

Environmental Health Playbook:

Investing in a Robust Environmental Health System



The National Environmental Health Partnership Council presents the case for healthy communities for all across the United States.

Executive Summary

Background and Need for Action

Environmental Health is the branch of public health that focuses on the interrelationships between people and their environment, promotes human health and well-being, and fosters healthy and safe communities. As a fundamental component of a comprehensive public health system, environmental health works to advance policies and programs to reduce chemical and other environmental exposures in air, water, soil, and food to protect residents and provide communities with healthier environments. Environmental health protects the public by tracking environmental exposures in communities across the United States and potential links with disease outcomes.

To achieve a healthy community, homes should be safe, affordable, and healthy places for families to gather. Workplaces, schools, and child care centers should be free of exposures that negatively impact the health of workers or children. Nutritious, affordable foods should be safe for all community members. Access to safe and affordable multimodal transportation options, including biking and public transit, improves the environment and drives down obesity and other chronic illnesses. Outdoor and indoor air quality in all communities should be healthy and safe to breathe for everyone. Children and adults alike should have access to safe and clean public spaces, such as parks. When a disaster strikes, a community needs to be prepared; it should have the tools and resources to be resilient against physical (infrastructure and human) and emotional damage. All these activities require the participation of federal, state, local, and tribal governments.

Building a Robust Environmental Health System

Investing in essential governmental environmental health services through dedicated resources will create an effective environmental health system that proactively protects communities and helps everyone attain good health. Federal, state, local, and tribal governments should adopt standard approaches to ensuring environmental health equity, protections, and access for all, particularly vulnerable and at-risk populations.

The federal government can help build an effective and strong environmental health system by:

- **CREATING AN INTEGRATED INFRASTRUCTURE TO COLLECT AND TRACK CRUCIAL INFORMATION.**
- **DEVELOPING A WELL-TRAINED AND HIGHLY SKILLED WORKFORCE.**
- **PROVIDING AMPLE AND SUSTAINABLE FUNDING FROM DIVERSE SOURCES.**
- **ENSURING THAT POLICY AND PROGRAMS ARE GROUNDED IN EXISTING AND UP-TO-DATE EVIDENCE-BASED RESEARCH.**
- **ENCOURAGING/INCENTIVIZING CROSS-SECTORAL PARTNERSHIPS TO SUPPORT CONSIDERATION OF HEALTH IMPACTS.**
- **ASSURING ENVIRONMENTAL HEALTH SERVICES ARE EQUITABLY ACCESSIBLE.**

A cohesive environmental health system monitors and measures diseases, hazards, exposures, and health outcomes; can collect data over time; and can present real-time data to quickly respond to

emergencies and identify problems for program planning. All government agencies should assess the environmental health impacts of their programs and policies across all sectors to improve the health of all communities and people.

Opportunities for Action

Governmental environmental health services are not a luxury; they are essential to providing basic needs to the public, such as safe drinking water, clean air, lead poisoning prevention, climate change adaptation, and more. Everyone should have the opportunity to achieve the highest possible level of health at all stages of life, which encompasses physical, mental, and social well-being and extends beyond the absence of disease. As such, the following opportunities for action support the uncomplicated right to environmental health:

- **PREVENTION:** Enable federal, state, local, and tribal governments to promote resilient, equitable, and healthy communities for all Americans, especially those who are most vulnerable and most at risk.
- **RESPONSE:** Build and support the governmental environmental health system, including workforce needs, as well as tracking disease outcomes and environmental exposures.
- **REAL-LIFE SOLUTIONS:** Strengthen environmental health protections and support peer-reviewed research to inform environmental health decision making and practice.

Case Examples that Demonstrate the Need for a Strong and Equitable System

Environmental health professionals work every day to ensure that the air we breathe, the water we drink, and the foods we eat are safe and secure. No one would want a person without a medical degree performing surgery, nor should anyone want the safety of their food or water being determined by a person who is not a highly skilled professional. Offering collaboration early on, enhancing their capabilities to detect and respond to threats, grounding policy and actions in evidence-based research, and ensuring that their services reach everyone are critical tenets of a system that can create resilient communities after a disaster.

Recent major emergencies demonstrate the need for a strong governmental nationwide environmental health system. The Zika virus outbreak, Flint water crisis, and Hurricane Katrina are three examples with stark environmental health implications. These emergencies will not be the last, so we must prepare by investing in a robust environmental health system.



Table of Contents

Executive Summary	1
A Vision for Healthy Communities	4
Challenges to Achieving Healthy Communities.....	6
The Hope: Build a Robust Environmental Health System.....	9
Case Examples.....	11
Zika Virus.....	12
Flint Water Crisis.....	15
Hurricane Katrina and Super Storm Sandy	17
Essential Focus Areas of a Robust Environmental Health System.....	21
Safe Drinking Water	22
Clean Air.....	25
Vector Control	29
Food Safety.....	33
Chemical Safety	37
Community Design	41
Healthy Housing	45
Climate Effects.....	49
Emergency Preparedness	53
Environmental Equity.....	56
Opportunities for Action	59
About the National Environmental Health Partnership Council	61
Endorsements	63
References	66

A Vision for Healthy Communities

Environmental health professionals work every day to ensure that the air we breathe, the water we drink, and the foods we eat are safe and secure. No one would want a person without a medical degree performing surgery, nor should anyone want the safety of their food or water being determined by a person who is not a highly skilled professional. Offering collaboration early on, enhancing their capabilities to detect and respond to threats, grounding policy and actions in evidence-based research, and ensuring that their services reach everyone are critical tenets of a system that can create resilient communities after a disaster.

Recent major emergencies demonstrate the need for a strong governmental nationwide environmental health system. The Zika virus outbreak, Flint water crisis, and Hurricane Katrina are three examples with stark environmental health implications. These emergencies will not be the last, so we must prepare by investing in a robust environmental health system.

Notably, four interrelated environments play a role in achieving well-being for all: natural, built, social, and cultural/spiritual environments that come together to embody a healthy community.¹ By working toward healthy communities across the country, we as a nation must acknowledge that environmental injustices still exist and need to be systematically addressed. Some populations—be it the basis of race, ethnicity, income, or age—disproportionately bear the burden from environmental stressors, policies, and enforcement.¹ From the 1950s to 2016, from Love Canal to the Flint Water Crisis, Americans have unequivocally experienced the health impacts of their tainted upstream environments. The US is known to have far more cases than other countries in the world in which there is strong, undeniable evidence of racial/ethnic populations disproportionately affected by the location of environmental burdens.²

Environmental health is central to achieving a healthier nation; however, it is limited by the human and capital resources available. Fortunately, environmental health services are, by nature, preventative measures that are far more affordable than the absence of action. In 2008, the annual cost of environmentally mediated diseases for children, including lead poisoning, methylmercury exposure, cancer, asthma, autism, and more were \$76.6 billion.³ Just \$1 invested in an environmental health program can go a long way. For instance, deteriorating lead paint is a common source of lead exposure for children that can cause biologic and neurologic damage. For every \$1 invested in lead paint hazard control, a household has the potential to save \$12-\$155.⁴ Asthma is the third leading cause for hospitalization in children.⁵ On average, each case of asthma costs approximately \$3,800-\$4,000.⁶ However, for every \$1 spent on national- and state-level programs, \$71 in asthma-related expenditures is saved.⁴ Environmental health saves money and saves lives.

Yet, the workforce and the infrastructure behind the economic and preventative gains are nearly invisible to the public. Just like an airport ground crew is comprised of a team of well-trained professionals charged with ensuring that everything goes safely and smoothly on the runway, the work of providing environmental health services to ensure the public's safety is dependent upon a well-trained, multidisciplinary workforce. Though the public may not always witness the *who*, they rely on environmental health professionals' technical skills, planning, and training to maintain a healthy environment and prevent harm in the way a ground crew works to get passengers from departure to destination. While the airport ground crew includes flight dispatchers, mechanical inspectors, and others; the environmental health workforce includes a diverse team of professionals from many disciplines, including sanitarians or environmental health specialists, health inspectors, microbiologists, toxicologists, engineers, nurses, and more. For example, a flight inspector inspects the plane before take-off for any defects as a preventative measure. Similarly, an environmental health professional inspects restaurants, swimming pools, and other public spaces for their safety. Just like passengers, individuals cannot always ensure their own safety, but rather have to rely on highly trained experts. The work that the environmental health professionals perform is greatly realized at the community level.



Environmental Health Saves Money, Saves Lives

Furthermore, the public does not see the infrastructure that provides the tools and evidence these professionals need in order to measure, assess, and respond to known and emerging threats. Surveillance has a frightening name, but in the public health world, regular data collection, and monitoring provide the necessary information for planning, implementation, and evaluation of everyday public health practice.⁷

Challenges to Achieving Healthy Communities

Environmental health services are not a luxury; they are essential to providing the public basic needs like safe drinking water, clean air, chemical and food safety, solid waste management, radiation protection, healthy and affordable housing, and more.⁸ When these basic human rights are realized, people have the opportunity to achieve optimal health, which encompasses physical, mental, and social well-being and extends beyond the absence of disease.⁸

This aspiration, however, is difficult to realize in the absence of a cohesive environmental health system. An environmental health system incorporates a structure, costs, funding mechanisms, vulnerable populations, and a trained multidisciplinary workforce to serve and protect the health of community members.⁹

The problem remains that in the US has taken a scattered, disconnected approach to providing these tools. There is no coordinated environmental health system. The environmental health services and efforts at the federal, state, tribal, and local levels vary in quantity, quality, and organization, creating a patchwork system. All levels of government must work together to ensure that the policies and programs reach the intended population, and that there is proper enforcement of the safeguards put into place to protect communities. This approach means multiple agencies can shift responsibility when an issue or a question from a concerned resident arises. Additionally, each state, tribe, and local government organizes environmental health services differently. Some environmental health services reside in the state health department, while others reside in the department of environmental protection or local health department. This distribution of services differs in every state. This complicates how to structure a system and which entity to hold responsible to ensure prevention of certain health outcomes during an environmental health crisis or after an event to assess the long-term damage. Notably, a recent example of lack of accountability unveiled itself during and after the Flint Water Crisis (see case example on page 15).

Decades of sound, evidence-based science support the work of environmental health professionals. For example, we now know that high blood lead levels resulting from exposure to tainted drinking water, leaded paints, and other environmental sources, are associated with significant biological and neurological damage.¹⁰ And the links between air pollution and adverse health outcomes—such as worsening cardiovascular disease, poor pregnancy outcomes, increasing asthma attacks, and premature deaths—are clear.¹¹

However, governmental policies and regulations have not caught up to the science-based evidence. For instance, the Toxic Substances Control Act of 1976 was updated in 2013 to give the US Environmental Protection Agency authority to regulate new or existing chemicals. While the law, renamed the Chemical Safety Improvement Act, has allowed EPA to streamline the process for obtaining and reviewing the safety of a chemical, the sheer volume of chemicals in use today—upwards of 80,000 registered chemicals in the US alone—makes it difficult for EPA to ensure their

safety and intended uses. Additionally, although current law aims to increase protections for children and pregnant women, it does not adequately address the type of testing necessary to ascertain risks to these vulnerable populations before potentially harmful products become pervasive in the consumer market.

The Clean Air Act is another example of a well-intended policy that could benefit from updating. Congress passed this legislation in 1970 and amended it in 1977 and 1990, intending the act to protect communities from harmful air pollution. A key element of the law was the creation of National Ambient Air Quality Standards as official limits on the six most widespread outdoor air pollutants. The act explicitly requires EPA to review these standards every five years to ensure they protect public health within a margin of safety. Since 1970, the nation has reduced these six pollutants by 70 percent, while simultaneously growing the economy by over 240 percent.¹² Despite this success, EPA faces challenges to maintain these reviews and to set protective standards based on the emerging science. It also faces challenges to its role in evaluating new air pollution threats and enforcing standards effectively and equitably. States, tribes, and local governments, likewise, face challenges to maintain air pollution monitoring systems and to implement existing pollution controls to meet the standards.

The Safe Drinking Water Act's Lead Copper Rule has also been called into question. Originally enacted in 1991, the Lead Copper Rule lacks enforcement measures that would fully ensure that lead concentrations in drinking water do not exceed recommended levels. (Both lead and copper are known to cause a range of health problems and to enter the body through corroded plumbing.¹²)

In addition to out-of-date or inadequate policies and regulations, the level of fiscal resources devoted to environmental health provides challenges. Every year, funding for public health is on the Congressional chopping block. Without adequate funding, public health—at all levels of government—is ill equipped to detect, monitor, and prevent environmental health crisis. Life-saving interventions, like home-based asthma care, go unfunded. Laboratories are not able to purchase equipment to assess food safety risks, like *E. Coli* in baking goods. Above all, the workforce necessary to protect communities is dangerously reduced.

As it stands, an entire cohort of skilled environmental health professionals is being lost, as the Baby Boomer generation approaches retirement. The next wave of environmental health professionals needs mentoring and training. While graduate-level environmental health programs are more plentiful than in the past, program alumni give students' limited hands-on experience and few incentives for joining the public sector.¹³

\$71

\$1

For every \$1 spent on national and state-level programs, \$71 in asthma-related expenditures is saved.

Environmental health professionals are highly trained individuals who work every day to ensure that the air we breathe, the water we drink, and the food we eat are safe. No one would want a surgeon without a medical degree performing surgery. Nor should anyone want the safety of their food or drinking water to be determined by someone who is not an accredited environmental health professional.

Another barrier to achieving a truly protective environmental health system is political will. Mitigating newly detected environmental health problems may require the appropriation of funding or other action from an elected official. Of course, it is easier and less expensive in the short-term to do nothing. In the long-term, however, communities bear the cost of governmental inaction by way of adverse health and environmental outcomes.

The Hope: Build a Robust Environmental Health System

But there is hope. By investing in essential governmental environmental health services through dedicated resources will create an effective environmental health system that proactively protects communities and helps everyone attain good health. Federal, state, tribal, and local governments should adopt standard approaches to ensuring environmental health equity, protections, and access for all, particularly vulnerable and at-risk populations. The federal government can help build an effective and strong environmental health system by:

1) CREATING AN INTEGRATED INFRASTRUCTURE TO COLLECT AND TRACK CRUCIAL INFORMATION.

The World Health Organization argues that surveillance is “the cornerstone of public health security.”¹⁴ A cohesive environmental health tracking or surveillance system measures hazards, human exposures, and health outcomes. The system must collect consistent, comparable data over time to identify problems. It must also provide real-time data to inform efforts to plan, execute, and assess environmental health services.¹⁵ Such a system can be achieved in partnership with state, tribal, and local governments; academia; and laboratories.

Academic institutions can gather evidence-based research to elucidate the essential characteristics of an effective environmental health surveillance system, and laboratories can build capacity to collect and analyze environmental and human samples for environmental toxicants. Currently, there are several federally funded surveillance efforts that could be integrated into the Centers for Disease Control and Prevention National Environmental Health Tracking Network platform¹⁶ to enable real-time, data-driven decisionmaking. These include the CDC National Biomonitoring Program,¹⁷ the Agency for Toxic Substances and Disease Registry ToxProfiles,¹⁸ the ATSDR National Amyotrophic Lateral Sclerosis Registries,¹⁹ the Department of Defense Environmental Health Surveillance Registry,²⁰ the Air Quality System,²¹ the National Air Toxics Assessments,²² and, now, the US Zika Pregnancy Registry.²³

2) BUILDING A WELL-TRAINED AND HIGHLY SKILLED WORKFORCE.

The ability for the environmental health system to detect, assess, and prevent adverse environmental exposures is only as good as the workforce. The next generation of environmental health professionals must have the training to continue this work, as well as opportunities for continuing education to remain current with the latest science.

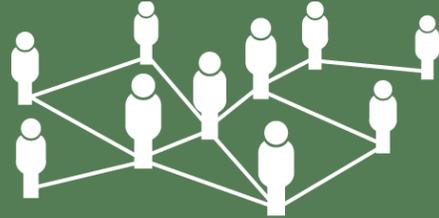
3) PROVIDING AMPLE AND SUSTAINABLE FUNDING FROM DIVERSE SOURCES.

To successfully face an environmental health challenge, such as climate change, requires adequate sustainable funding from diverse sources. It is not enough to fund an emergency response immediately after a devastating flood or hurricane. Rather, well-funded adaptation, mitigation, and recovery measures must be planned proactively to help communities guard against the effects of extreme climate events. Additionally, multiple entities should support these efforts, so that funding is not contingent on any one agency's budget.

4) ENSURING SOUND POLICIES AND PROGRAMS ARE GROUNDED IN EXISTING AND UP-TO-DATE EVIDENCE-BASED RESEARCH.

Environmental health policies should be predicated on existing evidence-based research and updated regularly as new research become available. New research must be integrated regularly to ensure that policies remain up-to-date. This structure should include federal and state regulations.

Implementation and enforcement of policies



AN INTEGRATED SYSTEM

National Environmental Health Tracking Network – system of integrated health, exposure, and hazard information and data from a variety of national, state, and city sources.

National Biomonitoring Program – offers an assessment of nutritional status and the exposure of the US population to environmental chemicals and toxic substances.

National Amyotrophic Lateral Sclerosis Registries – the only population-based registry in the US for persons with ALS to help scientists learn more about ALS and its causes.

