and updated to reflect changes and advancements in technologies and theories in the environmental health and protection field. The study guide covers the following topic areas: general environmental health; statutes and regulations; food protection; potable water; wastewater; solid and hazardous waste; zoonoses, vectors, pests, and poisonous plants; radiation protection; occupational safety and health; air quality; environmental noise; housing sanitation; institutions and licensed establishments; swimming pools and recreational facilities; and disaster sanitation.

308 pages / Paperback
Member: $149 / Nonmember: $179

Emergency Public Health: Preparedness and Response

G. Bobby Kapur and Jeffrey P. Smith (2011)



Emergency Public Health provides a unique and practical framework for disaster response planning at local, state, and national levels. This book is the first of its kind to systematically address the issues in a range of environmental public health emergencies brought on by natural calamity, terrorism, industrial accident, or infectious disease. It features historical perspectives on a public health crisis, an analysis of preparedness, and a practical, relevant case study on the emergency response. Study reference for NEHA's Registered Environmental Health Specialist/Registered Sanitarian credential exam.

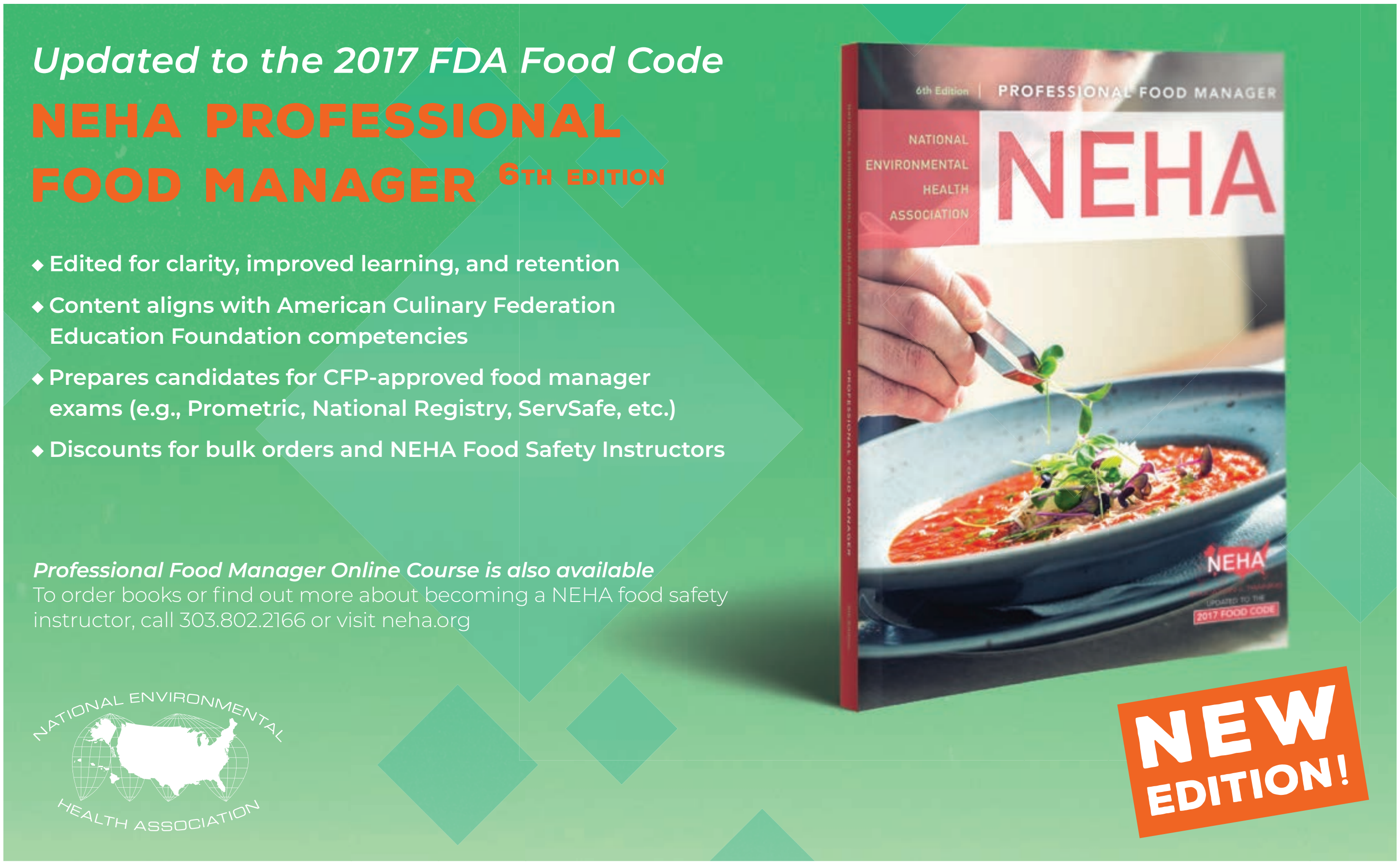
568 pages / Paperback
Member: $114 / Nonmember: $124

