Division of Science, Research and Technology

Research Project Summary

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# Detailed Air Quality Evaluation of Teterboro Airport, Teterboro, New Jersey

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***Abstract***

The general purpose of the study was to evaluate the potential air quality and health risks associated with operations of Teterboro Airport. Four monitoring stations were established near each end of the two runways, and equipment was set up to monitor volatile organic compounds (VOCs), carbonyls, fine particulate matter ($PM_{2.5}$), black carbon (BC), and other gaseous compounds (continuously measured by open path monitors), as well as wind speed and direction, traffic, and aircraft activity. The study showed that (1) concentrations of certain VOCs (e.g., formaldehyde, toluene) at Teterboro Airport were higher than at other New Jersey Department of Environmental Protection (NJDEP) monitoring locations; (2) risks associated with the concentrations of VOCs at parts of Teterboro Airport were higher than risks at other NJDEP monitoring locations (based on conservative risk screening calculations intended to overestimate exposures and be health protective), but these risks were not necessarily associated with the airport operations; (3) similar to other locations in New Jersey, risks at Teterboro Airport exceed health benchmarks, and these exceedances are typical of urban areas in the U.S; (4) $PM_{2.5}$ average concentrations at Teterboro Airport appears to be higher than at other New Jersey monitoring locations in 2006, although the method used to measure $PM_{2.5}$ at Teterboro Airport typically yields higher concentrations than the Federal Reference Method; (5) high BC, $PM_{2.5}$ concentrations and signals from open path monitors were observed to come from both roadways and the airport. It is concluded that the airport activities have measurable impacts on local air quality, although the data were insufficient to quantify these impacts.

## Introduction

The impact of air traffic on local air quality has been the subject of several research projects (Rogers et al. 2002; Morin and Vandeslice 2007; Schürmann et al. 2007). Although routine monitoring of air pollutants are conducted by the airport authorities, the impact of the emissions from the airport activities on local air quality has not been well characterized.

As the oldest operating airport in the New York/New Jersey metropolitan area, Teterboro Airport (TEB) has grown into one of the busiest General Aviation airports in the United States, with over 200,000 arrivals and departures per year. The 827-acre airport consists of a two-runway configuration. The airport is located in Bergen County, New Jersey, within the municipalities of Teterboro and Moonachie, and is bordered by Hasbrouck Heights and Wood-Ridge to the west; Moonachie to the south; Little Ferry to the east; and South Hackensack to the north. Other nearby municipalities include Bogota, Carlstadt, East Rutherford, Hackensack, Maywood, Oradell, Rutherford, and Teaneck. In 2001, a screening-level evaluation of potential air quality impacts of the Teterboro Airport operations was conducted (ENVIRON, 2001). The overall results of the screening study indicated that airport operations may be affecting ambient air quality in the immediate vicinity.

Subsequent to the 2001 Screening Study, a modeling study was conducted by the Environmental and Occupational Health Sciences Institute (EOHSI) (Georgopoulos et al. 2003) to estimate the impact of TEB operations on local air quality. The EOHSI study concluded that:

- The relative contribution of Teterboro airport operations to the ambient concentrations of air toxics in the modeled area is minor, due to the presence of multiple other mobile, area, and point sources.

- The Teterboro Airport contribution to ambient air toxics levels at 51 of the 53 census tracts within a 5 km radius from the airport is less than 1%. Naphthalene is an exception; however, its levels are very low.

- The contributions of airport operations to air toxics levels in the Moonachie and Teterboro census tracts are generally on the order of 1-5% (except naphthalene).

The general purpose of this study was to evaluate the air quality and health risks associated with operations of Teterboro Airport in detail. This study was designed to provide data to meet the following objectives:

- Assess long-term ambient concentrations of selected pollutants (including chemicals regulated as hazardous air pollutants) in the immediate vicinity of the airport and the associated risks to human health;

- Provide monitoring results consistent with other data being collected by NJDEP, which would allow for a comparison of the Teterboro Airport results to data collected for other locations in New Jersey (including Camden, Chester, New Brunswick, and Elizabeth); and

- Evaluate whether contributions from airport emissions can be discerned from the contributions of other background sources.

Four sampling and monitoring stations were established at the airport fenceline near each end of the runways, and equipment was set up to monitor volatile organic compounds (VOCs), carbonyls, fine particulate matter ($PM_{2.5}$), black carbon (BC), other gaseous compounds (measured by open path monitors), wind speed and direction, traffic, and aircraft activity.

