The National Near-Road Mobile Source Air Toxics Study: Las Vegas

Control #: **553**

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INTRODUCTION

EPA, in collaboration with FHWA, has been involved in a large-scale monitoring research study in an effort to characterize highway vehicle emissions in a near-road environment. The pollutants of interest include particulate matter with aerodynamic diameter less than 2.5 microns ($PM_{2.5}$), mobile source air toxics (MSATs) and black carbon as well as regulated gaseous pollutants.

The primary objective of the research study is to determine $PM_{2.5}$ and MSAT concentrations and variability as a function of distance from the highway. Relevant factors include highway vehicle activity, such as traffic counts, vehicle types and speeds. Moreover, the effects of meteorological conditions such as wind speed and wind direction are important considerations. Specifically, the data will be used to address the following goals:

1. Identify the existence and extent of elevated air pollutants near roads.
2. Determine how vehicle operations and local meteorology influence near-road air quality for criteria and toxic air pollutants.
3. Collect data that will be useful in evaluating and refining, if necessary, models used to determine the emissions and dispersion of motor vehicle related pollutants near roadways.

The study design, based on a detailed monitoring protocol that was developed to ensure a uniformity of measurements across study cities, calls for consecutive year-long studies to be conducted in three cities (Las Vegas, NV; Detroit, MI; and tentatively Raleigh, NC). The first study city is Las Vegas, NV, with data covering December, 2008-December, 2009.

STUDY DESIGN

Site Selection

The site selection process consisted of a series of seven steps. Each of these steps had varying degrees of complexity due to "real-world" issues. The first step, determining site selection criteria (Table **1**), had been developed by U.S. FHWA prior to the site selection process and is documented in the monitoring protocol[1]. The follow-on steps (steps 2-7) included (2) developing a list of candidate sites and supporting information; (3) applying site selection filter

("coarse" and "fine"), (4) conducting site visits; (5) selecting candidate site(s) via team discussion; (6) obtaining site access permission(s); and (7) implementing site logistics.

Table 1. Site Selection Considerations.

Selection Considerations	Monitoring Protocol Criteria
Annual Average Daily Traffic (AADT)	> 150,000 vehicles per day
Geometric Design	"Clean" geometric design -- No nearby complex interchanges, ramps, etc.
Topology (i.e., Noise Barriers, Road Elevation)	Exclude locations with noise barriers; extreme elevation changes.
Geographic Location	Geographic diversity within the U.S.
Availability of Data (Traffic Volume Data)	Automated traffic monitoring data from nearby instrumentation must be readily available
Meteorology	Wind flow from road to air monitoring stations is required.
While not explicitly included in the Monitoring Protocol, the following selection criteria were deemed important to the selection process and were included.	
Downwind Sampling	Unrestricted wind flow is required
Potentially confounding air pollutant sources	Avoid potentially confounding air pollutant sources.
Site Access (Admin/Physical)	Unrestricted site access is required.

FHWA's "detailed monitoring protocol" outlines a uniform approach to conduct all studies for evaluating mobile source contributions to air toxic compounds and $PM_{2.5}$ and their dispersion patterns in up to five cities [1]. A more detailed examination of the monitoring protocol indicates that for each city, continuous monitoring and integrated sample collection is required at four monitoring sites **(**Figure 1). In addition, wind speed and wind direction is required at each site. Moreover, monitoring for the complete suite of meteorological parameters is required at the monitoring station positioned 50 to 150 m from the roadway (100 meter downwind). Table 2 summarizes the measurements to be taken at each monitoring site and Table 3 summarizes the data types, pollutants, methods and sample types and frequency for the project.

