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February 23, 2012

EPA-CASAC-12-003

The Honorable Lisa P. Jackson
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Subject: Review of the Draft Near-Road Nitrogen Dioxide Monitoring Technical Assistance Document

Dear Administrator Jackson:

The Clean Air Scientific Advisory Committee (CASAC) has reviewed EPA's "Near-Road NO_2 Monitoring Technical Assistance Document (TAD) – Draft August 11, 2011." This letter summarizes CASAC's views on monitoring issues pertaining to the draft EPA document, and encloses CASAC's responses to the EPA charge questions (Enclosure A) and a compilation of individual panel member comments (Enclosure B).

In February 2010, EPA promulgated new minimum monitoring requirements for the nitrogen dioxide (NO_2) monitoring network in support of a newly revised 1-hour NO_2 National Ambient Air Quality Standard (NAAQS). In the new monitoring requirements, state and local air monitoring agencies are required to install near-road NO_2 monitoring stations in larger urban areas at locations where maximum NO_2 concentrations are expected to occur, including within 50 meters of major roadways.
In August 2010, EPA's Office of Air Quality Planning and Standards (OAQPS) requested that CASAC review the initial phase of EPA's Near-Road project. In November 2010, CASAC issued a final report (EPA-CASAC-11-001) for its review of the outline for the TAD entitled "Near-road Guidance Document – Outline" and "Near-road Monitoring Pilot Study Objectives and Approach." OAQPS considered CASAC's recommendations and drafted the TAD to provide guidance to state and local air monitoring agencies on how to successfully implement near-road NO_2 monitoring, and to assist stakeholders in making decisions associated with siting monitors as required by the recently promulgated primary NAAQS for NO_2.

CASAC generally found that the TAD was well written and provided information that would assist state, local and tribal agencies with siting of NO_2 monitors. The document adequately deals with the EPA's approach for using Annual Average Daily Traffic (AADT) to prioritize monitoring locations, and many of the details and issues associated with monitor siting. CASAC recognizes that EPA has released an updated, 12/21/11 version of the TAD on its website[1] that further refines and advances the guidance and

[1] http://www.epa.gov/ttn/amtic/nearroad.html

addresses issues raised by CASAC's Air Monitoring and Methods Subcommittee (AMMS) during its two public teleconference calls on September 29 and November 17, 2011, though CASAC is not reviewing those revisions as part of this report. CASAC provides the following priority recommendations to strengthen and improve EPA's Near-Road program. Additional details on these and other recommendations are enclosed. We have three major recommendations.

First, the TAD must clearly define the objectives of the Near-Road NO_2 network in the context of EPA's Policy Assessments for the review of NAAQS. In the November 2010 report, CASAC noted that "the objectives of the network are not well defined in the current outline. High priority should be given to developing clear objectives and providing a rationale for each." This advice was not carried through into the TAD. A revised draft TAD should clearly state the objectives of the Near-Road NO_2 network, along with the rationale for each objective. In the absence of clearly stated network objectives, the Subcommittee had difficulty assessing how well the information provided in the TAD would lead to appropriate siting decisions. Furthermore, it is difficult for state, local and tribal agencies to choose suitable monitoring locations without a clear understanding of the network objectives. For example, the TAD should define the specific population exposures that are to be characterized by the monitors, specifically with regard to population exposures and on-road vehicle occupants. The EPA asserted that the NO_2 standard applies to those in vehicles on the roadway in addition to those in areas adjacent to the roadway. Applying the NO_2 standard to populations on the roadway has significant ramifications for choosing appropriate site locations because the near-road monitoring program required in the regulation may not capture on-road concentrations. While the highest exposures to roadway emissions may be on the roadway itself, routine monitoring on the roadway is not practical for safety and other reasons. Furthermore, the gradients away from the roadway are steep and the concentrations at a receptor can be very different from the measured values at a specific distance. Thus, it will be difficult to use single-site monitoring data to assess exposures of populations near roadways.

Second, the TAD should more specifically state how siting decisions should be made given the range of available information that can be used, identify what would or would not be allowed in terms of monitoring site placement, and describe the real limits on making such selections. For example, should results from monitoring, modeling or the use of the AADT take precedence? CASAC continues to view that too much emphasis is placed on the AADT. Another example is that the current guidelines appear to allow monitoring in a roadway tunnel. CASAC strongly recommends against monitoring in tunnels or other unusual places to enforce a NAAQS.

Third, the current document does not provide guidance specific to siting of the second monitor in those areas requiring two near-road NO_2 monitors. CASAC suggests that separate guidance be developed and that the objectives of the second site may be differentiated from the first site. For example, the second monitor could be located to test hypotheses as to the sources of NO_2 impacting population exposures or to sample other pollutants as part of the multipollutant network.

In laying out the objectives of the network, EPA also should address the need to continue to characterize exposures to the broader populations in urban areas. CASAC continues to be concerned with the potential decrease in the number of monitors sited to characterize population-wide exposures; these monitors have provided the exposure data that is critical for epidemiologic analyses. CASAC strongly recommends that key population-oriented monitors be maintained, particularly those that have been used in past health-focused and accountability studies. Population-oriented monitors allow exploration of pollutant gradients, and can be used for comparison to near-road exposures. CASAC also strongly encourages a dialog with the epidemiology community and other stakeholders to minimize the loss of critical data.

CASAC appreciates the opportunity to provide input to the EPA on this issue. We look forward to receiving the Agency's response.

Sincerely,

/Signed/ ***/Signed/***

Dr. Armistead (Ted) Russell, Chair
CASAC Air Monitoring and Methods Subcommittee

Dr. Jonathan M. Samet, Chair
Clean Air Scientific Advisory Committee

Enclosures

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This report has been written as part of the activities of the EPA's Clean Air Scientific Advisory Committee (CASAC), a federal advisory committee independently chartered to provide extramural scientific information and advice to the Administrator and other officials of the EPA. CASAC provides balanced, expert assessment of scientific matters related to issues and problems facing the Agency. This report has not been reviewed for approval by the Agency and, hence, the contents of this report do not necessarily represent the views and policies of the EPA, nor of other agencies within the Executive Branch of the federal government. In addition, any mention of trade names or commercial products does not constitute a recommendation for use. CASAC reports are posted on the EPA website at: http://www.epa.gov/casac.

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Clean Air Scientific Advisory Committee
Air Monitoring and Methods Subcommittee

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Abbreviations and Acronyms

AADT	Annual Average Daily Traffic
AMMS	Air Monitoring and Methods Subcommittee
CAA	Clean Air Act
CASAC	Clean Air Scientific Advisory Committee
CBSA	Core Based Statistical Areas
CFR	Code of Federal Regulations
CO	Carbon Monoxide
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
HD	Heavy-Duty Trucks
LD	Light-Duty Passenger Vehicles
NAAQS	National Ambient Air Quality Standards
NO_x	Oxides of Nitrogen
NR	Near-road
OAQPS	EPA Office of Air Quality Planning and Standards
ORD	EPA Office of Research and Development
O_3	Ozone
PM	Particulate Matter
QA/QC	Quality Assurance/Quality Control
SAB	EPA Science Advisory Board
SOx	Sulfur Oxides
TAD	Near-Road NO_2 Monitoring Technical Assistance Document
VOCs	Volatile Organic Compounds

Enclosure A
CASAC Air Monitoring and Methods Subcommittee (AMMS) Consensus Responses to Charge Questions

Background

On February 9, 2010, new minimum monitoring requirements for the nitrogen dioxide (NO_2) monitoring network were promulgated (75 FR 6474) in support of a revised Oxides of Nitrogen National Ambient Air Quality Standard (NAAQS). The NO_2 NAAQS was revised to protect against peak 1-hour exposures that may occur anywhere in an area, and included a 1-hour level of 100 parts per billion (ppb), 98^{th} percentile form, averaged over three years, while retaining the annually averaged NAAQS of 53 ppb.

In the preamble to the final NO_2 rulemaking, the EPA recognized that roadway-associated exposures account for a majority of ambient exposures to peak NO_2 concentrations. In particular, the EPA recognized that increased vehicle miles traveled (VMT) can result in an increased potential for exposure and associated risks to human health and welfare. In the final NO_2 rulemaking, the Agency required that ambient monitoring be conducted at the locations where peak, ambient 1-hour NO_2 concentrations can be expected to occur in an area, with a focus on characterizing those maximum NO_2 concentrations attributable to mobile source emissions near major roads. In addition, the EPA required that ambient air monitoring agencies submit their plans for any required near-road (NR) NO_2 stations by July 1, 2012, and that the near-road NO_2 monitoring network be implemented and operational by January 1, 2013.

The EPA's Office of Air Quality Planning and Standards (OAQPS) drafted the Near-road NO_2 Monitoring Technical Assistance Document (TAD) to provide state and local air monitoring agencies with recommendations on how to successfully implement required near-road NO_2 monitors. In developing the TAD, OAQPS collaborated with multiple state and local air monitoring agencies and federal and state departments of transportation. At an early phase of development of the TAD, OAQPS requested that the Clean Air Scientific Advisory Committee (CASAC) provide advice through its review of EPA's Near-road Guidance Outline and Near-road Monitoring Pilot Study Objectives. In November 2010, CASAC issued a final report for its Review of the "Near-road Guidance Document – Outline" and "Near-road Monitoring Pilot Study Objectives and Approach" (available at http://yosemite.epa.gov/sab/sabproduct.nsf/ACD1BD26412312DC852577E500591B37/$File/EPA-CASAC-11-001-unsigned.pdf). OAQPS considered CASAC's November 2010 advice, drafted the TAD, and requested that CASAC's Air Monitoring and Methods Subcommittee (AMMS) provide advice and ideas on how to improve the draft TAD. CASAC's AMMS held two public teleconference calls on September 29 and November 17, 2011 to review EPA's draft Near-road NO_2 Monitoring TAD. The chartered CASAC reviewed the AMMS Review Report on the Near-road NO_2 Monitoring TAD during the January 27, 2012 public teleconference, and approved the Report after the teleconference.

CASAC focused on the following charge questions as part of its review, and provides the following responses to these charge questions.

Monitoring Objectives

Charge Question 1: *Does the TAD, particularly based upon the information provided in Sections 1 and 2, provide clear objectives of the document and give appropriate rationale for the objectives?*

Sections 1 and 2 could be combined and the discussion of objectives and rationale could be strengthened. The primary operational goal of the network is clearly stated, i.e., to capture peak NO_2 concentrations near roadway. In the TAD, "near roadway" is defined as ideally less than 20 meters from the active traffic lane, although up to 50 meters is allowed by the rule. However, the rationale for that siting and the objective of the network design, in terms of what populations are expected to be protected by the network, is not described. It is very important that the TAD provide a clear description of what the network is intended to accomplish in terms of health protection and environmental goals and how that drives the monitoring network design and probe siting. This would include a clear description of the populations subject to elevated vehicle exhaust exposure (such as those living or recreating near the road or those in vehicles on the road); the near-road network objectives as stated in the NO_2 final rule preamble should be included in this section. It is unclear if siting criteria should take into account the presence of residential exposures -- does it matter if no one lives near the near-road site? If the network is intended to be able to characterize on-road concentrations, even 20 meters might be too far from the road since gradients going away from the road in the first 20 meters are steep and highly variable.

A secondary (longer-term) goal of creating a near-road (NR) monitoring network infrastructure and providing data for a range of NR-relevant pollutants or indicators to support health assessments also should be stated. This section should note the importance of NR siting relative to nearby community-scale air monitoring stations to allow evaluation of the "NR excess" and estimation of gradients from the road for pollutants of interest. References to studies on health effects for the exposures of interest would be helpful. It would be useful to specify NR network requirements as stated in the NO_2 final rule and characterize to what extent options are available to agencies in order to adhere to regulatory requirements. This section also should include language to clarify the options agencies would have if they are in noncompliance due at least in part to local traffic sources. It would be helpful to include the reasoning behind the monitoring network, a brief scientific overview of pollutant interactions (dynamics of ozone titration), and a discussion on the limitations of the data that would be generated by the network.

Site-Selection Factors

Charge Question 2: *Does the AMMS believe that the suggested approach in the TAD places an appropriate amount of weight and consideration on all six factors (AADT, fleet mix, congestion patterns, roadway design, terrain, and meteorology) required to be considered as part of the near-road NO_2 site selection process?*

Among the six factors that are discussed in the current draft of the TAD, there is too much emphasis on Annual Average Daily Traffic (AADT). More attention should be given to congestion patterns, background concentrations, NO–O_3 chemistry, physical mixing, terrain, and meteorology, especially as it influences flow patterns and NO_2 concentrations in the 0–50 m closest to roadways.

Additional factors that should be considered include the potential of sites to characterize hot spots, the potential of sites to characterize human exposure, public accessibility, safety, the potential influence of other nearby NO_2 sources (e.g., cumulative effects of nearby roadways), the availability of ancillary measurements at the site (e.g., traffic counts with high temporal resolution or other measures of congestion), and the availability of ancillary nearby measurements (background NO_2, ozone and meteorological data). In addition, the TAD should more explicitly and clearly address the issue of location of the site within a distance of 0-50 m of the roadway (e.g., consider 20 m or less with a vertical height dependent on distance from roadway and terrain features). As documented in individual panel member comments, there is extensive scientific literature on the significant concentration changes for NO_2 that occur within 50 m of roadways. The TAD should provide guidance on which parts of this distribution are of greatest interest and how to weight the six factors and incorporate these data into the roadway process. For example, the TAD should specify whether the goal is to measure maximum average concentration, concentrations at locations that are likely to experience the highest value for the 98th percentile concentration, or the concentrations most likely to be associated with human exposures.

Fleet Equivalent AADT

Charge Question 3: Does the AMMS see opportunities to improve the usefulness of the Fleet Equivalent AADT metric introduced and discussed within Section 5?

The Fleet Equivalent (FE) AADT metric is an acceptable starting point for initially ranking road segments based on combined Light-Duty Passenger Vehicle (LD) and Heavy-Duty (HD) Truck traffic counts. The accuracy, however, of a national default value must be determined. Although the FE-AADT is a reasonable starting point to identify hot spot roadway segments for potential NO_2 monitoring, it is unlikely that this approach will capture the details of local on-road/near-road hot spot pollutant exposures impacting commuters and near-road neighborhood environments (e.g., see HEI 2010).

Before consideration of the FE-AADT as a screening tool, further characterization of uncertainties in the default values and assumptions in the approach should be provided. These include:

- Identification of the variation in HD emissions with the age of the vehicle fleets and the variation in vehicle fleet age across Core Based Statistical Areas (CBSAs) and regions.
- An assessment of the contribution of HD gross emitters on total HD emissions and the likely locations of these outlier sources.
- An estimate of the introduction and penetration of clean diesel technologies (filter trap and Selective Catalytic Reduction, or SCR) and their impact on the direct primary emissions of NO_2.
- Applying available local emission inventory data to refine the choice of a default ratio of 10 for heavy-duty to light-duty NOx emissions (HDm) for specific road segments.
- The distribution of traffic congestion should be considered whenever possible utilizing location-specific temporal transportation data. Incorporation of such data should improve upon the current congestion ranking as applied in the TAD, which has limited power and does not provide any specificity to distinguish within the severe ranking category.

The EPA should review existing research study results and, to the extent possible, develop statistics on HD multiplier values based on roadside monitoring across different CBSAs. This information will provide monitoring agencies with a reasonable estimate of FE accuracy to help determine how precisely they should follow the rankings produced by the FE metric and allow for the consideration of other available factors affecting site selection.

The Health Effects Institute (HEI) Special Report 17. 2010. Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects. http://pubs.healtheffects.org/view.php?id=334.

Roadway Pollutant Dispersion

Charge Question 4: Within Section 6, does the AMMS believe we have adequately described the effects of roadway design, roadway structures, terrain, and meteorology on roadway pollutant dispersion and suggested how those effects can be considered in the near-road site selection process?

Overall, CASAC concurs that this section of the TAD does a good job of describing the physical considerations in identifying a near-road monitoring site. Subcommittee members suggested a few additional considerations that should be included in this section, and were critical of one of the figures in the section. Highway interchanges where multiple roads intersect were discussed as being likely locations of the highest near-road NO_2 concentrations, and the members felt this could be more explicitly stated in this section (possibly as a sub-section of 6.1 Roadway Design). Alternatively, a brief discussion of interchanges might be more appropriate in Section 5 as part of the road segment ranking process. Local highway density combined with congestion and slowed speeds at interchanges increase the likelihood of high NO_2 concentrations; in particular, the effects of road density should be discussed more clearly in this draft TAD.

