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'Gold Standard' for Remediation of WTC Contamination

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'GOLD STANDARD' FOR REMEDIATION OF WTC CONTAMINATION

TECHNICAL WORKING GROUP*

ABSTRACT

The events of September 11, 2001 and thereafter resulted in arguably the worst environmental disaster in the history of New York City. Particulate matter and combustion by-products containing asbestos, lead, mercury, dioxin, PAHs, and other toxic substances, not only affected rescue and recovery workers but also infiltrated thousands of residences and workplaces. Government agencies did not acknowledge responsibility for residential indoor environmental quality until eight months later, and still have not accepted responsibility for indoor environmental quality in commercial or government buildings. In May 2002, 200 representatives from 38 community, labor, environmental, and public health organizations met to discuss unmet post-9111 public health needs. They established a technical working group to press the Environmental Protection Agency to expand and improve its proposals for the cleanup of Lower Manhattan. This 2002 document, "The 'Gold Standard' for Remediation of WTC Contamination," articulates the environmental health concerns and suggestions of grassroots organizations active in 9111 response efforts at that time.

1. INTRODUCTION

This document presents an overview of the principles, methods, and procedures that should be followed in addressing removal of contaminants from areas impacted by 9/11-related contaminants. The recommended criteria for effective

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remediation are supported by references in the scientific and technical literature and in environmental and occupational safety and health standards and regulations. The aim of this Gold Standard document is to maximize protection of public health and worker safety.

1.1 History

On September 11, 2001, an unprecedented amount of asbestos, lead, mercury, dioxin, and other toxic substances was dispersed throughout neighborhoods where hundreds of thousands of people live, work, and attend school. In addition to being victims of a terrorist attack, residents, landlords, workers, and employers had to bear the burden of environmental testing and decontamination without governmental coordination or adequate financial assistance. While EPA's decision to begin removal of contaminants from downtown residences is welcome, even more than a year after the attack, it does not go far enough. Further, it does not comply with the statutory requirements of the National Contingency Plan (NCP) under the Comprehensive Environmental Response and Liability Act (CERCLA) for the removal and remediation of hazardous substances.

The need for an ***effective and comprehensive*** removal of contaminants from all indoor and outdoor spaces in Lower Manhattan is compelling:

- Environmental sampling by public and private agencies provides ample evidence of contamination of many indoor spaces by asbestos, fibrous glass, lead, mercury, and dioxin [1].
- Water incursion in some buildings has resulted in mold growth [2].
- Clinical diagnosis of downtown residents and non-Ground Zero workers offers substantial documentation of both short-term and chronic health effects [3, 4].
- Additional long-term health effects may not present for several decades [5].

1.2 Removal of Contaminants from Affected Areas

Not every residence or workplace has suffered significant contamination. Nor have occupants of every residence or workplace experienced significant exposure. ***However, as a matter of prudent public health policy, the potential for exposure requires remediation of contaminated residences and workplaces.*** Removal of contaminants should not be limited to EPA's arbitrary geographical boundary of Canal and Pike Streets, but should be available wherever there is potential for exposure.

1.3 Precautionary Principle

The United States, as a signatory to the Rio Declaration on Environment and Development, is an endorser of the Precautionary Principle. This principle is well summarized by the American Public Health Association:

- Proof of cause-and-effect relationships is often difficult to establish because of non-specificity of health effects, long latent periods, subtle changes in function that are difficult to detect without resource-intensive studies, and complex interactions of variables that contribute to adverse health effects.
- Public health decisions must often be made in the absence of scientific certainty, or in the absence of perfect information.
- Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation [6].

The tenets of the Precautionary Principle should guide the design and implementation of the cleanup process.

1.4 National Contingency Plan

Further, the provisions of the National Contingency Plan (NCP, 40 CFR §300) for the removal and remediation of releases of hazardous substances require that EPA conduct the evaluation and cleanup according to clearly defined standards [7]. These standards should be followed in this case.

2. PUBLIC HEALTH PRINCIPLES FOR REMEDIATION OF WTC CONTAMINATION

2.1 Basic Principles

To make affected areas safe again for children, residents, and workers, shortcomings in EPA's cleanup plans must be corrected.

- EPA's cleanup process should include schools, workplaces, and commercial establishments, not only residences. Contamination does not discriminate.
- EPA should be the lead agency responsible for the cleanup—not FEMA or local agencies. All funding for the cleanup should be channeled through EPA. FEMA's role should be limited to that of a financial conduit. It should not make decisions that impact health and the environment [8].
- All habitable and non-habitable indoor spaces, including mechanical ventilation systems, ducts, plenums, elevator shah, hallways, basements, boiler rooms, spaces above dropped ceilings, and so forth, should be cleaned. In order to limit recontamination, cleanup should be conducted on a building-by-building and area-by-area basis, rather than apartment-by-apartment or office-by-office, basis [9]. In order to achieve this systematic approach, EPA should exercise its authority under 40 CFR §300.400(d) [10], which grants entry and access to any building, property, or other establishment to remove hazardous substances.