ToxProfiles – provide comprehensive information on hundreds of chemicals to determine when exposures in communities pose health risks.

Zika Pregnancy Registry – federal, state, local and tribal health agencies work together to collect information about pregnancy and infant outcomes following Zika infection during pregnancy.

Environmental Health Surveillance Registry – can be established to contain the names of all the individuals who were known or believed to have been exposed, along with estimates of their exposure.

is equally important, as a policy is only as strong as its application. The Clean Air Act requirement that National Ambient Air Quality Standards be reviewed every five years is a good example of updating policies to reflect the current science base. Another example is the most recent ozone standard review, which considered new information showing a link between ozone pollution and increased risk of low birthweight in newborns.²⁴ Finally, policy enactment and enforcement should be considered equally important, as a policy is only effective if it is implemented.

5) ENCOURAGING CROSS-SECTORAL PARTNERSHIPS.

Partnerships among environmental health professionals, communities, transportation and urban planners, housing officials, hospitals, safety net providers, and others are necessary to address cross-cutting environmental health issues and to ensure that communities have a voice in decisions affecting them. Such partnerships should be incentivized by offering funding for specific projects. Also, these partnerships should cross the federal, state, tribal, and local thresholds, as every level of government is responsible for reaching outside of its sector to build new partnerships.

6) ASSURING ENVIRONMENTAL HEALTH SERVICES ARE EQUITABLY ACCESSIBLE.

All governing bodies should make environmental health equity a priority. Each should particularly seek to aid vulnerable populations so that they, too, can realize good health.

Case Examples

Environmental health professionals work every day to ensure that the air we breathe, the water we drink, and the foods we eat are safe. No one would want a surgeon without a medical degree performing surgery, nor should anyone want the safety of their food or drinking water determined by someone who is not a highly skilled professional. Effective environmental health systems foster community resilience and share several key features: strong collaboration with partners, continuous quality improvement to enhance capabilities for threat detection and response, evidence-based policies and action plans, and services accessible to all community members.

Recent emergencies demonstrate the need for a strong nationwide, governmental environmental health system. The Zika virus outbreak, Flint water crisis, and Hurricane Katrina are three examples with stark environmental health implications. These emergencies will not be the last, so we must prepare by investing in a robust environmental health system.

ZIKA VIRUS



The Challenge

The Zika virus—transmitted both sexually and by the bite of an infected *Aedes* species mosquito—was first documented in 1947 in Tanzania’s Zika forest and spread intermittently through Africa and Asia for decades. Since then, a generally warming climate, industrial development, and environmental damage have facilitated mosquito migration to new areas.^{25, 26} The Zika virus spread to the Federated States of Micronesia and French Polynesia in the South Pacific and reportedly infected 11 percent of the population between 2013 and 2014. By 2015, 1.5 million people were infected with the Zika virus in Central and South America.²⁶ In 2016, local Zika virus transmission was first documented in the United States.

Zika infection during pregnancy can cause a range of birth defects, including microcephaly—a neurological disorder characterized by unusually small head size resulting from an underdeveloped brain. The disorder ranges in severity from mild to severe and is linked to seizures, developmental delays, intellectual disability, movement and balance problems, difficulty swallowing, and hearing and vision problems. In the United States, between 2 and 12 babies in every 100,000 live births have microcephaly.²⁷ Yet, between 2015 and early 2016, in Brazil alone, 3,893 babies were born with microcephaly, of which at least 49 have died.²⁶

Zika is also potentially linked to Guillain-Barré syndrome, a rare nervous system disease. In the US, there are about 1 to 2 cases per 100,000 people annually.²⁸

Rapid detection of Zika infection is difficult. Zika diagnostics are needed at local and state laboratories level. In addition, obstetricians need guidance on speaking with patients about risks of Zika.

Zika is a new disease to the Americas that does not shadow existing epidemiologic studies and response practices of previous large-scale outbreaks, like those involving Ebola virus and dengue fever. The geographical location of the outbreak is a highly connected area that cannot be contained through quarantine or isolation.²⁹ Research is ongoing to prevent or cure the disease. In the meantime, there are strategies that could limit or delay the spread and transmission of the disease,

such as avoiding mosquitoes through the use of chemical repellants, bed nets, protective clothing,³⁰ and safe sexual practices, such as abstinence or condom use.³¹

Environmental Health Response

Previously, the *Aedes* mosquito was found in tropical weathers. However, with climate change—and increases in temperatures over longer periods of time—mosquitos have spread into regions that historically have not seen *Aedes* mosquitos. Over 20 countries and territories have reported local transmission of the Zika virus.³² In the United States, the *Aedes* mosquito has expanded its distribution into the northern regions of the country. The threat of a US Zika outbreak is a public health emergency driven by climate change and should be met with a response rooted in environmental health principles. A robust environmental health system that protects water, reduces harmful chemical exposures, promotes safe housing, and is backed by a sound surveillance system will be able to reduce or prevent the spread of further illness from Zika.

Integrated Mosquito Management

The best way to prevent disease-carrying mosquitoes is through community-based mosquito control and public education programs. Integrated mosquito management programs provide mosquito monitoring and surveillance of the disease, remove standing water where mosquitos lay eggs, and carefully apply pesticides to significantly reduce mosquito populations while protecting water systems and minimizing undue human and animal exposure.³³

Housing

There are several actions homeowners can take to lessen the risk of Zika virus exposure, such as installing screens on windows, especially in homes that lack air conditioning and rely on open windows for cooling. Also, dumping out standing water around the home found in places like flower pots, rain gutters, bird baths, and more.

Surveillance and Detection

In 2016, CDC set up the Zika Pregnancy Registry—a combined effort from federal, state, tribal, and local health agencies to collect information about pregnancy and infant health outcomes following Zika infection.²³ This information could feed into a larger surveillance system to detect patterns in all vector-borne disease over time and in the areas affected to help plan a response based on disease prevalence.



Zika infection during pregnancy has been known to cause birth defects, including microcephaly leading to an underdeveloped skull and, often, brain size.

Environmental health professionals conduct routine mosquito surveillance to determine local vector presence and risk to humans, and to document trends once transmission is detected. This data informs mosquito control activities, as well as targeted outreach to educate the health care community and public about Zika risks.³⁴

In addition,³⁵ syndromic surveillance can enhance outbreak detection and situational awareness by identifying morbidity trends before diagnoses are confirmed. Collecting useful health data, climatology information, and geo-spatial vulnerability (limitations both geographical and regarding access to care or treatment) are all critical components to painting a picture of outbreak evolution.¹⁴ This public health tool applies existing and real-time data—such as data on over-the-counter drug sales or the number of patients presenting in emergency departments with specific symptoms—for early detection of unusual disease clusters or sentinel cases. It might also provide information on the trajectory of an outbreak after it begins and provide situational awareness in the absence of an outbreak.³⁵ But Zika surveillance depends on the ability for laboratory confirmation of disease cases. This, in turn, requires Zika diagnostics at regional reference laboratories or local public health laboratories²⁹ to improve test turn-around times.

Vulnerable Populations

As discussed above, infants born to Zika-infected mothers are especially vulnerable to adverse health consequences. A second vulnerable population is those living in poverty who may reside in sub-standard housing that might have damaged or no window screens and/or standing water in or around the home or a multi-unit building, and more. Women living in poverty may lack access to prenatal care, decreasing their opportunities to receive information about the risks of Zika infection during pregnancy.

Workforce

Just as an airport ground crew works to ensure passenger safety, the well-trained, multidisciplinary environmental health workforce endeavors to maintain an environment conducive to human health. Instead of pre-flight plane inspections, environmental health professionals monitor water safety, conduct mosquito control activities, carry out syndromic surveillance and biomonitoring, and engage in other critical activities. The work that environmental health professionals perform is greatly realized at the community level, especially by those most vulnerable to harmful environmental exposures.

Opportunities for Action

- 1) Increase mosquito surveillance capabilities and resources for mosquito control.
- 2) Instill confidence in the public by creating a robust environmental health system with a lead agency.
- 3) Provide resources and training to ensure a qualified environmental health workforce.

FLINT WATER CRISIS



The Challenge

The safety of our nation's drinking water systems has recently been called into question. The water crisis that began in Flint, Michigan, in April 2014 sheds light on the interplay between weak governmental policy, the physical environmental health infrastructure, and the lack of oversight and accountability in a post-industrial region suffering from years of under-employment and industry divestment. Over the course of many months, a population of nearly 100,000 was stripped of one of the most basic human needs: clean drinking water.

Flint's aged water system—similar to that in many US urban areas—contains a large percentage of lead pipe sand plumbing.³⁶ In April 2014, the city switched its water source from treated Lake Huron/Detroit River water to improperly treated Flint River water, which corroded pipes and caused lead to leach into the water.

Lead can enter the body through drinking water, through foods cooked with contaminated water, or through infant formulas mixed with lead-tainted water. While lead occurs in the environment naturally, both EPA and CDC maintain no safe blood lead level in children.^{37, 38} In fact, lead exposure is linked to developmental and neurological damage in children,¹⁰ whose bodies absorb ingested lead at the alarming rate of 40 to 50 percent, compared with 3 to 10 percent in adults.³⁶ Groups suffering disproportionate lead exposure include children, pregnant women, and low-income individuals.³⁶

Most water system damage, as in Flint, is preventable with enforcement of proper regulatory safeguards. The application of federally mandated anticorrosive water pipe treatments would have cost Flint an estimated \$100 a day. Absent such treatments, the cost to replace Flint's lead water pipes is an estimated \$1.5 billion.

As the water crisis was ongoing, Flint experienced a second, unrelated emergency (though also pertaining to water safety): 91 cases of Legionnaires' disease, resulting in 12 deaths. The disorder is a form of pneumonia caused by bacteria commonly found in lakes and rivers.³⁹ The *Legionella* bacteria is contracted through aspiration of contaminated water, often droplets of water from large building air conditioning systems or from water used in showering. While there are no vaccines for

Legionnaire’s disease, 9 out of 10 outbreaks can be avoided by effective water management.⁴⁰ CDC recently developed a practical guide addressing the implementation of industry standards for water management to reduce the growth and spread of *Legionella* in buildings.⁴¹

The difficulty for the residents of Flint to recover from such an environmental health disaster is multifactorial.

Environmental Health Response

The Flint Water Crisis has brought attention to a nationwide problem. Washington, DC; Los Angeles, CA; Newark, NJ; and Baltimore, MD, all face similar challenges. The reoccurrence of this problem demonstrates the need for a universal solution, such as an environmental health system.

Housing

Although lead use was restricted in plumbing materials in 1986, lead-laced service lines, solders, and plumbing fittings are still extant in many older homes and neighborhoods.³⁶ Coupled with contaminated water from the Flint River, inadequate water systems treatment, corroded water system infrastructure, and older homes, the community of Flint was unacceptably exposed to lead.

Screening and Biomonitoring

CDC’s Childhood Lead Poisoning Prevention Program provides resources to nearly 60 state and local health departments to screen for high blood lead levels in children and conduct various lead poisoning prevention activities.⁴² When elevated blood lead levels are detected, the child is referred to a physician for remediation.

Biomonitoring—analysis of human specimens to detect exposure to environmental toxicants—plays a critical role in lead poisoning surveillance in children and adults.⁴³ Data collected through the National Health and Nutrition Examination Survey show background levels of exposure for a typical (noninstitutionalized) US resident to more than 200 environmental chemicals. This baseline data complements state- and local-level biomonitoring data, which may show spikes in exposure for certain populations. Few states, however, have an adequate biomonitoring program, and not all test for lead exposure.



Most water systems damage, like in Flint, Michigan, could be prevented with the proper investments, regulations, and enforcement.

The National Environmental Health Tracking Network,¹⁶ a program of CDC’s National Center for Environmental Health, can overlay data on lead-poisoned children with geospatial maps to

determine whether a particular water system might be implicated in the lead contamination and to monitor exposures in vulnerable communities.

Vulnerable Populations

Historically, lead was introduced into the environment through gasoline and paint. However, recognizing the risk of childhood lead poisoning, it was banned from these products and, as a result, childhood blood lead levels began to decline. In contrast, incidences of lead in drinking water have increased due to the corroding water system infrastructure.

In Flint, exclusionary housing practices forced minorities and low-income families into older homes³⁶ with older plumbing. Additionally, 42 percent of Flint children live in poverty, compared with 16.2 percent in the state of Michigan and 14.8 percent nationally.

Workforce

Just as an airport ground crew works to ensure passenger safety, the well-trained, multidisciplinary environmental health workforce endeavors to maintain an environment conducive to human health. Instead of pre-flight plane inspections, environmental health professionals monitor water safety, conduct mosquito control activities, carry out syndromic surveillance and biomonitoring, and engage in other critical activities. The work that environmental health professionals perform is greatly realized at the community level, especially those most vulnerable to harmful environmental exposures.

Opportunities for Action

- 1) Offer stronger enforcement of the Safe Drinking Water Act's Lead Copper Rule, which sets an action level of 0.015 mg lead per liter tap water.
- 2) Improve surveillance capabilities to prevent, detect, and monitor exposures to harmful environmental chemicals over time.
- 3) Instill confidence in the public by creating a robust environmental health system with a lead agency.
- 4) Provide resources and training to ensure a qualified environmental health workforce.
- 5) Develop a federal interagency plan to eliminate lead exposure.

HURRICANE KATRINA and SUPER STORM SANDY



The Challenge

Although a community can prepare for an extreme weather event with sound infrastructure, policies, and public education, it cannot necessarily prevent all adverse impacts. When severe, widespread storm damage is sustained, some communities may never recover. The level of resiliency after a severe weather event is one way to measure preparedness (although after-the-fact).

In August 2005, Hurricane Katrina precipitated massive flooding in New Orleans, Louisiana, damaging or destroying over 100,000 homes and causing \$108 billion in total damage.⁴⁴ In October 2012, Super Storm Sandy devastated coastal New Jersey, causing major infrastructure damage, power outages, and disruption to transportation services totaling over \$37 billion in damage.⁴⁵

Stress from both storms had far-reaching environmental health impacts with acute and long-term health implications, such as post-traumatic stress disorder caused by injury or loss of life, loss of or damage to property and possessions, forced relocation, financial loss, and more.⁴⁶ Additionally, transportation challenges in flooded areas delayed ambulatory care, increasing risk of permanent myocardial damage or death.⁴⁵ Many residents suffered lost or damaged property, financial loss, and the trauma of forced relocation.⁴⁶

Severe weather events such as Hurricane Katrina and Super Storm Sandy are predicted to increase in frequency in the coming years, due to climate change.

Environmental Health Response

When a storm causes immense damage to buildings and roads, as well as psychological and emotional stress, victims may be unaware of risks associated with contaminated tap water or other environmental threats. Skilled environmental health professionals are tasked with responding to and monitoring compounded environmental threats in the immediate aftermath of an event and over time.

Clean Air

Hurricane-induced flooding can cause mold growth inside dwellings, diminishing indoor air quality. Poor air quality, in turn, may aggravate asthma and increase the incidence of lower respiratory tract infections (e.g. pneumonia) and upper respiratory tract symptoms.⁴⁷ Unfortunately, cleaning up after

a storm often involves burning piles of accumulated debris, adding further to the air pollution burden. Ensuring that debris disposal does not worsen health is a challenge even now.⁴⁸

Safe Water

Warm waters create a hospitable environment for harmful algae blooms and the growth of other waterborne pathogens. Flood waters often contain a variety of contaminants, and can overwhelm a region's drainage and wastewater treatment systems, increasing the risk of exposure to bacteria, parasites, and other harmful pollutants.⁴⁹

Healthy Community Design

After a hurricane, travel through flooded, damaged or debris-strewn areas becomes challenging, even for first responders. Delays in emergency medical care can result in additional adverse health events: following the destruction caused by Super Storm Sandy, an additional 125 cases of myocardial infarctions, 35 cases of stroke, and 70 deaths were recorded—beyond the otherwise expected incidence.⁴⁵ The medical, disaster preparedness and first responder communities are challenged with not only responding to injuries and death caused directly by the weather event, but also indirectly caused by stress and transit limitations.

Housing

One hundred and thirty-five thousand structures sustained damage from Hurricane Katrina, including about 105,000 homes.⁵⁰ Many of the damaged homes, built before the 1950s, underwent demolition. The destruction of lead-painted structures elevated soil lead levels; 61 percent of these homes had lead levels that exceeded EPA standards. Children residing or attending school near construction sites that dispersed lead dust were at risk of elevated blood lead levels.⁵⁰

Tracking and Biomonitoring

The National Environmental Health Tracking Network integrates data from a variety of sources pertaining to health conditions (e.g. asthma and birth defects), environmental exposures (e.g. blood lead levels), and environmental hazards (e.g., air pollution).¹⁶ This data enables researchers and health authorities to pinpoint localities with environmental health problems and to track problems over time.



In August of 2005, Hurricane Katrina flooded the city of New Orleans, Louisiana, damaging or destroying over 100,000 homes and causing \$108 billion in damage.

Biomonitoring plays a critical role in accessing exposures to potentially harmful chemicals, such as lead, in adults.⁴³ Biomonitoring data collected through CDC’s National Health and Nutrition Examination Survey show background levels of exposure for a typical (noninstitutionalized) US resident to more than 200 to 300 environmental chemicals.¹⁷ This baseline data complements state- and local-level biomonitoring data, which may show spikes in exposure (compared with baseline) for certain populations. Few states, however, have an adequate biomonitoring program, and not all test for every analyte tracked by CDC.