CASAC recommends that EPA explicitly mention two types of locations to avoid when considering monitoring sites because they could impact dispersion: (1) locations near stands of trees, and (2) those near significant surface waters such as lakes, rivers and coastal waters (because these waters may affect NO_2 concentrations). Finally, CASAC recommends that Fig. 6-2 be deleted because the figure does not represent the downwind concentration profiles of ultrafine particles that have been reported for some other locations, nor does it represent the behavior of NO_2 near roadways. Due to their temperature-dependent volatility and high coagulation rates, 20 nanometer (nm) size particles are expected to behave differently than NO_2 or conserved pollutants such as CO in the near-road environment. Presentation of similar data on the near-road behavior of a conserved gas such as CO is encouraged in a revised Fig. 6-2.

Siting Requirements for Near-Road Monitors

Charge Question 5: Within Section 7, does the AMMS believe we have adequately discussed the siting requirements and provided appropriate suggestions for how to properly site monitor probes while considering the design of the target road and/or roadside structures?

Section 7 is well-written and clearly presents minimum requirements for siting near-road monitors. However, there are several areas where additional information could be provided. The presentation could be strengthened by including results from photochemical models with high space-time resolution to illustrate NO_2 formation and photolysis as a function of downwind distance from road segments. Detailed modeling also could be performed to provide bounding estimates of both primary and secondary NO_2 as a function of downwind distance. Findings from two recent modeling studies (Wang and Zhang 2009; Wang et al. 2011) might provide useful insights for site selection. It should be noted that AERMOD and other regulatory models generally lack the detailed chemistry and/or space-time resolution to deal with problems of this nature at such proximity to a complex and dynamic source.

Another concern involves the horizontal placement of monitors with respect to walls, parapets, etc. The guidance allows a separation of as little as 1 meter horizontal distance between an inlet and adjacent (supporting) structure. Depending on the nature of the structure, and other variables, there likely will be a perturbation of air flow near the structure. This, in turn, will enhance or depress NO_2 concentrations. Table 7 should state explicitly that the probe should be on the side of the supporting structure facing the traffic or above the supporting structure.

One topic that may need further discussion is the relationship between the sample inlet distance from the road and the inlet height. The TAD separately discusses inlet distance and height, and should discuss the effect of inlet height at different distances from the road. Inlet height should be in the range of 2-7 meters, taking into account likely exposures in the vicinity of the site. Traffic speed, wind speed and the location of barriers all will affect downwind concentrations. It would be useful to study some of these effects using Computational Fluid Dynamics (CFD) models, as described in various recent studies (see example references in comments from J. Chow). Such information will provide monitoring agencies with a better picture of the distribution of near-road pollutant concentrations to aid their decisions regarding sample inlet location.

Finally, there was no mention of residence time in inlet lines or materials of construction for inlet lines. In some cases, it might be necessary or desirable to locate an NO_2 inlet at some distance (10-20 meters) from an equipment shelter, rather than adjacent to it. If so, then some effort should be made to minimize residence time and to maintain clean, inert sample lines.

Wang, Y.J.; DenBleyker, A.; McDonald-Buller, E.; Allen, D.; and Zhang, K.M. 2011. Modeling the chemical evolution of nitrogen oxides near roadways. *Atmospheric Environment* 45(1):43-52.

Wang, Y.J.; and Zhang, K.M. 2009. Modeling near-road air quality using a computational fluid dynamics model, CFD-VIT-RIT. *Environmental Science & Technology* 43(20):7778-7783.

Exploratory Monitoring

Charge Question 6: *Does the AMMS believe that Section 8 has adequately discussed and explained the varied approaches on the optional use of exploratory monitoring as part of the near-road site selection process?*

Yes, although some improvements can be made. Section 8 offers several reasonable exploratory monitoring options: saturation designs; focused monitoring campaigns; and mobile monitoring. However, further guidance is needed to help the user to specify the purpose(s) of the exploratory monitoring. There are many possible objectives; e.g., finding the maximum near-road NO_2; characterizing the spatio-temporal gradients; assessing the relationship between the multiple pollutants, to permit choosing the monitoring approach that will best provide the information needed to achieve the defined objectives. The combination of these methods also should be discussed. In many cases, it will be desirable to use near-road models to integrate and to interpret the results of the exploratory monitoring. Thus, there needs to be integration between this monitoring guidance and the modeling material provided in Section 9.

Dispersion Modeling

Charge Question 7: *Within Section 9, does the AMMS see opportunities to improve the description of how the (optional) use of AERMOD and MOVES can be used to conduct dispersion modeling in the near-road site selection process?*

The TAD should stress the importance of using models as a companion to exploratory monitoring. It is not clear that AERMOD is the best tool for near-road plume modeling applications and it would be helpful for the TAD to offer other options. There are line source models available that could be better adapted or adopted, such as CALINE4, or AERLINE when it becomes available. Properly accounting for background NO_2 is expected to be a major issue in modeling near-road NO_2 in urban areas. Background NO_2 should be assessed by accounting for multiple background sources. The TAD discusses the issue of dealing with background point sources of NO_2 in AERMOD but the network of upwind roadways may be more relevant. An example of AERMOD application to near-road NO_2 simulation, along with description of the user interface, would be a useful addition to the TAD.

It is essential that the plume dispersion model account for NO- NO_2- O_3 chemistry and the TAD should provide clearer guidance on this topic. Tier 1 and Tier 2 of AERMOD, where NO_2 is treated as inert or as a fixed fraction of NOx, are unacceptable. Tier 3, accounting for NO- NO_2- O_3 photochemistry, should be used if AERMOD is the model chosen. The maximum near-road NO_2 conditions are not likely to be associated with directly emitted NO_2 but rather with emitted NO that is oxidized to NO_2 by ozone. The time scale for oxidation is ~1 min under high-ozone conditions but may be much longer under stable conditions when ozone is titrated. Thus near-road NO_2 is not necessarily highest under the most stagnant conditions, nor is it necessarily highest close to the roadway. The chemistry involved is simple but its coupling to meteorological conditions has some subtleties that are highly relevant to the conditions and locations where maximum NO_2 is to be expected. A short tutorial on NO- NO_2- O_3 chemistry, its coupling to plume dispersion, and the implications for near-road NO_2 would be a very useful addition to the TAD.

If a multi-pollutant sampling strategy is adopted that involves measurements of other non-conserved species such as ultrafine particles, models also will be required to interpret measurements of their downwind concentrations.

Characterizing Candidate Near-Road Sites

Charge Question 8: *Within Section 10, does the AMMS believe the list of items needed to appropriately characterize individual candidate road sites is complete and adequately described? If the list is considered incomplete, please provide a list of the missing characteristics that should be included.*

The list of items in Section 10 is quite comprehensive (and repetitive with the rest of the document). Some items that are missing or underemphasized include:

- representativeness of site (e.g., avoid unique situations like toll booths, tunnels, and acceleration ramps);
- other NO_2 sources (e.g., nearby roads, other sources);
- existing monitoring sites (both near-road and background sites);
- roadway grade; and
- surrounding land use (and population density).

CASAC commends the Agency for recommending the use of new digital resources to facilitate field reconnaissance.

Collaboration with Transportation Agencies

Charge Question 9: *From an air agency perspective, does the AMMS find that the definitions and explanation of transportation agency policies and expectations are adequate? Are there opportunities to improve upon the material presented within this section?*

Section 11 of the TAD covers the intended topic very thoroughly and might be edited to remove excessive detail. The considerable discussion of "air rights" in Section 11 is confusing since it would seem that an "easement" (right to use the land) is just as important as "air rights". While the discussion of safety issues here is critical, a bulleted list of key safety elements to consider would be helpful to highlight the most relevant information. This section assumes that a Department of Transportation (DOT) would be involved only if the site is on a DOT right of way, which is not always the case; DOTs often own land that is near the highway but completely off the Right of Way (ROW) or the safety zone. This circumstance is more likely for a site within 50 meters of the active traffic lane than for one within 20 meters.

There are some elements of this section that do not warrant more than a brief mention:

- A Near-Road site should never require access from within the ROW; this limitation should rule out a site from further consideration.
- The need to enhance roadway safety infrastructure for a Near-Road site as discussed on page 11-8 is very unlikely to happen due to funding limitations.

Site Comparison Matrix

Charge Question 10: *Does the AMMS have ideas for improvement with respect to the organization and usefulness of the suggested site comparison matrix discussed within Section 13?*

CASAC agrees that there are some advantages to developing the matrix and suggests adding some additional information to make the matrix more useful. A category for the distance to interchanges, intersections and other road segments should be incorporated. There also should be a qualifier for each element to assist in determining the appropriate weight for each of the categories. The direct element-to-element comparison of candidate sites will help to justify the ultimate site selected and the locations not selected should be considered as potential replacement sites. Since monitoring sites in urban areas often have to be relocated due to frequent and sometimes unexpected construction, repaving and repair projects, backup locations should be developed for each site in case it needs to be changed quickly.

The site selection matrix is one of many tools that can be used in the near-road site selection process. However, use of the matrix may not be necessary and could be burdensome in CBSAs where there are few choices or where a suitable candidate site already is available. The one element that could not be quantified, but that likely will play into the site selection process, is the application of "local knowledge." Road segments likely will have different rankings on days when traffic flow is disrupted due to accidents, road and bridge closures or mass transit shut downs. These types of issues are difficult to objectively quantify and present in a matrix format for comparison with other site attributes.

Priorities for Pollutant Monitoring

Charge Question 11a: Does the AMMS concur with the order of presentation of each pollutant or metric of interest in the near-road environment, as was suggested by the previous AMMS panel, within Section 14?

No, the specific requirements for near-road NO_2 monitoring for different state and local agencies might vary, and it is difficult to follow the exact ranking order. However, CASAC suggests that rather than an ordered list, pollutants should be grouped by priority (e.g., primary, secondary, tertiary) to allow flexibility in near-road monitoring. Following are the recommendations for priority grouping:

- **Primary Group**: NO/NO_2 and CO, O_3, 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**: CO_2, $PM_{2.5}$ and $PM_{10\text{-}2.5}$, and organic and elemental carbon (OC and EC, respectively)

The Primary Group contains NO/NO_2 and CO, which are required as part of current EPA regulations for near-road monitoring. The NO_2/NO_x ratio will be highly related to O_3, so O_3 is important for understanding O_3-NO chemistry and to distinguish primary versus secondary contributors to near-road NO_2. Meteorology data (especially high-resolution [1–5 s] wind speed and wind direction) is needed to understand the turbulence induced by moving vehicles that will disperse emissions and the importance of nearby structures (e.g., barriers, surface roughness).

The Secondary Group contains air toxics from combustion and other sources which are of great health concern, especially for those residents in close proximity to a busy roadway. BC is a good indicator of primary emissions from high emitters and/or heavy-duty diesel vehicles. Particle size distribution provides information on potential impacts, dynamics and sources. Particle number concentration is an emerging health indicator, with its measurements to be used for future European (and possibly U.S.) engine certification. Traffic counters/DOT cameras will allow for accurate representation of road use.

The Tertiary Group includes an inexpensive, fast-response CO_2 monitor, which would allow fuel-based emission factor distributions to be estimated. An optical particle counter for PM may be more useful than a compliance $PM_{2.5}$ or PM_{10} sampler. Expenses associated with operations and maintenance for continuous OC/EC analyzers also should be recognized.

Furthermore, for priority/criteria pollutants on the list, the EPA should clarify whether agencies are restricted to using EPA methods for the analysis of the pollutants, or whether use of other methods would be acceptable.

Charge Question 11b: Does the AMMS concur with the description of each pollutant or other metric discussed in Section 14, including its impact on human health (as appropriate), the reason for interest in the near-road environment, and the description or suggestions for measurement?

Yes, there is an adequate description of each pollutant of interest.

Charge Question 11c: Does the AMMS believe that a pollutant or other metric should be removed from the list within Section 14, or that an unlisted item should be included within this section?

Yes, sulfur dioxide and lead should be removed from the list. Traffic counters or the use of DOT cameras should be added to the list as part of the Secondary Group, since they are easy to install and operate and will allow the examination of congestion patterns as elevated NO_2 concentrations are recorded.

Enclosure B
Comments from Individual Members of the CASAC Air Monitoring and Methods Subcommittee (AMMS)

Comments from Mr. George Allen

These comments are a broad overview of the draft document, with some specific comments on section 11.

The TAD is a very comprehensive review of all possible issues that might be in play for a Near Road site. There are parts that could benefit from editing to make them shorter, clearer, and more concise. If the key information in the TAD is not readily accessible, it is less likely to be used. This document would be much more readable if the essential components were condensed into a 10-minute read, with additional supplemental material referenced in appendices. The first 25 sites will be deployed in large cities which generally have experienced monitoring staff that do not need the level of detail currently in this TAD.

It must be realized and clearly acknowledged that in the longer run (< 10 years?], Near Road sites are not likely to be about compliance monitoring. With the current CO NAAQS, there are almost no attainment issues. Over time (the next several years), as HDD NOx engine controls already in effect penetrate the fleet, NO2 will likely also become a minimal issue with regard to determining attainment with the NAAQS. <u>Thus, the longer term siting and network design must take into consideration the underlying goal of the Near Road network: providing data to support health effect assessment.</u> This means much more than just adding other key measurements like BC and particle # concentration. Site selection must consider the availability of relevant "background" sites that would allow estimation of the Near Road "excess" of a wide range of relevant pollutants. This information, along with detailed wind and traffic data, would allow modelers to develop estimates of multi-pollutant surfaces near roadways (including estimation of exposure gradients away from the road) with relatively similar terrain as the single Near Road site. This surface modeling is an essential component of any attempt to do near-road health assessments. A single site without a relevant "background" site pair has little to no value in a non-NAAQS context - it can not be used for health effect assessments since it represents only a single micro-scale environment.

Along with an appropriate background site, highly detailed traffic data [including vehicle class information], is very important. In large urban areas, the DOTs usually have several "permanent" hi-resolution traffic counters. These two siting factors [background site and detailed traffic data] are critical in making the Near Road data useful in any context beyond demonstration of attainment with the NAAQS. These factors should be the primary drivers of any site selection process after AADT, terrain, and congestion are considered.

BC has been a useful marker for HDD, but like HDD NOx, it will continue to trend down over the next several years, eventually becoming lost in the urban and transport background. Thus, to the extent that "clean" diesel emissions are of interest (VOCs may not be removed by current control technologies), effort might be needed to establish a different HDD "marker" that is relatively easy to deploy and operate and be highly time-resolved. This is likely to be a difficult task. Along these lines, other air-toxic combustion products such as acrolein and 1-3 buta-d may become substantially more important than CO, NO2/NOx or even BC. We may eventually end up with a Near Road network with UFP and air toxics as the key measurements. These longer term aspects should be considered during network design.

One key component to Near Road site selection is that staff involved in the process must already be very familiar with the urban area under consideration. It is nearly impossible [considering limited agency staff resources] to do this without an understanding of the area[s] under consideration.

Along with the site comparison matrix in ch. 12, a decision flow chart, such as used in section 3, pg. 3-2, would be useful for site selection. The most important elements would be at the top -- those elements that would eliminate a potential site from further consideration early on in the decision process. This would help focus attention on the more subtle and fuzzy components of site selection. This would of course require at least some degree of prioritization of matrix components, but this has already been done in the TAD.

Although not required by the NO2 or CO NAAQS, on-site met monitoring is essential; it is critical to interpretation of the data. It may not have to be sonic 3-d, but some wind measurement must be made on-site or very near [<100 meters] from the site. Ideally wind would be measured on-site with very high time resolution [1 to 5-seconds] to provide information on turbulence conditions. Although EPA did receive some negative comments about sonic wind systems during the NO2 NAAQS comment period, that technology continues to improve, especially with regard to reliability and resistance to contamination. Sonic systems still need ongoing QC to verify proper operation, and this is more difficult to do than with mechanical systems. One approach is to establish an initial relationship between the Near Road wind sensor and the nearest wind data source. This relationship can be reviewed over time, and if the relationship pattern changes, something has probably failed. If Near Road met data are submitted to CWOP, this QC is automatically done by MADIS is and readily available.

