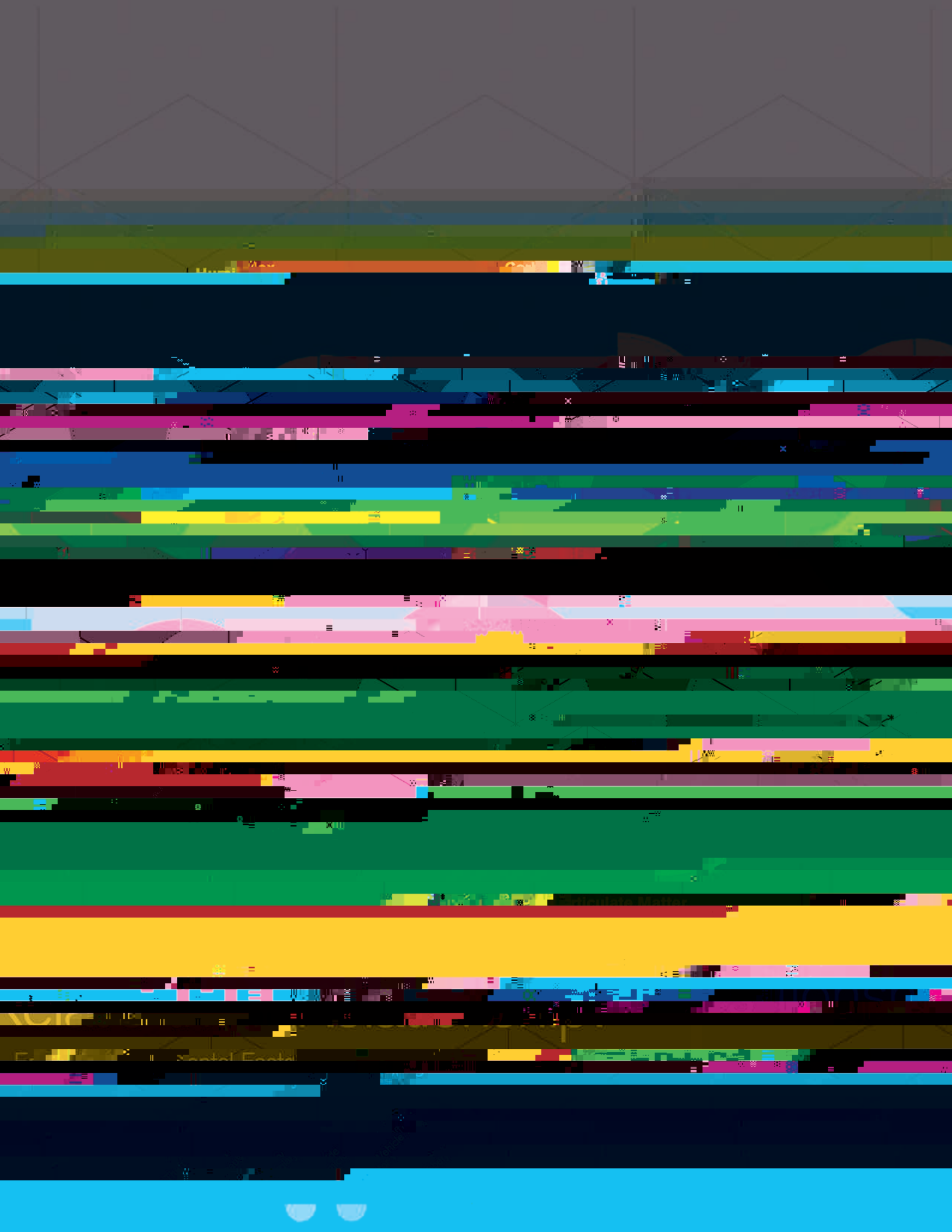

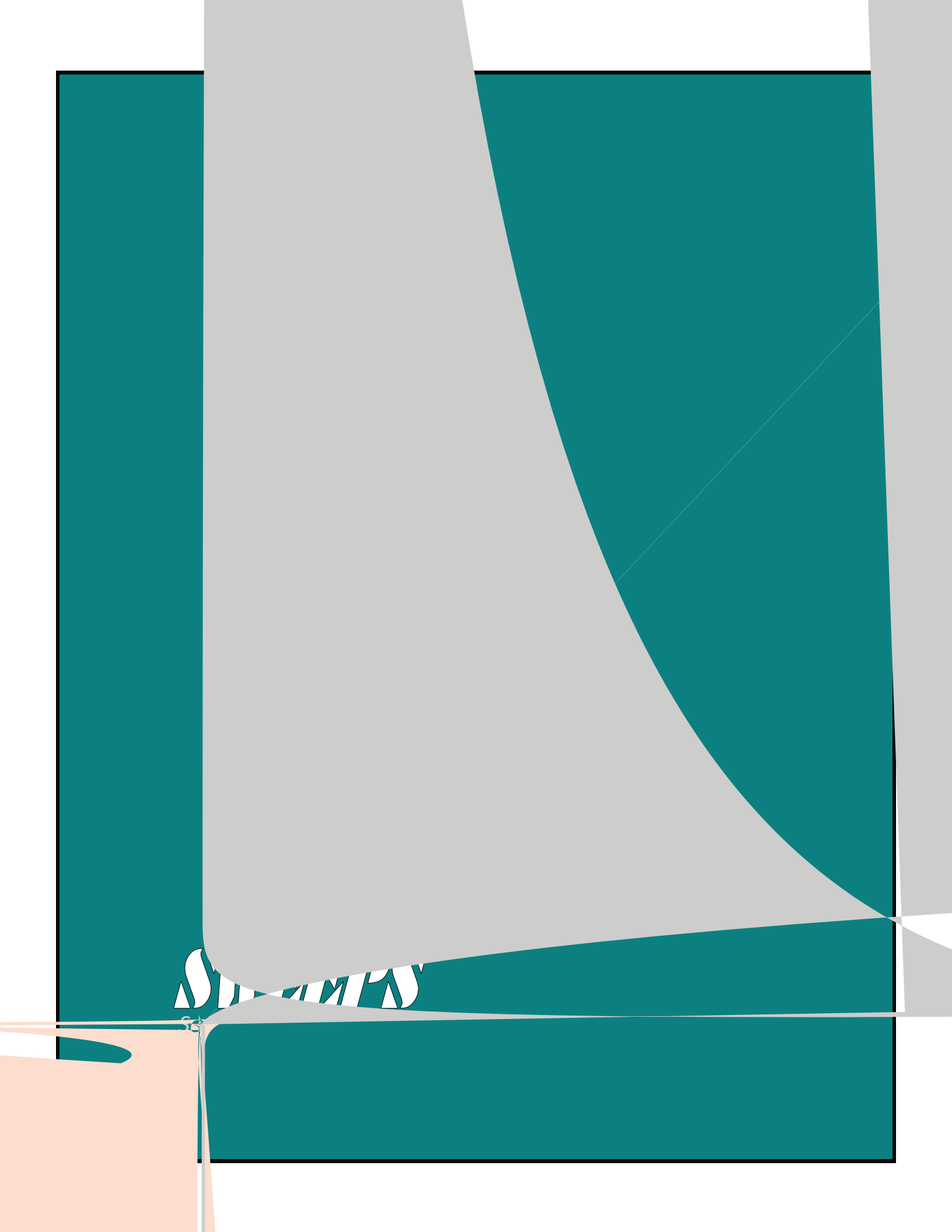

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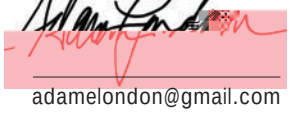
this bill is a bold step toward strengthening public health and safety. A stronger environmental health workforce is also good for the national security of the U.S. These are messages that should resonate with elected of - cials who have sworn to protect the nations well-being.

This month, I ask you to contact your elected of cials in Washington, DC, and tell them that you support H.R. 1909. More speci cally, focus your communications on the representatives who chair the committees where this bill currently resides. Please contact Representative Greg Walden (R-OR), who chairs the Committee on Energy and Commerce; Representative Michael Burgess (R-TX), who chairs the Committee on Energy and Commerces Subcommittee on Health; and Representative Virginia Foxx (R-NC), who chairs the Committee on Education and the Workforce.

Please let them know that the environmental health workforce is critical to our nations health, safety, and security. A list of elected of cials and how they can be contacted is available online at www.house.gov/representatives and www.congress.gov/members. Imagine the impact thousands of letters and calls from NEHA members could have on the process!



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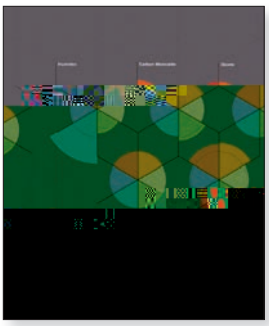

Editor's Note: A supplemental document that was submitted along with this peer-reviewed article has been posted online due to publication space limitations. The Journal did not copy edit the online supplemental document; the authors are providing it as an extra resource should the reader want more information. The supplemental document can be accessed at www.neha.org/jeh/supplemental.

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predictor of violent episodes was temperature. Additionally, aggressive crimes were found to increase by 50% when apparent temperature increased to 25 °C from -10 °C (Butke & Sheridan, 2010). Rotton and Cohn (2000) elaborated on this research by considering the impact of temperature on disorderly conduct, and found temperature was signi cantly asso-

ciated with this type of crime. Studies have also looked at the effects of weather variables like temperature and relative humidity in relation to crime. In a study focusing on the U.S., researchers analyzed 30 years of crime and weather data and concluded outdoor temperature had a strong effect on crime (Ranson, 2014). In a similar study conducted in New Zealand, temperature and precipitation were both identified as having had a significant effect on the number of violent crimes committed (Horrocks & Menclova, 2011).

Several other studies have also reported temperature as being significantly related to homicide (DeFronzo, 1984), assault (Bush-

Air Pionse
managed

were calculated to determine a daily average based on local air monitoring stations within each city. These data were matched to each city's crime data. Secondary datasets were created based on the categories of crime available by location and air monitoring station data. Due to missing data, Pb was removed from the analyses.

We sorted the ambient outdoor air quality data by geographic coordinates of the monitoring stations to determine the readings from within each city. The locations included air monitoring stations within a radius extending outside of city limits. In these cases, the monitoring stations were in nearby towns and were removed. The study utilized data from 10, 11, 10, and 4 air monitoring stations within Chicago, Houston, Philadelphia, and Seattle, respectively (locations of air monitoring stations considered in this study can be found in the online supplemental gures). City averages were calculated to determine a daily average based on local air monitoring stations within each city. These data were managed and cleaned in Microsoft Excel and subsequently matched to each city's crime data. This method created an aggregate daily data report of crime and air pollution concentrations for each location to analyze the potential relationships between changes in outdoor air pollution concentrations and the number of crimes reported by day.

