Monitoring and Surveillance of Disaster Responders: A Case Study

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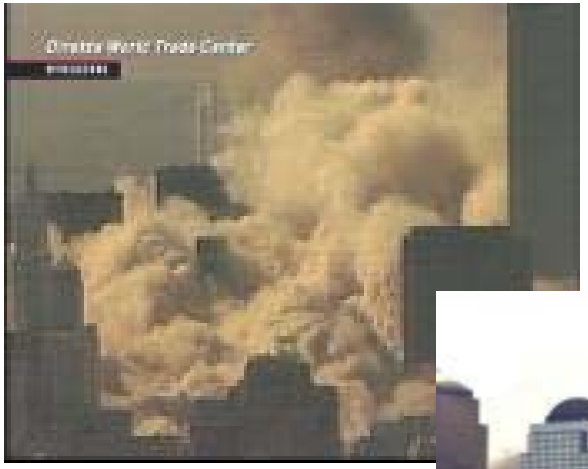
Air Quality and Exposure

Lingering questions from the WTC

WTC Dust Cloud on 9/11/01



View from lower Manhattan

View from Brooklyn Heights

View from upper Manhattan

View from across the river

http://911research.wtc7.net/wtc/evidence/photos/dust.html

Purpose of Monitoring for Airborne Contaminants at the WTC

Potentially exposed were:

- Anyone responding
  - police, firefighter, construction workers, volunteers
- Anyone living in the vicinity of the WTC
  - residents of Battery Park City, Tribeca, east of Broadway, below Canal
- Anyone working in the vicinity of the WTC
  - office and Wall St. workers, merchants, street vendors
- Anyone living in the 5 boroughs and New Jersey

Exposure at the Disaster Site

October 2001

Projected Airborne Contaminants of Concern

- Asbestos
- Particulate Matter (PM)
  - PM associated metals
- Volatile Organic Compounds (VOC)

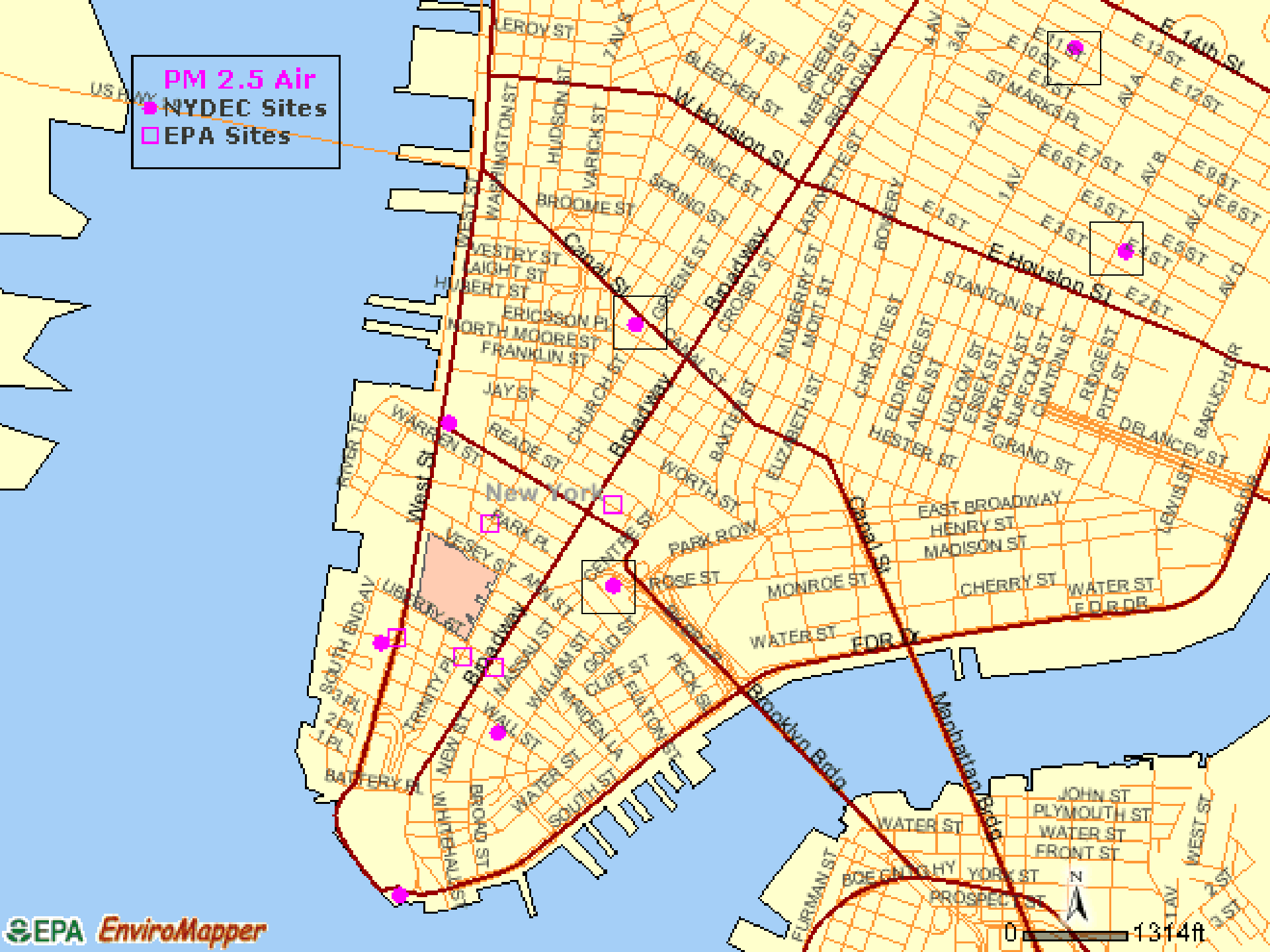
- Dioxins/furans
- Polychlorinated Biphenyls (PCB)
- Glass fibers
- Fiberous glass