The TAD makes no mention of consideration of siting near environmental justice neighborhoods. This should be part of the matrix, since lower SES neighborhoods are usually considered to a more susceptible and vulnerable population.

Section 11.

There is considerable discussion of "air rights" in section 11 of the TAD. This is confusing to me, since it would seem that "easement" [right to use the land] is just as important if not more so. This section also assumes that a DOT would be involved only if the site was on DOT right of way. This is not always the case -- DOTs sometimes own land that is near the highway but completely off the right of way or the safety zone. Examples of this case from Boston will be provided in my final comments.

Page 11-3, last line: I would expect that any Near Road site would never require access from within the ROW. This should be a show-stopper, not a discussion point. Likewise, the need to enhance roadway safety infrastructure for a Near Road site as discussed on page 11-8 is a non-starter; funds are not likely to be available for this kind of effort.

While the discussion of safety is critical, a bulleted list of key elements would be helpful. The discussion in 11.3 is excessively detailed, and thus not easy to access.

Section 14.

The list developed by the Nov. 2010 CASAC report is useful guidance, and the first 4 or 5 pollutants are indeed essential. Of the pollutants discussed in this section, CO2 and SO2 have very minimal value. Ozone, which did not rank very high in the CASAC list, might be very useful to sort out the primary vs. secondary contributions to Near Road NO_2. With a matched background site and Near Road NO, NO2, O3, and wind data, much of this could be sorted out. To the extent that Near Road NO2 is from local titration, that argues for siting to be further from the road [> 50 meters]. This is unfortunately in conflict with nearly all other Near Road network objectives however.

Comments from Dr. Linda Bonanno

1) Shouldn't the TAD have a glossary section?

2) Throughout document, important to note which are requirements and which things are not

3) page 4-7: There is a big space before the word data, and it happens in a cople of places on that page, not sure what it means

4) page 10-5: The term Jersey Barrier is used on page 10-5 and then defined on page 11-6, should be vice versa,

5) pg 14-4 4th sentence down......NOy species present in are dominated... present in what?

6) Also on pg 14-4 at bottom, EPA plans to continue to work with academia, should have a contact at EPA

7) Section 14.4 black (elemental) carbon section, need to define what portion of EC or BC can be said to represent diesel. Not all EC or BC in ambient environment is from diesel...

Comments from Dr. Doug Burns

General comments pertinent to Sections 6 and 10:
Response: In general, I believe that this TAD does a good job of providing guidance to monitoring personnel as to how to locate sites and the criteria to use in site selection. My biggest concern is whether adequate guidance or necessary priority has been given to the issue of background NOx emissions and other potential local sources beyond the immediate roadway. It seems that this issue is critical in linking NO2 concentrations to the immediately adjacent roadway. The issue of background and local sources is discussed at various places in the document, but for example, is not listed in Section 6 under "Physical Considerations". Instead, this issue gets raised in Section 10 (10-10 Surrounding Land Use). In my view, the background and other source issues are deserving of mention as a primary site consideration factor in Section 6. I am also uncertain whether consulting emissions inventories will be adequate for this task; number one because these inventories are somewhat out-of-date and number two because there are many sources of NOx such as landfills, wastewater treatment plants, and wetlands that may not be included in inventory data. Additionally, there is no real guidance as to what is meant by "nearby" sources in Section 10-10. What distance or radius should be considered? For example, there is evidence from the literature that overall road density in addition to near road sources provides significant NO2. Shouldn't a measure such as road density also be part of an assessment of monitoring site adequacy?

Charge Question 4: Within Section 6, does the AMMS believe we have adequately described the effects of roadway design, roadway structures, terrain, and meteorology on roadway pollutant dispersion and suggested how those effects can be considered in the near-road site selection process?
Response: I found that this Section generally does a good job of discussing the key issues and providing helpful guidance on matters such as barriers, topography, and meteorological conditions. I wonder if guidance should also be offered to avoid (if possible) roadside locations with a high density of mature trees given the evidence shown in Fig. 6-2. I note that the current discussion focuses primarily on noise barriers, but the data in Fig. 6-2 seems to suggest that the presence of mature vegetation along the roadway likely has an even greater effect than does noise barriers.
A second point is whether you might also include in the guidance that where possible, a roadway is selected that is near-perpendicular to the prevailing wind direction. The section already mentions that the downwind side of the road is preferred, but this could vary quite a bit depending on the angle of the road with respect to the dominant wind direction. This would be criterion to use when deciding among several road segments that are fairly close regarding the other criteria.

Comments from Dr. Judith Chow

Charge Question 1: Does the TAD, particularly based upon the information provided in Sections 1 and 2, provide clear objectives of the document and give appropriate rationale for the objectives?

Response: Yes, the objectives are adequately stated for NO_2 near-road monitoring and site selection. However, the TAD should clarify if the goal is to measure maximum NO_2 concentrations at near-road or to capture maximum human exposure in near-road environments.

Charge Question 2: Does the AMMS believe that the suggested approach in the TAD places an appropriate amount of weight and consideration on all six factors (AADT, fleet mix, congestion patterns, roadway design, terrain, and meteorology) required to be considered as part of the near-road NO2 site selection process?

Response: No. There is too much emphasis on annual average daily traffic (AADT) with fleet mix and congestion modifications and an insufficient discussion of and guidance for the other factors. Notably missing are discussions of human exposure, background NO_2 contributions, and NO_2 transformation potential.

- AADT is discussed on pp. 3-1 to 3-5, pp. 4-2 to 4-4, and pp. 5-9 to 5-14: It seems that >250,000 vehicles/day is overly restrictive. The examples in Table 1 of the TAD (p. 5-12) don't meet this criterion. With this limit, monitoring would be confined to 8 or more lane superhighways that are often elevated or depressed, have buffer zones around them, and have sound barriers in neighborhoods. Limiting monitoring to these roads would emphasize exposure of other drivers on the road rather than people near the road.
- Fleet mix is discussed on pp. 4-4 to 4-5 and pp. 5-13 to 5-21. The NO_2/NO_x ratio for gasoline vs. old diesel vs. new diesel should be considered in the Fleet Equivalent AADTs. Gasoline engines typically have a ratio of ~5%, while old diesels may have ratios >10%, and new diesels with urea-based SCRs may have ratios as high as 70% (but with much lower total NO_x emissions) (Alvarez et al., 2008; Grice et al., 2009).
- Congestion patterns are discussed on pp. 4-5 to 4-8 and pp. 5-22 to 5-25. The conjecture that congestion is a secondary factor needs to be supported by evidence. One could argue that congested traffic during the rush hours with calm meteorology would minimize turbulence caused by traffic flow, thereby allowing more NO_2 to accumulate at the roadside.
- Roadway design and structures are discussed on pp. 6-2 to 6-7: Figure 6-1 in the TAD (p. 6-5) is a good illustration (the caption needs to describe the wind direction and speed), but more evidence is needed on the effect of road design and structures. It would be useful to study some of these effects using Computational Fluid Dynamics (CFD) models, as illustrated in Figure 1 below and in other studies (Belalcazar et al., 2010; Gidhagen et al., 2004; Hahn et al., 2009; Karim and Nolan, 2011; Kondo et al., 2006; Kondo and Tomizuka, 2009; Kumar et al., 2009; Sahlodin et al., 2007; Wang et al., 2011; Wang and Zhang, 2009). Street canyons surrounded by tall buildings have been shown to concentrate and recirculate pollutants that might result in higher concentrations than those measured downwind of a heavily-travelled roadway (Benson et al., 2008; Buccolieri et al., 2011; Cai et al., 2008; Dixon et al., 2006; Eliasson et al., 2006; Gousseau et al., 2011; Grawe et al., 2007; Gromke et al., 2008; Hanna et al., 2006; Lam et al., 2008; Li et al., 2006; Murena et al., 2009; Salmond et al., 2010; Solazzo et al., 2007; Tay et al., 2010; Yassin et al., 2009; Yim et al., 2009; Zhou and Levy, 2008)

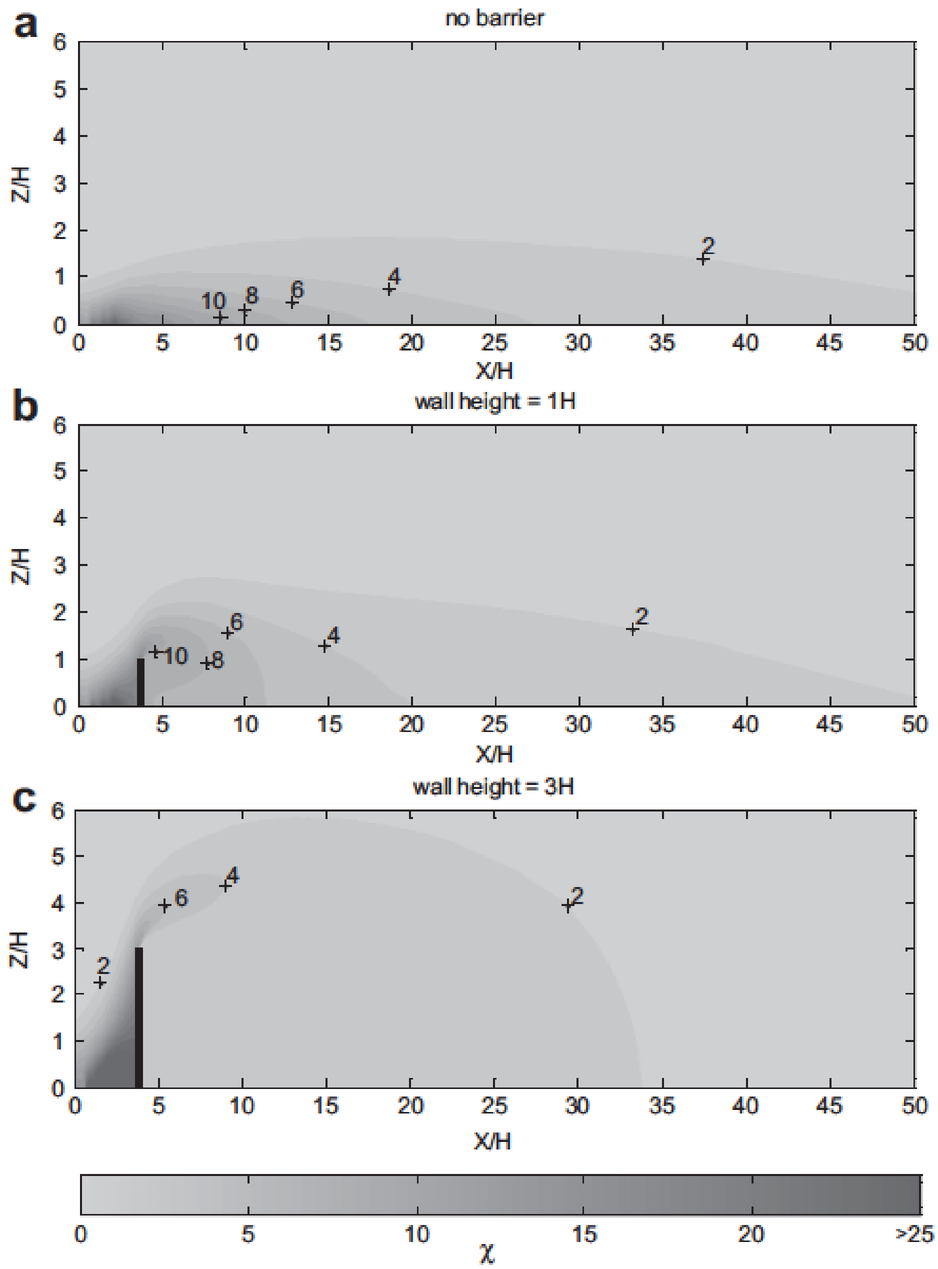

Fig. 4. χ for scenarios with orthogonal winds and cases with no barrier (a), barrier of height *H* (b), and barrier of height 3*H* (c).

Figure 1. Computational Fluid Dynamics (CFD) Modeling of dispersion downwind of a roadside sound barrier (Hagler et al., 2011). The plume is elevated by the barrier and dispersed on the downwind side.

- Terrain is discussed on p. 6-8: This topic seems highly related to roadway structures.
- Meteorology is discussed on pp. 6-8 to 6-9. Only wind direction is discussed. More needs to be added on the turbulence that would disperse the emissions and the importance of nearby structures (e.g., surface roughness) and moving vehicles in inducing that turbulence.
- Human exposure potential is discussed on pp. 12-2 to 12-3. This should be one of the prime considerations and should be moved to Sections 5 or 6. Why can't the "number of ways" to consider

human exposure be "listed here?" It might be that measurements near a bus-stop or transit center on a busy street would yield higher exposures than superhighway emissions, owing to the proximity of the people to the emission sources (e.g., bus exhaust pipes).

- Background concentrations and chemical transformations. The roadside NO_2 will be an increment over the neighborhood- (0.5–4 km) and urban-(4–100 km) scale NO_2 levels (Chow et al., 2002). It may be that a road with lower AADT shows higher levels owing to its proximity to other well-used roads in an urban area. Figures 2 and 3 below are examples of some analyses that would be useful to examine the relationships among the different variables.

The relationship from Marylebone Road in London (Figure 2; Carslaw and Beevers, 2005) used hourly NO_2, NO_x, and O_3 data to estimate primary NO_2 fractions from vehicle exhaust and NO_2 formed through reactions of NO with O_3. Reacted NO_2 increases rapidly for NO_x<100 ppb until roadside O_3 is depleted. Background levels were determined from urban-scale monitors. In Figure 3, Wang et al. (2011) showed that a NO_2/NO_x ratio of 5% may not be suitable for most roadways, especially those with a high fraction of heavy-duty truck traffic. High O_3 concentrations and peak NO_2 concentrations occurred within 20–50 m downwind of the road due to the high initial NO_2/NO_x conversion rates near roadways.

The TAD would be more useful if it contained an example that illustrates the different steps in the analysis, along the lines of network design guidance for $PM_{2.5}$ and PM_{10} in U.S. EPA (1997). It starts with a fairly detailed description of AADT and its modifications, with illustrative tables, for the Tampa area, then it becomes less specific for the following steps. The political and population statistical boundaries may be adequate in the eastern U.S., but this is not how air quality management regions are defined in the western U.S. with large counties containing relatively small populated areas surrounded by terrain (Clark County Department of Air Quality and Environmental Management, 2004; Seitz, 2000), or that consist of portions of several counties (SCAQMD, 2011).

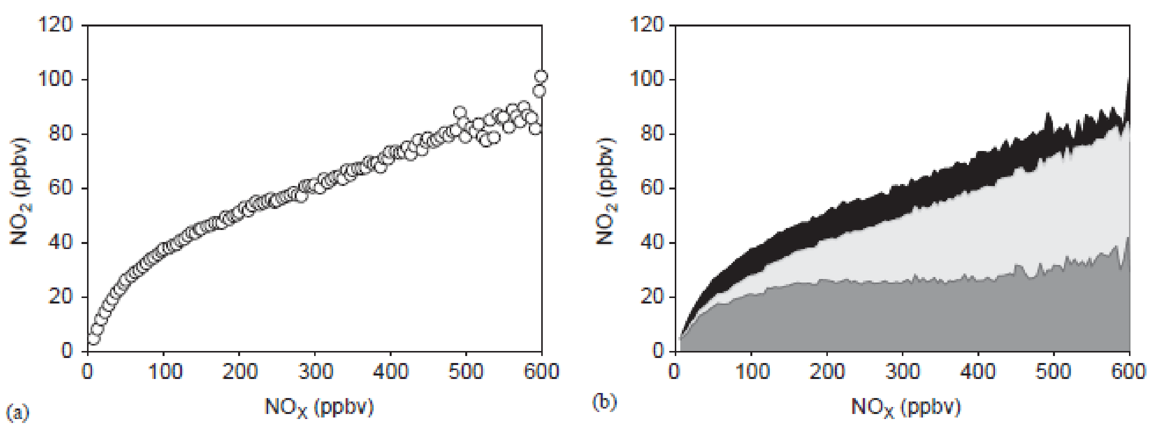

Fig. 2. (a) NO_X–NO_2 relationship for Marylebone Road (1998–2002), (b) NO_X–NO_2 relationship for Marylebone Road highlighting the principal contributors to the NO_2 concentration. The black shading, light grey and dark grey shows the estimated contribution from local NO–O_3 chemistry, primary NO_2 emissions and background air.