Weather information was downloaded from a database maintained by the Weather Channel. Asummary of the weather variables exported to create the weather data portion of the dataset can be found in the online supplemental tables. These variables were used to calculate temperature (C), visibility (km), wind speed (m/s), and precipitation (mm). The humidity index, referred to as humidex (Masterson & Richardson, 1979), and apparent temperature (Meng, Williams, & Pinto, 2012; Steadman, 1984) were also calculated to create two additional independent variables for analyses to consider how the combined temperature, relative humidity, and air feels outside; we used this calculation to determine the likelihood of acrime occurring when the humidex and/or apparent temperature values were high, and thus known to cause discomfort. See online supplemental gures for apparent temperature (Meng et al., 2012; Steadman, 1984) and humidex (Masterson & Richardson, 1979) formulas.

Due to the similarities of different weather variables, not all variables could be included in the datasets because they were recognized by SAS as similar variables and therefore removed from the analyses. The nal datasets included the following weather/climate variables: apparent temperature (°C), humidex, mean visibility (km), mean wind speed (m/s), precipitation (mm), and cloud cover (%).

The number of degree days (heating and cooling), were calculated based on the U.S. EPA climate change indicator de nition of heating days having a temperature colder than 65 °F and cooling days having a temperature warmer than 65 °F.This information was compared with weather and season information for each study location to provide a better understanding of the climate distribution by year.

Maps were developed using the Geographic Information System (GIS) ArcMap platform from Esri. The maps included data from Topologically Integrated Geographic Encoding and Referencing (TIGER) shape les downloaded from the U.S. Census Bureau. Other data included the use of standard roadway curbing information from state TIGER les (U.S. Census Bureau, 2015). Information about local emission sources was downloaded from the U.S. EPAair emission sources database to show the location of the crimes in relation to prominent outdoor point and area sources of air pollution. The crime data provided by each municipality included the latitude and longitude information so each crime could be mapped by point, with the exception of Houston. The Houston data had location information by block and by police beat (geographic patrol

Quartile Summary by Location and Air Pollutant, 2009–2013

area), which we used to aggregate crimes into centralized points within each block (City of Houston, 2015). Crime data were aggregated using Microsoft Excel to determine the number of crimes for each speci c geographic location (i.e., latitude/longitude combination [or block]) to determine if some areas were more prone to crime than others.

In some cases, the complete set of data points was not included on the map because the crime type had many data points over the 5-year study period. In these cases, a sample of the data was used to create the map, though in these cases, which remains unnoticeable because several points were located in the same geographic location and would have been masked by an already existing point.

