

PM_{2.5} Sampling and Analysis at NETL



United States Department of Energy - National Energy Technology Laboratory

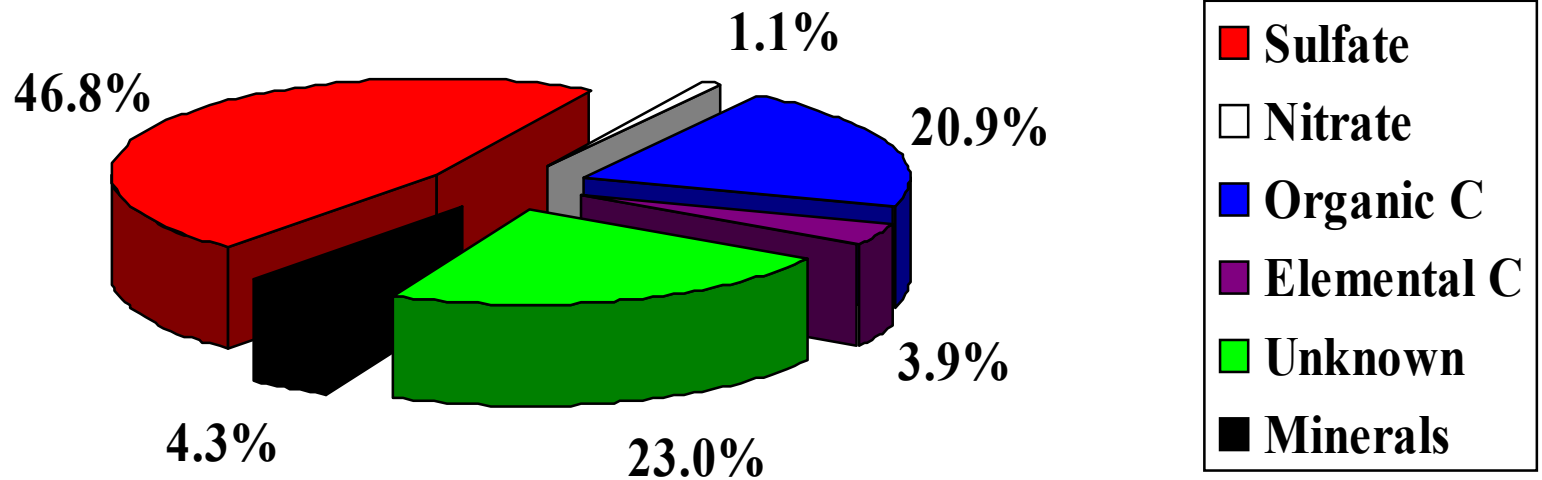


Why Is DOE Concerned About PM_{2.5}?

- Coal-based power systems emit both primary fine particles and PM_{2.5} precursors (SO₂ and NO_x)
- PM_{2.5} NAAQS require compliance determinations
- Non-compliance will likely trigger emissions control strategies
- What is the relationship between coal-fired boiler emissions and ambient PM_{2.5}?



