Diesel Emissions: Environmental, Occupational, and Public Health Impacts

Presentation to STAPPA/ALAPCO Mobile Sources Committee

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Project Introduction

- Five sites were evaluated
- Work funded by the Environmental Protection Agency
- Project lead:

  Northeast States for Coordinated Air Use Management

  Keene State College
- Collaborating Institutions:

  University of Massachusetts-Lowell

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Project Introduction

Goals:

- To evaluate occupational exposures and environmental impact of nonroad diesel equipment activity
- To qualify (and to the degree possible quantify) health risks for exposed populations

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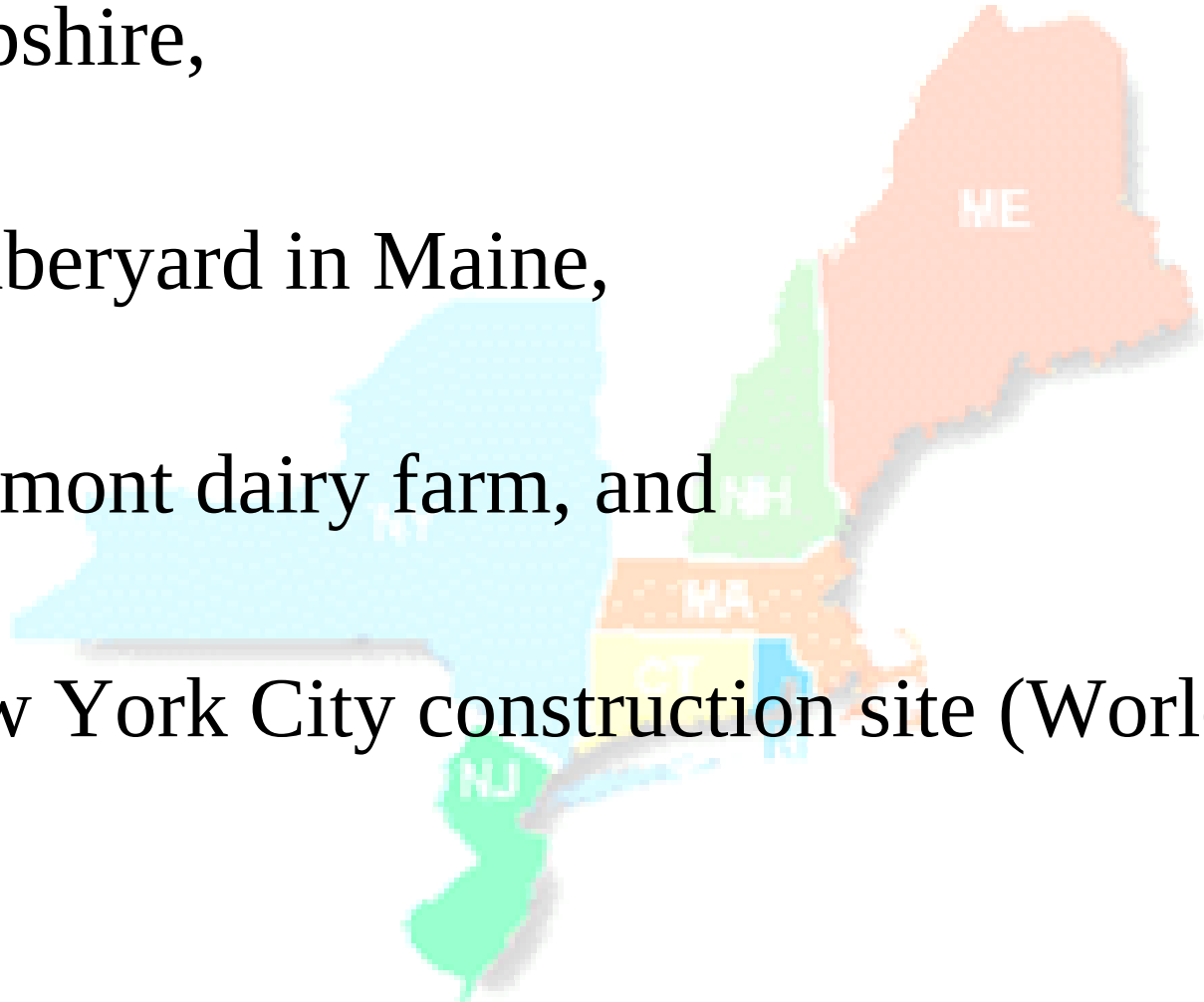
Monitoring Sites

- Construction sites in Keene and Manchester, New Hampshire,
- a lumberyard in Maine,
- a Vermont dairy farm, and
- a New York City construction site (World Trade#7).



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Project Timeline

- Project initiated April 2002.
- Field work initiated June 2002.
- Final field monitoring completed May 29, 2003.
- Final analytical results received by November 1, 2003.
- Data available now, report next week.

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Our Approach

- Use established occupational and environmental monitoring /analysis methods
- Monitor fine particulate matter exposure and ~45 gaseous pollutants
- Monitor exposures at the perimeter of a worksite (environmental)
- Monitor in-cabin exposures (occupational)
- Track local meteorological conditions
- Compare our monitoring results with allowable occupational and environmental health-protective standards

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Equipment Monitoring (3 pieces)	**Perimeter #1** (~300ft X 300 ft site)	**Perimeter #2** (~300ft X 300 ft site)
EC/OC (diesel soot) PM_4 Respirable cyclone @ 4.2 liters/minute **$PM_{2.5}$** $PM_{2.5}$ cyclone @ 3.5 liters/minute **Volatile Organic Compounds** (Carbotrap X and Carboxen 1016 absorbent trap) @ 0.200 liters/minute **Carbonyls** (DNPH with O_3 scrubber) @ 0.200 liters/minute	**EC/OC (diesel soot)** PM_4 @ 4.2 liters/minute **$PM_{2.5}$** $PM_{2.5}$ cyclone @ 3.5 liters/minute **Volatile Organic Compounds** SUMMA Canister with 8-hr orifice **Carbonyls** (DNPH w/ O_3 scrubber) @ 0.200 liters/minute **Real Time Black Carbon** Aethelometer (PM_4) **Real Time $PM_{2.5}$** EPAM5000 ($PM_{2.5}$ kit)—Real Time PM monitoring with side-by-side gravimetric mass analyses Data Logging **Weather** Station Tracking temperature, relative humidity, wind speed/direction, and dew point	**EC/OC (diesel soot)** PM_4 Respirable cyclone @ 4.2 liters/minute **EC/OC** BGI PQ100 ($PM_{2.5}$) @ 16.7 liters/minute **$PM_{2.5}$** $PM_{2.5}$ cyclone @ 3.5 liters/minute **Volatile Organic Compounds** SUMMA Canister with 8-hr orifice **Carbonyls** (DNPH w/ O_3 scrubber) @ 0.200 liters/minute **Real Time Black Carbon** Aethelometer (PM_4) **Real Time $PM_{2.5}$** EPAM5000 ($PM_{2.5}$ kit)—Real Time PM monitoring with side-by-side gravimetric mass analyses

Key: EC/OC PM – Elemental and Organic Carbon Particulate matter

Analyses:

Volatile Organic Carbon: EPA TO-15 and TO17
Carbonyls: EPA TO-11
EC/OC: NIOSH Method #5040

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Additional Analyses

- XRF speciation and ICP-MS for metals in selected $PM_{2.5}$ integrated samples.

- These data, combined with the EC/OC results will help to discern the fraction of the sample coming from diesel vs. soil in PM samples and identify variability in toxic metals.