Vulnerable Populations

Severe weather events do not account for race, income, gender, or age before striking. Yet, vulnerable populations—including communities of color, the elderly, young children, low-income communities, and those with chronic illnesses—bear the greatest burden of injury, disease, and death related to climate change. Similarly, socioeconomically disadvantaged communities are not always able to recover quickly, or recover at all, in the wake of environmental disasters.

Workforce

Just as an airport ground crew works to ensure passenger safety, the well-trained, multidisciplinary environmental health workforce endeavors to maintain an environment conducive to human health. Instead of pre-flight plane inspections, environmental health professionals monitor water safety, conduct mosquito control activities, carry out syndromic surveillance and biomonitoring, and engage in other critical activities. The work that environmental health professionals perform is greatly realized at the community level, especially by those most vulnerable to harmful environmental exposures.

Opportunities for Action

- 1) Promote clean air for all through enforcement of policies like the Clean Air Act.
- 2) Improve surveillance capabilities to prevent, detect, and monitor large-scale exposures.
- 3) Create a robust environmental health system with a lead agency to shoulder the burden of responding to and monitoring compounded environmental health threats to a community.
- 4) Provide resources and training to ensure a qualified environmental health workforce.

Essential Focus Areas of a Robust Environmental Health System

Environmental health professionals protect the public by tracking environmental exposures in communities across the United States and assessing potential links with adverse health outcomes.

To achieve a healthy community, homes should be safe, affordable, and healthy places for families to gather. Workplaces, schools, and child care centers should be free of exposures that negatively impact the health of workers or children. Nutritious, affordable foods should be safe for all community members. Access to multiple types of transportation that are safe and affordable, including biking and public transit, improves the environment and drives down obesity and other chronic illnesses. Outdoor and indoor air quality in all communities should be healthy and safe for everyone. Children and adults alike should have access to safe and clean public spaces, such as parks. When a disaster strikes, a community needs to be prepared. It should have the tools and resources to be resilient against physical (infrastructure and human) and emotional damage. All these activities require the participation of federal, state, local, and tribal governments.

The following are 10 focus areas that highlight segments of the environmental health system that are all required to ensure a safe community for everyone. Safe water, clean air, vector control, food safety, chemical safety, health community design, healthy housing, climate effects, emergency preparedness, and environmental health equity are among the most critical and timely based on the views of the National Environmental Health Partnership Council.



SAFE DRINKING WATER



Safe water is critical to the welfare of individuals, families, and the US economy. Sadly, two out of every five Americans rate their quality of water as poor. Within the next decade, at least 36 states will face water shortages. At the same time, contaminated water is a source of illness and premature death in the United States. About one in nine US residents gets his or her drinking water from a private well,⁵¹⁻⁵³ and about a quarter of the roughly 2,100 private wells sampled by the US Geological Survey between 1991 and 2004 were found to have at least one contaminant exceeding federal maximum contaminant levels for regulated substances or health-based screening levels for unregulated substances.⁵⁴ Over the past 45 years, the proportion of outbreaks associated with private water sources has increased.⁵⁵ Five waterborne illnesses—giardiasis, cryptosporidiosis, Legionnaire’s disease, otitis externa (inflammation of the ear canal), and non-tuberculous mycobacterial infection—cause an estimated 40,000 hospitalizations each year at a cost of \$970 million annually.⁵⁶ Altogether, researchers estimate that up to 900,000 people fall ill and up to 900 die annually from waterborne infectious diseases.⁵⁷

The Problem

Approximately 78 percent of fresh water consumed in the US is derived from surface waters, such as reservoirs, lakes, and streams.⁵⁸ These waters are susceptible to nonpoint pollution sources, such as heavy storms that wash fertilizers and other contaminants from watersheds to waterways. Some persistent chemicals (which resist decay) have been linked to human health problems. For example, perfluoroalkyl and polyfluoroalkyl substances—manmade chemicals used in a variety of industrial applications—have been associated with high blood cholesterol, obesity, hormone suppression, and cancer. Other pollutants, including nitrogen- and phosphorus-containing fertilizers and sewage effluent, can lead to harmful algal blooms. In the worst cases, toxic contaminants can make water unusable for fishing, recreation, and drinking.

Overall, approximately 85 percent of all water contaminants are nonpoint pollutants coming from diffuse sources.⁵⁹ Many of these are difficult to remove during conventional water treatment. In addition to drinking water, non-point pollutants can affect recreational waters and make the public sick either through direct contact or through consumption of fish or other tainted seafood.

Point-source pollutants enter the water supply in defined locations, such as chemical waste sites or lead water pipes. Cross contamination occurs when sewer lines and drinking water systems co-mingle as a result of antiquated water and sewage systems or natural disasters. Additionally, there are an estimated 240,000 water main breaks per year in the US,⁶⁰ each representing an opportunity for pollutants to enter the water supply. This source of contamination often occurs downstream of water treatment plants and is virtually undetectable by the consuming public, until people fall ill. The American Society of Civil Engineers' 2013 *Report Card for America's Infrastructure* rates our current drinking water infrastructure a D (poor-at risk) on the standard A (exceptional) to F (failing) scale.⁶⁰

Yet drinking water is not the only risk for consumers: recreational waters can cause illness as well. US residents make 300 million trips to pools⁶¹ and other swimming locales every year; however, recent CDC studies found that one in eight public pools are closed during routine inspections because of health hazards.⁶² In addition to infectious disease threats, public pools, hot tubs, water parks, and community water features may pose the risk of drownings and pool-chemical poisonings or chemical injuries.

Opportunities for Action

- 1) Ensure the major federal agencies responsible for water quality—EPA, CDC, US Corps of Engineers, US Department of Agriculture, and US Department of the Interior—develop a national action plan.
- 2) Encourage adoption of CDC's Model Aquatic Health Code.⁶³
- 3) Review, update, and systematically enforce primary drinking water standards.
- 4) Upgrade community water and wastewater treatment systems. Prioritize investments in remediation where the water or wastewater infrastructure poses health risks.
- 5) Identify and promote innovative water efficiency programs.
- 6) Ensure CDC provides necessary capacity-building support to local environmental agencies in order to anticipate, recognize, evaluate, and remediate high-risk infrastructure and contamination sources.
- 7) Develop a federal interagency plan to eliminate lead exposure, including water exposure to lead.

For more information, visit:

American Society for Civil Engineers

- *Report Card for America's Infrastructure:* <http://www.infrastructurereportcard.org>

Association of Public Health Laboratories

- National Water Laboratory Alliance:
http://forms.dev.aphl.org/AboutAPHL/success/Success_Stories_Archive/Safe-to-Drink.aspx

Centers for Disease Control and Prevention, National Center for Environmental Health

- Water protection tools and resources for states and localities:
<http://www.cdc.gov/nceh/ehs/activities/water.html>
- Water and lead website: <http://www.cdc.gov/nceh/lead/tips/water.htm>
- Model Aquatic Health Code: <http://www.cdc.gov/mahc/index.html>
- Harmful algal bloom website: http://www.cdc.gov/habs/pdf/cyanobacteria_faq.pdf
- Water sanitation & hygiene-related emergencies and outbreak resources:
<https://www.cdc.gov/healthywater/emergency/index.html>
- Environmental Health Tracking Network
 - Water Data: <https://ephtracking.cdc.gov/showWaterLanding.action>
 - Pesticide Exposure Data:
<https://ephtracking.cdc.gov/showPesticidesExposuresLanding.action>

Position papers on drinking water quality:

- American Public Health Association: <https://www.apha.org/policies-and-advocacy/public-health-policy-statements/policy-database/2014/07/14/13/22/drinking-water-quality-and-public-health-position-paper>
- Association of State and Territorial Health Officials: <http://www.astho.org/Policy-and-Position-Statements/Safe-and-Reliable-Drinking-Water-Position-Statement/>
- National Association of County and City Health Officials:
<http://www.naccho.org/programs/environmental-health/hazards/water>



Healthy air is essential to life. Unfortunately, polluted indoor and outdoor air places millions of Americans at risk, threatening not only health, but lives. Various airborne pollutants may aggravate existing lung disease; contribute to the development of lung cancer; contribute to chronic cardiovascular problems, potentially causing heart attacks and strokes; and play a role in central nervous system and developmental problems, including low birth weight. These adverse health effects worsen health inequities, posing a disproportionate risk to low-income populations in areas where transportation systems, zoning laws, and industrial policies increase exposure burdens. According to the American Lung Association’s 2016 *State of the Air* report, more than half of all US residents—over 166 million people—live in areas with unhealthy air.⁶⁴

The Problem

Ground-level ozone, often referred to as smog, is perhaps the form of air pollution most familiar to Americans. Ozone, generally, is also the single most widespread air pollutant in the United States, created by chemical reactions between nitrogen oxides and volatile organic compounds in the presence of sunlight. A second major air pollutant—and the most dangerous—is particulate matter, also known as particle pollution. Particle pollution is associated with heart attacks, strokes, and various forms of lung cancer.

Both ozone and particle pollution trigger asthma attacks and shorten lives. Approximately 7 million US children from birth to age 17 have asthma, with poor and minority children suffering a greater burden of the disease.⁶⁵ Asthma often persists into adulthood and imposes a high societal cost: medical expenses associated with childhood and adult asthma were estimated to be \$50 billion in 2007.⁶⁶

Other concerning outdoor pollutants include nitrogen oxides, sulfur dioxide, lead, and carbon monoxide. In addition, more than 180 other air pollutants, including acid gases, arsenic, dioxins, formaldehyde, and mercury, are emitted from sources across the county. Some of these, such as dioxins and formaldehyde, are recognized carcinogens. Others, like carbon dioxide and methane, are powerful climate change agents.

As is the case with so many pollutants, where one lives matters. Air pollution differs not only among communities, but also within communities. Living near a major source of pollution, such as an oil or gas refinery, a busy highway, or a power plant may impact life expectancy and susceptibility to chronic illnesses, like cardiovascular disease.

The Clean Air Act has helped drive the cleanup of air pollution; since 1970 emissions of many priority pollutants have been cut by 70 percent.⁶⁷ This success is due, in large part, to the development of national limits called National Ambient Air Quality Standards mandated by the Clean Air Act. These standards set limits on the concentration of six airborne pollutants considered harmful to health and the environment: carbon monoxide, lead, nitrogen dioxide, ozone, particle pollution, and sulfur dioxide. Another key tool has been the design of limits on emissions from sources of other toxic air pollutants. EPA has worked with state, local, and tribal governments to implement all of these standards and has now begun a similar effort to tackle climate change. The agency's Clean Power Plan, for example, sets interim and final emission rates for carbon pollution from power plants. Although the rule is currently under judicial review, some jurisdictions are continuing work to meet these carbon emission standards.

Indoor Air

Americans spend much of their time indoors, often in buildings where they work, study, receive child care, shop, recreate, or dine. Although many industrial and occupational exposures are limited by law, not all harmful exposures are restricted, or even reviewed in many indoor areas. For example, not all restaurants and bars are smoke free, so wait staff, cooks, and cleaning crews are potentially exposed for hours at a time to the long lists of toxicants in tobacco smoke. Radon or mold in school classrooms and child care facilities can threaten the health of teachers, administrators, and maintenance staff, as well as students including young children. Americans need protection from recognized indoor air pollutants in all the places where they spend time.

Cleaner Air Improves Life Expectancy and Health

Cleaner air means longer lives and better health. Research shows that life expectancy is greater in areas where air pollution levels, and especially levels of particle pollution, are lower.^{68, 69} One study, for example, found that children raised in California between 2007 and 2011, after air pollution levels had fallen in the state, had better lung function than two earlier cohorts of California children. This, in turn, reduced their risk of lifelong breathing difficulty.⁷⁰

Vulnerable People and Places

Advanced age and pre-existing conditions, such as asthma, cardiovascular disease, or diabetes, place people at increased risk for the adverse impacts associated with air pollution exposure.⁷¹ Children, whose lungs continue to develop until the teen years, are also at elevated risk. Moreover, since children tend to spend more time outdoors than adults, they have potentially greater exposure to outdoor pollutants.⁷² Pregnant women exposed to high levels of air pollution may be at risk for

premature births or low birthweight infants.⁷³ However, even healthy adults who suffer air pollution exposure can experience measurable harm.⁷⁴

Where one lives further exacerbates the risk to their health. Low-income individuals face a higher risk, as they often live or work in communities near major sources of pollution, like industrial plants. In addition, they may have pre-existing conditions caused or exacerbated by air pollution and fewer resources to secure medical care.⁷⁵

Thirty to 45 percent of the North American population now lives near a major highway or road. The pollution from vehicular traffic is linked to increased risk of developing asthma and decreased life expectancy.⁷⁶ Children living within 200 meters of a high traffic roadway have significantly higher rates of pediatric asthma.⁷⁷ While some choose to live close to major roads, others do so because they have limited housing options due to high costs or discrimination in the housing market.

Clean Air and Climate Change

Climate change threatens clean air and the public's health. Climate events, like drought and severe rainfall, worsen particulate matter pollution and contribute to the high number of days with unclean air. Warmer temperatures increase the risk of ozone formation, make cleaning up ozone even harder, and cause additional heat-related health problems.^{78, 79}

Opportunities for Action

- 1) Protect and enforce the Clean Air Act, one of the nation's most successful public health laws.
- 2) Strengthen outdated particulate matter standards and implement the 2015 ozone standards.
- 3) Encourage EPA to use the best available science to establish National Ambient Air Quality Standards that sufficiently protect the health of US residents, including vulnerable populations (e.g., children, the elderly, low-income groups, those with asthma or cardio-pulmonary diseases, etc.).
- 4) Adopt national steps to reduce emissions of methane and volatile organic compounds from existing oil facilities, gas facilities, and other sources.
- 5) Embolden each state to adopt a Clean Power Plan to reduce carbon pollution and mitigate climate change.
- 6) Adopt comprehensive smoke-free protections for all workers in all states, including workers in bars and restaurants.
- 7) Ensure that research continues through EPA and the National Institute for Occupational Safety Health to provide more information and assistance to employers and employees on indoor air pollutants in workplace settings.
- 8) Increase funding to state, local, and tribal governments to promote healthy air.
- 9) Support capacity-building efforts in state, local, and tribal health departments to enable them to monitor and address the health effects of air pollution and climate change.

- 10) Promote environmental justice through the development of policies and programs that reduce exposure to air pollution and decrease the impacts of climate change.
- 11) Educate the public about the connections between individual lifestyle behaviors and exposure to and production of air pollutants, including greenhouse gases.
- 12) Foster collaboration among state, local, and tribal air agencies to reduce air pollution and its associated ills.

For more information, visit:

American Lung Association

- 2016 State of the Air report: www.lung.org/our-initiatives/healthy-air/sota/key-findings/

Centers for Disease Control and Prevention, National Center for Environmental Health

- National Asthma Control Program: <http://www.cdc.gov/asthma/nacp.htm>
- Air Pollutions and Respiratory Health Program: <http://www.cdc.gov/nceh/airpollution/>
- National Environmental Health Tracking Network
 - Outdoor Air Data: <https://ephtracking.cdc.gov/showAirLanding.action>
 - Asthma Data: <https://ephtracking.cdc.gov/showAsthma>
 - Carbon Monoxide Poisoning Data: <https://ephtracking.cdc.gov/showCarbonMonoxideLanding>

National Association of County and City Health Officials

- Air quality position paper: <http://www.naccho.org/uploads/downloadable-resources/04-08-Ambient-Air-Quality.pdf>

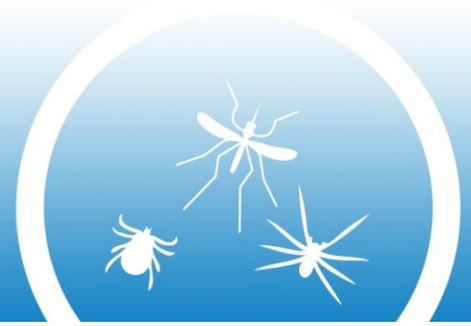
President's Task Force on Environmental Health Risks and Safety Risks to Children

- Coordinated Federal Action Plan to Reduce Racial and Ethnic Asthma Disparities: https://www.epa.gov/sites/production/files/2014-08/documents/federal_asthma_disparities_action_plan.pdf

US Global Climate Change Research Program

- Impacts of Climate Change on Human Health in the United States: health2016.globalchange.gov

VECTOR CONTROL



Global travel, natural disasters, and changing climates all promote the migration of disease vectors and the pathogens they carry. Given the prevalence of all three of these in the modern era, it is unsurprising that vector-borne diseases are on the rise. Altogether, almost half the world's population is at risk of vector-borne disease.⁸⁰ While most parts of the US have not suffered large-scale outbreaks of virulent vector-borne diseases in recent years, important vectors—such as *Aedes* species mosquitos and *Ixodes scapularis* ticks—are found in large swaths of the country. It is not difficult to imagine a situation in which an effectively transmitted pathogen is introduced into local vector populations, prompting sudden disease outbreaks.