Control of Communicable Diseases Manual (20th Edition)

Edited by David L. Heymann, MD (2015)

The *Control of Communicable Diseases Manual (CCDM)* is revised and republished every several years to provide the most current information and recommendations for communicable-disease prevention. The *CCDM* is designed to be an authoritative reference for public health workers in official and voluntary health agencies. The 20th edition sticks to the tried and tested structure of previous editions. Chapters have been updated by international experts. New disease variants have been included and some chapters have been fundamentally reworked. This edition is a timely update to a milestone reference work that ensures the relevance and usefulness to every public health professional around the world. The *CCDM* is a study reference for NEHA's Registered Environmental Health Specialist/Registered Sanitarian and Certified Professional–Food Safety credential exams.

729 pages / Paperback
Member: $59 / Nonmember: $64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www.arlingtonva.us

Association of Environmental Health Academic Programs
www.aehap.org

Baltimore City Health Department, Office of Chronic Disease Prevention
https://health.baltimorecity.gov/programs/health-resources-topic

Bureau of Community and Children's Environmental Health, Lead Program
www.houstontx.gov/health/Environmental/community_childrens.html

CDC ATSDR/DCHI
www.atsdr.cdc.gov/hac

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City of Laramie
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City of Racine Public Health Department
http://cityofracine.org/Health

City of St. Louis Department of Health
www.stlouis-mo.gov/government/departments/health

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Coconino County Public Health
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Erie County Department of Health
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Georgia Department of Public Health, Environmental Health Section
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Giant Eagle, Inc.
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Gila River Indian Community: Environmental Health Service
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Kentucky Department of Public Health
http://chfs.ky.gov/agencies/dph/Pages/default.aspx

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Louisiana State Board of Examiners for Sanitarians
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Marathon County Health Department
www.co.marathon.wi.us/Departments/HealthDepartment.aspx

Maricopa County Environmental Services
www.maricopa.gov/631/Environmental-Services

Metro Public Health Department
www.nashville.gov/Health-Department.aspx

MFC Center for Health
drjf14@aol.com

Multnomah County Environmental Health
https://multco.us/health

Nashua Department of Health
http://nashuanh.gov/497/Public-Health-Community-Services

National Environmental Health Science & Protection Accreditation Council
www.nehspac.org

National Restaurant Association
www.restaurant.org

New Mexico Environment Department
www.env.nm.gov

New York City Department of Health and Mental Hygiene
www1.nyc.gov/site/doh/index.page

Nova Scotia Environment
https://novascotia.ca/nse

NSF International
www.nsf.org

Oklahoma Department of Environmental Quality
www.deq.state.ok.us

Oneida Indian Tribe of Wisconsin
https://oneida-nsn.gov/resources/environmental

Opportunity Council/Building Performance Center
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Waukesha County Environmental Health Division
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Eastern Kentucky University
http://ehs.eku.edu

Michigan State University, Online Master of Science in Food Safety
www.online.foodsafety.msu.edu