Figure 2. Estimation of background, primary emissions, and reacted emissions of NO_2 as a function of NO_x levels along Marylebone Rd. in London (Carslaw and Beevers, 2005). Reacted NO_2 increases rapidly for NO_x<100 ppb until roadside O_3 is depleted. Background levels are determined from urban-scale monitors.

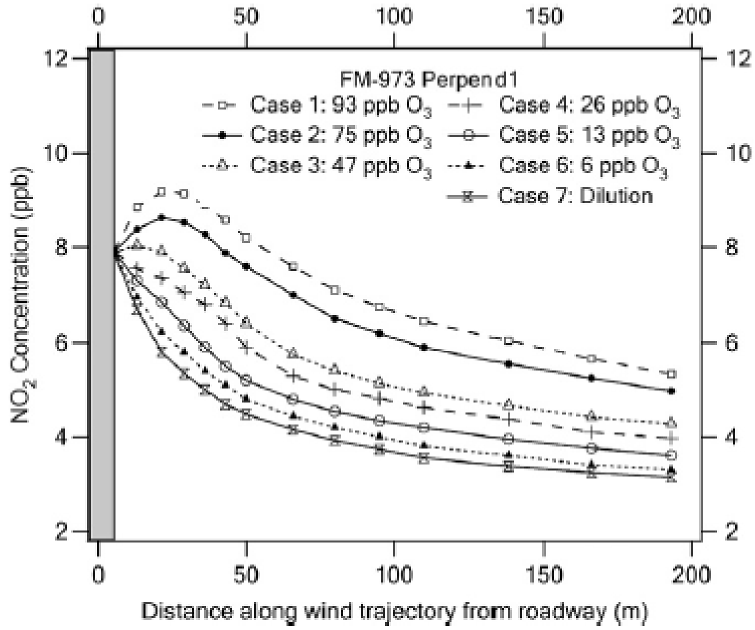

Fig. 6. Comparison of NO_2 concentration profiles under different ozone concentrations and corresponding photolysis rate for FM-973 Perpend1.

Figure 3. Higher NO_2 may be measured further downwind when O_3 is high, as shown by roadside Computational Fluid Dynamics (CFD) Modeling (Wang et al., 2011).

Charge Question 3: Does the AMMS see opportunities to improve the usefulness of the Fleet Equivalent AADT metric introduced and discussed within Section 5?

Response: Yes. See the recommendation under Question 2 to consider the NO_2/NO_x ratio from gasoline- vs. old and new diesel-powered engines.

Charge Question 4: Within Section 6, does the AMMS believe we have adequately described the effects of roadway design, roadway structures, terrain, and meteorology on roadway pollutant dispersion and suggested how those effects can be considered in the near-road site selection process?

Response: No. Many statements are made without sufficient support. Figure 6-1 of the TAD (p. 6-5) is useful, but a broader weight of evidence is needed.

Charge Question 5: Within Section 7, does the AMMS believe we have adequately discussed the siting requirements and provided appropriate suggestions for how to properly site monitor probes while considering the design of the target road and/or roadside structures?

Response: There are several well-established roadside monitoring sites to address human exposure in other countries (e.g., Hong Kong, India) that might provide some insight regarding data that can be acquired and analyzed. Existing air quality monitoring sites should be examined first. Are there already existing roadside sites that are likely to represent human exposure? Some analysis of the existing data in the airshed, especially the high exposure sites (e.g., bus stop–transit centers in Manhattan, NY) should be performed to determine how well existing monitors represent the desired spatial scales.

Charge Question 6: Does the AMMS believe that Section 8 has adequately discussed and explained the varied approaches on the optional use of exploratory monitoring as part of the near-road site selection process?

Response: Middle- (100–500 m) or neighborhood-scale studies would be a better term than "saturation study." A table outlining some of the instrumentation, accuracy, precision, averaging times, and detection limits with appropriate citations would be useful. Passive NO_2 filter adsorption has been widely studied and its advantages and disadvantages have been investigated (Ayers et al., 1998; Beckerman et al., 2008; Crouse et al., 2009; De Fouquet et al., 2007; Douglas and Beaulieu, 1983; Gilbert et al., 2003; Hauser et al., 2009; Heal et al., 1999; Heal et al., 2000; Heal and Cape, 1997; Henderson et al., 2007; Jimenez et al., 2011; Kirchner et al., 2005; Krochmal and Gorski, 1991; McConnaughey et al., 1985; Mukerjee et al., 2004; Mukerjee et al., 2009; Nash and Leith, 2010; Nishikawa et al., 2009; Norris and Larson, 1999; Ozden and Dogeroglu, 2008; Piechocki-Minguy et al., 2006; Plaisance et al., 2004; Sather et al., 2006; Sekine et al., 2008; Shooter et al., 1997; Sickles, II and Michie, 1987; Van Reeuwijk et al., 1998; Vardoulakis et al., 2009). Several microsensors are available that might be more useful for evaluating where and when high NO_2 levels might occur. There are also several examples of mobile-lab and in-plume monitors that might be useful for determining real-world emission rates and NO_2/NO_x ratios for different engine types (Beckerman et al., 2008; Bukowiechi et al., 2002; Herndon et al., 2004; Johnson et al., 2008; Johnson et al., 2009a; Kittelson et al., 2004; Maciejczyk et al., 2004; Morawska et al., 2007; Nussbaum et al., 2009; Pirjola et al., 2004; Pirjola et al., 2006; Pirjola et al., 2009; Shorter et al., 2005; Wang et al., 2009a; Yli-Tuomi et al., 2005; Zavala et al., 2006; Zhu et al., 2009).

Charge Question 7: Within Section 9, does the AMMS see opportunities to improve the description of how the (optional) use of AERMOD and MOVES can be used to conduct dispersion modeling in the near-road site selection process?

Response: A more concrete example would be useful. Other models and data analysis methods might be more accurate than AERMOD for the middle-scale, as suggested under Question 2.

Charge Question 8: Within Section 10, does the AMMS believe the list of items needed to appropriately characterize individual candidate road sites is complete and adequately described? If the list is considered incomplete, please provide a list of the missing characteristics that should be included.

Response: This seems repetitive of Sections 4, 5, and 6 except for the safety issues. A checklist or outline for site documentation might be more useful.

Charge Question 9: From an air agency perspective, does the AMMS find that the definitions and explanation of transportation agency policies and expectations are adequate? Are there opportunities to improve upon the material presented within this section?

Response: No comment.

Charge Question 10: Does the AMMS have ideas for improvement with respect to the organization and usefulness of the suggested site comparison matrix discussed within Section 13?

Response: Table 8 of the TAD (p 12-5) should include all of the considerations listed under Question 2. The focus is too much on the roadway while it is a combination of variables that influences concentrations and exposures.

Charge Question 11: Does the AMMS:

a. Concur with the order of presentation of each pollutant or metric of interest in the near-road environment, as was suggested by the previous AMMS panel, within Section 14?

Response: The priority monitoring should be: 1) NO_2/NO; 2) CO; 3) O_3; 4) wind speed and direction; 5) BC; 6) particle number; 7) CO_2; 8) $PM_{2.5}$ or PM_{10} mass (or surrogate); 9) toxics; 10) lead; 11) SO_2; and 12) OC. Priorities 1 to 3 are obvious. CO is less of an issue with modern engine technology, but it may result from high emitters (Bishop and Stedman, 2008). In addition, it is an EPA requirement to collocate CO at near-road monitoring sites. The NO_2/NO ratio will be highly related to O_3, so this is the next priority. On-site meteorological data are needed to understand NO-O_3 chemistry. BC is a good indicator of both primary emissions and high emitters and is relatively easy to measure and analyze data with an aethalometer (Hansen and Mocnik, 2010). Particle number is an emerging health indicator with a variation of its measurement to be used for future European (and possibly U.S.) engine certification (Dwyer et al., 2010a; Dwyer et al., 2010b; Giechaskiel et al., 2008; Johnson et al., 2009b; Wang et al., 2010). An inexpensive (e.g., $5,300 for a LI-COR sensor) fast-response CO_2 monitor would allow fuel-based emission factor distributions to be estimated from the other short-duration measurements (Sawyer et al., 2000; Sawyer, 2010). An optical particle counter (Peters et al., 2006; Wang et al., 2009b) for PM would be more useful than a filter compliance sampler to estimate the distribution of fuel-based emission factors. Toxics, lead, SO_2, and OC would not probably be worth the expense for modern fuels, unless there is a specific need by the local agency.

b. Concur with the description of each pollutant or other metric discussed in Section 14, including its impact on human health (as appropriate), the reason for interest in the near-road environment, and the description or suggestions for measurement?

Response: See answer above for importance of each measurement. There is a lack of balance in the measurement descriptions, with NO_x receiving more emphasis than others. An update of U.S. EPA (1998a; 1998b) guidance might be useful and incorporated by reference.

c. Believe that a pollutant or other metric should be removed from the list within Section 14, or that an unlisted item should be included within this section?

Response: No, the TAD should address the utility of the collected data, who would examine these data, and how they would be used to enhance understanding of the measured concentrations.

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Comments from Dr. Kenneth Demerjian

Charge Question 1: *Does the TAD, particularly based upon the information provided in Sections 1 and 2, provide clear objectives of the document and give appropriate rationale for the objectives?*
In reviewing the TAD in its entirety, it falls short of addressing the principal goal of deploying near-road NO2 monitoring which is to identify neighborhood populations at risk to high exposures of NO2 concentrations due to their proximity to major roadways. This is different from the over-arching objective identified in the TAD "…placing monitor probes as near as practical to highly trafficked roads where peak NO2 concentrations are expected to occur…." The primary objective of roadside monitoring needs to be clarified, as compliance monitoring and NO2 population exposures have different site demands for monitors.

The intersection of AADT and CBSA is a rather crude filter that is unlikely to identify high pollutant exposure risk neighborhoods in proximity to major roadway segments. The subject of traffic related exposures is discussed extensively in the HEI Special Report 17 "Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects," a reference conspicuously missing in this document.

HEI Special Report 17, (2010). Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects http://pubs.healtheffects.org/view.php?id=334.
The required consideration of the six factors in the site selection process: AADT, fleet mix, congestion patterns, roadway design, terrain, and meteorology are necessary but not sufficient. EPA must provide guidance on the uncertainties associated with each of these parameters and how they are affected by seasonal and regional factors. Also typical daily and weekday, weekend variances should be provided.

Charge Question 2: *Does the AMMS believe that the suggested approach in the TAD places an appropriate amount of weight and consideration on all six factors required to be considered (AADT, fleet mix, congestion patterns, roadway design, terrain, and meteorology) as part of the near-road NO_2 site selection process?*
More emphasis has to be placed on the quantification of traffic congestions and its contribution to roadway and near neighborhood hot spots.

Charge Question 3: *Does the AMMS see opportunities to improve the usefulness of the Fleet Equivalent AADT metric introduced and discussed within Section 5?*
The Fleet Equivalent AADT metric described in Section 5 of the TAD is a reasonable first step for triaging hot spot roadway segments for potential NO2 monitoring, but is unlikely to identify specific local hot spot pollutant exposures at the roadway/neighborhood intersection. Before implementation of the FE-AADT as a screening tool, several uncertainties in the approach should be addressed.

1) HD emissions will vary with the age of the vehicle fleet which likely varies within CBSA and by region. Emissions from HD fleets are not routinely monitor like the LD fleet and aged HD vehicles are likely more affected by gross emitters. Estimates of the uncertainties in HD emissions and their potential impact on local hot spot exposures should be documented across typical CBSAs under consideration.
2) A quantitative treatment of traffic congestion must be developed as it is a critically important component to exposure assessment. The LOS ranking A-F as applied in section 5.3 has no power

and does not provided any specificity to distinguish within the F ranking. Dismissing the quantitative treatment of traffic congestion based on these results is not acceptable and more effort needs to be made to address the congestion metric.

Charge Question 4: *Within Section 6, does the AMMS believe we have adequately described the effects of roadway design, roadway structures, terrain, and meteorology on roadway pollutant dispersion and suggested how those effects can be considered in the near-road site selection process?*
The section requires more emphasis on the effects of the subject factors (i.e., roadway design/structures, terrain, …) on population exposures in adjacent/nearby neighborhoods. .

Charge Question 5: *Within Section 7, does the AMMS believe we have adequately discussed the siting requirements and provided appropriate suggestions for how to properly site monitor probes while considering the design of the target road and/or roadside structures?*
The sting requirements as described pertain to compliance monitoring. If this is the appropriate objective and not population exposure to near-road NO2 pollution then it is adequate. Factors not taken into consideration that will affect the vertical distribution of NO2 on or near road include vehicle wake effects, tail pipe exhaust placement, traffic congestion, thermal convection and stable cold air drainage flow.

Charge Question 6: *Does the AMMS believe that Section 8 has adequately discussed and explained the varied approaches on the optional use of exploratory monitoring as part of the near-road site selection process?*
The section does identify the typical approaches that can be applied for exploratory monitoring to help with the near-road site selection process. The discussion should be more critical providing pros and cons of the various approaches and an assessment regarding which fair better in characterizing the spatial distribution of NO2 concentrations and their relative utility in addressing compliance vs. exposures objectives.

Charge Question 7: *Within Section 9, does the AMMS see opportunities to improve the description of how the (optional) use of AERMOD and MOVES can be used to conduct dispersion modeling in the near-road site selection process?*
A much broader array of dispersion line source models needs to be considered.

Charge Question 8: *Within Section 10, does the AMMS believe the list of items needed to appropriately characterize individual candidate road sites is complete and adequately described? If the list is considered incomplete, please provide a list of the missing characteristics that should be included.*
The list provided is comprehensive and identifies the key elements that should be considered in characterizing individual candidate road sites for potential on-road, near road monitoring.

Charge Question 9: *From an air agency perspective, does the AMMS find that the definitions and explanation of transportation agency policies and expectations are adequate? Are there opportunities to improve upon the material presented within this section?*
The section seems reasonable, but I would defer to the opinions of my colleagues from state agencies.

<u>Charge Question 10:</u> *Does the AMMS have ideas for improvement with respect to the organization and usefulness of the suggested site comparison matrix discussed within Section 13?*
I would suggest that AQS metadata (AB site street information) consider including a congestion indicator (quantitative or qualitative index)

<u>Charge Question 11:</u> *Does the AMMS:*

a. Concur with the order of presentation of each pollutant or metric of interest in the near-road environment, as was suggested by the previous AMMS panel, within Section 14?

I do not concur with the order. Propose replacing with the following order: NO2, (& NO), BC, meteorology, CO, traffic counters/cameras, CO2, OC, O3, PM mass, PM number, SO2, air toxics and Pb.

b. Concur with the description of each pollutant or other metric discussed in Section 14, including its impact on human health (as appropriate), the reason for interest in the near-road environment, and the description or suggestions for measurement?

The rationale for the selection of pollutants to be considered for multi-pollutant monitoring is acceptable.

c. Believe that a pollutant or other metric should be removed from the list within Section 14, or that an unlisted item should be included within this section?

No – The list is acceptable.

Comments from Dr. Eric Edgerton

Charge Question 1: Does the TAD, particularly based upon the information provided in Sections 1 and 2, provide clear objectives of the document and give appropriate rationale for the objectives?
Response: Yes. However, it might be worthwhile changing the title of the document to something like "**Near-Road NO2 Monitoring Technical Assistance Document for Site Selection"**, since the vast majority of space is devoted to site selection methodology. There is little or nothing in the document concerning data management and quality control. Given the near-road environment, it would be useful to have some guidance on data aggregation and summary statistics. For example, reporting sub-hourly averages, minima, maxima and standard deviations could provide valuable information on artifacts that occur with the approved method for NO2 (i.e., difference between NOx and NO).

In addition, Sections 1 and/or 2 should lay out the main options for site selection (road segment characterization, exploratory monitoring and modeling. The document places great emphasis on road segment characterization, such that the monotiroing and modeling options almost come as a surprise to the reader. Which options satisfy ALL requirements set forth in the CFR?

Finally, it is not entirely clear (at least to me) which NO2 metric(s) and which population or sub-population is driving the site selection process.