Two types of air quality monitoring were performed: discrete sampling and continuous measurements. The goal of the sampling was to collect integrated samples that can be used for assessing long term exposure, which can be compared with other areas of the state. Calendar day 24-hour integrated samples were collected on a once every six day schedule for a period of one year. The sampling schedule coincided with the six-day sampling schedule used by NJDEP (and USEPA) for its state-wide monitoring network. Based on this sampling schedule, a maximum of 61 samples were collected from each location. There were 8-9 samples for each day of the week, and 15-16 samples for each season.

In addition to the routine sampling, several continuous instruments were operational throughout the course of the one year project. They provided time series of the $PM_{2.5}$, BC and VOCs concentration. These data, together with continuous meteorological data and local vehicular traffic counts, were evaluated on a regular basis to determine the trends in concentrations as a function of airport activity and local traffic patterns.

## Results and Discussion

Among the individual VOCs and carbonyls concentrations that were measured throughout the study, the following 13 compounds were consistently detected in the canister/cartridge samples (detected in greater than 70% of the samples) at Teterboro Airport, and had higher median, mean, 95th percentile, and maximum concentrations than at all of the other NJDEP monitoring stations, including the mobile source-dominated Elizabeth site:

2-Butanone (MEK)
Acetone
Benzaldehyde
Benzene
Butyraldehyde
Ethylbenzene
Formaldehyde
Hexaldehyde
Methylene chloride
Propionaldehyde
Toluene
Valeraldehyde
Xylenes

The following three compounds were also detected at Teterboro Airport in greater than 70% of the samples, but not at concentrations that were consistently higher than all other NJDEP monitoring locations:

Acetaldehyde
Dichlorodifluoromethane
Trichlorofluoromethane

For some compounds (e.g., benzene, acetaldehyde), the concentrations measured at Teterboro Airport were comparable to those measured at other NJDEP locations (e.g., Elizabeth). However, for others (e.g., formaldehyde, ethylbenzene, toluene, xylenes, methylene chloride, 2-butanone), the concentrations measured at Teterboro Airport were more than four times higher than at other NJDEP locations. A particularly noteworthy observation from these data was a significant increase in formaldehyde concentrations during the summer months at one of the TEB sampling locations, which was not observed at the other TEB sampling location.

To provide some context for understanding the implications of these monitoring data, ENVIRON conducted a conservative screening risk assessment in accordance with NJDEP procedures. These screening assessments included multiple safety and uncertainty factors, and were designed to overstate risks to be health protective.

The concentrations of the compounds consistently detected at Teterboro Airport were associated with total cancer risks that were up to five times higher at parts of Teterboro Airport than the other NJDEP locations. The risks at all locations are largely associated with formaldehyde, which accounts for 76% to 87% of the risk at Teterboro Airport and 71% to 78% of the risk at the other NJDEP locations.

The concentrations of the compounds consistently detected at Teterboro Airport are associated with noncancer values that are up to two times higher at parts of Teterboro Airport than the other NJDEP locations. Again, the risks at all locations are largely associated with formaldehyde, which accounts for 78% to 88% of the risk at Teterboro Airport and 67% to 79% of the risk at the other NJDEP locations.

These risks are not necessarily associated with the airport operations. Nor is the observation that the concentrations detected at Teterboro are higher than the other NJDEP locations for certain compounds intended to suggest that these are the highest concentrations in the state.

The observation that the detected concentrations were elevated compared to NJDEP sites suggests that additional study may be warranted for the Teterboro Airport vicinity to characterize the sources of certain detected compounds, such as formaldehyde.

Continuous $PM_{2.5}$ data were collected at two of the monitoring stations using a beta attenuation monitor (BAM). $PM_{2.5}$ concentrations were observed to follow an inverse pattern with wind speed, with higher concentrations occurring when wind speeds were low. To evaluate the contributions to ambient $PM_{2.5}$ concentrations from the airport and roadways, the $PM_{2.5}$ data were screened based on wind direction. This analysis indicated several very sharp and distinct spikes occurring when winds were blowing from the airport runway toward the $PM_{2.5}$ monitor. Similarly, several sharp and distinct spikes were also observed when winds were blowing from the roadway toward the $PM_{2.5}$ monitor (i.e., away from the airport runway). The magnitude of the $PM_{2.5}$ concentration spikes were roughly equivalent, suggesting that both the airport and roadway activities appear be associated with similar ambient $PM_{2.5}$ concentrations. A similar pattern was observed for the black carbon concentrations. $PM_{2.5}$ average concentrations at Teterboro Airport were higher than at other New Jersey monitoring locations in 2006, although the method used to measure $PM_{2.5}$ at Teterboro Airport typically yields higher concentrations than the Federal Reference Method, which is used at the NJDEP locations.