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Gaseous Pollutants

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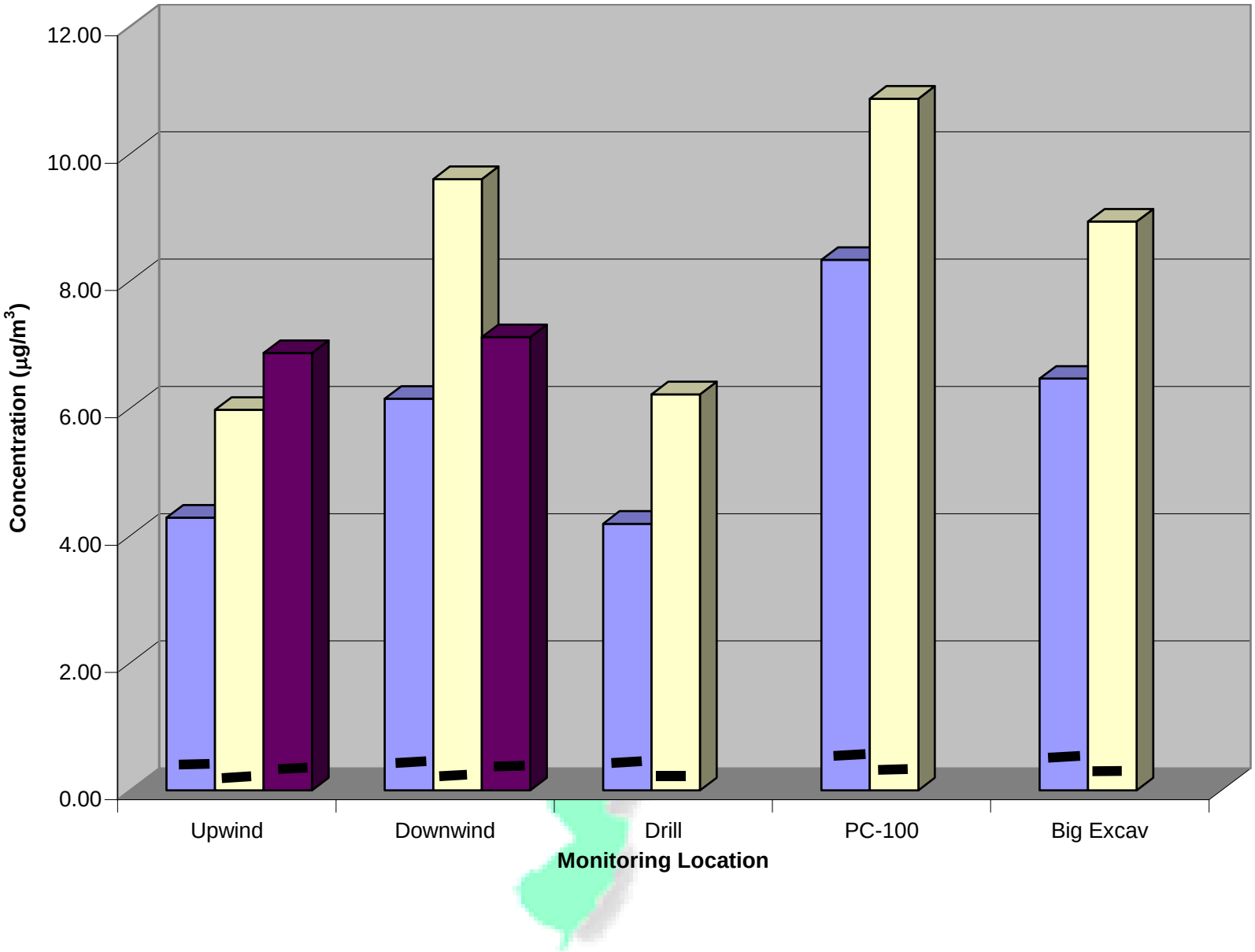
Target Gas Concentrations, NYC



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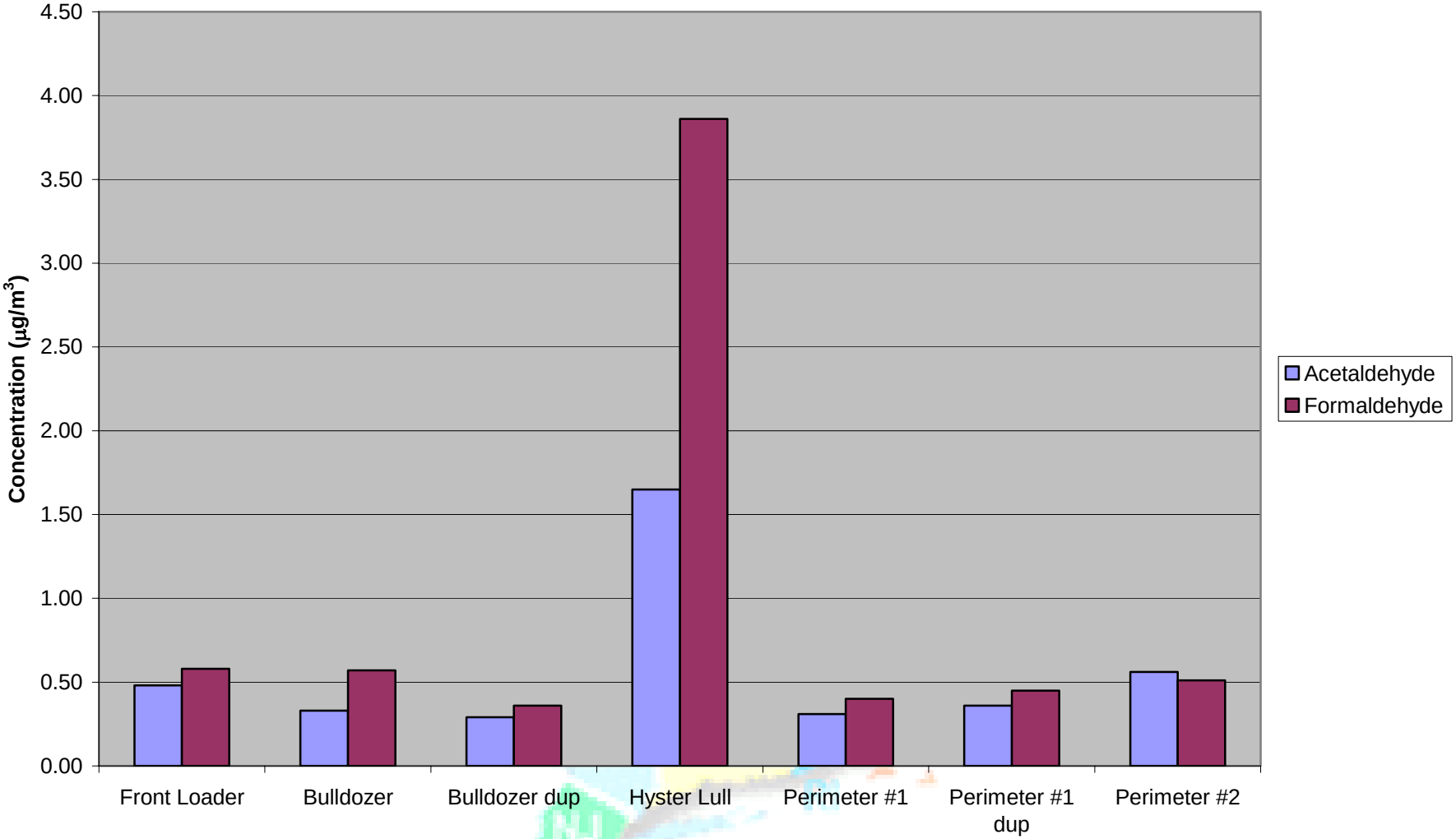
Keene, NH Acetaldehyde and Formaldehyde Concentrations, Day 1