The Problem

Vector-borne diseases pose a serious threat to public health. In the past 20 years, the US has become acquainted with three arthropod-borne diseases previously unknown in North America: West Nile virus (1999), chikungunya virus (2013), and Zika virus (2015).⁸¹ At the same time, some formerly endemic arthropod-borne illnesses are reemerging, such as dengue virus, which has caused outbreaks in Texas, Hawaii, and Florida; and St. Louis encephalitis, which researchers believe was reintroduced from Argentina to the US Southwest after an 11-year absence.^{82, 83}

Climate Change Impacts Vector-borne Outbreaks

Climate change can increase the incidence of vector-borne diseases by altering the survival rate, population growth, and habitats of vectors, and by changing disease transmission patterns.⁸⁴ Rain events and drought cycles could profoundly influence the spread of vector-borne disease in the United States, not only due to displacement of populations of humans and disease reservoirs, but in terms of vector abundance. Drought conditions, for example, could favor closer contact among vectors, pathogen reservoirs, and hosts, facilitating disease transmission. Or some areas could become too arid or too wet to remain hospitable to vectors, thus hindering disease transmission. Higher temperatures have already been correlated with increased incidence of vector-borne disease at local, regional, and national levels.⁴⁷

Since climate change is altering temperature and precipitation patterns across the country, it is critical that public health professionals prepare for a potential increase in the geographic ranges and periods of seasonal activity of vectors, such as mosquitoes.

Vector Control Preparedness is Key to Saving Lives and Money

Planning ahead improves efficiency, allowing sustainable vector control programs to save valuable local emergency response resources. Vector control programs are relatively inexpensive, costing about \$3.67 per person, per year—far less than the costs associated with the emergency use of contractors, pesticides, and application equipment.⁸⁵ For example, the cost of a West Nile virus outbreak in Louisiana during an eight-month period covering 2002 and 2003 was \$20.1 million, which included \$9.2 million in public health response, \$4.4 million in medical costs, and \$6.5 million in nonmedical costs.⁸⁶

Workforce Development

Thorough planning necessitates ongoing professional development of vector control staff, whose training might include meetings with entomologists and epidemiologists to better understand vector life cycles, disease patterns in an affected area, and other important public health considerations.

A Healthy Home Reduces Vector Risk

Assuring proper housing conditions is integral to vector-borne disease management. Health problems, such as asthma, can be triggered by the excrement of cockroaches, rodents, and other pests. Some of these same pests can also be vectors for significant problems that affect human health and well-being and are capable of transmitting diseases to humans. According to a 1997 American Housing Survey, rats and mice infested 2.7 million housing units.⁸⁷

States and localities can help diminish the Zika virus threat by implementing the recommendations found in the 2015 International Property Maintenance Code (IPMC), which require homeowners to meet certain minimum standards in the upkeep of their property.⁸⁸ These include installing screens on windows and doors and grading the property to prevent the accumulation of standing water. Communities may wish to supplement IPMC guidelines with applicable provisions from the [National Healthy Housing Standard](#) (NHHS). For example, the NHHS encourages the use of Integrated Pest Management (IPM) practices to reduce the sources of pests before resorting to chemical pesticides. CDC's Vector Control/IPM Program provides training, tools, resources, and expert guidance for states and localities to address vector-related challenges.⁸⁹

Syndromic Surveillance

The US needs comprehensive, linked surveillance and tracking systems. For instance, in 2016 CDC stood up the Zika Pregnancy Registry—a combined federal, state, local, and tribal registry that enables health agencies to track pregnancy and infant outcomes following Zika infection during pregnancy.²³ This information could feed into a larger surveillance system to discern disease patterns, identify affected areas, and help plan an appropriate public health response.

Furthermore, syndromic surveillance can enhance outbreak detection by identifying morbidity trends before diagnoses are confirmed.¹⁴ This public health tool applies existing and real-time data—such as the number of patients presenting in emergency departments with specific symptoms—for early detection of unusual disease clusters or sentinel cases. It might also provide information on the geospatial trajectory of an outbreak after it begins and provide situational awareness in the absence of an outbreak.³⁵

Of course, laboratory-based disease surveillance is essential to confirm infection with specific pathogens. When emerging vector-borne diseases are detected in an area, then state, regional, or local public health laboratory staff need adequate resources to develop and implement disease-specific tests and to build capacity for rapid, large-scale response in the event of an outbreak.

Opportunities for Action

Funding for vector control programs is limited or discontinued in many jurisdictions. The following opportunities for action aim to guide the establishment of new programs or augmentation of existing programs to ensure a measure of public health protection from vector-borne diseases:

- 1) Ensure the continuity of disease surveillance and data collection from people and a variety of vectors, including immature mosquitoes, adult mosquitoes, horses, wild birds, and sentinel vertebrates.
- 2) Prepare cooperative emergency resource-sharing agreements with other jurisdictions.
- 3) Establish shared service agreements, equipment pools, regional districts, and standard service contracts with nearby jurisdictions before an emergency occurs.
- 4) Establish partnerships with agricultural extension agents and subject matter experts.
- 5) Work with state agricultural and public health agencies to facilitate access to important surveillance data from veterinary diagnostic laboratories, zoos, and equine, falconry, and raptor rehabilitation organizations.
- 6) Coordinate with public health laboratories for testing and surveillance services during an emergency, and expand laboratory capacity to identify existing and emerging vector-borne pathogens in human, animal, and vector samples.
- 7) Provide training and continuing education on outbreak investigation in humans and animals and collection of vector samples and abatement activities.
- 8) Enhance data-sharing systems to facilitate effective communication among federal, state, and local jurisdictions.
- 9) Participate in longitudinal monitoring programs for vectors and pathogens to discern changes in vector distribution and abundance over time.
- 10) Develop models to predict the effects of climate change on vector-borne disease risk and the projected distribution and abundance of major hosts and vectors.

- 11) Create disease control and prevention plans to reduce the impacts of vector-borne diseases on local communities, including vulnerable populations.
- 12) Support integrated mosquito management programs designed to benefit or cause minimal harm to people, domestic animals, wildlife, and the environment.

For more information, visit:

Association of State and Territorial Health Officials

- Before the Swarm report: <http://www.astho.org/programs/environmental-health/natural-environment/before-the-swarm/>

Centers for Disease Control and Prevention, National Center for Environmental Health

- Integrated pest management tools, resources, expert guidance, and trainings: <http://www.cdc.gov/nceh/ehs/Topics/VectorControl.htm>
- Mosquito Control, Zika Virus: <https://www.cdc.gov/zika/vector/index.html>

National Association of County and City Health Officials

- Policy statement on climate change and vector-borne disease: <http://www.naccho.org/uploads/downloadable-resources/14-05-climate-change-and-vector-borne.pdf>

National Center for Healthy Housing

- Resources for professional groups, families, researchers, and others: <http://nchh.org/>



Americans spend more than \$1 trillion on food each year, nearly half of it in restaurants, schools, and other establishments outside the home.⁹⁰ Therefore, maintenance of a healthy and safe food pipeline is a strategic national imperative. To achieve that goal, federal agencies cooperate with state and local entities to develop systems, standards, and the workforce necessary to assure universal access to safe and nutritious food.

The Problem

The Government Accountability Office has identified as many as 15 federal agencies, including the Food and Drug Administration (FDA) and US Department of Agriculture (USDA), tasked with administering at least 30 food safety laws. Nonetheless, foodborne illness remains a problem in the US. According to CDC, every year one in six Americans becomes ill and 30,000 Americans die from ingesting contaminated food or beverages.⁹¹ Foodborne illnesses cost the country more than \$15.6 billion annually.⁹² While all Americans are susceptible to foodborne illness, certain populations, including children, pregnant women, people with disabilities, the elderly, and individuals with compromised immune systems, are particularly vulnerable.⁹³ Preventing foodborne illness remains one of public health's greatest challenges.

The laboratory-based network used to detect and help resolve foodborne disease outbreaks in the US is the PulseNet network established by CDC and the Association of Public Health Laboratories in 1996. According to a recent CDC report, PulseNet is not only effective, but cost-effective.⁹⁴

PulseNet, the national laboratory network that detects foodborne disease outbreaks, prevents an estimated 270,000 illnesses every year from the three most common causes of foodborne illness: Salmonella, E. coli O157, and Listeria monocytogenes. As a result, an estimated \$507 million is saved every year in medical costs and lost productivity. A recent economic evaluation of PulseNet activities from 1994 to 2009 shows the exceptional cost-effectiveness of this network. PulseNet costs public health agencies \$7.3 million annually. But it provides an economic benefit about 70 times greater than its cost by quickly identifying

problems in the food supply that would not otherwise be recognized. This fast detection of problems leads to prompt actions to stop foodborne outbreaks, prevent additional people from getting sick, and save lives.

Despite this success, PulseNet's effectiveness may be compromised by clinical laboratories' increasing use of molecular diagnostic tests that do not require growing microbial isolates in culture. This deprives the network of cultured isolates for later public health analysis. Sufficient funding to facilitate an evolution of PulseNet can help assure its continued effectiveness.⁹⁵

A Workforce That Protects Our Food

A qualified food safety workforce is essential to ensure the integrity of the food system. State and local food safety professionals comprise the principal governmental workforce that ensures safe food. Food safety professionals come from a diverse array of disciplines that include auditors, inspectors, regulators, epidemiologists, environmental health professionals, laboratorians, and other public health practitioners. These professionals benefit from standardized credentials and training to ensure integrated, science- and risk-based food safety practices across the entire food safety system.

Such a comprehensive system includes:

- **Work planning and inspections** to ensure coordinated approaches to plan and conduct industry oversight activities;
- **Compliance enforcement** to ensure coordinated and targeted food safety inspections;
- **Public health surveillance, response, and post-response activities** to ensure rapid detection and resolution of foodborne disease outbreaks;
- **Governmental food safety laboratories** to generate science-based data, detect outbreaks, and inform outbreak response activities;
- **Training and certification** (such as that provided by the National Environmental Health Association) to assure food safety professionals are well-qualified and appropriately credentialed; and
- **Information technology and data standards** to facilitate the sharing of electronic data among clinical and public health partners.

Access to Affordable and Nutritious Food

Universal access to affordable and nutritious foods is imperative for public health. Studies, however, have documented unequal access to retail food outlets in parts of the US. Supermarkets and other fresh food sources tend to be scarce in low-income, minority, and rural communities. Altogether, 6.5 million US children live in communities without access to fresh fruits and vegetables.⁹⁶

Pesticides in Food

Pesticides used to protect crops from insects, rodents, mold, and other pests are regulated by EPA, and pesticide residues are measured by USDA.⁹⁷ Still, every year a million children under age 6 are

involved in pesticide poisoning incidents.⁹⁸ Pesticide exposure has particularly severe impacts on children, compared with adults, owing to their underdeveloped physiology and smaller size.

Opportunities for Action

- 1) Enhance workforce training and credentialing.
- 2) Facilitate timely and efficient communications among all food safety agencies.
- 3) Support implementation of the foodborne disease-related provisions of the 2013 FDA Food Code to reduce the spread of foodborne illnesses in retail food establishments:
 - Exclude ill food service staff from working until at least 24 hours after symptoms, such as vomiting and diarrhea, have ended.
 - Prohibit bare hand contact with ready-to-eat food.
 - Require at least one food service employee to be a certified food protection manager.
 - Require food service employees to wash their hands before beginning work or returning to work after breaks.
- 4) Adopt a “Health in All Policies” approach for food safety to assure a clear mandate for coordination and engagement with food safety-related stakeholders within and outside of government. (“Health in All Policies” is a guide for state and local governments developed by the American Public Health Association, the Public Health Institute, and the California Department of Public Health.)
- 5) Adopt integrated pest management practices to reduce children’s exposure to pesticides.

For more information, visit:

American Public Health Association

- *Health in All Policies: A Guide for State and Local Governments:*
https://www.apha.org/~media/files/pdf/factsheets/health_inall_policies_guide_169pages.ashx

Association of State and Territorial Health Officials

- Position statement on an integrated food safety system: <http://www.astho.org/Policy-and-Position-Statements/Position-Statement-on-Integrated-Food-Safety-System/>

Centers for Disease Control and Prevention

- Food safety website: <http://www.cdc.gov/foodsafety/>
- National Center for Environmental Health food safety resources, tools, and training: <http://www.cdc.gov/nceh/ehs/activities/food.html>

- National Center for Environmental Health’s Environmental Health Specialist Network: <http://www.cdc.gov/nceh/ehs/ehsnet/index.htm>
- National Center for Environmental Health [e-Learning on Environmental Assessment of Foodborne Illness Outbreaks](http://www.cdc.gov/nceh/ehs/elearn/ea_fio/index.htm) training course: http://www.cdc.gov/nceh/ehs/elearn/ea_fio/index.htm
- Prevention Status Report – Food Safety Practices: <http://www.cdc.gov/nceh/ehs/news/features/2016/food-safety-psr.html>
- Vital Signs – Making Food Safer to Eat: <http://www.cdc.gov/vitalsigns/FoodSafety/>

National Association of County and City Health Officials

- NACCHO Food Safety Program: <http://www.naccho.org/programs/environmental-health/hazards/food-safety>

CHEMICAL SAFETY



US residents are exposed to thousands of chemicals every day through food, drinking water, air pollution, and consumer products. Toxic chemical exposures increase the risk for a variety of health problems, including cognitive and behavioral disorders, throughout the lifespan. Yet, communities often are unaware of local chemical exposure risks and associated potential adverse health impacts (which may be unclear even to the public health community). The yearly US cost of just four childhood health problems linked to chemical exposures—lead poisoning, asthma, cancer, and developmental disabilities—exceeds \$54 billion.⁹⁹

The Problem

Over 80,000 chemicals are in use in the US, many in everyday products and most untested for safety. Perfluoroalkyl substances (PFASs) or phthalates—a large class of chemicals used commercially in non-stick and stain- and water-resistant products, fire-fighting foams, food packaging, carpets, and furniture fabrics—are especially persistent in the environment and in the human body. Because they are highly lubricating and reduce friction, PFASs are also used by the aerospace, automotive, construction, and electronics industries. This widespread usage has resulted in PFAS exposure for virtually all US residents; the chemicals have been detected in breast milk, umbilical cord blood, and bloodstreams.¹⁰⁰ Moreover, owing to their slow metabolism, they remain in the human body for long periods of time.

Though not conclusive, studies suggest links between PFASs and fetal and childhood developmental delays; decreased fertility; altered hormone and enzyme levels; elevated cholesterol; immune system changes; increased uric acid levels; and prostate, kidney, and testicular cancers; among others in a long list of possible adverse health outcomes.¹⁰¹

Chemical Developmental Effects

While researchers cannot conclusively identify the causes of autism, there are linkages to the disorder and the environment. Scientists have observed pregnant woman's exposure to pesticides and phthalates could increase the chances of her child developing autism. However, the chemical

exposures pre- and post-natal only slightly elevate the risk of a child developing autism when coupled with genetic predisposition for the disorder.¹⁰²

Pesticides in Food

Pesticides used to protect crops from insects, rodents, mold, and other pests are regulated by the US Environmental Protection Agency, and pesticide residues are measured by the US Department of Agriculture.⁹⁷ Still, every year a million children under age 6 are involved in pesticide poisoning incidents.⁹⁸ Pesticide exposure has particularly severe impacts on children, compared with adults, owing to their underdeveloped physiology and smaller size.

Biomonitoring and Surveillance

Biomonitoring—the measurement of environmental contaminants (or their metabolites) in human blood, urine, or other specimens—provides definitive information about human exposure to potentially harmful substances, such as PFASs, pesticides, secondhand smoke, and lead.⁴³ In addition to documenting individuals' body burden of select environmental contaminants, biomonitoring generates data to explain exposure trends and inform and evaluate public health interventions.^{17, 103}

Biomonitoring data collected through CDC's National Health and Nutrition Examination Survey show background levels of exposure for a typical (noninstitutionalized) US resident to more than 200 to 300 environmental chemicals.¹⁷ This baseline data complements state- and local-level biomonitoring data, which may show spikes in exposure (compared with baseline) for certain populations. Few states, however, have an adequate biomonitoring program, and not all test for every analyte tracked by CDC.

Vulnerable Populations

Children's developing bodies make them particularly vulnerable to health issues from chemical exposures. For example, while researchers cannot conclusively identify the causes of autism, there are linkages to the disorder and the environment. Scientists have observed that a pregnant woman's exposure to chemicals, such as pesticides and phthalates, could increase the chances of her child developing autism. However, the chemical exposures pre- and post-natal only slightly elevate the risk of a child developing autism when coupled with genetic predisposition for the disorder.

Opportunities for Action

The Federal Toxic Substances Control Act (TSCA) of 1976 authorizes EPA to regulate and collect data on existing and new chemicals in the US market, but it has been criticized for its significant public health limitations. In June 2016, President Obama amended the TSCA by signing into law the Frank R. Lautenberg Chemical Safety for the 21st Century Act. The new law received bipartisan support in both chambers of Congress and includes much-needed improvements:

- A requirement for EPA to conduct a risk evaluation of “high priority” existing chemicals within a specified timeframe.
- The use of a new risk-based safety standard to determine whether a chemical use poses an “unreasonable risk,” including to susceptible and highly exposed populations.
- Easier public access to chemical information.
- Consistent funding to defray costs for new chemical reviews and implementation activities for existing chemicals.

