Air Quality Community of Practice

Construction Emissions Analysis

State-of-the-Practice

Requested by:

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and Transportation Officials (AASHTO)

Center for Environmental Excellence

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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. Use of trade names for commercial products is for example purposes only, and does not constitute approval or recommendation by the Air Quality Community of Practice members or AASHTO.

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EXECUTIVE SUMMARY

The topic of *Construction Emissions Analysis* was selected because State DOTs are interested in minimizing short term emissions impacts from construction activities and equipment. Construction activities can result in fugitive dust emissions from various types of activities, as well as exhaust emissions from heavy duty construction equipment. Also, since EPA recently revised the air quality standards for NO_2 and $PM_{2.5}$, State DOTs want to ensure that construction emissions do not contribute to violations of these new standards.

This report therefore highlights U.S. Environmental Protection Agency (EPA) and FHWA/FTA requirements and guidance documents related to analysis procedures for construction emissions. This report also summarizes the responses to the AASHTO Air Quality Community of Practice (COP) survey that was sent to State members to get a broader representation of current and planned State procedures and provides more detailed write-ups for selected States. Finally, the report includes a summary of selected research documents, reports, and websites that are relevant to the analysis of construction emissions, as well as a summary of additional technical assistance and research needs identified by COP members.

INTRODUCTION

The Center for Environmental Excellence by AASHTO (Center) established an Air Quality 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 DOTs' 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]
- State-of-the-Practice Report on *Air Quality Interagency Consultation* in June 2010;[4]
- State-of-the-Practice Report on *Establishing Air Quality Background Concentration Levels for Projects* in December 2010;[5]
- State-of-the-Practice Report on *Use of Transportation Control Measures and Reasonably Available Control Measures in Approved or Submitted State Implementation Plans* in April 2011;[6]
- State-of-the-Practice Report on *Public Education Programs* in January 2012;[7]
- State-of-the-Practice Report on *Establishing and Coordinating Motor Vehicle Emissions Budgets* in June 2012;[8] and
- State-of-the-Practice Report on *Project-Level Quantitative Hot-spot Analyses for $PM_{2.5}$ and PM_{10}* in December 2012.[9]

The Air Quality COP consists of representatives from 14 State DOTs, FHWA, FTA, and AASHTO. The Air Quality COP members considered a range of possible topic areas and agreed on *Construction Emissions Analysis* for this report. As noted above, COP members previously completed a report entitled, *Short Term Impacts from Construction Equipment and Operations.* That report focused primarily on State practices to mitigate construction emissions, whereas the current report's primary focus is on analyses procedures for predicting emissions from construction activities and construction equipment. Both of these topics were chosen because State DOTs are interested in minimizing short term

emissions impacts from construction activities and equipment. Construction activities can result in fugitive dust emissions from earth moving activities such as cut and fill operations, use of unpaved haul roads, etc. In addition, heavy duty construction equipment is normally powered by diesel engines which are high emitters of nitrogen oxides (NOx) and particulate matter (PM) emissions. Since EPA recently revised the National Ambient Air Quality Standards (NAAQS) for nitrogen dioxide (NO_2) and the annual standard for $PM_{2.5,}$ State DOTs want to ensure that construction emissions do not contribute to violations of these new standards.

States are also interested in determining what, if any, additional research or technical assistance State DOTs may need to help them more efficiently address analyses procedures for construction emissions now and in the future.

This report area will therefore summarize: EPA and FHWA/FTA requirements and guidance documents related to analyses procedures for construction emissions; current and planned practices of selected State DOTs for conducting these analyses; technical details such as which models States are using or plan to use; and current and completed research, as well as additional research or technical assistance State DOTs may need to more efficiently conduct these analyses.

EPA REGULATIONS/GUIDANCE

EPA has established a number of regulatory and guidance documents that relate to analysis of construction emissions for highway and transit projects. The following is a summary of several of these documents.