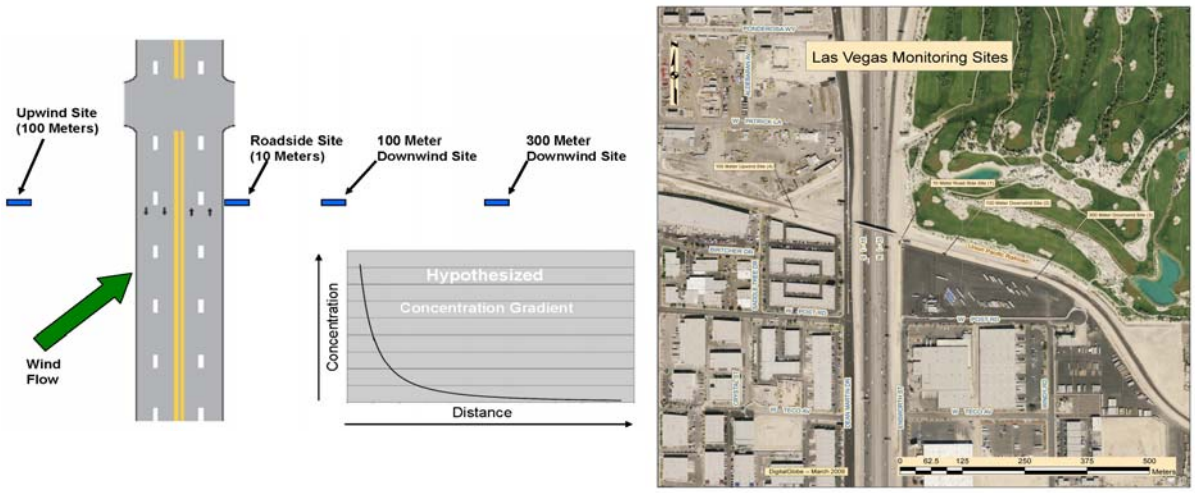

Figure 1. Illustration of Air Monitoring Locations and Actual Layout at I-15 Site.

Table 2. Summary of Measurements Conducted at Each Monitoring Site.

Measurements	10 Meters@ Roadside	100 Meter Downwind	300 Meter Downwind	100 Meter Upwind
TO-11A Cartridge sampling	X	X	X	X
TO-15 Canister sampling	X	X	X	X
Semi-continuous GC	X	X	X	X
DNSH Sampling (acrolein)	X	X	X	X
Continuous gas monitoring (CO, NO_x)	X	X	X	X
Continuous gas monitoring (SO_2)		X		X
Continuous black carbon monitoring (Aethalometer)	X	X	X	X
Continuous fine particle (TEOM)	X	X	X	X
Integrated $PM_{2.5}$ (FRM)	X	X	X	X
Condensation Particle Counters (TSI, 6nm – 3µm)	X	X	X	X
TSI Ultra-fine Particulate (UFP) Monitor	X		X	
CO_2 Monitors		X		X
Wind speed/wind direction	X	X	X	X
Meteorological monitoring (temp, RH, etc.)		X		
Nephelometer				X
Sound Meter	X	X		

Measurements	10 Meters@ Roadside	100 Meter Downwind	300 Meter Downwind	100 Meter Upwind
Video Camera	X	X		X
Cut Section Monitoring (3-CO & 3-Aethalometers)	X			

Study Design Enhancements

Study design enhancements included (1) semi-continuous GCs capable of measuring 1,3-butadiene and benzene every 30-minutes; (2) DNSH cartridges[2,3,4] for acrolein measurements; (3) continuous particle counters (6nm – 3μm); (4) two ultra-fine particulate monitors located at the 10 meter roadside site and 300 meter downwind site; (5) two SO_2 gas analyzers located at the 100 meter upwind site and 100 meter downwind site; (6) nephelometer; (7) 3-additional CO monitors and 3-additional aethalometers to more fully characterize the freeway "cut-section"; and (8) sound meters and video cameras to monitor train and plane activity from the railroad and nearby airport, respectively.

Traffic Activity

Traffic data (vehicle count, vehicle speed, vehicle length) was obtained from the Nevada Department of Transportation's Freeway and Arterial System of Transportation (FAST). This data was an ASCII text file that was sent electronically to EPA.

Table 3. Summary of Data Types, Pollutants, Methods and Sample Types and Frequency.

Data Type	Pollutant or Covariate	Method	Sample Type and Frequency
Mobile Source Air Toxics	Benzene 1,3-butadiene Acrolein	Semi-continuous GC	30-minutes
		TO-15	1-hour integrated 1-in-12 day schedule 9 samples each day at each road-side location
	Formaldehyde Acetaldehyde Acrolein	TO-11A	
	Acrolein	DNSH	
Mobile Source Related Air Pollutants	CO	NDIR	Continuous
	NO, NO_2, NOx	Chemiluminescence	
	SO_2	Fluorescence	
	Black carbon	Aethalometer	
	$PM_{2.5}$	TEOM	
	PM_{10}		
	PM-Coarse		

Data Type	Pollutant or Covariate	Method	Sample Type and Frequency
	Particle count	CPC	
	Nephelometer	Light scattering/absorption	
	CO_2	IR	
	Particle counts by size fraction	Diffusion charging of particles /size fractionation	
	$PM_{2.5}$	FRM	24-hour integrated 1-in-12 day schedule 1 sample each day at each road-side location
Traffic	Vehicle count Vehicle length Vehicle speed	Radar	Continuous
Meteorology	Wind speed/direction; Temperature Relative humidity	RM Young Sonic Anemometer; Vaisala Temp/Humidity	
Sound	Decibels	Sound meter	
Video	Images	Video camera	Semi-continuous

SUMMARY

This paper summarizes the site selection process and project implementation activity in Las Vegas, NV for a field conducted in Las Vegas, NV from Mid-December, 2008 through Mid-December, 2009. The objective of this research study was to determine $PM_{2.5}$ and MSAT concentrations and variations in concentrations as a function of distance from the highway and to establish relationships between MSAT concentrations as related to highway traffic flows including traffic count, vehicle types and speeds, and meteorological conditions such as wind speed and wind direction.

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