- Cleaning should proceed from the outside to the inside. First, facades, rooftops, and ledges should be cleaned, then mechanical ventilation systems, including ductwork and plenums, then common areas, and finally apartments and workplaces. EPA needs to acknowledge that HVAC systems can be sources or vehicles of recontamination.
- EPA's cleanup protocol should address all potential contaminants, not just asbestos. Representative sampling [11] for fibrous glass, lead, mercury, dioxins (TEQ—toxic equivalent), and in some cases, mold, should be conducted on a building-wide basis in every building to ascertain the need for abatement of other contaminants. In addition, representative sampling of a more extensive list of contaminants should be conducted at varying distances from Ground Zero to determine the geographic extent of the dispersion of toxic substances.
- All cleanup must address reservoirs of contamination. A reservoir is a place where toxic substances accumulate and which becomes a potential source for later release and exposure over time. For example, carpets, upholstered furniture, ceiling tile, and drapes can be substantial reservoirs for asbestos. Other reservoirs, including porous surfaces such as cement blocks, ceiling tile, unfinished concrete and bricks can harbor toxic substances such as dioxins.
- Demolition of contaminated buildings or parts of buildings has the potential to re-release contaminants into the air, possibly resulting in reentry and redeposition of contaminants into nearby buildings. All demolition procedures should follow the regulatory requirements of the Clean Air Act National Emission Standards for Hazardous Air Pollutants (NESHAPs) at 40 CFR §61.145 [12], including but not limited to wetting of surfaces, isolation of demolition areas with negative pressure, and controlling demolition activities to prevent escape of fugitive emissions to the ambient air.

2.2 Asbestos

Because asbestos is a known human carcinogen, EPA should abide by its long-standing policy that there is no safe level of exposure to asbestos:

> Available evidence supports the conclusion that there is no safe level of exposure to asbestos. This conclusion is consistent with present theory of cancer etiology and is further supported by the many documented cases where low or short term exposure has been shown to cause asbestos-related disease. . . [13].

Therefore, comprehensive and effective methods of asbestos abatement should be utilized in cleaning up Lower Manhattan.

2.3 Asbestos Standards

As a matter of prudent public health policy, abatement for asbestos should be conducted in all contaminated or presumed contaminated habitable and non-habitable indoor and outdoor spaces within EPA's designated geographic boundaries.

EPA's proposed use of visible dust as the indicator for contamination is not scientifically valid and is unacceptable [14]. It does not take into account respirable particulates that may not be visible but exposure to which may result in adverse health effects. In addition, use of visible dust as the indicator for contamination is subjectively based and could result in inconsistent decision-making.

- All indoor spaces within EPA's designated geographic boundaries (river to river, below Canal and Pike Streets) should be presumed to have been contaminated with asbestos [15, 16]. There is no scientific basis for assuming these spaces are free of asbestos. ***Unless proven free of asbestos by appropriate testing,*** all such indoor spaces should receive full asbestos abatements, in compliance with procedures for asbestos abatements specified in the National Emissions Standards for Hazardous Air Pollutants (NESHAPs) [17] and the guidelines of the U.S. Army Corps. Of Engineers [18].
- Further, the provisions of the National Contingency Plan (NCP, 40 CFR $300) for the removal and remediation of releases of hazardous substances require that EPA conduct the evaluation and cleanup according to standards clearly defined by the NCP (the "point of departure" of which is no greater than the 10^{-6} excess cancer risk level for lifetime exposure) [19]. NCP regulations must be followed.
- Asbestos abatement should be mandatory. Where it can be documented that asbestos is not present, EPA should be permitted to suggest to the occupant that cleaning may be unnecessary. (See section 3.6.) In this circumstance, the occupant should have the ultimate authority either to request or to waive a cleaning [20].

2.4 Other Toxic Substances

All affected indoor and outdoor areas should be remediated of all hazardous substances, not just asbestos. Clearance levels for occupancy should meet or be less than the 10^{-6} excess cancer risk level for all cumulative carcinogenic risks for a lifetime exposure. Levels also should not result in any non-carcinogenic, adverse health effect, such as asbestosis, other respiratory illnesses, neurological problems, or immune system deficits. These levels should incorporate an adequate margin of safety for the aggregate of exposures to all other substances as stated in the NCP [21]. (See section 3.3.) Removal must adhere to proper protocols, using state-of-the-art methodologies. (See section 3.)

2.5 Sampling And Analysis Methodologies

All sampling and analysis methods should be state-of-the-art, the most effective and sensitive available. Sampling should be capable of detection of contaminants to background levels in order to ascertain the extent of contamination and potential exposure. Sampling analysis should not be geared solely to regulatory levels. Sample analysis should utilize tests with adequate sensitivity to detect all target substances at concentrations in air or on surfaces lower than 10^{-6} risk level for all cumulative carcinogenic risks for a lifetime exposure.

2.6 Sampling for Extent of Contamination

Representative sampling should be conducted at varying distances from Ground Zero to determine the geographic extent of dispersion of toxic substances originating at the World Trade Center. Sampling should include but not necessarily be limited to asbestos, fibrous glass, lead, cadmium, mercury, dioxins, silica, pH, PCBs, PAHs (polycyclic aromatic hydrocarbons), and, where there is a recent history of water incursion, mold. Any protocol for geographic sampling should reference the extensive list of contaminants reported in Lioy et al. [22]. Broad spectrum analysis of particulate matter in heavily impacted buildings near Ground Zero and at less impacted sites throughout the EPA designated boundaries should reveal a characteristic "fingerprint" that should then be used to track WTC toxics beyond the designated cleanup zone.

