Air Quality Community of Practice
Establishing Air Quality Background Concentration Levels for Projects
State-of-the-Practice

Requested by:

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Disclaimer

This State-of-the-Practice Report summarizes the discussions of Air Quality Community of Practice members who spoke as individual members of the community and did not necessarily represent their agency's views or positions. In addition, the contents of the report do not necessarily represent the views or positions of AASHTO or the Center for Environmental Excellence.

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INTRODUCTION

The Center for Environmental Excellence by AASHTO (Center) established an Air Quality Community of Practice (COP) in 2008. The purpose of the Air Quality COP is to assemble a group of State DOT practitioners to have a focused discussion on the state of the practice, emerging issues, and research data needs on particular issues, as well as on other air quality issues of interest. This effort has essentially two goals, the first of which is to extend the State DOT's networks and contacts, enabling them to share experiences and learn from each other. In this regard, this effort expands and supplements a November 2008 Air Quality Practitioner's Conference that was held in Albany, New York[1]. The second goal is to develop State-of-the-Practice Reports on selected focus areas. To date, the Air Quality COP effort has produced the following reports:

- State-of-the-Practice Report on Mobile Source Air Toxics in May 2009[2];
- State-of-the-Practice Report on Short Term Impacts from Construction Equipment and Operations in March 2010[3]; and
- State-of-the-Practice Report on Air Quality Interagency Consultation in June 2010[4].

The Air Quality COP consists of representatives from thirteen State DOTs, FHWA, FTA, and AASHTO. The Air Quality COP members considered a range of possible topic areas and agreed on *Establishing Air Quality Background Concentration Levels for Projects* for the next report. This topic was chosen because of several recent changes by the U.S. Environmental Protection Agency (EPA). These changes include, among other things, the promulgation of a new 1-hour nitrogen dioxide (NO_2) standard and new near-road monitoring requirements in urban areas with populations of 500,000 or more, and proposed transportation conformity guidance for quantitative hot-spot analysis in particulate matter (PM) nonattainment and maintenance areas. These new requirements place a heavier emphasis on project level analyses and the need for States to find new ways of establishing air quality background levels, without the costly process of establishing project level monitors. In addition, EPA is proposing to consider a range of levels for the 1-hour and 8-hour carbon monoxide (CO) standards. If the CO standards are tightened that would also impact future project level analyses.

Establishing accurate background concentration levels is important because such levels must be added to both the current and future predicted concentration levels of the applicable pollutant so the total concentration levels at the various sensitive receptors sites can be compared to the National Ambient Air Quality Standards (NAAQS) for that pollutant. If a project is predicted to cause new violations of a NAAQS or make existing violations worse, costly mitigation measures will likely be required on the project before it can proceed.

This State-of-the-Practice Report discusses EPA programs and requirements that have a bearing on establishing air quality background concentration levels; applicable FHWA/FTA requirements and guidance; State practices for establishing current and future background levels for various pollutants; and future research needs for developing more effective and streamlined procedures for establishing background levels and future project level analysis.

EPA REGULATIONS/GUIDANCE

EPA – Guideline for Modeling Carbon Monoxide from Roadway Intersections:[5] This manual provides guidance on selecting intersections, intersection analysis procedures and for selecting appropriate receptor sites for CO modeling. It also includes guidance for establishing CO background concentration levels and for estimating 8-hour CO concentration levels from the 1-hour concentration levels. The manual suggests using local monitoring sites that are not affected by the intersection of interest to establish CO background concentration levels for the project. It further indicates that current monitored background concentration levels should be adjusted for the future by multiplying the present CO background by the ratio of the future MOBILE CO emission factor to the current MOBILE CO emission factor and multiplying by the ratio of future to current traffic. If representative background monitoring data is not available, the manual suggests the analyst contact the EPA Regional Office for use of default background concentration levels.

The manual provides guidance for establishing persistence factors for converting 1-hour CO concentration levels to 8-hour concentration levels. The manual indicates that since a persistence factor represents a combination of the variability in both traffic and meteorological conditions, the ratio of monitored data should be used since monitoring data include the effects of these variables. The preferred method is to use the ratio of the 8-hour to the maximum 1-hour measured CO concentration within the 8-hour period to establish the persistence factor. If monitoring data is not available, or if the monitoring data is for less than the recommended monitoring period, EPA recommends that a 0.7 default persistence factor be used. The EPA manual states that a 0.7 factor is a reasonably conservative factor based on studies of monitoring data throughout many regions of the country.

Guideline on Air Quality Models:[6] On November 9, 2005 EPA issued a final rule on revisions to the Guideline on Air Quality Models, which are included in Appendix W to 40 CFR Part 51. The guideline, among other things, provides a framework for defining the elements of background concentrations. The guideline states that background concentrations are an essential part of the total air quality concentrations to be considered and should include: (1) natural sources; (2) nearby sources other than the one(s) currently under consideration; and (3) unidentified sources. It states that typically, air quality data should be used to establish background concentrations in the vicinity of the source(s) under consideration and that an appropriate data validation procedure should be applied to the data prior to use. It recommends that background concentrations be determined for each critical concentration averaging time. The guideline provides two options for establishing background concentrations near isolated sources. They include the use of air quality data collected in the vicinity of the source, and if no local monitors are available, the use of a regional site that is located away from the area of interest but that is impacted by similar natural and distant man-made sources. For multi-source areas, the guideline recommends that background concentrations be determined from contributions from both nearby sources as well as other sources.