Univariate analyses were conducted to describe the distribution of each crime variable focusing on median, mean, mode, range, quantiles, variance, and standard deviation. Dummy variables were used to code data to indicate federal holidays and observances to consider the likelihood of changes in human activity patterns during these days because people may have days off from work and/or children may not be in school. We considered these variables to see if they have an effect on the results when compared with regular days throughout different days of the week or seasons. Differences between days of the week were assessed by assigning each day of the week as the reference day to see the variability of each weekday in comparison with the reference day. Weekdays and weekends were also compared post analysis to see if the likelihood of each crime type could be attributed to weekend behavior versus weekday behavior.

Poisson regression was used, with the crime data as the dependent variable to control for population size and potential zeros in the data. Study models were corrected for overdispersion, season, day of the week, and holidays using the SAS GENMOD procedure. Results for continuous variables are presented based on interquartile range (IQR) to compare the difference between the 25th per centile and the 75th percentile. In the model with all study cities, the cities were coded to account for differences between locations. Analyses were conducted in SAS version 9.4. The environmental variables included in each model are outlined in Figure 1.

Sociodemographic factors were considered post analysis and were not considered poten-

Crime Across Study Locations Considering Daily Air Pollution Concentrations and Environmental Parameters

tial confounders for analyses because they do not vary by day. Variance calculations were completed to consider intracity variability in comparison with variance across cities for each pollutant by crime type (Table 2). The formula for the variance calculation is shown in the online supplemental gures. Variance was considered to determine if the model joining data from the four study locations could be combined and presented as one dataset.

Results

Daily average air pollution concentrations and weather variables are summarized by season and location in the online supplemental tables. Table 3 summarizes the air pollution concentration distribution of each pollutant for the study period (2009–2013). Average numbers of heating and cooling degree days by year are summarized in Table 4. In Chicago, Philadelphia, and Seattle, a majority of the days throughout study years were heating days. The average number of daily crimes in cooling and heating degree days suggested a higher average was observed for cooling degree days. Indeed, across crime types and locations, there were higher daily average numbers on cooling degree days—with only three exceptions. These exceptions were for homicide in Philadelphia and robbery in Seattle, where the average daily number of crimes was the same on heating and cooling degree days. The third exception was in Seattle, where the average number of daily burglaries was higher on heating degree days. This was likely due to the number of heating degree days in Seattle.

Table 5 presents results suggested study locations. There was a 1.10 (95% confidence interval [CI] 1.04, 1.17) or 10%

Motor vehicle theft had an inverse relationship when comparing data to humidex and apparent temperature calculations. The number of motor vehicle thefts increased by 3.79 (95% CI

the placement of the local emission sources on the maps, the crimes seem to be dispersed throughout Houston instead of in areas surrounding multiple emission sources. Local emitters are concentrated towards the center of the city and eastern roadways outside of the city boundary. Hot spots fell outside of the immediate city limits with the exception of assault crimes, which were present in hot spots closer to the center of the city. In Philadelphia, emitters are evenly distributed throughout the city and crime hot spots were also evenly distributed across the city. The highest numbers of hot spots were observed for assault crimes. In Seattle, the center of the city had the highest concentration of crime. Hot spots overlapped areas with more emitters for assault, motor vehicle theft, robbery, and theft crimes. Homicide hot spots did not fall in the central area of Seattle, near the concentrated emitters, like the other crime types. The hot spot maps created for the four cities as part of this study can be found in the online supplemental figures.

Discussion

This study supported that acute exposure to air pollutants can impact behaviors that increase and decrease crime rates depending on daily air pollution concentrations and weather variables. CO is known to cause irritability in people exposed at high air concentrations or doses (Agency for Toxic Substances and Disease Registry, 2015). Based on this observation, the results from the Chicago model would be expected. Six of the seven significant results in the model suggested when CO concentrations increased from the 25th percentile to the 75th percentile, crimes increased. The Seattle model, however, had opposite results, with significant findings showing a decrease in crimes when CO concentrations similarly increased. The average daily CO concentrations in the present study's time period were higher in Chicago than in Seattle; however, it is unclear if the differences observed between models were simply due to Chicago having higher concentrations. In addition, the overall concentrations of CO throughout study cities were low and in most cases less than 1.0 ppm, which is 8.0 ppm less than the current National Ambient Air Quality Standards (NAAQS) 8-hr standard (U.S. EPA, 2016a).

In all but one case, the statistically significant relationships associated with increases in O_3 resulted in decreases in crime. The U.S. EPA (2016b) has outlined many known adverse health effects of O_3, including respiratory symptoms such as coughing, throat irritation, pain, burning, or discomfort in the chest along with airway inflammation. Future research could further investigate impacts of secondary air pollutants and other factors on urban crime.

NO_2 is also known to cause airway inflammation and other respiratory effects (U.S. EPA, 2017b). In the Chicago model, NO_2 concentration increases were found to have a relationship with decreases in crime. This finding was the opposite from what was observed in the Houston and Philadelphia models; however, the NO_2 concentrations in the present study's time period in Chicago were higher; increases from the 25th percentile to 75th percentile of concentration in Chicago likely approached the current U.S. EPA outdoor air quality standard of 53 ppb (annual mean) (U.S. EPA, 2016a).

The results for coarse, respirable particulate matter (PM_{10}) further suggested crimes decreased when outdoor air concentrations of pollutants causing irritation increased. PM_{10} is known to have an adverse respiratory effect, causing trouble breathing (U.S. EPA, 2017c). In 13 of 15 significant results, increases in PM_{10} resulted in decreases in crime. Decreases in crime rates relating to outdoor air pollutants known to cause discomfort suggested irritation and/or discomfort could be relevant social/behavioral factors, which resulted in different decisions being made, thus reducing crime rates.

Unlike PM_{10}, higher outdoor air concentrations of fine particulate matter ($PM_{2.5}$) seemed to have an immediate impact on crime increases, with statistically significant findings, resulting in an increase in crime when $PM_{2.5}$ concentrations increased from the 25th percentile to the 75th percentile. The difference between the two types of particulate matter might be in part due to the ability of $PM_{2.5}$ to penetrate deeper inside the lungs (U.S. EPA, 2017c). More research is necessary, also, on neurological impacts of particulate matter. The concentrations of $PM_{2.5}$ observed throughout the study period suggested the significant increases in crime rates could be more apparent for these results because the observed concentrations in the 3rd–4th quartiles were more likely to exceed the current NAAQS.