Old Dominion University
www.odu.edu/commhealth

The University of Findlay
www.findlay.edu

University of Illinois Department of Public Health
www.uis.edu/publichealth

University of Illinois, Illinois State Water Survey
www.isws.illinois.edu

University of Illinois Springfield
www.uis.edu/publichealth

University of Wisconsin–Madison, University Health Services
www.uhs.wisc.edu

University of Wisconsin–Stout, College of Science, Technology, Engineering, and Mathematics
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NEHA's Annual Financial Statement

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INDEPENDENT AUDITORS' REPORT

To the Board of Directors
National Environmental Health Association
Denver, Colorado

REPORT ON THE FINANCIAL STATEMENTS

We have audited the accompanying financial statements of National Environmental Health Association (the "Association"), which are comprised of the statements of financial position as of September 30, 2017 and 2016, and the related statements of activities and cash flows for the years then ended, and the related notes to the financial statements.

MANAGEMENT'S RESPONSIBILITY FOR THE FINANCIAL STATEMENTS

Management is responsible for the preparation and fair presentation of these financial statements in accordance with accounting principles generally accepted in the United States of America; this includes the design, implementation, and maintenance of internal control relevant to the preparation and fair presentation of financial statements that are free from material misstatement, whether due to fraud or error.

AUDITORS' RESPONSIBILITY

Our responsibility is to express an opinion on these financial statements based on our audits. We conducted our audits in accordance with auditing standards generally accepted in the United States of America and the standards applicable to financial audits contained in *Government Auditing Standards* issued by the Comptroller General of the United States. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditors' judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditors consider internal control relevant to the entity's preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control. Accordingly, we express no such opinion. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of significant accounting estimates made by management, as well as evaluating the overall presentation of the financial statements.

To the Board of Directors
National Environmental Health Association
Page Two

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

OPINION

In our opinion, the financial statements referred to above present fairly, in all material respects, the financial position of National Environmental Health Association as of September 30, 2017 and 2016, and the changes in its net assets and its cash flows for the years then ended in accordance with accounting principles generally accepted in the United States of America.

OTHER MATTERS

Our audits were conducted for the purpose of forming an opinion on the financial statements as a whole. The accompanying schedule of expenditures of federal awards, as required by Title 2 U.S. *Code of Federal Regulations* Part 200, *Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards*, is presented for purposes of additional analysis and is not a required part of the financial statements. Such information is the responsibility of management and was derived from and relates directly to the underlying accounting and other records used to prepare the financial statements. The information has been subjected to the auditing procedures applied in the audits of the financial statements and certain additional procedures, including comparing and reconciling such information directly to the underlying accounting and other records used to prepare the financial statements or to the financial statements themselves, and other additional procedures in accordance with auditing standards generally accepted in the United States of America. In our opinion, the information is fairly stated, in all material respects, in relation to the financial statements as a whole.

OTHER REPORTING REQUIRED BY *GOVERNMENT AUDITING STANDARDS*

In accordance with *Government Auditing Standards*, we have also issued our report dated December 21, 2017, on our consideration of the Association's internal control over financial reporting and on our tests of its compliance with certain provisions of laws, regulations, contracts, grant agreements, and other matters. The purpose of that report is to describe the scope of our testing of internal control over financial reporting and compliance and the results of that testing, and not to provide an opinion on internal control over financial reporting or on compliance. That report is an integral part of an audit performed in accordance with *Government Auditing Standards* in considering the Association's internal control over financial reporting and compliance.