Transportation Conformity Rule:[7] EPA's Transportation Conformity Regulations contain several sections that are applicable to establishing localized air quality background concentration levels and for making CO, PM_{10}, and $PM_{2.5}$ hot-spot analyses in nonattainment and maintenance areas. For a full understanding of these provisions the reader should read the conformity regulations. The most relevant sections for purposes of this report are:

> ***Section 93.116, Criteria and procedures: Localized CO, PM_{10}, and $PM_{2.5}$ violations (hot-spots)*** - This section discusses the criteria that must be met in order to meet the conformity requirements for project level hot-spot analyses for CO, PM_{10}, and $PM_{2.5}$. Basically it indicates that a **"***FHWA/FTA project must not cause or contribute to any new localized CO, PM10, and/or PM2.5 violations, increase the frequency or severity of any existing CO, PM10, and/or PM2.5 violations, or delay timely attainment of any NAAQS or any required interim emission reductions or other milestones in CO, PM10, and PM2.5 nonattainment and maintenance areas*."
>
> ***Section 93.123, Procedures for determining localized CO, PM_{10}, and $PM_{2.5}$ concentrations (hot-spot analysis)*** - Subsections (a) and (b) of this section discuss the procedures for determining localized CO, PM_{10}, and $PM_{2.5}$ hot-spot concentration levels for various types of projects. Subsection (a) indicates that CO hot-spot analysis must be based on quantitative analysis consistent with EPA's *Guideline on Air Quality Models*, unless different procedures were developed through the interagency consultation process and approved by EPA. With regard to PM_{10}, and $PM_{2.5}$ hot-spot analysis, subsection (b)(2) indicates that a qualitative consideration of local factors must be used to complete these analyses until a quantitative analysis method becomes available. As noted below, EPA is currently in the process of developing a quantitative analysis process. In addition, subsections (a)(3) and (b)(3) provide U.S. DOT, in consultation with EPA, the opportunity to make categorical CO, PM_{10}, and $PM_{2.5}$ hot-spots findings based on appropriate modeling without further hot-spot analysis. Establishing categorical findings would greatly reduce resource demands on State and local agencies by eliminating project-specific modeling for projects that do not cause or contribute to local air quality problems.

> Subsection (c) of this section includes some general provisions. One such provision states that, "*Estimated pollutant concentrations must be based on the total emissions burden which may result from the implementation of the project, summed together with future background concentrations. The total concentration must be estimated and analyzed at appropriate receptor locations in the area substantially affected by the project.*" Another provision states that, "*Hot-spot analyses must include the entire project, and may be performed only after the major design features which will significantly impact concentrations have been identified. The future background concentration should be estimated by multiplying current background by the ratio of future to current traffic and the ratio of future to current emission factors.*"

New 1-hour NAAQS for Nitrogen Dioxide (NO_2):[8] On January 22, 2010, EPA promulgated a new 100 parts per billion (ppb) 1-hour NO_2 standard. In addition, EPA established provisions for the placement of new NO_2 monitors in urban areas. These new provisions require that at least one monitor be located near a major road in any urban area with a population greater than or equal to 500,000 people. A second monitor is required near another major road in areas with either: (1) a population greater than or equal to 2.5 million people, or (2) one or more road segments with an annual average daily traffic (AADT) count greater than or equal to 250,000 vehicles. EPA requires the NO_2 monitors "to be placed near those road segments ranked with the highest traffic levels by AADT, with consideration given to fleet mix, congestion patterns, terrain, geographic location, and meteorology in identifying locations where the peak concentrations of NO_2 are expected to occur". EPA also requires the monitors, which must begin operating by January 1, 2013, to be placed no more than 50 meters (about 164 feet) from the edge of the nearest traffic lane. According to EPA these new provisions will result in approximately 126 NO_2 monitoring sites near major roads in 102 urban areas.

Transportation Conformity Guidance for Quantitative Hot-spot Analysis in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas:[9] EPA issued this proposed guidance in May 2010. Once the guidance is finalized, and after a specified grace period which EPA currently proposes to be two years after its approval of the new motor vehicle emissions model (MOVES2010) for use in project-level transportation conformity determinations, it will be used by state and local agencies to conduct "hot-spot analyses" for new highway and transit projects that involve significant diesel emissions in $PM_{2.5}$ and PM_{10} nonattainment and maintenance areas. Among other things the draft guidance describes how to estimate project emissions using EPA's MOVES2010 model, California's EMFAC2007 model, and other methods; how to apply air quality dispersion models for PM hot-spot analyses; how to determine background concentrations levels, including concentrations from nearby sources in the project area; and, includes appendices that provide additional resources and examples that may assist state and local agencies in conducting quantitative PM hot-spot analyses. The guidance indicates that the CAL3QHCR and AERMOD dispersion models are the recommended models for highways and intersection projects, but that AERMOD is the recommended model for transit and other terminal projects, and for projects that involve both highway/intersections and terminals, and/or nearby sources.

