

Preliminary Survey of Air Quality and Related Health Studies Conducted in the Vicinity of Ground Zero



**Prepared for
Dr. John H. Marburger III
Director, Office of Science and Technology Policy**

**by
The Air Quality Research Subcommittee
Committee on Environment and Natural Resources**

December 2002



A Preliminary Survey of Air Quality and Related Health Studies Conducted in the Vicinity of Ground Zero

On April 29, 2002 Dr. John H. Marburger III, Director, Office of Science and Technology Policy (OSTP) asked for the assistance of the Air Quality Research Subcommittee (AQRS) of the Committee on Environment and Natural Resources (CENR) in developing a list of activities related to air quality and related health studies in the vicinity of Ground Zero.

The material presented in this report was provided by the member agencies of the CENR Air Quality Research Subcommittee and as such represents a first survey of the research community involved in research related to the collapse of the World Trade Center and its impact on air quality and possible links to human health. Although the information in this draft represents a significant fraction of the relevant activities, there are clearly some deficiencies, e.g. there is very little information on the work conducted by non-Federal organizations. The AQRS will continue to survey the community and an update to this report will be prepared when sufficient new information has been received.

This report is a scientific and programmatic document, as the preceding Subcommittee reports have been, and it is not intended to represent governmental policy.

Copies of this report are available from:
NOAA Aeronomy Laboratory
Office of the Director, R/AL
325 Broadway, Boulder Colorado 80305-3328
E-mail: aldirhoff@al.noaa.gov
Phone: 303-497-3134
Fax: 303-497-5340

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Background

The collapse of the World Trade Center buildings as a result of the terrorist attacks of September 11, 2001 produced an enormous dust plume that persisted for several days. Additional air pollution was generated by fires at the site and by the debris removal process. In the wake of this tragedy, there has been concern for the health of workers involved in the rescue and clean-up efforts and for the people whose homes and places of work are in the immediate area and who may have been exposed to this pollution. As a consequence, a number of studies have been conducted by local, State, and Federal agencies to better quantify the impacts of the attacks on local air quality and related health issues.



On April 29, 2002 Dr. John H. Marburger III, Director, Office of Science and Technology Policy (OSTP), asked for the assistance of the Air Quality Research Subcommittee of the Committee on the Environment and Natural Resources in developing a list of research activities related to air quality and health studies in the vicinity of "Ground Zero" (Appendix A). A listing of relevant activities is included in Appendix B.

Inventory Overview



The descriptions of relevant research activities provided by the various agencies are collected in Appendix B. This material covers a broad range of activities that were explored in an attempt to assess the impact of the collapse of the buildings and subsequent rescue and clean up efforts on local air quality and the potential for related human health consequences. The research activities inventoried can be organized into the following broad categories:

Measurements of outdoor pollution – The U.S. Environmental Protection Agency (EPA), the State and city of New York, and several research institutions operated air pollution monitoring systems in and around Manhattan. These were quickly augmented by a number of agencies that brought specialized equipment to the area that allowed for a more detailed measurement of gas-phase and particle-phase pollution, including its radioactivity. Dust samples were collected

Studies of Air Quality and Health at Ground Zero

directly from the air and from the surfaces on which it deposited. The chemical and physical characteristics of these materials have been characterized in detail.

Measurements of indoor pollution – The dust created by the initial building collapse and subsequent work in the area was transported through open doors and windows and through building ventilation systems into the homes, offices, and schools in the area. Monitors were set up within these structures to quantify dust and fine particle levels and to follow the return to normal indoor levels. Chemical and physical analyses have been performed on airborne and settled dust.

Pollution modeling – State of the art numerical dispersion models and physical models are being used to estimate peak particle levels at a time resolution greater than is possible with the routine monitoring equipment that was in place on September 11. These models also provided estimates of particle exposure for areas of the surrounding area where there were no measurement data.

Health studies – A number of short-term and long-term studies are underway to evaluate the impact of exposure to the pollution at Ground Zero on the health of rescue workers, those involved in debris removal, and those who work and reside in the area.

Outreach – A variety of efforts are underway to provide public access to the enormous amount of data that has been collected regarding air quality and related health issues in and around Ground Zero. Keeping the workers and residents of the area informed has also been a priority of these endeavors.

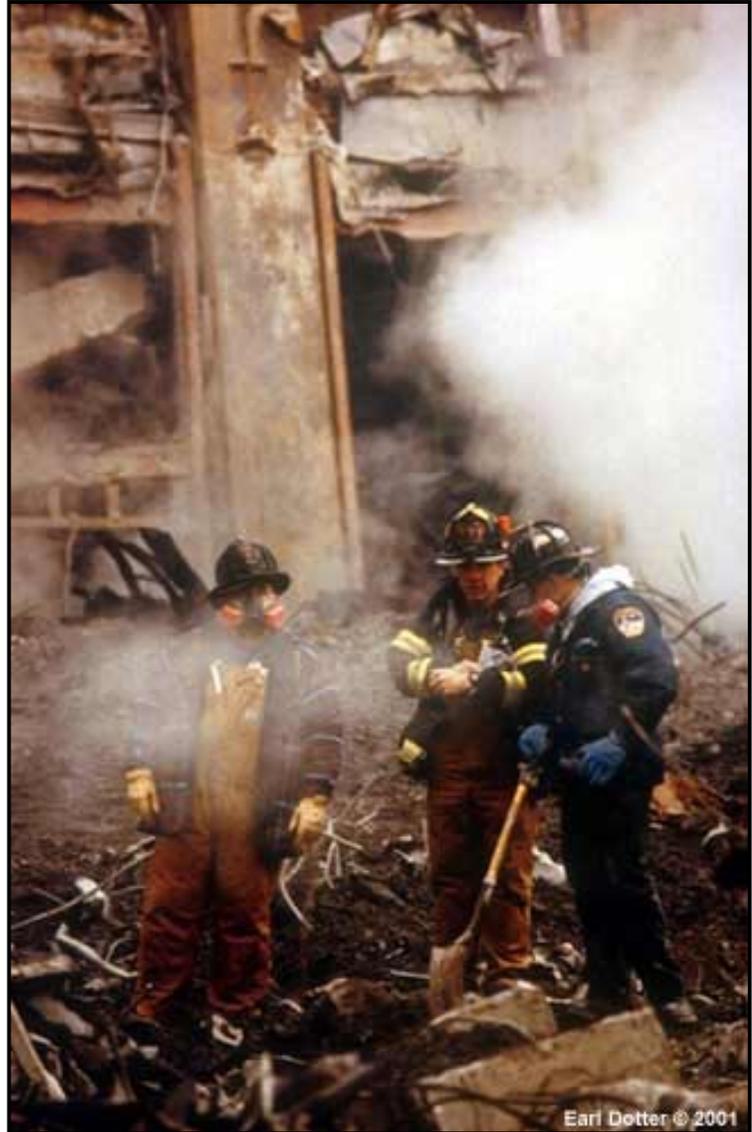


Table 1 provides a summary of the activities submitted by each agency and organized by the above categories.

Studies of Air Quality and Health at Ground Zero

Table 1. Reported activities by category

Agency Task	Activity Category				
	AQ Measurements Outdoor	AQ Measurements Indoor	Air Quality Modeling	Health Studies	Outreach
DOC-1			√		
DOD-1				√	
DOD-2	√	√			
DOD-3					√
DOE-1	√				
DOE-2	√				
DOE-3	√				
DOE-4	√				
DOE-5	√				
DOE-6	√				
DOE-7	√				
DOE-8			√		
DOE-9	√			√	
DOE-10	√				
DOE-11				√	
DOE-12			√		
DOI-1	√				
DOT-1			√		
EPA-1	√				√
EPA-2	√				√
EPA-3	√				
EPA-4	√		√		
EPA-5			√		
EPA-6	√				
EPA-7				√	
EPA-8	√		√	√	
EPA-9	√				
EPA-10	√	√			√
EPA-11					√
NASA-1	√				
NSF-1	√				
NSF-2	√		√		
NSF-3	√				
NIEHS-1	√				
NIEHS-2				√	
NIEHS-3					√
NIEHS-4				√	
NIEHS-5				√	
NIEHS-6	√				
NIEHS-7					√
NIEHS-8	√	√		√	
NIEHS-9					√
NIEHS-10					√
NIEHS-11					√
NIEHS-12	√	√			
NIEHS-13				√	
NIEHS-14					√
NIEHS-15				√	
NIEHS-16		√			
NIEHS-17			√		
NIEHS-18				√	
NIEHS-19				√	
NIEHS-20					√
NIEHS-21	√				

Status and Plans

The material presented in this report was provided by the member agencies of the CENR Air Quality Research Subcommittee (AQRS) and as such represents a first survey of the research community involved in activities related to the collapse of the World Trade Center and its impact on air quality and possible links to human health. Although the information in this draft is believed to represent a significant fraction of the relevant activities, there are clearly some deficiencies, e.g. there is yet very little information in the inventory on the work conducted by non-Federal organizations. The AQRS will continue to survey the community, and an update to this report will be prepared when sufficient new information has been received.