One novel aspect of this study was the application of open path optical techniques for airport monitoring. These techniques are an active field of research within USEPA for Near Road studies of mobile sources. Among the various open path techniques currently being developed and evaluated by USEPA is a Deep Ultra Violet Differential Optical Absorption Spectroscopy (DUV-DOAS) system, which measures the absorption of atmospheric constituents in selected regions in the ultraviolet (UV) and visible light spectrum. The DOAS technology used in this study specifically measured absorption in the deep UV spectrum, which generally refers to wavelengths between 200 and 300 nanometers (nm). The metric used in this study was an aggregate measure of the intensity at which compounds absorb in the DUV range, referred to as “DUV Intensity”.

To evaluate whether the DUV intensity readings could be related to airport activity or traffic on adjacent roadways, ENVIRON screened the DUV intensity data based on wind direction, as was performed for $PM_{2.5}$ and BC. Several very sharp and distinct spikes were observed to occur when winds were blowing from the airport runway toward the DUV-DOAS system. Similarly, several sharp and distinct spikes were also observed when winds were blowing from the roadway toward the DUV-DOAS system. The magnitude of the DUV intensity spikes were roughly equivalent, suggesting that both the airport and roadway activities appear to be associated with similar DUV intensity readings.

As an additional analysis, the times of the DUV intensity measurements were compared with the time elapsed since the most recent airplane landing and takeoff (LTO). The highest DUV intensity values occur when the time elapsed since the most recent LTO is very brief. As the amount of time since the most recent LTO increases, the DUV intensity values approach a steady background level. These analyses suggest a relationship between high DUV intensity and LTO activity.

Finally, for additional confirmation that the DUV intensity readings could be related to airport activity, the video footage for certain periods of time when high DUV intensity spikes were observed was reviewed. Numerous examples were identified in which a spike in DUV intensity occurred at a time when multiple airplanes were observed to be queued on the runway and idling, whereas more constant DUV intensity readings corresponded to the general pattern of planes departing without a significant amount of idling on the runway.

It is important to note that the use of this technology is still in the research and development phase. This approach has not been officially validated or approved by USEPA, NJDEP, or other regulatory agencies. The definition of DUV Intensity used in this study was an initial effort at quantifying DUV-DOAS readings with respect to aircraft and motor vehicle emissions, but other methods of interpreting these data are a recommended area of future study.

## Conclusions and Recommendations

Based on the results of this study, the following conclusions were reached:

- Certain VOCs were detected at parts of Teterboro Airport at higher concentrations than at other New Jersey DEP locations (e.g., formaldehyde, toluene); other VOCs (e.g., benzene, acetaldehyde) concentrations were comparable to concentrations at other New Jersey DEP sites.

- Risks associated with the concentrations of VOCs consistently detected at parts of Teterboro Airport were higher than risks at other New Jersey DEP locations (based on conservative risk screening calculations intended to overestimate exposures and be health protective). However, these risks were not necessarily associated with the airport operations.

- Similar to other locations in New Jersey, risks at Teterboro Airport exceed health benchmarks. These exceedances are typical of urban areas in the United States.

- $PM_{2.5}$ concentrations measured at Teterboro Airport appears to be higher than at other New Jersey monitoring locations in 2006, although the method used to measure $PM_{2.5}$ at Teterboro Airport in this study typically yields higher readings than the Federal Reference Method and procedures used at the other New Jersey locations.

- High BC, $PM_{2.5}$ concentrations and DUV signals were observed to come from both roadways and the airport.

These observations were supported by temporal and wind direction-filtered analyses, as well as review of videotapes.

- Airport contributions appear to be highly dependent on wind direction and wind speed, as well as airport activity.

- Although the data indicated that airport activities had a measurable effect on local air quality, the data were insufficient to quantify the contribution from these airport activities. The prevalence of these measurable impacts suggests that the airport is not an insignificant source of the local air pollution.

The following recommendations are provided:

- Additional study is needed to identify and quantify potential emission sources of certain detected VOCs and carbonyls, such as formaldehyde. In particular, the summertime increase in formaldehyde concentrations should be further evaluated to understand why it was elevated at one site but not at other locations. Concentrations of acrolein in the airport vicinity, which was not measured as part of this study, should be characterized.

- $PM_{2.5}$ and black carbon emission sources should be further studied and identified.

- While the DUV-DOAS open path system appears to be a promising tool for evaluating airport impacts on local air quality, more research is needed to develop this technology and to characterize DUV compounds.

- Additional study is needed to understand the impact of airport operations on the local community .

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