Charge Question 2: Does the AMMS believe that the suggested approach in the TAD places an appropriate amount of weight and consideration on all six factors required to be considered (AADT, fleet mix, congestion patterns, roadway design, terrain, and meteorology) as part of the near-road NO2 site selection process?
Response: No. Relative to the others, there is way too much emphasis on AADT. Physical mixing, chemistry, roadway orientation and the overall density of traffic segments needs more discussion.

Charge Question 3: Does the AMMS see opportunities to improve the usefulness of the Fleet Equivalent AADT metric introduced and discussed within Section 5?
Response: This seems like a static calculation that doesn't take into account changes in emissions due to mandated controls and new technologies. Also, it might be useful to consider statistics beyond annual averages, such as maxima or standard deviations.

Charge Question 4: Within Section 6, does the AMMS believe we have adequately described the effects of roadway design, roadway structures, terrain, and meteorology on roadway pollutant dispersion.
Response: This is a pretty good start. In terms of meteorology, I didn't see anything about roadway orientation and predominant wind direction. One might want to site a monitor such that there is a long fetch more or less aligned with the road. In terms of grade, wouldn't EPA want to encourage upslope versus downslope?

Charge Question 5: Within Section 7, does the AMMS believe we have adequately discussed the siting requirements and provided appropriate suggestions for how to properly site monitor probes while considering the design of the target road and/or roadside structures?
Response: Yes.

Charge Question 6: Does the AMMS believe that Section 8 has adequately discussed and explained the varied approaches on the optional use of exploratory monitoring as part of the near-road site selection process?
Response: Information is needed on comparability of methods and how to deal with different averaging times (e.g., hourly continuous data versus multi-day passive sampling).

Charge Question 7: Within Section 9, does the AMMS see opportunities to improve the description of how the (optional) use of AERMOD and MOVES can be used to conduct dispersion modeling in the near-road site selection process?
Response: The decription of the models is adequate, but it might be more useful if EPA developed a user interface tool for application of these models.

Charge Question 8: Within Section 10, does the AMMS believe the list of items needed to appropriately characterize individual candidate road sites is complete and adequately described?
Response: Section 10 is titled Field Reconnaissance, but most of the items listed do not require field reconnaissance; rather they serve as background information leading up to field reconnaissance. Such information should be gathered and assimilated, then used to identify specific candidate sites for Near Road monitoring. Field reconnaissance comes into play for the purpose of ground-truthing and refining priorities of candidate site locations.

Charge Question 9: From an air agency perspective, does the AMMS find that the definitions and explanation of transportation agency policies and expectations are adequate? Are there opportunities to improve upon the material presented within this section?
Response: No Comment.

Charge Question 10: Does the AMMS have ideas for improvement with respect to the organization and usefulness of the suggested site comparison matrix discussed within Section 13?
Response: Further description of how to use the matrix in the decision-making process. More quantitative measure(s) of potential population exposure and relevant non-road sources. Why even consider upwind locations?

Charge Question 11: Does the AMMS:
a. Concur with the order of presentation of each pollutant or metric of interest in the near-road environment, as was suggested by the previous AMMS panel, within Section 14?
Response: No. I would move ozone up in the list and replace Pb with Trace Elements, to the extent they are not covered under Air Toxics. On average, ozone concentrations should be relatively low at near-road sites. Concentrations will often be zero, and when they are zero, incremental NO2 can be used to estimate primary NO2 emissions. I would delete CO2.

b. Concur with the description of each pollutant or other metric discussed in Section 14, including its impact on human health (as appropriate), the reason for interest in the near-road environment, and the description or suggestions for measurement?
Response: Yes.

c. Believe that a pollutant or other metric should be removed from the list within Section 14, or that an unlisted item should be included within this section?
Response: See a.

Comments from Mr. Dirk Felton

Charge Question 1: Does the TAD, particularly based upon the information provided in Sections 1 and 2, provide clear objectives of the document and give appropriate rationale for the objectives?

Response: The objective of finding a suitable location for a near road monitor is well covered. The TAD is missing all of the reasoning behind the network design, the scientific overview of pollutant interactions and a discussion on the limitations of the data resulting from this network. The most important issue in near road monitoring is understanding the gradient of NO_2 and other mobile source pollutants in relation to distance from the edge of the road. There should be recommendations to make inlet distance from the road and height above the road as equivalent as possible particularly for sites within the same CBSA. If these distances are not equivalent, the data will be less useful for comparisons between sites. There should also be a discussion of the importance of having a nearby non near-road population exposure monitor so that the significance of the near road concentrations can be determined.

Charge Question 2: Does the AMMS believe that the suggested approach in the TAD places an appropriate amount of weight and consideration on all six factors required to be considered (AADT, fleet mix, congestion patterns, roadway design, terrain, and meteorology) as part of the near-road NO2 site selection process?

Response: The TAD only looks at these factors because the regulation is too focused on the emissions from segments of individual roadways. The effects of multiple roadways in dense urban areas can often lead to higher NO_2 concentrations that can be observed near the edge of a single heavily trafficked road. The on-going New York Community Air Survey, which is referenced in Section 8.1.1, utilizes passive samplers to clearly show that NO_2 levels are higher in the center of Manhattan than near the edge of the roadways with higher AADT.

The regulation and the supporting TAD should be flexible enough to permit and encourage monitor siting at the locations where the NO_2 levels are expected to have the greatest impact on human health. The EPA should add a seventh factor that accounts for the cumulative effect of multiple road segments in larger urban areas. The design of the seventh factor could be a weighted sum of the expected emissions impact from road segments and stationary sources within a kilometer or so of the candidate site.

Charge Question 3: *Does the AMMS see opportunities to improve the usefulness of the Fleet Equivalent AADT metric introduced and discussed within Section 5?*

Response: The FE metric is an acceptable approach for initially ranking road segments based on combined LD and HD traffic counts. The accuracy, however, of a national default value must be determined. Different regions have older or newer LD and HD fleets, more or less extensive clean diesel campaigns, road segments with low or steep grades and different degrees of congestion on road segments. All of these factors will affect the FE value for a particular CBSA. Some States and other research programs have performed remote sensing campaigns on multiple road segments within a CBSA. The data from these segments can be compared to the expected emissions based on known LD and HD traffic counts during the monitoring campaign in order to provide an estimate of the accuracy of the HD multiplier.

The EPA should review existing research study results and consolidate the HD multiplier values determined by roadside monitoring from as many different CBSAs as possible. Having this information available will provide monitoring agencies with a reasonable estimate of FE accuracy. Monitoring agencies can use the FE accuracy to determine how precisely they should follow the rankings produced by the FE metric. This will allow for the importance of FE ranking to be matched to other available factors affecting site selection.

The FE metric is going to be more useful in the larger CBSAs where the LD and HD traffic are often segregated to some extent based on tolls, weight restrictions or outright prohibitions for HD vehicles such as on New York City's Parkways. In smaller CBSAs where there are fewer transportation routes, it is likely that the FE will not significantly impact NO_2 near-road site selection.

Charge Question 4: Within Section 6, does the AMMS believe we have adequately described the effects of roadway design, roadway structures, terrain, and meteorology on roadway pollutant dispersion and suggested how those effects can be considered in the near-road site selection process?

Response: In the terrain and meteorology sections, the proximity to water bodies is not covered adequately. Urban areas and major roads are often built alongside the rivers and seashores that initially encouraged development in these areas. Monitoring in these river valleys and along the shores of large water bodies will tend to reduce the concentrations of locally emitted pollutants in comparison to sites away from the influence of these water bodies.

Charge Question 5: Within Section 7, does the AMMS believe we have adequately discussed the siting requirements and provided appropriate suggestions for how to properly site monitor probes while considering the design of the target road and/or roadside structures?

Response: The siting requirements are in fact quite minimal. Unusual sites such as locations within tunnels could meet these siting requirements but would provide little relevant information for populations living near roadways. This section should encourage the selection of sites that have an open fetch between the road and the monitor inlet as well as between the inlet and nearby residents. If there is a barrier between the affected population and the monitor inlet, the site's only purpose would be emission characterization and the resulting data would have little value for population exposure.

The allowance for wall mounted inlets is puzzling. The wall, even at 1 meter spacing will still represent a barrier to air movement and will trap pollutants between the inlet and the roadway. The use of a site with this type of inlet will also preclude the use of this site for other pollutants such as PM $\geq$ 2.5 which require vertical inlets. These wall mounted inlets should only be permitted in areas where no other sites are possible and where only limited supplemental measurements are anticipated.

Charge Question 6: Does the AMMS believe that Section 8 has adequately discussed and explained the varied approaches on the optional use of exploratory monitoring as part of the near-road site selection process?

Response: The TAD omits how the information from exploratory monitoring should be weighted in relation to the other factors. Existing data from passive samplers such as from the New York Community Air Survey, which is referenced in Section 8.1.1, indicate that the highest 1-hr NO_2 levels in New York City are likely to be found in mid-town away from the highways with the highest AADT. The design of the NO_2 near road network should be flexible enough to accommodate the combined NO_2 contributions of multiple road segments within dense urban communities. The use of a seventh site factor as outlined in my response to charge question 2 could help to incorporate the data from exploratory monitors in the site selection process.

Charge Question 8: Within Section 10, does the AMMS believe the list of items needed to appropriately characterize individual candidate road sites is complete and adequately described? If the list is considered incomplete, please provide a list of the missing characteristics that should be included.

Response: The section barely touches on surrounding land use. This category should be expanded to include population exposure, stationary sources as well as how wide an area a specific site represents. Sites that can be said to represent a significant length of a roadway, similar nearby roadways and larger neighborhoods should be considered to be more valuable than a monitor that only represents a single road segment.

Charge Question 9: From an air agency perspective, does the AMMS find that the definitions and explanation of transportation agency policies and expectations are adequate? Are there opportunities to improve upon the material presented within this section?

Response: The legal requirement to install a near road monitoring site should be explicitly included in the TAD. Does this requirement extend to the DOT if a location within their right of way is the most suitable location for a near road monitor? This is information that will be needed by the monitoring agencies as well as by the EPA Regional offices.

Monitoring agencies should consider installing traffic cameras at each near-road site or asking the local DOTs to include these sites in their system. Having this information readily available will assist with the validation of outlier 1-Hr NO_2 data after these sites begin collecting data. In dense urban areas, accidents, vehicle fires, road maintenance, snow removal activities and mowing can all have significant short-term impacts on NO_2 concentrations.

Charge Question 10: Does the AMMS have ideas for improvement with respect to the organization and usefulness of the suggested site comparison matrix discussed within Section 13?

Response: The site selection matrix is an idealized version of the way sites are likely to be selected by today's under staffed, over worked and underfunded monitoring agencies. Candidate sites that run into a road block such as an access, lease cost or a safety issue will be dropped from consideration and it would be a waste of time to continue to research the site/segment parameters necessary to complete the matrix.

The site comparison matrix would be more relevant if it was expanded to include a seventh factor that incorporates the impacts from additional road segments as suggested in my response to charge question 2.

It is preferable to collect the site segment information necessary to complete the matrix only for an Agency's most promising 2-4 locations within each CBSA. The effort to collect this information is only warranted if the sites are feasible and are likely to be approved by the local DOT and EPA. The advantage to having several fully evaluated candidate sites in each CBSA is that the sites that are not ultimately selected are essentially pre-approved as back up monitor locations. Urban monitoring locations are often impacted by road and bridge construction, building construction and other urban planning initiatives. Many of the installed near road sites will have to be relocated within the next 5-10 years and it would be sensible to maintain a short list of acceptable replacement sites.

Charge Question 11: Does the AMMS:
a. Concur with the order of presentation of each pollutant or metric of interest in the near-road environment, as was suggested by the previous AMMS panel, within Section 14?

Response: Air Toxics should be moved up in order of relevance. These compounds are likely to be much more valuable to the monitoring and health communities.

b. Concur with the description of each pollutant or other metric discussed in Section 14, including its impact on human health (as appropriate), the reason for interest in the near-road environment, and the description or suggestions for measurement?

Response: The discussion of PM number concentration should include a discussion of size distribution, inlet configuration and inlet uniformity from site to site.

The PM section should clearly indicate that the short comings of both the $PM_{2.5}$ FRM and the $PM_{2.5}$ FEMs will be more pronounced in the near road environment.

The OC section should include a caveat that discusses the limitation of the CSN carbon sampler. This sampler is optimized for use in rural areas as part of the visibility program. It is not as useful for capturing the higher proportion of semi-volatile OC expected to be prevalent in the near-road environment.

c. Believe that a pollutant or other metric should be removed from the list within Section 14, or that an unlisted item should be included within this section?

Response: $PM_{2.5}$ should be removed from the list until a method is approved that is better able to handle semi-volatile PM. SO_2 should be removed from the list because the fuel reformulations have already occurred and the concentrations in the near road environment are expected to be low. CO_2 should be removed from the list because only a few monitors are necessary nationwide for objectives related to characterizing green house gas emissions.

Comments from Dr. Phil Fine

Charge Question 2: Does the AMMS believe that the suggested approach in the TAD places an appropriate amount of weight and consideration on all six factors (AADT, fleet mix, congestion patterns, roadway design, terrain, and meteorology) required to be considered as part of the near-road NO2 site selection process?

Response: In general, yes. In practice, AADT and fleet mix should be the driving factors for choosing candidate sites (i.e. total NOX emissions), and then logistics will be the driving factor in making final selections.

Charge Question 3: Does the AMMS see opportunities to improve the usefulness of the Fleet Equivalent AADT metric introduced and discussed within Section 5?

Response: The factor of 10 is a reasonable default, but many areas should have mobile source NOx inventories that should provide a more accurate factor.

Charge Question 9: From an air agency perspective, does the AMMS find that the definitions and explanation of transportation agency policies and expectations are adequate? Are there opportunities to improve upon the material presented within this section?

Response: The discussion in this area is understandably brief, since requirements in different states will be different. While this section may help states get the approval process started, it may not help when state-specific requirements and restrictions are encountered. What would help is a national and regional EPA outreach effort to FHWA and state DOTs to highlight the importance of the program and prepare them for the access requests. Another option that should be mentioned is private or publicly owned land within 50 meters that is not DOT controlled. Permissions and approvals may be much easier in these locations.

Charge Question 10: Does the AMMS have ideas for improvement with respect to the organization and usefulness of the suggested site comparison matrix discussed within Section 13?

Response: I believe this question refers to section 12.3. I suggest inclusion or the availability of a sample matrix rather than just a description of the parameters to put in the matrix.

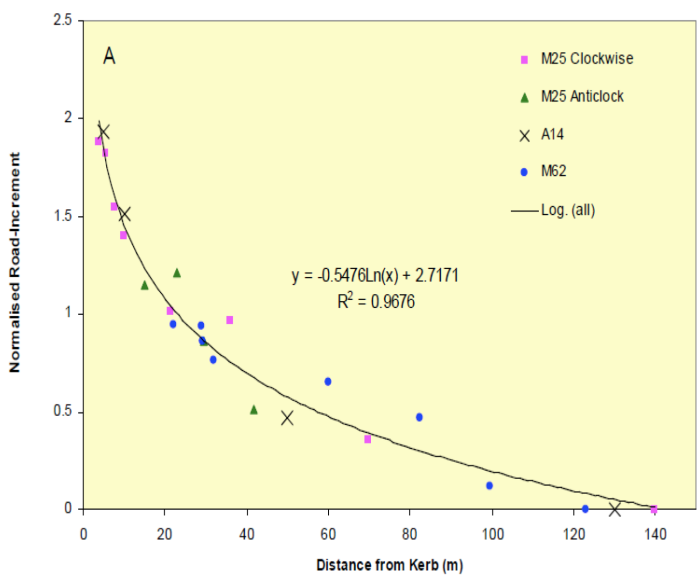
Comments from Dr. Rudolf Husar

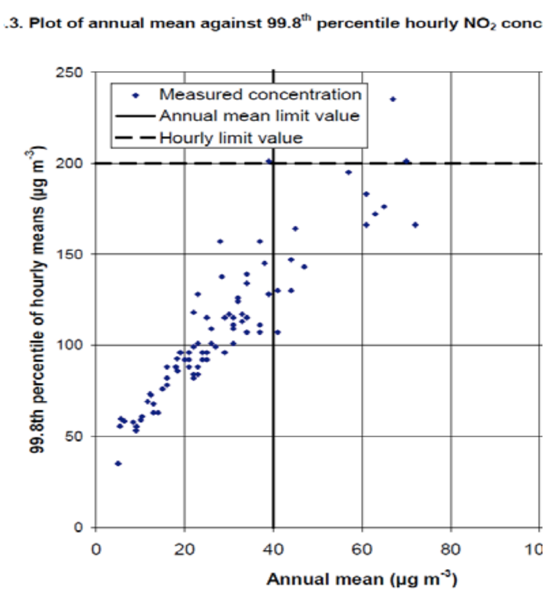
Charge Question 1: Does the TAD, particularly based upon the information provided in Sections 1 and 2, provide clear objectives of the document and give appropriate rationale for the objectives?
Response: The TAD contains a set of well-structured technical instructions and guidelines for the location selection of the roadway monitoring sites. However, the TAD does not offer a well-defined criteria for the 'optimal' site, nor for the optimization in general.
Buried in a paragraph on page 4-6**: the objective of the monitoring effort is to characterize the peak NO2 concentrations that are occurring in the area**.. Is finding and 'characterizing' the peak hourly near-road NO2 the siting optimization criteria?