Groups involved in air quality monitoring and exposure assessment

- US EPA/NYSDEC
- OSHA
- NIOSH/NYC DOH
- NIEHS Centers – Johns Hopkins University*, University of Medicine and Dentistry New Jersey
- USGS

*National Institute of Environmental Health Sciences

Supplement to grant no. P30 ES0 3819


PM 2.5 Air
● NYDEC Sites
□ EPA Sites
New York
US HWY
LEROY ST
7 AV S
W 3 ST
BLEECKER ST
GREENE ST
MERCER ST
BROADWAY
4 AV
3 AV
E 10 ST
E 11 ST
E 13 ST
E 14th St
E 12 ST
E 9 ST
ST MARKS PL
AV A
2 AV
AV B
E 7 ST
E 6 ST
E 5 ST
E 4 ST
E 3 ST
E 2 ST
E 1 ST
AV C
E 8 ST
AV D
WASHINGTON ST
HUDSON ST
VARICK ST
W Houston St
PRINCE ST
SPRING ST
BROOME ST
LAFAYETTE ST
BOWERY
1 AV
E Houston St
West St
VESTRY ST
LAIGHT ST
HUBERT ST
Canal St
GREENE ST
Broadway
CROSBY ST
MULBERRY ST
MOTT ST
STANTON ST
ERICSSON PL
NORTH MOORE ST
FRANKLIN ST
CHURCH ST
CANAL ST
CHRYSTIE ST
ELDRIDGE ST
ALLEN ST
LUDLOW ST
ESSEX ST
NORFOLK ST
SUFFOLK ST
CLINTON ST
RIDGE ST
PITT ST
BARUCH PL
JAY ST
WARREN ST
READE ST
BAXTER ST
ELIZABETH ST
HESTER ST
GRAND ST
DELANCEY ST
RIVER TE
WORTH ST
LEWIS ST
F D R DR
EAST BROADWAY
HENRY ST
MADISON ST
PARK PL
VESEY ST
CENTRE ST
PARK ROW
ANN ST
ROSE ST
MONROE ST
CHERRY ST
WATER ST
SOUTH END AV
LIBERTY ST
NASSAU ST
WILLIAM ST
GOLD ST
CLIFF ST
PEARL ST
FDR Dr
TRINITY PL
NEW ST
WALL ST
MAIDEN LA
FULTON ST
PECK SL
Brooklyn Brdg
Manhattan Brdg
3 PL
2 PL
1 PL
BATTERY PL
WHITEHALL ST
BROAD ST
WATER ST
SOUTH ST
JOHN ST
PLYMOUTH ST
WATER ST
FRONT ST
FURMAN ST
YORK ST
PROSPECT ST
BQE ON TO HY
WEST ST
1 AV
2 ST
3 ST
N
0
1314ft
EPA EnviroMapper