A finding of a significant quantity of any of these contaminants should result in redesign of cleanup protocols and reimplementation of cleanup. For purposes of this document, significant quantity refers to the risk-based standards specified in the NCP. (See section 3.4.)

2.7 Limits of Occupational Standards

Occupational standards may not provide adequate protection for residents and even some workers. The elderly, the infirm, and infants and young children may be more susceptible to adverse health effects from exposure to toxic substances. Occupational standards apply to 8-hour work days, or a 40-hour week, whereas environmental exposures can occur over longer periods. For example,

> Occupational exposure standards for asbestos are not generally applicable or protective for residents or workers in non-asbestos environments because occupational standards are intended to protect individuals who a) are fully aware of the hazards of the occupational environment, b) have specific training and access to protective equipment such as respirators and/or protective clothing, and c) actively participate in medical monitoring. None of these conditions apply to residents or to workers at typical commercial

> establishments, thus, simple compliance with the OSHA standards is not evidence that exposure levels are acceptable in a home or in a non-asbestos workplace. Indeed, risks to residents or workers occur at exposure levels substantially below the OSHA workplace standards . . . [23].

2.8 Enforcement

All occupational and environmental health and safety laws, standards and regulations must be enforced during cleanup operations. There is no justification for suspension of these legal requirements during cleanup.

2.9 Environmental Justice

Cleanup must omit no income group and/or ethnic group. Executive Order 12898 requires that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations" [24].

2.10 Compensation

A comprehensive cleanup cannot be achieved without compensation to those affected. Residents and workers who are temporarily displaced by cleanup operations should be fully compensated for temporary alternative lodging and/or for lost wages. Residents and businesses should be reimbursed for the replacement value of personal or commercial property found to be contaminated and discarded as part of the cleanup process.

2.11 Centralization and Access to Data

EPA should gather, coordinate, and provide full access to all public and private data, environmental sampling reports, studies, risk assessments, and other information pertaining to environmental and public health issues resulting from the WTC environmental disaster and its cleanup. All data available to EPA should simultaneously be made available to the public and should not be filtered.

2.12 Public Participation

EPA should follow the regulatory requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, parts 300.805,810,815 and 820) [25] for removal and remediation of hazardous substances, including:

- public notice in local newspapers of the availability of the administrative record
- public access to EPA's record file which documents how sampling, analysis, and cleaning and clearance protocols for remediation have been determined and implemented
- public comment period
- written response to significant submitted comments.

In addition, EPA should make full use of its Internet web site to promptly post all standards, protocols, sampling and analysis data, and all other pertinent information that it gathers and educational materials that it produces or disseminates, and to provide opportunities for public comment. All postings should be written in easily understandable language and in languages appropriate for the affected communities.

3. CRITERIA FOR EFFECTIVE CLEANUP

3.1 Where to Clean

Zones 1–3, as outlined below, are created for use in this document and do not necessarily coincide with EPA's defined zones.

Zone 1—Heavily impacted buildings near ground zero that have or had:
- structural damage, and/or
- heavy debris accumulation, and/or
- significantly elevated sampling results for one or more toxic substances since 9/11 (i.e., sampling results that indicate exceedence of NCP risk-based standards).

Zone 2—Other buildings within EPA's designated cleanup zone, located:

- river to river, south of Canal and Pike Streets.

Zone 3—Buildings outside EPA's designated cleanup zone:

- where there is potential for exposure to WTC contaminants, e.g., where there has been visible dust ***or*** symptoms or illness, ***or*** where USGS or other aerial maps or modeling show plume dispersion or contamination [26, 27].

The following sections proceed from preparations for cleanup, section 3.2, to the cleanup itself, section 3.3, to the clearance standards which can be used to evaluate adequacy of removal of contaminants.

3.2 Preparations for Cleanup

- Prior to cleanup, a building-wide assessment should be undertaken in each instance, taking into account damage, prior cleanup or abatement efforts,

if any, and incidence of occupant symptoms or illness. In Zones 1 and 2, asbestos and/or fibrous glass should be presumed to be present, unless sampling results indicate otherwise. In Zone 3 buildings under consideration for cleanup, representative sampling should include asbestos and fibrous glass. The building-wide assessment should also include representative sampling in both occupied and unoccupied spaces, including mechanical ventilation systems, utilizing sufficiently large sample size, for lead, dioxin, and mercury. Sampling for mold should be included where there is a recent history of water incursion from structural damage, firefighting efforts, or uncontrolled sprinkler discharge.

- Since indoor spaces within Zones 1 and 2 are presumed to have been contaminated with asbestos, they should receive mandatory abatements by licensed asbestos abatement contractors. If results of environmental sampling for asbestos, as outlined below in section 3.6, and for fibrous glass, lead, dioxins, and mercury, are negative for any given space, EPA may present these results to the occupant and suggest that cleaning may be unnecessary. However, in this circumstance the occupant should have the ultimate authority either to request or to waive a cleaning. In determining whether an indoor space is contaminated with asbestos, the occupant should be permitted to choose from among air sampling and/or dust sampling (i.e., air sampling under aggressive conditions and microvac sampling, as detailed in section 3.8).
- Geographically representative, comprehensive, broad-spectrum testing for particle size distribution and for speciation for heavy metals and toxic organic compounds should be conducted in heavily impacted buildings (Zone 1) and at various distances from Ground Zero in Zones 2 and 3. Sampling should include but not be limited to asbestos, fibrous glass, lead, silica, mercury, dioxin, pH, PCBs, PAHs, and, where there is a history of water incursion, mold. Any protocol for geographic sampling should reference the extensive list of contaminants reported in Lioy et al. [28].
- Sample analysis should utilize tests with adequate sensitivity to detect all target substances at concentrations in air or on surfaces lower than 10^{-6} NCP risk-based standards, or background levels, whichever is lower. If test results produce a characteristic 'fingerprint,'' that information should then be used to track WTC toxics beyond the designated cleanup.