Though SO_2 is also known to cause respiratory problems such as bronchoconstriction (U.S. EPA, 2017d), the results differed between models. In Chicago, statistically significant results were related to increases in crime, while in Seattle, statistically significant results were related to decreases in crime. Therefore, additional research is needed to understand how SO_2 can impact crime. The slight increases in SO_2 concentration observed in the winter season in Chicago, Houston, and Philadelphia suggests the role of home heating via fireplaces and/or other means (i.e., beyond electricity-generating coal-fired power plants) as sources affecting urban area outdoor air quality.

Genc and coauthors (2012) outlined how PM, and even nanosized particles, can translocate to the central nervous system (CNS) and activate an immune response, and how emerging research evidenced the idea of air pollution-induced neuroinflammation, oxidative stress, microglial activation, cerebrovascular dysfunction, and alterations in the blood-brain barrier contributing to CNS pathology. Glass and coauthors (2010) explained how neuroinflammation can activate microglial cells, which

Cross Model Comparison by Environmental Factor and Crime Type

coldest average temperature was observed in Chicago and the warmest average temperature was observed in Houston. The highest and lowest amounts of daily precipitation were observed in Seattle, with 4 mm in the fall and 1 mm in the summer. Chicago also had a high of 4 mm in the spring. In addition, the average daily air pollution concentrations varied across locations. SO_2 values were low and comparable in three of four seasons, with winter concentrations slightly higher in Chicago, Houston, and Philadelphia. The highest average concentrations of NO_2 were also observed in the winter in Chicago, Houston, and Philadelphia with 39.4, 29.3, and 37.2 ppb, respectively. Average daily $PM_{2.5}$ and PM_{10} were highest in the summer in Chicago and in Houston. In Philadelphia, the average daily concentration of $PM_{2.5}$ was highest in the summer and for PM_{10} was highest in the spring. In Seattle, the average daily concentration of $PM_{2.5}$ was highest in the fall.

This study suggested environmental factors could have an impact on crime rates with both positive and negative associations possible. When looking at the weather/climate variables, for example, as apparent temperature increased, so did the number of several different crime categories. Fay and Maner (2014) reported heat exposure promoted hostile social responses, supporting the nd- ings that increased apparent temperatures related to increases in crime. Similarly, Ely and coauthors (2013) reported increases in ambient temperatures over short periods of time can lead to fatigue, confusion, anger, and depression. The nd- ings of this study supported how feeling hot and being exposed to increased ambient air temperatures could promote anger and hostility, increasing the number of crimes of various types.

Interestingly, only 2 of the 11 statistically signi cant results for humidex were associated with increased numbers of the particular crime type. Additional studies should explore this association, as it would seem reasonable for the same irritation or anger observed during higher temperatures to also occur during higher humidity and/or higher temperature and humidity combinations (e.g., urban summers). It is possible higher ambient air

temperatures cause a physiological response that is muted when humidity is high, or that humidity causes people to feel more uncomfortable and crimes are not committed

Lead was not included as a variable in this study because it was not available daily and had to be removed from analyses due to the amount of missing data. Therefore, this study can only inform future studies based on the use of mass data, and additional information would be needed in future studies to identify causal relationships. This study was also limited to the air monitors within each city. In locations like Seattle, fewer monitors were available within city limits and might have contributed to differences in results between Seattle and the other study locations. Stud

JEH QUIZ

Environmental Factors and Fluctuations in Daily Crime Rates

JEH Quiz #1 Answers

July/August 2017

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

` SPECIAL REPORT

Foodborne illness is an important pub-

them from asking employees about their illness symptoms. But this belief is incorrect; ADA does not prevent managers from asking employees about their illness symptoms. ADA does, however, speci cally prohibit asking an employee if he or she has a disability or what kind or how severe the disability might be.

ADA de nes "disability" as "a physical or mental impairment that substantially limits one or more major life activities of such individual; a record of such an impairment; or being regarded as having such an impair ment" (Americans With Disabilities Act, 1990a). The majority of foodborne illnesses transmitted in restaurants present with mild to moderate gastrointestinal symptoms and are predominantly short term in nature (U.S. Department of Health and Human Services, 2013d). Therefore, they are not considered a "disability" under ADA's de nition.

When a foodservice employee has a short-term gastrointestinal illness that puts consumers and other employees at risk of a foodborne illness—one that is not considered a "disability" by ADA—his or her manager may inquire about symptoms without violating ADA. In the rare event that an employee does have a foodborne illness that is considered a disability by ADA, employers would need to take into consideration both ADA and their state's food code.

Each year, the Department of Health and Human Services releases a list of "infectious and communicable diseases that are transmitted through handling the food supply," which can be found at www.cdc.gov/foodsafety/pdfs/ada2017_transmittedbyfood_final.pdf (Americans With Disabilities Act, 1990f; U.S. Department of Health and Human Ser vices, 2017b). Under ADA, an employer may require current employees to report whether or not they have been diagnosed with an illness from the list (U.S. Department of Health and Human Services, 2013c). If an employee does have an illness on the list, ADA requires the manager to consider a "reasonable accommodation" for the employee (Americans With Disabilities Act, 1990g). A reasonable accommodation may include adapting facilities or reassigning job duties for individuals (Americans With Disabilities Act, 1990c).

If no reasonable accommodation exists, then the manager may "refuse to assign or continue to assign the [employee] to a job involving food handling" (Americans With Disabilities Act, 1990c). If an employee has an illness included on the list and the manager cannot provide a reasonable accommodation, the manager, under ADA, may choose to give the employee assignments that do not include handling food.

ADA also emphasizes that employers may follow "any state, county, or local law, ordinance or regulation applicable to food handling which is designed to protect the public health from individuals who pose a signi cant risk to the health or safety of others" (Americans With Disabilities Act, 1990h). Thus, if a manager requires foodservice employees to report symptoms not related to a disability, the manager is both complying with ADA and following best practices outlined in the Food Code. It is impor tant to remember that ADA not only recognizes the importance of food safety and public health, but promoth