In addition to EPA’s work, there are a number of non-governmental efforts underway to reduce harmful chemical exposures. Project TENDR—Targeting NeuroDevelopmental Risks—is a collaboration among concerned scientists, healthcare professionals, and children’s advocates to reduce exposures to environmental toxicants that contribute to neurodevelopmental disorders. The project’s call to action includes recommendations to develop targeted mechanisms to identify toxic chemicals, to expand and improve monitoring of chemical exposures, and to update curricula and examinations for health care professionals to assure full understanding of the health impacts of priority chemicals.

While these efforts are valuable, much more could be gained by the federal government expanding its role in chemical oversight.

- 1) Utilize existing federal sources, such as the Agency for Toxic Substances and Disease Registry Toxicological Profiles, CDC’s National Report on Human Exposure to Environmental Chemicals, and EPA’s Integrated Risk Information System, to advance scientific understanding of chemicals.
- 2) Improve training and coordination at all levels of government to facilitate chemical oversight activities.
- 3) Require industry to assume the burden of proving chemical safety, including pre-market testing of chemicals.
- 4) Commission more evidence-based research to augment understanding of the health impacts of chemical exposures.
- 5) Prioritize funding for state-level biomonitoring and tracking programs.
- 6) Update legislation, such as TSCA, to reflect new scientific findings regarding chemical risks.
- 7) Educate the public about chemical risks to enable safe lifestyle choices.

For more information, visit:

[Agency for Toxic Substances and Disease Registry](#)

- ToxProfiles and Toxic Substances Portal:
<https://www.atsdr.cdc.gov/ToxProfiles/index.asp>

Association of State and Territorial Health Officials

- *Chemical Exposures: State Ideas for Safeguarding Health*
http://www.astho.org/uploadedFiles/Programs/Environmental_Health/Built_and_Synthetic_Environment/Chemical%20Exposures%20State%20Ideas%20for%20Safeguarding%20Health_ASTHOFinalReport.pdf

Centers for Disease Control and Prevention

- National Center for Environmental Health, National Biomonitoring Program:
<http://www.cdc.gov/biomonitoring/>
- *National Report on Human Exposure to Environmental Chemicals*:
<http://www.cdc.gov/exposurereport/>
- National Environmental Public Health Tracking Network (NEPHTN), Acute Toxic Substance Releases Data: <https://ephtracking.cdc.gov/showToxicSubstanceLanding>
- NEPHTN Biomonitoring: Population Exposures Data:
<https://ephtracking.cdc.gov/showBiomonitoringLanding>

Georgetown University

- PFAs and Health: <https://georgetown.app.box.com/s/aplftwkvrikol107aylshnnqzhjuctcn>

National Association of County and City Health Officials

- Position statement on chemical policy reform:
<http://www.naccho.org/uploads/downloadable-resources/12-16-chemical-policy-reform.pdf>

Project TENDR

- Project website: <http://projecttendr.com>



The communities where we live, work, learn, and play have a significant impact on our health. The way communities are designed and built—including the design and maintenance of sidewalks, public transportation, housing, retail establishments, etc.—has a profound effect on residents’ physical and mental health. For example, when communities have ample walkable sidewalks and bike-friendly transit routes, residents tend to be more active and less obese. Moreover, decreasing vehicular traffic improves air quality, a boon for respiratory health. Other benefits accrue as well.

The Problem

Active Transportation

The Partnership for Active Transportation defines active transportation as “a means of getting around that is powered by human energy, primarily walking and biking.”¹⁰⁴ By planning and building communities that support active transportation, we can increase rates of physical activity. Land use mix, the balance of jobs to housing, the distance between residential and retail areas, and the numbers of intersections are all important design considerations.¹⁰⁵ Locating sidewalks along roads, for instance, increases the likelihood of walking fourfold.¹⁰⁶ Given that half of all vehicular trips in the US are less than three miles long—creating more pollution per mile than longer trips—there is much room for improvement.¹⁰⁷

Healthy and Safe Workplaces

A healthy, safe, and capable workforce is a critically important resource for the US economy.¹⁰⁸ Yet, the societal cost of work-related illnesses, injuries, and fatalities in the US was estimated at \$250 billion in 2007, including medical costs and productivity losses.¹⁰⁸

Healthy Schools

A healthy school environment supports children’s overall health, school attendance, and academic success in the same way that a healthy work environment supports worker health, safety, and productivity. Given the amount of time children spend indoors, particularly in learning environments

(e.g. child care centers, early learning centers, schools), it is important that these environments are healthy. Resources to support healthy school environments are critically needed.¹⁰⁹

Public Spaces

Availability of green space, walking paths, and other outdoor public spaces is known to improve health for all.¹¹⁰ As the distance to a park increases, the likelihood of using the park decreases.¹⁰⁶ Moreover, people who have access to a park are almost 50 percent more likely to meet the daily-recommended level of walking than those without such access.¹⁰⁶ Additionally, parks and green spaces provide mental health benefits, reduce stress, encourage social interaction, and reduce heat islands in urban areas.^{111, 112} Despite these benefits, low-income and minority communities experience inequitable access to parks and recreation facilities.^{106, 113}

Food Safety and Security

Each year, foodborne pathogens sicken 48 million US residents, cause more than 128,000 hospitalizations, and kill about 3,000 people.⁹¹ Hospitalizations due to foodborne illness are estimated to cost more than \$3 billion dollars annually, and lost productivity is estimated to cost between \$20 billion and \$40 billion each year. The US Department of Agriculture estimates that foodborne illnesses cost the US economy more than \$15.6 billion annually.⁹¹

Several studies document unequal access to retail food outlets in the US. Supermarkets and other fresh food sources, for example, tend to be scarcer in low-income, minority, and rural communities. Fully 7.9 million US children lack food security, meaning they do not have reliable access to a sufficient quantity of affordable, nutritious food.¹¹⁴

Safety

Lack of safety, or even the perceived lack of safety, is often a barrier to walking and other outdoor physical activities. Past transportation decisions and policies have led to high-traffic, high-volume roadways through communities of color and low-income communities. Approximately 35,000 traffic deaths occurred in 2015, with a disproportionate impact on older adults, youth, and people of color.^{115, 116}

Obesity

Regular physical activity improves health and increases life expectancy. Yet, just under half of US adults meet the 2008 *Physical Activity Guidelines for Americans*. Since walking is the most common form of exercise, communities can promote physical activity throughout the day by providing more sidewalks and walking trails.^{104, 117} In fact, the health benefits of active transportation outweigh any associated risks by as much as 77 to 1 and can add more years to life than are lost from inhaled air pollution and traffic injuries.¹⁰⁷

Housing

Adequate, safe, and affordable housing is a hallmark of a healthy community. Healthy housing is addressed in the next Focus Areas section.

Opportunities for Action

Everyone deserves to live in a community with a safe and healthy home, access to safe and healthy food, and decisionmakers who consider health and equity when making transportation and land-use decisions.

- 1) Implement equitable design practices that support all modes of transportation.
 - a. Increase access to safe multi-modal transportation alternatives.
 - b. Engage the community during transportation planning.
- 2) Ensure access to healthy and affordable food, water, housing, and transportation.
 - a. Increase access to green spaces and recreation centers to promote physical activity in communities of color and low-income communities.
 - b. Invest in clean-up of former industrial or commercial sites, also known as *brownfields*, to repurpose them for green, public spaces.
 - c. Offer shared-use agreements to encourage community use of public buildings.
- 3) Enact policies that promote a mix of land uses to serve residents at a variety of income levels.
- 4) Dedicate funding from multiple sectors of the federal government to braid funding for healthy community design across the country.

For more information, visit:

Center for Active Design

- Active Design Guidelines: <https://centerforactivedesign.org/guidelines/>

Centers for Disease Control and Prevention

- Healthy Places Program: <https://www.cdc.gov/healthyplaces/>
- Transportation Recommendations: <https://www.cdc.gov/transportation/default.htm>
- National Center for Environmental Health, Healthy Community Design Toolkit: <http://www.cdc.gov/healthyplaces/toolkit/>
- Agency for Toxic Substances and Disease Registry, Brownfield and Land Reuse Program: <https://www.atsdr.cdc.gov/sites/brownfields/index.html>
- Built Environment and Public Health Clearinghouse: <https://www.planning.org/nationalcenters/health/bephc/>
- CDC and US Department of Transportation, Transportation and Health Tool: <https://www.transportation.gov/transportation-health-tool>

- National Environmental Health Tracking Program
 - Community Design Data: <https://ephtracking.cdc.gov/showCommunityDesign.action>
 - Health Impact Assessment: <https://ephtracking.cdc.gov/showHealthImpactAssessment>
 - Homes Data: <https://ephtracking.cdc.gov/showBuildEnvironment>

Federal Highway Administration

- Bicycle and Pedestrian Program: http://www.fhwa.dot.gov/environment/bicycle_pedestrian/
- Pursuing Equity in Pedestrian and Bicycle Planning: http://www.fhwa.dot.gov/environment/bicycle_pedestrian/resources/equity_paper/

National Association of County and City Health Officials

- Healthy Community Design Program: <http://www.naccho.org/programs/community-health/healthy-community-design>

Robert Wood Johnson Foundation

- Exploring the Social Determinants of Health: Housing and Health: http://www.rwjf.org/content/dam/farm/reports/issue_briefs/2011/rwjf70451
- Exploring the Social Determinants of Health: Neighborhoods and Health: http://www.rwjf.org/content/dam/farm/reports/issue_briefs/2011/rwjf70450

Healthy Housing



Americans spend roughly 70 percent of their time in the home.¹¹⁸ The home environment, in turn, may promote or diminish health. Housing risks include dilapidated structures; roofing problems; heating, plumbing, and electrical deficiencies; water leaks; secondhand smoke exposure; vermin and other pests; and lead paint or radon gas exposure.¹¹⁹ Much more needs to be done to make homes safe, healthy, and affordable, especially among low-income families. Fortunately, there is a strong evidence base detailing what works to create healthier home environments.

The Problem

Housing Conditions and Health

About 35 million metropolitan homes in the US have at least one health or safety hazard, exposing residents to preventable risks. According to the 2013 American Housing Survey (AHS)—a large, representative, longitudinal sample of housing conditions at the national and the city levels—9.2 percent of non-Latino black homes and 7.2 percent of Latino homes have severe or moderate physical problems, compared with 3.2 percent of non-Latino white homes. This translates to roughly 3.1 million non-Latino black, 3.2 million Latino, and 6.6 million white people who live in homes that are moderately or severely inadequate.¹²⁰ Such disparities in housing quality exacerbate health disparities. And high rates of housing-related health problems—such as childhood lead poisoning—strain health, educational, and social service systems.

Inadequate housing can impact health in many ways.

- Deteriorating lead-based paint in older housing is the primary cause of lead poisoning, which affects some 535,000 US children. Additional exposures stem from older lead-laced plumbing and water pipes that carry drinking water and from consumer products. Each dollar invested in lead paint hazard control returns \$17 to \$221 to the healthcare, education, and criminal justice systems and other sectors.¹⁰

- Damp houses provide a nurturing environment for mites, roaches, rodents, and molds—all of which may exacerbate asthma. Each dollar invested to reduce home asthma triggers returns \$1.30 to \$14 to the healthcare and education sectors.¹²¹
- Radon exposure occurs naturally, often entering the home through cracks in the foundation. Radon is the second leading cause of lung cancer and is responsible for an estimated 20,000 lung cancer deaths in the US annually.¹²²
- An estimated 11,000 US residents die each year from preventable, unintentional injuries at home, including falls, fires, drownings, and poisonings. The very young and elderly are among the most susceptible to these injuries. The majority of injuries among children occur in the home. Falls are the most frequent cause of residential injuries to children, followed by injuries from objects in the home, burns, and poisonings. For seniors, six of every 10 falls occur at home.¹²³
- Exposures to asbestos, carbon monoxide, and secondhand tobacco smoke are far higher indoors than outside.
- Many household products can be hazardous to health. Paints, varnishes, and glues may contain a variety of materials with potential health or nuisance effects. Household cleaning compounds can also pose a health hazard, especially to young children who might ingest them. Emerging concerns include phthalates in vinyl products, cadmium in jewelry, and defective drywall imported from China.¹²⁴
- Secondhand smoke in multi-unit housing remains a major source of exposure for nonsmokers. In some studies, nearly 50 percent of multi-unit housing residents reported that secondhand smoke seeped into their residences from other units.¹²⁵ One study found that children living in nonsmoking households in multi-unit buildings had 45 percent greater exposure to tobacco smoke compared with children living in detached houses.¹²⁶ Secondhand smoke is a recognized cause of lung cancer and is associated with heart disease and respiratory problems in adults. Children are particularly vulnerable, facing an increased risk of developing asthma, sudden infant death syndrome, and respiratory and ear infections.¹²⁷
- Neighborhood characteristics can also affect a resident’s health. For instance, “more than 11 million people in the US live within 150 meters of a major roadway. Exposure to traffic-related pollution is linked to asthma and other respiratory symptoms, development of childhood asthma, and cardiovascular disease and death.”¹²⁸

Homes not only serve as residences, but also can serve as child care centers, early learning centers, or residential properties.¹²⁹ In addition, homes serve as places of employment for care providers, social workers, and others in-home service providers. The Association for Family Child Care reports there are approximately 1 million paid providers caring for children in home-based settings.¹³⁰

Housing Affordability

Almost 17 million US households spend more than half their income on housing, meeting the definition of unaffordable housing and limiting resources for food, heating, and other essential

needs.¹¹⁹ Lack of affordable housing often leads families to move frequently, disrupting children's lives and leading to emotional, behavioral, and academic problems.

Opportunities for Action

- 1) Develop public-private initiatives to expand affordable housing through subsidies enabling individual tenants to rent in the private sector and through construction of new health-promoting affordable housing.
- 2) Enact and enforce state and local building and housing codes, land use, and zoning policies that promote fair and safe housing options.
- 3) Continue federal oversight of fairness-in-lending standards for banking and loan institutions. Improve private-sector banking and lending procedures to create equal opportunities for credit.
- 4) Support smokefree multi-unit housing.
- 5) Work with government, quasigovernmental, and private sector housing finance organizations to ensure that it is standard practice to detect and mitigate radon, lead, and other housing hazards before new residents occupy a property.
- 6) Improve housing codes so that they protect and benefit health.
- 7) Implement proactive housing inspections at the local level and improve enforcement.
- 8) Create financing streams that provide low- or no-interest loans to repair homes or rental units with hazardous conditions.
- 9) Increase collaboration among government agencies, community groups, public health agencies, advocacy groups, and other stakeholders to ensure a coordinated approach to safe housing for all.
- 10) Increase partnership with and investment from the healthcare sector to address housing as a key social determinant of health.
- 11) Explore private initiatives, such as Habitat for Humanity and Rebuilding Together, to create more affordable, safe, and healthy housing.
- 12) Enhance workforce training and credentialing for housing and code inspectors, home-visiting health professionals (e.g., visiting nurses, who can report hazardous conditions), and home maintenance professionals (e.g., contractors, painters, abatement specialists). Efforts can include cross-training initiatives among government agencies.
- 13) Improve data collection to better document housing conditions at the local, state, and national levels.

For More Information visit:

American Lung Association

- Healthy Air website: <http://www.lung.org/our-initiatives/healthy-air/indoor/>
- Secondhand Smoke website: <http://www.lung.org/our-initiatives/tobacco/smokefree-environments/multi-unit-housing/secondhand-smoke.html>

Centers for Disease Control and Prevention, National Center for Environmental Health

- National Center for Environmental Health, Healthy Home's Program: <http://www.cdc.gov/HealthyHomes/>
- Healthy Places website: <https://www.cdc.gov/healthyplaces/media.htm>
- National Childhood Lead Poisoning Prevention Program: <http://www.cdc.gov/nceh/lead/>

National Center for Healthy Housing

- Website: <http://www.nchh.org/Home.aspx>
- APHA and NCHH Healthy Housing Standards: <http://www.nchh.org/Policy/NationalHealthyHousingStandard.aspx>

Robert Wood Johnson Foundation

- *Housing and Health* Issue Brief: http://www.rwjf.org/content/dam/farm/reports/issue_briefs/2011/rwjf70451

CLIMATE EFFECTS



Climate change poses many risks to human health. Scientific research provides a solid foundation to recognize that the changing climate will continue to have profound impacts on the health of all Americans. The health impacts of climate change are already being felt in the US. We need to safeguard our communities by protecting people’s health, well-being, and quality of life from climate change impacts.

The Problem

Extreme Heat

Extreme heat events can trigger a variety of heat stress conditions. Heat stroke is the most serious heat-related disorder, caused by the body overheating. The condition can cause death or permanent disability without timely emergency treatment. Young children, the elderly, people with chronic diseases, low-income populations, and outdoor workers have higher risk for heat-related illness.

Extreme heat events contributed to more than 7,800 deaths in the US from 1999 to 2009, and experts predict that such events will occur more frequently, last longer, and be more severe in the future.^{131, 132} Many US cities, including St. Louis, Philadelphia, Chicago, and Cincinnati, already have seen large increases in death rates during heat waves.^{79, 133}

Air Quality

Warmer temperatures increase conditions that can worsen air quality, introducing a number of health risks and concerns. According to the US Global Change Research Program, climate change will make it more difficult to clean up ground-level ozone and will worsen particulate matter air pollution in large parts of the country.¹³⁴

Ground-level ozone (a key component of smog) causes many health problems, including diminished lung function, increased asthma hospitalizations, and emergency department visits, plus an increased risk for premature death. Particulate matter in the smoke from wildfires—which are also expected to be more frequent and severe—increases sudden onset respiratory illness, respiratory

and cardiovascular hospitalizations, and medical visits for lung illnesses, as well as the risk of premature death. The frequency of wildfires is expected to increase as drought conditions become more prevalent.