Nevertheless, the current status gives a very useful indication of the magnitude and scope of the many air quality and health-related research activities that were in response to the tragic event. The summaries in Appendix B, with their goals, brief descriptions, and contact information, should be useful in enhancing awareness, interaction and collaboration among these and other endeavors.

The AQRS also plans future discussions on this topic at future meetings as it explores the general relationship between Homeland Security and air quality science. The goal of these discussions is to help further strengthen the interaction among those agencies involved in air quality and related health studies in the vicinity of Ground Zero.

The Subcommittee appreciates the efforts by its members to canvas their departments and agencies for relevant research activities.

Appendix A

April 29, 2002

MEMORANDUM FOR THE COMMITTEE ON ENVIRONMENT AND NATURAL RESOURCES

FROM: John H. Marburger, III
Director, Office of Science and Technology Policy (OSTP)

SUBJECT: Ground Zero Air Quality Tasking

The aftermath of the attacks on the World Trade Center on September 11, 2001 resulted in environmental and health concerns associated with air quality in the vicinity of Ground Zero. Numerous Federal, state, and local agencies and departments and private contractors have undertaken testing and monitoring of the conditions at, and surrounding, Ground Zero. The goal of these activities is to better inform Ground Zero workers and those who live, go to school, and work in lower Manhattan. The Administrator, Environmental Protection Agency (EPA), has requested OSTP's assistance in coordinating the monitoring activities and the communication of data related to air quality and health effects at Ground Zero and the surrounding areas affected by the September attacks.

To address EPA Administrator Whitman's request, OSTP is formally tasking the Committee on Environment and Natural Resources (CENR) of the National Science and Technology Council (NSTC) to provide data relevant to this subject. OSTP requests that the recipient agencies address the following issues:

1. Survey existing activities within the agency to determine any that address:
Monitoring of outdoor and indoor air quality at and around Ground Zero in association with the events of September 11 and the ensuing activities.
Monitoring of acute and chronic health effects from incident-related air quality problems at, and surrounding, Ground Zero.
Please include the following information: project name, brief scope, dates of performance (or ongoing), and contact information for a project leader.
2. Identify activities that the agency sponsors or in which it takes an active role related to Ground Zero air quality and health related activities at the state and local government levels and also within the private sector, including non-government organizations (NGOs). In addition, the agencies should identify non-Federal activities of which they are aware, even though they may not be active participants.

Where known, please provide OSTP with the following information on these activities: project name, brief scope, dates of performance (or ongoing), and contact information for a project leader.

Recipient agencies are requested to work through their CENR Air Quality Research Subcommittee representative (when appropriate) and respond to OSTP by May 24, 2002, with ongoing updates as warranted by additional activities. Point of contact for this action is Paul Anastas (202-456-6105, panastas@ostp.eop.gov).



Appendix B

Project Descriptions by Agency

Department of Commerce - DOC

DOC-1

Project Name: Plume Forecasts from World Trade Center Collapse Site

Scope: The collapse of the World Trade Center buildings created an enormous plume of smoke and dust of questionable composition. In an effort to forecast the plume trajectory, the NOAA Air Resources Laboratory HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) model was configured to simulate dispersion using the recently updated version of the model, which included improved advection algorithms as well as updated stability and dispersion equations. The model was run interactively on the Web through the ARL Real-time Environmental Applications and Display sYstem (READY) coupled with National Weather Service Eta model data. Forecast output data from the model were verified using NASA TOMS satellite information. Forecast simulations were performed for several days while a strong regional signal was apparent in the satellite photographs.

Dates of Performance: September 11 - 15, 2001.

Project Leader: Bruce Hicks, Director, NOAA Air Resources Laboratory, Silver Spring, Maryland. Phone: 301-713-1811, fax: 301-713-0119, email: bruce.hicks@noaa.gov.

Department of Defense - DOD

DOD-1

Project Name: Staten Island Landfill Investigation Personal Exposure Assessment

Scope: The debris from the World Trade Center was deposited at multiple sites within the Staten Island landfill, which is known to contain asbestos. A multi-agency effort developed to investigate exposure to atmospheric emissions generated by heavy equipment, road traffic and helicopters. Work was performed by US Army Center for Health Promotion and Preventive Medicine (CHPPM) occupational health and air quality teams, the New Jersey Army National Guard (ARNG), and Phillips and Jordon, Inc. in cooperation with the US Army Corps of Engineers (COE), US Coast Guard, Environmental Protection Agency (EPA), and Occupational Safety and Health Administration (OSHA). Sampling used NIOSH and EPA reference methods for personal dose monitoring and OSHA accepted methods for collection and analysis of asbestos, mercury, silica, heavy metals, total dust, combustibles, and carbon dioxide samples. Bulk and wipe samples taken in the support area and debris deposit sites were analyzed and archived. Preliminary analysis shows no exceedences for any of the samples.

Dates of Performance: September 2001 - October 2001

Project Point of Contact: Ms. Shirley Chapman
Maryland National Guard
Telephone: 410-942-0273 ext 12
Email: shirley.chapman@md.ngb.army.mil

DOD-2

Project Name: Staten Island Landfill Investigation Area Atmospheric Monitoring

Scope: The debris from the World Trade Center was deposited at multiple sites within the Staten Island landfill, which is known to contain asbestos. A multi-agency effort developed to investigate exposure to atmospheric emissions generated by heavy equipment, road traffic and helicopters. Work was performed by US Army Center for Health Promotion and Preventive Medicine (CHPPM) occupational health and air quality teams, the New Jersey Army National Guard (ARNG), and Phillips and Jordon, Inc. in cooperation with the US Army Corps of Engineers (COE), US Coast Guard, Environmental Protection Agency (EPA), and Occupational Safety and Health Administration (OSHA). Sampling used NIOSH and EPA reference methods for indoor and outdoor locations and OSHA accepted methods for collection and analysis of asbestos, mercury, silica, heavy metals, total dust, combustibles, and carbon dioxide samples. Meteorological data collected included temperature, humidity, wind speed and wind direction. Preliminary analysis shows no exceedences for any of the samples.

Dates of Performance: September 2001 - July 2002

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Project Point of Contact: Ms. Paula Higgins
Corps of Engineers, New York District
Telephone: 212-264-1376
Email: paula.m.higgins@nan02.usace.army.mil

DOD-3

Project Name: Army World Trade Center Support Health Assessment

Scope: This outreach program is intended to assess all Army components involved in relief efforts and to capture the nature of any associated health problems. The goal of the program is to document respiratory and psychological health concerns and identify recovery trends. The health assessment was sent to approximately 116 Army civilians and active duty soldiers and 130 members of the New Jersey Army National Guard. The New York ARNG used the New York Department of Health survey, which was sent to approximately 7,000 individuals.

Dates of Performance: April 2002 - ongoing

Project Leader: COL Richard Kramp
US Army CHPPM
Telephone: 410-436-2714
Email: richard.kramp@amedd.army.mil

LTC Tim Mallon
US Army CHPPM
Telephone: 410-436-4312
Email: timothy.mallon@amedd.army.mil

Department of Energy - DOE

DOE-1

Project Name: Impactor Measurements and Aerosol Size-Fractionated Analyses

Scope: A DRUM impactor, loaned to the Environmental Measurements Laboratory (EML) by the University of California - Davis, was installed on the Laboratory's building roof at 201 Varick Street (approximately one mile north of the WTC). It provided a continuous record of atmospheric aerosols in 8 size ranges. Analyses of these samples from October 2001 have provided information of the atmospheric aerosol mass size distribution with a time resolution of 45 minutes. Elemental analyses of the samples provided a time resolution of 3 hours. The complete analysis of the samples includes: optical - color macro photography of the samples, optical transmission spectroscopy at 320-820 nm in 1 nm steps; mass - soft beta ray transmission, scanning transmission ion in vacuum, STIM; elemental composition (Na-U) - synchrotron x-ray fluorescence, digital Si(Li) analysis; hydrogen - proton elastic scattering analysis (PESA); size and morphology - scanning electron microscopy (SEM) with x-ray analysis; speciated organic matter - laser desorption ionization time-of-flight mass spectrometry (LDITOF/MS). The analyses are being carried out by: the University of California - Davis, Department of Applied Science; Lawrence Livermore National Laboratory, Center for Accelerator Mass Spectroscopy; and the University of Utah, Department of Meteorology.