Acetaldehyde = 0.45 µg/m^3 Formaldehyde = 0.077 µg/m^3

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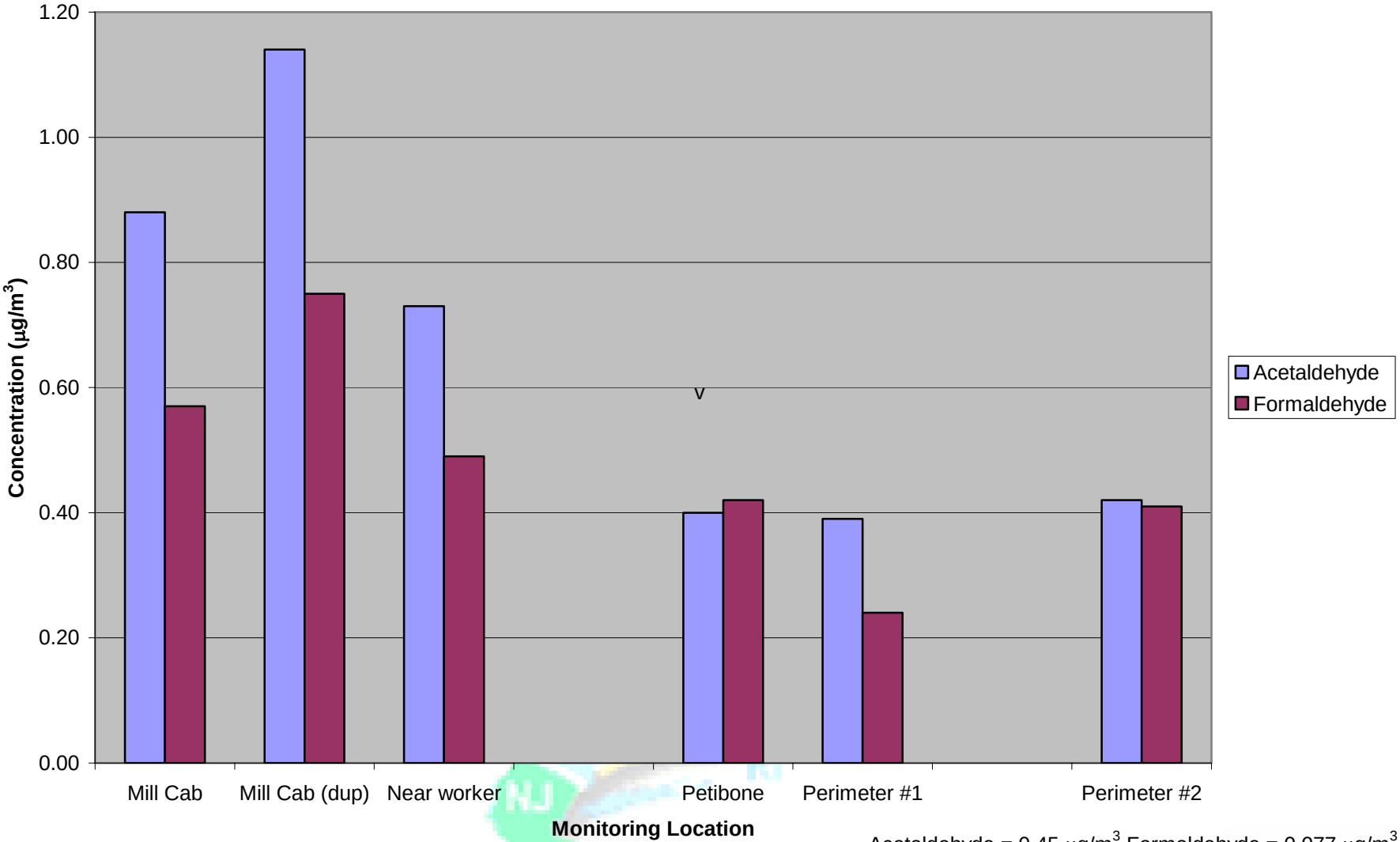
Carmel, ME Acetaldehyde and Formaldehyde Concentrations, Day 1



Acetaldehyde = 0.45 µg/m^3 Formaldehyde = 0.077 µg/m^3

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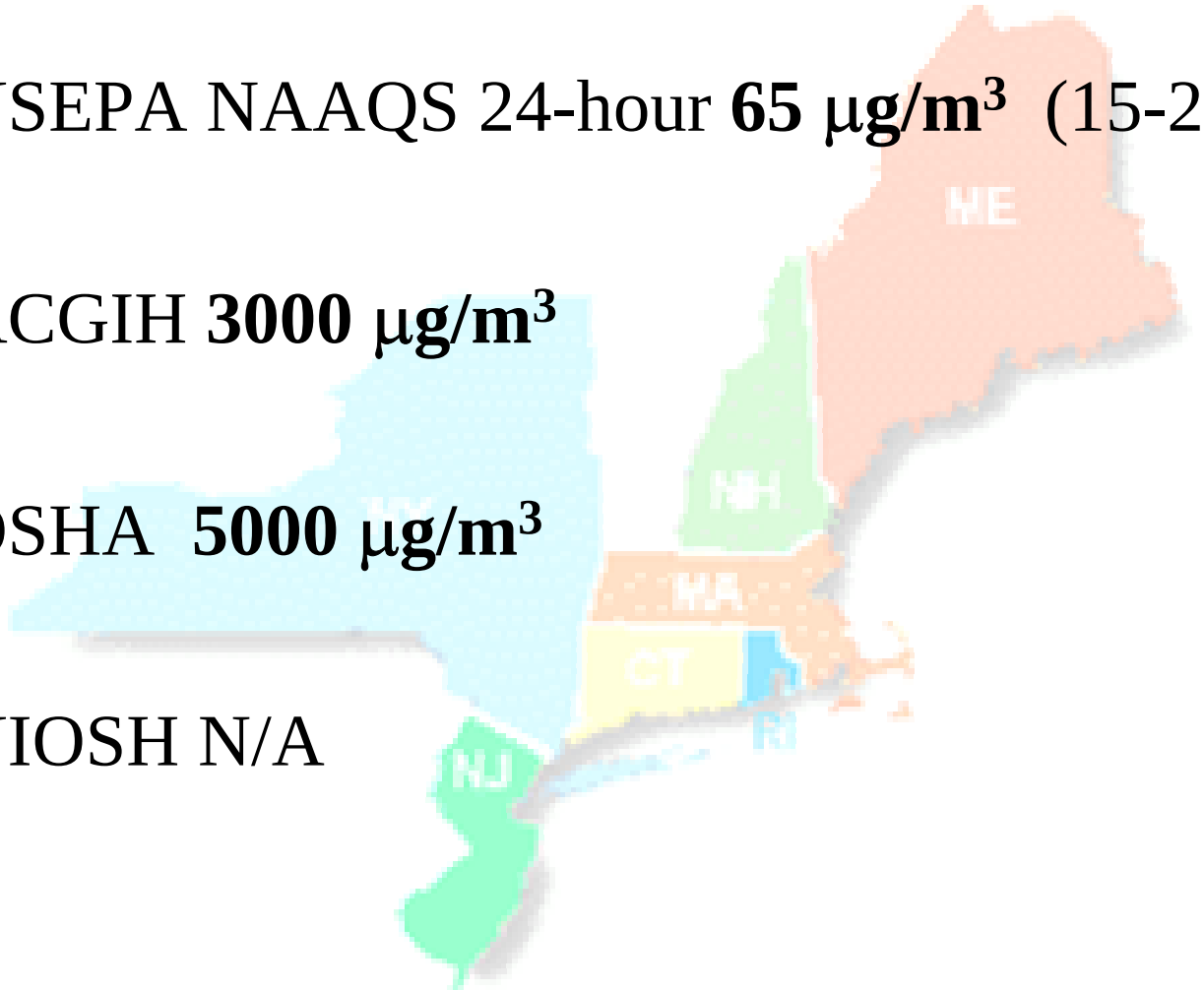
Fine Particulate Matter, N.O.S. Standards,