It should be noted that while Section 93.123(c)(2) of the conformity rule states that, "The future background concentration should be estimated by multiplying current background by the ratio of future to current traffic and the ratio of future to current emission factors.", this proposed guidance indicates that this simplified methodology is not a technically viable option for PM hot-spot analyses. Therefore other methods for determining background concentration levels, such as using monitoring data from a single monitor or interpolation between several monitors, will likely be required in the final guidance.

Policy Assessment for the Review of the Carbon Monoxide National Ambient Air Quality Standards:[10] The Clean Air Act requires EPA to review the various air quality standards at 5-year intervals, and to set primary and secondary standards for pollutants listed under section 108. The primary standard is intended to protect public health with an adequate margin of safety, and the secondary standard is intended to protect the public welfare from any known or anticipated adverse effects associated with the presence of the pollutant in the ambient air. The current primary standards for CO are set at 9 parts per million (ppm) as an 8-hour average and 35 ppm as a 1-hour average, neither to be exceeded more than once per year. CO secondary standards were set the same as the primary standards in 1971, but they were revoked in 1985. In its October 2010 Policy Assessment, EPA concludes that it is appropriate to give consideration to a range of levels from 15 to 5 ppm for the 1-hour CO standard, and to a range from 9 to 3 ppm for the 8-hour CO standard, with a 99^{th} percentile daily maximum revised form, averaged over three years. The Assessment concludes there is not sufficient information to support the consideration of a secondary CO NAAQS at this time due to climate-related effects.

Using MOVES in Project-Level Carbon Monoxide Analysis:[11] EPA is developing this guidance document to describe how to use the MOVES emissions model to estimate CO emissions from transportation projects, including roadway intersections, highways, transit projects, parking lots and intermodal terminals. This guidance can be applied when using MOVES to complete hot-spot analyses for transportation conformity determinations, modeling project-level emissions for state implementation plan (SIP) development, and completing analyses pursuant to the National Environmental Policy Act. The guidance applies in all states except for California, where the most recently approved version of the EMFAC model is used. This document notes that it only updates the emission rate calculation procedures in the 1992 EPA *Guideline for Modeling Carbon Monoxide from Roadway Intersections* to reflect the use of the MOVES model. EPA indicates that with the release of this document, any references to the MOBILE emissions model, MOBILE emission rates, or other emission factor guidance in the 1992 Guideline should be disregarded. Otherwise the 1992 Guideline remains in effect, including the procedures for determining background concentration levels, use of persistence factors, etc.

FHWA/FTA GUIDANCE

Transportation Conformity Guidance for Qualitative Hot-spot Analysis in PM2.5 and PM10 Nonattainment and Maintenance Areas:[12] On March 29, 2006, FHWA and EPA jointly issued guidance for making qualitative PM hot-spot analysis. This guidance provides information to help State and local agencies meet the $PM_{2.5}$ and PM_{10} hot-spot analysis requirements established in the March 10, 2006, final transportation conformity rule, and supersedes the PM_{10} Qualitative Analysis Conformity Guidance that FHWA issued on September 12, 2001. The current guidance includes an overview of the $PM_{2.5}$ and PM_{10} hot-spot conformity requirements; a discussion of the analytical requirements and methods for performing qualitative $PM_{2.5}$ or PM_{10} hot-spot analysis; and provides examples of projects of air quality concern, of qualitative $PM_{2.5}$ or PM_{10} hot-spot analyses, and of potential mitigation measures. Until EPA's quantitative hot-spot analysis guidance noted above is issued in final form and the grace period has ended, this guidance will continue to apply in PM areas.

Clarification to the 2006 Joint EPA/FHWA Transportation Conformity Guidance for Qualitative Hot-Spot Analysis in PM2.5 And PM10 Nonattainment and Maintenance Areas:[13] On February 10, 2009, FHWA issued clarification to the March 29, 2006 PM qualitative hot-spot guidance because of a subsequent lawsuit that was filed challenging a project's conformity determination, including the project's $PM_{2.5}$ hot-spot analysis that relied on a comparison to another location with similar characteristics. The guidance indicates that it is intended to clarify how to implement the March 29th guidance and the hot-spot analysis requirements in the final rule, but that it does not supersede these documents. This document provides clarification on: 1) the factors to consider in selecting a "surrogate" monitor for the proposed project, 2) the factors to consider in selecting the most appropriate monitor if more than 1 monitor is within the vicinity of the proposed project area, 3) monitoring information that should be considered if all the monitors within the project area are deemed inappropriate, 4) the process that should be used to determine the appropriate air quality monitor(s), 5) how to consider and document the results from the chosen surrogate monitor(s), and other qualitative factors in the PM qualitative hot-spot analysis, and 6) how the general requirements of 40 CFR 93.123(c) apply when conducting qualitative PM2.5 and PM10 hot-spot analyses.

