National Conversation on Public Health and Chemical Exposures

Education and Communication Work Group Report
November 2010

I. Introduction

The *National Conversation on Public Health and Chemical Exposures* (*National Conversation)* is a collaborative project, supported by the Centers for Disease Control and Prevention (CDC) and the Agency for Toxic Substances and Disease Registry (ATSDR). The *National Conversation* vision is that chemicals are used and managed in ways that are safe and healthy for all people. The project's goal is to develop an action agenda with clear, achievable recommendations that can help government agencies and other organizations strengthen their efforts to protect the public from harmful chemical exposures. The *National Conversation* Leadership Council will author the action agenda, utilizing input from six project work groups, and members of the public who choose to participate in Web dialogues and community conversations.

National Conversation work groups were formed to research and make recommendations on the following six cross-cutting public health and chemical exposures issues: monitoring, scientific understanding, policies and practices, chemical emergencies, serving communities, and education and communication. This report is the product of the Education and Communication work group's deliberations. While issued to the *National Conversation* Leadership Council, the work group hopes that this report will be of value to others in a position to act on the recommendations contained herein.[1]

CDC and ATSDR worked with several groups to manage the *National Conversation*, including RESOLVE, a nonprofit organization dedicated to advancing the effective use of consensus building in public decision making, the American Public Health Association, the Association of State and Territorial Health Officials, and the National Association of County and City Health Officials. These organizations and others helped ensure that a broad range of groups and individuals were engaged throughout this collaborative process, including government agencies, professional organizations, tribal groups, community and non-profit organizations, health professionals, business and industry leaders, and members of the public.

For more information on the *National Conversation* project, please visit www.atsdr.cdc.gov/nationalconversation.

Work Group Charge, Scope, and Objectives

The *National Conversation*'s Education and Communication work group was formed in recognition of two specific needs: a well-informed, well-equipped public and a competent network of health professionals.[2] In its early discussions, the Education and Communication work group identified four major goals for the results of its work: (1) ensure that timely, accurate, and clear communication of

[1] This report was developed as part of the *National Conversation on Public Health and Chemical Exposures*, an independent process facilitated by RESOLVE, a neutral non-profit consensus building organization. This report represents the work of one of six *National Conversation* work groups and reflects the consensus of the work group members. Consensus is defined as each member being able to "live with" the report taken as a whole, rather than as agreement with each recommendation. Members were asked to participate as individuals, rather than on behalf of their organizations or constituencies. The Centers for Disease Control and Prevention's National Center for Environmental Health and the Agency for Toxic Substances and Disease Registry provided funding for the facilitation, member travel, meetings, Web dialogues, community conversations, and other costs associated with the *National Conversation*. This report does not necessarily reflect the views of the Centers for Disease Control and Prevention, the Agency for Toxic Substances and Disease Registry, RESOLVE, or other organizations involved in the *National Conversation*.

[2] See Appendix A. "Education and Communication Work Group Charge."

information about links between chemical exposures and health is provided to medical, public health, and occupational/environmental health professionals ("health professionals"); the general public; and the country's workforce; (2) contribute to the development of a network and a pipeline of health professionals competent to help prevent, recognize, and address chemically-related health problems; (3) offer a model of government/public/workforce/health professional communication and engagement that is timely, responsive, and accountable; and (4) ensure that discussions between agencies and communities about chemical exposures and health are transparent and maximally accessible.

To meet its goals, the Education and Communication work group was charged with the following tasks:

1. Identify audiences that could most effectively use, communicate, and/or benefit from information about chemicals and public health.

2. Identify the knowledge base and tools needed by these target audiences to enhance understanding of the potential effects of chemical exposures on health; potential solutions and preventive strategies; and the roles and responsibilities of government agencies and other institutions in identifying, protecting against, remediating, and preventing harmful exposures.

3. Facilitate new and creative strategies to enhance understanding of chemical exposures and public health among health professionals, the general public, and the workforce.

4. Facilitate new and creative strategies to enhance the knowledge and skills of health professionals so they can more efficiently and effectively address the concerns of their patients and communities about chemical exposures.

5. Ensure the development of an educational pipeline to produce future health professionals and public health workers who are themselves diverse and prepared to meet the needs of vulnerable and diverse populations.

6. Suggest new strategies that promote meaningful inclusion of stakeholders; provide a structure for stakeholder dialogue; and facilitate the transfer of knowledge and experiences about chemicals and health between and among the public, the workforce, health professionals, government agencies, industry, and other relevant institutions, communities, and individuals.

7. Facilitate new, practical and effective methods to enable members of the public, the workforce, and health professionals to relay information to relevant government agencies about specific local chemical exposures or threats of exposure so that community-based knowledge about chemical contamination and public health can become a force-multiplier by enhancing government knowledge about and response to chemical exposures.

Membership

Work groups were formed in 2009 following an open nomination process. Work group members were selected based on a three stage process designed to ensure that each work group would have the capacity to address and reflect different individual and organizational perspectives.[3] The specialized skill sets and individual qualities considered in selecting members for the Education and Communication work group were technical and clinical expertise; experience in outreach and community participation processes; ability to translate technical and scientific information for wider audiences; reputation in the individual's field and ability to reach out to others in the sector; and experience or interest in public and health professional education. Furthermore, to achieve overall balance, the team sought to compose a diverse work group in terms of discipline, perspective, gender, and geographic region.

Work group membership included public, private, and nonprofit sector representation from 21 organizations, with broad expertise. The Education and Communication work group members are listed in Appendix B. The work group recognizes the lack of members from industry as a gap in its composition. The member originally appointed to bring this perspective to the committee was unable to participate in the committee's early deliberations and later officially resigned from the group.

Dr. Kathleen Rest, executive director of the Union of Concern Scientists, served as chair of the Education and Communication work group. Dr. Rest was supported by Jana Telfer, NCEH/ATSDR senior liaison to the Education and Communication work group and associate director for communication for CDC's National Center for Environmental Health (NCEH) and the Agency for Toxic Substances and Disease Registry (ATSDR); Jennifer Peyser, Senior Mediator, RESOLVE; Dana Goodson, Facilitator, RESOLVE; and Jennifer Van Skiver, Management and Program Analyst at NCEH/ATSDR.

Subgroups

The work group formed and worked in two major subgroups: the Public Subgroup addressed education and communication issues related to the public; the Health Professionals Subgroup addressed issues specific to ensuring the development and maintenance of a competent network of health professionals. To utilize the diverse perspectives represented by members, both subgroups included members with and without experience in a health profession. The subgroups completed their initial research in task groups.

Data Sources

Both subgroups developed bibliographies and topical inventories. At the start of their work, both subgroups looked for and were unable to find comprehensive inventories of resources or activities in their respective areas,[4] so each began to collect and compile information in order to inform their own work and assemble it in one place for use by others. The Public Subgroup began to compile an inventory of information resources and organizational efforts generated or undertaken by governmental, non-governmental, and other publicly available non-commercial resources that provide information on public health and chemical exposures. The Health Professionals Subgroup compiled a brief inventory, primarily of federal government occupational and environmental health resources and programs for health

[3] For additional information on the work group member selection process, see http://www.atsdr.cdc.gov/nationalconversation/docs/membership_selection_process_report.pdf.

[4] While they did not find a single comprehensive inventory of relevant resources, the work group recognizes that several related efforts are currently underway (e.g., the National Library of Medicine's Toxicology and Environmental Health Information Program).

professionals. Given the time constraints of this volunteer effort, the inventories are not complete. However, it is the work group's hope that by the time this report is finalized, it will have found an online home for the inventories so that they can become living documents, available to be used and updated on an ongoing basis.

Terms and Definitions

Education: The work group defines education as those initiatives that create a more informed and literate citizenship; this includes both formal and informal education strategies at all points in the life course.

Communication: The work group accepted Nelson, Hesse, and Croyle's (2009) characterization of communication as the process by which verbal or visual messages are intentionally transmitted by sources through channels and received by targeted audiences.

Public: The work group defined the public broadly to encompass all parties who are health-affected or who are concerned about chemical exposures and health; have a stake in research, education, and policy decisions about chemical exposures and health; and/or have potential roles in communication and education on this topic. These parties include consumers, workers, communities, children and their parents or caregivers, health-affected populations including those facing disproportionate health impacts, nonprofit and for-profit groups, scientists, health professionals, news media, educators, industry, academia, and government agencies. As depicted in Figure 1 and described later in this report, these parties can serve as sources, targets, and/or amplifiers of information.

Health professionals: The work group adopted a similarly broad definition of health professionals to include clinicians (physicians, nurses, physician assistants, veterinarians); professionals in traditional public health disciplines (e.g., epidemiology, biostatistics, environmental health science, toxicology, behavioral science, health education, etc.); and persons working in public health agencies and laboratories, with or without formal degrees in public or environmental health.

Chemical: For the purposes of the *National Conversation*, "chemical" is defined broadly to include industrial and naturally occurring chemicals regardless of their source, including biologically produced chemical substances. National Conversation participants were encouraged to consider emerging chemical exposure issues such as those presented by engineered nanoparticles. The project does not address human health risks posed by radioactive properties of chemicals.

Environmental literacy: Recognizing numeracy as a critical element, the work group defines environmental literacy as the ability to understand the symbiotic relationship between humans and the environment, as well as the ability to understand, assess, interpret, and act on both qualitative and quantitative information about the environment. The work group adopts a broad definition of environment to include home, workplace, school, neighborhood, and community environments, both ambient and built.

Health literacy: The work group accepted the Society for Public Health Education (SOPHE, 2007) definition of health literacy as the ability to understand, evaluate, and act on oral, written, and visual health information in order to mitigate risk and live healthier lives.

Environmental health literacy: Again informed by integrating, and extending the SOPHE definitions of environmental literacy and health literacy, the work group defines environmental health literacy as the ability to seek out, understand, evaluate, and use information about the environment (broadly construed) and health. Environmental health literacy enables people to act individually and collectively to prevent and reduce risks, make informed choices, participate in policy and decision-making processes, and otherwise protect, improve, and promote human health and the health of the environment.

Caveats and/or Limitations

The Education and Communication work group identified government agencies, private industry, nonprofit/non-governmental organizations, labor unions, the media, and health professionals as major communicators, educators, and providers of information on chemicals and health. Due to time and resource constraints – and the fact that action on public health and chemical exposures often focuses on the interaction of government, health professionals, and community groups – the work group limited the focus of its recommendations primarily to government and health professional education and practice organizations.

II. Current Status of Issues

Educating and Communicating with the Public

It is now widely acknowledged that chemical exposures can have a profound influence on human health and that both preventing such exposures in the community, home, and workplace, and understanding their effects is key to protecting and improving public health. The quality of the air we breathe, water we drink, food we eat, the safety of the products we use, and the quality of the medical care we receive are all part of this discussion. Improving and expanding education and communication on these issues – with health professionals, key target audiences, and the general public – is now fundamental to ensuring the health of both humans and the environment. It is the work group's hope that the recommendations put forth in this report will help further such education and understanding.

Public health and environmental agencies at all levels of government, along with industry, labor unions, and non-governmental organizations have substantial collective experience with and involvement in communicating with the public about chemicals and health. Many organizations offer guidelines and resources for risk communication, such as the U.S. Environmental Protection Agency's *Risk Communication in Action*[5] workbook and ATSDR's *Health Risk Communication Primer*,[6] among many others, and the literature is replete with research, advice, and best practices related to risk communication (see Appendix C, "Public Subgroup Bibliography"). The Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH) provide many resources for workers and employers on workplace health and safety, although easily accessible information on workplace assessment tools, best practice controls, occupational exposure limits, and safer, substitute materials and processes is lacking. Furthermore, the capacity – and in some cases the willingness – to engage in robust communication with the public about chemicals and health is uneven across government agencies. In particular, state, local, and tribal health and environmental department budgets, staff resources, and organizational cultures vary greatly across the nation.

Numerous ongoing efforts designed to educate and provide information to the public about the nature of chemical exposures, their sources, possible health effects, and intervention/prevention strategies are also conducted by industry, academia, and non-governmental organizations (and combinations thereof). These

[5] EPA's *Risk Communication in Action* workbook was produced in 2007 by the National Risk Management Research Laboratory. See http://www.epa.gov/nrmrl/pubs/625r05003/625r05003.pdf.
[6] ATSDR's *Health Risk Communication Primer* was updated in 1994 and is available at http://www.atsdr.cdc.gov/risk/riskprimer/index.html#preface.

efforts include informing decision making by consumers, parents and caregivers, policy makers, workers, and residents of communities where specific industrial facilities or operations may be located.
A host of environmental education and communication activities are also taking place in other countries and within multi-lateral and global contexts. For example, the United Nations Economic Commission for Europe's (UNECE) Aarhus Convention (www.unece.org/env/pp/) on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters links environmental rights and human rights, as well as government accountability and environmental protection. Its Kiev Protocol on Pollutant Release and Transfer Registers (PRTRs) requires parties to the Convention to establish free, publicly accessible databases covering releases and transfers of assorted pollutants, akin to the US EPA's Toxics Release Inventory (TRI). The Aarhus Clearinghouse showcases information on laws and practices relevant to the public's right to access environmental information, participate in environmental decision-making, and achieve justice on environmental matters. The U.S. could both learn from and possibly contribute to such international efforts.

Despite extensive communication efforts and attention to public health and chemical exposure issues in the media, the public is often unaware of actual or potential health issues related to chemical exposures until something adverse or contentious happens (e.g., discovery of community contamination; an industrial accident, exposure incident, or cluster of health problems in the workplace; an attempt to site a new industrial facility; information, suspicion, or concern about a product with harmful health impacts that makes the news; a potential disease cluster; or the illness of a family member, friend, or acquaintance that is suspected of being related to chemicals). Education and communication efforts often commence or ramp up in the wake of these types of situations, and such efforts achieve varying degrees of success.

Based on the research literature and the work group's experience, in the emergent situations described above the public often wants to know (1) if and to what chemicals they and their loved ones have been exposed; (2) what is known and not known about the effects of past, present, or cumulative chemical exposures on the health of humans, animals, and the environment; (3) who is responsible for the incident, exposure, or contamination; (4) who will act and what will be done to respond to the exposure; (5) what they can do to prevent or minimize risk; (6) whether exposures have been properly abated; (7) when and how their health needs will be met, and who will meet them; (8) whether their health or social status will affect their susceptibility or vulnerability to chemical exposures; (9) what rights they have to information, compensation, legal action, and other potentially corrective measures; (10) how their own knowledge, experiences, questions, and needs will inform the government's response, research, and potential policy development; (11) how best to direct public officials and policy makers toward health-protective decisions and policies; and (12) how to prevent such potentially harmful exposures from occurring again in the future.

In these situations, the public looks to the government and other actors for this kind of information. The public deserves not only accurate, timely, and transparent answers to their questions, but also an active role in the information exchange (communication) process. Too often, government agencies have responded to chemical exposure events and public concern by simply disseminating findings and conclusions of investigations conducted or supported by the government. They have lacked the capacity and/or willingness to go beyond this unidirectional flow of information. Deitz and Stern (2008), for example, report that agencies addressing chemical exposures have characterized public participation as burdensome, and have limited funding of mechanisms that foster it. This unidirectional, non-participatory approach fails to provide the necessary context for the information provided, and it limits the public's participation to that of a passive target. This work group report describes the rationale and a model for multidirectional communication, which the work group sees as essential for communicating, understanding, and ultimately preventing and resolving issues of chemical exposures and public health.

At the same time, the work group recognizes that *education* about chemical exposures and public health is a longer-term and more sustained effort. Even the best multidirectional *communication* in the face of specific problems, exposures, assessments, or studies does not provide the level of environmental health literacy needed to understand and participate in problem-solving and decision-making about the increasingly complex chemical exposure and health challenges that will continue to arise.

A 2005 report by the National Environmental Education and Training Foundation (NEETF),[7] since renamed the National Environmental Education Foundation, provided ten years of NEETF/Roper research on environmental literacy in the U.S. They found that formal environmental education has increased significantly over the past three decades, with an estimated 30 million K-12 students and 1.2 million teachers participating in environmental instruction. While this has increased environmental *awareness* overall, the average American adult does not yet have the deeper knowledge of environmental principles, understanding of causes and solutions, and ability to apply this knowledge in real world settings. NEETF/Roper research found that the public's top environmental concern is the protection of human and family health, with 60% of adults stating the main reason to protect the environment is to protect them from pollution. The research also found that adult Americans typically acquire their environmental knowledge and information from traditional media such as television, newspapers, and radio (Coyle, 2005).

NEETF/Roper research found that over 96% of American parents supported having environmental education in the K-12 setting; 90% believed adults should receive similar education and that these programs should receive private and government support. In 2005, the environmental education community founded the Campaign for Environmental Literacy (http://www.enviroliteracy.org) to restore and expand federal government support for environmental education in schools. For more than a decade, the Environmental Literacy Council has assembled cross-disciplinary resources for students, teachers, policy makers, and the public, and there are a host of environmental literacy programs, partnerships, and initiatives in schools and communities across the country that develop curricular materials and provide training opportunities for students and teachers alike.[8]

Challenges for Educating and Communicating with the Public

Governmental and other efforts to effectively communicate and engage with the public about chemical exposures and health face several serious challenges, any number or combination of which may be particularly relevant to different target audiences.

Scientific illiteracy: Widespread scientific and environmental health illiteracy will likely slow assimilation of information people need in order to become informed and responsive community participants. This will hinder their ability to interpret or understand the role and limitations of the scientific method, as well as the differing risk levels and other uncertainties often inherent in studies about the health effects of exposure to specific chemicals. As a result, people might not be adequately prepared to evaluate the risks posed by different pollutants, engage in informed dialogue, or assess the relative values of various courses of action.

[7] NEETF was chartered by Congress in 1990 to advance environmental knowledge and action. It was established as a complementary body to the Environmental Protection Agency to extend EPA's ability to foster environmental literacy in all segments of American society.

[8] For a short summary of environmental health literacy efforts, see Chepesiuk (2007): http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2022675/pdf/ehp0115-a00494.pdf.

Uncertainty: There are considerable gaps in our scientific knowledge and understanding of chemical hazards, such as their potential health effects, sources and routes of exposure, and the potential interactions of different chemicals following multiple exposures. Critical information on chemical remediation, clean-up, and control is also often lacking or incomplete, forcing risk management decisions to be made in the context of uncertainty. While scientists and other experts may employ statistical methods to deal with uncertainty, the public is generally ill-prepared to fully grasp the nuances of probabilities and uncertainties. In addition, when data are lacking or do not suggest a clear course of action, the public may have entirely different tolerances for specific risks and different preferences for risk management than other stakeholders. This challenge of making decisions in the face of uncertainty is especially acute for individuals who do not have the benefit of training and experience enjoyed by scientists working for government agencies, academic institutions, industry, and non-governmental organizations. Such disparities can weaken the general public's trust in the credibility and motives of scientists in the face of uncertainty.

Trust and credibility: Public distrust of government information and motives behind communication and public participation efforts could hamper or discourage their engagement in communication and education programs and initiatives. The public is also wary of information coming from parties with vested interests in a problem or outcome of an environmental issue. Public acceptance of information about chemicals and health depends in large part on whether they deem the sources "credible." As described by McGinnies & Ward (1980), credibility is highly associated with perceived trustworthiness coupled with expertise; i.e., having faith in the source's credentials, intentions, honesty, and robust research practices.