Transportation Conformity Rule:[10] EPA's Transportation Conformity Regulations contain several sections that are applicable to analysis of construction emissions. The most relevant sections for purposes of this report are:

> ***Section 93.102(b)(3), Geographic applicability; and Section 93.119(f)(8), Pollutants:*** These sections indicate that $PM_{2.5}$ from re-entrained road dust only needs to be considered in regional conformity analyses in $PM_{2.5}$ nonattainment and maintenance areas if: 1) the EPA Regional Administrator or the Director of the State air agency has made a finding that re-entrained road dust emissions within the area are a significant contributor to the $PM_{2.5}$ nonattainment problem and has so notified the [Metropolitan Planning Organization] MPO and DOT; or 2) the applicable State implementation plan (SIP), or SIP submission, includes re-entrained road dust in the approved, or adequate, SIP budget. As Section 93.102(b)(3) notes, re-entrained road dust emissions are produced by travel on paved and unpaved roads.
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> ***Section 93.122*(e), *PM_{10} from construction-related fugitive dust:*** This section indicates that fugitive PM_{10} emissions associated with highway and transit project construction are not required to be considered in the regional emissions conformity

analysis if the SIP does not identify construction-related fugitive PM_{10} emissions as a contributor to the nonattainment problem. If, however, the SIP does identify these fugitive emissions as a contributor to the nonattainment problem, the regional PM_{10} emissions analysis must consider construction-related fugitive PM_{10} emissions and must account for the level of construction activity, the fugitive PM_{10} control measures in the applicable SIP, and the dust-producing capacity of the proposed activities.

Section 93.122(f), $PM_{2.5}$ from construction-related fugitive dust: This section is essentially identical to section 93.122(e) above, except that it applies to $PM_{2.5}$ instead of PM_{10} emissions. This section indicates that fugitive $PM_{2.5}$ emissions associated with highway and transit project construction are not required to be considered in the regional emissions conformity analysis if the SIP does not identify construction-related fugitive $PM_{2.5}$ emissions as a significant contributor to the nonattainment problem. If, however, the SIP does identify these fugitive emissions as a significant contributor to the nonattainment problem, the regional $PM_{2.5}$ emissions analysis must consider construction-related fugitive $PM_{2.5}$ emissions and must account for the level of construction activity, the fugitive $PM_{2.5}$ control measures in the applicable SIP, and the dust-producing capacity of the proposed activities.

Section 93.123(c)(5), Procedures for determining localized CO, PM_{10}, and $PM_{2.5}$ concentrations (hot-spot analysis), General requirements: This section indicates that carbon monoxide (CO), PM_{10}, and $PM_{2.5}$ hot-spot analyses are not required to consider construction-related activities which cause temporary increases in emissions. Temporary increases are defined as those which occur only during the construction phase and last five years or less at any individual site. The section further indicates that each site which is affected by construction-related activities shall be considered separately, using established guideline methods.

General Conformity Rule: EPA issued the General Conformity Regulations on November 30, 1993.[11] This rule applies to all federal actions, other than for those transportation plans, programs, and projects funded under title 23 U.S.C. or the Federal Transit Act by FHWA and FTA. The rule has been amended several times, but it has not been substantially revised since it was originally established. The latest revision to the rule occurred on March 24, 2010.[12] The preamble to that rule indicates that several commenters, including federal agencies suggested that EPA consider exempting construction activity emissions from the general conformity requirements. EPA indicated, however, that although the existing General Conformity Regulations do not specifically mention construction emissions, they implicitly require federal agencies to include emissions from construction activities in the conformity evaluation. EPA states that construction emissions can contribute significantly to exceedances of the NAAQS, and unlike the construction activities associated with transportation conformity, construction activities associated with general conformity actions vary widely in type. For example, EPA states that general conformity is concerned about localized impacts of direct and indirect impacts of particular actions or projects, while transportation conformity is

primarily concerned with the regional impacts of long-term use of the roads, and secondarily concerned with short-term and localized impacts. Consequently, EPA reaffirmed that construction emissions must be considered in general conformity evaluations.

Announcement of Availability, Official Release of the January 2011 AP–42 Method for Estimating Re-Entrained Road Dust from Paved Roads:[13] This notice indicates that on January 13, 2011, EPA posted the latest version of the method for estimating re-entrained road dust emissions from cars, trucks, buses, and motorcycles on paved roads. The notice also indicates that EPA is approving the January 2011 edition of Section 13.2.2 of AP-42 that reflects the methodology for calculating re-entrained road dust from paved roads for use in PM_{10} and $PM_{2.5}$ SIPs and regional emissions analyses for transportation conformity determinations. This action, which was effective on February 4, 2011, also started a two-year grace period. Starting February 5, 2013, the January 2011 AP–42 method is required to be used in regional conformity analyses in PM_{10} nonattainment and maintenance areas and any $PM_{2.5}$ nonattainment and maintenance areas where the EPA regional administrator or the state air quality agency determined that re-entrained road dust is a significant contributor to the area's $PM_{2.5}$ problem, or if the area has a $PM_{2.5}$ motor vehicle emissions budget that includes re-entrained road dust. The notice indicated that the document is not relevant to SIP development or regional conformity analyses for ozone (O_3), CO, and nitrogen dioxide (NOx) nonattainment and maintenance areas, or for areas that use EPA-approved locally developed road dust methods. It also does not change the methods for calculating road dust from unpaved roads which were last updated in November 2006.