OVERVIEW OF THE STATE-OF-THE-PRACTICE ON ESTABLISHING AIR QUALITY BACKGROUND CONCENTRATION LEVELS FOR PROJECTS

The transportation community first became involved with estimating project level concentration levels in the 1970s. This was the result of: 1) the Clean Air Act Amendments of 1970 which, among other things, required the newly established EPA to set the NAAQS to protect public health and welfare; and 2) the 1970 Federal-Aid Highway Act which required the Secretary of Transportation, after consultation with the EPA Administrator, to develop and promulgate guidelines to assure that Federal-aid highway projects are consistent with SIPs for the attainment and maintenance of a NAAQS. As a consequence, the States often set up on-site project monitors to establish CO background concentration levels in the 1970s, especially for controversial urban projects. These practices varied among the States with some conducting monitoring operations during the

"CO season" typically November through January, and others conducting monitoring operations for longer time frames. Since CO emissions and the corresponding concentration levels have continued to decline over the years, other less costly and time consuming measures have been used to establish background concentration levels the last several decades.

The transportation community now uses a variety of practices to establish background concentration levels. These practices include such efforts as assuming worst case background levels, establishing background levels through coordination efforts with State and local air quality agencies, using monitored data from nearby monitors, extrapolating between several different monitors in the project vicinity, using roll back procedures for determining future background levels, etc. This section contains an overview of selected State DOT's practices for establishing current and future air quality background concentration levels, and for converting 1-hour CO concentration levels to 8-hour CO concentration levels.

California DOT *(Caltrans)*

Caltrans uses the *Transportation Project-Level Carbon Monoxide Protocol (CO Protocol)*, developed by the University of California, Davis as the standard method for project-level CO analysis.[14] The Protocol includes a discussion of general air quality regulations, project requirements, local analysis procedures, and the acceptability of impacts. It also includes a number of Appendices that provide additional information and guidance.

For establishing CO background concentration levels, the Protocol suggests the following procedures:

- Use a nearby permanent neighborhood-scale monitoring station if one is available. A neighborhood-scale monitor is defined as one that is not significantly affected by the project or other major roadways.
- If a neighborhood-scale monitoring station is not available, the Protocol suggests using an areawide model such as the Urban Airshed Model to interpolate between neighborhood scale monitoring stations.
- If an areawide model is not available, the Protocol suggests using either: 1) isopleths, which are contour lines of constant background concentration levels drawn on a map for a specific area, that are obtained by interpolation of measured background concentrations from permanent monitoring stations; or 2) project-specific monitoring.

When estimating CO background concentration levels, the Protocol list the following key aspects that must be considered:

- The estimates must reflect the same time of day as the traffic volumes used in the project analysis.
- The estimates should minimize duplication of CO concentrations (also know as double counting).

- The estimates should have the same averaging times as the analysis being performed. For example, a 1-hour background concentration estimate should not be used in an 8-hour CO analysis.

Since practically all projects that may need CO modeling are located in urban areas, the first method for determining background (use of permanent monitoring sites) is almost always used. Recent (2008) data show that the highest 8-hour CO concentrations in California are 4-5 ppm and the highest 1-hour concentrations are in the 7-8 ppm range.

To determine CO background concentration levels for future years, the Protocol recommends application of factors to a base year background level. The factors are based on the ratio of the estimated future year CO emissions to the existing CO emissions within each air quality analysis area. If such factors are not available, the analyst may determine the future CO background concentration levels by either: 1) adjusting the present background levels by application of a factor that is proportional to the expected reduction in CO concentration levels between 1990 and the CO standard for the attainment year; or 2) extrapolating the trend of CO background concentrations using ten years of monitored data.

Caltrans does not at this time have published procedures for establishing background concentrations for other pollutants.

The Protocol also describes how to develop persistence factors in order to convert 1-hour CO concentrations to 8-hour concentrations. A table of recommended generalized persistence factors includes: 0.6 for rural and suburban areas, 0.7 for urban locations, and 0.8 for urban areas with a tendency for persistent stagnant meteorological conditions and/or persistent traffic congestion.

Illinois DOT (IDOT)

The IDOT uses the Carbon Monoxide Screen for Intersection Modeling (COSIM) model to analyze CO from proposed roadway projects. The COSIM model has the CAL3QHC dispersion model and Illinois' specific MOBILE6.2 emission factors built into it to predict CO for IDOT proposed highway projects, state-wide.

COSIM, Version 1.0 was originally released in 1999. During the development of this internal model, IDOT collaborated with air quality staff at the Illinois Environmental Protection Agency (IEPA) on the appropriate CO background values to use statewide as well as the persistence factor to use for converting the 1 hour CO value to an 8-hour CO value.

Based on recommendations from the IEPA, IDOT uses CO background concentrations of 2 ppm for proposed projects in rural locations in Illinois, and 3 ppm for proposed projects in urban locations. The default background value in COSIM is 3.0 ppm.

In addition, based upon a recommendation of IEPA, IDOT also uses a persistence factor of 0.7.

New York State DOT *(NYSDOT)*

NYSDOT's procedures and criteria for determining which projects need air quality analysis, and how to conduct that analysis, are included in its Environmental Procedures Manual (EPM).[15] With regard to establishing CO background concentration levels, the manual includes a table with baseline 1-hour and 8-hour background concentrations and persistence factors for the various NYSDOT Regions. The table is used to calculate the appropriate 1-hour and 8-hour background concentrations levels in ppm.