EKS&H LLLP

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December 21, 2017
Denver, Colorado

	For the Years Ended					
	September 30, 2017			September 30, 2016		
	Unrestricted	Temporarily Restricted	Total	Unrestricted	Temporarily Restricted	Total
Revenues and gains						
Research and development	$ 1,868,359	$ -	$ 1,868,359	$ 1,514,445	$ -	$ 1,514,445
Annual Educational Conference	654,199	-	654,199	878,217	-	878,217
Credentialing and education	699,839	-	699,839	774,868	-	774,868
Membership dues	372,184	-	372,184	394,391	-	394,391
Journal of Environmental Health	183,554	-	183,554	229,628	-	229,628
Special projects	1,545,870	-	1,545,870	3,183,029	-	3,183,029
Contributions	17,526	5,172	22,698	11,005	-	11,005
Publications and module contracts	28,789	-	28,789	56,435	-	56,435
Miscellaneous income	36,468	-	36,468	24,515	-	24,515
Investment income	38,922	1,146	40,068	30,756	1,130	31,886
Total revenues and gains	5,445,710	6,318	5,452,028	7,097,289	1,130	7,098,419
Expenses						
Research and development	1,428,954	-	1,428,954	1,511,344	-	1,511,344
Annual Educational Conference	590,082	-	590,082	612,206	-	612,206
Journal of Environmental Health	300,256	-	300,256	270,100	-	270,100
Credentialing and education	567,809	-	567,809	503,741	-	503,741
Membership	106,520	-	106,520	59,670	-	59,670
Publications and module contracts	8,636	-	8,636	21,520	-	21,520
Special projects	1,668,260	-	1,668,260	3,253,836	-	3,253,836
Administration and general	770,385	-	770,385	290,765	-	290,765
Total expenses	5,440,902	-	5,440,902	6,523,182	-	6,523,182
Change in net assets	4,808	6,318	11,126	574,107	1,130	575,237
Net assets at beginning of year	1,614,739	81,835	1,696,574	1,040,632	80,705	1,121,337
Net assets at end of year	$ 1,619,547	$ 88,153	$ 1,707,700	$ 1,614,739	$ 81,835	$ 1,696,574

See notes to financial statements.

The information in this statement is derived from audited financials; the entire audited report can be obtained by contacting NEHA.

SPECIAL **LISTING**

The board of directors includes NEHA's nationally elected officers and regional vice-presidents. Affiliate presidents (or appointed representatives) comprise the Affiliate Presidents Council. Technical advisors, the executive director, and all past presidents of the association are ex-officio council members. This list is current as of press time.

Priscilla Oliver, PhD
President-Elect

National Officers

President—Vince Radke, MPH, RS, CP-FS, DLAAS, CPH, Environmental Health Specialist, Atlanta, GA.
President@neha.org

President-Elect—Priscilla Oliver, PhD, Life Scientist, Atlanta, GA.
PresidentElect@neha.org

First Vice-President—Sandra Long, REHS, RS, Inspection Services Supervisor, City of Plano Health Department, Plano, TX.
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Second Vice-President—Roy Kroeger, REHS, Environmental Health Supervisor, Cheyenne/Laramie County Health Department, Cheyenne, WY.
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Immediate Past-President—Adam London, RS, MPA, Health Officer, Kent County Health Department, Grand Rapids, MI.
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NEHA Executive Director—David Dyjack, DrPH, CIH, (nonvoting ex-officio member of the board of directors), Denver, CO.
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Region 1—Matthew Reighter, MPH, REHS, CP-FS, Retail Quality Assurance Manager, Starbucks Coffee Company, Seattle, WA.
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Region 2—Major Jacqueline Reszetar, MS, REHS, U.S. Army, Retired, Henderson, NV.
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Region 3: Rachelle Blackham, MPH, LEHS, Environmental Health Deputy Director, Davis County Health Department, Clearfield, UT.
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Colorado, Montana, Utah, Wyoming, and members residing outside of the U.S. (except members of the U.S. armed forces). Term expires 2021

Region 4—Kim Carlton, MPH, REHS/RS, Environmental Health Supervisor, Minnesota Department of Health, St. Paul, MN.
Region4RVP@neha.org
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Region 5—Tom Vyles, REHS/RS, CP-FS, Environmental Health Manager, Town of Flower Mound, TX.
Region5RVP@neha.org
Arkansas, Kansas, Louisiana, Missouri, New Mexico, Oklahoma, and Texas. Term expires 2020.