AP-42, Compilation of Air Pollutant Emission Factors:[14] AP-42 is EPA's compilation of data and methods for estimating average emission rates from a variety of activities and sources from various sectors. The sections of AP-42 that address emissions of re-entrained road dust from paved and unpaved roads and emissions of construction dust from heavy construction operations are found in AP-42, Chapter 13, "Miscellaneous Sources."

EPA indicates that AP-42 users should consult its website to ensure they are using the latest approved version, as the methodology and procedures may change over time. In addition to the latest version of AP-42, EPA's guidance indicates that alternative local methods can be used for estimating road or construction dust; in some areas, these methods may already exist and can be considered for use in quantitative PM hot-spot analyses.

Transportation Conformity Guidance for Quantitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas:[15] This guidance document describes conformity requirements for quantitative PM hot-spot analyses. With regard to construction emissions, Chapter 6 of the guidance provides guidance on how to estimate re-entrained road dust, transportation-related construction dust, construction-related vehicle and equipment emissions, and emissions from other sources in the project area. It indicates that re-entrained road dust must be considered in $PM_{2.5}$ hot-spot analyses only if EPA or the State air agency has made a finding that such emissions are a significant contributor to the $PM_{2.5}$ air quality problem in a given nonattainment or maintenance area;

but must be included in all PM_{10} hot-spot analyses because road dust is a significant component of PM_{10} inventories.

It further states that emissions from construction-related activities are not required to be included in hot-spot analyses if such emissions are considered temporary. But if required, construction emissions resulting from construction vehicles and equipment, including exhaust emissions as well as dust (if required by the conformity regulation), must be included in the analysis. The guidance indicates that AP-42 provides a method for estimating emissions of re-entrained road dust from both paved roads and unpaved roads, and for construction-related dust emissions. Different equations are provided for vehicles traveling unpaved surfaces at industrial sites and vehicles traveling on publicly accessible roads. The guidance also allows the use of locally-developed methods for estimating re-entrained road dust emissions and construction-related road dust emissions if the equations in AP-42 do not apply to a particular project, as they were developed using a particular range of source conditions.

Since the MOVES and EMFAC (in California) emissions models do not estimate emissions of road or construction dust, the guidance must be consulted if dust is required to be included in the analysis. Emission factors for road and construction dust must then be added to the emission factors generated for each link by the MOVES or EMFAC emissions models.

With regard to emissions resulting from construction vehicles and equipment, the guidance indicates that State and local air agencies may have quantified these types of emissions for the development of SIP non-road mobile source inventories, and that related methods should be considered for PM hot-spot analyses. The guidance states that evaluating and choosing models and associated methods and assumptions for quantifying construction-related emissions must be determined through an area's interagency consultation procedures. The guidance also describes mitigation and control measures that can be considered, if necessary.

NONROAD2008 Emissions Model:[16] EPA developed the NONROAD model to assist States and local regulatory agencies in creating accurate non-road emission inventories. EPA indicates that the NONROAD2008 model is a major update to, and supersedes all, previous versions of the NONROAD model. The user may select the national, State, or county geographic area and time period for analysis. At the most detailed level, the user can estimate sub-county emissions, but in this scenario the guidance indicates the user must supply sub-county input data. Thus the model is capable of estimating emissions for nonattainment areas which may consist of multiple counties or sub-counties in one or more States. The guidance indicates that the model calculates past, present, and future emission inventories for all non-road equipment categories except commercial marine, locomotives, and aircraft. Fuel types in the model include: gasoline, diesel, compressed natural gas, and liquefied petroleum gas. The model estimates exhaust and evaporative hydrocarbons (HC), CO, NOx, PM_{10}, $PM_{2.5}$, sulfur dioxide (SO_2), and carbon dioxide (CO_2) emissions. The model also estimates emissions of non-exhaust HC for diurnal, refueling spillage,

vapor displacement, hot soak, running loss, tank permeation, hose permeation, and crankcase emissions.