- USEPA NAAQS 24-hour **65 μg/m³** (15-24 μg/m³)
- ACGIH **3000 μg/m³**
- OSHA **5000 μg/m³**
- NIOSH N/A



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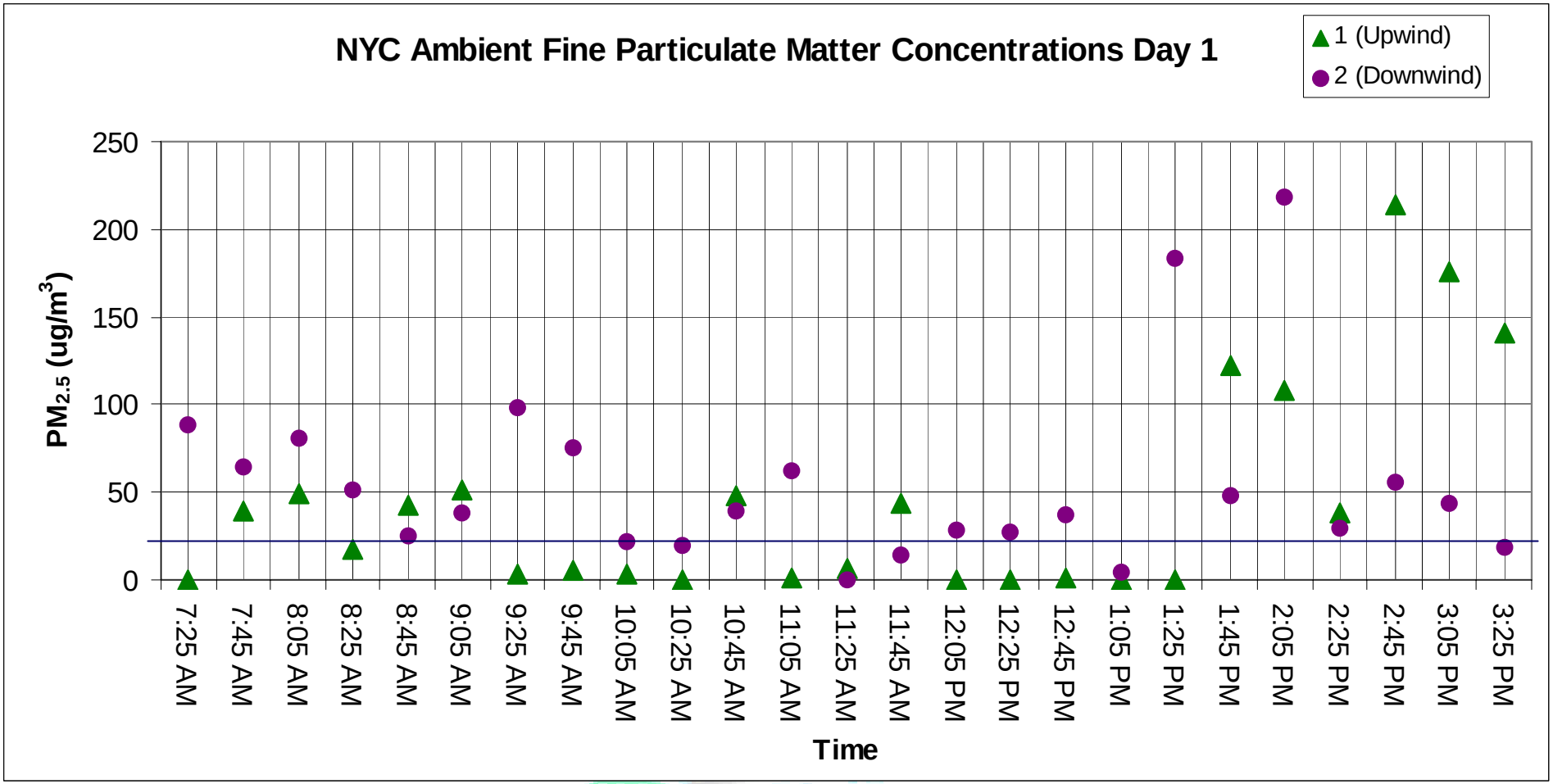

Average, Site 1: 44 µg/m³
Average, Site 2: 55 µg/m³

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Measured Fine Particulate Matter Concentrations

	New York City (μg/m3)	MAINE (μg/m3)	KEENE STATE (μg/m3)
DAY 1			
Perimeter #1	**49.27**	**0.30**	**45.19**
Perimeter #2	**76.57**	**-5.56**	**23.79**
Big Drill	**36.70**		
PC-100	**45.68**		
Big Excavator	**66.25**		
DAY 2			
Perimeter #1	**58.24**	**9.79**	**-0.59**
Perimeter #2	**59.62**	**21.89**	**15.93**
Big Drill	**-0.86**		
PC-100	**44.37**		
Big Excavator	**69.58**		
DAY 3			
Perimeter #1	**34.50**	**13.42**	**14.44**
Perimeter #2	**20.86**	**11.69**	**25.10**
Big Drill	**49.47**		
PC-100	**77.13**		
Big Excavator	**45.43**		

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Metal	Health Effect(s)	ACGIH 8-hr Exposure Limit
Nickel	Pneumoconiosis	0.2 μg/m^3
Zinc Oxide	Lung Effects	10 μg/m^3
Iron Oxide	Pneumoconiosis	5 μg/m^3 *5,000 ng/m^3*
Vanadium	Lung Irritation Chronic Respiratory Disease	0.05 μg/m^3 *50 ng/m^3*
Silica (Quartz)	Silicosis, Lung Function change, Cancer	0.05 μg/m^3

