EPA’s Emerging Near-Road Ambient

An overview of the rationale for EPA’s new near-road monitoring program with a particular emphasis on the NO2 portion of the network, including details about technical and logistical challenges, measurements, and the expected value of the resulting data.

In 2010, the U.S. Environmental Protection Agency (EPA) finalized requirements for a new national air quality monitoring network that include the characterization of nitrogen dioxide (NO2) in the near-road environment. Additional monitoring requirements for carbon monoxide (CO) and fine particulate matter (PM2.5) monitoring in the near-road environment have been finalized in the past two years. This near-road network will provide ambient pollutant measurements to support a series of key national objectives addressing air quality standard compliance, health studies, and other science and policy initiatives in an area that has been largely unmonitored until now. The NO2 portion of the near-road network is expected to become operational in the largest urban areas by January 1, 2014, with additional sites and measurements coming on-line in subsequent years.

Near-Road Monitoring: Community Impacts

A bird’s-eye view of any major urban area reveals a complex network of roadways and transportation corridors. In such areas, the multi-lane Interstate highways and beltways are most obvious, but as one zooms in for a closer look, the web of other arterial roads, as well as local streets, reveals the ubiquitous nature of roads. What may be less obvious is the proximity of residential communities and commercial areas to major roads. A widely quoted statistic derived from the 2009 American Housing Survey estimates that 22 million total housing units are located within 300 feet of a 4-or-more-lane highway, railroad, or airport. Further, estimations based on these data indicate that more than 47 million people live in proximity to these major transportation facilities noted above.
These proximate communities are exposed to a wide variety of air pollutants from motor vehicles, including primarily emitted and secondary pollutants such as CO, NO₂, nitric oxide, hydrocarbons, particulate matter, and air toxics such as benzene and 1,3-butadiene. Although the pollutant gradients will vary according to specific factors, such as the pollutant mixture, meteorology, and physical roadway configuration, it is generally agreed that pollutant concentrations decay with increasing distance from the source roadway with the zone of elevated concentrations versus background levels extending at least several hundred meters away from major roads.

A large body of research is available on the health consequences of near-roadway exposure. Potential impacts include respiratory illness, such as asthma, heart disease, and cancer. EPA’s Office of Research and Development supports an active research program in this area, including the characterization of near-road pollution levels; however, the availability of long-term ambient air quality data sets has been hampered by the lack of a nationally required monitoring network dedicated to near-road objectives. EPA recognized this critical information gap by requiring the establishment of a near-road NO₂ monitoring network as part of the 2010 final rulemaking establishing a revised National Ambient Air Quality Standard (NAAQS) for NO₂.

Near-Road Network Design Requirements

The requirement for state and local air monitoring agencies to locate monitors near roadways is not a new policy. Decades ago, when mobile sources were a predominant source of ambient lead (Pb), EPA’s Network Design Requirements stated: “For areas where the predominant lead levels come from automotive sources, the station must be a microscale or middle scale station located near a major roadway [>30,000 average daily traffic, (ADT)] in order to measure maximum Pb concentrations from mobile sources. In areas where there are no roadways exceeding 30,000 ADT, the station should be located near the roadway with the largest traffic volume.” For CO, network designers were told: “…to consider average daily traffic on all streets in the area, wind roses for different hours of the day, and maps showing one-way streets, street widths, and building heights. If the station is to typify the area with the highest concentrations, the streets with the greatest daily traffic should be identified.”

The issue of near-road monitoring again became front-and-center in the recent NO₂ NAAQS review when the EPA Administrator proposed: “…to set a level for the 1-hour NO₂ primary NAAQS that reflects the maximum allowable NO₂ concentration anywhere in an area. This concentration is likely to occur on or near a major roadway. Monitoring studies suggest that NO₂ concentrations near roadways can be approximately 30 to 100% higher than concentrations in the same general area that are farther away from the road. This NO₂ concentration gradient around roadways is one factor considered by the Administrator in determining the appropriate standard level to propose. EPA proposes to set the level of the standard such that, when available information regarding the concentration gradient around roadways is considered, appropriate public health protection would be provided by limiting the higher short-term peak exposure concentrations expected to occur on and near major roadways, as well as the lower short-term exposure concentrations expected to occur away from those roadways.”

Accordingly, EPA took comment on the proposal and finalized specific NO₂ near-road monitoring requirements in 2010 to commence the planning and implementation of a dedicated set of sites to support characterization for the NO₂ NAAQS, as well as to encourage multi-pollutant monitoring at near-road sites to allow a more comprehensive understanding of the near-road environment. These requirements included the establishment of one near-road NO₂ station in each Core Based Statistical Area (CBSA) with a population of 500,000 or more persons, with additional sites required in larger CBSAs with road segments with 250,000 or greater annual average daily traffic (AADT) counts. Additional criteria concerning the allowable probe monitoring height, as well as the maximum distance from the edge of the closest traffic lane (50 m), were finalized to ensure that new sites were located on a consistent basis.
Network Implementation Challenges

During the process leading up to the finalization of the NO₂ near-road requirement, EPA received numerous comments that state and local monitoring agencies would need a significant level of assistance to handle the logistical and technical issues of identifying candidate near-road sites. As a result, a detailed Technical Assistance Document (TAD) was created to serve as a guide for monitoring agencies to consult during the network planning and implementation process. The TAD was completed with assistance from state and local air monitoring agencies and organizations, such as the National Association of Clean Air Agencies, partnering state departments of transportation, and the U.S. Federal Highway Administration. It also reflected feedback, concepts, and suggestions from two reviews conducted by the Clean Air Scientific Advisory Committee (CASAC) Ambient Monitoring and Methods Subcommittee (AMMS).