Policy Guidance on the Use of the November 1, 2006, Update to AP-42 for Re-entrained Road Dust for SIP Development and Transportation Conformity:[17] This guidance notes that on November 1, 2006, EPA released changes to the AP-42 methods used to calculate $PM_{2.5}$ re-entrained road dust emissions from both paved and unpaved roads. This guidance, therefore, provides details about the changes made to the AP-42 methods for road dust and how and when to use them in $PM_{2.5}$ SIP development and transportation conformity determinations. This guidance supersedes the AP-42 portions of previous EPA guidance which addressed both MOBILE6.2 and AP-42. The guidance notes that PM_{10} estimates of re-entrained road dust remained unchanged.

***Diesel Retrofits: Quantifying and Using Their Benefits in SIPs and Conformity*:**[18] EPA issued this guidance to help quantify emission reductions from highway and non-road diesel vehicles, engines, and equipment that have been retrofitted with emission reduction technology. This guidance document describes how to quantify and use reductions of NOx, volatile organic compounds (VOC), PM_{10}, $PM_{2.5}$ and CO in 8-hour ozone, PM_{10}, $PM_{2.5,}$ and CO nonattainment and maintenance areas. For States other than California, EPA indicates it recommends the use of the National Mobile Inventory Model (NMIM) to estimate emission reductions from retrofit projects for SIPs and for conformity analyses. EPA states that NMIM is the recommended method because it estimates the impact of a retrofit project for highway or non-road diesel vehicles, engines, or equipment under local conditions. The report indicates that retrofitting construction equipment with cleaner engines can provide a cost-effective approach for reducing emissions from such equipment and help obtain the NAAQS and establish conformity in nonattainment and maintenance areas.

It should be noted that EPA's web site on NMIM (http://www.epa.gov/otaq/nmim.htm) indicates that while the model was developed to help estimate current and future emission inventories for on-road motor vehicles and non-road equipment, it currently uses versions of the MOBILE6 and NONROAD models. Since MOBILE6 has been replaced by MOVES for estimating emissions from cars, trucks and motorcycles, EPA indicates it cannot be used for modeling these emissions.

Diesel Emissions Quantifier: User's Guide:[19] The Diesel Emissions Quantifier (DEQ) is an interactive tool that evaluates clean diesel projects and options for medium and heavy-heavy duty diesel engines by estimating emission reductions, cost effectiveness, and health benefits. The Quantifier can calculate emissions estimates of NOx, PM, HC, CO, and CO_2 for highway and non-road vehicles, and marine vessels that utilize various emissions control technologies. The Quantifier calculates the emissions reduced by the use of control technologies, and the cost effectiveness of control technologies for the fleet's baseline emissions for one year, and for the lifetime of a fleet. EPA's website indicates that the DEQ does not currently provide estimates for light-heavy duty or non-heavy duty engines or vehicles, non-diesel engines or vehicles, pre-1980 engines, or ocean going vessels. The guidance indicates that the DEQ is intended as a helpful tool to prepare emissions

estimates, but that it is not designed to meet other air quality requirements such as for the development of SIPs or for conformity determinations.

FHWA/FTA REGULATIONS/GUIDANCE

Congestion Mitigation and Air Quality Improvement (CMAQ) Program:

Legislation: In 1991, Congress adopted the Intermodal Surface Transportation Efficiency Act (ISTEA) and authorized the CMAQ program to help fund transportation programs and projects that contribute to attainment of a NAAQS. The CMAQ program is jointly administered by FHWA and FTA and was reauthorized in 2005 under the Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), and most recently continued under the Moving Ahead for Progress in the 21st Century Act (MAP–21) in 2012.[20] Among other things, MAP-21 indicates that in $PM_{2.5}$ nonattainment or maintenance areas States and MPOs must give CMAQ funding priority to projects that are proven to reduce $PM_{2.5}$ emissions, including diesel retrofits. In addition MAP-21 indicates that a State or MPO may elect to obligate funds to install diesel emission control technology on non-road diesel equipment or on-road diesel equipment that is operated on a highway construction project within a $PM_{2.5}$ nonattainment or maintenance area.