Dates of Performance: October 2, 2001 to December 20, 2001

Project Leader: Dr. Robert Leifer
Environmental Measurements Laboratory (DOE)
Telephone: 212-620-3626
Email: robert.leifer@eml.doe.gov

DOE-2

Project Name: Total Particulate Sampling and Elemental Analysis

Scope: EML is operating a high volume filter sampler ($1 \text{ m}^3 \text{ min}^{-1}$ flow rate) used to assess total particulates on the Laboratory's building roof. With anticipated support from the U.S. EPA and collaboration with Lamont-Doherty Earth Observatory, filter samples will be analyzed for 28 elements on an axiom single collector high-resolution magnetic sector ICP-MS. Additional funding is being sought for ion chemical analysis and neutron activation analysis.

Dates of Performance: Ongoing

Project Leader: Dr. Robert Leifer
Environmental Measurements Laboratory (DOE)
Telephone: 212-620-3626
Email: robert.leifer@eml.doe.gov

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DOE-3

Project Name: Total Particulate Sampling and Sulfur and Oxygen Isotopic Analysis

Scope: A pilot study is underway to analyze a small number of EML's filters for the sulfur and oxygen isotopic composition of the collected aerosol. In collaboration with the University of California at San Diego the analysis of the filters would be carried out to provide information on the source of the sulfur and to characterize the chemical mechanism of formation of the sulfate. If these analyses are positive, funding for a full-scale program will be initiated.

Dates of Performance: Ongoing

Project Leader: Dr. Robert Leifer
Environmental Measurements Laboratory (DOE)
Telephone: 212-620-3626
Email: robert.leifer@eml.doe.gov

DOE-4

Project Name: Total Particulate Sampling and Radionuclide Analysis

Scope: The high volume total particulate sampler is also used to assess atmospheric radioactivity. Specific radionuclides are analyzed via high resolution gamma-ray spectrometry using high-purity germanium detectors. Results are posted to EML's homeland security web page (<http://www.eml.doe.gov>). Collaborative measurements are also being performed on some of these samples by Lawrence Berkeley National Laboratory using an ultra-low background facility in the attempt to detect any potential Am-241 from smoke detector debris.

Dates of Performance: Ongoing

Project Leader: Mr. Colin Sanderson
Environmental Measurements Laboratory (DOE)
Telephone: 212-620-3642
Email: colin.sanderson@eml.doe.gov

DOE-5

Project Name: Environmental Radiation Measurements

Scope: Beginning in October, 2001, EML started continuous background radiation monitoring on its roof using a pressurized ionization chamber. These real-time gamma exposure rate data are posted every minute on the EML's Homeland Security web page. Subsequently, these data have been supplemented with real-time gamma-ray spectrometric measurements using a NaI detector mounted on the roof. The spectroscopic data are also posted to the web site and can be used to distinguish the source of any rise in background levels.

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Dates of Performance: Ongoing

Project Leader: Mr. Colin Sanderson
Environmental Measurements Laboratory (DOE)
Telephone: 212-620-3642
Email: colin.sanderson@eml.doe.gov

DOE-6

Project Name: Aerosol Spectrometer Measurements

Scope: In conjunction with New York University, EML is operating an aerosol spectrometer, a newly-developed device funded through the DOE Environmental Management Science Program, which provides an aerosol size-weighted estimate of dose. This pilot study is directed toward the contribution of long-lived radionuclides, specifically, the actinides. Analysis of radioactive species is planned via ICP/MS.

Dates of Performance: Ongoing

Project Leader: Dr. Isabel Fisenne
Environmental Measurements Laboratory (DOE)
Telephone: 212-620-3643
Email: isabel.fisenne@eml.doe.gov

DOE-7

Project Name: Analysis of Aerosols from the World Trade Center Collapse Site

Scope: The collapse of the World Trade Center (WTC) buildings created an enormous collapse pile which emitted intense plumes of acrid smoke and dust until roughly mid-December, when the last spontaneous surface fire occurred. As part of the UC Davis Delta group we have been characterizing aerosols collected from October 2 until late October at a site roughly 1.8 km NNE of the World Trade Center collapse site. Particles were collected by size (8 modes, % 12 to 0.09 micrometers diameter) and time (typical resolution of 1 to 3 hours). The results, derived from seven independent beam-based analytical techniques, showed that while PM_{10} and $PM_{2.5}$ 24 hr values rarely, if ever, violated federal air quality standards, WTC-derived plumes that swept over lower Manhattan Island over periods of a few hours had sharply elevated coarse, fine, and very fine particulate levels. These plumes contained particles with unprecedented amounts of mass in the biologically important very fine mode, $0.26 > D_p > 0.09$ micrometers. Composition was dominated by sulfuric acid, complex organics including PAHs and their derivatives, and glass-like silicon-containing aerosols previously associated with high temperature processes in coal fired power plants. The coarse modes above 1 micrometer contained finely powdered concrete with soot-like coatings and anthropogenic metals, but little asbestos. This study shows the value of highly time resolved, size resolved, and compositionally resolved aerosol data in aerosol emission events that do not match the typical ambient aerosol patterns. In such situations, the impact on health cannot be derived from long-term epidemiological studies but must follow a

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model closer to acute industrial exposures. A person could, in a few hours, be subject to materials in amounts and composition that they would not have had to endure in years of typical conditions. While the WTC event is hopefully unique, there have been, in the past 30 years, many similar types of events that deviate strongly from typical ambient conditions, including industrial accidents, major fires, dust storms and the Mt St. Helens eruption, that would have benefited from increased information on the unique aerosols. Particle collection continued until late December 2001. We are currently applying to NIEHS to characterize the aerosols collected in November and December 2001.

Dates of Performance: Ongoing since October 2001

Project Leader: Dr. Graham Bench
Center for Accelerator Mass Spectrometry
Lawrence Livermore National Laboratory (DOE)
Telephone: 925-423-5155
Email: bench1@llnl.gov

DOE-8

Project Name: National Atmospheric Release Advisory Center (NARAC) modeling of initial World Trade Center Plume

Scope: The National Atmospheric Release Advisory Center performed dispersion modeling calculations of the World Trade Center initial plume emanating from Ground Zero on 9/11.

Dates of Performance: September – October 2001

Project Leader: Dr. Jim Ellis
National Atmospheric Release Advisory Center (NARAC)
Lawrence Livermore National Laboratory (DOE)
Telephone: 925-422-1808
Email: ellis6@llnl.gov

DOE-9

Project Name: Determining the Dust Composition Enveloping World Trade Center Workers

Scope: The complex mix of materials at the World Trade Center Site makes assessment of the risk of dust exposure to workers all the more difficult. No single chemical test can tell of the risk, as the hazard can depend critically upon the specific chemical compound present in the dust. Even a battery of tests can miss unexpected chemical compounds or elements. For this reason, PNNL's automated single particle analysis was added to the tools deployed at Ground Zero. Special samplers worn for an entire shift integrate the exposure that the workers encounter. We are analyzing the samples using automated scanning electron microscopy with

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simultaneous x-ray analysis. This is providing not only the size and shape of the dust particles, but also the precise elemental analysis of each dust particle. This make it possible to identify the chemical compound that comprises the dust, which helps determine its sources and likely health effects, if any. These workers are currently wearing extensive personal exposure protection that they lacked earlier in the clean-up project. The dust sampled now should provide insight into the heavier exposures that came earlier in the project (and via fugitive dust, all of NYC, even now). Our samplers are very small (tie-pin-sized), called TAQ (Tiny Air Quality) monitors. Their conveniently small size is possible because our single dust particle techniques require 1/1000'th the amount of sample of other techniques. This study is in conjunction with collaborators from Columbia University's and John Hopkins University's Public Health Departments (via Steve Chillrud and Alison Geyh), who are conducting a long duration study of the exposure of WTC workers. They are looking for possible acute and chronic health effects. They use a variety of chemical tests of the dust, collected with their larger traditional "fanny-pack"/harness samplers.