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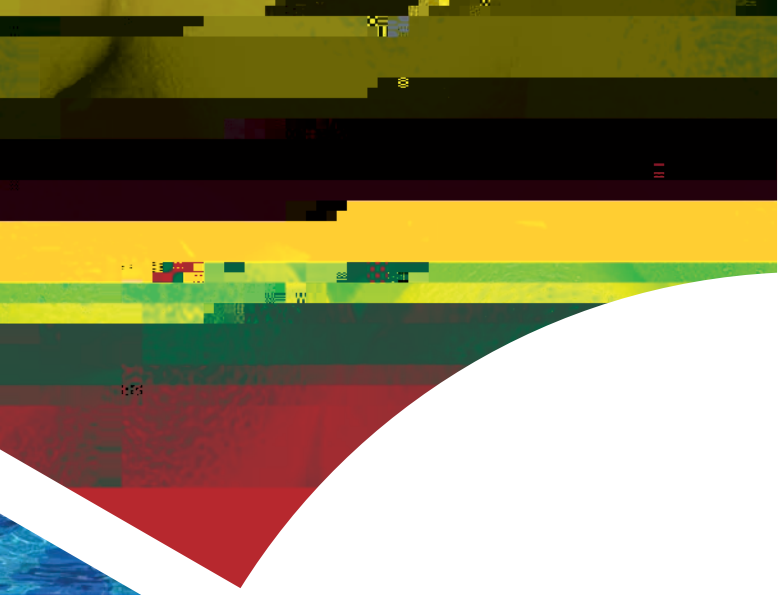
Americans With Disabilities Act of 1990, 42 U.S.C.A. § 12112(d)(4)(A) (1990e).
Americans With Disabilities Act of 1990, 42 U.S.C.A. § 12113(e)(1) (1990f).
Americans With Disabilities Act of 1990, 42 U.S.C.A. § 12113(e)(2) (1990g).
Americans With Disabilities Act of 1990, 42 U.S.C.A. § 12113(e)(3) (1990h).
Carpenter, L.R., Green, A.L., Norton, D.M., Frick, R., Tobin-D'Angelo, M., Reimann, D.W., . . . Le, B. (2013). Food worker experiences



ferent priorities than residents do. We then compared the results to qualitative methods previously used in these communities and present the advantages of different methods to further participatory methods for intervention planning and implementation.

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We conducted phone and online surveys in Alabama between February and March 2016 by the Survey Research Unit (SRU) at the University of Alabama at Birmingham. Full phone script and online survey instruments are available in the online supplemental document (www.neha.org/jeh/supplemental).

First, resident participants were given a brief description of EH: The eld of environmental health deals with the ways in which things in our environment affect our health. For example, restaurants are inspected to make sure they are safe places to eat, and public pools are inspected to make sure they are safe places to swim. Environmental health specialists ensure that the air, water, and soil in our communities are safe. I would like to know your opinion on some environmental health issues. Second, participants were asked open-ended questions requesting they report two local EH issues they were most concerned about. Both surveys included demographic questions (including income, education level, and asking participants to identify the group or groups that best represents their ancestry/ethnicity/race) to account for potential covariates across urban and rural communities.

We used random number landline and cell phone dialing to sample households. This approach is consistent with the sampling strategy used by the SRU to conduct the 2015 Behavioral Risk Factor Surveillance System funded by the Centers for Disease Control and Prevention (CDC), a health-related telephone survey mainly focusing on U.S. resident health-related risk behaviors, chronic health conditions, and use of preventive services (CDC, 2017). A total of 2,500 phone numbers were attempted at least once (and up to 9 times) in the Public Health Area 4 (PHA 4, which includes Jefferson County) and 3,000 phone numbers in PHA 7 (Sumter, Choctaw, Marengo, Hale, Perry, Dallas, Wilcox, and Lowndes counties) (Figure 1).

These public health areas were chosen to match with a previous study that conducted focus groups to identify EH priorities in underserved communities in urban (Birmingham) and rural (southwest) Alabama (Bernhard et al., 2013). A total of 830 responses were recorded during the phone survey (with the response rate of approximately 15.1%). After excluding 237 records (approximately 28.6%) without a vc 0Tw 8.4 Second,

Results of Chi-Square Tests for Differences in Environmental Health Priorities Among Rural, Suburban, and Urban Groups in Phone Survey Conducted in Alabama, February 2016

Results

Comparing Environmental Health Priorities for Rural Versus Urban Respondents

We used RUCA codes and population density metrics to classify Alabama ZIP codes into rural (small towns in RUCA codes or areas with the first tertile of population density: between 0.3–13.0 people/km^2), suburban (large towns in RUCA codes or areas with the second tertile of population density: between 13.1–56.0 people/km^2), and urban areas (in RUCA codes or areas with the third tertile of population density: between 56.1–3,139.0 people/km^2) in Alabama (Figures 1 and 2). Using both of these categorization schemes allows for identification of very isolated rural areas (rural as defined by RUCA codes) and highly urban areas (urban as defined by third tertile of population density) (Figure 2). This distinction is important because health disparities are exacerbated in both very isolated rural areas and in urban core areas, and the types of environmental exposures are likely different.

Table 1 shows demographic information of rural, suburban, and urban participants in the phone survey. Results show that, using the RUCA code characterization, 93 respondents were from rural areas, 19 from suburban areas, and 474 from urban areas, while the numbers in rural, suburban, and urban using population density tertiles were 141, 134, and 313, respectively (Table 1). Rural, suburban, and urban respondents were similar with respect to age, sex, ancestry, and income, but more rural and suburban participants compared with urban participants obtained a higher level of education.

We summarized categorization of participant responses to the question "What is the environmental health issue in your community that concerns you the most?" into 14 categories (see online supplemental document). Table 2 shows results of chi-square tests (with the Monte Carlo method) on significant differences in EH priority categories among rural, suburban, and urban areas. To simplify test results, we present the number of responses in each category, its percentage in each population group, the signi cant cat-

TABLE 3

Demographic Information of Participants in Phone and Online Surveys Conducted in Alabama, February and March 2016

Participants	Phone Survey	Online Survey	p-Value	Phone Survey	p-Value
	Residents # (%)	Environmental Health Professionals # (%)		Subgroup of Residents # (%)	
Number	588	63		81	
Age			.00		.64
Maximum	96	66		74	
Minimum	9	29		21	
Median	63	50		57	
Unknown	0	10		0	
Sex			.02		.69
Male	178 (30.3)	25 (39.7)		34 (42.0)	
Female	410 (69.7)	30 (47.6)		47 (58.0)	
Unknown	0 (0)	8 (12.7)		0 (0)	
Ancestry			.00		.17
White	217 (36.9)	39 (61.9)		56 (69.1)	
Black or African American	347 (59.0)	10 (15.9)		23 (28.4)	
Others[a]	17 (2.9)	5 (7.9)		2 (2.4)	
Unknown	7 (1.2)	9 (14.3)		0 (0)	
Highest level of education			.00		.48
High school diploma	230 (39.1)	0 (0)		0 (0)	
Associate or bachelor degree	301 (51.2)	37 (58.7)		59 (71.7)	
Graduate degree	53 (9.0)	18 (28.6)		22 (28.3)	
Unknown	4 (0.7)	8 (12.7)		0 (0)	
Income (pretax)			.00		N/A[b]
<$20,000	121 (20.6)	0 (0)		0 (0)	
$20,000	321 (54.6)	48 (76.2)		60 (74.1)	
Unknown	146 (24.8)	15 (23.8)		21 (25.9)	

Note. Numbers in bold are signi cant at .05.

[a]Includes Alaskan Native or American Indian, Asian, Native Hawaiian or other Paci c Islander, Hispanic or Latino, or some other race or mixed race.