Guidance: FHWA released revised CMAQ guidance on November 17, 2008 to incorporate the SAFETEA-LU provisions.[21] More recently, FHWA released a Fact Sheet[22] that summarizes the CMAQ provisions as contained in MAP-21, and interim guidance[23] to implement the MAP-21 CMAQ provisions. The interim guidance was effective on October 1, 2012, and indicates that projects eligible under the CMAQ program prior to enactment of MAP-21 generally remain eligible under the new authorization. It indicates there is some modification with new language placing considerable emphasis on select project types including electric and natural gas vehicle infrastructure and diesel retrofits. The guidance also recognizes the MAP-21 CMAQ funding priority for projects located in $PM_{2.5}$ nonattainment and maintenance areas. The guidance indicates that further information on this section will be provided in the future.

Air Quality Analysis: The CMAQ guidance requires that all project proposals include an assessment of the emissions benefits and disbenefits of the project. In most cases, a quantitative analysis is expected for most project types. The guidance indicates that this analysis should include all pollutants for which the area is in nonattainment or maintenance, including appropriate precursor emissions. The guidance does not specify any specific analytical methodology, however, it states that every effort must be taken to ensure that determinations of air quality benefits are credible and based on a reproducible and logical analytical procedure.

The guidance allows the use of qualitative assessments of the project emissions in those cases when it is not possible to accurately quantify emissions benefits. In these cases, the guidance states that the qualitative assessments are acceptable provided they are based on reasoned and logical determinations that the projects or programs will decrease emissions and contribute to attainment or maintenance of a NAAQS. The guidance also recognizes that in some cases, it may be more appropriate to examine the impacts of comprehensive strategies to improve air quality by grouping projects.

Interim Guidance Update on Mobile Source Air Toxic (MSAT) Analysis in NEPA - Appendix E: Mitigating for Construction MSAT Emissions:[24] The interim guidance does not require the analysis of construction emissions but provides information on a number of technologies and operational practices that should help lower short-term MSAT construction emissions for project-level assessments that pursue mitigation of construction emissions. These include such strategies as reducing the numbers of trips and extended idling times; reducing or redirecting work or shifting times to avoid community exposures; using verified emissions control technology retrofits, such as particulate matter traps, oxidation catalysts, and other devices that provide an after-treatment of exhaust emissions; fleet modernization of engines for construction equipment; using clean fuels, such as ultra-low sulfur diesel, biodiesel, or natural gas; etc. FHWA also indicates that a host of diesel retrofit technologies is supported in the CMAQ Program.

Planning-Level Assessment of Construction and Maintenance Emissions:[25] FHWA indicates that it is developing a spreadsheet tool for evaluating the greenhouse gas (GHG) emissions associated with roadway construction and maintenance activities at the planning level, along with the GHG reduction potential and monetary costs of construction and maintenance strategies that reduce GHG emissions. FHWA plans to have a draft tool available for pilot testing later in 2013.

CMAQ Project Cost Effectiveness Tables: FHWA is preparing a statement of work for a project to address requirements introduced by MAP-21 into 23 USC 149(i)(2) specifying that: "the Secretary in consultation with the Environmental Protection Agency shall evaluate projects on a periodic basis and develop a 'table' or other similar medium that illustrates cost effectiveness of a range of project types for funding under this section……the 'table' shall show measures of cost-effectiveness, such as dollars per ton of emissions reduced, and assess those measures over a variety of planning timeframes……States and metropolitan planning organizations shall consider the information in the 'table' when selecting projects or developing performance plans."[26] Eligible CMAQ projects types evaluated will include $PM_{2.5}$ emission reduction practices applicable to non-road and on-road diesel equipment operated on a highway construction project.

OVERVIEW OF THE STATE-OF-THE-PRACTICE ON CONSTRUCTION EMISSIONS ANALYSIS

To determine current and planned State procedures for conducting construction emissions analysis, the AQ COP members decided to send out an AASHTO survey to the States that are members of this COP. (See Appendix A). In addition, COP member States were requested to send in more detailed information on their planned or current practices. This section contains a summary of the survey results and an overview of selected State practices.

Survey Results:

Eight of the 14 COP States responded to the AASHTO survey. Three other COP States that did not respond to the survey submitted some information. Consequently, 11 States provided information for this report. Below is a summary of the information received:

- About one half of the States reported that construction emissions are a concern in their States, although they are considered to be temporary in nature. The areas of concern that were identified include road dust; the generation of fugitive dust from ground disturbance activities and earth moving operations, such as hauling and stock piling materials; diesel emissions from construction vehicles and equipment; concrete saw cutting operations; and on-site processing emissions such as from asphalt batch plants and concrete plants.