Charge Question 2: Does the AMMS believe that the suggested approach in the TAD places an appropriate amount of weight and consideration on all six factors required to be considered (AADT, fleet mix, congestion patterns, roadway design, terrain, and meteorology) as part of the near-road NO2 site selection process?
Response: Why is the distance to the source not a major factor? It is an exponential factor. The recommended 20-50 m distance and 2-7m in elevation covers a wide range of constrictions near the road and introduces considerable ambiguity in attaching meaning to the measurement

Charge Question 3: Does the AMMS see opportunities to improve the usefulness of the Fleet Equivalent AADT metric introduced and discussed within Section 5?
Response: He formula makes sense. The data for the fleet mix is the problem. The diurnal, weekly, seasonal cycles of the mix, particularly for the HD vehicles is hard to get. So, little info is available for the source of the NO2 near the road.

Charge Question 4: Within Section 6, does the AMMS believe we have adequately described the effects of roadway design, roadway structures, terrain, and meteorology on roadway pollutant dispersion and suggested how those effects can be considered in the near-road site selection process?
Response: It is made way too complicated in TAD. As if there were no regularities but randomness everywhere. Here are two charts from R Poirot's comments in the Nov 2010 review:





Left Chart: The concentration of roadway emissions (normalized to 20m distance) declines exponentially. The closer you get to the source, the higher the concentration. Is this law of dispersion different in the US?
Right Chart: The annual average and the 98% hourly data correlate well. The slope may vary some, but it provides a useful guide.

Charge Question 5: Within Section 7, does the AMMS believe we have adequately discussed the siting requirements and provided appropriate suggestions for how to properly site monitor probes while considering the design of the target road and/or roadside structures?
Response: As seen on the above chart (Left), between 20 and 50 m distance from the 'kerb', the concentration declines by a factor of two. At 2 meters from the kerb (truck) the NO2 concentration is higher by a factor of two. In other words, a person in the car on the same lane as the trucks is exposed to a concentration four times that of the sampler at 50m. So which is the relevant concentration, at the location of the drivers or the arbitrary location of the sampler?
Also, how would one establish an exceedance? Normalize all the data to the 20m distance? Can such a procedure withstand legal scrutiny?

Charge Question 6: Does the AMMS believe that Section 8 has adequately discussed and explained the varied approaches on the optional use of exploratory monitoring as part of the near-road site selection process?
Response: The section discusses several exploratory monitoring options: saturation study; focused monitoring campaign and mobile monitoring. A 'Saturation study" or a more sophisticated "Multi-scale" monitoring study would be helpful if dispersion from roadway emissions roadway emissions was a new topic. I would recommend reading and analyzing the existing studies.
Focused monitoring program may be helpful to verify physical and/or empirical dispersion models (e.g. the above chart). Mobile monitoring over a specific candidate road segment would be terrific if combined with model(s) and the planned monitoring site. Driving up-end down the road segment could establish the relationship between the ambient concentration over the roadway and the chosen monitoring site.

Charge Question 7: Within Section 9, does the AMMS see opportunities to improve the description of how the (optional) use of AERMOD and MOVES can be used to conduct dispersion modeling in the near-road site selection process?
Response: Models should be companions to the monitoring and complement the observations. Clearly, chemical kinetics is superfluous; even the aerosol size distribution is frozen right after the tailpipe (coagulation is a second order process). EPA should recommend a specific simple modeling procedure similar to this TAD.

Charge Question 8: Within Section 10, does the AMMS believe the list of items needed to appropriately characterize individual candidate road sites is complete and adequately described? If the list is considered incomplete, please provide a list of the missing characteristics that should be included.
Response: The Agency is to be commended for recommending the use of new digital recourses for evaluating and characterizing candidate monitoring sites. One-foot resolution satellite images along with mapping tools like Google Earth provide a simple and relevant view of the roadways, 3D terrain, surrounding environment, etc. At the resolution of these maps, distance measurements can also be performed. Furthermore, virtually all US urban areas are now documented with thousands of geo-referenced photographs that are shared through Paronamio, Flickr and other photo-sharing websites that can be displayed on maps. The combination of these resources can resolve many of the questions related

to:
Road Segment Identification
Road Segment Type
Road Segment End Points
Interchanges
Roadway Design
Terrain
Roadside Structures

With these electronic resources, the burden placed on the air managers and the DOT offices can be considerably reduced.

Comments from Dr. Daniel Jacob

Charge Question 1: Does the TAD, particularly based upon the information provided in Sections 1 and 2, provide clear objectives of the document and give appropriate rationale for the objectives?

Response: Yes.

Charge Question 2: Does the AMMS believe that the suggested approach in the TAD places an appropriate amount of weight and consideration on all six factors required to be considered (AADT, fleet mix, congestion patterns, roadway design, terrain, and meteorology) as part of the near-road NO2 site selection process?

Response: I'm surprised that little weight is given to background NO2. This background could be of great importance considering that the 1-h NAAQS is 100 ppb but urban NO2 concentrations upwind of the roadway can easily be tens of ppb. The TAD recognizes the importance of background NO2 as provided by point sources upwind, but this may be less relevant than the network of other roadways in the urban area. An isolated roadway with high AADT may have lower roadside NO2 than a downtown roadway with lower AADT.

I don't understand why below-grade highways would cause less near-road NO2 than at-grade highways. Under stable conditions, elevated NO2 could pool in the depressed roadway bed and eventually spill in the surrounding area, causing higher concentrations than an at-grade highway would.

Meteorology is not important for transport alone. NO-NO2 chemistry is coupled to meteorology through availability of ozone, solar radiation, and NO to NO2 conversion time (translating into distance from roadway), it seems to me that some work is needed using a plume dispersion model with NO-NO2 chemistry (such as AERMOD) to identify the worst meteorological conditions for NO2 and provide general guidance to local agencies on this matter. The worst meteorological conditions for an inert pollutant may not be necessarily be the worst for NO2.

Charge Question 3: Does the AMMS see opportunities to improve the usefulness of the Fleet Equivalent AADT metric introduced and discussed within Section 5?

Response: Looks good to me, I'm no expert.

Charge Question 4: Within Section 6, does the AMMS believe we have adequately described the effects of roadway design, roadway structures, terrain, and meteorology on roadway pollutant dispersion and suggested how those effects can be considered in the near-road site selection process?

Response: I think this could be improved. See my response to Charge Question 2.

Charge Question 5: Within Section 7, does the AMMS believe we have adequately discussed the siting requirements and provided appropriate suggestions for how to properly site monitor probes while considering the design of the target road and/or roadside structures?

Response: I think that plume dispersion modeling including NO-NO2 chemistry would be very beneficial in identifying the expected location of peak NO2 concentrations for different meteorological conditions. This could also be done using NO2 measurement transects near roadways for a range of meteorological scenarios (morning and evening rush hours, different seasons, different wind speeds, etc.). The general recommendation of the TAD is to place the site as close to the roadway as possible and as low-altitude as possible (2 m), but this may not be where NO2 concentrations are highest because of the time lag for NO conversion to NO2.

Charge Question 6: Does the AMMS believe that Section 8 has adequately discussed and explained the varied approaches on the optional use of exploratory monitoring as part of the near-road site selection process?

Response: I think that it's important to emphasize the need for exploratory monitoring over a range of meteorological conditions expected to cause high NO2 (see response to Charge Question 5). PSDs seem useless for this purpose because of the multi-day integration time (as opposed to the 1-h metric of the NAAQS) and this could be better recognized. It seems to me that the best approach is with a mobile unit doing transects parallel to and normal to the highway under traffic and meteorological conditions where maximum NO2 is expected. If it is difficult to make NO2 measurements from a mobile unit with high temporal resolution, the aerosol number concentration could be used as a tracer instead (although that would not factor in the time lag for NO-to-NO2 conversion, see response to Charge Question 5).

Charge Question 7: Within Section 9, does the AMMS see opportunities to improve the description of how the (optional) use of AERMOD and MOVES can be used to conduct dispersion modeling in the near-road site selection process?

Response: Tier 3 AERMOD modeling including NO-NO2 chemistry seems essential. Treating NO2 as inert or assuming a fixed NO2/NOx ratio is inadequate – that ratio is expected to greatly vary downwind of highways. The contribution of nearby highway sources to the upwind background should also be recognized.

Charge Question 8: Within Section 10, does the AMMS believe the list of items needed to appropriately characterize individual candidate road sites is complete and adequately described? If the list is considered incomplete, please provide a list of the missing characteristics that should be included.

Response: I have no expertise on this.

Charge Question 9: From an air agency perspective, does the AMMS find that the definitions and explanation of transportation agency policies and expectations are adequate? Are there opportunities to improve upon the material presented within this section?
Response: I have no expertise on this.

Charge Question 10: Does the AMMS have ideas for improvement with respect to the organization and usefulness of the suggested site comparison matrix discussed within Section 13?

Response: There may be the need to better consider the role of nearby roads in contributing to the NO_2 background. This could be very important. See my response to Charge Question 2.

Charge Question 11: Does the AMMS:
a. Concur with the order of presentation of each pollutant or metric of interest in the near-road environment, as was suggested by the previous AMMS panel, within Section 14?

Response: I suggest giving a higher priority to ozone because of its value of interpreting NO_2 in terms of the effect of NO-NO_2 titration (higher ozone leading to higher NO_2). I would also suggest including NO if possible, for the same reason and with even more importance ($NO_x = NO+NO_2$ could be viewed as a conserved tracer on the time scales of interest).

b. Concur with the description of each pollutant or other metric discussed in Section 14, including its impact on human health (as appropriate), the reason for interest in the near-road environment, and the description or suggestions for measurement?

Response: I think that the (marginal) interest of SO_2 is that it can provide a signature on point source background influences on the site. This could be stated.

c. Believe that a pollutant or other metric should be removed from the list within Section 14, or that an unlisted item should be included within this section?

Response: I would remove Pb (this is not a roadway pollutant anymore). I would add NO (see response to a).

Comments from Dr. Peter H. McMurry

General Comments/Overview:

Overall, I found the document to be well written. I feel that it provides very clear guidance to state, local and tribal agencies for factors that need to be considered as they proceed towards implementation of near-road NO2 monitoring stations before January 1, 2013.

The goal is to measure exposure hot-spots in the vicinity of roadways. This will be accomplished by sampling NO2 at fixed locations. In addition to measuring NO2, agencies are encouraged to consider a multi-pollutant sampling strategy that would include other species that are emitted by vehicles.

I have two observations that might bear consideration:

•The document does not address exposures of vehicle passengers. While those exposures would likely be for short periods, the short-term exposures could be significantly higher than for residence living downwind of roadways. For example, concentrations of NO2 within tunnels or above below-grade highways might be considerably greater than concentrations 20 to 50 m downwind of highways. It might be a good idea to state explicitly that the document does not apply to exposures of vehicle passengers.

•The document provides guidance on factors that should be avoided when selecting sampling sites (e.g., try not to sample on a side of the roadway that is predominantly upwind; do not sample downwind of elevated roadways on pilings, etc.) I think, however, agencies would also benefit from a clear statement of measurement objectives. For example, is the objective to locate the sampler at a site that would measure the maximum concentrations to which residents might be exposed, or is it to find a site that meets the guidelines specified in the TAD yet leads to the minimum value of the measured concentration (i.e. the fewest exceedences)?

For example, on p. 6-8 the document states "Another example might be considering roads through valleys, where, due to the increased potential for inversion conditions within the valley, higher near-road NO2 concentrations may be found than what is found along alignments on the tops of hills, along hillsides, or in open terrain." Would it be good or bad to locate a sampling site in such a location?

Specific Comments:

<u>Section 6. Physical considerations for candidate near-road monitoring sites.</u>

Figures 6-1 and 6-2 illustrate the impact of roadway design on downwind concentration profiles. These observations show clearly that measured concentrations are strongly dependent on downwind distance within about the first 100 m from the road's edge. The guidelines are for sampling sites to be located a distance of preferably within 20 m and not more than 50 m from the road's edge.

Published data for pollutants that might reasonably be assumed to be conserved near the roadway (e.g., CO) show that, concentrations might be expected to decrease by roughly a factor of two as the sampling location moves from 20 to 50 m (see, e.g., Figure 2 in Zhang et al. (2005). Given the tolerances specified in NAAQSs, a factor of two is significant. Agencies should be given some guidance: should they preferentially site sampling locations 50 m from the road to avoid exceedences, or should they put them 20 m or less from the road (if possible) to ensure that maximum concentrations are obtained within the constraints provided by this TAD?

I do not feel that Figure 6-2 is consistent with actual measurements of "20 nm particles" downwind of roadways, and I recommend that it be replaced or deleted. First, in the atmosphere one would not carry out studies with monodisperse (e.g., 20 nm) particles. Instead, one would measure distribution functions and report concentrations of particles in a specified size interval (e.g., 15 to 25 nm). Also, the results shown in this figure are not representative of particle decay rates downwind of roadways for particles in the 20 nm size range. For example, Zhu et al. (2002) show that concentrations of 6 to 25 nm particles decay much more rapidly with distance than concentrations of particles in other size ranges (25 to 50 nm; 50 to 100 nm; 100 to 220 nm). This observation has been extensively discussed (Zhang et al. 2004; Jacobson et al. 2005; Zhu et al. 2009). It is the consensus of these researchers that concentrations of the smallest particles decrease more rapidly than concentrations of conserved pollutants due to (i) evaporation, and (ii) enhanced multimodal coagulation rates of the small particles as their size decreases by evaporation. Figure 6-2 does not discuss what is known about the behavior of 20 nm particles downwind of roadways, and might imply that they can reasonable be regarded as conserved. This would be inappropriate for this document.

In particular, I have no idea what is meant by the "concentration of 20 nm particles." To obtain meaningful results for concentration from DMA-CPC data, it is necessary to integrate between two sizes. The upper and lower size limit should have been specified. It is possible that for these measurements the DMA was set to classify 20 nm and then 75 nm particles, and that size distributions were not measured. In this case, the data cannot be interpreted unless the DMA flowrates are also mentioned (i.e., two different DMAs operated at different flowrates but both set to select 20 nm particles would report different results for 20 nm concentrations.) I feel that when authors report data, the data should be described in sufficient detail to allow for unambiguous interpretation. It would have been easy for the authors to do this. Secondly, while I have no doubt that this plot reflects something that was measured during this study, it is not necessarily representative of what has been observed for sub 25 nm particles downwind of freeways, and therefore I think it should probably be discussed in the context of those previous studies. The document provides no clue that sub 25 nm particles downwind of freeways are not conserved.

Also for Figures 6-1 and 6-2, information on wind direction relative to the roadway should be mentioned.

References are not given. I assume Baldauf et al. (2009) is an EPA report. Baldauf and coworkers have also written some peer reviewed journal articles (Hagler et al. 2009). I would encourage you to also refer to the papers by Zhu and coworkers. Their size-resolved measurements provide a better understanding of size-dependent concentration profiles downwind of freeways.

<u>Section 7. Siting Criteria</u>

My principle concern with this section is summarized above. The agencies need to be provide clear guidance: what is the measurement goal? The TAD leaves quite a bit of room for interpretation, and the resulting outcome may vary significantly given the strong dependence of concentrations on the sampling site chosen.

Details:

Section 8.2 requires careful editing.