Summary of EPA's Monitoring Effort

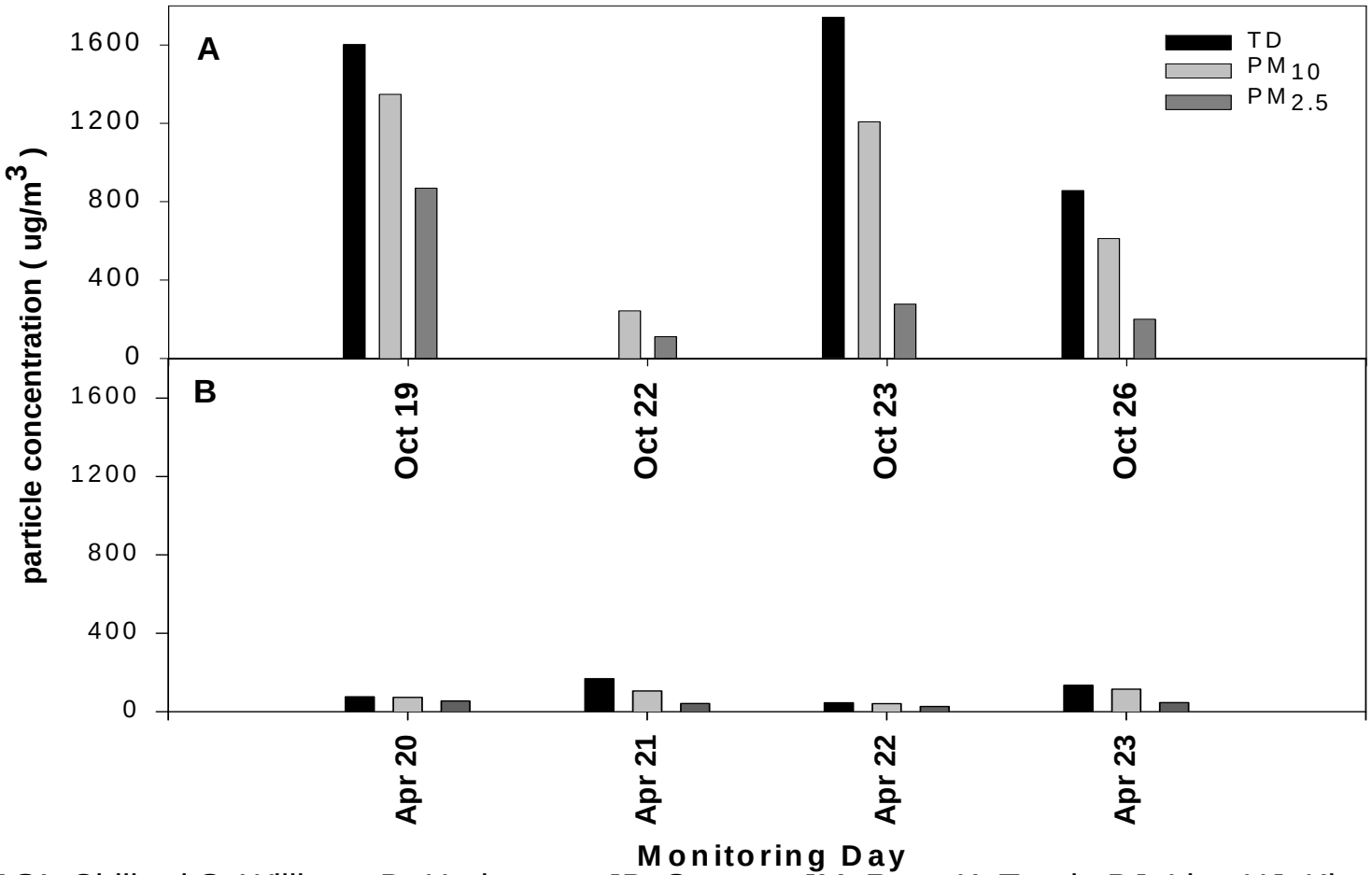
analyte	start date	end date	method	N
asbestos	9/15/01	7/30/02	filter(PCM) (TEM)	12,674 8,870
dioxin/furan as TEQs	9/16/01	5/28/02	integrated 24 or 72 hr	761
Particles $PM_{2.5}$ PM_{10}	9/21/01	3/31/03	continuous/ hourly reports	NA
Particles	9/21/01	01/02	integrated	131
PCB	9/16/01	5/28/02	integrated 24 hr	437
VOC	9/16/01	5/29/02	majority 4 min grab	335