- Most States have not developed qualitative or quantitative procedures for analyzing construction emissions, and have not completed any such analysis. However, two States indicated they have completed a quantitative analysis. One State is working on a spreadsheet tool, similar to a spreadsheet tool developed by one of its municipalities to estimate construction emissions, but more focused on that particular State's construction practices.

- One of the two States that has completed a quantitative construction emissions analysis indicated that when construction emissions are expected to be substantial, or there is substantial interest from the public regarding construction emissions for a project, quantification of the emissions with EPA's NONROAD emissions model and appropriate dispersion modeling, including the use of the AERMOD model, will be used to confirm that no violations of air quality standards will occur during construction. This State has in fact completed one such analysis on a major project. The other State indicated it completed a quantitative analysis on a project because it anticipated that construction activities would exceed five years at several of the project's construction sites. In addition, the State expanded its analysis to other construction sites even though construction activities were expected to be less than five years in duration because of public comments received during project development.

- Most States indicated they control construction emissions in a variety of ways, including, but not limited to, standard specifications; programs that help fund diesel retrofits for construction vehicles and equipment; use of ultra-low sulfur diesel fuel in construction equipment; idling restrictions on diesel equipment; protecting air intakes for buildings and/or facilities from the impacts of diesel exhaust fumes; etc. One State indicated that construction emissions are generally addressed in regional conformity analysis or in SIPs, or in emissions inventories, rather than at the project stage. Another State indicated it will attempt to develop a model contract containing emissions performance specifications for projects above a certain size/cost threshold that can be used by public agencies.

- Most States indicated that the counties and municipalities in their State have not developed any qualitative or quantitative procedures for analyzing construction emission that their State would be required to follow. One State reported that a municipality has developed a spreadsheet model that calculates a project's emissions over the entire construction period. The spreadsheet uses a simplified methodology, because of the lack of detailed project information at the environmental review stage of the project. Consequently, the spreadsheet encourages users to enter as much project specific information as is available for the project being analyzed. Another State indicated that the State Air Agency uses Western Air Partnership (WRAP) emissions calculation estimates in addition to EPA adopted models such as NONROAD, and AP-42, but they generally do not develop independent emissions quantification methods outside of what is required to be submitted to EPA or that is already widely in use.

- Several States reported that they have analyzed construction emissions for programs such as CMAQ, and for DERA (Diesel Emissions Reduction Act) grants. One State indicated that it used the EPA National Clean Diesel Campaign's Diesel Emission Quantifier procedures to quantify emissions reductions for a DERA grant. Another State uses an engine dynamometer and portable emissions measurement systems (PEMs) or modeling to analyze construction emissions reductions for these programs. MPOs typically have procedures in place to analyze emissions reductions for CMAQ projects. For example one State reported that one of its MPOs has procedures in place for quantifying emission benefits and disbenefits, and for calculating the cost-effectiveness, of proposed CMAQ projects. This includes methodologies for evaluating such projects as diesel retrofits for both on-road and off-road vehicles, diesel anti-idling programs, truck stop electrification projects, paving unpaved roads, street sweepers, etc.

- States generally report that they do not anticipate any problems or major concerns with future construction emissions or impacts. However one State reported that the public is concerned about dust, exhaust, and noise associated with large scale construction projects that are in close proximity to sensitive receptors, especially in higher populated project locations, so construction emissions could become more of an issue on future projects. Another State indicated that new EPA

requirements for near-road monitors for NO_2 and $PM_{2.5}$ in larger urban areas and ongoing near road research may also identify issues of concern in the future. On the other hand, most States believe that construction specifications for controlling dust emissions and continued improvements in vehicle technologies and cleaner fuels will be sufficient in most cases to address concerns for construction emissions over time.

- States that have completed a construction emissions analysis typically coordinate with agencies such as MPOs, State and Local Air Quality Agencies, State Health Departments, FHWA, FTA, and EPA. Several States indicated that the transportation conformity consultation process, or something equivalent to it, was or will be used. Other States indicated that if they do construction emissions analysis for projects in the future a consultation process would need to be developed. Screening processes, model selection, and model inputs and parameters are determined through the interagency consultation process. States also typically consult with other agencies on meteorological data, background concentration levels, and receptor placement.

- No State reported using a vendor or utility software for analyzing construction emissions. One State did indicate that it is has a current research effort in progress to survey vendors and software for a project that will require the use of EPA's MOVES emissions model, but indicated that effort is not specific to construction emissions.