Different views of risk: Social science research has shown that assessments of risk or what constitutes safety are subjective and influenced by culturally-shaped value judgments. Context is also an important element, as one can reasonably question whether any or how much risk must be taken or tolerated in a particular situation. Scientists tend to assess risk in terms of probability of harm; the public's concept of "acceptable risk" often includes qualitative variables, such as prior histories and experiences, their personal level of comfort with the uncertainties involved, risk to future generations, the degree to which the risk is voluntary or individually controlled as opposed to involuntary or controlled by others, and the short-term, long-term, and catastrophic potential of a chemical exposure (Sandman, 1991). Expert evaluations that fail to take into account local perspectives might miss important information about the nature, prevalence, and health impact of a given chemical, or fail to address needs critical to members of affected communities. This "top-down" approach can erode the public's trust in the legitimacy and credibility of official findings, positions, and claims. By assessing "acceptable risk" for others, it also becomes an exercise in power that allows control not only of the assessment, but also of the recommended response to the hazard in question (Slovic, 1999).

Access barriers: Populations affected by, or audiences targeted for, information and education about chemical exposures could face barriers that prevent or limit their ability to engage in communication or education efforts. These barriers include economic, cultural, and social barriers to accessing information, such as language, low literacy, social or geographic isolation; and lack of access to or ability to use information sources due to health challenges or disabilities. For example, compromised physical and cognitive functioning can interfere with the ability to access information. In addition, certain health problems or disabling conditions (such as chemical and electrical sensitivities) can prevent persons from traveling or using electrical devices, and thus make them unable to use computers or attend public meetings. Access barriers of an entirely different kind include lack of public (and even agency) access to existing information about unregulated constituents of products.

Appropriate communication modalities: Technologies used to communicate or amplify information (e.g., television, radio, and Internet-based communications, such as Twitter) are diverse and evolving.

Individuals or organizations trying to disseminate information through these media might not know which technology will best reach, capture the interest, and meet the needs of their target audiences.

Amount, pace, and quality of information: The number, volume, and diverse uses of chemicals continue to grow, as does scientific knowledge about chemical exposures and health. The ability to keep up with and ensure the public has access to the most important and relevant information will be an ongoing challenge. This is further complicated by the rapidity and quantity of information available and pushed out online. The variable ability of target audiences to recognize and differentiate accurate and reliable information from inaccurate and unreliable information – as well as the ability to distinguish opinion from fact – will also be a major challenge.

Opportunities for Educating and Communicating with the Public

Despite these challenges, the work group believes there are enormous opportunities for enhancing education and communication about chemical exposures and health. The vast majority of the American public wants environmental education for both youth and adults. Public awareness of environmental issues is high, although their level of understanding is not deep. Affected people, communities, and populations are hungry for and receptive to information and communication. The Internet makes vast stores of information and educational opportunities accessible to many people, although information overload and the variability of data quality are ongoing challenges. Some government agencies have become more adept at and cognizant of the value of multidirectional communication and public participation. Environmental subjects and courses are taught or available at all levels of education.

Creative and effective communication programs could reignite enthusiasm for civic engagement among those target audiences whose views are traditionally ignored, those who have become apathetic, and those unaware that they are or may be exposed to hazardous chemicals. Communication and education efforts around chemical exposures and health can be an exercise in participatory democracy.

In situations that range from the aftermath of Hurricane Katrina; discovery of groundwater pollution and its effects in Woburn, MA, Endicott, NY, and Camp Lejeune, NC; and air and water pollution for fenceline communities in Alabama, Texas, Louisiana, and West Virginia; to the Deepwater Horizon oil disaster on the Gulf Coast, multidirectional communication around issues of chemical exposures and public health would serve as essential tools for understanding and resolving outstanding and ongoing individual and community concerns.

Educating Health Professionals

Health professionals must be prepared to prevent, diagnose, and treat health conditions related to the widespread exposures of their patients and communities to chemicals. The public counts on healthcare providers and other health professionals to manage health concerns related to chemical exposures, but all too often healthcare providers and professionals are not prepared to address these issues effectively. Indeed, only physicians trained in preventive medicine in the field of occupational medicine receive specific training in occupational and environmental medicine through the established system of post-graduate, residency education.

Health Provider Education

Many leading health professionals and the organizations that represent them recognize the need to develop competencies in environmental health. Some organizations focus specifically on educating health professionals and healthcare providers in particular about environmental and occupational health. These include, for example, the Association of Occupational and Environmental Clinics (AOEC), which serves as a resource for occupational and environmental health information and skills needed by all health professionals, and the Pediatric Environmental Health Specialty Unit (PEHSU) network, which provides

support and training to health professionals, parents, schools, and community groups working to protect children from environmental hazards. Many board-certified occupational medicine specialists practice in affiliation with AOEC member clinics and PEHSUs and/or are professional members of the American College of Occupational and Environmental Medicine.

Still, these and other health professional organizations acknowledge that current efforts are not enough. For example, a majority of nurse practitioner program directors have stated there should be greater emphasis on environmental health in their programs, and a majority of medical school deans and family practice residency directors believed moderate emphasis on environmental health in their programs would be ideal (Bellack, Musham, Hainer, Graber, & Holmes, 1997; Graber, Musham, Bellack, & Holmes, 1995; Musham, Bellack, Graber, & Holmes, 1996). Box 1 below illustrates the range of professional organizations expressing support for such efforts.

Despite this extensive support, healthcare providers are often unprepared to manage environmental health problems, in large part because environmental health education is under-emphasized in medical and nursing education. A survey of environmental medicine content in U.S. medical schools found that 75% of medical schools require only about seven hours of study in environmental medicine over four years (Schenk, Popp, Neale, & Demers, 1996). In addition, a survey of Migrant Clinicians Network clinicians found that approximately half had not had any training or courses related to environmental and/or occupational health (Liebman & Harper, 2001). A National Environmental Education Foundation (NEEF) study also found that health professionals need more training in environmental health and assessed the medical and nursing education structures to identify key leverage points for curricular change (McCurdy et al, 2004). Another NEEF study found that a majority of primary healthcare providers are not equipped to answer patient questions about pesticides or ask patients about possible pesticide exposure (Balbus, Harvey, & McCurdy, 2006). A survey of chief residents of U.S. pediatric residency programs found that fewer than half of pediatric programs routinely include pediatric environmental health issues in their curriculum, other than lead poisoning and environmental exacerbation of asthma (Roberts & Gitterman, 2003). Therefore, there is a clear need to increase environmental health education in medical, nursing and other health professional training programs. In addition to an under-emphasis of environmental health in medical and nursing education, clinical diagnostic tools are lacking. Without clinical tests for chemical exposures, instructional emphasis on chemical exposure-related health issues is less likely to be included in clinician education.

Box 1. Examples of Support for Advancing Health Professional Education in Environmental Health
Academic Pediatric Association: Established the National Fellowship Program in Pediatric Environmental Health and proposed competencies for pediatric environmental health specialists (Etzel, et al., 2003)
American Academy of Pediatrics Committee on Environmental Health: Published medical text on childhood environment health problems (American Academy of Pediatrics Committee on Environmental Health, 2003), and technical reports and policies on numerous pediatric environmental health issues
American College of Preventive Medicine: Supported Agency for Toxic Substances and Disease Registry efforts to educate healthcare providers on preventing exposure to these substances (American College of Preventive Medicine, 2003)
American Medical Association: AMA policy encourages "… physician educators in medical schools, residency programs, and continuing medical education sessions to devote more attention to environmental health issues" and "… the training of medical students, physicians, and other health professionals about the human health effects of toxic chemical exposures" (American Medical Association, 2004 & 2008).
American Nurses Association: Resolved to broaden work in occupational and environmental health and apply the precautionary approach when an activity raises threats of harm to human health or the environment (American Nurses Association, 2003)
Institute of Medicine: IOM has stated: "If environmental health hazards and health effects are to be recognized and dealt with effectively, it is of fundamental importance that all healthcare providers have a clear understanding of the association between the environment and health" (Pope, Snyder, & Mood, 1995, p.2).
National Council for Science and the Environment: NCSE has stated: "It is essential that we equip our healthcare professionals with adequate environmental health information to provide better health care for all citizens" (National

Council for Science and the Environment, 2007, p.25).
National Environmental Education Foundation: Published a position statement on Health Professionals and Environmental Health Education calling for collaboration to ensure healthcare providers are prepared to deal with health problems related to environmental health hazards , which has been endorsed by leading health professional organizations (NEEF, 2004)
U.S. Department of Health and Human Services Division of Nursing: Established as nursing practitioner competency the ability to recognize environmental health problems affecting patients and provide health protection (U.S. Department of Health and Human Services, 2002)

Environmental Public Health Workforce

In addition to clinicians, the nation relies on a large corps of health professionals to help protect and promote the health of humans, animals, and the environment. These professionals work in public health and environmental departments and other government agencies, healthcare institutions, non-governmental organizations, industry, and academic institutions. Their academic pathways to public health and to environmental health more specifically, vary considerably. They may have any of a variety of backgrounds (e.g., undergraduate or graduate degrees in public health or environmental health; a basic, laboratory, or environmental science; the humanities; health education; public policy; or public administration). They may have had little or no formal training in environmental health in general or chemical exposures and health in particular. In fact, as of 2006, more than 90 percent of the environmental health workforce had no formal degree in public health or environmental health (Herring, 2006).

The Association of Environmental Health Academic Programs (AEHAP) is a key organization working to expand the environmental health workforce and increase awareness of environmental health workforce issues. AEHAP provides student recruitment, retention, and diversity enhancement grants, minority student recruitment grants, and other support to member programs through a cooperative agreement with CDC. The National Environmental Health Science and Protection Accreditation Council (EHAC) advances environmental health competencies by accrediting environmental health degree programs. As of June 2010, EHAC has accredited 33 undergraduate programs and seven graduate programs (Association of Environmental Health Academic Programs, 2010).[9]

The Council on Education for Public Health (CEPH) accredits schools of public health, but there is no credentialing *requirement* for graduates of public health programs. However, the National Board of Public Health Examiners (NBPHE) administers a voluntary certification exam to ensure that students and graduates from schools and programs of public health accredited by the CEPH have mastered the knowledge and skills relevant to contemporary public health. The certification exam covers environmental health as one of the five core public health disciplines.

Apart from degree programs, there are a host of other initiatives and programs designed to expand, enhance, and otherwise develop the environmental public health workforce. These include, for example, (1) the Environmental Public Health Leadership Institute, a year-long competency-based program for state and local environmental health specialists coordinated and managed by CDC and the National Public Health Leadership Development Network; (2) the Uniformed Services Environmental Public Health Career Initiative, designed to help Uniformed Services environmental health practitioners leaving active duty service transition to post-military careers in environmental public health; and (3) the National Environmental Health Association (NEHA) Environmental Health Workforce Development Consortium,

[9] The list of environmental health degree programs accredited by the National Environmental Health Science and Protection Accreditation Council is available at http://www.aehap.org/accred_members.htm.

designed to increase coordination and leadership in the environmental health workforce and to support CDC's national strategy for revitalizing environmental public health.[10]

Public Health Department Accreditation

A national voluntary accreditation program for state, local, territorial and tribal public health departments is also under development by the Public Health Accreditation Board (PHAB). The national public health accreditation program's goal is to improve and protect the health of the public by advancing the quality and performance of all state, local, territorial and tribal health departments in the country. PHAB maintains that accreditation will incentivize continuous improvement of public health departments. Thirty public health departments are currently beta testing this accreditation program. After conclusion of and adjustments to the basis of the beta test, the national public health accreditation program will launch in 2011. By 2015, PHAB aims to have 60 percent of the U.S. population served by an accredited public health department. The two sets of accreditation standards – one for state and territorial health departments and another for local and tribal health departments – both contain measures that explicitly include environmental public health hazards alongside public health problems (e.g., measures related to analysis of public health data for identification of environmental health hazards and investigation of environmental public health hazards to protect the community) (Public Health Accreditation Board, 2010). Environmental public health is not, however, a major focus of the proposed accreditation process.

III. Vision of a Successful System

The work group envisions a future in which the public at large is more knowledgeable about environmental health and key (target) audiences have the knowledge, skills, and ability to actively and effectively participate in communication, discussion, deliberation, community-based research, and decision making about the environment and health. It envisions a system in which government agencies at all levels embrace a multidirectional approach to communication and education, based on trust, mutual respect, and a commitment to civic empowerment and capacity building. In addition, the work group envisions a diverse cadre of healthcare providers and public health professionals who are well-trained in environmental health, see prevention as primary, and are committed and prepared to meet the needs of affected individuals, vulnerable populations, and marginalized communities who bear a disproportionate environmental health burden or are geographically remote.

The work group believes certain values are fundamental to the success of government education and communication programs. Precepts of justice, equity, human rights, and the Precautionary Principle should underpin these efforts. Credibility, integrity, and transparency are also essential. The issue of credibility is a critical one, as most segments of the public draw on information they consider credible to advance their knowledge and inform policy, make recommendations, or change personal behaviors to better protect public health. Public acceptance of information about chemicals and health depends in large measure on whether they deem the sources "credible." Credibility also depends on the integrity of investigations, interpretation of results, and how these results are integrated or excluded from public health policy decision making. Therefore, scientific input must be impartial, unsuppressed, and free from manipulation. This suggests that industry or government data should not be assumed to be the final word before being replicated and confirmed by disinterested parties.

[10] CDC issued *A National Strategy to Revitalize Environmental Public Health Services* in 2003. See http://www.cdc.gov/nceh/ehs/Docs/NationalStrategy2003.pdf.

The credibility of scientific data might be enhanced by (1) complete disclosure of study limitations and uncertainties; (2) prompt retraction of studies demonstrated to be biased, flawed, misleading, or outdated; (3) data transparency; and (4) strict compliance with the Freedom of Information Act. Publication of information in peer-reviewed journals is one mechanism by which the scientific community tries to ensure the credibility of sources and the information they produce. However, the history of paper retractions and disclosures of biases and errors in published papers suggests that this mechanism is not flawless. In the end, determinations of a source's credibility often must rely on individual, community, or institutional decisions about which sources to trust. Sources of information about chemical exposures and public health are often perceived as "credible" when they are (a) believed to possess necessary knowledge and expertise, and (b) seen as honest, open, caring, and committed to the promotion of the public good (Peters, Covello, & McCallum, 1997).

The work group also believes it is important to explore the diversity of models existing outside U.S. borders, to determine what global projects the U.S. might participate in, to take instruction from existing models, and to identify opportunities for it to help other, particularly developing, countries, tackle their own chemical exposure concerns through partnerships.

Multidirectional Learning as the Basis of Public Education and Communication

The work group's broad definition of "the public" discourages the traditional unidirectional model of education and communication in which the government is the source of information, and the general public is the target. Rather, the Education and Communication work group proposes a multidirectional model for communication, education, and learning that includes sources, targets, and amplifiers of information. This multidirectional approach is designed to avoid the tragic consequences of unrecognized public health threats[11] and to capitalize on the knowledge, skills, resources, and reach of these different groups.

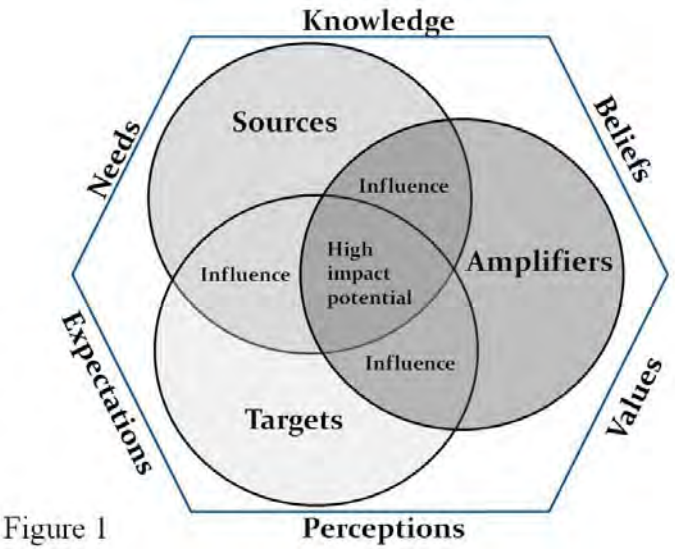

Figure 1

[11] For example, evidence suggests that exclusive reliance on the diagnostic methods and recommendations of traditional "experts" would have missed such serious public health risks as human exposure to diethylstilbestrol and Agent Orange.

In a multidirectional model (Figure 1), sources, targets, and amplifiers of information intersect. Acknowledging that the process of gathering, developing, disseminating, and receiving information about chemical exposures and public health is inherently dynamic and informed by knowledge, beliefs, values, perceptions, expectations, and needs (personal, professional, institutional, financial, and political), the work group shows graphically how a group – such as a government agency, industry, policy-making entity, affected community – can, depending on the circumstance, be at one time a source and at another time a target of information, or both a source and a target simultaneously. For example, a government agency may be a source of information about a specific chemical, but may also become a target of information about the same chemical if it engages in research efforts or communication with groups that have alternative perspectives on the subject. Similarly, an affected community may be a target of information, but may also become a source of information if it engages in research efforts or communication with groups that are open to its message. As a source or target or both, a group can also be what the work group is calling an "amplifier" of information – taking on the role of not only communicating information but of expanding its reach or influence. Typical amplifiers include traditional media and social media, but other groups such as health professionals, community leaders, educators, libraries, and NGOs can also assume this role.

Depending on the relative involvement, size, influence, status, and authority of the source(s), target(s), and amplifier(s) in each case, the circles in the diagram might expand or contract. In some cases, for example, the amplifier circle might be entirely absent. The Education and Communication work group hopes this diagram helps illustrate the reciprocal and multidirectional avenues of education and communication about chemical exposures and public health.

Although over the past several decades various federal agencies have adopted a multidirectional education and communication approach to chemical exposures and public health, they have never institutionalized it as a model. Institutionalization of such a model promises to improve the quality of research, public policy, and public health messaging, and thus to engender greater trust between government agencies and non-governmental segments of the public on behalf of the protection of public health. According to Dietz & Stern (2008), "When done well, public participation…can lead to better results in terms of environmental quality and other social objectives. It also can enhance trust and understanding among parties," (p.2).

While transparency and access to information are only part of this model, government agencies are already working to make information they hold more accessible to the public. For example, to improve usability of such information, as of March 2010, the Environmental Protection Agency (EPA) provides free Web access to the consolidated Toxic Substances Control Act (TSCA) Chemical Substance Inventory, a list of thousands of industrial chemicals maintained by the agency not previously available in this form. Another EPA transparency initiative is the "Rulemaking Gateway," which provides information on rules that have not yet been proposed, those open for public comment, and those awaiting a final EPA rule.

The proposed multidirectional model expands the more traditional "brief interaction" between government and non-governmental parties to systematic and robust partnerships that allow for comprehensive, sustained, and transparent research, investigation, and negotiation. The work group's vision for multidirectional education, communication, and learning leads it to advocate for public participation in government studies of the effects of chemicals on health and related policy and decision-making processes. There is a growing precedent for such active engagement in Community-Based Participatory Research (CBPR) programs. CBPR is an approach to research that enables the public to partner with government, academic, and other researchers (O'Fallon & Dearry, 2002). For example, the National Institute of Environmental Health Sciences (NIEHS) has led development of these approaches in

its Partnerships for Environmental Public Health program (http://www.niehs.nih.gov/research/supported/programs/peph), including its Environmental Justice program and the trans-NIH Community Participation in Research and Community Participation Research Targeting the Medically Underserved programs.