JHSPH WTC Exposure Assessment

- Clean Up and Recovery Worker Exposure Assessment
  - on site **October 2001**
    - 54 trucker drivers
    - 5 area locations
  - on site **April 2002**
    - 15 truck drivers
    - 4 area locations
  - Total Dust, PM_{10}, $PM_{2.5}$, asbestos, volatile organic compounds

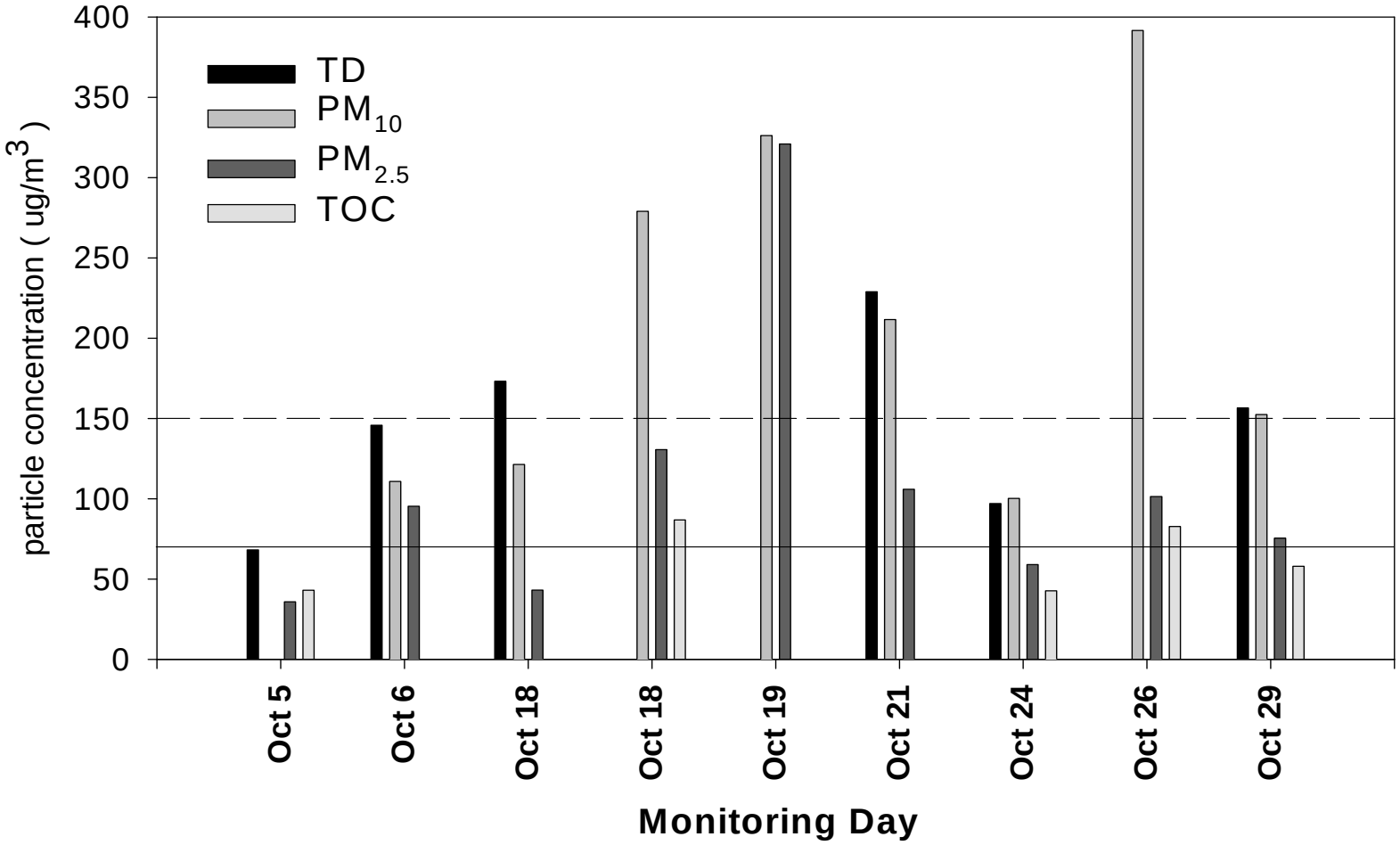
Middle of the Debris Field
October '01 vs April '02