Region 6—Lynne Madison, RS, Environmental Health Division Director, Western UP Health Department, Hancock, MI.
Region6RVP@neha.org
Illinois, Indiana, Kentucky, Michigan, and Ohio. Term expires 2019.

Region 7—Tim Hatch, MPA, REHS, Deputy Director and Director of Logistics and Environmental Programs, Alabama Department of Public Health, Center for Emergency Preparedness, Montgomery, AL.
Region7RVP@neha.org
Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina, and Tennessee. Term expires 2020.

Region 8—LCDR James Speckhart, MS, USPHS, Health and Safety Officer, FDA, CDRH-Health and Safety Office, Silver Spring, MD.
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Region 9—Larry Ramdin, REHS, CP-FS, HHS, Health Agent, Salem Board of Health, Salem, MA.
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NEHA NEWS

Note of Thanks to Departing Board Members

We would be remiss if we did not acknowledge the dedication, hard work, and efforts of four members of NEHA's board of directors on the occasion of their departure from the board: Region 2 Vice-President Keith Allen, Region 7 Vice-President Timothy Mitchell, Immediate Past-President David Riggs, and Region 4 Vice-President Sharon Smith.

Region 2 Vice-President Keith Allen leaves the board after 3 years of dedicated service and leadership, serving in this position from 2015–2018. Keith has worked in the field of environmental health for nearly 18 years and is currently employed as a senior environmental health specialist with the City of Long Beach Department of Health & Human Services. In addition, he is a part-time faculty member at his alma mater, Long Beach State University, where he teaches graduate level courses in environmental health.

Keith was the 2005 president of the California Environmental Health Association's (CEHA) Southern Chapter and was the 2006 CEHA Charles Senn Award recipient. He also proudly holds the prestigious status as a diplomate of the American Academy of Sanitarians. Keith coauthored an article in the September 2014 issue of the *Journal of Environmental Health* titled "A Community Outbreak of *Salmonella enterica* Serotype Typhimurium Associated With an Asymptomatic Food Handler in Two Local Restaurants."

"Serving on the NEHA board over the past 3 years has truly been an unforgettable experience," states Keith. "It was rewarding to serve my colleagues in the environmental health community and in helping make our profession better. I am very blessed to have made some lifelong friends with fellow NEHA board members."

Region 7 Vice-President Timothy Mitchell leaves the board after 1 year of dedicated service and leadership. Timothy has worked in the public and private environmental health sectors for two decades. He is credentialed through NEHA as a Registered Environmental Health Specialist/Registered Sanitarian and Certified Professional–Food Safety. Timothy is a strong advocate of NEHA's credentialing programs, training opportunities, and support of the environmental health profession.

Immediate Past-President David Riggs leaves the board after 15 years of dedicated service and leadership. Dave has retired after a 48-year career in management and training in environmental health and has been a member of NEHA for 43 years. He has been a strong advocate for the state affiliates, as well as individual environmental health professionals. Over the years he has served in leadership roles in three state affiliates and was responsible, along with other environmental health professionals, in promoting a revitalized and active Alaska affiliate.

During Dave's term as NEHA president, the association strengthened relationships with other environmental and public health associations and gained increased recognition as a leader on the national stage by federal and state agencies. It was during his tenure as president that the now annual visit to members of Congress by NEHA's national officers was initiated. Dave was also deeply involved in NEHA's leadership transition in 2014. Prior to being a national officer, he served as NEHA's Region 1 vice-president.

Going forward, Dave will remain active in environmental health through his activities as a consultant for local environmental health agencies in operations, management, and training. He will also remain active in his community though his various charitable organizations. Dave and his wife, June, will continue to conduct and organize the annual Youth in Government day involving high school students and elected government officials.

Looking back on his last 15 years on the NEHA board, Dave describes it as "the most enlightening, rewarding, and enjoyable experience of my career. The things I have learned, the friends I have made, and the affiliates I have visited would not have been possible. I encourage our young professionals to take full advantage of their membership in NEHA."