Targets for Public Education and Communication

Although the Education and Communication work group's definition of the public is broad, and its multidirectional model calls for out-of-the-box thinking about sources, targets, and amplifiers, there are groups that merit special attention. These include those who are (1) already exposed or affected by chemical contamination (e.g., suffering from an environmentally-induced illness, including chemically sensitive individuals who react to everyday exposures); (2) especially susceptible (e.g., pregnant women, children, elders, people with chronic illness); (3) vulnerable to being involuntarily exposed to harmful chemicals due to conditions in their home, school, work environment, or community; (4) workers who are disproportionately exposed due to the chemicals involved with their occupation; (5) living in remote locations and lacking ready access to information and other resources; (6) impacted by or involved in responding to chemical emergencies or disasters (e.g., 9/11 and the Deepwater Horizon Oil Spill); (7) concerned about the issues (e.g., patient groups, parents, environmental justice groups); and (8) capable and willing to be amplifiers. Agencies and organizations that take the lead in establishing multidirectional communication strategies should develop a list of target audiences in order to avoid omitting – and alienating – those people who need to be informed.

For developing and enhancing environmental health literacy at a deeper level, target audiences include (1) the media, an important amplifier and purveyor of information; (2) community leaders in government, business, health, education, and civic affairs, especially those who routinely make environmentally-related decisions; (3) educators, i.e., those who do or could offer environmental health education to our youth, especially at the K-12 level; and (4) health professionals, especially clinicians who encounter patients with questions, risks, or effects of chemical exposures.

Starting off on the Right Foot

Intensive government efforts will be required to initiate or foster the multidirectional model the work group envisions. For example, a successful model will likely require agencies to (1) develop and adopt a clear policy on the use of multidirectional models of investigation, education, and policy development – and require partners to use that model; (2) establish new and flexible ways to encourage easy exchange of information between and among public, private, and government entities; and (3) ensure groups with vulnerabilities, susceptibilities, disabilities, or other needs have the tools and access required for effective engagement with the government. These groups include environmental justice communities; vulnerable, susceptible, underprivileged, or underserved populations, including individuals with chemical and electrical sensitivities; those with other disabilities; and certain worker populations). Additionally, the work group envisions government agencies cultivating and using a network of trained and experienced grassroots community organizations and leaders to facilitate effective communication between local communities and tribes and government agencies. In fostering multidirectional communication, agencies will need to make special effort to avoid legitimizing predetermined agency agendas through pro forma public engagement and stoking conflict between competing stakeholders vying for government attention.

Effective multidirectional education, communication, and learning also entail meaningful opportunity for community participation in research, with a government commitment to share results. For example, government agencies should share population-based biomonitoring information derived in whole or in part from studies of exposures to, and the environmental health effects of, chemicals – with appropriate confidentiality and privacy protections. This information should be made available to the affected communities in terms understandable to non-scientists and in the context of its relevance to the community. Both government agencies and the public could use this information to inform policy making

and to encourage future multidirectional communication efforts. Study participants have a right to choose whether they wish to be informed of their own results and opportunities to reduce their exposures through individual or community action, and they must be assured of the confidentiality of their personal information.

Collaboration could be especially fruitful if study participants help interpret and disseminate the results. It could also encourage and facilitate community collaboration in the development of informed policies regarding chemical exposures and the promotion of community health. The success of such an effort would likely depend on tailoring methods to the specific community context and taking into consideration the environmental health literacy of community members (see examples of successful multidirectional education and communication in Appendix D of this report).

Agencies should invest in and tap the potential of amplifiers in education and communication efforts. Amplifiers can serve as outreach agents to the community, overcoming barriers faced by individuals or neighborhoods with limited means of communication, residents who speak limited English, and people with chemical and electrical sensitivities or other disabilities that restrict communication through traditional channels. Amplifiers could also complement traditional channels of information delivery with new and creative forms of communication, for example, texting, tweeting, and blogging. Storylines about toxic exposures in television dramas are another potentially fruitful outreach mechanism. Such strategies can help to foster and sustain community partnerships with government agencies and research institutions and should be an integral and continuously evolving part of multidirectional education and communication.

The education and communication infrastructure could be greatly enhanced if agency Web sites featured (1) cross-references to other government and non-government Web sites addressing relevant chemical exposures; (2) updated lists of relevant scientific journals or peer-reviewed papers; and (3) lists of relevant resources other than government studies or peer-reviewed papers (e.g., policy documents). A common Web-based source of information on regulatory status, safety standards, exposure limits, and health effects for specific chemicals would be invaluable, as would databases of practical tools, checklists, and other information to assess and control workplace exposures,. Checklists or matrices that summarize what is known and unknown about the toxicity of specific chemicals would be especially useful to health professionals; these should include the acute and chronic health outcomes or systems studied, the types of populations considered in the studies, and the adequacy/strength of the studies. Basic information should be presented in lay and user-friendly formats, and could be linked to more detailed data housed in various agencies.

Achieving these outcomes will likely require that (1) education and communication programs are funded and adequately staffed; (2) education and communication officers help community participants become literate and competent to discuss issues on an equal basis with well-informed and powerful stakeholders; (3) government studies be peer-reviewed not only by experts the government trusts, but also by members of affected communities and the experts they trust; (4) government information discloses both the 'knowns' and the 'unknowns' in existing scientific knowledge about chemical exposures and public health; (5) flawed government studies are retracted in a timely manner; (6) cumulative impacts and overall health risk are used as guiding frameworks for educating the public about chemical exposures; and (7) government information is accurate, complete, and targeted to those who need it.

Environmental Health Literacy: Investing in the Future

The lack of scientific, health, and environmental literacy within the American populace is a critical challenge for the future. While simple awareness of environmental issues may contribute to public support for strong environmental policy, it is insufficient for informed decision-making and engagement in the policy process. True environmental health literacy begins with sustained and focused efforts around

environmental and health education – starting with youth – and continues through efforts of life-long learning.

Thus the Education and Communication work group calls for institutionalizing environmental curricula at all levels of education, with a strong and central focus on human health. The work group's goals are to build environmental health literacy among the public; foster a commitment to life-long learning of environmental health issues; and create a pipeline for careers in environmental health.

Educating Health Professionals

A multifaceted approach is needed to prepare current and future health professionals to adequately address chemical and other environmental exposures. There is a need to establish a model for career-long learning for healthcare providers—from the basic education of clinicians in training to continuing education for those already practicing in clinical settings. *National Strategies for Health Care Providers: Pesticide Initiative,* which has been developed by a large group of national experts, recommends a three – pronged strategy with specific activities in education, practice, and resources/tools.[12] Working clinicians need a set of skills and tools for diagnosing, treating, and intervening to prevent chemical exposures, as well as for answering questions and providing information about chemical exposures to their patients and communities. The model should aim to establish an integrated set of educational materials and clinical tools, which should be used by trainees during undergraduate clinical education at a basic science level and advancing in sophistication as the clinician matures into an established practitioner. This must include teaching them how to play their very essential role in surveillance systems for chemical exposures and health effects. Additionally, in order to more fully prepare healthcare providers to address chemical exposures, validated clinical diagnostic tools similar to blood lead testing used to confirm exposure to lead are needed. Clinical diagnostic tools are needed for healthcare providers to accurately diagnose chemical exposure in their patients and more actively participate in public health surveillance. Moreover, the mere existence of clinical diagnostic tools will help promote training of healthcare professionals on the proper use of such tests in a differential diagnosis. In other words, if a clinical test exists, instructional emphasis on how and why to use such a test will be more likely to be included in clinician education.

The work group further believes that health professionals should have a corresponding set of competencies in environmental public health that prepare them to address chemical exposures and their impact on the health of individuals and communities. These competencies will enable healthcare providers and the larger public health community to better address the needs of individuals and populations, particularly those who may be disproportionately burdened by environmental health hazards that play an important role in producing and maintaining health disparities.

Finally, the work group believes there is a need to create a pipeline of future public health professionals through early investment in training. For example, a multidisciplinary course of study at the undergraduate level can introduce students to exciting career opportunities in public health. Public and environmental health subjects can be integrated into existing science and humanities courses, enriching them with interesting, exciting, and practical applications. Schools and programs of public health can establish partnerships and foster collaborations with other professional schools and degree programs,

[12] The National Environmental Education Foundation's *Implementation plan: National strategies for health care providers: Pesticides initiative* at http://www.neefusa.org/health/pesticides/implplan.htm.

local and state health departments, and community organizations, thus supplementing and extending the workforce involved in public health.[13]

In making the recommendations for health professional education, the work group believes:

- All health professionals should understand the relationship among and between individual and population health and the environment (including the work environment). This includes types of environmental health hazards, exposure pathways, basic prevention and control strategies, the interdisciplinary nature of effective interventions, the importance of disease reporting and surveillance, and the role of research.
- All health professionals, including clinicians, should demonstrate knowledge of the role of advocacy, ethics, and risk communication in patient care and community intervention with respect to the potential adverse effects of the environment on health.
- All health professionals/clinicians should have a basic awareness of the policy framework, laws, regulations, and reporting requirements related to occupational and environmental health.
- All healthcare providers should be trained and prepared to take an occupational and environmental health history; be able to recognize potential environmental hazards and sentinel illnesses and make appropriate referrals for conditions with probable environmental etiologies; provide information to patients and communities; and locate specialty and referral resources (Pope, Snyder, & Mood, 1995).

In addition to the health professional workforce, researchers play an important role in shaping the nation's understanding of and ability to address chemical exposures and health. Researchers and educators should focus on how best to teach occupational and environmental exposures; how to ensure that emerging information (e.g., gene-environment interactions and epigenetics) is incorporated into health professional education; and what strategies are most effective in changing knowledge, attitudes, and behaviors of providers and patients around environmental health.

IV. Action Recommendations

1. Institutionalize a multidirectional model of education and communication in government agencies, convening a multi-stakeholder workgroup to develop guidelines.

Cooperative efforts to promote education and communication between the government and the public and workforce must incorporate and honor multiple sources of knowledge and experience, styles of learning, diverse cultural values and resources, and varying levels of education and access to information. Therefore, government agencies must devote adequate resources to train staff and develop infrastructure to enable all members of affected and concerned communities to participate in public health decision making, the development of knowledge, and the creation of effective health-protective recommendations.

The key principles of this multidirectional learning process should be the cultivation of mutual trust and respect and the encouragement of full participation and reciprocity among all stakeholders, regardless of differences in formal education or financial and political resources. Indeed, these types of principles in government affairs have been promoted by two administrations under Executive Order 12898 of 1994 ("Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," http://www.archives.gov/federal-register/executive-orders/pdf/12898.pdf) and the Open Government Initiative of 2009 (http://www.whitehouse.gov/open/documents/open-government-directive).

[13] For additional information, see Institute of Medicine, National Academy of Sciences. (2002). *Who Will Keep the Public Healthy? Educating Public Health Professionals for the 21st Century.*

The work group recommends convening a 30-40 member working group comprising federal and state agencies, academia, professional and other non-governmental organizations, health care and public health organizations, and community stakeholders in environmental and occupational health that has a mandate to develop within 18 months a national multidirectional communication model. This working group will also be charged with devising federal and state guidelines for using this approach as the basis of education and communication programs on chemical exposures and public health. Key participants and financial sponsors of this working group's activities should be the U.S. Environmental Protection Agency (EPA), National Institute of Environmental Health Sciences (NIEHS), Centers for Disease Control and Prevention (CDC), especially the National Center for Environmental Health (NCEH) and the National Institute for Occupational Safety and Health (NIOSH), the Agency for Toxic Substances and Disease Registry (ATSDR), and the Occupational Safety and Health Administration (OSHA). The authority of the working group must derive from the commitment of the leadership of these key stakeholder agencies to *champion the group's recommendations* and *provide and generate funds* for developing this model and integrating it into standard operating procedures of government agencies. Membership of non-governmental stakeholders in the working group must be open to all interested members of the public. The selection process must be transparent and guided by a commitment to diversity and different types of expertise.

Suggested initiatives for the working group's consideration include:

- Create agency staff positions or extend duties of selected existing staff to equip traditionally disempowered communities to better negotiate with historically empowered stakeholders on issues directly affecting their health by enhancing their scientific literacy and advocacy skills.
- Create agency staff positions or extend duties of existing staff to include using the multidirectional model in all government education and communication initiatives so these initiatives are collaborative, culturally appropriate, transparent, effective, and scientifically sound.
- Create agency staff positions or extend duties of existing staff to cultivate and routinely partner with networks of grassroots community organizations and leaders who have training and experience in facilitating effective communication between local communities and government agencies.
- Establish a mutually supportive network of ongoing education, communication, and training among federal, state and local governments of staff members who are dedicated to fostering multidirectional education and communication.
- Incorporate financial support for multidirectional education and communication programs into the operational decisions for projects that prevent, assess, or remedy chemical contamination events and public exposure to environmental pollutants.

This recommendation would be considered a preliminary success if the initial model were developed and tested in three health-affected, underserved and underrepresented communities (e.g., an environmental justice community, a community that has experienced a chemical emergency, and a low-literacy community) within 1.5 years, and ultimately successful if this model were incorporated into all relevant agency interactions with non-governmental constituents and communities within 5 years.

2. Build public trust in government studies, publications, and communications by developing and enforcing clear guidelines and creating an ombudsman position.

Trust is a critical element in efforts to educate, communicate with, and otherwise engage the public about chemical exposures and health. Public mistrust of the data sources, study methods and results, or interests and intentions of the researchers or communicators, can undermine education and communication efforts

about chemical exposures and public health and render these efforts futile. The scientific community is guided by a set of principles, traditions, norms, and standards that embody the values of honesty, integrity, objectivity, openness, and collegiality.[14] Because these standards have not always been upheld,[15] government in particular should take steps to strengthen the trust in and credibility of its science and its capacity to improve the public's health. In addition to ensuring easy access to data and information deemed important by the public (see Recommendation #3), the work group recommends that agencies develop and enforce clear guidelines for scientific research involving chemical exposures in a specific community or region that require:

- Public participation early in the investigative process (i.e., when the problem to be studied is defined and the research questions are identified), giving voice to affected and vulnerable groups, independent scientists and public health experts;
- Full and fully verified federal government responsibility for the data used in government studies and its accuracy, even if that data originated in local, regional, or state offices;
- Full disclosure of authors' financial and non-financial conflicts of interest, as well as uncertainties and limitations of their research;
- Peer-review for all government studies that includes reviewers selected by the affected community/communities;
- Full transparency of data sets, analyses, notes, and draft reports, to be subject to Freedom of Information Act (FOIA) requests with no exceptions; and
- A clear retraction policy requiring government studies with falsified, fabricated, or missing data, as well as erroneous or misleading analyses and/or conclusions to be removed fully and in a timely and transparent manner.

In addition, agencies that address public health and chemicals should create an ombudsman position with the authority to investigate allegations of scientific misconduct for any study authored by the government (or published in a government journal).[16] The ombudsman must be required to carry out investigations in a fair and timely manner, respond to all complainant charges fully, and make findings available to the public. Guidelines and ombudsman positions should exist at all relevant agencies within two years.

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[14] National Academy of Sciences, National Academy of Engineering, Institute of Medicine, Committee on Science, Engineering, and Public Policy, Panel on Scientific Responsibility and the Conduct of Research. Responsible Science – Ensuring the Integrity of the Research Process. Vol. 1. Washington, DC: National Academy Press, 1992;

[15] See the following for examples of past problems with government science*: A Public Health Tragedy: How Flawed CDC Data and Faulty Assumptions Endangered Children's Health in the Nation's Capital* (May 2010): http://democrats.science.house.gov/Media/file/Commdocs/hearings/2010/Oversight/20may/Staff%20Report_DC%20Lead_5.20.10.pdf; *Agency for Toxic Substances and Disease Registry: Policies and Procedures for Public Health Product Preparation Should Be Strengthened* (April 2010): https://atlanta.securemail.hhs.gov/exchweb/bin/redir.asp?URL=http://democrats.science.house.gov/Media/file/Commdocs/hearings/2010/Oversight/20may/GAO_Report_ATSDR_5.20.10.pdf; *The Agency for Toxic Substances and Disease Registry (ATSDR): Problems in the Past, Potential for the Future?* (March 2009): https://atlanta.securemail.hhs.gov/exchweb/bin/redir.asp?URL=http://democrats.science.house.gov/Media/file/Investigations/ATSDR%2520Staff%2520Report%252003%252010%252009.pdf; *EPA Science: New Assessment Process Further Limits the Credibility and Timeliness of EPA's Assessments of Toxic Chemicals.* (September 18, 2008) Government Accountability Office, Testimony before the Subcommittee on Oversight and Investigations, Committee on Energy and Commerce, House of Representatives; *U.S. Fish and Wildlife Service: Endangered Species Act Decision-Making.* (May 21, 2008). Government Accountability Office. Testimony before the Committee on Natural Resources, House of Representatives.

[16] CDC's National Center for Environmental Health/the Agency for Toxic Substances and Disease Registry had this position at one time.

3. Develop, perhaps under the auspices of the National Library of Medicine's existing Toxicology and Environmental Health Information Program, a comprehensive online portal for information on health and chemical exposures.

The number, volume, and diverse uses of chemicals continue to grow. Accordingly, scientific knowledge about these chemicals and the resources with which to communicate this knowledge to the public also continue to grow. However, the many existing databases and information sources on public health and chemical exposures are often isolated, hard to find, difficult to use, or outdated. In order to ensure that the public has adequate opportunity to obtain the information it needs, it is essential to improve access to these information sources, whether available on the Internet or by other means. Improved access necessitates strategic positioning of information so that it is accessible to diverse audiences with different needs and circumstances.

For example, the National Library of Medicine's Toxicology and Environmental Health Information Program[17] (TEHIP) provides a Web site (http://sis.nlm.nih.gov/enviro.html) with access to resources produced by TEHIP, other government agencies, and non-governmental organizations. The TEHIP Web site includes "…links to databases, bibliographies, tutorials, and other scientific and consumer-oriented resources" (National Library of Medicine, 2010). In addition, TEHIP manages the Toxicology Data Network (TOXNET), which provides access to numerous toxicology and environmental health databases.

While the TEHIP program begins to achieve some of the work group's goals, the work group envisions an improved information portal, which will function as a single point of entry for chemical risk and exposure information sources held by academic, governmental, industry, labor unions, and non-governmental organizations. TEHIP should (1) provide easy access to sources of information pertinent to each chemical, such as regulatory status, safety standards, exposure limits, and health effects; (2) acknowledge sources and limitations of research for each resource; (3) cite any incomplete, ongoing studies that the agency is aware of; and (4) provide the best information and education available even if the issues are not well addressed by government agencies, e.g., on such topics as nanotechnology, mixed exposures, and problems related to chemical and electrical sensitivities, or point interested parties to other resources.

The portal should provide a brief description of the utility of each information source, cross-referencing and linking (1) government and non-government Web sites; (2) peer-reviewed papers; (3) non-government "grey literature," such as relevant policy documents and credible unpublished reports; and (4) tools and methodologies developed by various professional subgroups to educate the public and healthcare providers about health and chemical exposures. Agencies that develop information on chemical risks should tabulate and make accessible the health outcomes studies it uses, and include information about the population(s) studied, the adequacy and strength of the studies, and what is known and unknown about the chemical under consideration. As chemical exposures often occur first and worst in occupational settings, OSHA and NIOSH should develop easily accessible information on workplace assessment tools, best practice controls, occupational exposure limits, and safer, substitute materials and processes.

Because the portal links to various sources of information, guidance should also be developed to ensure federal agency Web sites (1) are regularly updated; (2) present information in lay-audience and user-friendly formats; and (3) include a method to allow public and transparent input on the relevance,

[17] A TEHIP fact sheet is available at http://www.nlm.nih.gov/pubs/factsheets/tehipfs.html.

accuracy, and completeness of posted documents. In addition, data should be presented not only in its scientific format, but also summarized in a form that is understandable by the lay public to ensure that knowledge is accessible to all. Consistent with the multidirectional model, the portal needs to allow for feedback loops in communication that enable information to flow both to and from the public. Agencies should develop guidance ensuring that such feedback mechanisms are present. Social media should be used, if possible and practical, to share information on the status of chemical pollutant incidents, especially if the status changes rapidly, and to surface community knowledge with the goal of improving accuracy and accessibility of these resources so that they best serve the interest of improving and protecting public health. NLM's Toxicology and Environmental Health Information Program should implement these strategies within two years.