Eastern PM_{2.5} Mass Apportionment - *Current Understanding?*



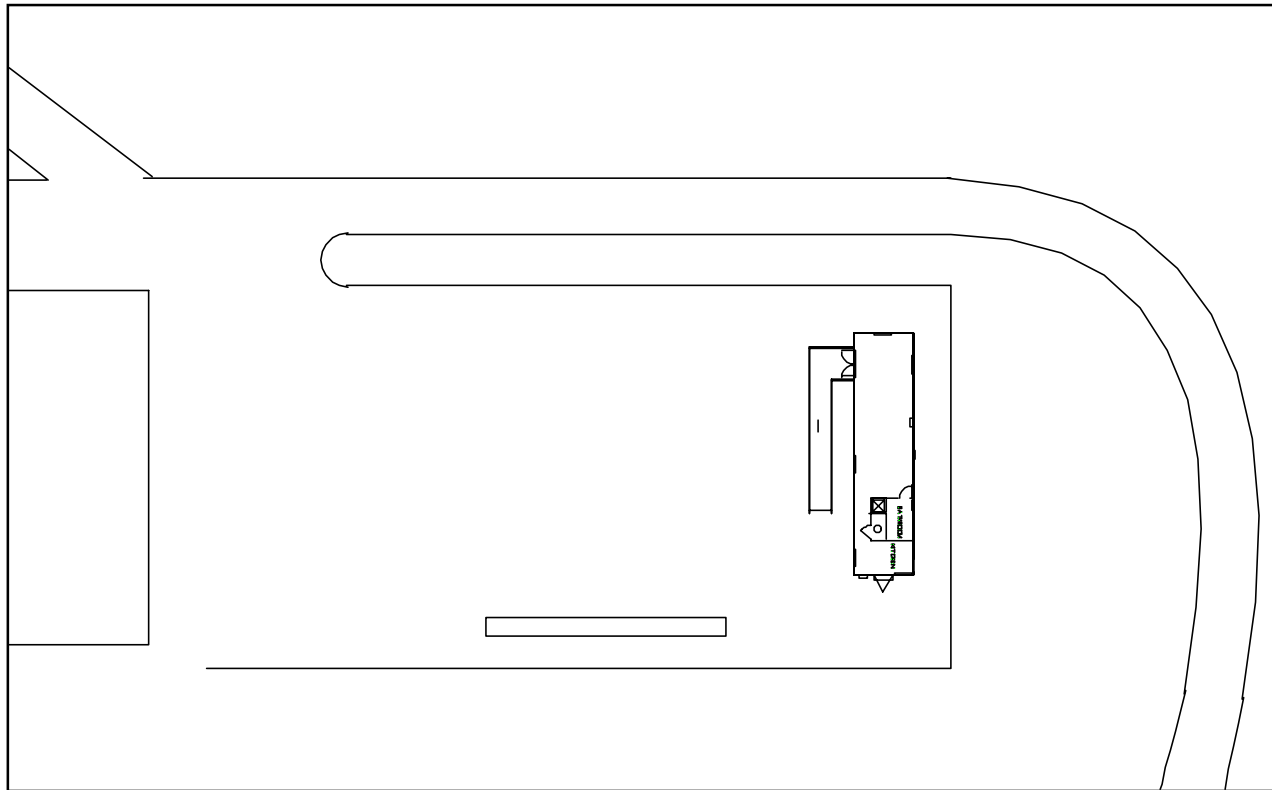
Source: EPA, April 1995

The NETL OST PM 2.5 research program has these specific research goals and objectives for FY2000:

- Provide insight into the degree to which the local coal-fired electric power generating stations contribute to the primary particulate matter load in ambient air in Pittsburgh;
- Provide state-of-the-art characterization of the organic components on the particles;
- Provide insight into the formation and atmospheric chemistry of secondary PM_{2.5} formed from reaction of SO_x, NO_x and NH₃;
- Provide comparisons of the mass of PM_{2.5} as measured by a variety of commercially available instruments that measure PM_{2.5} mass when they are co-located at NETL and when scattered over South Park Township; and
- Study the diurnal and seasonal variation in fine particles at NETL to correlate with sampling stations located in urban Pittsburgh and Morgantown, part of the Upper Ohio River Valley Project (UORVP).



UPPER OHIO RIVER VALLEY PM2.5 SAMPLING STATION - NETL/PGH



EQUIPMENT RACK



AMBIENT AIR MONITORING STATION



LIST OF SAMPLING EQUIPMENT

- I. **PM2.5 Partisol®- Plus FRM Sequential Air Sampler (R&P),**
- II. **ENVIROcheck Model 107M Environmental Particulate Monitoring System (Grimm),**
- III. **PM2.5 Allegheny County Health Department FRM Sampler (R&P),**
- IV. **PM2.5 Consol Research FRM Sampler (Andersen),**
- V. **PM2.5 DustTrack Aerosol Monitor (TSI),**
- VI. **PM2.5 TEOM® Ambient Particulate Monitor equipped with an AccuSampler (R&P),**
- VII. **PM2.5 RASS 2.5-400 Speciation Sampler (Andersen),**
- VIII. **PAS 2000 Real-time PAH Monitor (EcoChem Analytics),**
- IX. **Seven Day Pollen and Mold Spore Trap (Burkard),**
- X. **Continuous Total Gaseous Peroxide Monitor (Kok),**
- XI. **Continuous Gas Monitors -- SO₂, O₃, CO, NO_x, NO_y, NH₃, H₂S (API),**
- XII. **PM2.5 BOSS Sampler (BYU),**
- XIII. **High Volume Samplers (BYU and NETL),**
- XIV. **PM2.5 Ambient Carbon Particulate Monitor (R&P),**
- XV. **Highly Instrumented Meteorological Tower (Climatronics).**



