Final Technical Report of the Public Health Investigation to Assess Potential Exposures to Airborne and Settled Surface Dust in Residential Areas of Lower Manhattan

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New York City Department of Health and Mental Hygiene
and
Agency for Toxic Substances and Disease Registry
U.S. Department of Health and Human Services

As a part of the

World Trade Center Environmental Assessment Working Group

September 11, 2001

In remembrance of those who were lost on September 11, 2001, and to the families and friends who will love them forever and keep their memories alive.

In grateful recognition of the countless responders and the many who supported their efforts.

New York City Department of Health and Mental Hygiene

U.S. Agency for Toxic Substances and Disease Registry

EXECUTIVE SUMMARY

From November 4 through December 11, 2001, environmental samples were collected in and around 30 residential buildings in lower Manhattan. In addition, four buildings above 59th Street were sampled and used as a comparison area for this investigation. The New York City Department of Health and Mental Hygiene (NYC DOHMH) and the U.S. Agency for Toxic Substances and Disease Registry (ATSDR) conducted this limited investigation with support and collaboration from the U.S. Public Health Service Commissioned Corps Readiness Force and the World Trade Center Environmental Assessment Working Group. The purpose of the sampling was to assess the composition of both outdoor and indoor settled surface and airborne dust within residential areas around the World Trade Center. This information was used to help determine whether additional public health actions are needed to address any remaining World Trade Center-related dust inside residential areas. The information collected could also be used to compare the findings from the locations that were known or were likely to have received dust directly from the collapse of the World Trade Center towers, to findings from areas that were unlikely to have received dust directly from the disaster (comparison areas).

Attention was given to those materials reasonably expected to be in the original dust cloud and in dust generated by ongoing activities at the World Trade Center. The focus was on building materials that have been shown to have irritant properties (e.g., synthetic vitreous fibers [SVF] and gypsum) and be associated with long-term health concerns (i.e., crystalline silica and asbestos). The samples collected during this investigation were analyzed for the following materials: asbestos, SVF, mineral components of concrete (crystalline silica, calcite, and portlandite), and mineral components of building wallboard (gypsum, mica, and halite). Efforts were made to get as much information as possible with the sampling that could be conducted, given accessibility and equipment limitations.

Results from this investigation do not necessarily reflect conditions that would be found in other buildings, at other times just following the collapse, or after the sampling period. The measurements reflect conditions present at the time of the sampling (November 4–December 12, 2001) in the buildings and areas sampled. The limited number of results obtained from the comparison areas above 59th Street was an attempt to determine the New York City–specific background levels of asbestos, SVF, mineral components of concrete (quartz, calcite, and portlandite), and mineral components of building wallboard (gypsum, mica, and halite).

Sampling Overview

U.S. Public Health Service Commissioned Corps Readiness Force Officers were detailed to the New York City Department of Health and Mental Hygiene and composed the sampling teams for this investigation. The teams completed a survey form for each sampling location. The information collected by the survey was obtained from direct

observations and from owners or representatives of building management when available. The survey form and photographs were reviewed along with the analytical results to put the sampling results into the context of where and how the samples were obtained and to determine the general conditions of the sampling locations.

Air and settled surface dust samples were collected and analyzed for the following materials used in WTC construction components: asbestos, SVF, crystalline silica, calcite, portlandite, gypsum, mica, and halite. SVF *(*e.g., fiberglass) is used in thousands of products because of its chemical resistance, strength, and ability to insulate against heat and sound. All of the crystalline minerals analyzed in this project are commonly used in building construction materials. *Quartz,* a form of crystalline *silica*, is a naturally occurring mineral and is a component of cement. *Cristobalite* and *tridymite* are different crystalline forms of silica. *Calcite and portlandite* are naturally occurring, high pH minerals used in cements and mortars. *Gypsum* is a naturally occurring mineral used in plaster, wallboard, and in some cements. *Mica* is a group of naturally occurring minerals that are used in paint, joint cements, plastics, roofing, and rubber. *Halite* (also known as rock salt or sodium chloride) is used in ceramic glazes, fire extinguishing, metallurgy, and highway de-icing and table salt.

In addition to analyzing the samples for the fibers and minerals found in common building materials, when a sufficient quantity of settled surface dust was present, it was mixed with water and the pH of the resulting mixture was measured.

Air Samples

Air samples were collected using vacuum pumps to draw air through a filter positioned at an adult's breathing level. In addition to a filter for fiber analysis, multiple particulate samplers were placed at each sampling location to collect different particle sizes including respirable (PM4 and PM2.5), thoracic (PM10), and total inhalable (PM100). This resulted in the collection of overlapping, or nested, particulate size fractions.