Finally, all government agencies should develop guidance to ensure communities with access barriers to the online portal can still receive information. Local, public, and private institutions should be recruited to amplify and assist in disseminating offline communication initiatives to ensure that individuals without access to computers and/or the Internet still receive information. Communication strategies should take into consideration the needs and limitations of different target audiences (i.e., affected communities, economically, demographically, or geographically isolated or marginalized communities, individuals with chemical and electrical sensitivities, etc.) described in this report.

4. Develop 21st century environmental and occupational health education for K-16+ through agency collaboration.

It is critically important to expose students to environmental health issues from the earliest educational stages and throughout their formal education. A 21st-century environmental and occupational health education model for K-16+ is needed to build environmental health literacy, numeracy, and foundations for careers to create the next generation of informed citizens and practitioners through interdisciplinary curricula that are standards-aligned, place-based, and student-centered, all aimed at developing a new cadre of environmental health guardians of the future.

- *Standards-aligned*: States, in collaboration with federal education and health departments, should develop interdisciplinary K-12 educational standards, including (but not limited to) the subjects of science, civics, social studies, reading, and math, that require teaching the scientific and social bases of environmental health. These K-12 standards should ensure that students will be eligible for college and post-college programs that prepare environmental health professionals. Experts should review curricula to ensure they cover chemical pollutants and their effects on environmental health, identify gaps, and help teachers better integrate this topic into their courses.
- *Place-based*: Curricula should consider local geographic and community relevance to account for and relate to diverse communities. This includes a particular emphasis on environmental justice and vulnerable populations.
- *Student-centered*: The U.S. Department of Education, the Centers for Disease Control and Prevention (CDC), and the National Institute of Environmental Health Sciences (NIEHS) should train teachers in a student-centered approach to teaching environmental health. Student-centered teaching increases student enthusiasm for the content matter, allows for experiential knowledge and application of concepts, and reinforces and operationalizes the multidirectional learning approach we recommend in recommendation number one, above. Models include the CDC's

Science Ambassador Program,[18] which targets teachers, and the NIEHS's Summers of Discovery Program, which works with students directly in lab settings.

For undergraduate and graduate education, institutions of higher education, certifying professional associations, and government health and environmental agencies should develop professional competencies (including ethics); assess student proficiency in these competencies through certification and licensure exams; and assess institutional proficiency in these competencies through the accreditation process. Partnerships with colleges and universities serving students traditionally underrepresented in environmental health should be prioritized (e.g., Tribal Colleges and Universities and Historically Black Colleges and Universities). As recommended by the Consensus Conference on Undergraduate Public Health Education, the work group proposes that public health provide an effective interdisciplinary framework for fulfilling general education requirements found in many undergraduate institutions. The work group also encourages non-biomedical disciplines to teach concepts of environmental health literacy to help create a broad base of professionals committed to increasing public knowledge about public health and chemical exposures.

The work group recommends that the Department of Education, CDC, NIEHS, and EPA convene a multi-state collaboration to develop environmental health education standards for adoption and implementation purposes at the state level and for their incorporation into the Common Core[19] standards**.** Curricula that achieve these standards should be stored in a centralized, publicly available online repository co-hosted by the Department of Education and the CDC that facilitates collaboration between teachers. Additionally, the work group recommends these agencies train teachers in new approaches, technologies, and methods to effectively achieve these standards, with the end goal of encouraging and ensuring population-wide environmental health literacy and numeracy.

5. Incorporate environmental and occupational health competencies into formal health professional education.

Exposure to chemicals can have serious adverse health effects, especially for children, people with chemical sensitivities, and other vulnerable populations. Yet most healthcare providers are not prepared to recognize, manage, and help prevent chemical exposure-related illness in their patients. All healthcare providers should have basic competency in environmental health. Leading health institutions and professional organizations have emphasized the need to enhance the knowledge and skills of healthcare providers in environmental health. Over the years, expert bodies have made recommendations and developed resources to integrate environmental health curricula into medical and nursing education. To date, most of our medical and nursing schools and training programs have not adequately met this need or used these resources.

Chemical exposures are not going away and related health risks and effects may become increasingly important and complex as people encounter multiple, often low-level, chemical exposures. Ensuring a health professional workforce with basic competence in environmental health in general, and chemicals

[18] For more about CDC's Science Ambassador Program, see http://www.cdc.gov/excite/ScienceAmbassador/ScienceAmbassador.htm.

[19] The Common Core State Standards define the knowledge and skills students should have within their K-12 education careers so that they will graduate high school able to succeed in entry-level, credit-bearing academic college courses and in workforce training programs. See http://www.corestandards.org/about-the-standards.

and health in particular, is in the public interest. So it's time for another push to incorporate environmental health competencies into medical and nursing education and training.

Recommended strategies for facilitating incorporation of environmental and occupational health into health professional education include (1) health professionals, their professional organizations, and their decision making bodies (i.e., curriculum committees, accrediting institutions, etc.) should collaborate to develop national guidelines that recommend competencies specific to the prevention, recognition, and management of environmental exposures for both undergraduate and graduate training in medicine and nursing; (2) national professional organizations should endorse these guidelines and ensure that these competencies are addressed in licensure and certification exams; (3) health professional organizations and their decision making bodies should create board exams and set curriculum requirements to include competencies on environmental health; and (4) the relevant federal agencies (i.e., CDC, ATSDR, EPA, and HHS) should work together to create and launch an Environmental Health Leadership Program that would fund 146 faculty champions (one faculty champion in each of the 126 academic health centers in the U.S., plus an additional 20 faculty champions in 20 other higher education institutions) and create a vibrant network of educators committed to ensuring a pipeline of healthcare professionals competent in environmental health. A faculty champion, for purposes of this initiative, is defined as a faculty member who takes a leadership role in integrating environmental health into his/her institution in a sustainable fashion (Rogers, McCurdy, Slavin, Grubb, & Roberts, 2009). This component is designed to ensure the development of a nationwide cadre of faculty champions who will lend expertise and support for this effort in their institutions and surrounding communities.

The work group suggests the Leadership Program be evaluated after five years and considered a success if the schools and training programs specifically include and address environmental health competencies in their required curriculum.

6. Educate, mentor, and hire environmental and occupational health professionals committed to and/or coming from under-resourced and historically marginalized communities and their institutions by creating pipeline experiential learning opportunities for students at all levels.

The United States currently has a dearth of well-trained environmental health professionals who come from the under-resourced and historically marginalized communities that bear a disproportionate environmental burden. The nation can begin to develop an extensive, diverse pipeline of environmental health professionals by establishing a broad and diverse foundation through student and scientist opportunities.

CDC, NIEHS, state agencies, and institutions of higher education should collaboratively create a bold, exciting, new transdisciplinary approach for students by developing a meaningful dialogue and experiential learning opportunities with medical professionals, science administrators, epidemiologists, environmental scientists, behavioral researchers, social workers, and policy representatives that motivate and strengthen environmental health literacy in the social and scientific implications of public health and chemical exposures.

All agencies that hire environmental health professionals (i.e., CDC, NIEHS, EPA, state, local, and tribal health and environmental departments, NGOs, etc.) should create and participate in organized approaches to identifying potential environmental health professionals early and providing them with prestigious, well-paid opportunities that allow them to continue to develop as professionals over the course of their career through formal program coursework, fellowships, and practical experience. We recommend that these programs (1) emphasize identifying and encouraging participation by under-represented

professionals and their institutions (2) prioritize serving under-resourced and historically marginalized communities.

Such programs could (1) establish comprehensive fellowships and experiential opportunities for environmental health students and individuals who have graduate degrees that emphasize community outreach and research; (2) permit flexible scheduling that adapts training schedules to a variety of educational and career-development pathways; and (3) conduct proactive, equal-opportunity recruitment that ensure representation of a wide variety of cultures and races. In addition, government and academic centers should offer internships that engage students at all academic levels in environmental health and identify and mentor those showing significant promise as environmental health professionals.

Such programs can be modeled after existing programs such as the:

- NIEHS Summers of Discovery Program, which provides cutting-edge research internships and mentors to outstanding high school, undergraduate, and graduate students who want to pursue a career in the biomedical or biological sciences;
- CDC Collegiate Leaders in Environmental Health program, which provides summer internships and mentors at the CDC to undergraduate students majoring in environmental studies, engineering, chemistry, biology, ecology, or related fields;
- CDC Summer Program in Environmental Health, which offers a summer internship for students working toward an environmental health degree in a National Environmental Health Science and Protection Accreditation Council degree program;
- Post-graduate training in government agencies, such as the NIEHS-funding post-doctoral program that includes community-based experience, the CDC Public Health Prevention Service training and service program, and the Presidential Management Fellows program; and
- An adaptation of the Teach for America model to train college graduates who do not yet have graduate degrees by providing intensive summer training in environmental public health in preparation for a two-year placement in local/state health departments or other institutions (perhaps in collaboration with ASTHO or NACCHO) in which participants simultaneously earn a Master of Public Health degree by the end of their two-year commitment.

7. Convene experts from primary care specialties to develop specialty-specific clinical practice guidelines for addressing chemical exposures.

Clinicians usually have limited time to address many issues during patient visits. Beyond focusing on a patient's specific concerns, clinicians also try to assess multiple risk factors, deliver preventive services, and counsel about health behaviors. Integrating environmental health into such a demanding practice will require developing new health care strategies. For example, identifying populations that are disproportionately impacted by occupational and environmental exposures could facilitate recognizing chemical exposures and instituting follow-up care.

Clinical practice guidelines have been developed and proven effective for several health conditions and risk factors, from breast cancer screening to counseling on tobacco use. Practice guidelines for preventing and treating harmful chemical exposures are limited; they exist for pesticides, lead, and tobacco. A more comprehensive set of guidelines for occupational and environmental exposures that incorporate knowledge, practice skills, insertion points in practice settings, and resources could better prepare clinicians to address chemical exposures. Prevention of chemical exposures should be a primary goal.

The Institute of Medicine should convene an expert committee to review any existing guidelines, identify gaps, and develop national environmental health practice guidelines for practicing clinicians that

recommend practice skills for each primary care specialty. These clinical practice guidelines should address occupational and environmental history taking, clinical assessment, prevention and treatment of chemical exposures, referral indicators and resources, and access to other relevant resources. The work group recommends focusing on practice in medicine and nursing (including physician assistants, nurse practitioners and nurse midwives). The committee should develop an integrated set of occupational and environmental practice guidelines within three years, to be disseminated to relevant audiences and included in the National Guideline Clearing House of the Agency for Healthcare Research and Quality (AHRQ). The Committee should recommend a strategy for evaluating the use and effectiveness of the guidelines. Specialties include family medicine, internal medicine, emergency medicine, pediatrics, obstetrics and gynecology, and occupational health.

These guidelines should be endorsed by leading professional associations such as the American Medical Association, American Academy of Pediatrics, American Academy of Family Physicians, American Academy of Physician Assistants, American Academy of Nurse Practitioners, American College of Nurse Midwives, American College of Obstetrics and Gynecology, American College of Occupational and Environmental Medicine, American Nurses Association, and others.

8. Expand development of diagnostic tools and biomarkers related to chemical exposure by using existing EPA authority on pesticides and working with the National Toxicology Program on other chemicals.

Healthcare providers need better and more extensive diagnostic tools, such as validated biomarkers of exposure and effect of environmental chemicals, to improve diagnosis and treatment if an exposure is known or suspected. Having a biomarker, screening, or diagnostic tool that is readily available – such as the Quick Environmental Exposure and Sensitivity Inventory (screening questionnaire),[20] blood lead level, and cholinesterase depression (biomarker of exposure to organophosphate pesticides), etc. – can make it easier to confirm or rule out a diagnosis. If validated, biomarkers can be key to successful medical surveillance efforts. Diagnosis of exposure – facilitated through use of a clinically available biomarker – may result in prevention of future exposure for the affected individual and others. For example, in the case of mevinphos, an organophosphate pesticide, reports of widespread exposure in farm workers in Washington State resulted in the cancellation of this chemical for any use. At the same time, the work group acknowledges that biomonitoring might be neither possible nor practical for certain chemical substances and exposures, including exposures at lower levels or to mixtures or to substances that are not lipid soluble, stored in other tissues, or are otherwise short-lived in the body. [21]

The work group also acknowledges the privacy and confidentiality issues that often emerge in the context of biomonitoring, especially in occupational settings. It is because biomonitoring results can and have been used to discriminate against workers that OSHA included medical removal protection for workers participating in workplace monitoring and surveillance programs for lead. Clearly, results of workplace

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[20] The Quick Environmental Exposure and Sensitivity Inventory (QEESI) is available online at www.chemicalexposures.org. For additional information, see Miller, C. S. & Prihoda, T. J. (1999.) The environmental exposure and sensitivity inventory (EESI): a standardized approach for measuring chemical intolerances for research and clinical applications. *Toxicol Ind Health*, June; 15(3-4):370-385.

[21] See, for example, Ashford, N.A., Spadafor, C.J., Hattis, D.B. & Caldard, C.C. (1990). *Monitoring the worker for exposure and disease: Scientific, legal, and ethical considerations in the use of biomarkers.* Baltimore, MD: Johns Hopkins Press.

and community-based surveillance and biomonitoring efforts must be available to employers and health authorities in order to identify problems and take corrective action. But, in making this recommendation, the work group cautions that information generated by the use of biomarkers in individual patients in the clinical practice setting be appropriately protected by the physician-patient relationship.

The Federal Insecticide Fungicide and Rodenticide Act of 1972 (FIFRA) gives EPA wide authority to require extensive information from pesticide registrants about the potential health effects of pesticides. Based on this authority, EPA has a rigorous testing regimen that it mandates be completed in order for a company to register a pesticide. The regimen includes numerous toxicity tests on animals, as well as studies about metabolic fate. It does not require a registrant to provide either a biomarker or diagnostic tool for its product, although it conceivably could.

For other chemicals, the Government Accountability Office (GAO) recently produced two reports critical of EPA's lack of use of biomarkers in their estimates of health effects from exposure to commercial chemicals. The GAO recommended that EPA obtain legal authority from Congress to obtain and use biomonitoring data in regulating TSCA chemicals. Therefore, it is necessary to expand development and implementation of diagnostic tools and biomarkers related to chemical exposures.

Given its existing authority, the work group recommends that EPA require pesticide registrants to develop population-based biomarkers of exposure and, if possible, valid clinical diagnostic tools. Further, to advance the development and validation of population-based biomarkers for other chemicals, the work group recommends that the EPA, NIEHS, and NIOSH request the National Toxicology Program undertake an effort to identify chemicals for which population-based biomarkers could be developed and subsequently validated for use, if appropriate, in clinical practice settings, with adequate confidentiality protections. Ideally, the NTP should issue its findings in a public report within a two-year period.

9. Create economic, legal, and peer/professional incentives for change in clinical practice through expert consultation.

Although practice guidelines and new diagnostic and screening tools can help practicing clinicians recognize and address the environmentally-related health problems, risks, and concerns of patients, the demands and constraints of practice remain a challenge. Incentives will be needed to facilitate appropriate attention to occupational and environmental health issues in clinical practice. Incentives could be economic, legal (such as a regulatory requirement to report a pesticide poisoning), and peer/professional in nature.

Possible strategies include:

- Add the occupational and environmental history to the Evaluation and Management (E&M) coding and billing or make it a specific item in standardized patient medical records, both of which could increase the likelihood of providers collecting this information.
- Promote documentation of an occupational/environmental history by making it part of quality assurance/quality control mechanisms.
- Include questions about environmentally-related health conditions or specific chemical exposures in certification and re-certification exams.
- Encourage or require insurers to cover patient visits for occupational/environmental history-taking and workup of suspected occupationally or environmentally related health conditions.
- Build on the successes in integrating certain environmental health issues into practice (e.g., pediatrician surveys and counseling on exposure to secondhand smoke and lead screenings; training healthcare providers and assisting health centers to modify their clinical systems to improve

prevention, recognition and management of environmental and occupational exposure, injuries, and illnesses); demonstrate model programs to targeted organizations and health professionals in the U.S.
- Arrange endorsement of guidelines and incentives for these changes in the practice setting by leading professional associations.

The work group recommends that CDC, specifically NCEH; ATSDR; and the Health Resources and Services Administration (HRSA) jointly collaborate to convene and fund the activity of an expert committee representing primary care disciplines (pediatrics, family medicine, internal medicine, OB/GYN, and nursing) to identify realistic incentives for incorporating environmental and occupational health considerations in clinical practice and to create a plan for implementing and evaluating them.

10. Maintain and expand opportunities for the professional development of the environmental public health workforce through credentialing and government training and education programs.

The work group supports standardized competencies for addressing the harmful effects of chemical exposures, including educating and communicating with the public about such issues, and establishing curriculum requirements for schools of public health and accredited environmental health education programs. The work group also supports accreditation of environmental health degree programs by the National Environmental Health Science & Protection Accreditation Council. It recognizes, however, that many environmental public health professionals enter the workforce without having completed public health or environmental health degree programs. Thus, environmental public health professionals require on-the-job training and education to maximize their effectiveness.

The work group advocates for building on the success of programs that educate health professionals at all stages of their career. For example, the National Public Health Training Centers Network, which links public health practitioners with schools of public health and other academic institutions, should provide educational opportunities in the prevention and control of chemical exposures. The Health Resources and Services Administration should require the inclusion of such training at each training center as a condition for funding.

The work group recommends that the National Environmental Health Association (NEHA) continue to expand and market its credentialing program for state, tribal, and local environmental health employees (e.g., registered environmental health professional exams, certified professional – food safety, certificates of public health, etc.). These credentialing programs, the training products that help people prepare for the exams, and the exams themselves may be issued or conducted by state and local public health agencies, national organizations such as NEHA, or other accrediting organizations.

Success is measured by annual increases in the number and percent of credentialed environmental health professionals in state, local, and tribal public health departments, such that within five years, every health department has at least one credentialed environmental health professional on staff.

In addition, continuing education requirements for these credentials need to be supported in both concept and practice. A credential that does not include some kind of expectation that the holder will maintain their competency by keeping up with emerging issues over the course of their careers is a credential that is of compromised value.

In addition, CDC should continue to offer leadership training and resources for state, local, and tribal environmental public health professionals. For example, CDC should continue to dedicate funds to its Environmental Public Health Leadership Institute (EPHLI), a one-year developmental program for practicing environmental health professionals, and should use participant feedback to ensure it continues

to be relevant to the workforce. CDC can further expand EPHLI's benefit to the nation's environmental public health workforce by providing all health professionals access to the growing network of EPHLI graduates. Within two years, CDC should establish a process by which state, local, and tribal health professionals can consult with former EPHLI fellows on issues of mutual interest.

11. Adopt current health department accreditation processes to advance the capacity and competence of public health agencies to succeed in environmental public health work.

Residents of communities facing chemical problems will frequently contact their local, tribal, or state health department with questions about chemical exposures, but many health departments do not have the expertise to help these residents. To encourage improvements in environmental health services, the work group recommends that the public health field take advantage of existing accreditation efforts. In particular, the Public Health Accreditation Board's (PHAB) national accreditation program for state, local, territorial, and tribal health departments should include strong standards related to departments' competence to address chemical exposure issues. A national accreditation program that calls for each accredited health department to possess the knowledge and skills to address – and to communicate and educate the public about – chemical exposures and health would help to improve local knowledge of these issues. The work group recommends that the PHAB establish a strong national standard for public health agencies to demonstrate their capacity to address the chemical exposures most relevant to their community.