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OST PM2.5 PARTNERS

- 1) CONSOL RESEARCH**
- 2) R. J. LEE CORPORATION**
- 3) CHEMICON CORPORATION**
- 4) BRIGHAM YOUNG UNIVERSITY**
- 5) ALLEGHENY COUNTY HEALTH DEPARTMENT**
- 6) MINE SAFETY AND HEALTH ADMINISTRATION**
- 7) NETL ENVIRONMENTAL SAFETY AND
HEALTH DIVISION**



OST PM2.5 PARTNERS

- **CO-LOCATE SAMPLING EQUIPMENT**
- **SHARE DATA**
- **TRADE SAMPLES FOR ANALYSIS**
- **CO-AUTHOR MANUSCRIPTS DESCRIBING
OUR JOINT RESULTS**

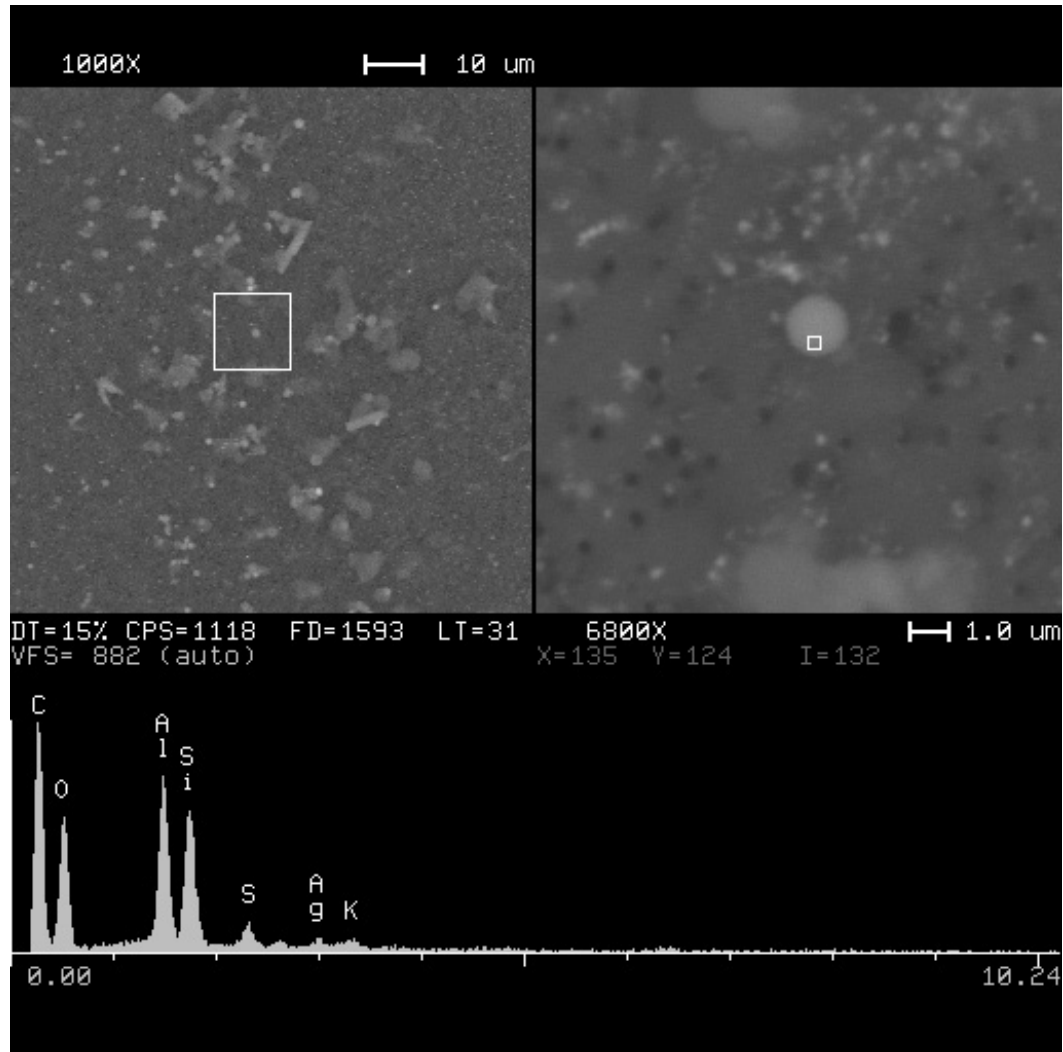


EXPERIMENTAL APPROACH TO OBJECTIVE ONE

In order to provide insight into the degree to which coal-fired electric power generating stations directly contribute to the primary particulate matter load in Pittsburgh's ambient air, spherical aluminosilicate (SAS) particles, a somewhat unique emission from high temperature coal combustion, will be quantitatively determined. The total primary and secondary particle load will be measured and the number of SAS particles will be determined, allowing an estimate of the direct contribution that coal-fired electric power generating stations make to the total primary particle load. It is thought that this information will provide insight into the potential impacts that the new National Ambient Air Quality Standards (NAAQS) may have on coal-based power systems. The SAS particles will be determined using two methods-- a method described by Eatough et al. and by an SEM/EDX counting technique using R. J. Lee's personal SEM. Values from the two methods will be compared.



SEM/EDS of SAS



EXPERIMENTAL APPROACH TO OBJECTIVE TWO