The particle size determines how deeply a particle can travel into the respiratory tract. Respirable particles with diameters of 4 microns or less (PM4) are very small particles that can be breathed in and can travel deeply into the air sacs of the lung. At some locations another sampler was used that collected a smaller set of respirable particles, those with diameters of 2½ microns (PM2.5) or less. Another sampler collected particles with diameters of 10 microns (PM10) or less. This sampler would collect not only respirable particles, but also those slightly larger particles that tend to land in the upper regions of the respiratory tract, including the throat. A fourth sampler collected a larger set of particles, those 100 microns (PM100) or less in diameter. The larger particles in this fraction can land in the nose and throat. Where a particle lands determines what types of health effects might be experienced. Particles too large to travel into the narrower passages of the lower respiratory tract might deposit in the upper airways (e.g., the nose and throat) and cause irritation. Similarly, larger particles might cause eye irritation. If

the settled surface dust contains sufficient amounts of particles of a very small size, then effects consistent with particles reaching the lower respiratory tract might occur (coughing, shortness of breath).

Each of the particulate air sample fractions was analyzed for crystalline minerals (quartz, cristobalite, tridymite, calcite, portlandite, gypsum, mica, and halite). X-ray diffraction analysis (XRD) identifies a mineral by the unique diffraction pattern given off when the x-ray strikes its surface. The diffraction pattern serves as a "fingerprint" to identify the mineral present.

Other air samples were screened for fibers using phase contrast microscopy (PCM) to count the total number of all fibers present. If the concentration of total fibers was higher than the maximum concentration of fibers found in the comparison homes (0.003 fibers per cubic centimeter of air) the sample was re-analyzed for asbestos by transmission electron microscopy (TEM). Additionally, scanning electron microscopy (SEM) was used to look for SVF if the PCM fiber counts was higher than 0.003 fibers per cubic centimeter (f/cc) and if the settled surface dust sample from that area contained SVF.

Settled Surface Dust Samples

The composition of settled surface dust reflects particles and fibers that have been tracked into an area or that were present in the air and have with time, deposited on surfaces. Settled surface dust was collected indoors using a specialized vacuum cleaner. Outside settled surface dust was collected by scooping any visible dust-type material into a container. As with the air samples, the settled surface dust samples were analyzed to assess the presence of fibers and minerals. The analysis performed does not allow the determination of what size particles are present in the dust. The composition of the settled surface dust was evaluated to determine if, on the basis of its composition, it could be an irritant if it became airborne or came in contact with skin or eyes during cleaning activities.

The dust samples were analyzed for the presence of asbestos and SVF using polarized light microscopy (PLM). PLM can distinguish between fiber types by their unique appearance and color when viewed under different wavelengths of light. In addition, TEM analysis was conducted on all dust samples that showed asbestos content by PLM as less than 1%. TEM analysis is very specific, can detect smaller fibers of asbestos, and is subject to less interference than PLM.

The dust samples were also analyzed for mineral content using XRD as described previously for the air samples. For the dust samples, the mineral and the fiber results are expressed as a percent, indicating the weight percent each component represents in the portion of the dust sample analyzed. The different analytical techniques, XRD and microscopy (PLM, TEM, SEM), help to characterize what was in the settled surface dust; however the results from the two methods each performed on a portion of the dust

collected, cannot simply be added together to "sum up" what was in the dust. XRD results are based upon the weight of the dust sample analyzed. While, PLM, TEM, and SEM results are based on the surface area viewed under the microscope.

Limitations

While the goal of the sampling was to evaluate the air and dust samples for a range of contaminants, there is no one sample collection method or analysis that can provide all of the determinations that were desired. The analysis strategy was to identify what components were present in order to provide the public with information quickly if any of the analyses revealed a significant concern. In order to strive for both of those goals, some modifications to conventional protocols were made which limited some analyses from determining the precise level of the materials in the sample (e.g., XRD conducted on air and dust samples). Whenever an analysis is expanded beyond its specific intent, there is the potential loss of sensitivity and an increase in the variability in the data. Those particular analytical results are reported as estimated values and marked with a "J."

Results for the airborne particulate matter were rejected due to issues found during the quality assurance analysis. However, the XRD analysis for airborne minerals that used the same filter samples as the particulate matter analysis are considered valid because the analysis method does not depend on the filter sample weighing process used to determine the particulate matter concentration. The XRD mineral air concentrations are based on individual mineral weight standard curves—not the weight of the dust sample collected on the filters. These standard curves are not impacted by pre- and post-sampling filter weight variability.

Air Sampling Results

Total fiber counts of air samples taken in lower Manhattan were similar to the comparison areas above 59th Street sampled during this investigation. The six lower Manhattan areas that had elevated total fiber counts were re-examined by TEM and SEM to determine the types of fibers. The TEM and SEM results indicated that neither asbestos nor synthetic vitreous fibers (e.g., fiberglass) contributed to the elevated total fiber counts.