Federal agencies, especially CDC and EPA, should draw on health department accreditation efforts to improve environmental public health practice. While PHAB accreditation is voluntary, CDC and EPA should endorse the program and should institute accreditation as a requirement for federal funding. They should also assist with training and consultation. It is particularly important for accreditation to occur in geographically, socio-economically, ethnically, and racially diverse health departments, and CDC should work with PHAB to assist with program outreach to ensure that the program is marketed broadly.

The PHAB accreditation program is currently under beta testing in 30 health departments across the nation and will be launched officially in 2011. A measure of success for this recommendation would be for 60% of the U.S. population to be served by an accredited health department, that is, a health department that has demonstrated its ability to achieve and maintain the standard of competence and capacity for responding to chemical exposure issues, among other standards, by 2015.

CDC should also encourage and support the use of the existing Environmental Public Health Performance Standards,[22] which will help prepare public health programs for the accreditation process. Specifically, CDC should enumerate and increase (1) the environmental public health programs that use the Environmental Public Health Performance Standards and (2) the users of standards that report addressing identified gaps and program improvement measures.

[22] The Environmental Public Health Performance Standards are based on the 10 essential services of environmental public health and were developed to drive continuous improvement in the delivery of environmental public health services. See http://www.cdc.gov/nceh/ehs/envphps.

V. Conclusion

This report presents the Education and Communication work group's vision, findings, and recommendations for developing a public and a health professional workforce that are well-informed and well-equipped to understand and address issues related to chemical exposures and public health. The work group report characterizes current efforts in these areas, outlines the values that inform its goals for both the public and the health professional workforce – including justice, respect, prevention, and integrity – and offers action items to achieve its goals.

The Education and Communication work group calls for a multidirectional approach to communication about health and chemical exposures that acknowledges the needs, knowledge, beliefs, values, perceptions, and expectations of the target audiences, sources of information, and amplifiers of information (See Figure 1). The work group emphasizes the importance of trust in education and communication efforts around chemicals and health, as well as a strong belief in the need for public participation in government processes affecting environment and health. The report describes steps organizations can take to ensure that people have access to the information they need to make health protective decisions and opportunities to provide input into the communication and decision making processes.

The work group further identifies healthcare providers as a key group requiring additional training and capacity to prevent, recognize, and treat health impacts related to chemical exposures. The work group also recognizes the critical importance of advancing the broader health professional field comprising professionals working in the public, private, and nonprofit sectors. The work group concludes that both healthcare providers and the broader cadre of health professionals would benefit from increased incorporation of environmental health into their formal education. In addition, both target groups need opportunities for professional development to continuously develop their knowledge and skills related to environmental health.

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Appendix A. Education and Communication Work Group Final Charge

Goals
The goals of this workgroup are to:

1. Ensure timely, accurate, and clear communication of information about links between chemical exposures and health is provided to medical, public health, and environmental health professionals ("health professionals"), the general public, and the country's workforce.

2. Contribute to the development of a network and a pipeline of health professionals competent to help recognize, address, and prevent chemically-related health problems.

3. Offer a model of government/public/workforce/health professional communication and engagement that is timely, responsive, accountable, and transparent.

4. Ensure that discussions between agencies and communities about chemical exposures and health are transparent and maximally accessible.

Charge
To meet these goals, the Education and Communication Workgroup will make actionable recommendations that:

1. Identify audiences that could most effectively use, communicate, and/or benefit from information about chemicals and public health, such as, but not limited to, workers, healthcare professionals, public health authorities, the media, inhabitants of homes and communities burdened with chemical contamination, parents of young children, pregnant women, and individuals with chemical sensitivities.

2. Identify the knowledge base and tools needed by these target audiences to enhance understanding of the potential effects of chemical exposure on health; potential solutions and preventive strategies; and the roles and responsibilities of government agencies and other institutions in identifying, protecting against, remediating, and, preventing harmful exposures.

3. Facilitate new and creative strategies to enhance understanding of chemical exposures and public health among health professionals, the general public, and the workforce.

4. Facilitate new and creative strategies to enhance the knowledge and skills of health professionals so they can more efficiently and effectively address the concerns of their patients and communities about chemical exposures.

5. Ensure an educational pipeline to produce future health professionals and public health workers who are themselves diverse and prepared to meet the needs of vulnerable and diverse populations.

6. Suggest new strategies that promote meaningful inclusion of stakeholders; provide a structure for stakeholder dialogue; and facilitate the transfer of knowledge and experiences about chemicals and health between and among the public, the workforce, health professionals, government agencies, industry, and other relevant institutions, communities, and individuals.

7. Facilitate new, practical and effective methods to enable members of the public, the workforce, and health professions to relay information to relevant government agencies about specific local chemical exposures or threats of exposure so that community-based knowledge about chemical contamination and

public health can become a force-multiplier by enhancing government knowledge about and response to chemical exposures.

Activities
The workgroup will inventory current efforts of government, industry, and non-governmental organizations to:

1. **Provide information and education** about chemical exposures and health to the public, including underrepresented and underserved populations, including people with chemical sensitivities.

2. **Review studies or evaluations** of the effectiveness of these information, communication, and education programs.

3. **Assess existing efforts** to build the capacity of health professionals to address chemical exposures and health.

4. **Identify existing channels** through which government agencies can receive information about chemical exposures and health from the public, the workforce, and members of the health professions.

5. **Review the published and gray literature** on environmental health literacy of health professionals, the general public, and the workforce, as well as issues of concern to the public, the workforce, and the health professions concerning chemical exposures and health.

Appendix B. Education and Communication Work Group Membership List

Chair
Kathleen Rest, Union of Concerned Scientists, *chair*

Members
Rosemary Ahtuangaruak, Inupiat Community of the Arctic Slope
Sophie Balk, Children's Hospital at Montefiore, Albert Einstein College of Medicine
Alan Bookman, New Jersey Department of Environmental Protection
Julia Brody, Silent Spring Institute
Stephanie Chalupka, Worcester State University
Alison Cohen, Brown University
Diana Degen, The Cadmus Group, Inc.
Peter Dooley, Laborsafe
Elizabeth Grossman, freelance journalist
Marc Kusinitz, U.S. Food and Drug Administration
Yanna Lambrinidou, Parents for Nontoxic Alternatives
Mary Lamielle, National Center for Environmental Health Strategies
Amy Liebman, Migrant Clinicians Network
Leyla Erk McCurdy, National Environmental Education Foundation
Karen Miller, Huntington Breast Cancer Coalition / Prevention Is The Cure, Inc.
Matthew Stefanak, Mahoning County District Board of Health
John Stine, Minnesota Department of Health
John Sullivan, University of Texas Medical Branch / NIEHS Center in Environmental Toxicology
Robert Washam, Florida Department of Health, Martin County
Philip Wexler, National Institutes of Health, National Library of Medicine

Support
Dana Goodson, RESOLVE *facilitator*
Jennifer Peyser, RESOLVE *senior mediator*
Jana Telfer, NCEH/ATSDR *senior liaison*
Jennifer Van Skiver, NCEH/ATSDR *staff*

Appendix C. Public Subgroup Bibliography

This bibliography reflects searches completed November 2009 – January 2010. Keyword searches in PubMed included "environment OR environmental AND literacy OR education," "environment OR environmental AND risk communication" and "environmental health literacy." Keyword searches in ERIC included "environmental health" AND "literacy" (yielding 14 articles), "chemical literacy" (yielding 5 articles), "public health" AND "literacy" (yielding 93 articles), and "risk communication" (yielding 49 articles). Keyword searches in Google included "literacy," "chemical exposures," and "public."

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This article addresses media literacy, which can have large effects on public health, education, and communication outcomes, and correlates with measures of critical thinking.

Ashford, N.A. & Miller, C.S. (1998). *Chemical exposures: Low levels and high stakes.* 2nd ed. New York, NY: John Wiley & Sons.

Burger, J., McDermott, M., Chess, C., Brochenek, E., Perez-Lugo, M., & Pflugh, K., (2003). Evaluating risk communication about fish consumption advisories: Efficacy of a brochure versus a classroom lesson in Spanish and English. *Risk Analysis, 23*(4): 791-803.

In all cases, women exposed to information via a classroom lesson demonstrated better understanding than those who read the brochure.

Cabrera, N. & Leckie, J. (2009). Pesticide risk communication, risk perception, and self protective behaviors among farmworkers in California's Salinas Valley. *Hispanic Journal of Behavioral Sciences, 31*(2): 258-272.

Although there were language barriers and non-standardized safety trainings, responding farmworkers understood most of the potential health effects of chemical exposure, and had elevated perceptions of risk as compared to the general public. However, they still partook in "unnecessarily risky" activities.

Campaign for Environmental Literacy. (2010). "Campaign for Environmental Literacy." Retrieved from http://www.fundee.org/.

The Campaign for Environmental Literacy was formally established in February 2005 as a response to the environmental education (EE) community's most vital political need: concerted support from the federal government. The timing for such an initiative is opportune. Washington, D.C.'s current atmosphere of partisan deadlock provides a strong incentive for both political parties to seek out less partisan and controversial issues in which progress can clearly be demonstrated. EE, with its history of outstanding levels of bipartisan support both in Congress and throughout American households, presents one such exceptional opportunity. Most importantly, the EE field itself is poised and ready to engage in building a broad-based movement among its extraordinarily diverse and influential proponents, practitioners, and supporters.

The Campus Consortium for Environmental Excellence. (2008). *What's changed? What hasn't? Campus*

EH&S at a Crossroads [PDF document]. Retrieved from http://www.c2e2.org/what'schangedmay08.pdf.

Divided into ten topic areas, the first section of this booklet focuses on the inner workings of the campus environmental department and the roles and responsibilities of the EH&S professional. The second half points the spotlight outward on the changing nature of the relationships between EH&S and campus and community constituencies. Each topic area is organized according to "What's Changed" and "What Hasn't Changed." The final section of the booklet offers insights in the form of "rules'" for the journey ahead.

The Cancer Prevention Coalition. (1995). The "dirty dozen" consumer products. Retrieved from http://www.preventcancer.com/consumers/general/dirty_dozen.htm.
The Cancer Prevention Coalition (CPC) and Ralph Nader will release tomorrow a "Dirty Dozen" list of consumer products used in most American homes, and manufactured by giant U.S. corporations. "Dirty Dozen" products contain a wide-range of carcinogenic and other toxic ingredients and contaminants to which most of us are exposed daily. CPC Chairperson Samuel Epstein, M.D., and investigative journalist, David Steinman, compiled the "Dirty Dozen" from data on over 3,500 consumer products analyzed and ranked in their recently published The Safe Shopper's Bible.

Caress, S. M. & Steinemann, A. C. (2004). A national population study of the prevalence of multiple chemical sensitivity. *Archives of Environmental Health,* 59(6):300-305.

Case, D. (2009, January 14). The real story on Bisphenol A. *Fast Company. 132*. Retrieved from http://www.fastcompany.com/magazine/132/the-real-story-on-bpa.html.

This article chronicles the controversies over Bisphenol A (BPA), including varying positions on science as well as policy, including regulation. The article reviews studies and contrasts industry funded research with independently funded research.

Chepesiuk, R. (2007). Environmental literacy: Knowledge for a healthier public. *Environmental Health Perspectives*, *115*(10), A494-A499. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2022675/pdf/ehp0115-a00494.pdf.

This piece outlines environmental/environmental health literacy initiatives, including WEACT, NIEHS, and National Environmental Education Foundation (NEEF) efforts, among others. The article discusses the need to incorporate environmental education into curricula at various levels and in various sectors.

Chess, C., & Purcell, K., (1999). Public participation and the environment: Do we know what works? *Environmental Science & Technology, 33*(16): 2685-2692.

The authors review the literature on public meetings, workshops, and community advisory committees and discuss public participation based on empirical evidence.

Committee on Human Biomonitoring for Environmental Toxicants, Board on Environmental Studies and Toxicology, Division on Earth and Life Sciences, National Research Council of the National Academies. (2006). *Human biomonitoring for environmental chemicals.* Washington, DC: The National Academies Press. Retrieved from http://www.nap.edu/catalog.php?record_id=11700.

This book includes a chapter on "Communicating Results, Interpretations, and Uses of

Biomonitoring Data to Nonscientists" (See http://books.nap.edu/openbook.php?record_id=11700&page=201).

Committee on Risk Perception and Communication, Commission on Physical Sciences, Mathematics, and Resources, Commission on Behavioral and Social Sciences and Education, National Research Council. (1989). *Improving risk communication*. Washington, DC: National Academy Press. Retrieved from http://www.nap.edu/catalog.php?record_id=1189.

Dostal, R. L. (The Dow Chemical Company, USA). (1991). Proceedings from 13th World Petroleum Congress: *Impact of Environmental Concerns on Future Chemical Development*. Buenos Aires, Brazil.

Of all the issues which confront our industry today, the environment is one of the most pressing. How well we perform in this arena will impact our long-term ability to build new facilities, renew permits, manufacture new products, attract new employees, and compete in a global marketplace. Within the environmental arena, industry managers will be faced with challenges in four key areas: 1. implementing internal environmental guidelines for manufacturing operations based on global consistency and continuous improvement. Such guidelines define the performance requirements in the design, construction, operation, maintenance and ultimate closure of all facilities. 2. Understanding the hazards of our chemical processes and products, evaluating the risks, and exploring alternatives so as to reduce risks to our employees, plant communities, and customers. 3. Transportation and distribution of hazardous chemicals. This is an issue of increasing public concern and governmental scrutiny. 4. Community outreach and communications. Industry needs to do a better job of interacting with key publics regarding environmental stewardship. Companies which effectively address these issues will have a competitive advantage as we move toward and into the 21st century.

Dunn, A.J. & Alexeef, GV. (2010). Beyond risk assessment: Principles for assessing community impacts. *International Journal of Toxicology, 29*(1): 78-87.

Based on an evaluation of California EPA's Office of Environmental Health Hazard Assessment activities, the authors identify principles to guide community assessments and explore how their application can improve assessments.

Endreson, D. (2008). Minimizing methylmercury exposure in the Hmong community from sport-caught fish consumption in Minnesota (Plan B Masters paper, University of Minnesota, 2008). Retrieved from http://conservancy.umn.edu/bitstream/44311/1/Endreson%20Daniel%20Plan%20B.pdf.

This report concludes that efforts taken by the Minnesota Department of Health in educating Hmong anglers have the promise of being effective in reducing methylmercury exposure from fish consumption. However, based on theories of risk perception and communication, more needs to be done at both the state and local level to effectively target this specific subpopulation in Minnesota.

Ennals, R. (2002). Partnership for sustainable healthy workplaces: Warner Lecture, British Occupational Hygiene Society, Sheffield 9 April 2002. *Annals of Occupational Hygiene*. *46*(4): 423-428.

The paper sets out a fresh approach to healthy workplaces, laying foundations to meet the demands of the new millennium. Professionals such as occupational hygienists deal with issues at the heart of the economy and society, which are beginning to attract the attention of politicians.

Old disciplinary barriers must be crossed and communication improved so that healthy work is accepted as a mainstream concern, integral to sustainable development. This presents challenges both to professionals and to those with responsibilities for policy. As a first step, we need to develop an understanding of how conclusions from research can inform responsible decision making. We will not be able to design and build perfectly safe environments, but real progress can be made in the field of workplace health defense, using available human, technical and financial resources. A vital ingredient is partnership in the workplace, involving social partners and professionals working in collaboration.

The Environmental Literacy Council. (2008). "Environmental Health." Retrieved from http://www.enviroliteracy.org/subcategory.php/170.html.

For more than a decade, the Environmental Literacy Council has been dedicated to helping teachers, students, policymakers, and the public find cross-disciplinary resources on the environment. An independent, 501(c)3 organization, the Council offers free background information on common environmental science concepts; vetted resources to broaden understanding; and curricular materials that don't tell teachers how to teach, but give them the tools to augment their own backgrounds - no matter what their current knowledge. This page serves as the home page for the group's environmental health resources.

Fagerlin A., Ubel, P.A., Smith, DM., & Zikmund-Fisher, BJ. 2007. Making numbers matter: Present and future research in risk communication." *American Journal of Health Behavior*, 31 (suppl 1): S47-S56.

Many Americans have low numeracy, and risk communication methods may need to target high numeracy and low numeracy populations differently.

Fenske, R., Bradman, A., Whyatt, R., Wolff, M., Barr, D. (2005). Lesson learned for the assessment of children's pesticide exposure: Critical sampling and analytical issues for future studies. *Environmental Health Perspectives, 113*(10): 1455-1462. Retrieved from http://ehp.niehs.nih.gov/members/2005/7674/7674.pdf.

The authors examine sampling strategies and analytical methods used in a series of recent studies of children's exposure to pesticides that may prove useful in the design and implementation of the National Children's Study.

Glanz, K., Rimer, B., & Viswanath, K. (Ed.s.). (2008). *Health behavior and health education: Theory, research and practice*. San Francisco: Jossey-Bass.

The book is divided into five parts: Health Education and Health Behavior: The Foundations; Models of Individual Health Behavior; Models of Interpersonal Health Behavior; Community and Group Models of Health Behavior Change; and Using Theory in Research and Practice.

Governor's Interagency Council on Health Disparities. (2008). Environmental Exposures: Targeted environmental scan: Working document. Retrieved from http://healthequity.wa.gov/About/docs/envscans/EnvExp.pdf.

This document summarizes current efforts in the community and government to reduce environmental exposures to toxics among communities of color. In this document, environmental exposure refers to the exposure of people to toxics in the water, soil, and air. Research indicates that people of color may bear a greater burden of exposures to toxins. Exposure to toxics in our

environment has been linked to various health conditions.

Grason, H.A. & Misra, D.P. (2009). Reducing exposure to environmental toxicants before birth: moving from risk perception to risk reduction. *Public Health Reports, 124(*5): 629-41.

This study considered approaches to reducing maternal exposure to hazardous environmental toxicants, focusing on risk communication to pregnant women and providers, but also considering identification of environmental toxicants in the community and reduction of environmental toxicants.

Gist, Ginger L. (1998). NEHA's role in environmental education: Leadership. *Journal of Environmental Health*, 61 (2): 4.

NEHA president calls for environmental education to begin early and to be based in sounds science and critical thinking.

Grass, R. & Agyeman, J. (2002). Second National People of Color Environmental Leadership Summit Resource Paper Series: *Reorienting Environmental Education for Environmental Justice*. Retrieved from: http://www.ejrc.cau.edu/summit2/EnviroEducation.pdf [accessed 5 Nov. 2009].

This paper addresses environmental education as a tool for achieving environmental justice and criticizes the environmental education movement's failure to systematically address the lack of diversity in the field. It also provides examples of existing programs and organizations addressing environmental justice.

Habron, G., Barbier, M., & Kinnunen, R. (2008). Local understanding of fish consumption advisory risks in Michigan's Upper Peninsula: The role of structure, culture, and agency." *Rural Sociology*, *73*(2): 275-299.

Example of hot-spot community.

Hance, B.J., Chess, C., & Sandman, P. (1988). Setting a context for explaining risk. *Risk Analysis, 9*(1): 113-117.

The authors suggest that agencies and industries need to place a greater priority on understanding community concerns, involving communities in risk decisions, and developing trust and credibility.

Hatfield, T. (1994). A risk communication taxonomy for environmental health. *Journal of Environmental Health*, *56*(8): 23-28.

This taxonomy is intended to serve the dual purpose of reference guide and framework for further development.

Hill, Lilian H. (2004). Health literacy is a social justice issue that affects us all. *Adult Learning*, 15 (1-2): 4-6.

Adult educators must work on health literacy too because it is a social justice issue and, when taught effectively, can be empowering for learners.

Hutcheson, S. (1999). Effective use of risk communication strategies for health and safety educational materials. *Journal of Extension*, *37*(5).