Figure 2

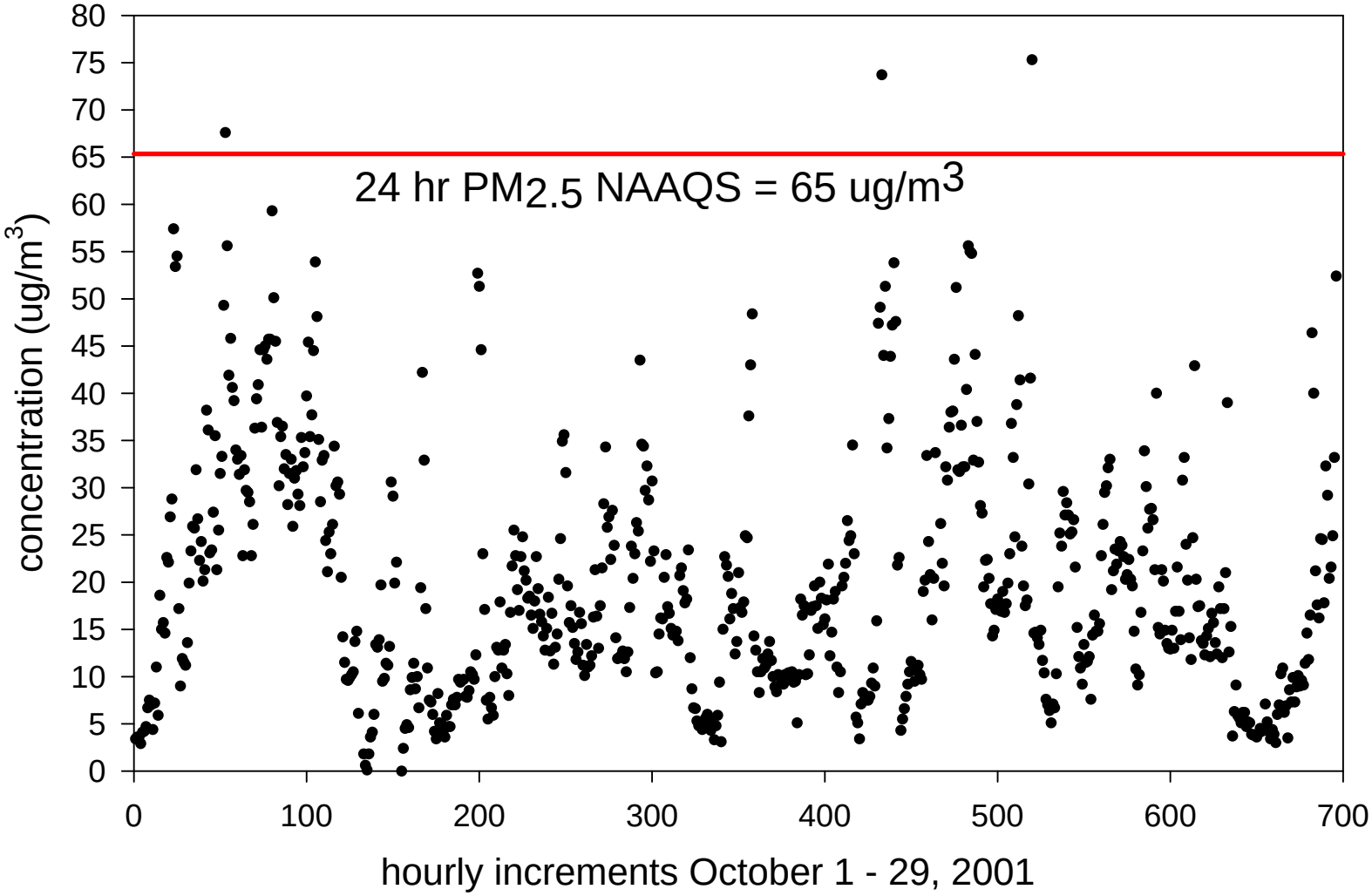


Geyh AS*, Chillrud S, Williams D, Herbstman JB, Symons JM, Rees K, Trupin,BJ, Lim, HJ, Kim, SR, Breysse PN "Assessing Truck Driver Exposure at the World Trade Center Disaster Site: Personal and Area Monitoring for Particulate Matter and Volatile Organic Compounds during October 2001 and April 2002" 2005 J. Occ. Environ. Hygiene 2 179-193.