3.3 Cleanup/Abatement

1. Cleanup Protocol — State-of-the-art, most effective and protective measures available should be used to clean exteriors, mechanical ventilation systems and ducts, and all interior spaces, as determined in a transparent public review and comment process by EPA and outside experts. (See section 2.12.)

2. Mechanical ventilation systems, ducts, and plenums should be cleaned by qualified persons, such as licensed asbestos abatement workers utilizing appropriate respiratory protection and personal protective equipment. Where ducts are lined with fibrous glass, the preferred option is replacement. Ventilation filters should be replaced and changed at least twice annually. In the absence of standards for removal of toxic contaminants from mechanical ventilation systems, the standards of the National Air Duct Cleaners Association [29] must be supplemented by site-specific protocols for removal of asbestos, lead, or other toxic substances [30]. Procedures for asbestos abatements specified in the National Emissions Standards for Hazardous Air Pollutants (NESHAPs) [31] and the asbestos abatement guidelines of the U.S. Army Corps. of Engineers [32] should be followed.

3. All habitable indoor spaces, including residences and workplaces, and all non-habitable indoor spaces, including mechanical ventilation systems, plenums, elevator shafts, hallways, basements, boiler rooms, spaces above dropped ceilings, etc., within Zones 1 and 2 should be presumed to have been contaminated with asbestos and should receive mandatory asbestos abatements, pursuant to the National Emissions Standards for Hazardous Air Pollutants (NESHAPs) [33] and the asbestos abatement procedures of the U.S. Army Corps. of Engineers [34], unless found to be free of 9/11-derived asbestos.

4. Where representative building sampling in Zones 1 and 2 finds evidence of contamination other than asbestos, appropriate cleanup protocols must be implemented in conjunction with the asbestos abatement. Consideration should be given both to adsorption of contaminants onto particulate matter and to volatilized substances.

5. Asbestos-contaminated carpets cannot be effectively cleaned by either vacuuming or HEPA-vacuuming (including wet extraction HEPA vacuuming) [35]. Contaminated carpets or other porous materials can serve as sources of continuing long term exposure. Carpets should be tested using ASTM method D 5755 (microvac). Contaminated carpets should be discarded. Occupants or owners should be reimbursed by the government for the loss of their carpets.

6. Window- and wall-mounted air conditioning/heating units should be carefully removed under containment from spaces that receive asbestos abatements. They should either be steam-cleaned (and filters replaced) or discarded and replaced with new units. Steam cleaning or replacement costs should be borne by the government.

7. Remediation efforts in Zone 3 buildings where multiple contaminants are found should be similarly coordinated.

8. Remediation of mold should be conducted in accordance with published guidelines of the New York City Department of Health [36] and the United States Environmental Protection Agency [37].

9. Demolition of contaminated buildings or parts of buildings has the potential to re-release contaminants into the air, possibly resulting in reentry and

redeposition of contaminants into nearby buildings. All demolition procedures should follow the regulatory requirements of the Clean Air Act National Emission Standards for Hazardous Air Pollutants (NESHAPs) at 40 CFR §61.145 [38], including but not limited to wetting of surfaces, isolation of demolition areas with negative pressure, and controlling demolition activities to prevent escape of fugitive emissions to the ambient air. EPA should provide at least one week's notice to area residents and workers of any planned demolition activities.

3.4 NCP Principles for Environmental Clearance Standards

The National Contingency Plan (NCP), 40 CFR 300.430 (Remedial Investigation1 Feasibility Study and Selection of Remedy), specifies that EPA use standards for removal or remediation that are pegged to risk assessment levels:

- "The screening concentration for a specific hazardous substance corresponds to its reference dose for inhalation exposures or for oral exposures" [39] (non-carcinogens).
- "If the substance is a human carcinogen" (the screening concentration) corresponds to its 10^{-6} individual lifetime excess cancer risk for inhalation exposures or oral exposures" [40].
- EPA should consider the effect of multiple contaminants or pathways and should develop standards for evaluation of synergistic effects [41].

3.5 Gold Standard Criteria for Developing Cleanup Clearance Standards

The following criteria should be utilized in developing cleanup clearance standards:

- All habitable and non-habitable indoor spaces within Zones 1 and 2 should be cleaned to a clearance standard based on the above NCP risk criteria. All habitable and non-habitable indoor spaces within Zone 3 that had visible dust or symptoms or illness or where USGS, NASA, or other aerial maps or modeling show plume dispersion or contamination should also be cleaned to a clearance standard based on the above NCP criteria. An abatement or cleanup that does not result in attainment of clearance standards should be repeated until clearance standards are met [42]. Habitable or non-habitable spaces within Zones 1 and 2 that meet this standard prior to cleanup may be exempted from cleanup if the occupants agree. (See Endnote 20.)
- All habitable and non-habitable indoor spaces within Zone 3 that had visible dust or symptoms or illness or where USGS, NASA, or other aerial maps or modeling show plume dispersion or contamination also should be cleaned to a clearance standard based on the above NCP criteria. An abatement or cleanup that does not result in attainment of clearance standards should be repeated until clearance standards are met. Habitable or non-habitable spaces within

Zones 1 and 2 that meet this standard prior to cleanup may be exempted from cleanup if the occupants agree. (See Endnote 20.)