Dates of Performance: April 15-May 10, 2002 (sampling), Analysis is ongoing

Project Leader: Alex Laskin, Project Leader
Environmental Molecular Sciences Laboratory
Pacific Northwest National Laboratory (DOE)
Telephone: 509-376-8741
Email: alexander.laskin@pnl.gov

DOE-10

Project Name: RAP Response

Scope: To provide radiological monitoring assistance at ground zero. On September 12, 2001, Region 1 RAP Team responded to the World Trade Center site at the request of the NYC Dept. of Health. Purpose of request was to monitor for possible radioactive sources that were thought to be in the towers at the time of collapse. RAP Team performed several air samples for airborne radionuclides at ground zero. All samples were analyzed and no airborne radionuclides were detected. No monitoring of RAP Team members was performed either for acute or chronic symptoms. RAP Team also performed air samples for airborne radionuclides as part of its normal services at the scene of any event. At Ground Zero, several samples were taken and analyzed. The analyses showed no airborne radionuclides present.

Dates of Performance: September 12-19, 2001

Project Leader: Steve Centore
Regional Response Coordinator
Brookhaven Area Office (DOE)
Telephone: 631-344-7309
Email: centore@bnl.gov

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DOE-11

Project Name: Acute Exposure Guideline Levels

Scope: Toxicologists in the Toxicology and Hazard Assessment Group of the Life Sciences Division at Oak Ridge National Laboratory responded to requests and provided Acute Exposure Guideline Level Technical Support Documents to the Division of Environmental Health Assessment of the New York State Department of Health. Information concerning HFC and phosgene were provided in response to air quality concerns at the World Trade Center site.

Dates of Performance: September, 2001

Project Leader: Barry Berven
Oak Ridge National Laboratory (DOE)
Telephone: 865-574-4521
Email: bervenba@ornl.gov

DOE-12

Project Name: High-Resolution Tracer Simulations in Lower Manhattan

Scope: As part of the DOE Chemical-Biological Nonproliferation Program, Los Alamos has developed the capability to simulate the dispersion of agents in the extraordinarily complex terrain of urban environments. The capability includes not only the effect of buildings and other “terrain” but also the effects of radiative heating of the buildings on lofting the dispersive agents. Recently, we have begun to investigate dispersion patterns in Lower Manhattan. These simulations are being conducted using the Los Alamos large-eddy model called HIGRAD, and they are using realistic “topography” from Lower Manhattan. In addition we are working in collaboration with the US EPA wind tunnel facility in North Carolina to use their physical model of Lower Manhattan to validate our simulations.

Dates of Performance: Ongoing.

Project Leader: Dr. Michael J. Brown
Telephone: 505-667-1788
Email: mbrown@lanl.gov

Department of Interior - DOI

DOI-1

Project Name: USGS Environmental Studies of the World Trade Center Area After September 11, 2001

Summary: Within the first few days after the September 11, 2001, attack on and collapse of the World Trade Center (WTC) towers, the U.S. Geological Survey (USGS) was asked by the U.S. Environmental Protection Agency and the U.S. Public Health Service to carry out, in cooperation with NASA and the Jet Propulsion Laboratory (JPL), a remote sensing and mineralogical characterization study of lower Manhattan around the World Trade Center site. The purpose of this requested study was to provide as rapidly as possible information to emergency response teams about the concentrations and distribution of asbestos and other materials in the dusts deposited around lower Manhattan after the September 11 WTC building collapse.

The Airborne Visible / Infrared Imaging Spectrometer (AVIRIS), a hyperspectral remote sensing instrument, was flown by JPL/NASA over the World Trade Center area on September 16, 18, 22, and 23, 2001. A 2-person USGS field crew collected sweep samples of dust deposits and airfall debris from more than 30 outdoor localities within a 1-km radius of the WTC site on the evenings of September 17 and 18, 2001; this sampling occurred after a major rainstorm event on September 14. Two samples of indoor dust deposits were collected that were presumably not affected by the rainfall. Two samples of material coating a steel beam in the WTC debris close to Ground Zero were also collected. The USGS field crew also carried out on-the-ground reflectance spectroscopy measurements during daylight hours to field calibrate AVIRIS remote sensing data. Laboratory calibration and rectification of the AVIRIS data were done at JPL/NASA laboratories in Pasadena. Surface reflectance calibration, spectral mapping, and interpretation were done at the USGS Imaging Spectroscopy Lab in Denver. The dust, debris, and beam-insulation samples were analyzed for a variety of mineralogical and chemical parameters using Reflectance Spectroscopy (RS), Scanning Electron Microscopy (SEM), X-Ray Diffraction (XRD), chemical analysis, and chemical leach test techniques in U.S. Geological Survey laboratories in Denver, Colorado.

Preliminary results of the study were released, as dictated by Federal government emergency response protocols, via the internet to emergency response teams on September 18 and September 27, 2001. After September 27, limited additional work was done to fill in remaining data gaps, and the study was subjected to more detailed peer review. Permission was received in November to release the web site to the public, which was done on November 27, 2001.

The full report of this study can be viewed at

<http://greenwood.cr.usgs.gov/pub/open-file-reports/ofr-01-0429/>

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Dates of Performance: Nearly all work was done within the period from 9/14/01 to 11/27/01. Some minor new data characterization is still occasionally being performed as new questions arise about the dusts.

Project contacts:

Roger N. Clark, rclark@usgs.gov

Gregory P. Meeker, gmeeker@usgs.gov

Geoffrey S. Plumlee, gplumlee@usgs.gov

Robert Green, rog@spectra.jpl.nasa.gov

Department of Transportation - DOT

DOT-1 (Related Activity)

Subject: Air Quality Impacts of the September 11th Terrorist Event

Issue: Has the September 11th tragedy affected air quality because of a shift of travel to surface transportation?

FHWA Position: Based on the preliminary information we have been able to gather to date, there is no clear evidence that air quality has been affected due to changes in vehicle traffic patterns or volumes. In fact, it's not yet clear whether there has been a noticeable increase in vehicle miles traveled (VMT) due to the September 11 tragedy once other factors, such as the economy, are taken into account.

Background:

- Many complex factors influence air quality, including meteorological and chemical conditions. Because of this, changes in motor vehicle emissions do not result directly in changes in the concentration of air pollutants in relation to health standards.
- In addition, because of improved technology, increases in VMT do not necessarily result in increased emissions.
- Data for September show that VMT decreased in 2001 from the same month in 2000. The presumed reason for this decline is the continuing downturn in the US economy. This may change once data for October and November are complete. But preliminary data from 20 States for October only show an approximate 1.6% increase of VMT over October of 2000 (which, in turn, was lower than 1999 VMT).
- Because emissions have been trending downward for the past several years despite increasing VMT, it is unlikely that a small increase in VMT compared to last year can significantly affect emissions or air quality.
- Regional air quality data from the national air monitoring network run by the States and EPA for the period of interest are yet to be released. As soon as the data complete quality assurance and are available we will analyze them for a clear picture of whether there was any increase in the number or severity of violations. We are checking with EPA to see if they have done any specialized analysis of the data.
- Annual VMT versus annual motor vehicle emissions:

Year	VMT (000,000)		Total On-Road Mobile Source Emissions (1000 tons)	
1995	2,422,596		68,883	
1996	2,485,848	+ 2.6%	69,067	+ 0.2%
1997	2,581,895	+ 3.9%	68,008	- 1.5%
1998	2,631,522	+ 1.9%	66,927	- 1.6%
1999	2,691,335	+ 2.3%	64,171	- 4.1%

Sources: EPA National Air Quality Emissions Trends Report, 1999 and FHWA Highway Statistics Series 1995, 1996, 1997, 1998, and 1999.

Environmental Protection Agency - EPA

EPA-1

Office of Air and Radiation Office of Air Quality and Standards (OAQPS)

Project Name: Air monitoring coordination, data assimilation, and communications

Scope:

- **Initial Coordination of air monitoring efforts:** The OAQPS, at the request of EPA's Emergency Response Team (ERT), assisted development of an air monitoring plan in response to the World Trade Center disaster. Deployed monitors in the neighborhoods of lower Manhattan and expanded the list of pollutants monitored.
 - By September 19th, four new air monitoring sites were established on roof tops (within a 2-6 block radius of impact zone) to sample for asbestos, continuous particles (PM_{2.5} through TEOMs) and 24-hr averaged PM₁₀ (through gravimetry). These new sites were operated by the NYDEC.
 - Additional gaseous compound and particulate matter sampling was conducted periodically by ERT contractors in the immediate work zone areas (WTC and Staten Island).
 - OAQPS staff also coordinated the deployment of advanced and comprehensive air sampling conducted by NERL (**See Task #EPA-3**).
- **Assimilation of data and presentations:** OAQPS developed the model for the website (**See Task #EPA-2**) used by the Agency to respond to questions about air quality related to the World Trade Center disaster.
 - Continue to help quality assure data put onto the website.
 - Continue to work on the most appropriate ways to display monitored data and articulate health messages for the public.
 - Conducted a variety of analyses tracking New York City air quality and comparing post-September 11 levels with pre-September 11 levels for different pollutants.
- **Communications support on health risks:** In conjunction with EPA Region 2 (**See Task #EPA-2**), OAQPS developed risk communications information for asbestos (dust and air samples), particulate matter (coarse and fine particles), PCBs, dioxins, lead, benzene, chromium, and metals.
 - Worked with EPA's Office of Research and Development and American Toxics Substance and Disease Registry (ATSDR) on developing fact sheets concerning health effects associated with air pollutants (i.e., PM, asbestos).
 - Worked closely with Region 2, EPA's Office of Communications, Education and Media Relations, and other parts of EPA to respond to numerous inquiries from national health and environmental groups, Congressional staff, citizens, the press, other Agencies, etc.