Region 4 Vice-President Sharon Smith leaves the board after 2 years of dedicated service and leadership. While as a regional vice-president, she served on NEHA's membership, affiliate engagement, Annual Educational Conference & Exhibition, and global engagement committees. Prior to joining the board, Sharon served as a NEHA Technical Advisor from 2011–2016 and represented the association on a U.S. Environmental Protection Agency Small Systems Workgroup.

Sharon recently retired from a 33-year career as an environmental health specialist. She was a regional supervisor for the noncommunity unit of the Drinking Water Protection Section at the Minnesota Department of Health. She began her career developing an environmental health program for a rural county public health agency. Sharon has been active in the Minnesota Environmental Health Association (MEHA) for many years, serving as its president from 2001–2002. She received merit awards numerous years and was named the MEHA Environmental Health Professional of the Year in 1998. Over the years she has served as co-chairperson of MEHA's publications, marketing, scholarship, and conference committees.

Sharon states that serving as a regional vice-president has been "a rewarding experience and I encourage all to volunteer to raise our profession at the national and state levels. I'm excited to continue to serve NEHA as a member of its credentialing committee."

NEHA NEWS

NEHA Staff Profile

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 one NEHA staff member. Contact information for all NEHA staff can be found on page 57.

Christine Ortiz Gumina

I joined NEHA in September 2017 as its new project coordinator for the Washington, DC, office. As one third of the Washington, DC, staff, my role is to oversee, assist, and coordinate project work in the areas of vector control, climate change, child and maternal health as it pertains to lead exposure, and environmental health emergency preparedness. I also am responsible for NEHA's work on the National Environmental Public Health Internship Program and Epi-Ready Team Trainer: Foodborne Illness Response Strategy Program. In addition to my project work, I assist and participate in meetings, conferences, and workshops in the Washington, DC, area that pertain to environmental public health issues.

I earned a Bachelor of Science degree in kinesiological science from the University of Maryland, College Park, and a Master of Public Health from Eastern Virginia Medical School with a concentration in global environmental health. I was born in Ceiba, Puerto Rico, to Puerto Rican parents and spent my life in and out of the island as the daughter of a U.S. Navy service member. I have lived in various places—Puerto Rico, Florida, California, Virginia, Connecticut, Maryland, and the beautiful island of Guam. As a graduate student I worked on the Hampton Roads Intergovernmental Pilot Project, which brought a whole government and whole community approach to sea level rise and emergency preparedness issues in the Hampton Roads region of Virginia. This area of Virginia is incredibly vital to the U.S. as it hold one of the largest and deepest commercial sea ports on the east coast and is home to the U.S. Navy Atlantic Fleet.

Prior to joining NEHA I was an environmental health specialist for the City of Norfolk in Virginia. My experience with the health department was enlightening and informative, but my passion remained with environmental health preparedness. My goal at NEHA is to recognize environmental health's role in emergency preparedness in order for local, state, territorial, and tribal health agencies to better prepare for the next major disaster.

Did You Know?

NEHA has posted two new policy statements on ear piecing guns and microblading that were recently approved by its board of directors. You can find these and other policy statements at www.neha.org/publications/position-papers.

DirecTalk
continued from page 62

tently close our minds or conduct ourselves in a manner that excludes a segment of society. NEHA is for everybody—not just those who agree with us.

NEHA represents environmental health professionals regardless of their beliefs. Our members come from all walks of life and represent the entire political, religious, and racial spectrum. We intend to be an inclusive association that respects the full menu of perspectives on issues of national and global health, safety, and security. NEHA is committed to the proposition that while we may disagree with someone's viewpoint or orientation, we can and will treat them with respect and listen to their story.

I want each of you to know that I take inclusivity seriously. As we hire new employees we desire that they reflect the heterogeneous U.S. population. Our members live in red, blue, and purple states. I know that because I have had the privilege to visit many of them. I have a special affection for frontier and rural environmental health programs because environmental health is public health for many of those communities. From Saipan to Puerto Rico and Utqiaġvik to Key West, our association strives to provide a safe and healthy environment for all. We can't achieve that if we live separate professional lives because as the cliché goes, all of us are smarter than one of us.