- EPA should implement a transparent public review and comment process for all aspects of its cleanup plans, including risk assessment, clearance standards, and abatement methodologies, as specified in section 2.12. EPA should utilize its own experts as well as outside experts to establish clearance standards for mercury, dioxins, and other contaminants based on the NCP risk assessment criteria above.
- All indoor spaces that are abated for asbestos must be tested to clearance standards as outlined below. All indoor spaces that test positive for contaminants other than asbestos prior to cleanup shall be retested to clearance standards after cleanup.

3.6 Clearance Standard for Lead Dust

The cleanup ***goal*** for 9/11-derived lead dust on surfaces and in ducts should be 10 μg/sq ft (wipe sample) with a clearance ***standard*** of 20 μg/sq ft [43]. These are practical criteria for monitoring since at least five of seven EPA-accredited lead laboratories within EPA Region 2 indicate they have reporting limits at or below 10 μg/ft2; 20 μg/ft2 is required for accreditation [44].

3.7 Clearance Standards for Mold

The presence of visible mold should trigger a full mold remediation as per New York City Department of Health and EPA guidelines [45, 46]. A recent history of water incursion or the smell of mold or mildew, even in the absence of visible mold, should trigger an investigation for mold contamination. The investigation may include environmental sampling for mold. Environmental sampling must be utilized in ascertaining whether clearance standards have been met. Clearance standards for mold should be:

1. resolution of the water or moisture problem, and
2. indoor fungal counts not significantly elevated above measured ambient outdoor levels, and
3. the absence of elevated levels of toxic molds.

3.8 Asbestos-Sampling and Analysis Protocols, Clearance Standards

Air sampling, even the aggressive air sampling techniques required by the Asbestos Hazard Emergency Response Act (AHERA) and the NYC Asbestos Control Program, may not be effective for measurement of fibers trapped in reservoirs such as carpets and upholstery [47]. EPA Region 8 is currently employing additional sampling methodologies in its asbestos cleanup in Libby, Montana

[48]. Therefore, additional sampling methodologies should be utilized to determine whether WTC asbestos fibers are embedded in carpets or other porous materials. EPA, in consultation with occupants, should determine which one or more of the following methods to use:

- ***Aggressive Air Sampling (at least 5 samples per residence or similarly-sized workplace)—A*** 1-horsepower leaf blower should be used to stir up settled asbestos fibers, as required by the New York City Asbestos Control Program [49]. Laboratory analysis should utilize TEM (transmission electron microscopy). All asbestos fibers, including those smaller than 5 microns, should be counted. The clearance standard for asbestos in air should be the concentration that represents an excess lifetime cancer risk of no greater than the 1 in a million (10^{-6}) risk level established by EPA (0.000004 fibers (f)/cc, PCM equivalent) [50]. If this is not technically achievable, EPA should show why not and should use the highest standard technically achievable. Filter overload or clogging when testing subsequent to cleanup should be taken as an indication that additional cleanup is warranted.
- ***Dust Sampling—at least 5 samples per residence or similarly-sized workplace, obtained from microvacuuming of dust,*** ASTM method ***D*** 5755 with a hand-held microvacuum suction pump. When carpet or fabric is sampled by this method, use the suction pump for at least 30 minutes over a 16-inch-square (100 cm^2) area of the carpet/fabric, working the pump deep into the carpet pile or fabric. Samples should be collected in areas least affected by prior cleaning and other activities, i.e., under refrigerators, stoves, and radiators. Sampling results above 10,000 structures per square centimeter (s/cm^2) are considered to exceed background levels and should trigger consideration of abatement. Results at or above 100,000 s/cm^2 are considered highly elevated and should trigger abatement [51].

3.9 Clearance Standard for Fibrous Glass

The clearance standard for fibrous glass should be 0.01 f/cc, PCM analysis [52].

4. LONG-TERM PUBLIC HEALTH NEEDS

4.1 Health Registry and Medical Surveillance

A single health registry and medical surveillance system, coordinated among the various relevant health organizations, needs to be established for the following distinct exposure populations:

- people caught in the dust cloud on September 11,
- rescue and recovery workers, including volunteers
- workers involved in the restoration of essential services

- workers involved in the removal of contaminants from impacted buildings
- residents, students, and workers within EPA's designated cleanup zone
- other residents, students, and workers who have exhibited symptoms or illness that can be reasonably expected to be 9/11-related or whose buildings are shown through environmental sampling to have been contaminated by WTC toxic substances

4.2 HEALTH CARE DELIVERY

Medical care, at government expense, should be provided to people who suffer adverse health effects related to the events of September 11. Post-traumatic stress disorders and other emotional traumas and mental health conditions should be included in the health conditions surveyed and treated.

4.3 Remediation Prior to Reconstruction or Reuse

The 16 acres of the World Trade Center complex, the waste transfer site at Pier 25, and the sites of any other destroyed or demolished buildings should be determined to be free of contamination prior to reuse or reconstruction.