[b]All individuals in the environmental health professional and subgroup of resident groups had an income $20,000, thus there is no test here and these two groups had no difference on this aspect.

egory with the higher/lower expected count (highlighted in bolded numbers), and the p-value.

Results of the three models show that consistent EH priority differences existed among rural, suburban, and urban respondents. For instance, all three models show water pollution and paper mill-related pollution were high priorities for rural participants. Model 2 shows that sewage systems, in addition to water and paper mill-related issues, were higher priorities in rural areas, and urban residents placed a higher priority on the built environment (including abandoned housing) and air pollution. Taking paper mill-related pollution as an example, rural participants reported, “Area I live in has a paper mill and dumping in the water,” “Pollution from paper mills,” and “Possible effects from the paper mill plant close to river.” In comparison, urban participants reported, “Abandoned houses,” “Old building left empty,” “Roads have many holes,” “Smoking in public places,” and “Car emissions.”

When compared with our previous results using nonprobability convenience sampling in these same regions of Alabama, focus groups (Bernhard et al., 2013) and a more recent written survey conducted at a workshop (see online supplemental document) show similar rural–urban differences. Speci cally, rural residents prioritized sewage and septic, water pollution, and paper mill-related issues, while urban residents prioritized built environment issues (particularly abandoned housing) and air pollution.

Comparing Environmental Health Priorities of Residents Versus Environmental Health Professionals

EH professional respondents were younger, more educated, and more likely to be male and white compared with resident respondents; therefore, we created a subsample from the resident respondents with similar demographic characteristics (Table 3).

Results in Table 4 show that EH priorities of residents were signi cantly different from EH professional respondent priorities, even when using a demographically matched subsample of the resident respondents. In particular, EH professionals considered food safety as a high priority, but residents did not. For instance, professionals reported, “Safe food at restaurants,” “Safe food handling at restaurants,” and “Quality of restaurant inspections due to time/budget restraints.” Moreover, EH professionals were more likely than residents to respond that sewage systems are a high priority. Residents were more likely than EH professionals to consider soil and air pollution as important priorities; however, this difference was not signi cant in the demographically matched subsample of residents (Table 4).

Discussion

This study used a large, representative phone survey to distinguish between EH priori-

ties of residents living in urban versus rural areas of Alabama and also compared resident responses to those of EH professionals. Our study indicates that perceptions of important EH issues are different across the rural–urban landscape, particularly on the aspects of the built environment, sewage systems, industry-related pollution, water pollution, and air pollution. Consistent with previous research (Butterfield et al., 2011; Israel et al., 2006; Smith et al., 2008), this result suggests characterization of the differing needs of urban and rural communities is needed to tailor EH communication strategies and services provided at the local level.

As part of a community-engaged research program, focus groups were conducted in the same urban and rural regions of Alabama in 2012 that were composed of residents recruited via referral sampling by local community partner organizations ($N = 40, N = 33$ in West Central Alabama and Birmingham, respectively) (Bernhard et al., 2013). This community-research partnership has continued, and a more recent written survey was conducted in fall 2015 ($N = 34, N = 48$ in West Central Alabama and Birmingham, respectively) (see online supplemental document).

Comparing our study results with the 2012 focus group and workshop results Twr T* (ti4s Tw5Tc -0.01 T/T1_4 n needs daTc -0.02 al., 220(e s-0.ma aJ 0 Tw Tw [(focus gr)o-)]Tiorne study21labam(3explal 15 Tw [(213cus gr)o-)iw T* (a 2 2cus gr) 0.hip h T* (a 2 3cus gr)o-a 2 2cus gra 2 3cus gr,eTJ 0.2ep 0 T,aTc -0.272cus gres

resident/EH professional differences may be limited. For instance, Arcury and Christianson (1993) did not identify urban/rural differences in EH priorities in Kentucky, which could be due to survey design differences or differences in how urban and rural areas are de ned (Hart, Larson, & Lishner, 2005). We have previously shown that methods for de ning urban and rural areas are important

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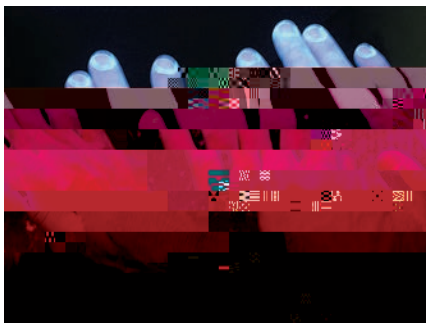

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The Role of Environmental Health in Understanding and Mitigating

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2010; Hendrickson, Vogt, Goebert, & Pon, 1997; Loehn et al., 2011; McKinney, Houser, & Meyer-Arendt, 2011; Ryan et al., 2015b; Swerdel, Janevic, Cosgrove, Kostis, & Myocardial Infarction Data Acquisition System Study Group, 2014).

This challenge has been recognized globally by the United Nations in the Sendai Framework for Disaster Risk Reduction 2015–2030. Item 30(k) suggests that NCDs should be included in the design of policies and plans to manage risks before, during, and after disasters, including having access to life-saving services (UNISDR, 2015).

In Australia, NCDs cause approximately 90% of all deaths, account for 88% of the burden of disease, and are responsible for 83% of recurrent health expenditure (Australian Government Department of Health, 2017; Queensland Government, 2014). The challenge of managing NCDs stems from a lack of initial understanding of the problem and a shortage of appropriate mitigation strategies (Lim, Chan, Alsagoff, & Ha, 2014). Healthcare providers typically focus on the treatment aspects of NCDs with a tendency to be response oriented, which alone will not either mitigate or solve the problems NCDs have exposed on society (Sabaté, 2003; Tinetti, Fried, & Boyd, 2012). The challenges posed by NCDs encompass a range of disci-

Descriptions of Public Health Infrastructure

nance, prevention, supplies, service, transport, and surveillance (Ryan et al., 2016b). During the analysis, another category of "other" was created for any data that did not align with PHI themes. This process also provided an opportunity to validate PHI themes and priorities before, during, and after a disaster.

The terms used to guide the analysis were based on the NCDs with the highest burden in Queensland, Australia, and those considered at greatest risk during the "acute phase" postdisaster (the first 4 weeks) due to their reliance on PHI for treatment and care (Health Council of the Netherlands, 2006; Queensland Government, 2014). These NCDs included cardiovascular diseases, cancers, respiratory conditions, and diabetes. The focus was people who already had an NCD, rather than those who might have developed a condition due to disaster exposure. During the analysis, three additional themes for NCDs were identified and used: renal diseases, NCDs (general), and other.

Ethics approval was provided by James Cook University (H4871) and Townsville Hospital and Health Service Human Research Ethics Committee (HREC/13/QTHS/251).