The 8-hour concentrations in the table (except for those in NYSDOT Region 11 (the New York City Region)) were recommended by the NYS Department of Environmental Conservation (NYSDEC) based on evaluation of 1993 - 1997 CO monitoring data at monitoring stations located across New York State. The 1-hour concentrations in the table were calculated from the 8-hour background concentrations using the listed persistence factors.

For NYSDOT Region 11, the 8-hour average CO background concentrations levels and persistence factors in the table were based on the evaluation of 1991-1996 NYSDEC monitoring data by NYSDEC and NYCDEP. The 1-hour background concentration for Midtown Manhattan was calculated by dividing the 8-hour concentration by its respective persistence factor. For the rest of NYSDOT Region 11, the 1-hour background concentration was based on the highest calculated background resulting from dividing the 8-hour background concentrations by the persistence factors of Lower Manhattan, Downtown Brooklyn-Long Island City and the rest of the City.

The EPM includes a rollback method for determining the background concentration levels for future years. The rollback method allows the mobile source component of the CO background levels to be proportionately rolled back in future years to reflect the reduction in mobile source CO emissions. In order to rollback future CO background concentration levels, the EPM requires the following information:

> 1) emission factors for both the base year and the future year under study, which can be obtained from NYSDOT's online emission factor tables; and
>
> 2) either a representative no-build traffic volume for the base year and the year under study, or regional traffic growth rate from the base year to the year under study.

The EPM indicates that a representative base year no-build traffic volume can be obtained by extrapolating backwards from the estimated time of completion (ETC), ETC+10, and/or ETC+20 for the project or other years for which this information is available. At least two different years' volumes are necessary to establish a reasonable extrapolation. The EPM includes the following formulas for rolling back the CO concentration levels:

Formula using no-build traffic volumes for the base year and a future year:

$$C_{future} = C_{base} \times (0.2 + ((EF_{future} \times V_{future}) / (EF_{base} \times V_{base})) \text{ x } 0.8),$$

where C_{base} and C_{future} are the base year and future year background concentrations (can be either 8-hour or 1-hour background), EF_{base} and EF_{future} the emission factors for the base year and the future year, and V_{base} and V_{future} the traffic volumes for the base year and the future year.

Formula using regional traffic growth rate:

$$C_{future} = C_{base} \times (0.2 + ((EF_{future} \times G) / EF_{base}) \times 0.8),$$

where G is the ratio of the future year traffic volume to the base year traffic volume. The EPM also includes several formulas for determining G depending on whether it is based on a linear or compound growth rate.

The EPM recommends that the background concentration rollback calculations for all NYSDOT Regions, except Region 11, be performed using year 2000 as the base year. For Region 11, the EPM provides future year background concentrations through year 2007. For analysis years beyond 2007, the EPM recommends using year 2007 as the base year for background concentration rollback calculations.

It should be noted that NYSDOT is currently updating the Air Quality Chapter of the EPM. As a result of the update, NYSDOT is developing new base year CO background concentrations and persistence factors. It is anticipated that the updated Air Quality Chapter will be available to the public in 2011.

North Carolina DOT *(NCDOT)*

NCDOT uses the North Carolina Department of Environment and Natural Resources' (DENR) *Guidelines for Evaluating the Air Quality Impacts of Transportation Facilities* for its project level analysis.[16] The purpose of these guidelines is to assist developers, transportation planners, and air quality specialists to demonstrate that any proposed project that falls under pertinent sections of North Carolina Administrative Codes will not contribute to or cause a violation for any Federal or State air quality standard for CO. Among other things, this document includes guidance for establishing background concentration levels, and persistence factors for converting 1-hour CO concentration levels to 8-hour concentration levels. The guidance indicates that the NC Division of Air Quality (DAQ) developed a statistically based method to determine 1-hour CO background concentrations. This method averaged the "hourly data hour-by-hour for each month for each year to develop twelve composite 24-hour sets of concentrations". After combining the twelve 24-hour sets the DAQ computed the 67th percentile concentration which represents the worst-case 1-hour background concentration levels. Then using methods consistent with the EPA *Guideline for Modeling Carbon Monoxide from Roadway Intersections*, the DAQ calculated 1-hour CO background concentrations for 7-North

Carolina regions using 2000-2002 CO monitoring data. These values are reflected in a Table that includes both site and regional averages for 1-hour CO background concentrations and persistence factors. The guidance indicates that the site average background concentration levels and persistence factors should only be used if the project is within approximately two blocks of a monitoring site. Otherwise the regional averages should be used within the regions.

The Table includes a statewide 1-hour average CO background concentration level of 2.9 ppm that can be used throughout the State, if the project is located outside of one of the 7-regions. If the area outside the regions has monitoring data, the average 1-hour and 8-hour monitored background concentrations are to be used. If local CO monitoring data are available, an area-specific background value may be used if it is based on either DAQ data or DAQ-approved outside data.