The EPA has developed a suite of 33 hazardous air pollutants (HAPs) including trace metals, semi-volatile organics, and volatile organics that it is interested in monitoring in ambient air. A Particle Concentrator-BYU Organic Sampling System (PC-BOSS) has recently been added to the NETL sampling station. These samples will be recovered and sent to BYU. BYU will perform functional group analysis for -NO_x containing semi-volatile compounds. These potentially highly carcinogenic -NO_x containing semi-volatile compounds are classified as “polycyclic organic matter (POM)” in the official EPA list of 33 HAPs.



BYU PC-BOSS



EXPERIMENTAL APPROACH TO OBJECTIVE TWO CONTINUED

OST will provide advanced state-of-the-art characterization of the organic components, potential HAPs, on the particles in order to comply with the NRC recommendation to obtain better chemical characterization of the ambient fine particles especially with respect to the organic components. This characterization will include Raman microscopy, ion chromatography (IC) and inductively coupled plasma (ICP) analysis of the water soluble components, followed by thermal extraction and analysis by HRMS and GC-MS. Specifically, Raman microscopy will be performed before and after aqueous extraction by Chemlcon. They have built a Raman spectral library of common materials that we expect to find on the filters such as ammonium sulfate, ammonium bisulfate, and ammonium nitrate, common crustal minerals, tire particles, soot particles, leaves, etc. In addition to providing analysis of inorganic components of the fine particles, Raman can also potentially provide organic functional group maps of the particle surfaces.