Church and Dey Sts. October 5 – 29, 2001

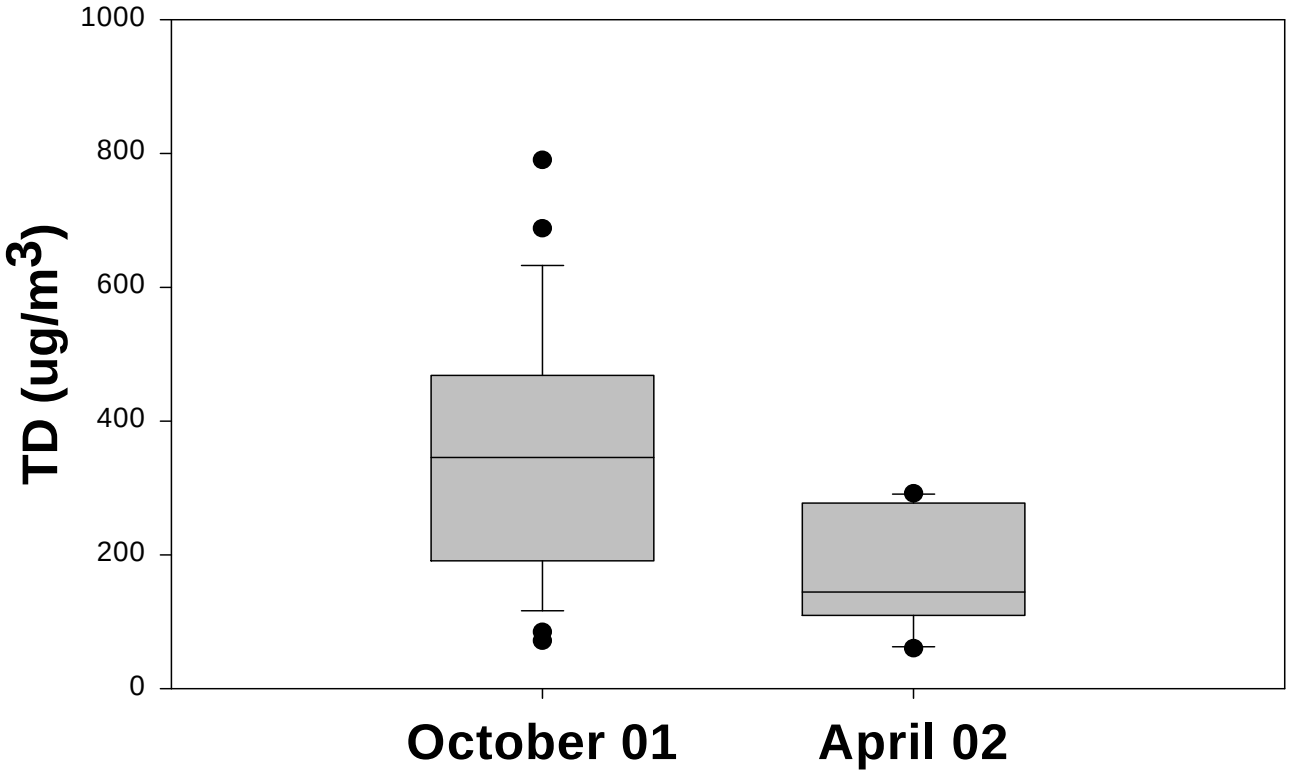


Pace Plaza
October 1 – 29, 2001



Personal Particle Exposure October '01 vs April '02

Figure 6



Geyh AS et al. "Personal and Area Monitoring for Particulate Matter and Volatile Organic Compounds at the World Trade Center Disaster Site during October 2001 and April 2002" JOEH 2005

What were the challenges to evaluating air quality and exposure?