<u>References Cited:</u>

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Comments from Dr. Allen Robinson

General comment

This is a very complex problem. Near road way pollutant concentrations vary strongly in space and time based on a large number of factors, many of which are discussed in the TAD. NO2 concentrations will also depend on photochemistry (in addition to pollutant dispersion). In light of these facts, trying to select one or two sites that are representative of near road exposures to NO2 in a CBDA is a very daunting task. Given the sensitivity of NO2 with location presumably whether or not a CBDA will be in or out of attainment will depend very strongly on specific site locations. For example, I could envision a CBDA with (in reality) worse NO2 problems than some other CBDA but being ranked as being better (even in attainment) based on where the one or two monitors are sited in the different CBDA. Therefore, site selection is going to be critical. This document is a good start at describing the site selection process but I think that given the very limited number of sites (one or two) per CBDA I think that alot more thought and specificity needs to go into the site selection criteria in order to make fair and consistent attainment designations among different areas. Right now the TAD leaves alot of room for states to interpret the siting requirements.

In the end, I am skeptical that one can deploy only one or two sites in a very large area to robustly characterize near road way exposures that inherently have very strong spatial variations. A better approach would be to implement more sites (likely impossible given fiscal climate). One may also be able to use models (e.g. to calculate some standard spatial distributions around model road ways) which are then used to interpret data from different sites in a more consistent way. If done correctly, this could potential allow for more consistent attainment designations. However, the modeling is not straightforward so some real thought would be needed.

A few more comprehensive case studies are needed that describes how EPA would weight all the factors to ultimately arrive at a site. The TAD has a partial case study for Tampa Bay, which uses the AADT and fleet composition data. However, what is shown (AADT) is the easy part because those are quantitative data that can be easily combined to create overall ranking. I fear that this will lead to states just basing site selections on AADT analysis and not really considering other factors (which may be as important). It would be good to continue that case study and show how to consider all of the relevant factors discussed in the TAD to ultimately come up with a recommended site or two in Tampa Bay. Doing complete case studies for several locations would likely be very helpful. Especially if the case studies were selected to illustrate important issues that would be commonly encountered.

Charge Question 1: Does the TAD, particularly based upon the information provided in Sections 1 and 2, provide clear objectives of the document and give appropriate rationale for the objectives?
Response: The objective of the TAD is clearly stated. It is to provide guidance for site selection by which agencies might implement near-road NO2 monitoring stations. However, the document does not provide much rationale for behind this objective specifically the scientific motivations and potential limitations of site selection. What is goal of NO2 measurement? What is it supposed to represent for NAAQS determination. For example, the TAD discussing many factors that are states should consider to select a site but it does not state what the ultimate objective of what is guiding the site selection. Is the site supposed to have the highest NO2 concentrations, is it supposed to be representative of some population weighted exposure of near road population exposure to NO2, etc.?

Charge Question 2: Does the AMMS believe that the suggested approach in the TAD places an appropriate amount of weight and consideration on all six factors required to be considered (AADT, *fleet mix, congestion patterns, roadway design, terrain, and meteorology) as part of the near-road NO2 site selection process?*

Response: No. The TAD does a reasonable job of discussing many factors that need to be considered but it is not clear how to weight them because the TAD does ultimately specify what the overall scientific and other objective is for site selection (highest NO2, etc. see response to question 1). If this overall objective for site selection was clearly stated then it would provide states importance on how to weight these different factors. I think this important because while some factors (AADT and fleet mix) can easily combined to create rationale ranking other important factors (e.g. terrain, metereology, safety, etc) cannot be so easily combined into a numerical rank. Therefore, states will need to do the ultimate weighing themselves so it is important they know the ultimate objectives driving site selection.

One factor in particular that I don't think is emphasized enough in the TAD is the distance from road way. The data in the TAD (and other data in literature) show that there is a very steep gradients in pollutant concentrations near road way. Therefore the exact distance a site located from the roadway will likely have a significant effect on measured NO2 concentrations and ultimately attainment designations. This gradient depends on site specific factors so it is impossible to a priori know where peak concentrations would be (and even for a given physical location it will change with metereology). Therefore it seems like scoping studies are important. However,

One note on Figure 6-1, it was not clear if this was for an inert pollutant, e.g. CO, or for NO2. NO2 concentrations will depend on photochemistry so that needs to be accounted for the results to provide guidance for site selection (dispersion of inert pollutant is not the same). Similarly Figure 6-2 shows results for 20 nm particles. 20 nm particles is a very dynamic pollutant whose concentrations are rapidly changing due to the coupling of dilution and microphysics (evaporation) as one moves away from road. The physics that controlling 20 nm particle is different than NO2 so it is not clear that 20 nm provides guidance for NO2 selecting NO2 sites.

Charge Question 3: Does the AMMS see opportunities to improve the usefulness of the Fleet Equivalent AADT metric introduced and discussed within Section 5?

Response: Fleet equivalent measure seems like a rational, first step to try to incorporate the differences in emission factors between LDV and HDV. One factor that might be considered would be that the emissions of diesel fleet are going to change dramatically over the next decade or two as aftertreatment technologies are implemented. For just DPF equipped vehicles NO2 emissions can increase significantly. For DPF and SCR equipped vehicles they should go down. The effectiveness of these technologies will then change as vehicles age (this aging is not well understood given our limited experience). It seems like these issues need to be considered because it will influence the truck to car ratio of NOx emissions and this ratio will change with time (presumably decreasing over time).

Another issue that the FE AADT should more formally account is the effect of congestion. This can have large effect on NOs emission, but is currently not part of FE AADT. One approach might be to make the HDm value a function of the congestion ratings.

Charge Question 4: Within Section 6, does the AMMS believe we have adequately described the effects of roadway design, roadway structures, terrain, and meteorology on roadway pollutant dispersion and suggested how those effects can be considered in the near-road site selection process?

Response: This section provides a reasonable, largely qualitative discussion the effects of these parameters on near-roadway pollutant dispersion. However, it does not really address the question of how these factors should be considered in selecting sites. For example, it states that valleys coupled with inversions could lead to high levels. Is that a good thing or a bad thing in terms of site selection? Table 6 provides guidance on how to weight some of these issues but is not comprehensive. More effort needs to be made to make Table 6 more comprehensive. Essentially, the document describes the effect of some structure but does then provides little guidance to the states of how to weight that information. Ultimately, I believe this shortcoming is tied to the document not clearly stating the scientific criteria that is driving site selection.

Charge Question 5: Within Section 7, does the AMMS believe we have adequately discussed the siting requirements and provided appropriate suggestions for how to properly site monitor probes while considering the design of the target road and/or roadside structures?
Response: Is 1 m offset adequate for probes installed on walls, etc? I am skeptical.

As in other statements, distance from roadway seems like a key parameter that needs to be better constrained.

Charge Question 6: Does the AMMS believe that Section 8 has adequately discussed and explained the varied approaches on the optional use of exploratory monitoring as part of the near-road site selection process?
Response: Given the sensitivity of NO_2 concentrations to distance from roadway and a myriad of other factors, I think that exploratory studies of a short list of sites would be very important. It would be very useful for EPA to provide more guidance of how this data would be used. For example, can the EPA provide a couple of case studies based on actual data collected at a couple of sites (analogous to the Tampa Bay AADT example) that illustrate how states would interpret and use pilot data to select a site.

One approach that is described in the TAD is saturation sampling with passive monitors. While these are relatively cheap to deploy in a distributed network they measure long term average concentrations. However, the regulation is for 1 hr peak NO_2. The documentation mentions this issue but it seems to me it is a major problem. It is not clear that the long-term data will provide much guidance for site selection and therefore I question the overall utility of the approach in terms of aiding the selection to identify 1 hr peak NO_2.

It is not clear over what spatial area the exploratory studies should be performed. Just within the first 50 m of roadway. What about over a longer spatial scale which may incorporate more people. Upwind and downwind? Many near road way studies have been performed. EPA should describe one or two of those in the TAD as an example for good practices for study design.

Charge Question 7: Within Section 9, does the AMMS see opportunities to improve the description of how the (optional) use of AERMOD and MOVES can be used to conduct dispersion modeling in the near-road site selection process?
Response: Given the complexity of near road way pollutant dispersion, it seems like coupled modeling and exploratory studies will be important to select robust sites. One issue that was not discussed in modeling was potential effects of "background NO_2." The document has a very strong road segment focus however these road segments are generally part of a complex urban environment with many sources. These other sources (other nearby roads, industrial sources, etc.) could strongly influence the

NO2 levels around a particular road segment. There needs to be more guidance on how to use the models to incorporate this complexity into the analysis.

Charge Question 8: Within Section 10, does the AMMS believe the list of items needed to appropriately characterize individual candidate road sites is complete and adequately described? If the list is considered incomplete, please provide a list of the missing characteristics that should be included.
Response: The list is pretty comprehensive (and repetitive with earlier sections). A table or checklist of items might be useful in organizing material.

A few factors not on list.

The document has a strong road segment focus. The potential for other NOx sources (and background NO2 in general) should be considered.

What about using existing sites?

Surrounding land use seems to be a key issue that is not discussed in this section. In particular population seems like a critical parameter to consider. Also sites with large populations that are influenced by "multiple" road segments may be more valuable.

Road way grade seems like an important issue.

Charge Question 9: From an air agency perspective, does the AMMS find that the definitions and explanation of transportation agency policies and expectations are adequate? Are there opportunities to improve upon the material presented within this section?
Response: I am not an expert in this area, but it seemed reasonable. This section should provide air agency enough information to effectively interact with DOT.

Charge Question 10: Does the AMMS have ideas for improvement with respect to the organization and usefulness of the suggested site comparison matrix discussed within Section 13?
Response: No response.

Charge Question 11: Does the AMMS:
a. Concur with the order of presentation of each pollutant or metric of interest in the near-road environment, as was suggested by the previous AMMS panel, within Section 14?
Response: O3 should be higher given role in NO to NO2 conversion. Maybe one could combine NOx data with O3 to make simple estimate of NO2 levels using a model?

PM number – I would move down. Given the regulatory focus on PM mass it seems that mass and major mass constituents from motor vehicles (OC, EC, road dust) should be higher on list. Number is interesting, but number size distributions would be much more useful given the transformations that occur near road way

Air toxics should be moved up list. Right after PM mas and major mass components.

My list
NO_2
Meteorology
EC
CO
O_3
PM mass
OC
Air toxics
Pb
PM number distributions

SO_2 seems like least important (remove?) on list.

b. Concur with the description of each pollutant or other metric discussed in Section 14, including its impact on human health (as appropriate), the reason for interest in the near-road environment, and the description or suggestions for measurement?

c. Believe that a pollutant or other metric should be removed from the list within Section 14, or that an unlisted item should be included within this section?
Response: I would remove SO_2.
It seems like NO would be important given the relationship with NO_2.

Comments from Dr. Jamie Schauer

Charge Question 1: Does the TAD, particularly based upon the information provided in Sections 1 and 2, provide clear objectives of the document and give appropriate rationale for the objectives?
Response: Section 1 seems like a good place to briefly note the health studies that have shown health risk of residing and traveling near roadways. This provides a strong motivation to approach near-road exposures from a multi-pollutant perspective.

Charge Question 2: Does the AMMS believe that the suggested approach in the TAD places an appropriate amount of weight and consideration on all six factors (AADT, fleet mix, congestion patterns, roadway design, terrain, and meteorology) required to be considered as part of the near-road NO2 site selection process?
Response: The weight of factors seems appropriate in the context of TAD

Charge Question 3: Does the AMMS see opportunities to improve the usefulness of the Fleet Equivalent AADT metric introduced and discussed within Section 5?
Response: I would recommend providing more information on calculating the HD_m. The current write up seems to suggest that the national default value is good enough and does not really provide incentive or motivation to have a more site specific value. I would recommend site specific values where possible.

Charge Question 4: Within Section 6, does the AMMS believe we have adequately described the effects of roadway design, roadway structures, terrain, and meteorology on roadway pollutant dispersion and suggested how those effects can be considered in the near-road site selection process?

Response: Given the target audience, I think this section is appropriate in terms of the scope and level of detail.

Charge Question 5: Within Section 7, does the AMMS believe we have adequately discussed the siting requirements and provided appropriate suggestions for how to properly site monitor probes while considering the design of the target road and/or roadside structures?
Response: Given the target audience, I think this section is appropriate in terms of the scope and level of detail.

Charge Question 6: Does the AMMS believe that Section 8 has adequately discussed and explained the varied approaches on the optional use of exploratory monitoring as part of the near-road site selection process?
Response: This section may be more useful if a summary of the pros and cons of the different exploratory monitoring approaches were explicitly stated and summaries.

<u>Charge Question 7</u>: Within Section 9, does the AMMS see opportunities to improve the description of how the (optional) use of AERMOD and MOVES can be used to conduct dispersion modeling in the near-road site selection process?
Response: None

<u>Charge Question 8</u>: Within Section 10, does the AMMS believe the list of items needed to appropriately characterize individual candidate road sites is complete and adequately described? If the list is considered incomplete, please provide a list of the missing characteristics that should be included.
Response: In this section and in the report in general, it seems that some characterization of the roadway grade (i.e. incline or decline) needs to be considered. Clearly, this will have a significant impact on HDD emissions.

<u>Charge Question 9</u>: From an air agency perspective, does the AMMS find that the definitions and explanation of transportation agency policies and expectations are adequate? Are there opportunities to improve upon the material presented within this section?
Response: No suggestions to improve

<u>Charge Question 10</u>: Does the AMMS have ideas for improvement with respect to the organization and usefulness of the suggested site comparison matrix discussed within Section 13?
Response: No suggestions to improve

<u>Charge Question 11</u>: Does the AMMS:
a. Concur with the order of presentation of each pollutant or metric of interest in the near-road environment, as was suggested by the previous AMMS panel, within Section 14?
b. Concur with the description of each pollutant or other metric discussed in Section 14, including its impact on human health (as appropriate), the reason for interest in the near-road environment, and the description or suggestions for measurement?
c. Believe that a pollutant or other metric should be removed from the list within Section 14, or that an unlisted item should be included within this section?
Response: In section 14.7 concerning PM, it may be useful to explain the relative roadway sources that impact PM2.5 versus Coarse PM (PM10-PM2.5). They key point is that brake wear, tire wear and resuspended road dust will impact will largely be Coarse PM and tailpipe emissions will largely be submicron PM.

Comments from Dr. Jay Turner

<u>Charge Question 1</u>. *Does the TAD, particularly based upon the information provided in Sections 1 and 2, provide clear objectives of the document and give appropriate rationale for the objectives?*

Response: The objectives are generally clear. It might be helpful to directly include excerpts from the final rule such as section 4.3 from Appendix D of Part 58 and the revisions to Appendix E of Part 58. These sections could be appended to the TAD or in some cases excerpts could be added as text boxes to the main body to reinforce the requirements and constraints to the monitor siting approach that are imposed by the regulation. These issues are discussed throughout the TAD with reference to the final rule, but in some cases it would be helpful to have the formal language handy.

<u>Charge Question 2</u>. *Does the AMMS believe that the suggested approach in the TAD places an appropriate amount of weight and consideration on all six factors required to be considered (AADT, fleet mix, congestion patterns, roadway design, terrain, and meteorology) as part of the near-road NO2 site selection process?*

Response: It is understandable that the required approach starts with AADT and builds in the additional factors because AADT data should be readily available for all affected areas. On the other hand, many areas have time-resolved traffic data and the TAD provides no clear vision for how these data could be most effectively incorporated into the ranking process. Congestion metrics such as level of service (LOS) partially capture the within day dynamics but this is a rather coarse grained metric and cannot be used to refine the prioritization of roadway segments with the same LOS. Indeed, the Tampa example demonstrates that the vast majority of road segments ranked in the top 30 have an F ranking for the LOS. In light of this issue, if hourly data are available then an additional useful metric may be the daily maximum hourly traffic volume (better yet, the daily maximum hourly fleet equivalent hourly traffic volume).

Can the EPA offer any guidance on how to cluster the ranked results? For example, the Tampa example provides a ranked list. Can approaches be taken subsequently group the segments into highest priority, moderate priority, and lowest priority? Clearly there are no bright lines for making such distinctions but on the other hand the rank ordering of road segments should not be overly interpreted given the subjective linkage between the ranking criteria and maximum hourly NO2 concentrations.