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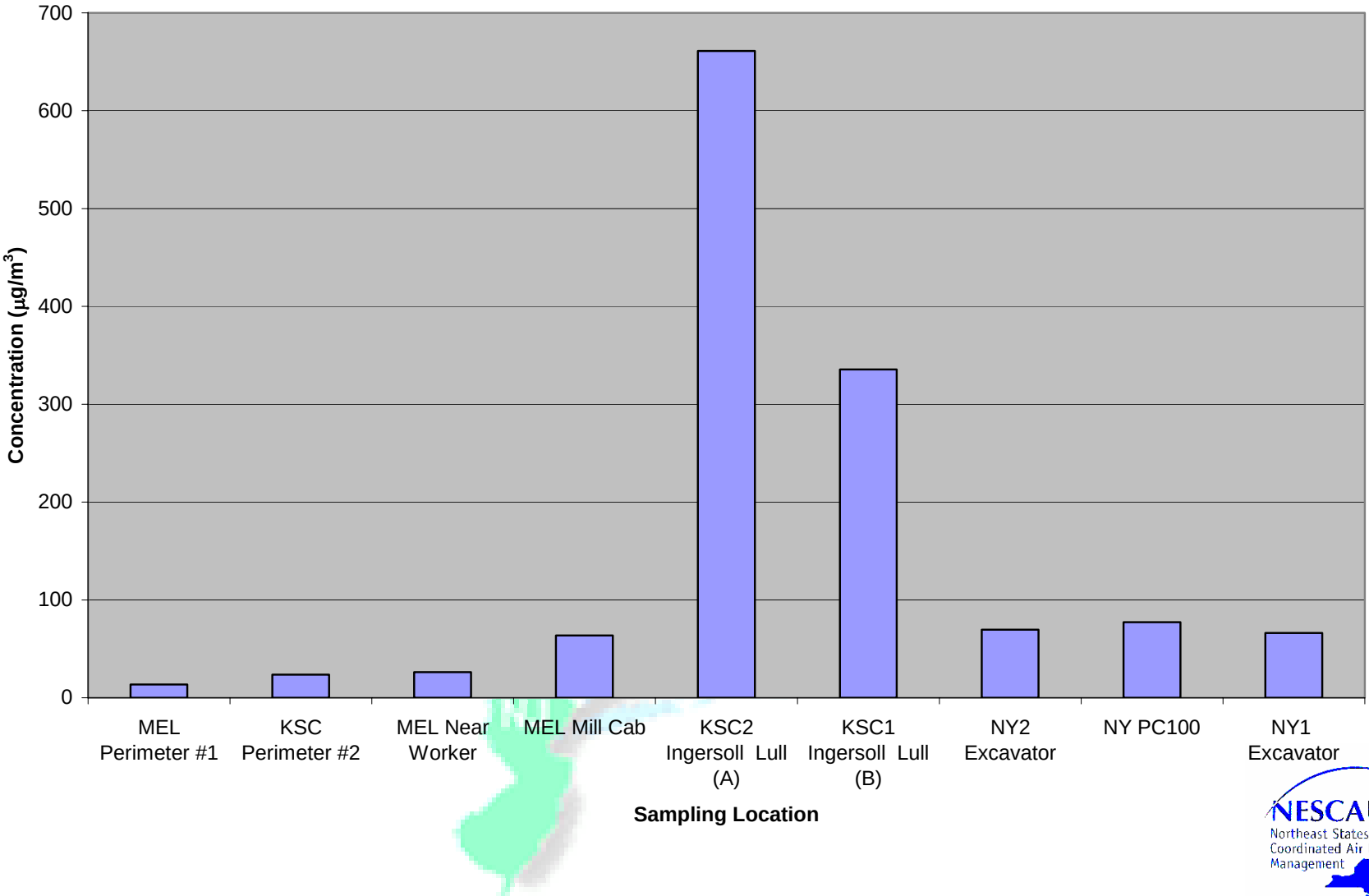
Total Collected $PM_{2.5}$ Mass 8 hour Average Sample Concentration



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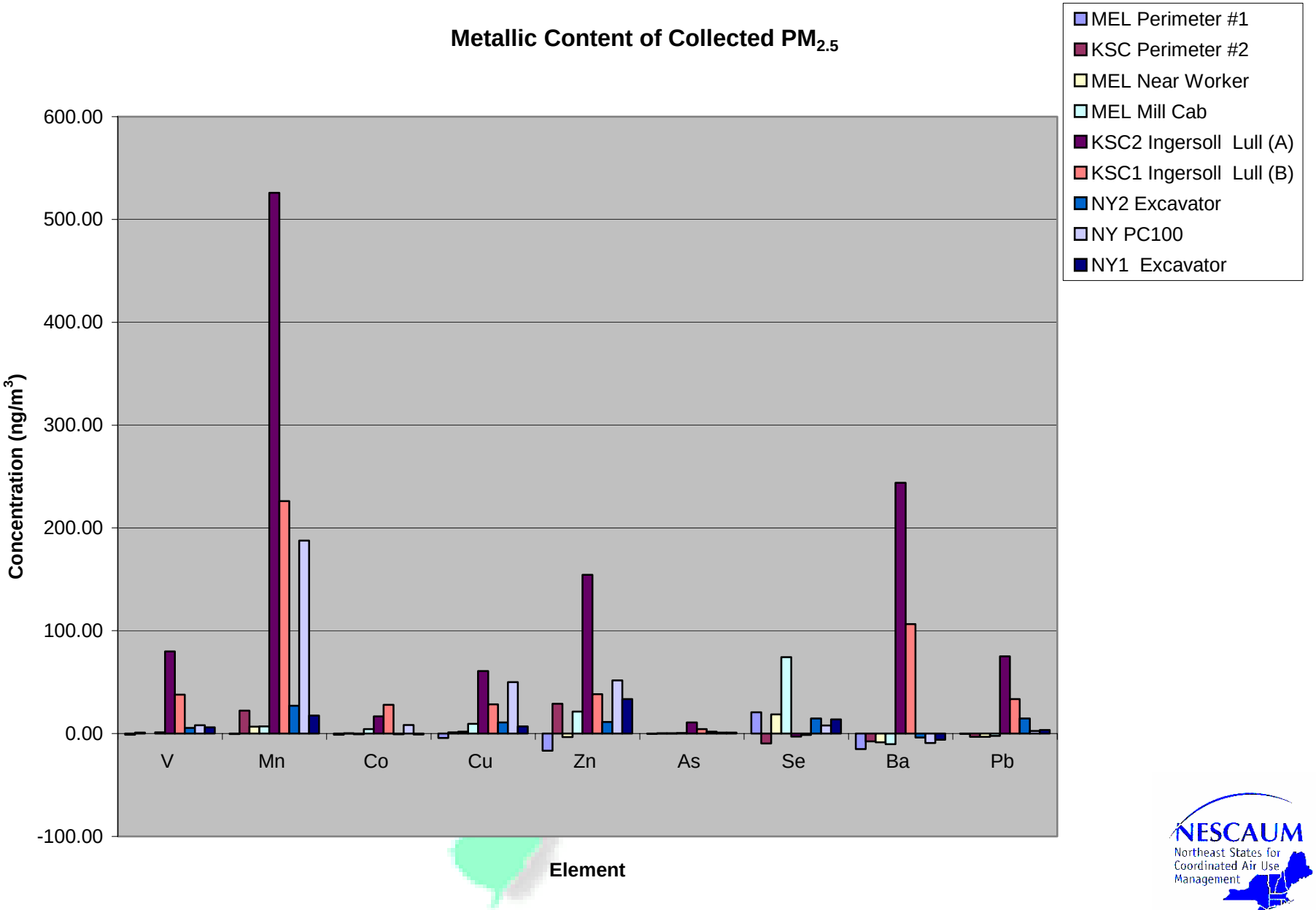
Metallic Content of Collected $PM_{2.5}$



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Diesel Particulate Matter Standards

DPM considered more toxic than unspecified $PM_{2.5}$

- USEPA **reference concentration of 5 μg/m^3**
- MSHA interim **400 μg/m^3 (160 μg/m^3)**
- OSHA "compound of concern"
- NIOSH "lowest feasible concentration"