Overview of Selected State DOTs:

Arizona

Background

Arizona DOT (ADOT) indicates that road construction emissions are an issue for the State. These construction emissions are generally included in the motor vehicle emissions budgets contained in SIPs, in emissions inventories, and/or as part of the regional conformity analysis, rather than as part of project level environmental analyses. The impacts of these construction emissions are quantified for re-entrained dust from paved and unpaved roads and for general construction activities from both earthmoving operations and tailpipe emissions from construction equipment. ADOT states that construction emissions analyzed at the regional level tend to be over estimated and may not accurately reflect a typical road construction project's actual contribution to emissions, thereby resulting in mitigation measures that may have minimal impacts on actual emissions.

Analysis Procedures

The State Air Agency uses EPA adopted models such as the NONROAD emissions model, AP-42 emissions factors, and the Western Regional Air Partnership's (WRAP) emissions calculation estimates. WRAP is a voluntary partnership of States, tribes, federal land

managers, local air agencies and EPA whose purpose is to understand current and evolving regional air quality issues in the Western States. The State Air Agency generally does not develop independent emissions quantification methods outside of what is required to be submitted to EPA or is already widely in use. WRAP has developed emissions estimations procedures for construction emissions that describe how on-road and off-road mobile source emissions inventories were developed.[27] For all pollutants, emissions were estimated separately by equipment type and engine type for off-road sources. Emissions were also summarized for both gasoline and diesel-fueled engines. WRAP also developed emissions estimations procedures that describe how the fugitive dust emissions inventory was developed.[28] Fugitive dust emissions as represented in the WRAP modeling inventories include, among other things, general source categories such as construction and mining operations, road dust, and wind blown dust from vacant lands. WRAP's website for Emissions Data Analysis Tools can be found at http://vista.cira.colostate.edu/TSS/Results/Emissions.aspx.

While construction emissions are addressed at the regional level, ADOT does not have any qualitative or quantitative procedures for analyzing construction emissions as part of its project level environmental analyses. Only mitigation measures are identified at this stage. ADOT indicates that at this time environmental documents only include a notation that construction emissions are temporary and refer to State and local regulations and requirements to control these emissions. ADOT further indicates that various counties do require dust control permits that include required mitigation and test procedures such as site stabilization and opacity measurements; and that contractors are generally responsible for ensuring compliance with dust permits.

ADOT also notes that a former Governor issued an Executive Order[29] at a 'policy' level to provide incentives to bidders in contracts to include diesel retrofits; newer clean diesel technologies and fuels; or "green diesel," biodiesel fuel, or other fuels that are cleaner than petroleum diesel in road construction projects. ADOT is awaiting further guidance before implementing the EO in contract requirements.

ADOT indicates that in the future it may complete construction emissions analyses at the project level for those areas that have clearly identified construction dust as a significant issue, although this evaluation will likely be included in project level hot-spot analysis and not in environmental analysis. As an example, ADOT states that since the State Air Agency included construction emissions as part of the motor vehicle emissions budget in the Nogales isolated rural $PM_{10}/PM_{2.5}$ nonattainment area, these emissions will be addressed as part of a project level hot-spot analysis or similar effort if needed. ADOT notes, however, that it will need a methodology to address these road construction emissions on a project level given the methodology to establish the budget was at a regional level.

Also ADOT reports it has no experience with EPA's NONROAD emissions model and other air dispersion modeling procedures, and that staffing levels required to complete the analysis will be a concern.

ADOT has not utilized any CMAQ or grant funds for construction equipment or emissions. However, analysis procedures are in place for evaluating diesel retrofits and road paving projects funded with CMAQ funds. For example the Maricopa Association of Governments has procedures in place for quantifying emission benefits and disbenefits and for calculating the cost-effectiveness of proposed CMAQ projects.[30] This includes methodologies for evaluating such projects as diesel retrofits for both on-road and off-road vehicles, diesel anti-idling programs, truck stop electrification projects, paving unpaved roads, street sweepers, etc.

Interagency Consultation

ADOT reports that since construction emissions are generally developed during the development of the SIP, or emissions inventories, and evaluated as part of the regional conformity analysis, the consultation procedures in the conformity regulations will be used by each MPO area. ADOT, MPOs, and State/Local Air Quality Agencies, will be involved in any construction emissions analysis, in consultation with FHWA, FTA, and EPA. ADOT further reports that a project level consultation process for NEPA documents will need to be established.