HIGH RESOLUTION MS



EXPERIMENTAL APPROACH TO OBJECTIVE THREE

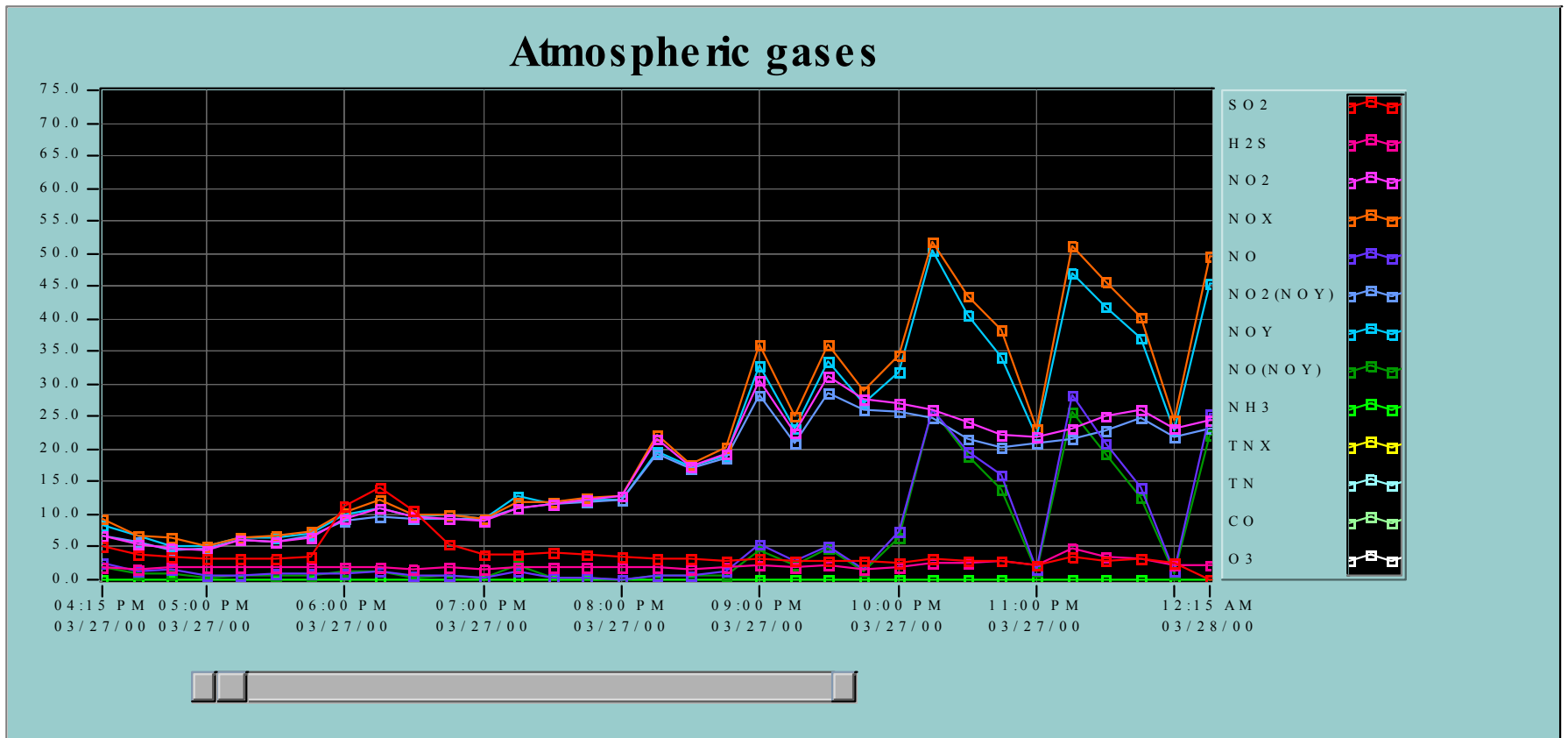
In order to provide insight into the formation and atmospheric chemistry of secondary PM_{2.5} formed from reaction of SO_x, NO_x and NH₃ these gases will be continuously monitored as will the sulfate and nitrate content of the air. The sulfate and nitrate values will come from analysis of the denuders used in the Andersen RASS. A bank of continuous gas monitors housed in the indoor facility at the monitoring station provides the concentration of O₃, SO₂, NH₃, NO_y, NO_x, CO, H₂S on a continuous basis. Thus, we will search for relationships between the concentration of SO₂ and the nitrogen oxides (NO_y, NO_x) with the sulfate and nitrate concentration. The data will be evaluated for the effect of O₃ and UV intensity on any relationship.