Reported Impact of Disasters on Public Health Infrastructure and Proposed Resilience Strategies

workforce. Within each theme, a potential role for EH was identi ed. A description of the mitigation strategies is in Table 4 and discussed in the following:

- NCommunicationCommunication could be used to discuss preparedness individually with people who have NCDs, and more broadly the community. For effective communication, multiple methods should be used including newspaper, radio, social media, and television. It was important that the communication instructed people to be self-suf cient and was clearly linked with the local disaster coordination system. Any direct communication with patients should be led and guided by clinicians.
- NGovernanceEstablishing and maintaining governance structures would help to mitigate the impact of disasters on people with NCDs. These governance structures should include ensuring government and nongovernmental organizations had a clear understanding of roles and responsibilities, working in partnership across jurisdictions, and community-based plans. Hospital and interagency planning was required, along with the testing of plans

TABLE 3

Reported Impact of Disasters by Public Health Infrastructure and Noncommunicable Diseases (NCDs)

Public Health Infrastructure	Cancer	Cardiovascular	Diabetes	Respiratory	Renal Diseases	NCDs (General)
Power				Patients who required oxygen needed help during power outage; generators for oxygen and respiratory equipment ran out of fuel.	Patients who required dialysis needed help during power outage.	Generators used inside, which resulted in carbon monoxide poisoning.
Prevention						If NCDs were poorly managed prior, there was an increased risk of poor outcomes after a disaster.
Sanitation			Person with diabetes cut foot while cleaning, and then died due to infection.	Asthma reactions resulted from exposure to mold after a ood.		People who were immunocompromised or had an NCD were susceptible to infections after a disaster.
Services	Lack of services resulted in cancer patients requiring acute care that was not available.	Lack of ongoing care increased risk of acute myocardial infarction or heart attack.		Patients who required oxygen needed help during power outage; asbestos exposure due to inadequate cleanup.	Patients who required dialysis needed help during power outage.	Chronic disease management programs fell by the wayside during emergencies.
Supplies				Generators for oxygen and respiratory equipment ran out of fuel; little to no fuel resupply for generators during a disaster.		Lack of medication; people who required drugs often ran out of supplies; medications could be almost nonexistent after cyclones; people with food allergies were at risk if inadequate food.
Transport						Reduced transport options for the elderly and for people who required treatment.
Water					Loss of safe water supply for dialysis; contaminated water in reverse osmosis systems.	

Note. There were no reported impacts for the following public health infrastructures: communication, equipment, governance, physical structure, surveillance, workforce, an

for people with NCDs, particularly people who cannot self-medicate at home.

- Prevention. Prevention can be a mitigation strategy by empowering people to take care of their own health. This strategy can include individual planning, sustained education, and training campaigns.
- Services. Targeted services, such as basing doctors at evacuation centers to maintain treatment, were identi ed as strategies to help mitigate the impact of disasters on people with NCDs.
- Surveillance. By establishing and maintaining surveillance, the impact of disasters on people with NCDs can be reduced. This mitigation of impact could be achieved by having central registration points for people with NCDs and maintaining registries of people at risk. Rapid and regular surveys of evacuation centers and other infrastructure could be used to understand community needs before, during, and after a disaster.

Discussion

To effectively reduce the risk disasters pose to people with NCDs, it is critical for the EH profession to be part of interdisciplinary solutions. This inclusion is particularly important because the work of the EH pro-

fession interweaves across various disciplines and stakeholders (Anderson, Naujokas, & Suk, 2015). For example, safe water is important for clinicians overseeing dialysis treatment. Achieving reduced risk will require working collaboratively with individuals, the community, government, and other entities to achieve the best outcome for people with NCDs. To implement this approach, a number of strategies are recommended.

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This change could easily be achieved by building on existing roles in the disaster setting, which include monitoring and assessing public health risks before, during, and after a disaster. To achieve this change, an authentic trespassing of professional boundaries is required; for example, combining a team of integrative expertise that could include clinicians, engineers, and EH professionals working together to prepare for and respond to disasters (MacLachlan, 2009).

The rst step to achieve this integration would be for a global leader in EH and disaster management, such as the International Federation of Environmental Health or the National Environmental Health Association, to actively seek involvement in developing local, national, and international strategies to address the challenges faced by NCDs. Achieving this integration would re ect the emerging risks, diversity, and intensity of recent disasters and show a sign of maturity within EH and disaster management systems (Burkle, 2015). Most importantly, the result would be a credible step towards improved health outcomes for people with NCDs before, during, and after a disaster.

or rapid access to life-saving services during and after disasters (UNISDR, 2015).

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The reported impact of disasters on people with NCDs demonstrates the need for mitigation strategies to be targeted towards speci c

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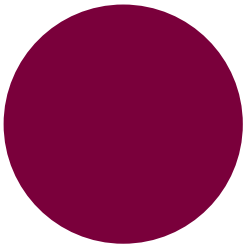

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Most state and local health departments in the U.S. have food safety programs that deliver important services such as food safety education, restaurant inspections, and investigations of foodborne illness outbreaks (Association of State and Territorial Health Of cials, 2014; National Association of County and City Health Of cials, 2016). In 2016, the Centers for Disease Control and Preventions (CDC) National Center for Environmental Health surveyed local and state food safety programs to learn how they use and apply the 10 Essential Environmental Public Health Services (Table 1) that programs should provide to protect and improve environmental health (CDC, 2014, 2017).

We surveyed every state department of healths food safety program and a random sampling of food safety programs at local health departments. The survey asked program respondents to identify the

- % 10 essential services their food safety program provided,
- % three services they thought were most important for their program to provide, and
- % resources that could help their food safety program provide better services to the public.

Almost 18% (87) of the surveyed programs responded to the survey. Although this response rate was low, the data provide some insight into the status of the 10 Essential Environmental Public Health Services provided by food safety programs and the resources needed for increasing capacity.

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Most survey respondents said their programs provided the following essential services (Figure 1):

- % Essential Service 6: Enforce laws and regulations that protect environmental public health and ensure safety (98%);
- % Essential Service 3: Inform, educate, and empower people about environmental public health issues (90%); and
- % Essential Service 8: Assure a competent environmental public health workforce (85%).

About only half of the programs, however, reported providing the following essential services (Figure 1):

- % Essential Service 1: Monitor environmental and health status to identify and solve community environmental public health problems (55%);
- % Essential Service 9: Evaluate effectiveness, accessibility, and quality of personal and population-based environmental public health services (53%);
- % Essential Service 4: Mobilize community partnerships and actions to identify and solve environmental health problems (51%); and
- % Essential Service 10: Research for new insights and innovative solutions to environmental public health problems (48%).