Strategies for risk communication include describing existence and severity of risk, demonstrating ways to avoid risk, and describing how risks threaten abilities and/or values.

Illinois Sustainable Technology Center. (2010). Environmental News Bits [Blog]. Retrieved from http://lib.wmrc.uiuc.edu/enb/.

Environmental News Bits is written and maintained by Laura L. Barnes, who is the Illinois Sustainable Technology Center's Librarian.

Institute of Medicine. (2009). *Health literacy: a prescription to end confusion*. (Nielsen-Bohlman, L., Panzer, A., & Kindig, D., Eds.). Washington, DC: The National Academies Press.

To maintain their own health and the health of their families and communities, consumers rely heavily on the health information that is available to them. This information is at the core of the partnerships that patients and their families forge with today s complex modern health systems. This information may be provided in a variety of forms ranging from a discussion between a patient and a healthcare provider to a health promotion advertisement, a consent form, or one of many other forms of health communication common in our society. Yet millions of Americans cannot understand or act upon this information. To address this problem, the field of health literacy brings together research and practice from diverse fields including education, health services, and social and cultural sciences, and the many organizations whose actions can improve or impede health literacy.

Johnson, B. & Chess, C. (2006). From the inside out: Environmental agency views about communications with the public. *Risk Analysis*, *26*(5): 1395-1407.

This study examined attitudes at the New Jersey Department of Environmental Protection and found that staff and managers fell into two general groups: The Enthused group felt that they had attitudinal support from program culture and managers; the Constrained group focused on the lack of concrete operational support in terms of time, money, and expertise. When ideal program communications were discussed, the focus was on the need for all kinds of commitment and support (i.e., culture, managers, time, money, building expertise through training), as well as on more proactive and responsive communication.

Kegler, M.C. & Miner, K. (2004). Environmental health promotion interventions: Considerations for preparation and practice. *Health Education and Behavior*, *31*(4): 510-525.

Need interdisciplinary (environmental/public health and health education) interventions that can be proven to reduce environmental health burden in communities.

Kennedy, M., Eustis, E., Huang, G., Beck, V., & Wells, K. (2007). Proceedings from the American Public Health Association 125th Annual Meeting and Expo: *Increasing Environmental Health Literacy about Toxic Substance Exposures through Television Drama Storylines.* Washington, DC: APHA.

CDC and EPA experts consulted with scriptwriters on two storylines about toxic substance exposure that aired on popular primetime network dramas, Numb3rs (CBS) and Law & Order: SVU (NBC). The first storyline concerned children who had been exposed to hazardous

chemicals buried under school playgrounds and the second was about unregulated pesticide use in an apartment building.

Krieger, R. (2007). Perceptions in chemical exposure assessment. In R. Krieger, N. Ragsdale, & J. Seiber (Ed.s.), *Assessing exposures and reducing risks to people from the use of pesticides* (1-15). Washington, DC: American Chemical Society. Retrieved from http://pubs.acs.org/doi/pdf/10.1021/bk-2007-0951.ch001.

Chemicals used as pesticides are both a broad, vital catalyst for the support and advancement of all aspects of our lives, and at the same time targets of extensive suspicion and mistrust. Spectacular beneficial responses to chemical technologies in medicine, agriculture, nutrition, and manufacturing have occurred over long periods of time. Issues and common perceptions of the health and environmental significance of chemical exposure often dominate discussion of pesticide use indoors and in agriculture. As those technologies have been developed and used, adverse effects have been observed from time to time, but that reality is dwarfed by subjective feelings that often outweigh reason.

Lahr, J. & Kooistra, L. (2009). Environmental risk mapping of pollutants: State of the art and communication aspects. *Science of the Total Environment.*

Authors discuss contamination maps, exposure maps, hazard maps, vulnerability maps and 'true' risk maps. The paper also discusses, in a general way, the most important issues that need to be addressed when making risk maps for communication purposes: risk perception, target audience, scale and spatial aggregation and visualization such as use of colors and symbols.

Lieberman, G. & Hoody, L. (1998). *Closing the Achievement Gap: Using the Environment as an Integrating Context.* State Education and Environment Roundtable. Poway, CA: Science Wizards. Retrieved from http://www.seer.org/extras/execsum.pdf [accessed 5 Nov. 2009].

This paper addresses an educational framework that uses a school's surroundings and community as a basis for student learning. This summary discusses benefits of the Environment as an Integrating Context approach, best practices, and next steps.

Lipkus, I. & Peters, E. (2009). Understanding the role of numeracy in Health: Proposed theoretical framework and practical insights. *Health Education and Behavior, 36*(6): 1065-1081.

This article provides a framework for health numeracy, which has implications for risk communication and medical decisions.

Lo, B., & O'Connell, M.E. (Ed.s). National Research Council and Institute of Medicine Committee on Ethical Issues in Housing-Related Health Hazard Research Involving Children, Youth and Families. Board on Children, Youth, and Families, Division of Behavioral and Social Sciences and Education and Institute of Medicine. (2005). *Ethical Considerations for Research on Housing-Related Health Hazards Involving Children*. Washington, DC: The National Academies Press.

Ethical Considerations for Research on Housing-Related Health Hazards Involving Children explores the ethical issues posed when conducting research designed to identify, understand, or ameliorate housing-related health hazards among children. Such research is often conducted with children in low-income families given the disproportionate prevalence of housing-related conditions such as lead poisoning, asthma, and fatal injuries among these children. This book

emphasizes five key elements to address the particular ethical concerns raised by these characteristics: involving the affected community in the research and responding to their concerns; ensuring that parents understand the essential elements of the research; adopting uniform federal guidelines for such research by all sponsors (Subpart D of 45 CFR 46); providing guidance on key terms in the regulations; and viewing research oversight as a system with important roles for researchers, IRBs and their research institutions, sponsors and regulators of research, and the community.

Ma'at Youth Academy & University of California, Berkeley, School of Public Health. (2007). Proceedings from Toxic Exposure in Our Communities: What is the Role of Biomonitoring? *Community Discussion and Dialogue.* Oakland, CA. Retrieved from http://envirohealth.berkeley.edu/biomonitoring/CommBioMon2007.pdf.

This meeting report summarizes the December 17, 2007 meeting on biomonitoring. Meeting objectives were to identify community perspectives on how biomonitoring could be positive or negative; to provide training on what biomonitoring is and how it has been and could be used; to increase awareness and understanding of the state program; to develop a vision for how people working on environmental health in communities would see a biomonitoring program that would be positive for their communities and to identify any pitfalls to be avoided.

McBeth, W. & Volk, T.L. (2010). The National Environmental Literacy Project: A baseline study of middle grade students in the United States. *The Journal of Environmental Education*, *41*(1): 55-67.

The authors discuss environmental literacy in the United States and present a brief summary of the results of a major national study designed to attain a baseline measure of environmental literacy among middle school students in the United States The authors include events that led up to the study and describe future directions for environmental literacy assessment.

Morello-Frosch, R., Brody, J.G., Brown, P., Gasior Altman, R., & Rudel, R.A. (2009). Toxic ignorance and right-to-know in biomonitoring results communication: a survey of scientists and study participants. *Environmental Health* 8: 6. Retrieved 03 January 2010 from http://www.ehjournal.net/content/8/1/6.

Exposure assessment has shifted from pollutant monitoring in air, soil, and water toward personal exposure measurements and biomonitoring. This trend along with the paucity of health effect data for many of the pollutants studied raise ethical and scientific challenges for reporting results to study participants. METHODS: We interviewed 26 individuals involved in biomonitoring studies, including academic scientists, scientists from environmental advocacy organizations, IRB officials, and study participants; observed meetings where stakeholders discussed these issues; and reviewed the relevant literature to assess emerging ethical, scientific, and policy debates about personal exposure assessment and biomonitoring, including public demand for information on the human health effects of chemical body burdens. RESULTS: We identify three frameworks for report-back in personal exposure studies: clinical ethics; community-based participatory research; and citizen science 'data judo.' The first approach emphasizes reporting results only when the health significance of exposures is known, while the latter two represent new communication strategies where study participants play a role in interpreting, disseminating, and leveraging results to promote community health. We identify five critical areas to consider in planning future biomonitoring studies. CONCLUSION: Public deliberation about communication in personal exposure assessment research suggests that new forms of community-based research ethics and participatory scientific practice are emerging.

National Institute of Building Sciences, prepared under contract for the U.S. Access Board. (2006). *Indoor environmental quality project report.* Retrieved from http://www.access-board.gov/research/ieq.

NC Latino Health. (2003). *Final report of the Latino Health Task Force.* Durham, NC: North Carolina Institute of Medicine. Retrieved from http://www.nciom.org/projects/latino/latinopub/fullreport.pdf.

The growing Latino population has created new health care challenges for the state. Most North Carolina Latinos are recent immigrants: nearly two-thirds are foreign-born. Because many Latinos are coming directly from Mexico or other foreign countries, they still have language barriers. In addition, persons coming from other countries are accustomed to different health care systems. The rapid growth of this new population has overwhelmed many public agencies, and the underlying issues of lack of insurance coverage, language barriers, different cultural and health care beliefs, and general unfamiliarity with the US health care system have not been adequately addressed. The North Carolina Institute of Medicine (NC IOM), in collaboration with El Pueblo, Inc., helped create a Task Force to study these issues. The task force identified guiding principles, major health issues, and recommendations.

Nelson, D., Hesse, B., & Croyle, R. (2009). *Making data talk: Communicating public health data to the public, policy makers, and the press*. USA: Oxford University Press.

The demand for health information continues to increase, but the ability of health professionals to provide it clearly remains variable. The aim of this book is (1) to summarize and synthesize research on the selection and presentation of data pertinent to public health, and (2) to provide practical suggestions, based on this research summary and synthesis, on how scientists and other public health practitioners can better communicate data to the public, policy makers, and the press in typical real-world situations. Because communication is complex and no one approach works for all audiences, the authors emphasize how to communicate data "better" (and in some instances, contrast this with how to communicate data "worse"), rather than attempting a cookbook approach. The book contains a wealth of case studies and other examples to illustrate major points, and actual situations whenever possible. Key principles and recommendations are summarized at the end of each chapter.

Oleckno, W.A. (1995). Guidelines for improving risk communication in environmental health. *Journal of Environmental Health, 58*(1): 20-23.

Effective risk communication can be a crucial element in the development of sound environmental health policy. It is more likely to be an issue, however, when it comes to the implementation of environmental health policies, standards, regulations, or practices as past conflicts among industries, regulators, and communities will attest.

Patisaul, H. (2010). Assessing risks from bisphenol-A. *American Scientist, 98*(1): 30. Retrieved from http://www.americanscientist.org/issues/feature/2010/1/assessing-risks-from-bisphenol-a/1.

This article discusses the implications of difficulties in risk assessment (e.g. lack of consensus around BPA safety) and the need to develop a clear and comprehensive strategy for assessing the potential public health consequences of endocrine disruptors such as BPA, that may contribute only economic value.

Pediatric Environmental Health Specialty Units. (2006). "The Pediatric Environmental Health Specialty Units: A Network of Experts in Children's Environmental Health." Retrieved from http://www.aoec.org/PEHSU/aboutus.html.

This page provides basic information about PEHSU purposes, as well as contact information.

Paulson, J., Karr, C., Seltzer, J., Cherry, D., Sheffield, P., Cifuentes, E., Buka, I., & Amler, R. (2009). Development of the Pediatric Environmental Health Specialty Unit network in North America. *American Journal of Public Health*, Nov 2009; 99: S511-S516.

Training in environmental health in general, and pediatric environmental health in particular, is inadequate. The Agency for Toxic Substances and Disease Registry began to develop pediatric environmental health specialty units (PEHSUs) after noting the dearth of practitioners who could evaluate and manage children with exposures to environmental health hazards. The Environmental Protection Agency subsequently joined in providing support for what has developed into a network of 13 PEHSUs in North America.

PEHSUs provide services to families, act as consultants to clinicians and public agencies, develop educational materials, and respond to natural disasters, including hurricanes and wildfires. PEHSUs are relatively easy to organize and should be replicable internationally.

Quandt, S., Arcury, T., Austin, C., & Cabrera, L. (2001). Latino immigrants: Preventing occupational exposure to pesticides: using participatory research with Latino farm workers to develop an intervention. *Journal of Immigrant Health. 3*(2): 85-96.

Pesticide exposure is an occupational health hazard for migrant farm workers. The US-EPA Worker Protection Standard (WPS) mandates training programs to prevent or reduce exposure. WPS implementation in a local context requires understanding individual, workplace, and community environmental factors that lead to exposure and influence intervention effectiveness. Participatory research within the PRECEDE–PROCEED planning framework was used to design a WPS training program for Mexican farm workers in North Carolina cucumber and tobacco production. Research with farm workers, farmers, health care providers, and Cooperative Extension agents identified modifiable behaviors and environmental factors, as well as structural and regulatory barriers requiring intervention. Data were gathered and analyzed through individual and group interviews, community forums, an advisory board, and a partnership between academic researchers and a community-based organization. The intervention's dominant features are (a) focus on key health behaviors, (b) relevance to local conditions, and (c) attention to issues of control in the workplace. Participatory research is effective for designing a health intervention where diverse social, cultural, political, and regulatory issues affect farm workers' risk of exposure.

Resnik, D.B. (2009). Environmental health research and the observer's dilemma. *Environmental Health Perspectives, 117*(8): 1191-4.

This paper addresses whether - and how - to inform research subjects about risks they face in their environment.

Reyna, V. & Brainerd, CJ. (2007). The importance of mathematics in health and human judgment: Numeracy, risk communication, and medical decision making. *Learning and Individual Differences, 17*(2): 147-159.

Americans aren't proficient in math (according to national surveys), which has repercussions in everyday life, including for understanding health-relevant risk communication. Numeracy, just like literacy, is critical for making health and social decisions.

Reyna, V., Nelson, W., Han, P., & Dieckmann, N. (2009). How numeracy influences risk comprehension and medical decision making. *Psychological Bulletin, 135*(6): 943-973.

Low numeracy can distort risk perception and limits the effectiveness of risk communication and appears to adversely affect prevention and medical efforts.

Roth, W. & Lee, S. (2004). Science Education as/for participation in the community. *Science Education*, 88(2): 263-291.

This article addresses scientific literacy as collective property; rethinks science education as preparation for lifelong participation in science-related issues (like environmental health).

Rudd R.E., Colton, T, & Schacht, R. (2000). An overview of medical and public health literature addressing literacy issues: An annotated bibliography. NCSALL Reports #14. (ED440302). Retrieved from http://www.eric.ed.gov/ERICWebPortal/contentdelivery/servlet/ERICServlet?accno=ED440302.

Rudd, R. (2004). Adult education and public health partner to address health literacy Needs. *Adult Learning*, 15 (1-2): 7-9.

Adult educators and health educators are working together to build critical literacy skills that can be applied to improving health literacy (one of Healthy People 2010 objectives).

Schield, M. (2009). *Confound Those Speculative Statistics* [PowerPoint slides]. Retrieved 03 January 2010 from http://www.statlit.org/pdf/2009SchieldASA6up.pdf.

Speculative statistics are model-based statistics. These include deaths attributable to being in a group (deaths linked to a distant cause). Such deaths are those due to primary smoke, second-hand smoke, obesity and radon. This paper reviews the epidemiological model used and introduces a graphical technique to present three big ideas: that a confounder can influence (1) an association in an observational study, (2) the speculative statistics generated by epidemiological models and (3) the statistical significance calculated in comparing these statistics. This paper argues that if students are to deal with the statistics of everyday life, they must appreciate these three big ideas. They must be aware that speculative statistics are often indistinguishable from actual statistics and are vulnerable to confounding. A separate statistical literacy course based on these ideas is recommended.

Severtson, DJ. & Henriques, J.B. (2009). The effect of graphics on environmental health risk beliefs, emotions, behavioral intentions, and recall. *Risk Analysis, 29*(11): 1549-65.

Study results indicate that images facilitated meaningful comprehension of environmental health risk information and suggest foci for further research.

Slovic, P. (1999). Trust, emotion, sex, politics, and science: surveying the risk-assessment battlefield. *Journal of Risk Analysis. 19*(4): 689-701.

Risk management has become increasingly politicized and contentious. Polarized views, controversy, and conflict have become pervasive. Research has begun to provide a new perspective on this problem by demonstrating the complexity of the concept "risk" and the inadequacies of the traditional view of risk assessment as a purely scientific enterprise. This paper argues that danger is real, but risk is socially constructed. Risk assessment is inherently subjective and represents a blending of science and judgment with important psychological, social, cultural, and political factors. In addition, our social and democratic institutions, remarkable as they are in many respects, breed distrust in the risk arena. Whoever controls the definition of risk controls the rational solution to the problem at hand. If risk is defined one way, then one option will rise to the top as the most cost-effective or the safest or the best. If it is defined another way, perhaps incorporating qualitative characteristics and other contextual factors, one will likely get a different ordering of action solutions. Defining risk is thus an exercise in power. Scientific literacy and public education are important, but they are not central to risk controversies. The public is not irrational. Their judgments about risk are influenced by emotion and affect in a way that is both simple and sophisticated. The same holds true for scientists. Public views are also influenced by worldviews, ideologies, and values; so are scientists' views, particularly when they are working at the limits of their expertise. The limitations of risk science, the importance and difficulty of maintaining trust, and the complex, sociopolitical nature of risk point to the need for a new approach--one that focuses upon introducing more public participation into both risk assessment and risk decision making in order to make the decision process more democratic, improve the relevance and quality of technical analysis, and increase the legitimacy and public acceptance of the resulting decisions.

Stern, P. C. & Fineberg, H. V. (1996). *Understanding risk: Informing decisions in a democratic society.* Washington, DC: National Academy Press.

Understanding Risk addresses a central dilemma of risk decision-making in a democracy: detailed scientific and technical information is essential for making decisions, but the people who make and live with those decisions are not scientists. The key task of risk characterization is to provide needed and appropriate information to decision makers and the public. This important new volume illustrates that making risks understandable to the public involves much more than translating scientific knowledge. The volume also draws conclusions about what society should expect from risk characterization and offers clear guidelines and principles for informing the wide variety of risk decisions that face our increasingly technological society.

Stratman, J., Boykin, C., Holmes, M., Laufer, M.J., & Breen, M. (1995). Risk communication, metacommunication, and rhetorical stases in the Aspen-EPA Superfund controversy. *Journal of Business and Technical Communication, 9*(1): 5-41. Retrieved from http://jbt.sagepub.com/cgi/content/abstract/9/1/5.

This article explores the relationship between theoretical definitions of risk communication, EPA’s role in defining health and environmental risks, and possible explanations for EPA’s inability to persuade the city of Aspen, Colorado, to accept its cleanup plan for a toxic lead mine wastes.

U.S. Environmental Protection Agency. (1992). Proceedings from conference sponsored by the Federal Task Force on Environmental Education: *Building a Shared Vision for Environmental Education*, November 19-21, 1991. Washington, DC. Retrieved from http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/13/0d/b9.pdf.

This initiative included a work group on environmental health risk education. See pages 178-180.

U.S. Occupational Safety & Health Administration (OSHA). (2009). Facts on aligning the Hazard Communication Standard to the GHS. Retrieved from http://www.osha.gov/as/opa/facts-hcs-ghs.html.

OSHA proposed to modify the current Hazard Communication Standard (HCS) to align with the provisions of the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). The HCS requires that chemical manufacturers and importers evaluate the chemicals they produce or import and provide hazard information to downstream employers and workers by putting labels on containers and preparing safety data sheets. Under the current HCS all employers must have a hazard communication program for exposed workers, including container labels, safety data sheets, and training.