Like most States, NC use persistence factors to account for the variation in traffic and meteorological conditions and to convert the 1-hour CO worst-case concentration levels to 8-hour average concentrations. The persistence factors within the 7-regions range from 0.73 to 0.86 for projects within two blocks of a monitoring site and from 0.73 to 0.82 for other projects within the regions. The guidance indicates an 8-hour persistence factor of 0.79 should be used for all other areas throughout the State. If 8-hour concentrations are determined by modeling 8-hour traffic counts in areas outside of the 7-regions, the guidance states that a persistence factor of 0.85 can be used to account for weather variability.

Pennsylvania DOT *(PennDOT)*

PennDOT has a Project Level Air Quality Handbook that provides guidance to PennDOT and its consultants for the completion of project level air quality analyses. This guidance is intended to satisfy state and federal air quality requirements for transportation improvement projects.[17] The Handbook includes several different methods for determining CO background concentration levels for project level modeling. First, the Handbook indicates that the air quality analyst should reference the closest Pennsylvania Department of Environmental Protection (DEP) monitoring station whenever possible to document the second-highest 1-hour and 8-hour CO concentration levels. This can be done by using the most recent DEP Ambient Air Quality Report. The Handbook indicates that if the monitoring site is more than 20 miles from the project site, or does not adequately represent the project area, a default value should be assumed.

Assuming a default background concentration level, in the event that air quality monitoring data is not available or appropriate for the project corridor, is the second method described in the Handbook. It suggests that a 1-hour background concentration level of 2.0 ppm can be typically assumed for rural conditions, and 3.0 ppm for urban/suburban conditions. For 8-hour CO predictions, the Handbook suggests that a 1.5 ppm background concentration level be assumed for those areas where no DEP CO monitoring data is available. These assumed background levels represent the worst-case ambient conditions based on recent conditions and trends at current monitoring stations throughout the state.

The Handbook further indicates that the project level analyses should be projected to represent the worst-case 1-hour and 8-hour averaging periods, and that the air emissions and dispersions modeling be conducted using a 1-hour CO averaging period. Once the 1-hour concentration levels are determined, the Handbook suggests applying a 0.7 persistence factor to the 1-hour concentration levels to predict the 8-hour concentration levels. The 0.7 persistence factor represents a combination of the variability in both traffic and meteorological conditions, focusing on 1-hour and 8-hour durations, and is based on EPA guidance. The Handbook states that this factor is reasonably conservative based on the review of state-wide CO monitoring data.

The Handbook stresses that the monitored or assumed background CO concentrations need to be added to the worst-case project-specific CO predictions before they are compared to the NAAQS for CO.

Virginia DOT *(VDOT)*

VDOT periodically reviews available monitoring data for CO and updates background concentrations as appropriate. The last such review and update was in 2008.[18] The 2008 memorandum provides specific recommendations for 1-hour and 8-hour CO background concentration levels for all major urban areas in the Commonwealth as well as for rural areas. The recommended levels for the urban areas range from 2.9 to 3.6 ppm for the 1-hour standard and from 2.0 to 2.5 ppm for the 8-hour standard. In rural areas the recommended CO background concentration level is 1.7 ppm for the 1-hour standard and 1.5 ppm for the 8-hour standard.

The recommended background concentrations were determined using monitoring data for calendar years 2005 through 2007, which were the most recent years for which quality-assured data were available from the Virginia Department of Environmental Quality (VDEQ). The background concentrations were generally taken as the second highest maximum value reported during the three year monitoring period for each major urban area or region, consistent with the form of the standard (i.e., not be to be exceeded more than once per year) and EPA guidance. For rural areas, the background concentrations were determined based on data for a Fairfax County monitoring site that the VDEQ recommended as the most representative for rural areas in the Commonwealth. The maxima of the recommended background concentrations for urban areas was also listed to provide users of the data a conservative option to be applied at their discretion.

Since compliance with the CO NAAQS can usually be demonstrated by a substantial margin, forecast concentrations are not generally rolled-back. EPA default persistence factors are typically used.

The next review and update of background concentrations and persistence factors for CO will likely follow the release and finalization by EPA of new project-level guidance for CO and revisions to the CO NAAQS.

RESEARCH & REPORTS

The following is a summary of selected research and reports that are relevant to establishing background concentration levels for projects. Also included is a list of suggested future research needs by COP members to help establish more cost-effective and streamlined procedures for establishing background concentration levels and future project level analysis.

COMPLETED RESEARCH AND REPORTS:

EPA- Technical Report on Estimate Background Concentrations for the National-Scale Air Toxics Assessment:[19] The purpose of this project was to develop a method to improve the estimation of background concentrations for future National-Scale Air Toxics Assessments (NATA) and to estimate annual average background concentrations across the nation for the 33 urban hazardous air pollutants. The report summarizes the progress toward developing such a method; and summarizes the results of the study. The report also provides extensive summaries of countywide background concentration levels for the various hazardous air pollutants across all the counties that had sufficient data.

EPA - Background Concentrations for 1999 National-Scale Air Toxics Assessment: [20] In 2006, EPA released an update to its 1999 NATA to identify and prioritize air toxics, emission source types and locations which are of greatest potential concern in terms of contributing to population risk. For the 1999 assessment, EPA developed background concentrations for 13 air toxics based on available monitoring data. For the remainder of the air toxics in the assessment, EPA used background levels reported in the technical literature, or assumed zero background if no such levels were reported.