4.4 Research

No other large urban community in the United States has experienced such a major environmental disaster. Given the presence of many major research institutions, New York City is an ideal setting in which to continue research characterizing long-term environmental and health effects of such disasters. In order to increase the ability of the government to promptly and effectively remediate environmental disasters and prevent further health damage, a National Environmental Disaster Research Center should be established in New York City for the purpose of

- determining background levels of contaminants present in New York City prior to September 11 and currently, outdoors and indoors,
- determining increases of concentrations of contaminants outdoors and indoors resulting from the World Trade Center disaster,
- determining background biological burdens of contaminants in the tissues of New Yorkers and the health impacts of additional exposure to individual and multiple pollutants,
- quickly mobilizing emergency response and scientific resources in the event of an environmental disaster,
- evaluating and making recommendations for improvement in emergency preparedness and response, including training of first responders, availability of equipment, policies for building and area evacuation, fire suppression and spill response techniques, etc.,
- assessing the need for new regulatory standards, and

- developing new methods and improving current methods for measuring and tracking contaminants and evaluating health risks.

DISCLAIMER

This document represents the current opinions of the authors and is based on the information available to them at the time of writing. This is a science-based policy document, the purpose of which is to foster public discussion and to influence government policy. This document should not be used for technical guidance in the design or application of contaminant testing or remediation, for which site-specific professional assistance should be obtained from qualified industrial hygienists, ventilation engineers, and other environmental experts. The authors emphasize that their participation in meetings with EPA or other government agencies does not relieve these agencies of their legal and ethical obligations to provide for a full public review and comment process in the design and implementation of an effective and comprehensive cleanup.

ENDNOTES

1. For example, elevated concentrations of asbestos have been found at 105 Duane Street and 90 Church Street. Elevated levels of lead dust have been found at Stuyvesant High School and borough of Manhattan Community College. Elevated levels of mercury have been found at 90 Church Street and 45 Warren Street. Elevated concentrations of dioxin have been found at 30 West Broadway and 100 Church Street.
2. For example, elevated levels of mold have been found at 90 Church Street, 30 West Broadway, and 130 Liberty Street.
3. Levin, Dr. Stephen, Co-Director, Mount Sinai-Irving J. Selikoff Center for Occupational and Environmental Medicine, presentations at "Beyond September 11—Environmental and Public Health Policy—A Working Conference," The Graduate Center, City University of New York, May 9, 2002, and "A Conference: The Public Health Impact of September 11th," Hunter College, City University of New York, March 14,2002.
4. Bernard, B. P. et al., Impact of September 11 Attacks on Workers in the Vicinity of the World Trade Center—New York City, ***Morbidity and Mortality Weekly Report,*** Centers for Disease Control, September 11,2002, pp. 8-10.
5. Ibid.
6. ***American Journal of Public Health.*** March 2001, Vol. 91, No. 3:20-21, http://www.apha.org/legislative/policy/Pols2000_rev.pdf..
7. US EPA, Title 40—Protection of Environment, Chapter 1—Environmental Protection Agency, Part 300—National Oil and Hazardous Substances Pollution Contingency Plan, www.access.gpo.gov/nara/cfr/cfrhtml_00/Title_40/40cfr300_00.html.
8. For example, at a July 9,2002 EPA meeting with representatives of labor unions and the New York Committee for Occupational Safety and Health (NYCOSH), Kathleen Callaghan, Assistant Administrator, Region 2 EPA,. stated that Lower Manhattan cleanup could not extend to workplaces because FEMA declined to provide funds for workplace cleanup.

9. For example, recontamination has occurred in Lower Manhattan buildings that were incompletely or inadequately cleaned, including 105 Duane Street, 150 Franklin Street, and Stuyvesant High School.
10. U.S. Code of Federal Regulations, Title 40—Protection of Environment, Chapter 1—Environmental Protection Agency, Part 300—National Oil and Hazardous Substances Pollution Contingency Plan, Subpart E—Hazardous Substance Response, Sec. 300.400 General, (d) Entry and Access, http://frwebgate.access.gpo.gov/cgi-bin/get-cfr.cgi?TITLE=40&PART=300&SECTION=400&YEAR=2001&TYPE=TEXT.
11. Representative sampling means sampling which accurately characterizes the degree and distribution of contamination in a building or area.
12. U.S. Code of Federal Regulations, Title 40—Protection of Environment, Part 61—National Emission Standards for Hazardous Air Pollutants, Subpart M—National Emission Standard for Asbestos, Sec. 61.145 Standard for Demolition and Renovation, http://frwebgate.access.gpo.gov/cgi-bin/get-cfr.cgi?TITLE=40&PART=61&SECTION=145&YEAR=2001&TYPE=TEXT.
13. US EPA (April 25, 1986) Toxic Substances; Asbestos Abatement Projects. Final Rule. Federal Register, vol. 51, p. 15722 ff.
14. For example, environmental sampling at 105 Duane St found unacceptable levels of asbestos even after removal of visible dust.
15. "In that the materials containing asbestos were used in the construction of the Twin Towers, the settled dust from their collapse must be presumed to contain asbestos. Therefore, the use of Transmission Electron Microscopy (TEM) is not necessary in order to establish that the applicable provisions of the Construction Asbestos standard, 29 CFR 1926.1101 apply during the demolition or salvage of the affected structures." Henshaw, John, Assistant Secretary for Occupational Safety and Health, United States Department of Labor, Standard Interpretation Letter, January 31, 2002, http://www.nycosh.org/WTCcatastrophe/OSHA_Jan31_InterpretationLetter.html.
16. "We have advised people that if they have WTC dust in their homes or offices, it may be easiest for them simply to assume that it meets EPA's definition for "asbestos-containing material" rather than paying to test each dusted area separately and awaiting the results before taking any further action. We have further advised people to use professional asbestos abatement contractors to carry out cleaning wherever there is more than a minimal amount of dust. . . . We have been giving this advice, inter alia, because a significant number of the WTC bulk dust samples that we analyzed did have more than 1% asbestos. . . ." Mugdan, Walter, Regional Counsel, Region 2, United States Environmental Protection Agency, "Environmental Impacts and their Remediation, presentation at annual meeting of the Environmental Law Section of the New York State Bar Association, New York Marriott Marquis Hotel, New York City, January 25, 2002.
17. U.S. Code of Federal Regulations, Title 40, Part 61, Subpart M, National Emission Standard for Hazardous Air Pollutants—Asbestos, http://www.nycosh.org/asbestosNESHAP.htm.
18. U.S. Army Corps. Of Engineers, Department of the Army, Asbestos Abatement Guideline Detail Sheets, Engineer Pamphlet 1110-1-11, Washington D.C., 30 September 1997, www.usace.army.mil/inet/usace-docs/eng-pamphlets/ep1110-1-11/entire.pdf.