Additionally, when sensitive individuals are simultaneously exposed to allergens and air pollutants, allergic reactions often become more severe. Thus, the increase in air pollutants makes the effects of increased allergens associated with climate change even worse. People with existing pollen allergies may have increased risk for acute respiratory effects.^{134, 135}

Vector-borne Disease

The development and survival of ticks, their animal hosts (e.g., deer), and the bacterium that causes Lyme disease are all strongly influenced by climatic factors, especially temperature, precipitation, and humidity. Most US Lyme disease cases occur in the Northeast, particularly Connecticut. An expansion of ticks' geographic range may lead to more human contact with infected ticks. In regions where Lyme disease already exists, milder winters result in fewer disease-carrying ticks dying during the cold season, increasing the overall tick population and the concomitant risk of human-tick interactions.

West Nile virus is another vector-borne disease likely influenced by climate change. Preventing people from contracting the virus is important because there is no West Nile virus vaccine or drug treatment, and recovery from severe disease may take several weeks or months.¹³⁶

Extreme Weather

Flooding, hurricanes, tornadoes, and droughts are just some of the extreme weather events predicted to occur more frequently as a result of climate change. Not only can these events directly harm human health (e.g., through drownings in floodwaters), but responses to the events also threaten health. As seen with Hurricane Katrina and Superstorm Sandy, extreme weather can force residents to evacuate their homes, leaving behind medical care, jobs, and pets. Cleaning up storm debris potentially exposes people to harmful chemicals, sewage water, and downed electrical lines. Getting homes, schools, child care facilities, hospitals, and other essential buildings repaired or rebuilt after devastating events often takes far longer than expected, delaying recovery for many communities.¹³⁴

Vulnerable Populations

Many climate-related health impacts are already occurring.¹³⁷ Disadvantaged populations with limited resources to adapt to climate change will experience disproportionately greater adverse health impacts.¹³⁸ Vulnerability to climate change impacts depends on community and individual resilience. Communities can increase general resilience by addressing the core social determinants of health (e.g., poverty, educational level, social capital, and health care access). But they must also implement specific mitigation measures critical to reducing vulnerability.¹³⁹

As noted by the US Global Change Research Program’s Climate and Health Assessment, “Every American is vulnerable to the health impacts associated with climate change.” However, some groups face even greater risks. Among the groups most at risk are children and teens, older adults, people with chronic diseases, people who work or exercise outdoors, and low-income individuals and communities (including many communities of color and tribal communities).

Climate change threatens health through extreme temperatures, worsening air quality, and extreme weather events. For example, outdoor workers, such as farmers and military personnel, face potentially excessive heat events on the job. Children are especially vulnerable to air pollution, heat-related illness, and waterborne diseases. Older adults react severely to heat waves and face serious harm from air pollution and infectious diseases. People with chronic medical conditions, including asthma, diabetes, and cardiovascular diseases, face special risks if their access to medical care is interrupted.¹³⁴

Opportunities for Action

- 1) Reduce emissions of carbon dioxide, methane, and other pollutants that worsen climate change.
- 2) Increase the use of clean renewable energy.
- 3) Increase the energy efficiency of cooling systems, all modes of transportation, and other energy-intensive products.
- 4) Help communities plan for and adapt to the impacts of climate change. Many states and localities have begun this planning but will need resources to continue this work and to coordinate with neighboring jurisdictions. Disadvantaged communities will need special assistance to explore and develop ways to protect residents.
- 5) Require federally supported activities to include a climate risk and impacts analysis.
- 6) Encourage the US Occupational Safety and Health Administration to adopt a standard to protect workers against excessive heat.
- 7) Ensure that funding is sufficient for implementation of climate-health initiatives and to conduct climate change research and programs across federal agencies.

For more information, visit

Agency for Toxic Substances and Disease Registry

- Social Vulnerability Index: <https://svi.cdc.gov/>

American Public Health Association

- Policy statement on climate change: <http://www.apha.org/policies-and-advocacy/public-health-policy-statements/policy-database/2015/12/03/15/34/public-health-opportunities-to-address-the-health-effects-of-climate-change>

Centers for Disease Control and Prevention

- Climate and Health Program: <http://www.cdc.gov/climateandhealth/default.htm>
- CDC/APHA climate and health factsheets: <http://www.cdc.gov/climateandhealth/effects/default.htm#factsheets>
- National Environmental Public Health Tracking Network
 - Climate change data: <https://ephtracking.cdc.gov/showClimateChangeLanding.action>
 - Heat stress illness data: <https://ephtracking.cdc.gov/showHeatStressIllnessLanding>

US Environmental Protection Agency

- EPA/CDC climate change guidebook: <http://www.cdc.gov/climateandhealth/pubs/extreme-heat-guidebook.pdf>

Federal Executive Actions/Orders on Climate Change Adaptation

- US Global Research Change Program: <http://www.globalchange.gov/browse/federal-adaptation-resources/executive-orders-and-policies>
- White House Council of Environmental Quality resilience initiative: <https://www.whitehouse.gov/administration/eop/ceq/initiatives/resilience>
- US Environmental Protection Agency “Adapting to Climate Change” website: <https://www3.epa.gov/climatechange/adaptation/federal-partner-collaboration.html>

National Association of County and City Health Officials

- Climate change website: <http://www.naccho.org/programs/environmental-health/hazards/climate-change>



Environmental health practitioners perform many critical functions during and after an emergency caused by natural calamity, terrorism, industrial accidents, or infectious disease. Their role is to:

- Ensure adequate safe drinking water.
- Conduct food inspections.
- Ensure basic sanitation services.
- Promote personal hygiene.
- Assist first responders by providing health risk consultations or advising on exposure pathways.
- Provide information to emergency managers to help assess the scale of the emergency to ensure an effective response.
- Ensure safe and healthy building environments.^{140, 141}

After an event, environmental health practitioners remain on the scene conducting longitudinal assessment of hazardous exposures. With a strong environmental health system, experts can also help prevent or lessen damage from routine incidents, such as mercury spills in schools. Investing in infrastructure, like secure water systems, before an event makes communities less likely to live without clean water and sanitation services post-disaster.¹⁴²

The Problem

Built Environment

After severe storms, buildings can fill with floodwater and can sustain structural or electrical damage that makes them unsafe to enter. Floodwaters alone can cause mold, leading to adverse respiratory health outcome, such as asthma. Environmental health inspectors ensure building safety and help to mitigate hazardous exposures, like carbon monoxide.

Radiation

After a radiological disaster, intentional or accidental, environmental health practitioners measure ambient radiation levels. The federally funded radiological arm of the Laboratory Response Network—a group of laboratories funded by CDC to prepare for a coordinated response to radiological releases—should be the first line of defense at the local level.

To determine human exposure levels, CDC LRN laboratorians can perform a rapid urine analysis that detects radionuclides in the body. Based on screening results, public health workers and first responders can take appropriate response measures. CDC can currently test about 300 specimens a day. But national planning scenarios indicate the need to test 2,000 to 3,000 specimens per day to enable prompt administration of medical countermeasure to those who need them. Ideally, LRN laboratories will be funded to expand their radiological testing capabilities to build national testing capacity.

Chemical Incidents

The chemical arm of the Laboratory Response Network (known as the LRN-C) is tasked with mounting the laboratory response to chemical emergencies, such as toxic industrial releases or spilled mercury in a school classroom. A national biomonitoring network—with capability to detect a range of environmental toxicants in human blood, tissues, and other specimens—would increase the nation’s ability to detect and measure toxic environmental exposures. This information is needed to inform medical treatment for the exposed, recall notices (if exposures are related to consumer products), and policymaking. While the LRN-C receives federal funding through CDC, to date the “National Biomonitoring Network” exists only on paper.

Shelters

Shelters provide a safe place for affected communities to rest and recover after an emergency event. Services provided in shelters include food, sleeping quarters, sanitation facilities, and medical care for those displaced in the wake of an emergency. Environmental health practitioners conduct shelter assessments, testing the safety of drinking water, conducting food safety inspections, and more.¹⁴²

Opportunities for Action

CDC’s 2011 National Strategic Plan for Public Health Preparedness and Response lists eight national public health preparedness goals.

1. Prevent and/or mitigate existing and emerging threats to the public’s health, recognizing that the scale, timing, or unpredictability of these threats can overwhelm routine public health system capabilities and have substantial impacts on domestic and global economies, as well as national security.

2. Integrate public health, the health care system, and emergency management response to better address public health threats.
3. Promote resilient individuals and communities in the face of crises.
4. Advance public health surveillance, epidemiology, and laboratory science and service practice.
5. Increase the application of science to preparedness and response practice. The current evidence/science base for public health preparedness is limited and insufficient.
6. Strengthen the public health preparedness and response infrastructure, including communications and information technology infrastructure, emergency operation centers, and the emergency response workforce to address both the physical and logistical capacity to prepare for and respond to events.
7. Enhance stewardship of public health preparedness funds, including leveraging resources, reducing duplicative expenditures, improving the economic justification for investments in preparedness, and promoting the use of resources.
8. Improve the ability of the public health workforce to respond to health threats. Gaps in worker competency and organization/system capabilities must be addressed.

For more information, visit:

Centers for Disease Control and Prevention

- Emergency and terrorism preparedness for environmental health practitioners: <https://www.cdc.gov/nceh/ehs/ETP/default.htm>
- Laboratory Response Networks: <https://emergency.cdc.gov/lrn/>
- National Biomonitoring Network: https://www.aphl.org/aboutAPHL/publications/Documents/EH_National_Biomonitoring_Plan_112015.pdf

World Health Organization

- Environmental health in emergencies: http://www.who.int/environmental_health_emergencies/en/

ENVIRONMENTAL EQUITY



Federal health and environmental regulatory agencies define *environmental equity* as the fair treatment and meaningful involvement of all people—regardless of race, color, national origin, or income—in the development, implementation, and enforcement of environmental laws, regulations, and policies.¹⁴³ Environmental equity is a major theme of environmental health in all focus areas. Environmental health practitioners utilize health, demographic, and environmental monitoring data to ensure the protection of populations most vulnerable to the impacts of adverse environmental exposures.

Among the most vulnerable populations are children and pregnant women. Eliminating adverse exposures in utero and among children under age 12 continues to be a high public health priority. Adverse exposures during early development can prompt more serious health consequences than exposures during adulthood, and these consequences may be irreversible. For example, children under age six exposed to lead may suffer lifelong developmental and neurological effects. Similarly, in utero exposure to heavy metals (e.g., mercury) in seafood may lead to low birthweight, neurological problems, and other adverse outcomes.

Environmental health practitioners also work to ensure that other vulnerable populations, including the elderly and those with preexisting conditions (e.g., asthma, chronic respiratory disease, etc.), are protected from environmental exposures. These populations are at far greater risk of adverse health impacts related to environmental exposures (e.g., air pollution) than otherwise healthy populations.

Ensuring environmental equity is of particular importance as it relates to communities' physical infrastructure and to the presence of hazardous waste sites across the United States. In fact, low-income and minority populations disproportionately live near the most dangerous hazardous waste sites in the country and are also more likely to live in communities with substandard public utilities.

The water crisis in Flint, Michigan, that began in April 2014 is a recent example of an environmental emergency created by poor government decisionmaking. The city of Flint switched its water source, as a cost-savings measure, without ensuring appropriate water treatment. The improperly treated water corroded lead water pipes, causing the heavy metal to leach into tap water and resulting in

dangerously high levels of lead exposure for thousands of local children, especially those in disadvantaged neighborhoods.³⁶

A key facet of environmental equity is ensuring that all people have a voice in the decisions that might affect their health. As one example, to address American Indian/Alaska Native inequities, the tribal leaders of today report that many of their communities are exercising sovereignty by recognizing their own unique resiliency and commitment towards self determination to restore health and well-being. This work is hindered, though, by the existing burden of health and economic disparities and underfunded and underdeveloped public health systems. The Tribal Advisory Committee—an advisory body convened semiannually by the Centers for Disease Control and Prevention as part of the agency’s tribal consultation responsibilities—continues to prioritize the need for increased funding to address environmental public health inequities to achieve parity with other US public health efforts. Specifically, tribal leaders request direct funding to tribes and/or accountability measures enforced as funding is distributed within each respective state boundary.

For more information, visit:

Agency for Toxic Substances and Disease Registry

- Assessment of Chemical Exposure (ACE): <https://www.atsdr.cdc.gov/ntsip/ace.html>
- Brownfields/Land Re-use Action Model: <https://www.atsdr.cdc.gov/sites/brownfields/model.html>
- Principles of community engagement: https://www.atsdr.cdc.gov/communityengagement/pdf/PCE_Report_508_FINAL.pdf
- Social Vulnerability Index (SVI): <https://svi.cdc.gov/>
- Toxicological Profile and Health Assessment Toolkit (TopHAT): <https://trainex.org/offeringslist.cfm?courseid=428>

American Public Health Association

- Health equity website: <https://www.apha.org/topics-and-issues/health-equity>

Centers for Disease Control and Prevention (CDC), National Center for Environmental Health

- Healthy Homes and Childhood Lead Poisoning Prevention Program’s Environmental Justice – FAQs: http://www.cdc.gov/HealthyHomes/EJ/EJ_1page_English.pdf
- Drinking Water Advisory Communication Toolkit: <http://www.cdc.gov/healthywater/pdf/emergency/drinking-water-advisory-communication-toolbox.pdf>
- Information by location: <https://ephtracking.cdc.gov/InfoByLocation/>
- National Environmental Public Health Tracking Network: <https://ephtracking.cdc.gov/showHome.action>

- Protocol for Community Excellence in Environmental Health (PACE EH): http://www.cdc.gov/nceh/ehs/CEHA/PACE_EH.htm

National Association of County and City Health Officials

- Policy statement on environmental justice: <http://www.naccho.org/uploads/downloadable-resources/00-07-Environmental-Justice.pdf>

Opportunities for Action

Governmental environmental health services are not a luxury; they are essential to assure safe drinking water, clean air, climate change adaptation, and other basic needs. The following opportunities for action support the belief that everyone should have the opportunity to achieve optimal health during all stages of life, including physical, mental, and social well-being that extends beyond the absence of disease. As such, the following action steps support the uncomplicated right to environmental health:

1. **PREVENTION:**

Enable federal, state, local, and tribal governments to promote resilient, equitable, and healthy communities for all, especially those who are most vulnerable and most at risk.

- Decrease and eliminate exposures to toxicants and hazardous waste, placing high priority on communities that are most impacted and vulnerable to adverse environmental health exposures.
- Guarantee that all communities breathe clean, healthy outdoor air.
- Ensure safe and accessible water for drinking and recreation.
- Provide access to healthy, affordable, and safe foods.
- Ensure healthy indoor environments.
- Invest in green and sustainable building initiatives.
- Strive to achieve sustainable and resilient community planning.
- Provide safe and health-promoting transportation alternatives.
- Ensure access to safe spaces for recreation and physical activity.

2. **RESPONSE:**

Build and support the governmental environmental health system, including meeting workforce needs and tracking disease outcomes and environmental exposures.

- Invest in environmental health surveillance, including disease tracking, biomonitoring, early warning systems, and modeling. Expand the existing outdoor air quality monitoring system.

- Provide resources and training to ensure a robust and qualified environmental health workforce, particularly at the state and local levels.
- Create incentives, such as increased pay, benefits, professional development, and training to recruit and retain environmental health workers.

3. **REAL-LIFE SOLUTIONS:**

Strengthen environmental health protections and support peer-reviewed research to inform environmental health decisionmaking and practice.

- Strengthen and enforce existing standards and regulations to protect air, soil, and water from human health hazards.
- Enforce existing and implement newly established food safety and quality regulations.
- Support research on issues like chemical exposure to guide the regulation of indoor environments, including homes, childcare facilities, workplaces, and schools.
- Commission more economic analyses of the environmental health system.

About the National Environmental Health Partnership Council

The National Environmental Health Partnership Council comprises a variety of agencies and organizations dedicated to environmental health within the US. The NEHPC strives to support healthy people by working for healthier environments.

The NEHPC brings together diverse stakeholders to help expand and sustain awareness, education, policies, and practices related to environmental health.

The NEHPC strives to:

1. Build a collective voice in support of priority environmental health issues.
2. Foster and coordinate activities to advance environmental health.
3. Communicate new information and research to support better and more effective environmental health programs, practices, and policies.
4. Promote ways to leverage current and future resources to maximize the impact of environmental health activities.
5. Generate momentum and build greater public awareness of the role that environmental health plays in sustaining and promoting human health.

The American Public Health Association provides logistical support to the Partnership Council funded through cooperative agreement 5U38OT000131-04 between the Centers for Disease Control and Prevention and the American Public Health Association. The content of this document does not necessarily represent the official views of the Centers for Disease Control and Prevention.



It is critical that environmental health services be viewed as absolute necessities for ensuring the health and safety of our citizens.