- Access
  - to the site itself
  - to power to run continuous instrumentation
  - to people who should be monitored
  - to information about who and how many people were on site
- Availability
  - of equipment
  - of personnel and time
  - of financial resources
- Ability
  - to coordinate with other groups doing similar work
  - to create an infrastructure supporting work not directly involved with rescue and recovery
  - to structure the exposure assessment in support of currently conducted and future health studies

What we wish we knew

- Contaminant concentrations during the critical exposure period 9/11 – 9/18
- Contaminant concentrations on site across the entire rescue, recovery and clean up effort – 9/01 – 6/02
- Information on a broader range of contaminants; e.g. concentration of particles larger than 10 um.
- More measurements of personal exposure

Air Quality, Exposure, and Health

More lingering questions from the WTC

Concerns about health problems related to exposure at the site

- Early complaints of respiratory dysfunction “ I can’t breath like I use to; I use to be able to run 5 miles and now I can’t walk a block”
- Reports of irritation of the upper and lower airways during the first 3 months of the rescue, recovery and clean up operation
- Concern about physical health problems related to exposure to asbestos, silica, fiberous glass, concrete dust, “WTC dust”
- Concerns about psychological wellbeing

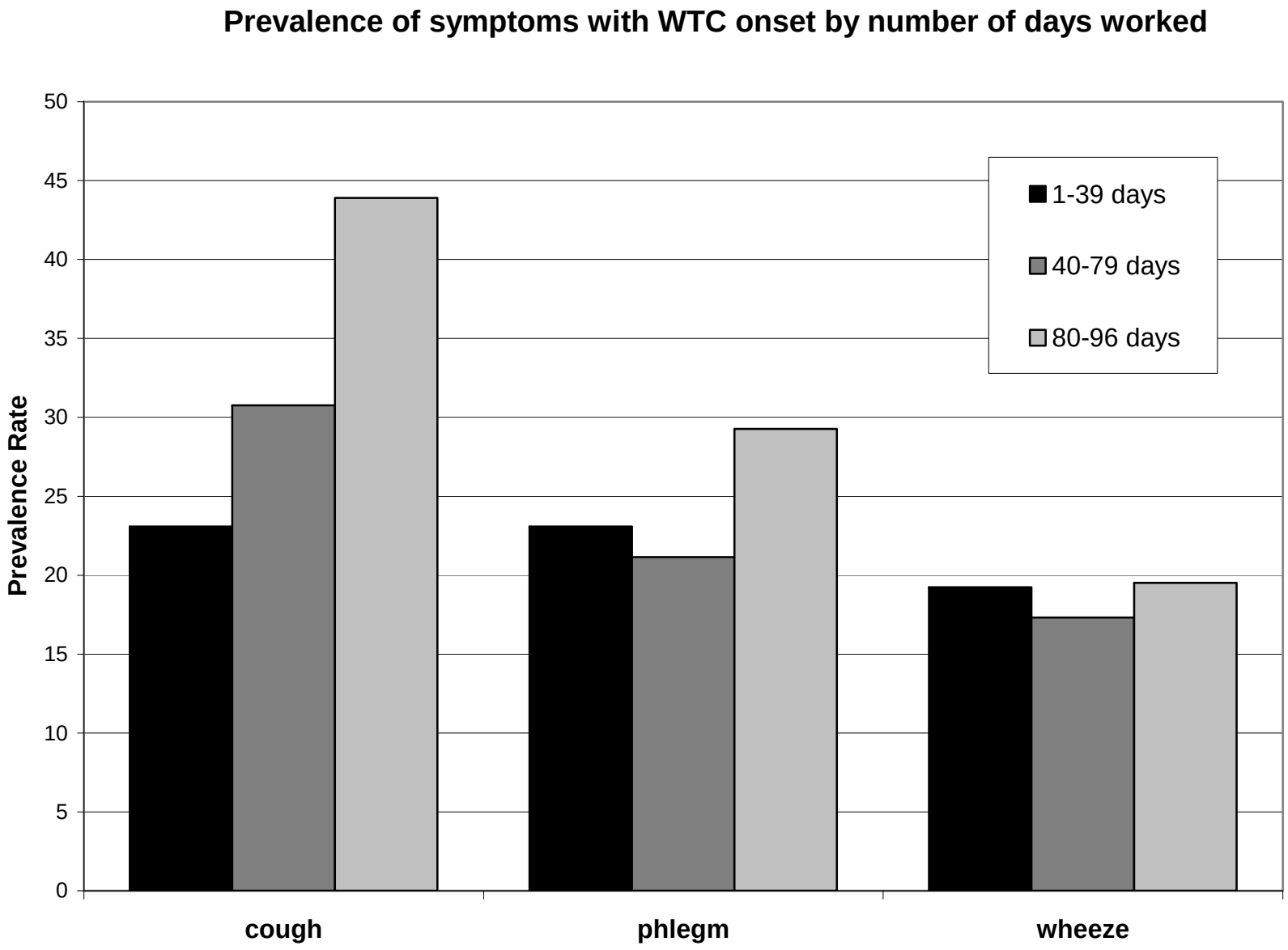
Linking Health to Exposure

Populations	Outcomes	Exposure Metric
Firefighters	WTC cough	arrival time at the site
Police/ Emergency Service Unit	lower respiratory symptoms	arrival time at the site
Immigrant workers	general respiratory symptoms	exposure to the site
Iron workers	upper and lower respiratory symptoms	arrival time at the site
Police/ Emergency Service Unit	lower respiratory symptoms	arrival time at the site
Workers and Volunteers	upper and lower respiratory symptoms/mental health symptoms	arrival time at the site