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Dates of Performance: Initial coordination of air monitoring from September 14 - 21. Assimilation of data, presentations, and communication support began September 13 and continues to present.

Contact Information: Coordination - Rich Scheffe, (919) 541-4650, sheffe.rich@epa.gov
Assimilation - Fred Dimmick, (919) 541-5537, dimmick.fred@epa.gov
Communication - Debbie Stackhouse, (919) 541-5354, stackhouse.debbie@epa.gov

EPA-2

EPA - Region II

Project Name: Ongoing air monitoring coordination, database, and communications

Scope:

- Coordination of monitoring of air, bulk dust, and water. Routine air monitoring being done for asbestos, PM2.5 mass, PM10 mass, and volatile organic compounds. Intermittent air monitoring being done for PCBs, PAHs, Dioxins, Furans, Lead, Chromium, and other metals. Bulk Dusts checked for asbestos. Drinking water in the area is checked for conformance with MCLs; ambient water and site discharge waters are checked for comparison to background contamination. Air monitoring and analysis being done by EPA (See Tasks #EPA-3 and #EPA-6), New York Department of Environmental Conservation, and the New Jersey Department of Environmental Protection.
- Maintain national and regional database. All data known to EPA on air, bulk dust, and water monitoring and analysis is centralized in a database maintained by Region II. Monitoring information and analyses from this data base are available in the form of daily to weekly reports on the *EPA Response to September 11* website at <http://www.epa.gov/wtc/monitoring.html>.
- Provide data, timeline information, and feedback on modeling for risk assessments being done by EPA's Office of Research and Development (See Task #EPA-8).
- Respond to public, Congressional, and press inquiries for data and information. While the EPA website provides up-to-date information on current and past monitoring results for air, water, and bulk dusts and their health benchmarks, questions and requests continue to pour in to the Regional offices. All requests are responded to through the Region II Communications Division.

Reports:

Daily and weekly reports are available at the *EPA Response to September 11* website at <http://www.epa.gov/wtc/monitoring.html>.

Dates of Performance: September 11 to present

Contact Information: Audrey Galizia, (732) 906-6887, galizia.audrey@epa.gov

Appendix B

EPA-3

Office of Research and Development, National Exposure Research Laboratory (NERL)

Project Name: Air quality monitoring at and around Ground Zero - Chemical characterization of the gases and particles released from the World Trade Center.

Scope:

- A network of four ambient (outdoor) air monitoring sites was established to measure concentrations of gases and particles in lower Manhattan:
 - Three ground-level 1st tier sites (A, C, K) were located within 100-200 m of Ground Zero (the area immediately affected by and including the WTC).
 - A 2nd tier site was located about 500 m from Ground Zero on the 16th floor balcony of the EPA Region 2 building at 290 Broadway.
- At the Ground Zero sites, battery operated equipment was used to collect ~22hr integrated samples of PM_{2.5} mass on quartz and Teflon filters. Continuous PM mass measurements were done by nephelometer. Volatile organic carbon grab samples were collected using evacuated canisters. Bulk dust samples were also initially collected for physical/chemical characterization.
- The 290 Broadway site was powered and sampling equipment included integrated PM_{2.5} and PM₁₀ mass filter samples, particle size distribution and continuous mass monitors including an aethelometer (elemental carbon) and nephelometer. A research grade sampler for semi-volatile organic carbon analysis was deployed during October and detailed organic characterization analysis was conducted on a subset of samples.
- Filter samples are being analyzed for gravimetric mass, elemental composition (by XRF) and elemental and organic carbon concentrations. Selected filter samples are being considered for PAH analysis through a grant arrangement now in review. All NERL data and analytical results are provided to Region 2 for consolidation with other monitoring activities (**Task #EPA-2**).
- NERL provided additional equipment to Region 2 for the collection of samples for dioxin/furan analysis. These samples were collected at 2nd tier sites by Region 2 and sent to Region 7 (**See Task #EPA-6**) for analysis.

Dates of Performance: Sample collection at the ground zero sites began 9/21/01 with a projected completion of 5/15/02. Sample collection at the 290 Broadway site began 9/22/01 and was completed 3/27/02. No sampling was conducted at these sites 12/20-29/02; 1/30/02-2/8/02; or 3/27/02-4/15/02.

Reports: Manuscripts in Preparation: 1) *Concentrations and Composition of PM at Ground Zero and lower Manhattan after September 11, 2001* - Alan Vette, Matthew Landis, Ronald Williams, Laura Webb, Thomas Ellestad and Daniel Vallero. 2) *Polyaromatic Hydrocarbons (PAHs) and*

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other Semi-Volatile Organic Compounds collected in New York City in response to the Events of 9/11 - Erick Swartz, Len Stockburger and Daniel Vallero. 3) *VOCs in Ambient Air near the World Trade Center Site* - Robert Seila and William Lonneman

Contact Information: Roy B. Zweidinger, (919) 541-2324, zweidinger.roy@epa.gov
Alan Vette, (919) 541-1378, vette.alan@epa.gov

EPA-4

Office of Research and Development, National Exposure Research Laboratory (NERL)

Project Name: Meteorological measurements and modeling supporting risk assessment.

Scope:

- Meteorological measurements were conducted by NERL using instruments (2 SODAR profilers and a 10-m tower) situated along the Hudson River (Pier 25) to capture the lower atmospheric oncoming wind profile and temperature difference, when wind is from South through West toward North, toward lower Manhattan. These wind directions are most frequent and they led to the transport of any emissions from the WTC recovery site to the nearest population areas North through East of lower Manhattan.
- Data on wind speed, wind direction and turbulent mixing depth will define outer boundary conditions for finer scale simulations of winds and pollution transport among the building surrounding ground zero. These measurements are being used to evaluate the performance of routine meteorological modeling to examine regional transport from the WTC recovery site as part of a June, 2002 risk assessment (**See Task #EPA-8**).
- A metropolitan scale wind and plume transport model, CALMET-CALPUFF, is being applied to characterize the plume from the WTC Recovery site from September 11 through December 2001. The results of the plume modeling have been depicted on a map of metropolitan New York City along with measured hourly-averaged PM_{2.5} data. This combined information is being used to characterize where and when emissions were transported and dispersed into the neighborhoods surrounding the WTC recovery site.
- In addition, a detailed 3-D virtual model of all buildings of lower Manhattan has been developed based on a commercial database. EPA has significantly refined this database to include monitoring site information and demolished building information to support refined wind and pollution simulations that are being planned and that will make use of both Computational Fluid Dynamics numerical simulations and physical models to project WTC plume dispersion (**See Task #EPA-5**).

Dates of Performance: Meteorological monitoring began 11/8/02 and ended 5/20/02. Summary data and model results described above are now supporting the EPA NCEA assessment (**See Task #EPA-8**) and have been provided to EPA Region II (**Task #EPA-2**).

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Reports:

- Manuscripts in Preparation: 1a) *Evaluation and 1b) Application of the CALMET-CALPUFF Dispersion Modeling System in the New York City Area for Estimating Plume Dilution Downwind of the World Trade Center Recovery Site following September 11, 2001* - Robert Gilliam and Alan Huber; 2) *SODAR Profiles and Surface Measurements for Characterizing the Atmospheric Boundary Layer Near the World Trade Center Recovery Site Following September 11, 2001* - Robert Gilliam and Alan Huber; and 3) *Characterizing the Effect of Meteorology on Air Pollution in New York City Post September 11, 2001* - Alan Huber, Robert Gilliam, Robert Kelly and Henry Feingersh.

Contact Information: Alan Huber, (919) 541-1338, huber.alan@epa.gov

EPA-5

Office of Research and Development, National Exposure Research Laboratory (NERL)

Project Name: Reconstruction of the Dust/Smoke Plume from the Collapse and Fires of the WTC - An EPA and EOHSI reconstruction of the days following September 11, leading to estimates of human exposures.