U.S. Senate Committee on Environment and Public Works. (2010). Subcommittee on Superfund, Toxics and Environmental Health hearing entitled, "Current Science on Public Exposures to Toxic Chemicals." Retrieved from http://epw.senate.gov/public/index.cfm?FuseAction=Hearings.Hearing&Hearing_ID=8a722315-802a-23ad-4e9a-b8477139e63f.

Senator Frank R. Lautenberg (D-NJ), Chairman of the Subcommittee on Superfund, Toxics, and Environmental Health, convened a hearing to examine the current science on public exposures to toxic chemicals on February 4, 2010. This webpage links to the archived webcast of the hearing, majority and minority member statements, and witness remarks. Witnesses included Steve Owens, Office of Prevention, Pesticides and Toxic Substances Environmental Protection Agency; Henry Falk, M.D., M.P.H., Acting Director, National Center for Environmental Health/Agency for Toxic Substances and Disease Registry, Centers for Disease Control and Prevention; John Stephenson, Director, Natural Resources and Environment, U.S. Government Accountability Office; Linda Birnbaum, Ph.D., D.A.B.T., A.T.S., Director, National Institutes of Environmental Health Sciences; Molly Jones Gray, participant in a biomonitoring study; Ken Cook, President, Environmental Working Group; Charles McKay, M.D., FACMT, FACEP, ABIM; Division of Toxicology, Department of Emergency Medicine, Hartford Hospital; and Tracey J. Woodruff, PhD, MPH, Associate Professor and Director Program on Reproductive Health and the Environment, Department of Obstetrics, Gynecology, and Reproductive Sciences, University of California, San Francisco.

Vida Health Communications. (2009). “Managing Environmental Risks in Pregnancy.” Retrieved from http://vidaresearchupdate.wordpress.com/2009/03/15/managing-environmental-risks-in-pregnancy-2/.

This blog entry explains a Vida Health Communications, Inc. project that will complete the development and evaluation of the web-based provider training and patient education multi-media prototyped in Phase I. The final products of this research will be (1) a cross disciplinary web-based training offering continuing education for obstetric providers serving urban populations, (2) an educational DVD in English and Spanish and group discussion guide for showing to patients in clinic and office waiting areas or in facilitated group discussions, (3) a library of colorful support materials in English and Spanish at appropriate levels of literacy for providers to print and distribute to patients made available both as electronic documents (pdf) and in preprinted form. The interventions will be evaluated using focus groups representative of the target audiences. Evaluators will use well-documented qualitative techniques to analyze focus

group data.

Vogel, Sarah A. (2009). The politics of plastics: The making and unmaking of Bisphenol A "safety." *American Journal of Public Health*, 99: S559-S566.

This paper discusses how BPA's safety has been defined and implications for policy.

Wang, C., Miller, S.M., Egleston, B.L., Hay, J.L., & Weinberg, D.S. (2009). Beliefs about the causes of breast and colorectal cancer among women in the general population. *Cancer Causes and Control*.

This study concludes that both genetic and environmental causes for breast and colorectal cancer are endorsed by unaffected women. Misconceptions about the causes of these cancers are important targets for public education and risk communication efforts.

Wilson, M., Chia, D., & Ehlers, B. (2006). *Green chemistry in California: A framework for leadership in chemicals policy and innovation*. Berkeley, CA: California Policy Research Center. Retrieved rom http://www.chemicalspolicy.org/downloads/CAGreenChemistryReport.pdf.

This report was prepared in response to a January 2004 request for technical in the area of chemicals policy from California State Senator Byron Sher, chair of the Senate Environmental Quality Committee, and Assembly Member John Laird, chair of the Assembly Committee on Environmental Safety and Toxic Materials. The request was prompted by the committees' interest in a California chemicals policy that would address public and environmental health concerns while also building long-term capacity in the design, production, and use of chemicals that are safer for humans and the environment. The committees were also interested in the implications for California of chemicals policy developments occurring in the European Union.

World Health Organization. (2008). *Reducing Workplace Exposure through Risk Management Toolkit: Report of the Regional Consultation: Chennai, India, 19-22 November 2007*. Retrieved 07 January 2010 from http://www.searo.who.int/LinkFiles/OEH_Health_36.pdf.

The limitations of the traditional approach of chemical exposure assessment and risk management extend beyond the pharmaceutical industry. There are rapidly increasing numbers of hazardous chemicals in commerce and insufficient data to set OELs for all of them. For example, there are fewer than 1,000 OELs for individual substances worldwide, yet there are hundreds of thousands of chemicals available commercially – and the list is growing. Further, it has been known and accepted for many years by the OSH community that SME owners and managers generally do not use OELs properly to protect workers in their enterprises. The reasons include insufficient knowledge and awareness of OELs (or how to apply them), scarce resources to hire OSH experts to measure workers' exposures to chemicals through air samples, and lack of incentives because SMEs usually have little regulatory pressure to comply with the OELs. That is, the probability of an SME being visited by a labor inspector is low, and in most developing countries the likelihood that a labor inspector knows how (or has the proper equipment) to measure and assess OELs is even lower.

Zahnd, WE., Scaife, SL., & Francis, ML. (2009). Health literacy skills in rural and urban populations. *American Journal of Health Behavior*, 33 (5): 550-557.

This article demonstrates that health literacy is lower in rural populations than urban populations (although this can be explained by known confounders).

Zarcadoolas, C., Timm, E., & Bibeault, L. (2001). Brownfields: A case study in partnering with residents to develop an easy-to-read print guide. *Journal of Environmental Health,* 64.1, 15-20.

This paper presents a case study of how literacy experts and environmental scientists partnered with a panel of inner-city residents to produce a community guide about brownfields.

Appendix D. Case Studies of Multidirectional Education and Communication

Background

A small sub-team of the Education & Communication Work Group explored the concept of the multidirectional model by drawing on their experiences with what they saw as successful cases of "multi-directionality" and cases that resulted in negative outcomes due, at least in part, to the exclusion of the public from critical decision-making processes (see Figure 1 of the draft work group report).

In nine of the case studies below, the multidirectional model was intentionally and successfully applied and in two case studies it was not. The case studies were not chosen from an exhaustive literature review or from contributions of experts in the subject, but represent the professional knowledge and personal experiences of members of the Education and Communication Work Group. We offer them as an appendix to give readers a "real-world" idea of what multi-directional education and communication (or its absence) can look like. Each case is followed by a list of "lessons learned" and keywords in order to offer concepts for future exploration and help facilitate the evaluation of multi-directionality in education and communication among parties engaged in environmental public health risk analysis or investigation.

I. Cases of Multidirectional Education & Communication

1. 2007 US Department of Defense decision to ship hydrolyzed VX chemical nerve agent to Port Arthur, TX for storage and incineration

Submitted by John Sullivan

In the spring of 2007, the US Department of Defense (DoD) awarded a contract to Veolia Environmental Services North America, a solid waste disposal company, for transportation, storage, and destruction in Port Arthur, TX of thousands of gallons of the chemical warfare agent VX nerve toxin. These shipments had been blocked by communities in New Jersey and Ohio, and DoD was eager to bring the VX destruction schedule in synch with international agreements under the Chemical Weapons Convention. DoD made the Port Arthur decision with no public input and no transparency. Moreover, it resulted in the transportation of what was perceived as a dangerous toxic agent into a petro-chemical fence-line community that is predominantly African American and that carries a huge burden of chronic chemical exposures and higher than average rates of respiratory illnesses and cancer.

The National Institute of Environmental Health Sciences' (NIEHS) Community Outreach and Education Core (COEC) partner in Port Arthur, "Community In-Power & Development Association," contacted NIEHS with an urgent request for the truth about the potential public health dangers of VX at Veolia's industrial incineration facility in Port Arthur. The University of Texas Medical Branch NIEHS research toxicologists and Preventive Medicine/Community Health Occupational Medicine specialists prepared and delivered in Port Arthur a presentation on risks posed by the shipment and disposal of the toxic agent in hydrolyzed form (VX hydrolysate). The information helped the community to better understand the actual risks and to mobilize additional support, including technical assistance from the citizen-based Chemical Weapons Working Group, to bring both DoD and Veolia to the table for negotiations.

Initially, the community succeeded in obtaining a temporary injunction and halting further shipments of VX until the process was explained to all concerned. Ultimately, however, the shipments and incineration process were resumed. Although the community's efforts did not succeed in stopping the transportation,

storage, and incineration of VX in Port Arthur, it increased the community's capacity to organize and advocate. In 2008, Port Arthur residents were able to block effectively efforts by Veolia to negotiate a National Environmental Policy Act (NEPA) variance that would have allowed the importation of foreign PCB-laden waste into Port Arthur for incineration.

See "VX in TX": a Community-Wide Outreach on VX Hydrolysate in Port Arthur, Texas. www.apha.org/membergroups/newsletters/sectionnewsletters/environ/spring07

Lessons Learned

- A lack of credible information on environmental health risks posed by VX Hydrolysate incineration amplified public perception that the risks were unacceptably high.
- A lack of transparency promoted a widely-held belief that DoD, Veolia and various levels of government were hiding information on health risks from the public. The fact that communities in New Jersey and Ohio had rejected more transparent plans to receive and destroy the toxic agent reinforced this belief.
- The fact that Port Arthur was already a community with a high cumulative risk / health inequities burden made west side residents feel that they were being targeted for disproportionate exposure because their community had been "written off as an industrial sacrifice zone."

Keywords: VX Hydrolysate, risk communication, cumulative risk / health inequities, transparency

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2. Updating Minnesota's Fish Consumption Educational Outreach for the Hmong Community[1]

Submitted by John Stine

Concerns about detections of perfluorooctanoic sulfonate in fish in Twin Cities' lakes prompted a series of meetings between the Minnesota Department of Health (MDH), the St. Paul-Ramsey County Department of Public Health (SPRCDPH), and other stakeholders. Although MDH had developed specialized outreach to Southeast Asians in the past, MDH and SPRCDPH initiated a Hmong outreach project to conduct a needs assessment and produce updated educational materials. This project was funded by the US Environmental Protection Agency (EPA) through the Great Lakes States Consortium.

MDH and SPRCDPH staff met with many individuals, organizations, and researchers who had experience working with the Hmong community to learn effective strategies for communicating health information, other educational outreach projects, and other potential outreach strategies. Based on these consultations, staff felt that several key questions needed answered in order to determine what specific educational program should be developed:

1. What fish do Hmong prefer to eat and how often do they eat fish?
2. How do the Hmong prefer to get health information?
3. What is the Hmong understanding of how contaminants get into fish?

[1] The Hmong people are native to Southeast Asia and migrated to the United States after the Vietnam War. See http://www.minneapolisfoundation.org/immigration/asia.htm for more information.

Answers to these questions were solicited through a series of activities:

1. Youth from the St. Paul Parks and Recreation Youth Corps posed the questions to Hmong fishermen at park lakes. The answers were summed up in a brief report.

2. MDH and SPRCPH staff participated in four "listening sessions," where a group of Hmong elders, youth or parents talked about fish, how they choose where to fish, contamination in fish, which fish they prefer to eat and how often.

3. At a meeting of the Capitol Sportsmen's Chapter of the Minnesota Deerhunters' Association, attendees with limited English, including members of the Hmong community, participated in a visual and interactive process that solicited information on which fish participants preferred to eat and how often. At the same meeting, the attendees were tested on their knowledge of mercury contamination in fish and state fish consumption guidelines; were shown an MDH video about how mercury gets into fish, how one can choose "safe" fish, and how to space fish meals to prevent undue exposures; and were then tested again to see if their understanding improved. Based on the pre- and post-video results, MDH produced a new DVD titled "Talk About Fish and Way of Eating Fish" in the Hmong language. In the future, MDH staff will evaluate this DVD in a series of meetings with members of the Hmong community.

See following URL for more information:
http://www.health.state.mn.us/divs/eh/fish/nonenglish/index.html

Lessons Learned
- Seeking community input and consultation prior to designing education outreach and communication made the government's interaction with the Hmong community successful.
- Early design of the evaluation of video educational tools assured the government and community that the video's effectiveness would be measured.

Keywords: educational outreach, fish consumption guidelines, Hmong, fish contamination

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3. Project COAL (Communities Organized against Asthma & Lead): an Environmental Justice Partnerships for Communication project funded by the National Institute for Environmental Health Sciences.

Submitted by John Sullivan

de Madres a Madres is a volunteer community-based, nonprofit organization near north Houston TX, promoting mother-to-mother support for at-risk, predominantly Hispanic women, children, and families. To facilitate communication with the community it serves and gather soft data on exposure pathways, risk perceptions and community environmental health priorities for collaborative research under the aegis of the NIEHS EJ Partnerships for Communication program (2003-2008), *de Madres a Madres* recruited and trained a community *grupo de teatro* (theater group) called *El Teatro Lucha por la Salud del Barrio* / Theatre That Fights for the Health of the Neighborhood.

This ensemble communicated environmental health information on the neurotoxic effects of lead poisoning, indoor air quality and its relationship to asthma pathogenesis, and provided models for peer-to-peer risk communication. The environmental health script was developed collaboratively by *de Madres a*

Madres and their university research partners: the University of Texas Medical Branch at Galveston (UTMB) and the City of Houston Bureau of Children's and Community Environmental Health.

An interactive feature of these performances – based on Augusto Boal's *Theatre of the Oppressed* – channeled information and opinions from the community directly into the performance, which allowed for the identification of exposure sources to hazardous chemicals that involved culturally-specific pathways or pathways that the community was unaware posed a health risk. Examples include the use of lead-based *greta* and *azarcon* for *empacho* (colic) in infants; children's proximity to unvented heat sources such as cooking stoves (NOX, Carbon Monoxide); and the widespread use of strong and sometimes illegal pesticides (in particular "Chinese chalk" (deltamethrin). These performances were also used to involve the community directly in designing culturally fluent and respectful protocols for an in-house inspection / symptoms survey used to assess environmental health risk and generate safety prescriptions for residents.

The multidirectional communication this outreach method promoted among all project partners was essential to the success of this project.

See *"El Teatro Luchas por Salud del Barrio: Theatre and Environmental Health in Texas."* www.communityarts.net/readingroom/archivefiles/2005/10/acrobats_of_the.php

Lessons Learned

- Local knowledge added value to scientific expertise in terms of mapping exposure pathways and developing culturally fluent outreach models.
- Direct community involvement in educational outreach broadened the scope and range of the environmental health risk message.
- The community trusted the credibility and motives of the messengers because the teatro actors were recruited directly from the community.

Keywords: environmental health, risk communication, local knowledge, Theatre of the Oppressed, lead exposure, asthma triggers

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4. National Institute of Environmental Health Sciences Town Meeting Process

Submitted by John Sullivan

In the fall of 2001, the National Institute of Environmental Health Sciences (NIEHS) and the Chronic Disease Prevention and Control Research Center at Baylor College of Medicine, with the support and collaboration of the regional NIEHS Centers and area universities, organizations and individuals, cosponsored a large-scale town meeting titled "Environmental Health in Our Neighborhoods: Speaking Out about Pollution & Health" at the University of Houston. The format featured expert panels drawn from policy-making, physical/environmental science, environmental health, health care practitioners, and recognized community voices – with full knowledge of the pitfalls in designating any individual as "the voice" of a specific community.

Each panel represented various stakeholder perspectives on specific issues related to air quality, followed by open mike questions and comments from the audience. While the level of detail in science and policy was sparse, the inclusive design of the forum allowed affected communities to present their cases directly, and created abundant opportunities for networking and coalition-building on many levels. Momentum from the town meeting contributed to the success of a later series of targeted air quality initiatives originating at the office of Houston Mayor, Bill White.

See following URL for *Town Meeting agenda:*
http://envirohealthhouston.org/files/Town_Meeting_Brochure.pdf

Lessons Learned
- Meaningful inclusion generates broad support for environmental health initiatives.
- Diverse input strengthens environmental health policy in terms of both overall scope and specific details.
- Multidirectional dialogue promotes the establishment of networks uniting scientists, clinicians, policy-makers, and community-based organizations.

Keywords: multi-directional communication, Town Meetings, stakeholder perspectives, community voice

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5. Western Mineral Products, Northeast Minneapolis (a Libby "daughter" site)

Submitted by John Stine

Western Mineral Products, which was purchased by W.R. Grace in the early 1960s, operated a vermiculite processing operation at 1720 Madison Street NE from the 1930s until 1989. Although the Minneapolis facility was one of many throughout the US and Canada that received vermiculite ore from a mine in Libby, Montana, it was the only site outside of Libby located in a major urban setting with significant community (non-occupational) exposure.

As part of a national response to reports of asbestos-related disease in Libby, in February 2000, the US Environmental Protection Agency (EPA) inspected the soil at the Western Mineral Products site and found asbestos contamination. Community residents reported that vermiculite waste from the facility was made available to local neighborhoods for use as fill in driveways, yards, and gardens. Others reported that children had played on the piles of waste deposited outside the plant.

In response, the Minnesota Department of Health (MDH) initiated the "Northeast Minneapolis Community Vermiculite Investigation" in order to identify and characterize exposures of past and present residents in a ½ mile radius of the site. The study also identified the location of properties contaminated with Libby asbestos and, with the owners' permission, referred these properties to the EPA for remediation. During the investigation's initial public health assessment, MDH health education staff met with local neighborhood associations, community-based service organizations, and city officials, and interviewed more than 7,000 past and present residents. It soon became clear that the only way to track how vermiculite waste had been taken from the site and used around the neighborhoods was from anecdotal stories and collective "community memory."

The resulting detailed study of the site included possible health risks and recommendations for actions to prevent further exposures. It was made available to community members, neighborhood associations, local government, state and federal legislators, related state agencies and other interested parties. More than 7,000 residents received information on the health risks posed by vermiculite waste. Continuing education for local health practitioners regarding asbestos-related disease, diagnosis, and case management was developed in cooperation with a team of local health care providers and presented in 11 different area clinics.

The government-community collaborations formed during the Northeast Minneapolis Community Vermiculite Investigation yielded several unanticipated benefits: a) MDH staff learned that residents desired information on low-cost sliding-scale health clinics, local smoking cessation programs, asbestos concerns within the home, and lead poisoning prevention; b) they strengthened the skills and capacities of neighborhood organizations and local community health services; and c) they enhanced the quality of MDH study information sheets and other educational materials, all of which were developed with the help of the community.

See following URL for more information:
http://www.health.state.mn.us/divs/eh/hazardous/sites/hennepin/western/index.html

Lessons Learned

- Neighborhood-based meetings and consultations with community residents provided the only reliable means to define potentially contaminated sites using "collective community memory."
- Collaboration with community-based health clinics amplified the impact of the knowledge gained regarding community exposure to vermiculite and related respiratory disease concerns of the community residents.

Key words: Asbestos, vermiculite, community memory, health education, neighborhood associations

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6. Hydrogen Sulfide Exposures in a Rural Community in Minnesota

Submitted by John Stine

The Excel Dairy near Thief River Falls in Marshall County, Northwestern Minnesota is a large concentrated animal feeding operation. Manure storage basins at the facility are uncovered and are the source of hydrogen sulfide (H_2S) and other gases, which are responsible for pungent odors, adverse health symptoms, and stress experienced by nearby residents. Elevated levels of H_2S are associated with symptoms such as persistent eye and throat irritation, headache and nausea, as well as stress that could exacerbate the effects of exposure.

In May 2008, residents living in the area surrounding the Excel Dairy complained to the Minnesota Department of Health (MDH) of strong odors and numerous health effects that they believed were related to H_2S gas emanating from manure lagoons on the dairy property. The residents had measured H_2S levels using a "Jerome meter" (i.e., a portable piece of equipment for measuring H_2S in air) and reported that the levels of H_2S in their communities were many times above 100 ppb, and in one sample more than 1,000 ppb. Even though MDH did not verify the methods used for collecting these data, the citizen-reported data were a factor in the agency's decision to conduct an "Exposure Investigation."