Endorsements

Laura Anderko, Council Co-Chair

Alliance of Nurses for Healthy Environments
Professor, Robert and Kathleen Scanlon Endowed Chair in Values Based Health Care
Director, Mid-Atlantic Center for Children's Health and the Environment
Georgetown University School of Nursing & Health Studies

Scott Becker, Steering Committee

Executive Director
Association of Public Health Laboratories

Suzanne Condon, Special Advisor

Retired Associate Commissioner
Massachusetts Department of Public Health

Dave Dyjack, Steering Committee

Executive Director
National Environmental Health Association

Doug Farquhar

Co-Chair
Environmental Health Coalition

Maida Galvez

Associate Professor, Environmental Medicine and Public Health, and Pediatrics
Region 2 Pediatric Environmental Health Specialty Unit
Icahn School of Medicine at Mount Sinai

Kristin Hill, Steering Committee

Former Director
Great Lakes Inter-Tribal Council

Richard J. Jackson, Special Advisor

Former Director
National Center for Environmental Health, Centers for Disease Control and Prevention
Professor, Environmental Health Science
University of California, Los Angeles

Megan Latshaw

Chair, Environment Section
American Public Health Association
Assistant Scientist, Bloomberg School of Public Health
Johns Hopkins University

Jennifer Li

Director, Environmental Health & Health & Disability
National Association of County and City Health Officials

Janice Nolen

Assistant Vice President, National Policy and Advocacy
American Lung Association

Surili Patel, Steering Committee and Lead Author

Senior Program Manager, Center for Public Health Policy
American Public Health Association

Jack Rayburn, Council Co-Chair

Senior Government Relations Manager
Trust for America's Health

Amanda Reddy

Executive Director
National Center for Healthy Housing

Jennifer Sass

Senior Scientist
Natural Resources Defense Council
Professorial Lecturer
George Washington University

Kathy Sessions

Executive Director
Health & Environmental Funders Network

Charles Treser

Executive Director

Association of Environmental Health Academic Programs

Nsedu Obot Witherspoon, Steering Committee

Executive Director

Children's Environmental Health Network

Note: Endorsement from individual National Environmental Health Partnership Council members does not necessarily represent endorsement from the NEPHC member's home organization. Participation in the National Environmental Health Partnership Council does not imply endorsement of this document.

References

1. Charles Lee. Environmental justice: building a unified vision of health and the environment. *Environmental Health Perspectives*. 2002;110:141-144.
2. Paul Mohai and Leah Temper. Map of most influential environmental justice conflicts in the US is released this week. 2017.
3. Leonardo Trasande and Yinghua Liu. Reducing the staggering costs of environmental disease in children, estimated at \$76.6 billion in 2008. *Health Affairs*. 2011;30:863-870.
4. National Environmental Health Partnership Council. The Value for Environmental Health Services: Exploring the Evidence. 2016. Retrieved from: https://www.apha.org/-/media/files/pdf/topics/environment/eh_values.ashx,%20p2.
5. Centers for Disease Control and Prevention Office of the Associate Director for Policy. Controlling Asthma. 2015. Retrieved from: <https://www.cdc.gov/policy/hst/statestrategies/asthma/> on April 3, 2017.
6. Sylvia J. Brandt, Laura Perez, Nino Künzli, Fred Lurmann and Rob McConnell. Costs of childhood asthma due to traffic-related pollution in two California communities. *European Respiratory Journal*. 2012;40:363-70.
7. World Health Organization. Public health surveillance. 2017. Retrieved from: http://www.who.int/topics/public_health_surveillance/en/ on April 5, 2017.
8. World Health Organization. Capacity Building in Environment and Health (CBEH) Project. Using impact assessment in environment and health: a framework. 2013. Retrieved from: http://www.euro.who.int/__data/assets/pdf_file/0007/190537/e96852-final.pdf.
9. John Sarisky and Justin Gerding. Environmental public health systems and services research. *Journal of environmental health*. 2011;73:24.
10. Elise Gould. Childhood Lead Poisoning: Conservative Estimates of the Social and Economic Benefits of Lead Hazard Control. *Environmental Health Perspectives*. 2009;117:1162-1167.
11. Anjum Hajat, Ana V. Diez-Roux, Sara D. Adar, Amy H. Auchincloss, Gina S. Lovasi, Marie S. O'Neill, Lianne Sheppard and Joel D. Kaufman. Air pollution and individual and neighborhood socioeconomic status: evidence from the Multi-Ethnic Study of Atherosclerosis (MESA). *Environmental Health Perspectives*. 2013;121:1325.
12. U.S. Environmental Protection Agency. Lead and Copper Rule. 2017. Retrieved from: <https://www.epa.gov/dwreginfo/lead-and-copper-rule> on April 5, 2017.
13. Jason W. Marion and Yalonda Sinde. The need for environmental public health professionals and the role of EHAC-accredited programs in increasing the pool. *Journal of Environmental Health*. 2015;78:36-42.
14. Jean-Paul Chretien, Howard S. Burkom, Endang R. Sedyaningsih, Ria P. Larasati, Andres G. Lescano, Carmen C. Mundaca, David L. Blazes, Cesar V. Munayco, Jacqueline S. Coberly, Raj J. Ashar and Sheri H. Lewis. Syndromic Surveillance: Adapting Innovations to Developing Settings. *PLOS Medicine*. 2008;5:e72.

15. Stephen B. Thacker, Donna F. Stroup, R Gibson Parrish and Henry A. Anderson. Surveillance in environmental public health: issues, systems, and sources. *American Journal of Public Health*. 1996;86:633-638.
16. U.S. Centers for Disease Control and Prevention. National Environmental Public Health Tracking Network. 2017. Retrieved from: <https://ephracking.cdc.gov/showHome.action> on April 7, 2017.
17. U.S. Centers for Disease Control and Prevention. National Biomonitoring Program. 2016. Retrieved from: <https://www.cdc.gov/biomonitoring/about.html> on April 6, 2017.
18. Agency for Toxic Substances & Disease Registry. Toxicological Profiles. 2016. Retrieved from: <http://www.atsdr.cdc.gov/toxprofiles/index.asp> on April 6, 2017.
19. Agency for Toxic Substances & Disease Registry. National Amyotrophic Lateral Sclerosis (ALS) Registry. 2017. Retrieved from: <https://wwwn.cdc.gov/als/> on April 6, 2017.
20. U.S. Department of Defense. Environmental Health Surveillance Registry. 2017. Retrieved from: <https://registry.csd.disa.mil/registryWeb/DisplayHomePage.do;jsessionid=a2e1de1fbb512010ea72ff33d4b2733b6b8d3e7f70d2dbc6d09be5b650123c.e3yLbh8NchoKe3iPc3eQa3uMeo> on April 6, 2017.
21. U.S. Environmental Protection Agency. Air Quality System (AQS). 2017. Retrieved from: <https://www.epa.gov/AQS> on April 7, 2017.
22. U.S. Environmental Protection Agency. National Air Toxics Assessment. 2016. Retrieved from: <https://www.epa.gov/national-air-toxics-assessment> on April 7, 2017.
23. U.S. Centers for Disease Control and Prevention. U.S. Zika Pregnancy Registry. 2017. Retrieved from: <http://www.cdc.gov/zika/hc-providers/registry.html> on April 7, 2017.
24. U.S. Environmental Protection Agency. Integrated Science Assessment (ISA) of Ozone and Related Photochemical Oxidants (Final Report, Feb 2013). 2013. Retrieved from: <https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=247492>.
25. Moritz U.G. Kraemer, Marianne E. Sinka, Kirsten A. Duda, Adrian Q.N. Mylne, Freya M. Shearer, Christopher M. Barker, Chester G. Moore, Roberta G. Carvalho, Giovanini E. Coelho and Wim Van Bortel. The global distribution of the arbovirus vectors *Aedes aegypti* and *Ae. albopictus*. *Elife*. 2015;4:e08347.
26. Jacob Lee. Zika virus infection: new threat in global health. *Journal of Korean Medical Science*. 2016;31:331-332.
27. U.S. Centers for Disease Control and Prevention. Facts about Microcephaly. 2017. Retrieved from: <https://www.cdc.gov/ncbddd/birthdefects/microcephaly.html> on April 7, 2017.
28. U.S. Centers for Disease Control and Prevention. Zika and Guillain-Barré Syndrome. 2016. Retrieved from: <https://www.cdc.gov/ZIKA/healtheffects/gbs-qa.html> on April 7, 2017.
29. Robert W. Malone, Jane Homan, Michael V. Callahan, Jill Glasspool-Malone, Lambodhar Damodaran, Adriano De Bernardi Schneider, Rebecca Zimler, James Talton, Ronald R. Cobb and Ivan Ruzic. Zika virus: medical countermeasure development challenges. *PLoS Neglected Tropical Diseases*. 2016;10:e0004530.

30. U.S. Centers for Disease Control and Prevention. Prevent Mosquito Bites. 2017. Retrieved from: <https://www.cdc.gov/zika/prevention/prevent-mosquito-bites.html> on April 7, 2017.
31. U.S. Centers for Disease Control and Prevention. Protect Yourself During Sex. 2016. Retrieved from: <https://www.cdc.gov/zika/prevention/protect-yourself-during-sex.html> on April 7, 2017.
32. Anna R. Plourde and Evan M. Bloch. A literature review of Zika virus. *Emerging Infectious Diseases*. 2016;22:1185.
33. U.S. Centers for Disease Control and Prevention. Integrated Mosquito Management. 2017. Retrieved from: https://www.cdc.gov/zika/vector/integrated_mosquito_management.html on April 7, 2017.
34. U.S. Centers for Disease Control and Prevention. Surveillance and control of *Aedes aegypti* and *Aedes albopictus* in the United States. Retrieved February. 2016;7:2016.
35. Kelly J. Henning. What is Syndromic Surveillance? *Morbidity and Mortality Weekly Report*. 2004:7-11.
36. Mona Hanna-Attisha, Jenny LaChance, Richard Casey Sadler and Allison Champney Schnepf. Elevated blood lead levels in children associated with the Flint drinking water crisis: a spatial analysis of risk and public health response. *American Journal of Public Health*. 2016;106:283-290.
37. U.S. Environmental Protection Agency. Basic Information about Lead in Drinking Water. 2017. Retrieved from: <https://www.epa.gov/ground-water-and-drinking-water/basic-information-about-lead-drinking-water> on April 7, 2017.
38. Wendy McKelvey, R. Charon Gwynn, Nancy Jeffery, Daniel Kass, Lorna E. Thorpe, Renu K. Garg, Christopher D. Palmer and Patrick J. Parsons. A biomonitoring study of lead, cadmium, and mercury in the blood of New York city adults. *Environmental Health Perspectives*. 2007:1435-1441.
39. U.S. Centers for Disease Control and Prevention. Legionnaires' Disease. 2016. Retrieved from: <https://www.cdc.gov/legionella/downloads/fs-legionnaires.pdf> on April 7, 2017.
40. U.S. Centers for Disease Control and Prevention. Prevention. 2016. Retrieved from: on April 7, 2017.
41. U.S. Centers for Disease Control and Prevention. Developing a Water Management Program to Reduce Legionella Growth and Spread in Buildings. 2016. Retrieved from: <https://www.cdc.gov/legionella/maintenance/wmp-toolkit.html> on April 7, 2017.
42. U.S. Centers for Disease Control and Prevention. CDC's Childhood Lead Poisoning Prevention Program. 2015. Retrieved from: <https://www.cdc.gov/nceh/lead/about/program.htm> on April 7, 2017.
43. Association of Public Health Laboratories. Biomonitoring Analysis of Human Exposure to Chemicals. 2013. Retrieved from: https://www.aphl.org/policy/factsheet_Documents/POL_2013_Fact-Sheet_Biomonitoring-Analysis-of-Human-Exposure-to-Chemicals.pdf on April 7, 2017.
44. Cable News Network. Hurricane Katrina Statistics Fast Facts. 2016. Retrieved from: <http://www.cnn.com/2013/08/23/US/hurricane-katrina-statistics-fast-facts/> on

45. Joel N. Swerdel, Teresa M. Janevic, Nora M. Cosgrove and John B. Kostis. The Effect of Hurricane Sandy on Cardiovascular Events in New Jersey. *Journal of the American Heart Association*. 2014;3.
46. Christian S. Chan and Jean E. Rhodes. Measuring exposure in Hurricane Katrina: a meta-analysis and an integrative data analysis. *PloS One*. 2014;9:e92899.
47. American Public Health Association and U.S. Centers for Disease Control and Prevention. Extreme Rainfall and Drought. 2016. Retrieved from: <https://apha.org/~media/files/pdf/factsheets/climate/precipitation.ashx> on April 10, 2017.
48. U.S. Environmental Protection Agency. EPA Has Developed Guidance for Disaster Debris but Has Limited Knowledge of State Preparedness. 2016. Retrieved from: <https://www.epa.gov/office-inspector-general/report-epa-has-developed-guidance-disaster-debris-has-limited-knowledge>.
49. American Public Health Association and U.S. Centers for Disease Control and Prevention. Warmer Water and Flooding Increase the Risk of Illness and Injury. 2016. Retrieved from: https://apha.org/~media/files/pdf/factsheets/climate/warmer_water.ashx on April 10, 2017.
50. Felicia A. Rabito, Shahed Iqbal, Sara Perry, Whitney Arroyave and Janet C. Rice. Environmental lead after Hurricane Katrina: implications for future populations. *Environmental Health Perspectives*. 2012;120:180.
51. National Groundwater Association. Groundwater Use in the United States of America. 2016. Retrieved from: <http://www.ngwa.org/Fundamentals/Documents/usa-groundwater-use-fact-sheet.pdf> on April 11, 2017.
52. U.S. Census Bureau. Population Estimates July 1, 2014. Retrieved from: <https://www.census.gov/quickfacts/table/PST045215/00> on April 11, 2017.
53. U.S. Census Bureau. Calculated by dividing the number of American residents served by a private well (NGWA) by the 2013 US population (U.S. Census). 2016. Retrieved from: <https://www.cdc.gov/nceh/ehs/safe-watch/index.html> on April 11, 2017.
54. Leslie A. DeSimone, Pixie A. Hamilton and Robert J. Gilliom. Quality of ground water from private domestic wells. *Water Well Journal*. 2009;1:33-37.
55. Gunther F. Craun, Joan M. Brunkard, Jonathan S. Yoder, Virginia A. Roberts, Joe Carpenter, Tim Wade, Rebecca L. Calderon, Jacquelin M. Roberts, Michael J. Beach and Sharon L. Roy. Causes of outbreaks associated with drinking water in the United States from 1971 to 2006. *Clinical Microbiology Reviews*. 2010;23:507-528.
56. S.A. Collier, L.J. Stockman, L.A. Hicks, L.E. Garrison, F.J. Zhou and M.J. Beach. Direct healthcare costs of selected diseases primarily or partially transmitted by water. *Epidemiology and Infection*. 2012;140:2003-2013.
57. American Public Health Association. Drinking Water Quality and Public Health (Position Paper). 2000. Retrieved from: <https://www.apha.org/policies-and-advocacy/public-health-policy-statements/policy-database/2014/07/14/13/22/drinking-water-quality-and-public-health-position-paper> on April 1, 2017.

58. U.S. Department of the Interior and U.S. Geological Survey. Summary of Estimated Water Use in the United States in 2010. 2014. Retrieved from: <https://pubs.usgs.gov/fs/2014/3109/pdf/fs2014-3109.pdf> on
59. U.S. Environmental Protection Agency. National Nonpoint Source Program—a catalyst for water quality improvements: A report on highlights of the §319 program. 2016. Retrieved from: https://www.epa.gov/sites/production/files/2016-10/documents/nps_program_highlights_report-508.pdf.
60. American Society for Civil Engineers. 2013 Report Card for America's Infrastructure. 2013. Retrieved from: <http://ascelibrary.org/doi/book/10.1061/9780784478837>.
61. U.S. Census Bureau. Table 1249. Arts, recreation, and travel: Participation in selected sports activities 2009. *Statistical abstract of the United States: 2012*. 2011.
62. Michele C. Hlavsa. Immediate closures and violations identified during routine inspections of public aquatic facilities—network for aquatic facility inspection surveillance, five states, 2013. *MMWR Surveillance Summaries*. 2016;65.
63. U.S. Centers for Disease Control and Prevention. The Model Aquatic Health Code (MAHC): An All-inclusive Model Public Swimming Pool and Spa Code. 2017. Retrieved from: <https://www.cdc.gov/mahc/editions/index.html> on April 11, 2017.
64. American Lung Association. Key Findings: The State of the Air 2016. 2016. Retrieved from: <http://www.lung.org/our-initiatives/healthy-air/sota/key-findings/> on April 11, 2017.
65. Lara J. Akinbami, Jeanne E. Moorman, Cathy Bailey, Hatice S. Zahran, Michael King, Carol A. Johnson and Xiang Liu. Trends in asthma prevalence, health care use, and mortality in the United States, 2001–2010. *NCHS Data Brief*. 2012;94:1-8.
66. U.S. Centers for Disease Control and Prevention. Asthma in the US. 2011. Retrieved from: <https://www.cdc.gov/vitalsigns/asthma/> on April 12, 2017.
67. U.S. Environmental Protection Agency. Our Nation's Air: Status and Trends through 2015. 2016. Retrieved from: <https://gispub.epa.gov/air/trendsreport/2016/>.
68. C. Arden Pope III, Majid Ezzati and Douglas W. Dockery Fine-Particulate Air Pollution and Life Expectancy in the United States. *New England Journal of Medicine*. 2009;360:376-386.
69. Andrew W. Correia, C. Arden Pope III, Douglas W. Dockery, Yun Wang, Majid Ezzati and Francesca Dominici. The effect of air pollution control on life expectancy in the United States: an analysis of 545 US counties for the period 2000 to 2007. *Epidemiology*. 2013;24:23.
70. W. James Gauderman, Robert Urman, Edward Avol, Kiros Berhane, Rob McConnell, Edward Rappaport, Roger Chang, Fred Lurmann and Frank Gilliland. Association of Improved Air Quality with Lung Development in Children. *New England Journal of Medicine*. 2015;372:905-913.
71. U.S. Environmental Protection Agency. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, Dec 2009). 2009. Retrieved from: <https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=216546>.
72. Committee on Environmental Health. Ambient air pollution: health hazards to children. *Pediatrics*. 2004;114:1699-1707.