JHSPH WTC Health Assessment

- Clean Up and Recovery Worker Respiratory Health Survey
  - on site **December 2001** with 183 clean up workers including truck drivers, heavy equipment operators, carpenters, dock builders, laborers
  - interview administered respiratory health survey and lung function testing

- World Trade Center Clean Up and Recovery Worker Health Survey
  - mailed survey March – June 2003 to 4546 workers involved at the WTC disaster site (25% responded) and 2103 workers who were never at the WTC disaster site (11% responded)
  - Workers groups included truck drivers, heavy equipment operators, laborers, and NYC Department of Sanitation workers.



Herbstman JB, Frank R, Schwab M, Williams, D L, Samet JM,, Breysse PN, **Geyh AS*** . "Respiratory Effects of Inhalation Exposure Among Workers During the Clean Up Effort at the World Trade Center Disaster Site" Environ. Res. 99 2005, 85-92.

Prevalence Rates of Lower Respiratory Symptoms (LRS) with Onset at WTC

	Workers arriving at the WTC with no LRS (N=119) n (%) [95% CI]
Cough	40 (34) [25, 42]
Phlegm	29 (24) [25, 42]
Wheeze	22 (19) [12, 25]

Herbstman JB, Frank R, Schwab M, Williams, D L, Samet JM,, Breysse PN, **Geyh AS*** . "Respiratory Effects of Inhalation Exposure Among Workers During the Clean Up Effort at the World Trade Center Disaster Site" Environ. Res. 99 2005, 85-92.

What we have learned about respiratory worker health

20 months after they left the disaster site…

Outcome - Lower Respiratory Health at the WTC vs never at the WTC	OR (95% CI)*
Cough	2.26 (1.55;3.28)
Phlegm	1.91 (1.31;2.76)
Wheezing	2.25 (1.57;2.34)
Shortness of Breath	2.67 (1.82;3.92)
Cough and/or Phlegm	2.17 (1.52;3.10)
Shortness of breath and/or Wheezing	2.88 (2.00;4.15)
Any Symptom	3.40 (2.33;4.94)

- Results of logistic regression controlling for age, gender, race, martial status, education, respiratory disease history, and smoking
- J. Occup. Environ. Med. 2007 Oct 49 (10) 1063

What we have learned about worker mental health

20 months after they left the disaster site…

Outcome - Mental Health at the WTC vs never at the WTC	OR (95% CI)*
anxiety disorder	3.93 (2.06;7.51)
panic disorder	6.46 (1.55;26.89)
post traumatic stress disorder	5.80 (1.26;26.68)
depression	
minimal symptoms	2.10 (1.37;3.19)
minimal depression	2.44 (1.49;3.93)
moderate severely major depression	2.25 (1.30;3.91)
severe major depression	3.38 (2.02;6.77)

*Results of logistic regression controlling for age, number of children, and marital status

•submitted for publication

What have been the challenges to evaluating health effect related to exposure at the WTC?

- Access
  - to exposure data that is informative for assessing health
    - it does not exist!
  - to people who were engaged at the site
    - no registry of people (workers, volunteers, random visitors) who were on site
    - no mechanism for contacting WTC workers
- Availability
  - of financial resources
    - resources were limited, not immediately available, and disappeared
- Ability
  - to engage with existing infrastructure promoting work not directly involved with rescue and recovery
    - disaster epidemiology

Gaps in our knowledge

- Nothing is known about concentrations of airborne contaminants during a critical exposure period
- Information about exposure that is available for the entire rescue, recovery and cleanup operation is incomplete
- Health studies are delinked from exposure information
- Health studies suffer from lack of access to exposed populations

If we are serious about understanding the health consequences of involvement in a disaster response, preparation for the future requires a commitment of immediately available resources including expertise, personnel, and funding