Air sampling results for minerals detected quartz (a form of crystalline silica) and other building-related materials in lower Manhattan. The other forms of crystalline silica were not detected in any air samples except for a one-time detection of cristobalite. The estimated concentrations of these minerals in air were low. In some locations, mineral components of concrete (quartz, calcite, and portlandite) and mineral components of building wallboard (gypsum, mica, and halite) were detected in air samples at higher estimated levels in lower Manhattan residential areas than in samples taken at comparison residential areas above 59th Street. The levels of minerals seen in airborne dust do not

pose potential health hazards even for a continuous year of exposure at the highest levels detected.

Settled Surface Dust Results

Results of the settled surface dust analysis indicate the composition of settled surface dust in lower Manhattan is different than the dust analyzed from the comparison areas above 59th Street. Although the materials found are consistent with materials expected from the World Trade Center collapse, these results cannot determine the actual source of the materials present because these materials are common building components and can come from other sources in a busy urban area.

In lower Manhattan, asbestos was found in indoor dust in 15 of 83 (18%) samples from residential units and common areas at levels ranging from less than 1% (<1%) to 1.5%. Asbestos was detected in 6 of 14 (43%) outdoor samples at levels ranging from <1% to 3.4%. Indoor settled surface dust contained SVF in 40 of 83 (48%) locations ranging from 2% to 35% of the dust content. SVF was detected in 11 of 14 (79%) outdoor locations at levels ranging from 1% to 72%. No asbestos or SVF was detected in dust in the comparison areas above 59th Street.

The XRD analysis for crystalline minerals in settled surface dust is semiquantitative (estimated values, indicated by "J"). However, quartz, calcite, portlandite and gypsum appear to make up a higher percentage of dust in some buildings in lower Manhattan when compared to settled surface dust samples from buildings above 59th Street. Quartz was detected up to an estimated 31%J versus up to 2%J found in the comparison areas above 59th Street. Neither cristobalite nor tridymite was detected in any of the settled surface dust samples. Similarly gypsum was found at a maximum estimated concentration of 30%J in settled surface dust, higher than the 4%J estimated in the comparison areas above 59th Street. Calcite and portlandite had maximum concentrations of 21%J and 8%J respectively. At lower Manhattan locations sampled, quartz was detected in 81% of common areas and 53% of residences. Gypsum was seen in 88% of common areas and 79% of residences. Minerals were found in all lower Manhattan outdoor settled surface dust samples at estimated values ranging as high as 27%J quartz, 19%J calcite, 6%J portlandite, and 27%J gypsum. No visible settled outdoor dust was available in the comparison areas above 59th Street.

Several of the minerals detected in the settled surface dust samples, such as portlandite and calcite, can make the dust more alkaline, or raise the pH. Only two dust samples provided enough material for the determination of pH. The samples, collected from two outdoor locations in lower Manhattan, had pH levels of 8.6 and 9.8. On the pH scale, values less than 7 are considered acidic, a value of 7 is neutral, and values above 7 are alkaline or basic. Based on the results of the pH analyses, these dust samples are slightly alkaline. This is consistent with the detection of portlandite and calcite (alkaline minerals present in concrete) in the mineral analysis of the dust sample from the same location.

Conclusions

Based upon the analytical results of samples taken between November 4 through December 11, 2001, and information collected during the sampling effort, the New York City Department of Health and Mental Hygiene and the U.S. Agency for Toxic Substances and Disease Registry make the following conclusions (not in order of importance).

- Total fiber counts of air samples taken in lower Manhattan were similar to the comparison areas above 59th Street sampled during this investigation. The six lower Manhattan areas that had elevated total fiber counts were re-examined by transmission electron microscopy (TEM) and scanning electron microscopy (SEM). The TEM and SEM results indicated that neither asbestos nor SVF contributed to the elevated fiber counts.

- Low levels of asbestos were found in some settled surface dust, primarily below Chambers Street. Many of the lower Manhattan locations sampled had been previously cleaned prior to this investigation. No asbestos was detected in the comparison indoor dust samples taken north of 59th Street. The City of New York has conducted follow-up activities at the locations where asbestos was detected in settled surface dust. Only two follow-up locations, outdoor areas, required professional asbestos abatement. Following-up activity at the other locations did not find any asbestos containing materials.

- When compared with the results obtained from the comparison sampling locations, the lower Manhattan residential areas sampled by this investigation tended to have a greater percentage of SVF (primarily fiberglass), mineral components of concrete (quartz, calcite, and portlandite), and mineral components of building wallboard (gypsum, mica, and halite) in settled surface dust. However, the frequency of detections and prevalence patterns of these minerals are similar in both residential areas.