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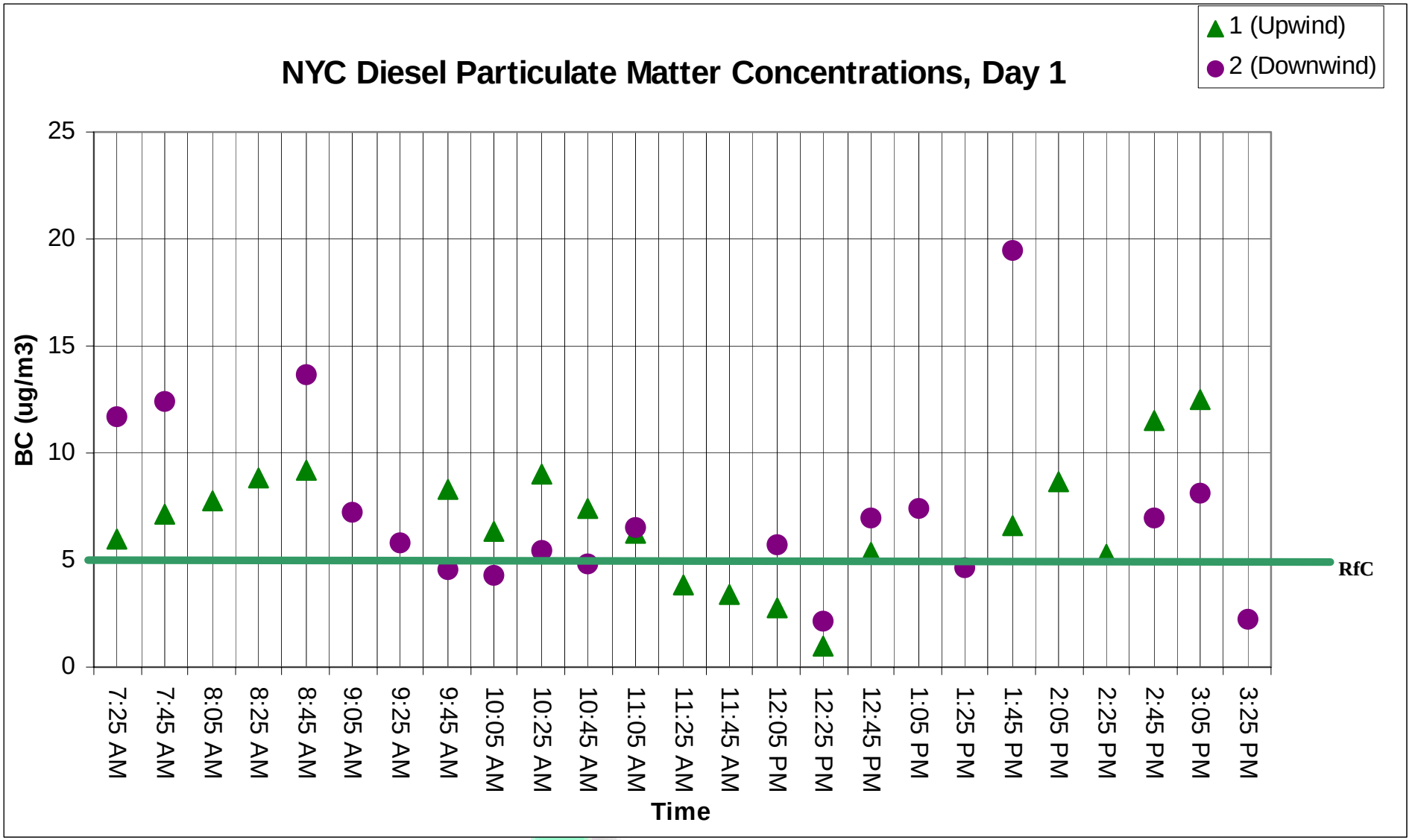

Average, Site 1: 6.9 µg/m³
Average, Site 2: 7.3 µg/m³

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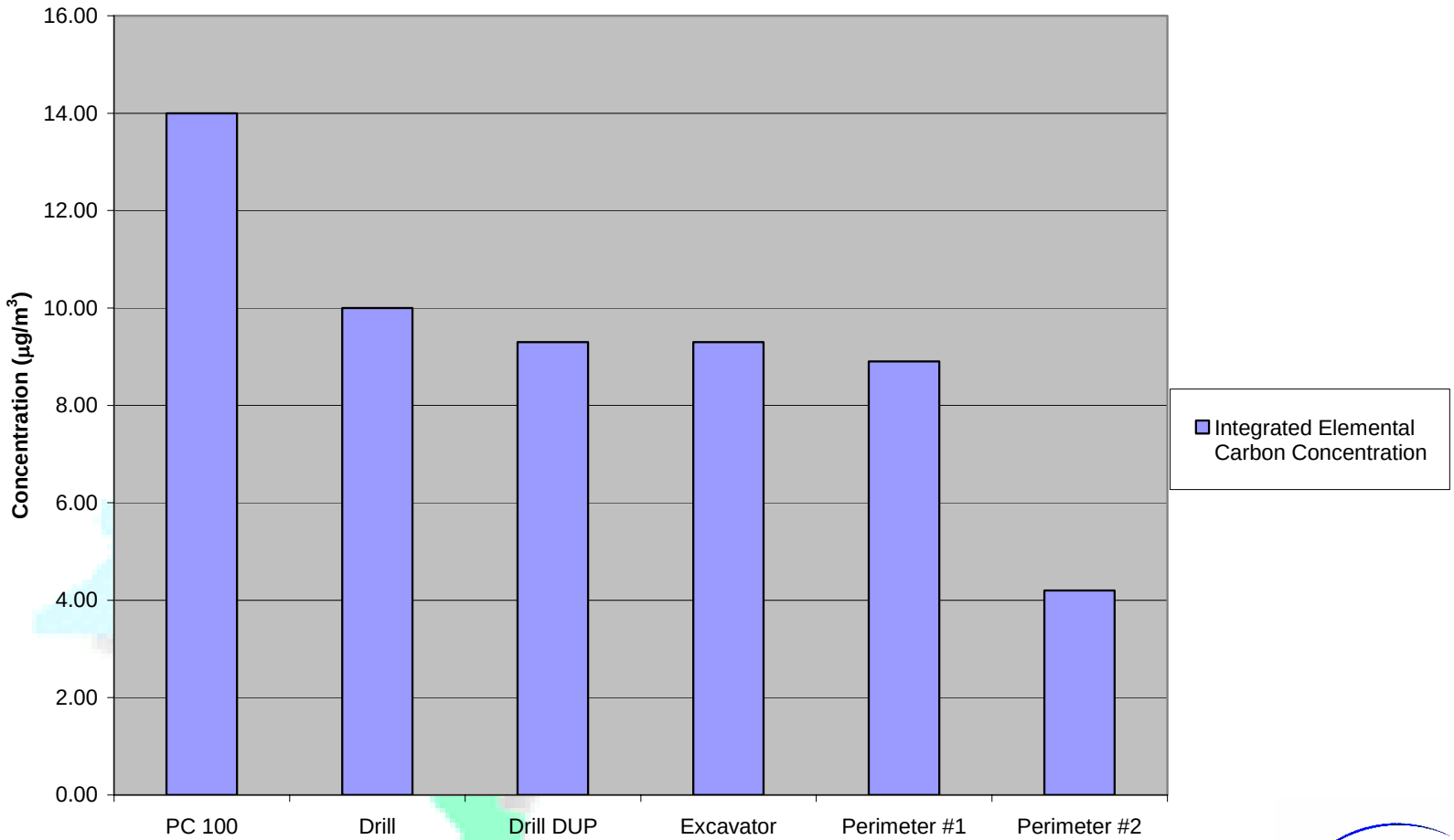
New York City Integrated Elemental Carbon Concentration, Day 2