According to monitoring rule requirements, and as discussed in the TAD, traffic volume, fleet mix, roadway design, traffic congestion patterns, local terrain or topography, and meteorology must be considered in determining where a required near-road NO₂ monitor will be placed. A fundamental issue is the process by which monitoring agencies will rank and select candidate road segments for potential use as NO₂ monitoring sites. Figure 1 represents the recommended road segment ranking process. A key concept of the ranking process is the calculation of Fleet Equivalent AADT (FE AADT), which is a combination of traffic volumes with fleet mix data, and is the metric expected to be the primary tool in the siting process. Once these traffic data are considered the other metrics come into play, along with logistical aspects (i.e., safety, access, utilities) in identifying candidate near-road sites. In some cases, dispersion modeling or saturation monitoring studies may also be helpful.

![Figure 1. Candidate road segment ranking process (from TAD).](image-url)
in assessing potential site locations along selected road segments.

Many stakeholders commented on the role that population exposure should play in the siting process. Given that the primary objective of the near-road network is to characterize locations of peak NO2 concentrations, the technical factors noted above are given greater consideration than population clusters in the selection of candidate locations. Nevertheless, EPA did state, "where a state or local air monitoring agency identifies multiple acceptable candidate sites where maximum hourly NO2 concentrations are expected to occur, the monitoring agency shall consider the potential for population exposure in the criteria utilized to select the final site location."

Other challenges in siting near-road monitors include obtaining permission to utilize right-of-ways that are typically under the purview of State Departments of Transportation (DOT), as well as the safety issues related to locating shelters and monitoring personnel near heavily traveled roadways. These issues are addressed extensively in the TAD to provide a framework for initiating conversations between monitoring agencies and state DOTs, and to address safety issues that may be new for the monitoring community such as the consideration of physical barriers, site distance requirements, and clear zones.

**Measurements and Timeline**

Although the NO2 NAAQS revision provided the impetus for the near-road network, EPA included near-road monitoring requirements in the ensuing final rules addressing the CO NAAQS and the PM2.5 NAAQS, consistent with the original multi-pollutant monitoring framework.11,12 Near-road monitoring will be required in metropolitan areas of 500,000 or greater population for NO2, and 1 million and greater for CO and PM2.5 (see Figure 2) no later than January 1, 2017. The ultimate size of the near-road network will be approximately 126 sites. The network will be phased in using a staggered approach with the initial 52 sites in significant CBSAs of 1 million or greater population expected to be operational for NO2 measurements by January 1, 2014.

The near-road network infrastructure will have the capability of supporting many types of measurements in addition to the required NAAQS pollutants. Due to the current lack of long-term monitoring
data near roads and high level of scientific and public interest in the potential for such exposure, EPA expects a wide range of monitors for gaseous and particulate matter pollutants to be placed in the near-road environment, together with meteorological measurements and tools for assessing traffic volumes.

During the CASAC reviews of the TAD, a tiered layer of recommendations were made for these measurements, including characterization at the near-road sites, as well as at sites measuring more background levels to establish the extent and strength of the gradient.13

Primary Group: NO/NO2 and CO, ozone, and meteorology
Secondary Group: Air toxics (BTEX), black carbon (BC), particle size concentration (preferable) or particle number concentration, and traffic counters/ DOT cameras
Tertiary Group: CO2, PM2.5, and PM10,2.5, and organic and elemental carbon

Although EPA does not expect that all of the above measurements will be available at every near-road site, monitoring agencies have been encouraged to consider possible leveraging opportunities. It is expected that measurements, such as BC and particle counts, will be more widely available in the years ahead at a greater number of sites. EPA will also encourage the use of monitoring methods for PM and air toxics that supply greater time resolution (e.g., hourly or even sub-hourly data vs. 24-hr averages) at near-road sites to better support the comparison of diurnal trends with varying traffic counts. There may be a future role for low-cost portable and personal sensors that are an emerging technology for characterizing air quality in a great many locations along major roads, with the near-road sites serving as anchor locations for comparing sensor measurements to more established methods.

Conclusion
State and local monitoring agencies are making significant progress in deploying the initial round of required near-road NO2 monitors. Over the ensuing years, the data from these sites will support compliance efforts for the NO2, CO, and PM2.5 NAAQS, and will greatly benefit health studies of near-road exposure, public reporting, accountability studies of the effectiveness of mobile source regulations impacting vehicle fleets and fuels, and the refinement and verification of mobile source and risk assessment modeling programs. em

References
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