MDH, in partnership with the federal Agency for Toxic Substances and Disease Registry (ATSDR), conducted an exposure investigation in July 2008, measuring H_2S gas in air at three residences near the Excel Dairy. The Minnesota Pollution Control Agency (MPCA) also monitored H_2S at the Excel Dairy fence line from May through October 2008. Additionally, as part of the MPCA's air permitting requirements, the facility reports ambient levels of H_2S, on an ongoing basis, during 2008 and 2009. These data indicated exceedances of health-based criteria for H_2S in air, including exceedances of various human exposure risk criteria, and almost 500 and 200 exceedances of Minnesota's Ambient Air Quality Standards (set by MPCA) in 2008 and 2009, respectively.

MDH held meetings with residents to discuss their health symptoms and concerns, inform them of the results of the exposure investigation, and provide health information. Participants were encouraged and received support to take an active role in all public processes related to permitting and enforcement, including presenting findings at meetings of the MPCA Citizens' Board and a Minnesota Senate committee. MDH also testified before the MPCA Board and the Minnesota Senate Committee on Health, Housing and Family Security, advocating for the affected citizens and MPCA regulatory programs. Finally, MDH provided comments to the MPCA on Excel Dairy's facility permit, specifying the need for stringent new timelines for pumping the manure basins and covering them, and recommending that residents be informed of enforcement activities and any other plans that might affect them.

MDH continues to collaborate with the MPCA to provide clear health information concerning findings of continuing MPCA air monitoring, and supports the MPCA proposal not to reissue Excel Dairy a facility permit because the company's facility continues to be a public health hazard.

See following URL for more information:
http://www.health.state.mn.us/divs/eh/hazardous/sites/marshall/exceldairy/index.html

Lessons Learned

- Neighborhood-based meetings and consultations with community residents provided the only reliable means to define potentially contaminated sites using "collective community memory."
- Collaboration with community-based health clinics amplified the impact of the knowledge gained regarding community exposure to H_2S and related respiratory disease concerns of the community residents.

Keywords: H_2S, community memory, health education, neighborhood associations

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7. Soil Sediment Sampling Project after Ike

Submitted by John Sullivan

Storm surge from Hurricane Ike deposited a fine layer of sediment throughout Galveston Island, Galveston, TX. At an early reorganization meeting in the gutted remains of a former preschool, Rev. Michael Jackson, director of St. Vincent's House, Galveston, a non-profit social service agency, forcefully stated his community's view that chemical residues in this sediment could compromise the health of children and other vulnerable members on the north side of the Island.

A succeeding meeting among St. Vincent's House and University of Texas Medical Branch at Galveston (UTMB)-National Institute of Environmental Health Sciences (NIEHS) Community Outreach and Education Core (COEC) and Environmental Toxicology Division personnel sketched out a small-scale project designed to get an overview of the extent of any new chemical burden in the top-soil layer of Galveston Island. MacArthur Fellowship recipient, Wilma Subra, an analytic chemist from New Iberia, LA was retained as a consultant to train community and NIEHS staff in EPA protocols for collecting, storing, and shipping soil samples, and completing proper chain of custody paperwork. Community and NIEHS staff collaboratively developed a sampling schema to analyze sediment deposited from major bodies of water ringed by industrial and petrochemical facilities: Chocolate Bayou, the Galveston Ship Channel, and the Texas City/Houston Ship Channel.

Results showed significant increases in the Island's arsenic, chromium and lead burdens, and appropriate safety recommendations were communicated to the City and County Health District. St. Vincent's House,

the UTMB NIEHS Center and the Center for Elimination of Health Disparities are presently collaborating on a series of public workshops covering environmental health threats from climate disasters and the design of principles to inform recovery and redevelopment efforts and create healthy neighborhoods.

Note: The Texas Commission on Environmental Quality (TCEQ) also conducted soil testing by actually doing core samples, in contrast to the smaller study's emphasis on the topmost layer, and gave the island a clean bill of health. However, there was scant educational outreach or risk communication coordination among the state agency and local entities involved in recovery, and no specific data were ever released to the public with sufficient attention to varying levels of environmental health literacy and the need to communicate health and safety precautions. This example illustrates an outmoded, hierarchical communication paradigm, and such apparent secrecy does not inspire confidence or trust.

See following URL for additional information on Ike recovery projects and a full report on results of soil sediment assays:
http://www.utmb.edu/cehd/Projects/sedimenttestinga.html

Lessons learned

- Local knowledge can be scientifically useful, pointing experts to productive environmental health research.
- Environmental health research helps protect public health when it responds to locally defined community needs and questions.
- Community members who have good information and appropriate training can assist scientific personnel in the field without compromising the quality and credibility of research.

Keywords: storm surge sediment, risk assessment, risk communication, vulnerable communities.

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8. Perfluorochemical contamination of drinking water in Washington County, Minnesota

Submitted by John Stine

Beginning in 2004, perfluorochemicals (PFCs), especially perfluorooctanic acid (PFOA), perfluorooctane sulfonate (PFOS), and perfluorobutanoic acid (PFBA), were found in groundwater and public and private drinking water supplies in cities in the East Metro area of the Twin Cities, Minnesota. The area of contaminated groundwater was ultimately found to be about 100 square miles and to have resulted from PFC waste disposal by 3M or its contractors at several area landfills from the 1950's to the 1970's. The investigation (2004-2007) found that approximately 152,000 people in seven suburbs were exposed to the chemicals through drinking water.

Initially, PFCs were discovered only in private wells, there was limited toxicological research available for PFCs, and no regulatory or health-based criteria were established for PFC levels in municipal drinking water. The Minnesota Department of Health's (MDH) educational outreach to residents clearly described the lack of available information, steps state agencies were taking to obtain more information, and a promise to bring new developments and discoveries to potentially affected communities as they became available.

Since that time, PFCs have become an active area of toxicological research, the MDH Public Health Laboratory developed the analytical methods to accurately detect PFCs, health-based criteria were established for PFCs found in MN drinking water, the MN Legislature passed legislation in 2006 authorizing Minnesota's state-funded environmental health tracking and biomonitoring program and

included a requirement to conduct biomonitoring for PFC exposures. Additionally, MDH has conducted "serial" health education activities to inform residents about new PFC-related findings. Most importantly, perhaps, residents exposed to PFC levels that exceeded the state health-based criteria were provided with alternative sources of drinking water with support from 3M grants to communities and state regulatory actions.

During this process, residents expressed concern about 1) cancer or other disease rates in the area that seemed higher than normal; 2) health implications for children who might have been exposed to contaminated water (both before and after birth); and 3) health of domestic animals that might have been drinking contaminated water. Residents also had questions about multiple exposure pathways to PFCs, and the lack of regulatory criteria for some PFCs in water. MDH worked to address these health issues where possible, produced multiple information sheets for area residents, regularly updated its web site on PFCs (www.health.state.mn.us/divs/eh/hazardous/topics/pfcs/index.html), and created an e-mail distribution list of about 1500 recipients to update residents and local officials. Other city agencies also provided multiple updates for local residents in their newsletters, water quality reports, and websites. There have also been numerous stories in state, Twin Cities, and local media.

The most significant of the outreach activities was a series of open-house meetings held in various Twin City suburbs. These open houses were held early in the investigation and repeated in 2008 after the development of a health-based exposure limit for the most widespread PFC (PFBA), and again for the presentation of biomonitoring results in the summer of 2009. The format allowed residents to visit one-on-one with staff from multiple government agencies stationed at display tables for several hours before and after a formal presentation and group question-and-answer time. The open house format also allowed government staff to gather information from residents about exposures, concerns, and unaddressed needs.

See following URL for more information:
http://www.health.state.mn.us/divs/eh/hazardous/topics/pfcs/index.html

Lessons Learned

- Intentionally designed community forum and open house style meetings were helpful in responding to individual and community questions as well as gathering input and feedback from citizens and the community about questions, concerns, and investigation needs.
- Email distribution of informational updates was a successful tool in updating the community.

Keywords: perfluorochemicals, PFCs, biomonitoring, health education, toxicology, public meetings, drinking water, groundwater, contamination

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9. US Access Board "Indoor Environmental Quality Project Report"

Submitted by Mary Lamielle

In 1991 the US Access Board received over four hundred comments in the form of pre-printed postcards from persons with chemical sensitivities in response to proposed Americans with Disabilities Act (ADA) regulations. The preamble to the ADA regulations issued July 26, 1991 noted that "Chemical and environmental disabilities present some complex issues which require coordination and cooperation with other Federal agencies and private standard setting agencies. Pending further study of these issues, the Board does not believe it is appropriate to address them at this time."

In November 1999, the Access Board issued a proposed rule to revise and update its accessibility guidelines. During the public comment period on the proposed rule, the Access Board received approximately 600 comments from individuals with chemical and electrical sensitivities. These individuals reported that chemicals released from products and materials used in construction, renovation, and maintenance of buildings, electromagnetic fields, and inadequate ventilation are barriers that deny them access to most buildings.

In response, the Access Board contracted with the National Institute of Building Sciences (NIBS) to establish an Indoor Environmental Quality Project as a first step in implementing an action plan. The collaborative project included advocates representing individuals with chemical and electrical sensitivities, clinicians, indoor air experts, government personnel, and others (http://www.access-board.gov/research/ieq/intro.cfm). The most important aspect of this process was the inclusion of persons with these disabilities who had varying abilities to enter or attend meetings in public buildings or, for example, to use telephones or electronic technology.

Four patient advocates worked with an NIBS representative and other indoor air experts to write the "Indoor Environmental Quality Project Report" (www.access-board.gov/research/ieq), which was completed in 2005 and published in 2006. This best practices guidance explains how to make public and commercial buildings healthier for everyone and more accessible for people with chemical and electrical sensitivities.

The key to this project, and the way that it differs from the failed effort by the Agency for Toxic Substances and Disease Registry (Case II.1. ATSDR *Draft* Report on Multiple Chemical Sensitivities), is that the Access Board staff, and in particular counsel Jim Raggio and several board members, worked to understand these disabilities. They were willing to listen to the patient advocates and explore and create novel ways to address the access needs of persons with chemical and electrical sensitivities. Even though this was a time-consuming and, at times difficult process, it produced recommendations that advanced the access needs of persons with these disabilities. In addition, it has been cited as a resource in other documents, including the recently released American Society of Heating, Refrigerating, and Air-Conditioning Engineers Indoor Air Guide.

In addition to the indoor environmental quality project, the Access Board previously adopted a fragrance-free policy for public meetings (http://access-board.gov/about/policies/fragrance.htm). The agency also included a nonprofit with expertise in indoor environmental quality and persons with chemical sensitivities on its Emergency Transportable Housing Federal Advisory Committee. The Access Board staff has unofficially expressed support for an interagency committee on chemical and electrical sensitivities, but the Access Board's governing body has not yet been asked to take a position on such a proposal.

Lessons Learned

- A federal agency can successfully engage in a collaborative and multidirectional project to address chemical and electrical sensitivities.
- Guidance in the final report has helped to identify disability access barriers for these individuals and educated the public, government agencies, and others about ways to improve indoor environmental quality to make buildings healthier for everyone and to meet the access needs of people with chemical and electrical sensitivities.

Key words: US Access Board; indoor environmental quality; chemical and electrical sensitivities

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II. Cases illustrating risks of excluding multi-directional education & communication

1. *Draft* ATSDR Report on Multiple Chemical Sensitivities

Submitted by Mary Lamielle

In 1993 the Agency for Toxic Substances and Disease Registry with directed Congressional funds convened an Expert Panel on Multiple Chemical Sensitivities. In part the expert panel recommended the creation of an interagency committee to examine this issue and develop a plan of action. Five years later, with no input from the public, affected populations, or federal disability agencies, the CDC issued a *predecisional draft*, "A Work on Multiple Chemical Sensitivity (MCS)," for public comment. Over four hundred comments were received, the majority of which identified the serious factual errors and problems with content and perspective. The CDC hired a consulting firm to review and categorize the comments at a cost of nearly $25,000. No changes were ever made to the report, and it was never finalized or released.

Seventeen years after the recommendation to create an interagency committee was made and a dozen years after the draft report was rejected by the public and professionals as inadequate and biased, it continues to be posted on a number of government websites, including the National Institute of Environmental Health Sciences and the Occupational Safety and Health Administration without noting that it is a *draft* report, thus conferring on the report a legitimacy it does not have. The draft report has been used against patients seeking medical and legal assistance and social services. This is a serious problem when accurate and timely government-funded documents and nongovernment resources are available to those seeking information on this issue.

Furthermore, while non-research agencies have been and continue to address this public health problem with policies and programs, research agencies have not. There is still a need for an interagency committee composed of agency representatives from research, policy, and disability agencies, among others, that enables clinicians and patient advocates to review what has been done to address this issue, identify the policy and research gaps, and develop a plan of action to address these public health problems in a timely and professional manner that involves impacted populations and responds to their needs.

Lessons Learned

- The report illustrates the need to collaborate with affected individuals, in this case people with chemical sensitivities and their representatives, as well as with other federal agencies who were already addressing a health problem, clinicians, and other experts.
- The many factual and historical errors in this draft report triggered significant criticism and required the extra expense of an outside contractor to review the public comments. Moreover, the document was never finalized, illustrating the potential for wasting time, effort, and money on reports that are not sufficiently inclusive of contributors who can ensure they are accurate and useful to the intended audiences.

Key words: chemical sensitivities; Proposed Interagency Committee on Chemical Sensitivities

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2. EPA's Lead and Copper Rule, partial lead service line replacements, and children's blood lead levels in Washington DC

Submitted by Yanna Lambrinidou

In January 2010, the Centers for Disease Control and Prevention (CDC) issued a national alert that a child's risk of elevated blood lead levels is increased in homes with a partial lead service line replacement (PSLR), compared to homes with an intact lead service line or no lead service line.[2] The CDC's announcement was based on preliminary findings from a study in Washington DC. PSLRs occur when a utility eliminates only part of a lead service line and replaces it with copper. PSLRs are a key part of the US Environmental Protection Agency's (EPA) 1991 Lead and Copper Rule program for mitigating lead contamination of water.

Between 2004 and 2008, Washington DC alone spent over $100 million dollars implementing PSLRs to comply with federal law and protect the residents' health.[3] PSLRs have been conducted in numerous other US cities as well. On the basis of the perceived US "success" with the practice, Canada is also implementing PSLRs.

The 2010 CDC alert followed more than two decades of warnings by scientists and environmental health advocates that PSLRs can actually increase children's lead exposure by producing lead-in-water "spikes" for an undetermined duration.[4] EPA, however, repeatedly defended the effectiveness of PSLRs.[5] To address the criticisms against Washington DC's massive PSLR program, the agency took active steps to generate two studies that reportedly determined the nature and extent of lead leaching after PSLR. Representatives from EPA Headquarters and EPA Region III involved themselves directly in the design and oversight of the first study.[6] EPA Region III – the agency with primacy over Washington DC's drinking water – funded the second study.[7]

The studies concluded that PSLRs do not produce significant lead-in-water spikes. Freedom of Information Act requests and painstaking independent investigations from 2004 to 2007 disclosed

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[2] Frumkin, H. 2010. Important Update: Lead-Based Water Lines, January 12, http://www.cdc.gov/nceh/lead/waterlines.htm (last accessed on August 13, 2010).

[3] Hawkins, G. S. 2010. Washington DC City Council Testimony, April 30, http://www.dcwasa.com/news/testimony/Oversight%20Questions.pdf (last accessed on August 13, 2010).

[4] Lead and Copper Rule, 40 CFR (1991); Lead Emergency Action for the District. 2004. Emergency Actions Needed to Protect Public Health and Restore Public Confidence in DC Tap Water, February 26 (available upon request); Edwards, M. A. 2004. Congressional Testimony Before the Committee on Government Reform, March 5, http://www.dcwatch.com/wasa/040305h.htm (last accessed on August 13, 2010); Olson, E. D. 2004. Congressional Testimony Before the Committee on Government Reform, March 5, http://www.dcwatch.com/wasa/040305f.htm (last accessed on August 13, 2010); American Water Works Association. 2005. Congressional Testimony Before the Committee on Government Reform, March 11, http://www.mwra.state.ma.us/04water/html/lead/031105awwatestimony.pdf (last accessed on August 13, 2010); Leonnig, C. D. 2008. Spikes in Lead Levels Raise Doubts about Water Line Work. *Washington Post*, February 23, http://www.washingtonpost.com/wp-dyn/content/article/2008/02/22/AR2008022202850.html?nav=emailpage (last accessed on August 13, 2010).

[5] Lead and Copper Rule, 40 CFR (1991); Rogers, R. 2005. Radio interview. WAMU (88.5 FM), April 4, http://thekojonnamdishow.org/shows/2005-04-04 (last accessed on August 13, 2010); Capacasa, J. M. 2008. Congressional Testimony Q&A Before the Federal Workforce, Postal Service and the District of Columbia Subcommittee of the House Oversight and Government Reform Committee, April 15.

[6] Wujek, J. 2004. Minimizing Peak Lead Concentrations After Partial Lead Service Line Replacement" [Conference proceedings], American Water Works Association Water Quality Technology Conference, San Antonio, TX, Nov. 14-18.

[7] Reiber, S. and L. Dufresne. 2006. Effects of External Currents and Dissimilar Metal Contact on Corrosion from Lead Service Lines [Report prepared for EPA Region III], http://www.epa.gov/dclead/Grounding_Effects_Study_Final_November_2006.pdf.

fundamental flaws in the execution and interpretation of both studies. These flaws render the studies' conclusions simultaneously meaningless and misleading.[8]

Despite repeated requests for answers, EPA has refused to address the public's concerns about the integrity of the two studies. Moreover, the agency has failed to release any of the raw lead-in-water measurements collected for the second study, which is still featured on the agency's Web site and has been cited in US Congress to allay fears about elevated lead after PSLR.[5]

As of July 2010, EPA has not acknowledged CDC's alert, the harm that was done and might continue to be done to children as a result of the Lead and Copper Rule's "mitigation" policy, the wasted ratepayer money used to finance Washington DC's PSLR program, or the flaws and unethical management of the two "PSLR-affirming" studies. The agency also has not taken any formal steps to reconsider the national and international public health ramifications of its actions.

This case illustrates how a federal agency's disregard for public concerns, questions, and independent scientific criticisms can perpetuate flawed policy and compromise public health.

Lessons Learned

- Scientific knowledge originating outside government institutions as well as local (community) knowledge can be useful sources of information about environmental health and might fill important gaps in public health policy.
- Government transparency of research data is critical in allowing the scientific community and the public to review and understand scientific analyses and conclusions. It can also help foster useful critiques that lead to corrections of the scientific record and to new research.
- Responding to public concerns and inquiries is an important step in a process that can foster constructive collaboration between the government and the public.

Keywords: non-governmental scientific research and critique, data transparency, mechanisms for correcting erroneous analyses and conclusions, government treatment of public concerns and inquiries.

[8] Edwards, M. 2008. Comments on the Region III Galvanic Study (E-mail message to Joseph Cotruvo, Board Member of the District of Columbia Water and Sewer Authority), May 29, https://www.filesanywhere.com/fs/v.aspx?v=8972688e5d626d7d9faf; Renner, R. 2010. Reaction to the Solution: Lead Exposure Following Partial Service Line Replacement. *Environmental Health Perspectives* 118(5): doi:10.1289/ehp.118-a202http://ehp03.niehs.nih.gov/article/info%3Adoi%2F10.1289%2Fehp.118-a202.

Appendix E. Health Professionals Subgroup Bibliography

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