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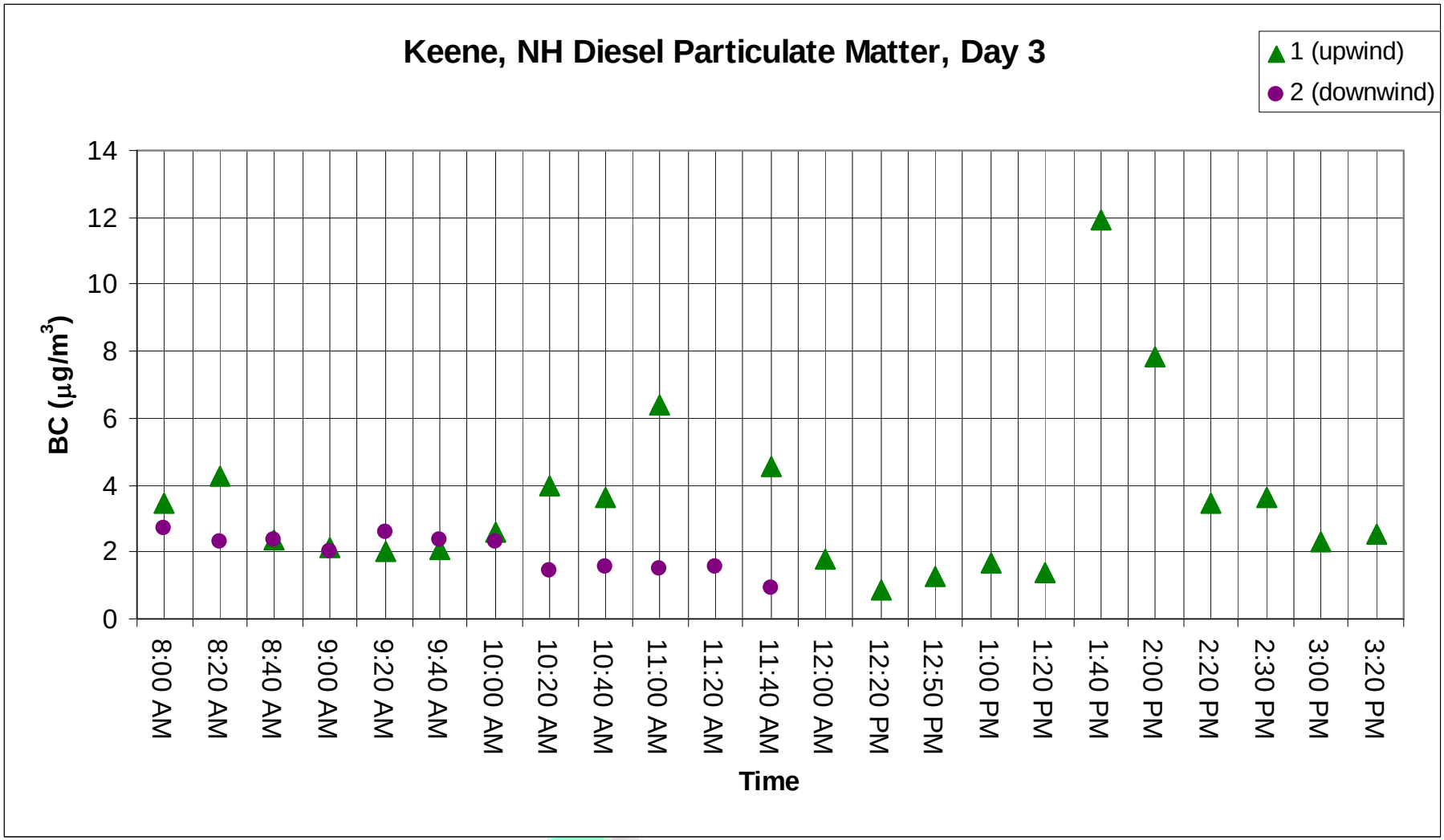

Average, Site 1: 3.5 µg/m³
Average, Site 2: 2.0 µg/m³

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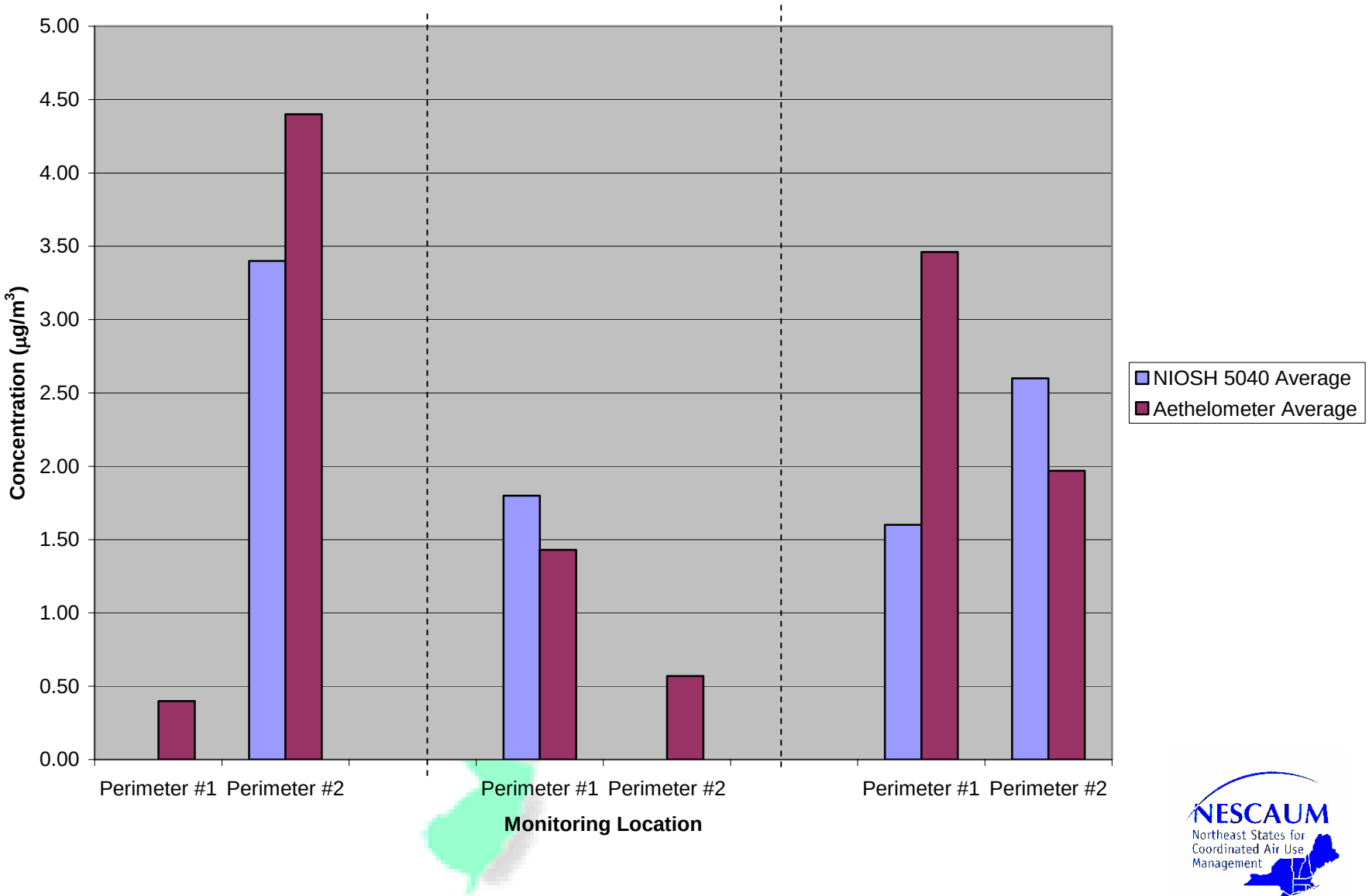
Elemental Carbon Monitoring Method Comparison, Keene, NH