The faces of NEHA. Photo courtesy of Michael Kitada, michael@michaelkitada.com.

Our association membership represents the second largest segment of the public health profession after nursing. We spend time in communities, businesses, and recreational areas. People across the country increasingly see us as leaders. There is tension in this time in our nation's history. Let's do our part to diffuse that tension. My heart tells me it is time to add compassion, empathy, and healing to our professional repertoire of essential services. Our country deserves no less.

Acknowledgement: Thanks to Joanne Zurcher and Chris Thorne who conceptualized and wrote a portion of the original content of this column.

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DirecTalk MUSINGS FROM THE 10TH FLOOR

David Dyjack, DrPH, CIH

Time Under Tension

The refrain "time under tension" echoes in my mind like a bat in search of prey. The phrase is commonly employed in strength and conditioning training and is a reference to how long a muscle is under strain during exercise. Reportedly, the longer the stress, the better the result. Except, I am *not* talking about my fitness regimen. I *am* talking about the current time in U.S. society and the state of national tension expressing itself in the form of a general lack of civility. As our association is increasingly seen as a national and influential voice on health issues, our profession is not immune to the winds that buffet our country and its people. I would like to share a couple examples of what this situation looks like in practice.

Every 2 years our annual conference is convened in partnership with the U.S. Department of Housing and Urban Development (HUD). Two years ago, then HUD Secretary Julián Castro spoke at our 2016 Annual Educational Conference (AEC) & Exhibition. This year, HUD Secretary Dr. Ben Carson was scheduled to speak at our AEC in Anaheim, California. NEHA's relationship with HUD is an important one. HUD provides funds to state and local governments to develop cost-effective ways to reduce lead-based paint hazards and other risks associated with the built environment. They are a critical player in the environmental health landscape, particularly for children and people living in poverty.

I was disappointed by the hate that quickly revealed itself on our Facebook page when Dr. Carson's proposed presence at the 2018 AEC was announced. Some of the hate was racial. Some was historical. Some was political. Some of our members threatened to end their relationships with us. Hate has never solved any problem and has no place in the NEHA network.

> *NEHA is for everybody—not just those who agree with us.*

Our partnership with HUD leverages both organizations on behalf of national health and safety. NEHA is a nonprofit and, by law, a bipartisan organization. The presence of a political appointee at our AEC is not to be construed as a NEHA endorsement. The political beliefs and ideologies of AEC speakers are their own. The purpose of the AEC is to provide an opportunity to engage in full and spirited dialogue on environmental health issues. We offer this opportunity to speak to AEC attendees on issues germane to the profession regardless of political party or agenda of the current political administration.

The second situation developed as an outcome of a recent AEC presentation. In at least one case, an attendee was deeply offended in the manner in which the lesbian, bisexual, gay, and transgender community was portrayed. I was not present at this session. Having said that, some felt that the language used to describe the study population was offensive. The presenter, when confronted, was surprised by the criticism. This case represents a teachable moment.

As our nation struggles with policy and practice around gender and sexual orientation issues, NEHA sees itself as a convener, a safe place, where legitimate health issues can be explored in an environment of mutual respect and inclusion. Bloodborne pathogens, needle exchange programs, and sexually transmitted diseases are, after all, legitimate public health issues. We should carefully attempt to strike the right tone and be sensitive to words that potentially convey hurt. I know this situation firsthand. About 15 years ago I (regretfully) introduced the president of a community college as the president of a "junior" college. Ouch, I'm still in recovery from that event. I was unaware of the sensitivity of the issue. I know now that words matter.

I am not asking you to embrace someone else's beliefs. I am not asking you to compromise your values. I am not asking you to question your identity. I *am* asking you to recommit yourself to the notion that environmental health is a fact-based profession. We are professionals who search for evidence, clues, and trends to support informed decisions related to public health. Being fact finders is to be on a journey of discovery. We cannot do justice to our profession and the people we serve if we deliberately or inadver-

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