19. Code of Federal Regulations, Title 40 • Protection of Environment, Chapter 1—Environmental Protection Agency, Part 300 - National Oil and Hazardous Substances Pollution Contingency Plan, http://www.access.gpo,gov/nara/cfr/cfrhtml_00/Title_40/40cfr300_00.html.
20. For purposes of this document, "occupant" shall mean tenant, landlord, worker, and/or employer. If there is more than one occupant (i.e., tenant and landlord or worker and employer), all affected parties should be involved in the process of selecting sampling and cleanup options. Where workers are represented by unions, the unions should also be part of the process. EPA should be responsible for implementing such a process.
21. U.S.Code of Federal Regulations, Title 40—Protection of Environment, Chapter 1—Environmental Protection Agency, Part 300—National Oil and Hazardous Substances Pollution Contingency Plan, Subpart E—Hazardous Substance Response, Sec. 300.430 General, Subpart E—Hazardous Substance Response, http://frwebgate.access.gpo.gov/cgi-bin/get-cfr.cgi?TITLE=40&PART=300&SECTION=430&YEAR=2001&TYPE=TEXT.
22. Lioy, Paul J. et al., "Characterization of the Dust /Smoke Aerosol That Settled East of the World Trade Center in Lower Manhattan After the Collapse of the WTC 11 September, 2001," ***Environmental Health Perspectives,*** Vol. 110, No. 7., pp. 703-714, July 2002.
23. U.S. Environmental Protection Agency, Region VIII, Amphibole Mineral Fibers in Source Materials in Residential and Commercial Areas of Libby Pose an Imminent and Substantial Endangerment to Public Health, memorandum from C.P. Weis, Senior Toxicologist, to P. Peronard, On-Scene Coordinator, December 20, 2001, p. 12.
24. Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations: Executive Order 12898, February 11, 1994, http://www.epa.gov/swerosps/ej/html-doc/execordr.htm.
25. Code of Federal Regulations, Title 40—Protection of Environment, Chapter 1—Environmental Protection Agency, Subchapter I—Superfund, Emergency Planning, and Community Right to Know Programs, parts 300.805 (Location of the Administrative File), 300.810 (Contents of the Administrative Record File), 300.815 (Administrative Record File for a Remedial Action) and 300.820 (Administrative Record File for a Removal Action), http://www.access.gpo.gov/nara/cfr/waisidx_01/40cfr300_01.html.
26. For example, USGS asbestos dispersion maps show asbestos dust well beyond EPA's designated cleanup zone, Clark, et. al., "World Trade Center area, New York, NASA/JPL AVIRIS data, Sept 16, 2001, 16:21 GMT, US Geological Survey, Imaging Spectroscopy Tetracorder 4.0a8 product, Material Absorption Feature map (minerals with Mg-OH features near 2.3-microns).
27. For example, NASA aerial photographs clearly show that many areas of Brooklyn were subject to fallout from the WTC plume. *Newsday,* August 23, 2002, page A5. http:llwww.newsday.com/news/local/newyork/ny-usplum23283531 4aug23.story?coll=ny%Dnynews%2Dheadlines
(Photos are available on the Web at www.911ea.org.)
28. Lioy, Paul J. et al., "Characterization of the Dust/Smoke Aerosol That Settled East of the World Trade Center in Lower Manhattan After the Collapse of the WTC 11 September, 2001," ***Environmental Health Perspectives,*** Vol. 110, No. 7, July, 2002, pp. 703-714.