CONTINUOUS EMISSION MONITORS



REMOTE REAL-TIME GAS ANALYSIS

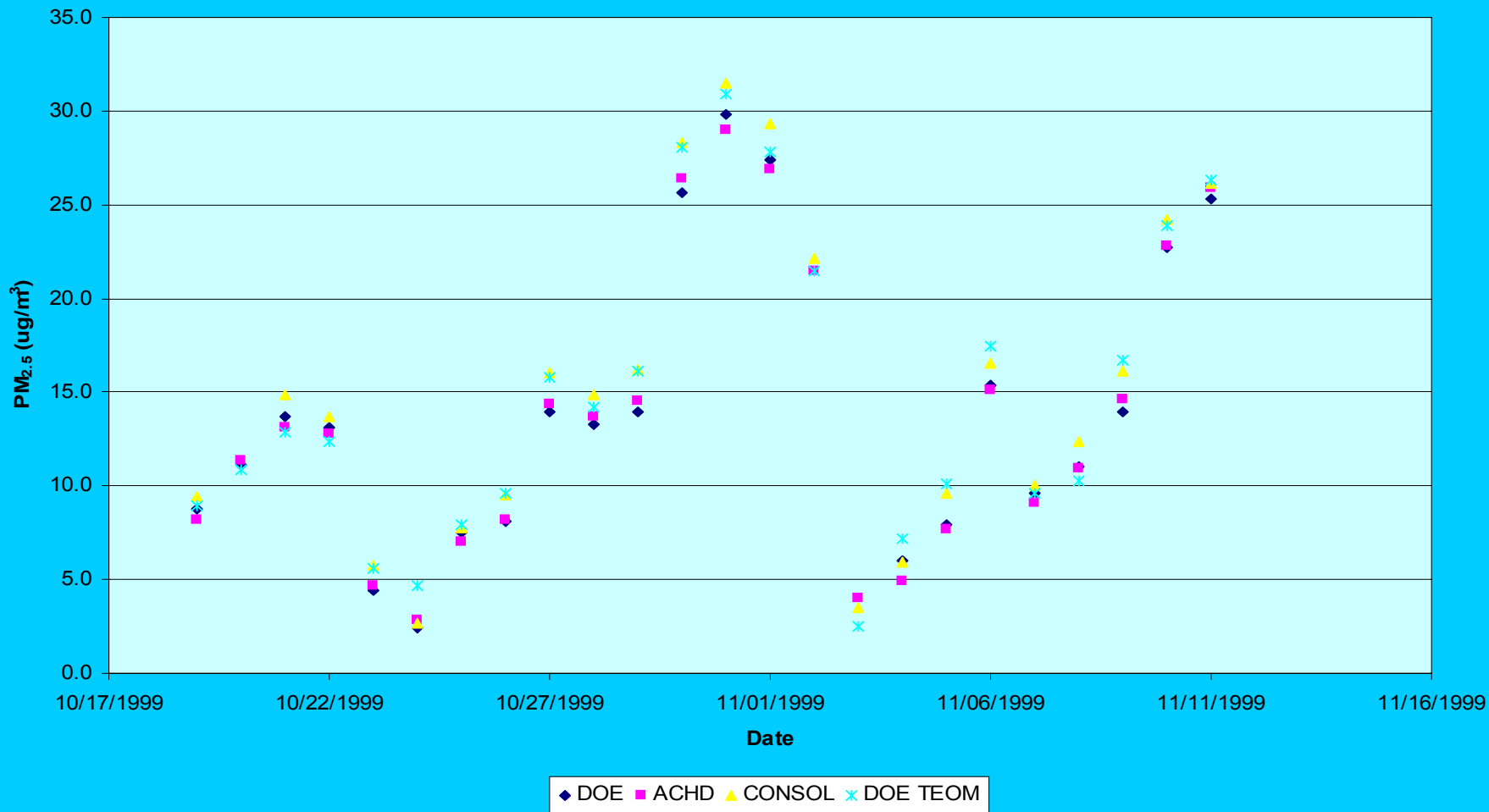


EXPERIMENTAL APPROACH TO OBJECTIVE FOUR

In order to provide insight into the variation of fine particulate matter over the US it is worthwhile to develop an understanding of how it varies over a small geographic area, in this case South Park Township. The masses determined by NETL's FRM as well as Consol's and one from the Allegheny County Health Department (ACHD) will be compared when they are co-located at NETL and when scattered over South Park Township. This will allow development of a clear picture of the variation of fine particulate matter over a small geographic area.



Comparison for Four PM_{2.5} Samplers - Fall 1999



EXPERIMENTAL APPROACH TO OBJECTIVE FIVE

In order to study the seasonal variation in fine particles at NETL, we propose to sample intensively in one month/30 day periods seasonally. In a more limited fashion, diurnal variation studies will be done during the off-seasonal periods.



SAMPLING SCHEDULE

- **Winter - - Thursday, January 20th to Monday, February 14th - 25 days.**
- **Spring - - Monday, April 24th to Thursday, May 18th - 24 days.**
- **Summer - - Monday, July 31st to Thursday, August 24th - 24 days.**
- **Fall - - Monday, October 16th to Thursday, November 9th - 24 days.**