- Exposure to significant amounts of synthetic vitreous fibers (SVF), mineral components of concrete (quartz, calcite, and portlandite), and mineral components of building wallboard (gypsum) may cause skin rashes, eye irritation, and upper respiratory irritation, all of which have been voiced as concerns by citizens and first responders. If the reported irritant effects are associated with World Trade Center related materials, these effects will subside once exposure to SVF, mineral components of concrete, and mineral components of building wallboard end. Some people with pre-existing heart or lung disease (e.g., asthma) or a previous history of very high levels of exposures (occupational) to SVF, mineral components of concrete, and mineral components may be more sensitive to the

irritant effects of SVF, mineral components of concrete, and mineral components of building wallboard.

- Sometimes mineral components of concrete (calcite and portlandite) and mineral components of building wallboard (gypsum, mica, and halite) were detected in air samples at higher estimated levels in lower Manhattan residential areas than in samples taken at comparison residential areas. These detected mineral levels are orders of magnitude below occupational standards. Although the occupational standards do not account for sensitive individuals or extended periods of exposure, they provide a comparison to an established health guidance value. The levels of minerals seen in airborne dust do not pose potential health hazards even for a continuous year of exposure at the highest levels detected.

- Some settled surface dust could become airborne if disturbed. Therefore, people could potentially inhale the asbestos, SVF, mineral components of concrete (quartz, calcite, and portlandite), and mineral components of building wallboard (gypsum, mica, and halite) found in settled surface dust of some lower Manhattan residences. Because we did not determine the weight of dust present in the areas sampled, it is not possible to determine whether any particular residence had an elevated dust loading. Appropriate continued frequent cleaning should minimize exposures.

- Several worst-case assumptions were made in order to assess the potential long-term public health risks of airborne asbestos and quartz. Some of the assumptions were that no cleaning of indoor spaces has occurred or will occur, all fibers found in air were asbestos fibers, and the highest levels detected last fall in air represent long-term air levels. Using these worst-case assumptions, prolonged exposure (decades) to airborne asbestos and quartz *may* increase the long-term, theoretical risk of people developing lung cancer and other adverse lung health effects (more than 1 additional case in 10,000 people exposed). For individuals who conduct frequent cleaning of their residences, as recommended in this report, or participate in the U.S. Environmental Protection Agency cleaning/sampling program, it is unlikely that their exposure would resemble these worst-case conditions.

- A review of the building sampling results from this investigation indicates that there is not a consistent spatial distribution pattern of asbestos, SVF, mineral components of concrete, and mineral components of wallboard in air and settled surface dust. This indicates that the materials are heterogeneously distributed. There are many factors that may contribute to the heterogeneous distribution, including whether the area was cleaned (indoors and outdoors), cleaning method, date since last cleaning, and how much dust was initially in the area. It is not clear which factors contributed to this pattern.

- Results from this investigation do not necessarily reflect conditions that would

be found in other buildings, at other times just following the collapse, or after the sampling period. The measurements reflect conditions present at the time of the sampling (November 4–December 12, 2001) in the buildings and areas sampled. The limited number of results obtained from the comparison areas above 59th Street may or may not reflect the New York City-specific background levels of asbestos, SVF, mineral components of concrete (quartz, calcite, and portlandite), and mineral components of building wallboard (gypsum, mica, and halite).

Recommendations

Based upon the conclusions of this investigation, the New York City Department of Health and Mental Hygiene and the U.S. Agency for Toxic Substances and Disease Registry make the following recommendations.

- Because more asbestos, synthetic vitreous fibers (e.g., fiberglass), mineral components of concrete (quartz, calcite, and portlandite), and mineral components of building wallboard (gypsum, mica, and halite) were found in settled surface dust in lower Manhattan residential areas when compared to comparison residential areas, the New York City Department of Health and Mental Hygiene and the U.S. Agency for Toxic Substances and Disease Registry are recommending that people continue to conduct frequent cleaning with HEPA vacuums and damp cloths/mops to reduce the potential for exposure.

- To ensure that the recommended frequent cleaning is effective and to ensure that the health of the people of New York City is protected, the New York City Department of Health and Mental Hygiene and the U.S. Agency for Toxic Substances and Disease Registry are recommending additional monitoring of residential areas in lower Manhattan. In addition, an investigation should be conducted to better define background levels specific to the city of New York for asbestos, synthetic vitreous fibers, mineral components of concrete (quartz, calcite, and portlandite), and mineral components of building wallboard (gypsum, mica, and halite).

- Lower Manhattan residents concerned about possible World Trade Center-related dust in their residential areas can request cleaning and/or testing from the U.S. Environmental Protection Agency (EPA) by logging on to the agency's World Trade Center Web page at www.epa.gov/wtc or by calling the EPA hotline at 1-877-796-5471.