Scope:

- Construction of a physical 1:600 scale model of lower Manhattan that will be used in EPA's Fluid Modeling Facility wind tunnel to simulate the WTC plume following the September 11 attack. The experimentally determined airflows and concentration gradients obtained during the wind tunnel simulation will be compared to an EPA Computational Fluid Dynamic (CFD) model so it (CFD Model) can then be used to simulate a greater number of scenarios.
- EPA's CFD results and work with the Environmental and Occupational Safety and Health Institute (EOHSI) will be used to support the development and applications of a model estimation of human population exposures.
- The combined EPA/EOHSI modeling study will:
 - Develop estimates of the temporal and spatial extent and patterns of the dust and smoke concentrations that were released from the collapse of the Twin Towers, and the fires that burned for over three months at the site of the WTC.
 - Develop estimates of population exposures for individuals living and working in Southern Manhattan at the time of the attack and during the weeks to months that followed the attack on the WTC.
 - Develop series of population based exposure distribution functions for use in various time and spatial weighted risk assessments, and characterize individualized exposure within various spatial and temporal zones of influence during the period of rescue and/or recovery after the attack on the WTC.

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- Develop a template for exposure characterization for future collaborations with epidemiological studies that are being designed by National Institutes of Environmental Health Science centers of excellence and other organizations.

Dates of Performance: A plan for these studies is being developed. Work is to be completed in time to support the NCEA 2003 risk assessment (see task #EPA-8).

Contact Information: Alan Huber, (919) 541-1338, huber.alan@epa.gov

EPA-6

EPA - Region VII

Project Name: Laboratory Analysis of WTC samples for Dioxins and furans

Scope:

- Ambient air samples (taken with High Volume air samplers using PUF cartridges) were collected by Region II personnel from three sites in the Manhattan area and mailed to the Region VII Laboratory. Two sets of dust samples from New York were also analyzed, one in late September (3 samples) and one in October (5 samples).
- Over 160 samples have been analyzed for Dioxins and furans by High Resolution Gas Chromatography/Mass Spectrometry (HRMS) by the Region VII lab. Approximately 20 samples were also analyzed for Aroclors.

Reports: The data have been posted on the EPA Response website
<http://www.epa.gov/wtc/monitoring.html>

Dates of Performance: Sample receipt began in October 2001 and the last sample analysis was completed in May 2002.

Contact Information: Laura Webb, (913) 551-5120, webb.laura@epa.gov

EPA-7

Office of Research and Development, National Health and Environmental Effects Research Laboratory (NHEERL)

Project Name: Toxicological Effects of Fine Particulate Matter Derived from the Destruction of the WTC

Scope:

- The Pulmonary Toxicology Branch /Experimental Toxicology Division on September 27,

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2001 responded to a request from New York University to collaborate in research efforts to evaluate the potential health effects of particulate matter in the immediate aftermath of the World Trade Center disaster.

- The purpose of the research has been to contribute to the scientific understanding of the short-term health risks associated with particulate matter generated from the immediate destruction of the two towers. The research focused on fine particulate matter (less than 2.5 microns in diameter), and not the larger, coarser particulate matter. The approach was to compare the toxicity of the WTC particulate matter with the toxicity of other particulate material of known varied toxicities.
- Three animal studies on mice were conducted by EPA in Research Triangle Park, North Carolina, to examine short-term respiratory effects of fine particulate matter using samples taken from the immediate vicinity of the World Trade Center on September 12 and 13.
- The results of the unpublished studies indicate that the fine particulate matter can cause respiratory problems in animals at relatively high doses that could conceivably have occurred in workers or others in the immediate vicinity of the World Trade Center. The respiratory problems observed included lung inflammation and airway sensitivity to agents, which constrict breathing passages. The effects of long-term or repeated exposures to inhaled particles were not addressed in this research effort. EPA and others will use the results in the ongoing effort to evaluate any potential health risks from the World Trade Center disaster.
- A rigorous internal and external review of the data is being conducted and results will be made available to the public as soon as possible following full Agency review.

Dates of Performance: September 27, 2001 to present

Reports:

- EPA Report EPA/600/R-02/028: Gavett SH, Haykal-Coates N, McGee JK, Highfill JW, Ledbetter AD, and Costa DL. Toxicological Effects of Particulate Matter Derived from the Destruction of the World Trade Center on the Respiratory Tract of Mice. May, 2002. 55 pages.
- Manuscripts in Preparation: Chemical and Physical Analysis of Particulate Matter Derived from Destruction of the World Trade Center for Use in Toxicology Studies. Dose-Response Relationships of Particulate Matter Derived from the Destruction of the World Trade Center in the Respiratory Toxicity in Mice

Contact Information: Ann Brown, (919) 541-7818, brown.ann@epa.gov
Stephen H. Gavett, (919) 541-2555, gavett.stephen@epa.gov

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EPA-8

Office of Research and Development, National Center for Environmental Assessment (NCEA)

Project Name: World Trade Center Collapse: Risk Assessment

Scope:

- In the weeks after the collapse, NCEA assisted OAQPS and Region II in preparation of Fact Sheets for PM Health Effects for EPA public website posting of PM data of Lower Manhattan and NYC.
- Assisted Region II and ORD NERL in determining siting of air pollution monitors (**Tasks #EPA-3 and #EPA-4**) in Lower Manhattan to augment data collection for risk evaluation of air emissions from Ground Zero
- Assisted Region II in providing advice on health benchmarks used as criteria for evaluating potential hazardous exposures to air pollutants in lower Manhattan area (**Task #EPA-2**).
- In November 2001, provided a preliminary evaluation of then available air pollution monitoring data to ascertain if air pollution values for particulate matter or its sub-constituents (e.g., lead, other metals, dioxin, etc.) or other volatile organic compounds exceeded (a) typical background levels for NYC/other urban areas or (b) health benchmark values indicative of increased health risk for chronic exposure effects.
- Provided inputs to NERL WTC plume modeling efforts (**Task #EPA-3**) to enhance potential usefulness for health risk evaluations.
- NCEA is currently preparing more detailed risk evaluation to include discussion of NERL and other monitoring and modeling (**Tasks #EPA-4**) results as well as NHEERL toxicity testing (**Task #EPA-7**) and information related to other air monitoring and health related evaluations, as currently available data permits. A second follow-on assessment will be produced one year later.

Dates of Performance: September 27, 2001 to present

Reports:

- Risk evaluation to include discussion of monitoring and modeling results, toxicity testing and information related to other air monitoring and health related evaluations (projected for June 2002).
- Anticipated preparation of a more extensive evaluation of additional data to be included in a report projected to be available late spring (April/May) 2003.

Contact Information: Herman Gibb, (202) 564-3334, gibb.herman@epa.gov
Lester Grant, (919) 541-4173, grant.lester@epa.gov

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EPA-9

Office of Pesticide Programs (OPP)
Biological and Economic Analysis Division (BEAD)
Environmental Chemistry Laboratory (ECL)

Project Name: EPA support to OSHA in response to WTC
Dioxin and furan analysis of OSHA samples for worker safety

Scope:

- OSHA asked assistance of the OPP/BEAD Environmental Chemistry Laboratory at Stennis Space Center, MS in the analysis of air samples for dioxins and furans. The primary purpose was to ensure that the proper respiratory protection could be provided for people working on cleanup of the area.
- OSHA collected air samples using samplers either worn by workers or fixed at a particular area at ground zero.
- 8 field samples and 5 control samples were sent to BEAD/ECL for short turn-around analysis from mid October to early November. Results were reported to OSHA in 9 to 21 days from sample shipment by OSHA.

Dates of Performance: October 14, 2001 through November 26, 2001

Contact Information: EPA – Joseph Ferrario, (228) 688-3171, ferrario.joseph@epa.gov
OSHA – Wayne Potter, (801) 524-7943, wayne.potter@osha.gov

EPA-10

Office of Environmental Information

Project Name: Ongoing database development and website management

Scope:

- Developed and continue to maintain the WTC Multi-Agency Environmental Monitoring Database to house monitoring data collected by thirteen federal, state, city and private organizations conducting monitoring at the WTC site. Developed data entry templates and protocols for each Agency to submit their data and provided interface/reports so these agencies can access and use the database in their decision-making. The Database currently contains hundreds of thousands of records from environmental monitoring conducted at dozens of sites in the lower Manhattan area and surrounding environs.
- In conjunction with Region II, OAQPS, EPA's Office of Communications, Education, and Media Relations (OCEMR) and other program staff, developed and continue to maintain an extensive series of interactive EPA Website postings to publicly display monitoring results

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for various constituents at the WTC site, including asbestos, particulate monitoring, PCBs, dioxins, metals, VOCs and many more. These postings provided the public with a “clickable” interactive map of all relevant monitoring locations with data tables for each location showing the tabular data results and narrative context to assist in the interpretation and understanding of results. Also developed the WTC EnviroMapper - an interactive mapping application that allows the user to select a geographic location and receive back information on all EPA monitoring conducted in that location.