FHWA- Survey of Screening Procedures for Project-Level Conformity Analyses:[21] This paper provides a summary of project-level screening procedures developed and adopted by a number of State DOTs across the country, references procedures with default background concentration levels and persistence factors, highlights several innovative practices, and offers recommendations for developing refined screening protocols. The report indicates that for projects that fail the screening procedures and require a full CAL3QHC analysis, there are refinements that should be considered. For example, the paper suggests that given the reductions in monitored CO values and MOBILE emission rates over the past 10 years the State DOTs should consider revisiting their background concentration levels. The paper also suggests that States can adopt a method for estimating future background concentrations, and for calculating area-specific persistence factors.

NCHRP - The Hybrid Roadway Intersection Model (HYROAD):[22] The HYROAD model predicts CO concentrations levels that occur near intersections. The model integrates three historically individual modules that simulate the effects of traffic, emissions and dispersion to provide a detailed treatment of traffic behavior, vehicle emissions, and the effects of meteorology on concentration patterns within 500 meters of an intersection. The model specifies default inputs for many of the variables and allows its use with minimal input from the user. The EPA website contains a User’s Guide and documentation for this model. The User's Guide includes a detailed description on how to run the model, and includes examples of a worst case screening analysis and a more refined analysis.

The Guide defines background concentration as the pollutant concentration which exists in the vicinity of the highway project from areawide and nearby point sources in the absence of the effects from local anthropogenic emissions. The guide indicates that background concentrations should be added to predicted concentrations for the project in accordance with EPA's 1992 *Guideline for Modeling Carbon Monoxide from Roadway Intersections* before comparing the concentration levels to the NAAQS. Under the screening procedures, the guideline indicates that the maximum 1-hour concentration should be converted to an 8-hour concentration in accordance with the EPA 1992 guidance for intersections. In the absence of historical monitored data a 0.7 persistence factor is recommended for converting the 1-hour concentrations to 8-hour concentrations.

NCHRP- Report 479, Short-Term Monitoring for Compliance with Air Quality Standards:[23] This report provides information on short-term monitoring procedures that are intended to reliably estimate peak emission concentrations of carbon monoxide near proposed roadway improvements without the need for extensive monitoring data as prerequisites inputs for dispersion models. The procedure presented in this report may be useful in reducing the time and resources required to identify and to develop further projects that can meet the requirements of ambient air standards. In addition, the report demonstrates the feasibility of short-term monitoring procedures and identifies a number of important issues in conducting such monitoring.

Background Concentrations of 18 Air Toxics for North America:[24] This study focuses on North American boundary layer background concentrations of the 18 air toxics measured in an EPA sponsored 10-City Pilot Study. The report indicates that measurements from multiple monitoring networks and from previously published studies were used to estimate remote and/or rural concentrations of these 18 air toxics. These background concentrations were then used to determine which, if any, species pose possible health risks in rural areas and assessed the contributions of background concentrations to typical urban concentrations. In addition, trends in background concentrations of air toxics were examined to determine whether the use of control measures resulted in changes over time. This study estimates that remote background air toxics concentrations are as much as 85% lower than those measured in previous studies, which according to the report indicates that regional and local contributions to urban hazardous air pollutant concentrations are higher than previously thought.

Modeling Uncertainties and Near-Road PM2.5: A Comparison of CALINE4, CAL3QHC and AERMOD:[25] This study assessed the capability and performance of the CALINE4, CAL3QHC, and AERMOD dispersion models in predicting near-road $PM_{2.5}$ concentrations. The comparative assessment included an intersection in Sacramento, California, and a busy road in London as sampling sites to evaluate how model predictions differed from observed $PM_{2.5}$ concentrations. At the Sacramento site, the analysis indicated that, CALINE4 and CAL3QHC performed moderately well, while AERMOD underpredicted $PM_{2.5}$ concentrations. For the London site, the report indicates that both

CALINE4 and CAL3QHC resulted in overpredictions when incremental concentrations due to on-road emission sources were low, while underpredictions occurred when incremental concentrations were high. The report states that the street canyon effect and receptor location likely contributed to the relatively poor performance of the models at the London site. The report also points out that $PM_{2.5}$ background concentration levels generally exceeded 70% of the total concentration levels for most sampling sites and that large background concentrations will tend to improve model performance when total concentrations are considered (background plus increment). Therefore, the study comparisons were conducted both with and without background scenarios.

FUTURE RESEARCH NEEDS:

The Air Quality COP recommends the following additional research initiatives to help advance the state-of-the-practice for developing more effective and streamlined procedures for establishing background levels and future project level analysis:

- **Develop PM screening processes for projects of air quality concern that may reasonably be expected to conform:** This research would develop a screening process for projects that meet EPA's thresholds for "projects of air quality concern" in its proposed PM quantitative hot-spot guidance, but otherwise might reasonably be expected to be found to conform if detailed dispersion modeling were to be conducted for the project. For example, a project in which build emissions would be equal to or less than the no-build emissions, and source-receptor distances are not decreasing, may reasonably be expected to be found to conform. Consequently such a screening process, if approved by EPA, could demonstrate that the project contributes to reducing the number and severity of existing PM violations (if any) in the immediate area and thus eliminate the need to complete detailed dispersion modeling with its attendant costs and delay.