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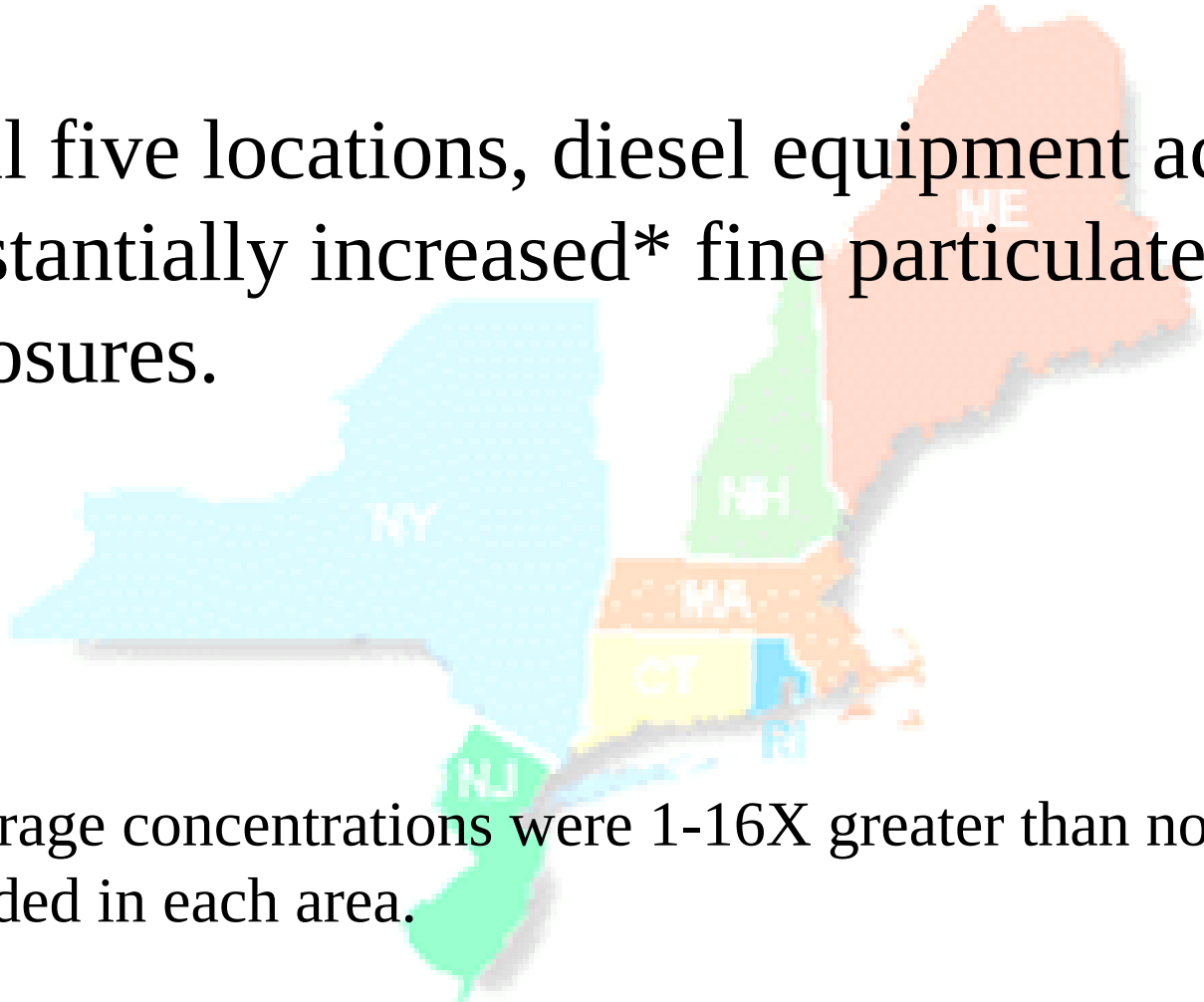
Conclusions

In all five locations, diesel equipment activity substantially increased* fine particulate matter exposures.



*Average concentrations were 1-16X greater than normally recorded in each area.

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Conclusions

In all five locations, diesel equipment activity increased* diesel particulate matter exposures.

*Other projects have concluded that, in an urban environment, diesel particulate "background" ranges between 0.4 – 1.5 μg/m^3. These data demonstrate that nonroad equipment activities will increase these concentrations by 1 - 6 X.

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Conclusions

- Concentrations of several monitored gaseous pollutants are several hundred times greater than carcinogenic risk screening thresholds

- Concentrations of toxic metals vary across sites and in some cases exceed established allowable exposure concentrations.

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Conclusions

- Occupational exposures to $PM_{2.5}$ for operators of the diesel equipment ranged from 2 to over 660 $\mu g/m^3$ (well below the ACGIH/OSHA standards).

- At the higher end of this range, exposure levels are more than 2 times above the current EPA ambient air standard.

- Diesel particulate matter concentrations shown to exceed the establish reference concentration in numerous instances.

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Conclusions

In the Northeast, between 48,262 and 201,022 employees are estimated to be exposed daily to diesel exhaust concentrations similar to those monitored in this study.

A number of nonroad projects present potential prolonged exposures for nearby residents.

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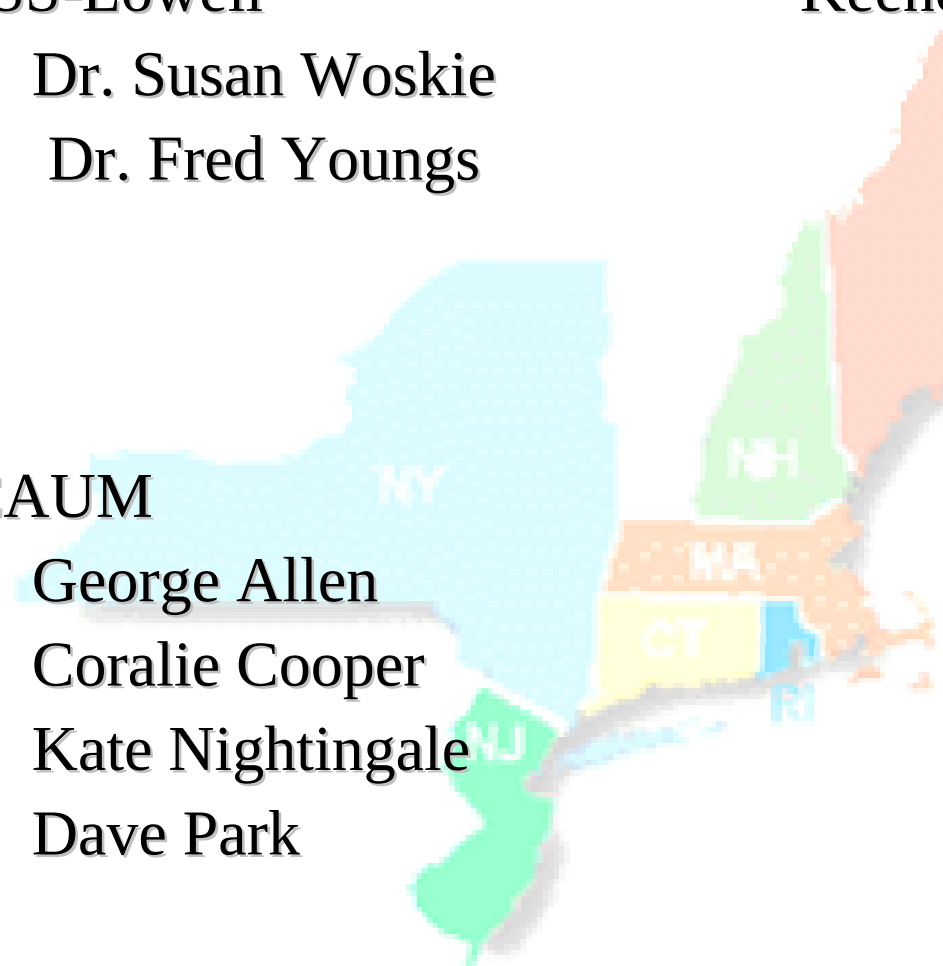

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