The TAD clearly describes the criteria for determining whether a second monitor is required (e.g. Figure 3-1). However, the objectives for the second monitor should be discussed in more detail. The final rule states "Where one CBSA is required to have two near-road NO2 monitoring stations, the sites shall be differentiated from each other by one or more of the following factors: fleet mix; congestion patterns; terrain; geographic area within the CBSA; or different route, interstate, or freeway designation." At a minimum this description should be provided with additional guidance offered if possible.

It would be helpful to provide additional guidance on whether and how background concentrations should be considered. Background concentrations are mentioned throughout the document but it would be helpful to discuss its role in the site selection process in more detail given many of the high traffic roadways may be in proximity to other roadways such as a road segments within an urban core transportation network. The emphasis clearly is on impacts from the adjacent roadway. The

TAD discusses impacts from nearby point sources and such but it would be helpful to step back and reflect upon the role of background concentrations when assessing candidate monitoring sites.

Charge Question 3. *Does the AMMS see opportunities to improve the usefulness of the Fleet Equivalent AADT metric introduced and discussed within Section 5?*

Response: Overall, I like the approach as a screening tool. Of course the use of road-segment specific fleet mix would be ideal but it is respected these data are not available in all affected areas. In the absence of such data, the approach will likely need to be more thoughtful than the "county by county characterization" mentioned on page 5-13 as one possible approach to fleet mix categorization. Additional guidance should be provided on approaches that could be taken to assign fleet mixes to road segments in the absence of segment-specific data.

The nomenclature could be improved to provide clarity. For example, the term "Fleet Equivalent (FE) AADT" is vague. It is actually a light duty (LD) vehicle equivalent measure because the heavy duty vehicle counts are being scaled to the number of equivalent light duty vehicles in terms of emissions. Second, the HD-to-LD emission ratio is represented by HDm and the HD annual average daily traffic count is HDc. The notation for these two variables is too similar. Consider representing HDm as (EFHD)/(EFLD) where EFi is a representative emission factor for vehicle class i.

Charge Question 4. *Within Section 6, does the AMMS believe we have adequately described the effects of roadway design, roadway structures, terrain, and meteorology on roadway pollutant dispersion and suggested how those effects can be considered in the near-road site selection process?*

Response: It seems that intersections/interchanges could be hot spots for NO2 concentrations. The ranking methodology focuses on roadway segments and gives too little attention to the confluence of roadway segments as being an important consideration. It is merely mentioned as a "desirable attribute" in Section 6 and one of the field characteristics that should be documented (Section 10.4) but should be given much more weight in the prioritization. Using the Tampa example, do two of the ranked segments represent a crossing of some type? If so, they should be collectively made a higher priority.

The guidance states that air channeling by terrain should be considered. The emphasis is on the macro-scale rather than the micro-scale such as air channeling by along cut-section roadways. It might be useful to clarify that the distinction between seeking to capture high near-roadway concentrations versus high on-roadway concentrations.

Charge Question 5. *Within Section 7, does the AMMS believe we have adequately discussed the siting requirements and provided appropriate suggestions for how to properly site monitor probes while considering the design of the target road and/or roadside structures?*

Response: The discussion is generally fine. The criteria are necessarily subjective in the absence of very detailed air flow modeling. The last sentence of Section 7 is not clear – what is meant by the agencies should "consider more than one linear pathway between the target road segment and the monitor probe"? This issue is discussed earlier in the section but this summary sentence does not bring the discussion together.

<u>Charge Question 6.</u> *Does the AMMS believe that Section 8 has adequately discussed and explained the varied approaches on the optional use of exploratory monitoring as part of the near-road site selection process?*

Response: This section provides some discussion of the context for conducting exploratory monitoring and could be more fully developed. It is stated that exploratory monitoring may be useful to compare and contrast sites that are ranked as high priority locations. Within this context, another example would be the case of intersections or interchanges between two road segments that were each ranked moderately high to determine whether their additive effects significantly increase their ranking. This would best be done by exploratory monitoring or modeling of the highest-ranks sites and these cases of intersections/interchanges, with the former needed for to provide context for the interpreting the latter.

<u>Charge Question 7.</u> *Within Section 9, does the AMMS see opportunities to improve the description of how the (optional) use of AERMOD and MOVES can be used to conduct dispersion modeling in the near-road site selection process?*

Response: I will address this charge question in more detail in my final comments.

One area that could be refined is the section on urban/rural classification in Section C.6.3. In the discussion of Figure 6-1 it is stated that "urban and rural concentrations are nearly equal at short distances but as distance from the source increases, the urban concentrations become much less than the rural concentrations." This figure and the level of detail in the subsequent text are certainly important if sources in addition to the road segment are being modeled. However, if only the road segment is being modeled then, as stated, the differences are insignificant over the spatial scales of interest for siting the monitor (within 50 m). This conclusion needs to be highlighted.

<u>Charge Question 8.</u> *Within Section 10, does the AMMS believe the list of items needed to appropriately characterize individual candidate road sites is complete and adequately described? If the list is considered incomplete, please provide a list of the missing characteristics that should be included.*

Response: To be addressed in my final comments.

<u>Charge Question 9.</u> *From an air agency perspective, does the AMMS find that the definitions and explanation of transportation agency policies and expectations are adequate? Are there opportunities to improve upon the material presented within this section?*

Response: Section 11 discusses the monitor site logistics including the need to coordinate with appropriate transportation agencies. In each of the affected areas there already exists a forum for exchanging information – transportation and air quality planning coordination required through the designated Metropolitan Planning Organization. As discussed in Section 11 the coordination will often go far beyond the transportation and air quality management planning level because instruments such as access agreements and permits may be involved. The bullet lists in Section 11.4 provide a reasonable overview of the key considerations.

<u>Charge Question 10.</u> Does the AMMS have ideas for improvement with respect to the organization and usefulness of the suggested site comparison matrix discussed within Section 13?

Response: The comparison matrix provides a nice framework. While this is not a strictly prioritized list, I believe the presence of interchanges/intersections should be moved up the table (e.g., immediately follow Congestion Information) and specifically call out cases where the crossing road segment is highly ranked.

For the meteorology parameter, the description should include a qualitative indicator of the likely representativeness of the data used. For example, if the data are from the area's airport and the site characteristics would lead one to believe such data may not be representative for the specific road segment, this should be qualified. In particular, attributes that increase the frequency of calm conditions should be mentioned.

<u>Charge Question 11.</u> Does the AMMS: (a) Concur with the order of presentation of each pollutant or metric of interest in the near-road environment, as was suggested by the previous AMMS panel, within Section 14? (b) Concur with the description of each pollutant or other metric discussed in Section 14, including its impact on human health (as appropriate), the reason for interest in the near-road environment, and the description or suggestions for measurement? (c) Believe that a pollutant or other metric should be removed from the list within Section 14, or that an unlisted item should be included within this section?

Response: I am comfortable with the ranked list with the following exception. Is Section 14.8 intended to be Organic Carbon in general – including both gaseous and PM species – or exclusively PM? The title and first sentence suggest the former but the remainder of the section focuses on particulate matter OC with key gaseous species addressed in Section 14.12 (Air Toxics). Also, mention of the HR-AMS seems inappropriate because it is strictly a research grade instrument. If anything, the ACSM would be a better instrument to mention in this context.

Section 14 should start with a list or table of the pollutants and metrics. My final comments will include suggestions for refining some of these pollutant-specific summaries. For example, the second paragraph of Section 14.7 (PM Mass) can be tightened up and I will provide specific suggestions.

My final comments will include suggestions for revising the presentation and wording in a various places throughout the entire document to improve clarity.

Comments from Dr. Yousheng Zeng

Charge Question 1 – Objectives and rationale
Response: The draft TAD does provide clear objectives of the document itself, i.e., *how* to implement near-road NO2 monitoring. The draft TAD also identifies objectives of the near-road monitoring network and describes rationale to support these objectives. With multiple objectives, it is necessary to clarify and prioritize the objectives. The following recommendations are made:

1. To clearly and explicitly state the minimum regulatory requirements and/or provide a summary of requirements by regulations (not just cite the regulation).
2. To clarify and prioritize the objectives of the near-road monitoring network: attainment/nonattainment designation, health effect study, modeling study, multi-pollutant study, etc. Another way to address this is to explain how EPA intends to use the monitoring data generated by this near-road monitoring network.

To clarify if the goal of setting up the monitors is to capture/measure (1) the highest NO2 concentrations on a short-term (hourly) basis without consideration of population exposure, or (2) the highest NO2 concentrations with consideration of potential exposure by near-road residents.

Charge Question 2 – Weight and considerations on six factors in the site selection process
Response: I believe that the TAD has given appropriate consideration on all six factors. However, the weight given to FE AADT may be too high. In addition, EPA should add some factors for consideration in the site selection process. These factors are not specified in 40 CFR 58 App. D, but they may influence the monitoring results or the use of the results. These factors may include:

1. Cumulative effect of multiple roadways. The site selection process discussed in the draft TAD focuses on individual roadways. They are treated as isolated roadways. In actual environment, if there are multiple roadways in very close proximity (e.g., a freeway segment in a city that is parallel to two major streets (not frontage roads), one on each side 100 meters away from the freeway. When evaluated individually, each of them may not be ranked high. However, the combined effect of these roadways can be significantly higher.
2. Nearby NO_2 stationary point or area sources. This issue is related to the monitoring objectives. Should we select a site that has the highest NO2 concentration (whether it is caused by traffic or traffic plus nearby stationary sources)? Should we avoid influence of stationary NO2 sources (i.e., only vehicle contributions) or are we concerned about cumulative effect of all sources?
3. Public accessibility. As stated in the TAD, the near-road monitor should be placed within 50 meters from the outer lane of the roadway. If there is no public access to the 50-m zone for a roadway segment (e.g., barbwire/fence along the roadway, natural terrain, etc., or combination of these), this segment should not be considered for monitoring even when the AADT is very high. The test of public accessibility for definition of "ambient air" has been a long-standing policy in the EPA PSD permit program. The same policy should be applicable to near-road NO2 monitoring.

The TAD should discuss the nature and effect of these factors; provide guidance on how to treat them in the site selection process and how to document them in the monitoring plans.

Charge Question 3 – FE AADT metric
Response: Use of Fleet Equivalent AADT to normalize fleet mix (i.e., converting HD vehicle traffic to equivalent LD vehicle traffic) and compare road segments on the normalized, FE AADT, basis is a significant improvement over the method based on AADT. There might be ways to further classify

vehicle types beyond the two classes (i.e., HD and LD). However, I think the method proposed in the draft TAD is most practical and adequate for most cases. For certain road segments (e.g., highway in Central Business Districts) where no HD vehicles are allowed, the monitoring agency can simply make AADT=FE AADT.

The draft TAD provides step-by-step procedures. However, the issue of multiple roadways in close proximity (see discussion and example above in response to Charge Question 2) and issue of major intersections is not addressed in the FE AADT based ranking scheme described in the draft AADT. Some high NO_2 areas may be missed.

There are cases where the median between divided highways is very wide. Should each direction be treated as a separate roadway in the ranking? If so, how wide does the median have to be in order for the two directions to be treated as separate roadways?

Charge Question 4 – Roadway pollutant dispersion

Response: The opening part of Section 6 and Table 6 provide a summary of the three factors that affect pollutant dispersion. Although the impact of these factors to dispersion is adequately described, the guidance on how to factor in the impact is not very clear. Should a monitoring site be selected so that the highest NO_2 concentration (the worst dispersion) is detected or avoided? It appears that conflicting message is given: sometimes the idea is to detect the highest near road pollutant concentrations; and other times the guidance is to avoid the worst dispersion conditions (e.g., presence of sound walls). In Table 6, some attributes are considered desirable because they cause better dispersion or lower concentrations, such as “at grade with surrounding terrain”, “low barriers present”, and “flat or gentle terrain”. However, other attributes are also considered desirable while they cause opposite effect (i.e., higher concentrations). The examples are “near ramps, intersections, lane merge locations”, “within a valley”, and “relative downwind locations”. Similar confusion exists under the heading of “Less Desirable Attributes”. Does TAD instruct monitoring agencies to select a site that is expected to have the highest NO2 concentrations? It would be very helpful that the principle used in dealing with these dispersion factors is clearly explained in the opening part of Section 6.

Charge Question 5 – Siting requirements and monitoring probe

Response: Section 7, specifically Table 7, provides a good summary of the regulatory requirements. Recommendations are specific and easy to follow. One area that may need further discussion is the relationship between the probe horizontal and vertical placement. The horizontal placement and vertical placement are discussed separately. Should there be a discussion on the interplay between the two? There is a range in both dimensions: horizontally from “as near as practicable” to 50 meters; vertically from 2 meters to 7 meters. When the horizontal distance is very close to the traffic, should the vertical distance be in the lower range, closer to 2 meters, rather than the higher range, closer to 7 meters? Under a condition of perpendicular wind, the plume coming out of the vehicle tailpipe will be closer to the ground and will gradually disperse as distance increases. Therefore at a very short horizontal distance from traffic, the plume may be closer to the ground and a probe intake position near 7 meters may be too high to intercept with the plume. If the probe is placed further away from traffic (further distance downwind from the traffic), the plume will be better dispersed, and a higher probe position may not be a significant issue.

It may also be a good idea to discuss the sample line length. If the probe intake is 7-meter high and the analyzer is at the ground level, there may be a long sample line running from the probe intake to the analyzer. A long sample line may cause issues in response time or loss of target compounds. The TAD should provide some guidance on either sample line length or sample residence time in the line.

Charge Question 6 – Exploratory monitoring in near-road site selection process

Response: The TAD provides some options and guidance on how to use exploratory monitoring in site selection process. It would be more helpful to provide some guidance on how to use the data collected from the exploratory monitoring to assist the site selection.

It is important to document traffic information (e.g., vehicle count, fleet mix, level of congestion, etc.) and other conditions (e.g., day of the week, time of the day, wind condition, etc.) that may affect the monitoring results. Some general recommendations on duration for each exploratory monitoring are also helpful.

Charge Question 7 – Use of AERMOD and MOVES modeling

Response: The TAD references well established modeling guidance documents. However, the application of the models for this purpose is different as compared to typical modeling analysis in air permitting processes. In a typical regulatory modeling analysis, the finest receptor grid has a spacing of 25 meters or larger. This spacing may not be sufficient if the model is used for the first and second purposes described in the opening paragraph of Section 9. A very significant concentration gradient is expected in the 50-m zone near road. A much finer spatial resolution is needed for this type of modeling analysis.

The EPA modeling guidance memos (e.g., the March 2011 memo on 1-hour NO2 modeling) are intended for typical permit modeling analysis. It focuses on traditional industrial sources and the modeling domain is large enough to use certain treatment to address the chemical reaction of NO/NO2. The techniques discussed in the draft TAD, e.g., NO2/NOx in stack ratio, Ozone Limiting Method (OLM), and Plume Volume Molar Ratio Method (PVMRM), may not be applicable/suitable to the near-road condition, or some adjustment may be needed. Simply referencing the existing modeling guidance memo seems inappropriate or inadequate.

Charge Question 11 – Multi-pollutant monitoring

Response: Near road sites for NO2 monitoring will be treated as ambient air. Monitoring of other criteria pollutants (e.g., CO, PM2.5, ozone) at these sites is technically feasible but will be problematic in terms of their regulatory implications. Exceedance of NAAQS in ambient air will cause designation of the area as nonattainment and there will be many serious consequences (development of SIP, Nonattainment New Source Review (NNSR) permitting, transportation and general conformity determination, attainment schedule, penalties, etc.). The regulatory framework for ozone, CO, and PM2.5 nonattainment is designed without special consideration of near road conditions. The criteria for ambient monitoring network for the purpose of attainment/nonattainment determination are different. It is one thing to establish a multi-pollutant monitoring network for research purposes, and a much more complex issue for regulatory purposes. An exceedance of NAAQS for ozone, PM2.5, or CO at a near-road site will bring a suite of regulatory issues that deserve much more careful considerations outside of the monitoring community. When suggesting multi-pollutant monitoring, the TAD should include cautionary comments and/or discuss the possible consequences and the way to manage them. If EPA is not prepared to provide corresponding policy guidance on these issues, the TAD should discourage multi-pollutant monitoring that include criteria pollutants, and provide guidance on how to approach the issue for pure research purposes.