- Provided support to EPA Region II and OCEMR to respond to public, congressional and private inquiries on status of monitoring activities at WTC site.

Contact Information: Debra Villari, (202) 566-0656, villari.debra@epa.gov.

EPA-11

Office of Communication, Education and Media Relations

Project Name: Health Risk Communications

Scope:

- Coordinated efforts of the Office of Air Quality Planning and Standards (OAQPS), the Office of Pesticides, Prevention, and Toxic Substances (OPPTS), and other Offices to develop contextual language about the pollutants being monitored.
- Worked with the Office of Environmental Information and Region 2 to provide the data and the context together on EPA's WTC Web site (<http://www.epa.gov/wtc/>) to ensure that people viewing the data understand their meaning, particularly with respect to health risks.
- Developed and continue to maintain the Web site for EPA's WTC information (<http://www.epa.gov/wtc/>). Provide editorial oversight for all information published by Region 2, OEI, and others.
- Translated documents into Spanish.
- Coordinated efforts of Region 2, OAQPS, OPPTS, and others to respond to public inquiries in the immediate aftermath of September 11.

Contact Information: Jeffrey Levy, Office of Communications, (202-564-9727), levy.jeffrey@epa.gov.

National Aeronautics and Space Administration - NASA

NASA's remote sensing expertise and measurement capabilities supported activities with the Federal Emergency Management Agency, EPA, and the city and state of New York during the aftermath of the September 11 tragedy. A very real potential for future cooperation between NASA and these Agencies exists in the area of multi-sensor data fusion and analysis, and tactical support with satellite-based geographic information systems (GIS). In addition, NASA imagery can convey the scope of such events to decision makers.

Following is a brief listing of the specific and related activities and contacts:

NASA-1

The NASA multispectral remote sensing AVIRIS instrument (Dr. Diane Wickland, dwicklan@mail.hq.nasa.gov) completed a final flight over the WTC and Staten Island area on September 23. Data from the flight were processed at JPL for "hot spot" updates (Dr. Robert Green, rog@mail2.jpl.nasa.gov) and at USGS/Denver for analysis of the distribution of contaminants from the debris (Dr. Roger Clark, rclark@usgs.gov). The AVIRIS data over the area was processed for 311 possible signatures of materials that the EPA is interested in identifying. Preliminary analysis by USGS of the plume indicated that asbestos was not a significant constituent of the plume. The USGS has established a password protected web site to provide appropriate access to the data. Ongoing.

Related Activities:

The Federal Geographic Data Committee's Civil Imagery and Remote Sensing Task Force was established to develop a coordinated National Civil Imagery Strategy for delivery to OMB and OSTP. The Task Force committee members have elected Co-Chair positions to be filled by Greg Snyder of USGS and Ron Birk of NASA. Ongoing.

The Spatial Technologies Industry Association and the Space Enterprise Council of the US Chamber of Commerce are co-sponsored a meeting on Homeland Security on November 8, 2001. NASA's Ron Birk (rbirk@mail.hq.nasa.gov) was invited to chair the panel on Issues and Capabilities with key leaders from the Federal Agencies and the Private Sector, including Jack Dangermond (ESRI), Larry Ellison (Oracle), John Copple (Space Imaging), Mike Thomas (VP Lockheed Martin), Leo Hazelwood, SAIC along with representatives of Department of Justice, EPA, FEMA, and OMB.

NASA provided technical support directly to FEMA ESF5 in New York at meetings of the FEMA disaster response team and serving as a consultant on use of remote sensing. The primary issues were the use of LIDAR to measure the extent of the debris field from the World Trade Center (WTC) and settling of the debris. Several press releases from Regional Applications Center for the Northeast (www.racne.org) acknowledge NASA's contribution of systems

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engineering support. Contact Dr. Bruce Davis (bruce.davis@ssc.nasa.gov), ongoing. Reference NASA Press Release <ftp://ftp.hq.nasa.gov/pub/pao/pressrel/2001/01-243.txt>.

NASA coordinated with the NASA Regional Applications Center for the Northeast (RACNE) to finalize design requirements for a virtual tour of the World Trade Center disaster site. The virtual tour was delivered to the State of New York, Office for Technology. Pictometry International provided the visuals at no cost.

NASA's Dr. Bruce Davis provided presentations of first-hand experience in providing NASA support to the response and recovery efforts for the 9/11 attacks on the WTC. These presentations were provided to the Federal Geographic Data Committee (FGDC) Homeland Security Working Group. The lessons learned and recommendations derived from NASA's experience are being incorporated in individual Agency Homeland Security plans and have been recommended for incorporation in a Rand Corporation study. (bruce.davis@ssc.nasa.gov)

National Science Foundation - NSF

NSF-1

Project Name: Analysis of aerosols from the World Trade Center collapse site, October 2 to October 31, 2001

Scope: The collapse of the World Trade Center (WTC) buildings # 2 (South Tower), #1 (North Tower) and #7 created an enormous debris pile that emitted plumes of acrid smoke and dust until roughly mid-December, when the last spontaneous surface fire occurred. The investigators collected particles resolved by size (8 modes, 12 to 0.09 micrometers diameter) and time (typical resolution of 1 to 3 hours) from October 2 until late December at a site roughly 1.8 km NNE of the collapse site. Samples from the period October 2 through October 30 were analyzed using seven independent beam-based analytical techniques. The total mass measured confirmed EPA 24 hr measurements indicating that PM10 and PM2.5 mass and lead standards were not violated during this period. However, well-defined WTC derived plumes of particles had unprecedented amounts of mass in the biologically important very fine mode, $0.26 > D_p > 0.09$ micrometers, dominated by sulfuric acid, complex organics, and glass-like silicon containing aerosols. The coarse modes particles (size above 1 micrometer) were finely powdered concrete and glass with anthropogenically-derived coatings of metals and soot. WTC plume intensity decreased markedly during October.

Dates of Performance: October 2 - 31 (samples were collected through mid-December but so far not analyzed)

Note: There is a follow-on project with the American Lung Association studying indoor air using the same techniques, same investigator, May 9 - circa May 31 2002. No results are available yet.

Contact: Thomas A. Cahill, Professor of Atmospheric Sciences and Physics, Emeritus; Research Professor, College of Engineering, University of California, Davis. phone: 530/752-4674, fax: 530/752-9804, email: tacahill@ucdavis.edu.

NSF-2

Project Title: Measurements of particle Emissions from The World Trade Center site in New York City

Scope: This research addresses questions on the particle transport from the World Trade Center (WTC) site through the deployment of state-of-the-art instrumentation to measure the emission and resuspension of particles into the atmosphere. It is planned to conduct the study over a ten-day intensive field observation period at the WTC site and the surrounding region of the greater New York City area to measure the flux of particles from the site and the vertical and horizontal extent of the aerosol plume. At the site, a combination of turbulence sensors, including Particle Image Velocimetry (PIV), Holographic PIV and sonic anemometers mounted on a telescopic

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profiling tower to continually measure the shear stress and the concentration and flux profiles of particles from the surface up to 10 m above the site. A scanning elastic lidar system will be deployed to measure at high resolution (1.5 m) the relative concentration of particles in the lower atmosphere (range up to 7 km). The lidar will be deployed both near the site and at sites yet to be identified in the greater NYC area. The lidar system will be calibrated using the concentration measurements obtained from the PIV systems. An analysis of the field data collected will be conducted to identify relationships between weather conditions (e.g., wind shear stress, sensible heat flux) and the magnitude of the surface flux of particles and the extent of the transport into the atmosphere.

Dates of Performance: March 15, 2002 – March 14, 2003

Contacts: Marc B. Parlange, Professor, Geography and Environmental Engineering, Johns Hopkins University; phone: 410/516-6042, fax: 410/516-8996; email: mbparlange@jhu.edu and Joseph Katz, Professor, Department of Mechanical Engineering, Whiting School of Engineering, Johns Hopkins University; phone: 410/516-5470, fax: 410/516-7254; email: katz@titan.me.jhu.edu.