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When asked which three essential services they rated as most important for their programs to provide to the public, respondents most frequently listed the following (Figure 1):

- Essential Service 8: Assure a competent environmental public health workforce (49%).

Less than 10% of respondents listed the following essential services as most important for their programs to provided7i(for)Tj 0.009 Tw [ )

Individual food safety programs may wish to consider using the Environmental Public Health Performance Standards to conduct an in-depth self-assessment of their delivery of the 10 Essential Environmental Public Health Services (CDC, 2014). Safe drinking water and vector control programs have used this assessment framework to identify strengths and weaknesses associated with their provision of the essential services (Gerding et al., 2016; Lamers & Hubbard, 2017). The assessment results can provide valuable information for planning and implementing performance improvement projects to increase the effectiveness and ef ciency of services.

Additionally, the 10 Essential Environmental Public Health Services are incorporated into the Public Health Accreditation Boards standards (Public Health Accreditation Board (F[im(785Tw T*(15(,)]TJ FJ4(,)]Tpr)ce6 FJ. 0.025ide2Bng ant-0(editation Boar).068s*(ter)T -0.15(,)]TJ FJ4(,)]Tp
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What Is Informatics?

Environmental public health informatics is an emerging eld that focuses on standardized data collection, sharing, and use. Data, compiled from multiple sources, are brought together to create a broad picture of an environmental health condition. This picture informs environmental health initiatives and allows for improved policies, interventions, and programs. By moving toward the wider adoption and use of informatics systems, data-driven decision making is made possible, which can have positive impacts on population health.

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the public health response to the opioid epidemic and has provided funding to 29 states through the Prescription Drug Overdose: Prevention for States (PfS) grant program (CDC, 2017a). Strategies in the public health portfolio include reducing the supply of prescribed opioids with prescriber guidelines (CDC, 2017b), providing clinical tools through prescription drug monitoring programs (PDMPs) (CDC, 2017c), maintaining robust public health surveillance, and mobilizing community responses to the epidemic.

States are also pursing strategies like drug take back programs (U.S. Department of Justice, n.d.), mitigating the damage from opioids through increased access to naloxone (Wheeler, Jones, Gilbert, & Davidson, 2015), and engaging with active drug users through syringe exchange programs (La Belle, 2017; Quinn, 2016). Public health is also playing a critical role by convening diverse groups to work on the epidemic through task forces and strategic planning.

Below is an outline of roles environmental health professionals can play in responding to the opioid epidemic.

%Learn about the epidemic and join the effort: Take a hazard-based approach to the opioid epidemic. While we don't have the expertise to deal with addiction, we're pretty good at controlling hazards. CDC has created a website that provides valuable resources regarding opioid basics, overdose prevention, information for patients and providers, state information, CDC publications, and a resource center (CDC, 2017d). Last y pde ring haosoin d2 of rtPm <TOCINTJ 0 7to s thr

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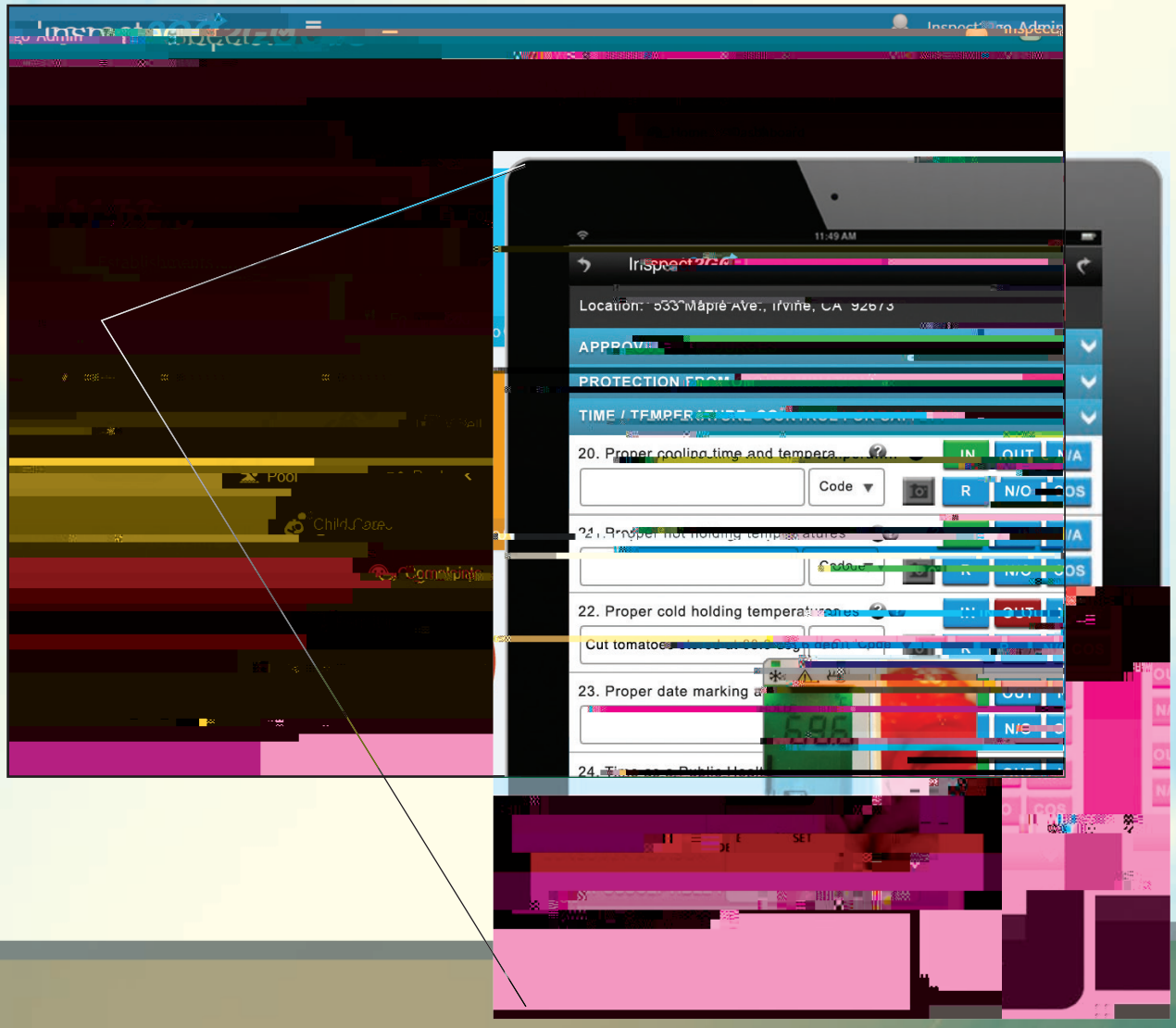

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