- **Develop PM default values for MOVES off-network inputs:** The EPA guidance for PM quantitative hot-spot analysis indicates that there are no default values available for any of the MOVES Off-Network inputs so users will need to input information describing vehicle activity in the off-network area being modeled. Research is needed to develop default values where possible, especially for the start fraction, extended idle fraction and parked vehicle fraction, to help streamline the analysis process in situations where the data are not readily available.

- **Develop spreadsheet tools and screening procedures for the AERMOD model:** Research is needed to develop spreadsheet tools and screening analysis tools to assist State and local agencies in calculating design values for PM hot-spot analyses. Such tools will help streamline the analysis process and reduce data needs.

- **Develop process for determining future background concentration levels:** Hot-spot analyses, including PM quantitative hot-spot analyses, may go beyond the attainment years that are modeled in SIPs, so research is needed to address adjustment of background levels beyond the attainment years. This research should also determine the validity of using the current process of adjusting current monitored background concentration levels to determine future levels by multiplying the present CO background by the ratio of the future CO emission factor to the current CO emission factor and multiplying by the ratio of future to current traffic, especially since future project level analyses will be conducted using the MOVES rather than the MOBILE emissions model. If the "ratio" method is still determined to be valid, it should specify if there are any caveats or qualifications associated with the use of this methodology.

- **Develop process for determining NO_2 background concentration levels:** EPA's promulgation of a 1-hour standard for NO_2 and for the placement of new NO_2 monitors in urban areas could result in dispersion model-based project level hot-spot NO_2 analyses. Consequently, research is needed to help develop a streamlined approach for establishing NO_2 background levels in order to avoid the need for on-site monitoring programs that could delay projects and increase costs. This process should be included in a comprehensive protocol for project level NO_2 screening and analysis.

- **Research the evolving role of State DOTs in determining the location of near-road monitors and for establishing background concentration levels:** As a result of EPA's new 1-hour NO_2 standard and proposed PM quantitative hot-spot guidance, States will likely need to take a more active role in determining the location of near-road monitors and for establishing background concentration levels for the various pollutants. This research effort could document the evolving role of State DOTs in coordinating with State and local air quality agencies for determining appropriate monitoring sites. It could also include suggestions for improving the States coordination efforts such that near-road monitor sites do not create future problems for planned construction sites, heavy truck corridors, etc.

SUMMARY

This State-of-the-Practice Report contains an overview of selected Federal requirements and guidance, and State practices for establishing current air quality background concentration levels for projects. It also includes a summary of selected procedures for estimating future background concentration levels which account for reductions in CO emissions and concentration levels, and for converting 1-hour CO concentration levels to 8-hour CO concentration levels. In addition it includes a discussion of relevant current research and reports, and future research needs for developing more effective and streamlined procedures for establishing air quality background concentration levels and future project level analysis.

This topic was chosen because of several recent changes by the EPA. These changes include, among other things, the promulgation of a new 1-hour NO_2 standard and new near-road monitoring requirements in urban areas with populations of 500,000 or more, and proposed transportation conformity guidance for quantitative hot-spot analysis in PM nonattainment and maintenance areas. These new requirements place a heavier emphasis on project level analyses and the need for States to find new ways of establishing air quality background levels, without the costly process of establishing project level monitors. In addition, in an October 2010 Policy Assessment, EPA concludes that it is appropriate to give consideration to revising the 1-hour and 8-hour CO air quality standards, so any strengthening of these standards could increase the number of localized project level analyses and on-site monitoring required in the future.

Currently the transportation community uses a variety of practices to establish CO background concentration levels. Most of the selected States in this report establish current background concentration levels based on existing monitoring data. If no air quality monitoring data is available, or it is not appropriate for the project corridor, States often use default background levels. The default levels are usually based on worst case conditions and monitoring trends throughout the State, and/or are established through coordination efforts with State and local air quality agencies. With regard to future CO background levels, several of the selected States use roll-back procedures to reflect the decrease in future CO emissions and concentration levels. Other States report that they do not roll-back future background concentrations since they have no difficulty in meeting the CO standards. Therefore their future predictions represent a conservative worst case approach. Several States suggested this process may need to be reconsidered if future NO_2 project level analyses are required and/or the CO standard is tightened. All of the selected States use a persistence factor to convert 1-hour CO concentration levels to 8-hour CO concentration levels. Most of the States use EPA recommended persistence factors. While others use persistence factors derived from monitoring data.

None of the selected States reported any procedures for establishing background concentration levels for pollutants other than CO.

The Air Quality COP recommended additional research initiatives to help advance the state-of-the-practice for developing more effective and streamlined procedures for establishing background levels and future project level analysis. These include research to: 1) develop PM screening processes for projects of air quality concern that may reasonably be expected to conform; 2) develop PM default values for MOVES off-network inputs; 3) develop spreadsheet tools and screening procedures for the AERMOD model; 4) develop a process for determining future background concentration levels; 5) develop a process for determining NO_2 background concentration levels; and 6) to research the evolving role of State DOTs in determining the location of near-road monitors and for establishing background concentration levels.

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