NSF-3

Project Name: Exploratory Research on the Environmental Impact of the World Trade Center Attack on Sediment Quality and Dynamics in New York Harbor

Scope: With this Small Grant for Exploratory Research, researchers at the University of Massachusetts at Boston are investigating the environmental impact of the World Trade Center terrorist attack on September 11, 2001, by studying the chemistry and mineralogy of sediments of New York Harbor. The studies will determine whether atmospheric and storm-water inputs of dust, debris, and contaminants can be used with radiotracers to identify and characterize an event-related stratigraphic imprint, assess impacts on sediment quality, and characterize spatial aspects of sedimentation.

Dates of Performance: February 1, 2002 – January 31, 2003

Contact: Dr. Curtis Olsen, Professor, Department of Environmental, Coastal, and Ocean Sciences, University of Massachusetts, Boston; phone: 617/287-7440; fax: 617/287-7474; email: curtis.olsen@umb.edu.

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National Institutes of Health / National Institute of Environmental Health Sciences – NIH/NIEHS

University	Project Titles	Principal Investigator	Contact Information	Study Information	Research Type
Columbia University					
NIEHS-1	Exposure Assessment	Simpson, James	845-365-8570 simpsonj@ldeo.columbia.edu	Geochemical based assessments of WTC emissions; high volume air and sediments	Monitoring
NIEHS-1	WTC-ITEA Database	Levy, Diane	212-305-6496 dl2015@columbia.edu	Database development	Monitoring
NIEHS-2	Follow-up study of children exposed in utero to the WTC tragedy	Perera, Frederica	212-305-6496 fpp1@columbia.edu	300 women & children; health during pregnancy; newborn weight, length, head circumference; 6-12 month child assessment; Bayley scales	Health effects
NIEHS-3	Public Dissemination of Database: COEP	Shepard, Peggy	212-961-1000	Public Dissemination of Database	Outreach
overall	Health & environmental effects of WTC exposures	Santella, Regina	212-305-1996 rps1@columbia.edu		
Mount Sinai School of Medicine					
NIEHS-4	Clinical & epidemiologic studies of ironworkers	Levin, Stephen	212-241-7811 stephen.levin@mssm.edu	200 ironworkers for respiratory abnormalities and PTSD	Health effects
NIEHS-5	Epidemiologic study of pregnant women & children	Berkowitz, Gertrud	212-241-8954 tberkowitz@mssm.edu	300 pregnant women; pregnancy outcomes - wt., ht., head circumference, fetal length, apgar, perinatal morbidity & mortality; Bayley	Health effects
NIEHS-6	Exposure assessment of WTC emissions using imaging spectroscopy and spatial analysis	Chillrud, Steven	845-365-8570 chilli@ldeo.columbia.edu	Remote sensing imagery for internal structure of the plume combined with ground measurements	Monitoring
NIEHS-7	Outreach to children and families	Forman, Joel	212-241-7207 joel.forman@mssm.edu	Through PESU; independent compilation of data; listserv; newsletter; website	Outreach
overall	Organochlorines in NY and the Hudson River	Landrigan, Philip	212-241-6173 phil.landrigan@mssm.edu		
Johns Hopkins University					
NIEHS-8	Registry, health assessment & monitoring	Geyh, Alison	410-955-3546 ageyh@jhsph.edu	Registry; truckers, heavy equipment, laborers. Questionnaire incl.: Respiratory health, risk perception, mental health, quality of life	Monitoring & Health Effects
NIEHS-9	Outreach	Geyh, Alison	410-955-3546 ageyh@jhsph.edu	Worker groups; open forums; newsletters; Risk communication panel	Outreach
overall	Long term effects of clean-up at the WTC disaster site	Groopman, John	410-955-3720 jgroopma@jhsph.edu		

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Appendix B

University	Project Titles	Principal Investigator	Contact Information	Study Information	Research Type
New York University					
NIEHS-10	NYC firefighters study	Rom, William	212-263-6479 william.rom@med.nyu.edu	Cardio-pulmonary effects in FDNY - 300- bronchial wall thickening; lung parenchyma	Health Effects
NIEHS-11	WTC resident respiratory impact study: physiologic characterization of residents with respiratory complaints	Reibman, Joan	212-263-6479 joan.reibman@med.nyu.edu	Respiratory screening of residents in the affected community with new onset of asthma-like symptoms; questionnaires ; field spirometry	Health Effects
NIEHS-12	Exposure Assessment	Lippmann, Morton	845-365-5292 morton.lippmann@med.nyu.edu	Indoor vs outdoor settled dust samples; air monitoring for MA	Monitoring
NIEHS-13	Toxicity Assessment	Chi Chen, Lung	845-731-3560 lung.chen@med.nyu.edu	In vivo, in vitro and ex vivo animal studies for dust toxicity analysis	Toxicology
NIEHS-14	Community outreach program	Thurston, George	845-731-3564 george.thurston@med.nyu.edu	Public forums; newsletter; video development; web pages	Outreach
overall	Health issues related to WTC disaster	Costa, Max	845-731-3515 costam@env.med.nyu.edu		
University of Medicine and Dentistry of New Jersey					
NIEHS-15	Qualitative risk assessment	Gallo, Michael	732-445-0175 gallo@umdnj.edu	Perceived vs actual risk; surveys; integrate information from psychological study	Health Effects
NIEHS-16	Analysis of indoor settled dust/smoke samples	Lioy, Paul	732-445-0155 plioy@ehsi.rutgers.edu	19 samples collected will be exhaustively analyzed	Monitoring
NIEHS-17	Microenvironment modeling in GIS/RDBS framework	Georgopoulos, Panos	732-445-0159 panosg@fidelio.rutgers.edu	Develop quantitative computational tools for assessing contaminant release on air quality of local microenvironments.	Monitoring
NIEHS-18	Reproductive outcomes of WTC	Lambert, George	732-445-0174 glambert@umdnj.edu	Study time trends for adverse reproductive outcomes for 3 months after 9/11 compared to data over past 3 years.	Health Effects
NIEHS-19	Population health and psychological symptoms	Kipen, Howard	732-445-0123 kipen@ehsi.rutgers.edu	Modeling exercise incorporating psychological symptoms with exposure data	Health Effects
NIEHS-20	Community outreach & education program	Gotsch, Audrey	732-235-9700 gotschar@umdnj.edu	New Jersey Town meetings; brochure development	Outreach
overall	WTC supplement	Gallo, Michael	732-445-0175 gallo@umdnj.edu		
University of North Carolina, Chapel Hill					
NIEHS-21	Community exposures following the WTC disaster	Rappaport, Steve	919-966-5017 stephen_rappaport@unc.edu	PAH analysis of air filters and validation of passive personal monitoring device for particulates	Monitoring
NIEHS-21	Spatiotemporal mapping	Christakos, George	919-966-1767 george_christakos@unc.edu	GIS-based Spatiotemporal Modeling	Monitoring
overall	Community Exposures following the WTC disaster	Swenberg, James	919-966-6139 james_swenberg@unc.edu		

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Committee on Environment and Natural Resources (CENR): Subcommittee on Air Quality Research

The CENR is charged with improving coordination among Federal agencies involved in environmental and natural resources research and development, establishing a strong information-transfer link between science and policy, and developing a Federal environmental and natural resources research and development strategy that responds to national and international issues. There are five research subcommittees under the CENR:

- Air Quality
- Ecological Systems
- Global Change
- Natural Disaster Reduction
- Toxics and Risk

The Air Quality Research Subcommittee has articulated two major goals in its Strategic Plan:

- to enhance the effectiveness and productivity of U.S. air quality research, and
- to improve information exchange between research and policy on air quality issues, including the scientific knowledge base for air quality standards and assessing compliance

The Air Quality Research Subcommittee is cochaired by DOC/NOAA, DOE and EPA. Dan Albritton of DOC/NOAA serves as Science cochair the Subcommittee, which includes representatives from the following departments and agencies:

Department of Agriculture - Agricultural Research Service
Department of Agriculture - Cooperative State Research, Education, and Extension Service
Department of Agriculture - Natural Resources Conservation Service
Department of Agriculture - U.S. Forest Service
Department of Commerce - National Institute of Standards and Technology
Department of Commerce - National Oceanic and Atmospheric Administration
Department of Defense
Department of Energy
Department of Health and Human Services - Centers for Disease Control and Prevention
Department of Health and Human Services - National Institutes of Health
Department of Housing and Urban Development
Department of State
Department of the Interior - National Park Service
Department of the Interior - U.S. Geological Survey
Department of Transportation - Federal Aviation Administration
Department of Transportation - Federal Highway Administration
Environmental Protection Agency
National Aeronautics and Space Administration
National Science Foundation
Office of Management and Budget
Office of Science and Technology Policy
Tennessee Valley Authority