73. March of Dimes Foundation. Air Pollution. 2016. Retrieved from: <http://www.marchofdimes.org/pregnancy/air-pollution-and-pregnancy.aspx> on April 12, 2017.
74. Ephraim I. Thaller, Sharon A. Petronella, Dan Hochman, Shawn Howard, Raj S. Chhikara and Edward G. Brooks. Moderate increases in ambient PM_{2.5} and ozone are associated with lung function decreases in beach lifeguards. *Journal Occupational Environmental Medicine*. 2008;50:202-11.
75. Marie Lynn Miranda, Sharon E. Edwards, Martha H. Keating and Christopher J. Paul. Making the Environmental Justice Grade: The Relative Burden of Air Pollution Exposure in the United States. *International Journal of Environmental Research and Public Health*. 2011;8:1755.
76. Health Effects Institute. Panel on the Health Effects of Traffic-Related Air Pollution. *Traffic-related air pollution: a critical review of the literature on emissions, exposure, and health effects*: Health Effects Institute; 2010.
77. Santa Barbara County Air Pollution Control District. Public Health and High Traffic Roadways. Retrieved from: <https://www.ourair.org/wp-content/uploads/pub-health-and-hi-traffic-roadways.pdf> on April 12, 2017.
78. George Luber, Kim Knowlton, John Balbus, Howard Frumkin, Mary Hayden, Jeremy Hess, Michael McGeehin, Nicky Sheats, Lorraine Backer, C. Ben Beard, Kristine L. Ebi, Edward Maibach, Richard S. Ostfeld, Christine. Wiedinmyer, Emily Zielinski-Gutiérrez and Lewis Ziska. Ch. 9: Human Health. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds.: U.S. Global Change Research Program; 2014: 220-256.
79. Allison Crimmins, J Balbus, JL Gamble, CB Beard, JE Bell, D Dodgen, RJ Eisen, N Fann, MD Hawkins and SC Herring. The impacts of climate change on human health in the United States: a scientific assessment. 2016.
80. World Health Organization. The world health report 2004: changing history. 2004.
81. Anthony S. Fauci and David M. Morens. Zika Virus in the Americas — Yet Another Arbovirus Threat. *New England Journal of Medicine*. 2016;374:601-604.
82. Nidhi Bouri, Tara Kirk Sell, Crystal Franco, Amesh A. Adalja, D. A. Henderson and Noreen A. Hynes. Return of Epidemic Dengue in the United States: Implications for the Public Health Practitioner. *Public Health Reports*. 2012;127:259-266.
83. Gregory S White, Kelly Symmes, Pu Sun, Ying Fang, Sandra Garcia, Cody Steiner, Kirk Smith, William K Reisen and Lark L Coffey. Reemergence of St. Louis Encephalitis Virus, California, 2015. *Emerging Infectious Diseases*. 2016;22:2185.
84. Charles B. Beard, Rebecca J. Eisen, Christopher M. Barker, Jada F. Garofalo, Micah Hahn, Mary Hayden, Andrew J. Monaghan, Nicholas H. Ogden and Paul J. Schramm. Ch. 5: Vectorborne Diseases. *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment*. 2016. Retrieved from: <https://health2016.globalchange.gov/downloads#vectorborne-diseases>.
85. Mosquito and Vector Control Association of California. 2013 Yearbook. 2013.

86. Armineh Zohrabian, Martin I. Meltzer, Raoult Ratard, Kaafee Billah, Noelle A. Molinari, Kakoli Roy, R. Douglas Scott and Lyle R. Petersen. West Nile Virus Economic Impact, Louisiana, 2002. *Emerging Infectious Diseases*. 2004;10:1736-1744.
87. U.S. Centers for Disease Control and Prevention and U.S. Department of Housing and Urban Development. Ch. 4: Disease Vectors and Pests *Healthy Housing Reference Manual* Atlanta, GA; 2006.
88. National Center for Healthy Housing. International Code Council. 2008. Retrieved from: <http://www.nchh.org/policy/nationalpolicy/internationalcodecouncil.aspx> on April 13, 2017.
89. U.S. Centers for Disease Control and Prevention. Vector Control / Integrated Pest Management (IPM). 2016. Retrieved from: <https://www.cdc.gov/nceh/ehs/topics/vectorcontrol.htm> on April 13, 2017.
90. Economic Research Service U.S. Department of Agriculture. Food Expenditures. 2017. Retrieved from: <https://www.ers.usda.gov/data-products/food-expenditures.aspx> on April 7, 2017.
91. U.S. Centers for Disease Control and Prevention, National Center for Emerging and Zoonotic Infectious Diseases and Waterborne Division of Foodborne, and Environmental Diseases. CDC and Food Safety. 2016. Retrieved from: <http://www.cdc.gov/foodsafety/cdc-and-food-safety.html> on April 14, 2017.
92. Dan Flynn. US Foodborne Illnesses Cost More than \$15.6 Billion Annually. *Food Safety News*. 2014.
93. Barbara M. Lund and Sarah J. O'Brien. The occurrence and prevention of foodborne disease in vulnerable people. *Foodborne Pathogens and Disease*. 2011;8:961-973.
94. U.S. Centers for Disease Control and Prevention. PulseNet Saves Lives and Money. 2016. Retrieved from: https://www.cdc.gov/pulsenet/pdf/pulsenet-economics-factsheet_508_final.pdf on April 14, 2017.
95. Association of Public Health Laboratories. Culture-Independent Diagnostic Tests: Paving the Way for Improved Diagnostics and the Future of Foodborne Disease Surveillance. 2015. Retrieved from: https://www.aphl.org/aboutaphl/publications/documents/fs_cidtfactsheet_feb2015.pdf on April 17, 2017.
96. U.S. Department Of Agriculture. Healthy Food Access. Retrieved from: <https://www.usda.gov/sites/default/files/documents/7-Healthyfoodaccess.pdf> on April 17, 2017.
97. U.S. Environmental Protection Agency. Food and Pesticides. 2017. Retrieved from: <https://www.epa.gov/safepestcontrol/food-and-pesticides> on April 17, 2017.
98. U.S. Environmental Protection Agency. Pesticides and Their Impact on Children: Key Facts and Talking Points. 2016. Retrieved from: <https://19january2017snapshot.epa.gov/sites/production/files/2015-12/documents/pest-impact-hsstaff.pdf> on April 17, 2017.

99. Agency for Toxic Substances and Disease Registry. Safeguarding Communities from Chemical Exposures. 2009. Retrieved from: <https://www.apha.org/~media/files/pdf/factsheets/aphaatsdrbookfinal2b.ashx> on
100. Molly M. Ginty. The Problem With PFASs Found in Your Food, Clothes, and Home. *Our Stories*. 2016;2017.
101. Agency for Toxic Substances & Disease Registry. Per- and Polyfluoroalkyl Substances and Your Health. 2016. Retrieved from: https://www.atsdr.cdc.gov/pfc/health_effects_pfcs.html on April 17, 2017.
102. Maricel V. Maffini and Thomas G. Neltner. Brain drain: the cost of neglected responsibilities in evaluating cumulative effects of environmental chemicals. *Journal of Epidemiology and Community Health*. 2015;69:496-499.
103. Association of Public Health Laboratories. National Biomonitoring Plan. 2015. Retrieved from: https://www.aphl.org/aboutaphl/publications/documents/eh_national_biomonitoring_plan_12015.pdf on April 17, 2017.
104. U.S. Centers for Disease Control and Prevention. Data on Healthy Community Design. 2015. Retrieved from: <https://www.cdc.gov/healthyplaces/docs/hcdi-data-on-healthy-community-design.pdf> on April 17, 2017.
105. Reid Ewing and Robert Cervero. Travel and the Built Environment: A Synthesis. *Transportation Research Record: Journal of the Transportation Research Board*. 2001;1780:87-114.
106. National Recreation and Park Association. Safe Routes to Parks: Improving Access to Parks through Walkability. 2015. Retrieved from: http://www.nrpa.org/uploadedFiles/nrpa.org/Publications_and_Research/Research/Papers/Park-Access-Report.pdf.
107. Alliance for Biking and Walking. Bicycling and Walking in the United States: 2014 Benchmarking Report. 2014. Retrieved from: <http://www.aarp.org/content/dam/aarp/livable-communities/documents-2014/2014-Bike-Walk-Benchmarking-Report.pdf>.
108. Centers for Disease Control and Prevention U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health. National Institute for Occupational Safety and Health. 2015. Retrieved from: <https://www.cdc.gov/niosh/docs/2013-140/pdfs/2013-140.pdf> on April 17, 2017.
109. U.S. Environmental Protection Agency. About EPA Schools. 2016. Retrieved from: <https://www.epa.gov/schools/about-epa-schools> on April 17, 2017.
110. Office of the Surgeon General U.S. Department of Health and Human Services. Step It Up! The Surgeon General's Call to Action to Promote Walking and Walkable Communities. 2015. Retrieved from: <https://www.surgeongeneral.gov/library/calls/walking-and-walkable-communities/call-to-action-walking-and-walkable-communities.pdf>.
111. Jenny Rowland. Parks for All: Building a More Inclusive System of Parks and Public Lands for the National Park Service's Centennial. *Energy and Environment*. 2016;2017.

112. American Planning Association. How cities use parks for... Climate Change Management. 2007. Retrieved from: <https://www.planning.org/cityparks/briefingpapers/climatechange.htm> on April 17, 2017.
113. James F. Sallis, Rachel A. Millstein and Jordan A. Carlson. Community Design for Physical Activity *Making Healthy Places*: Springer; 2011: 33-49.
114. Economic Research Service U.S. Department of Agriculture. Key Statistics & Graphics. 2016. Retrieved from: <https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/key-statistics-graphics.aspx> on April 17, 2017.
115. National Highway Traffic Safety Administration. NHTSA Data Shows Traffic Deaths up 7.7 Percent in 2015. 2016.
116. U.S. Department of Transportation. Road Traffic Fatalities by Mode. 2016. Retrieved from: <https://www.transportation.gov/mission/health/road-traffic-fatalities-mode> on 2016.
117. Ralph Buehler, Thomas Götschi and Meghan Winters. Moving toward active transportation: how policies can encourage walking and bicycling. *Active Living Research*. 2016.
118. Neil E. Klepeis, Andy M. Tsang and Joseph V. Behar. Analysis of the National Human Activity Pattern Survey (NHAPS) Respondents from a Standpoint of Exposure Assessment. *Las Vegas: Laboratory USEPANER*. 1996.
119. Paula Braveman, Mercedes Dekker, Susan Egerter, Tabashir Sadegh-Nobari and Craig Pollack. Housing and Health. 2011. Retrieved from: http://www.rwjf.org/content/dam/farm/reports/issue_briefs/2011/rwjf70451.
120. Amanda Reddy and David Jacobs. Building Justice: Genetic Code, ZIP Code and Housing Code All Affect Health and Equality. 2016;2017.
121. Tursynbek A. Nurmagambetov, Sarah Beth L. Barnett, Verughese Jacob, Sajal K. Chattopadhyay, David P. Hopkins, Deidre D. Crocker, Gema G. Dumitru, Stella Kinyota and Task Force on Community Preventive Services. Economic Value of Home-Based, Multi-Trigger, Multicomponent Interventions with an Environmental Focus for Reducing Asthma Morbidity: A Community Guide Systematic Review. *American Journal of Preventive Medicine*. 2011;41:S33-S47.
122. U.S. Centers for Disease Control and Prevention. Radiation and Your Health: Radon in the Home. 2016. Retrieved from: https://www.cdc.gov/nceh/radiation/brochure/profile_radon.htm on April 17, 2017.
123. National Institute on Aging. Falls and Older Adults. 2013. Retrieved from: <https://nihseniorhealth.gov/falls/homesafety/01.html> on April 17, 2017.
124. National Center for Healthy Housing. Keep You, Your Family and Your Home Healthy! A Resident Manual for Wheeler Terrace Residents. Retrieved from: http://www.nchh.org/Portals/o/Contents/Wheeler_Terrace_Resident_Manual_R2.pdf.
125. U.S. Department of Health and Human Services and U.S. Centers for Disease Control and Prevention. Healthy Homes Manual: Smoke-Free Policies in Multiunit Housing 2011. Retrieved from: https://www.cdc.gov/healthyhomes/Healthy_Homes_Manual_WEB.pdf.

126. Karen M. Wilson, Jonathan D. Klein, Aaron K. Blumkin, Mark Gottlieb and Jonathan P. Winickoff. Tobacco-Smoke Exposure in Children Who Live in Multiunit Housing. *Pediatrics*. 2011;127:85.
127. U.S. Department of Health and Human Services, U.S. Centers for Disease Control and Prevention and National Center for Health Statistics. Health, United States, 2011: With Special Feature on Socioeconomic Status and Health. 2012. Retrieved from: <https://www.cdc.gov/nchs/data/hus/hus11.pdf>.
128. U.S. Department of Transportation. Proximity To Major Roadways. 2016. Retrieved from: <https://www.transportation.gov/mission/health/proximity-major-roadways> on April 18, 2017.
129. Jeffrey Capizzano. Many Young Children Spend Long Hours in Child Care. 2005.
130. National Association of Family Child Care. About Us. 2016. Retrieved from: <https://www.nafcc.org/About-Us> on April 18, 2017.
131. National Research Council. *Climate Stabilization Targets: Emissions, Concentrations, and Impacts Over Decades to Millennia*: National Academies Press; 2011.
132. Kenneth D. Kochanek, Jiaquan Xu, Sherry L. Murphy, Arialdi M. Miniño and Hsiang-Ching Kung. Deaths: final data for 2009. *National Vital Statistics Reports*. 2011;60:1-116.
133. American Public Health Association and U.S. Centers for Disease Control and Prevention. Extreme Heat Can Impact Our Health in Many Ways. 2016. Retrieved from: https://www.apha.org/~media/files/pdf/factsheets/climate/extreme_heat.ashx on April 18, 2017.
134. Jerry M. Melillo, Terese (T.C.) Richmond and Gary W. Yohe. Climate Change Impacts in the United States: Third National Climate Assessment. 2014. Retrieved from: <http://www.globalchange.gov/browse/reports/climate-change-impacts-united-states-third-national-climate-assessment-o>.
135. American Public Health Association and U.S. Centers for Disease Control and Prevention. Climate Change Decreases the Quality of the Air We Breathe. 2016. Retrieved from: https://www.apha.org/~media/files/pdf/factsheets/climate/air_quality.ashx on April 18, 2017.
136. American Public Health Association and U.S. Centers for Disease Control and Prevention. Climate Change Increases the Number of Geographic Range of Disease-Carrying Insects and Ticks. 2016. Retrieved from: https://www.apha.org/~media/files/pdf/factsheets/climate/vector_borne.ashx on April 18, 2017.
137. World Health Organization. *Global health risks: mortality and burden of disease attributable to selected major risks*: World Health Organization; 2009.
138. Howard Frumkin, Jeremy Hess, George Luber, Josephine Malilay and Michael McGeehin. Climate Change: The Public Health Response. *American Journal of Public Health*. 2008;98:435-445.
139. American Public Health Association. Public Health Opportunities to Address the Health Effects of Climate Change. 2015. Retrieved from: <https://www.apha.org/policies-and-advocacy/public-health-policy-statements/policy-database/2015/12/03/15/34/public-health-opportunities-to-address-the-health-effects-of-climate-change> on April 18, 2017.

140. Minnesota Department of Health. Disaster and Emergencies: Preparing and Responding. 2013. Retrieved from: <http://www.health.state.mn.us/divs/eh/emergency/> on April 18, 2017.
141. U.S. Centers for Disease Control and Prevention. Emergency and Terrorism Preparedness for Environmental Health Practitioners (ETP). 2016. Retrieved from: <https://www.cdc.gov/nceh/ehs/etp/default.htm> on 2017.
142. World Health Organization. Environmental Health in Emergencies: Prevention. 2016. Retrieved from: http://www.who.int/environmental_health_emergencies/prevention/en/ on April 18, 2017.
143. U.S. Environmental Protection Agency. Environmental Justice. 2017. Retrieved from: <https://www.epa.gov/environmentaljustice> on April 18, 2017.