29. http://www.nadca.com.
30. See, for example, a summary of the protocol for abatement of lead dust in the mechanical ventilation systems at Stuyvesant High School http://www.stuypa.org/environment/02_09_Inspection.pdf.
31. U.S. Code of Federal Regulations, Title 40, Part 61, Subpart M, National Emission Standard for Hazardous Air Pollutants — Asbestos, **http://www.nycosh.org/asbestosNESHAP.html.**
32. U.S. Army Corps. Of Engineers, Department of the Army, Asbestos Abatement Guideline Detail Sheets, Engineer Pamphlet 1110-1-11, Washington D.C., 30 September 1997, www.usace.army.mil/inet/usace-docs/eng-pamphlets/ep1110-1-11/entire.pdf.
33. U.S. Code of Federal Regulations, Title 40, Part 61, Subpart M, National Emission Standard for Hazardous Air Pollutants — Asbestos, http://www.nycosh.org/asbestosNESHAP.html.
34. U.S. Army Corps. Of Engineers, Department of the Army, Asbestos Abatement Guideline Detail Sheets, Engineer Pamphlet 1110-1-11, Washington D.C., 30 September 1997, www.usace.army.mil/inet/usace-docs/eng-pamphlets/ep1110-1-11/entire.pdf.
35. Kominsky, J. R. et al. (1993). Evaluation of Three Cleaning Methods for Removing Asbestos from Carpet: Determination of Airborne Asbestos Concentrations Associated with Each Method. US EPA Risk Reduction Engineering Laboratory. Cincinnati, OH. EPA Publication Number EPA/600/SR-93/155, http://www.epa.gov/cgi-bin/claritgw?op-Display&document-clserv:epa-cinn:1522;&rank=4&template=epa.
36. New York City Department of Health & Mental Hygiene, Bureau of Environmental & Occupational Disease Epidemiology, Guidelines on Assessment and Remediation of Fungi in Indoor Environments, http://www.ci.nyc.ny.uSmtmVdoh/htmVepi/motl .html.
37. U.S. Environmental Protection Agency, Office of Air and Radiation, Indoor Environments Division, Mold Remediation in Schools and Commercial Buildings, EPA 402-K-01-00], March 2001.
38. U.S. Code of Federal Regulations, Title 40—Protection of Environment, Part 61—National Emission Standards for Hazardous Air Pollutants, Subpart M—National Emission Standard for Asbestos, Sec. 61.145 Standard for Demolition and Renovation, http://frwebgate.access.gpo.gov/cgi-bin/get-cfr.cgi?TITLE=40&PART=61&SECTION=145&YEAR=2001&TYPE=TEXT.
39. 40 CFR 300.430(e)(2)(i)(A), www.epa.gov/epahome/cfr40.htm.
40. Ibid.
41. 40 CFR 300.430(e)(2)(i)(D), www.epa.gov/epahome/cfr40.htm.
42. For the purposes of this document, "clearance standard" refers to either the result of pre-cleaning environmental sampling which is used to determine whether cleanup is necessary, or the result of post-cleaning environmental sampling which is used to determine whether further cleanup is necessary.
43. "Available evidence indicates that current and proposed guidelines for levels of lead in dust on floors may not adequately protect young children and that levels well below these guidelines are achievable and are often present even before intervention. Therefore, the goal should be to attain post-intervention dust lead levels that are as

low as is feasible, which is generally less than 10 µg/ft2 on floors, and that are at or below baseline levels." Centers for Disease Control, U.S. Dept. of Health and Human Services, Recommendations, Chapter 2, Assessment and Remediation of Residential Lead Exposure, Managing Elevated Blood Lead Levels Among Young Children: Recommendations from the Advisory Committee on Childhood Lead Poisoning Prevention, http://www.cdc.gov/nceh/lead/CaseManagement/caseManage_chap2.htm# Recommendations.

44. **http://www.centerforhealthyhousing.org/ht.**
45. Bureau of Environmental & Occupational Disease Epidemiology, New York City Department of Health, "Guidelines on Assessment and Remediation of Fungi in Indoor Environments." http://www.nyc.gov/html/doh/html/epi/moldrpt1.html.
46. Office of Air and Radiation, Indoor Environments Division, US Environmental Protection Agency, Mold Remediation in Schools and Commercial Buildings, EPA 402 K 01 001, March, 2001.
47. Millette, J. R., Clark, P. J., Brackett, K. A., Wheeles, R. K., "Methods for the Analysis of Carpet Samples for Asbestos," Settled Asbestos Dust—Sampling and Analysis, Appendix 4, Asbestos in Dust, Lewis Publishers, CRC Press, 1994, pp. 141-148.
48. United States Environmental Protection Agency, Region 8, Phase 2 Sampling and Quality Assurance Project Plan, Revision 0, For Libby, Montana—Evaluation of Exposure to Airborne Asbestos Fibers During Routine and Special Activities, March 2001.
49. New York City Asbestos Control Program, http://www.ci.nyc.ny.us/html/dep/pdf/asbestos.pdf.
50. U.S. EPA, Integrated Risk Management Information System (IRIS) Summary for Asbestos, www.epa.gov/iris/subst/0371.htm.
51. Millette, J. R., Hays, S. M., Settled Asbestos Dust—Sampling and Analysis, Chapter 6: Data: Levels of Asbestos in Dust, Lewis Publishers, CRC Press, 1994, p. 50.
52. Contaminants of Potential Concern Committee, World Trade Center Indoor Air Taskforce Working Group, World Trade Center Indoor Air Assessment: Selecting Contaminants of Potential Concern and Setting Health-Based Benchmarks, Peer Review Draft, September 2002, p. 21, http:llwww.tera.org/peer/WTCIDocuments.htm.

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