California

Construction emission analysis is a short-term impact concern for environmental impact analysis in California (especially CEQA – California Environmental Quality Act). Caltrans normally does only a qualitative emission analysis unless required, such as Indirect Source rules in the San Joaquin Valley area. In some cases, air pollution control districts have quantitative analysis (emission and dispersion modeling) requirements for State-level environmental documents that require district permits.

Project-level emissions modeling tools have been developed to calculate construction and other emissions for a variety of projects. For typical land development projects (not road projects), these models include the URBEMIS and CalEEMod modeling platforms. URBEMIS was used to calculate project air emissions using EMFAC2007 for on-road vehicle emissions and OFFROAD2007 model for off-road vehicle emissions.[31] In February 2011, the California Emissions Estimator Model (CalEEMod) was introduced as a replacement for URBEMIS.[32] Both models calculate criteria pollutant and greenhouse gas emissions. The current CalEEMOD tool provides construction emission analysis for general land uses and construction, but is better suited for area sources like residential and commercial development than road construction emission analysis. San Joaquin Valley requires it for indirect source analysis of non-road projects, so for instance an office building or maintenance station project would use the CalEEMod model.

For construction emissions from road projects, the Sacramento Air Quality Management District's Road Construction Emissions Model is commonly used. The model is based on EMFAC2011 and OFFROAD2011 emissions factors to calculate emissions from construction equipment.[33] OFFROAD2007 emissions factors are used for categories not included in OFFROAD2011. The Road Construction Emissions Model uses an emission

estimate worksheet to calculate a project's emissions in pounds per day by project phase and in tons over the entire construction period. The spreadsheet predicts Reactive Organic Gases (ROG), CO, NO_X, CO_2 and both PM_{10} and $PM_{2.5}$ exhaust and fugitive emissions from construction activities and equipment.

Caveats regarding the Sacramento spreadsheet approach include:

1) The spreadsheet uses a simplified methodology, involving estimates of acres of land disturbed daily by construction operations, to predict fugitive emissions. This is because estimates of fugitive emissions for individual vehicles and construction activities are not feasible for most studies due to a lack of detailed information about the number, types, and usage of equipment at the environmental review stage of the project.

2) The Sacramento model does not incorporate emission modeling for significant structures. It is designed more for local projects that do not include much structure construction.

3) The spreadsheet's default equipment fleet is incorrect for most significant road projects. Users need to enter as much project specific information as is available for the project being analyzed.

4) The spreadsheet is based on Sacramento-area vehicle fleet emission data, which may differ in other areas, so it's an approximation when used outside Sacramento County; however, off-road fleet emission factors don't vary as much across the State as the on-road fleet does. The Sacramento approach is therefore good enough that other air districts require or suggest its use. Sacramento model use is required in the San Joaquin Valley area for road projects under the San Joaquin Valley Air Pollution Control District's Indirect Source Rule (9510) to calculate impacts that feed into setting of mitigation fees and other requirements. To date, San Joaquin Valley remains the only area where this analysis is required by rule -- in other areas in California it may be done as part of the environmental analysis process.

Caltrans is working on a spreadsheet tool similar in concept to Sacramento's but more focused on Caltrans construction practices, and adding construction-related emissions that are difficult to address in Sacramento's model. However, this spreadsheet is not yet ready for general distribution.

For environmental work, Caltrans is transitioning (for the most part, has transitioned for NEPA and CEQA purposes) to using EMFAC2011 which is the current version of California's MOVES-equivalent emission model, and CARB's OFFROAD 2011 emissions modeling methods. For conformity, EMFAC2007 was the EPA-approved emissions model for studies started before February 22, 2013; for studies after that, EMFAC 2011 is available and will be required after August 22, 2013. Caltrans notes that project level construction emissions analysis is rare as part of a project level conformity determination

since few projects approach the 5-year construction duration that would trigger such a conformity analysis.

NOx emissions from construction equipment are controlled by State and local air district rules that are enforceable under Caltrans Standard Specifications. The State air board has on- and off-road vehicle/equipment fleet and portable engine rules that have specific schedules and equipment tracking/identification procedures for implementing emission controls.[34] Contractors must follow those rules and file documentation with the State. State air board regulations also limit idling to five minutes statewide for off- and on-road diesels, with some local regulations and ordinances further restricting idling times to as little as two to three minutes. State air board regulations also require that off-road diesel fuel meet on-road fuel formulation requirements (i.e. sulfur content <15 ppm, etc.). For public fleets, some local regulations (especially in the South Coast area) have more stringent requirements than the State rules including near-prohibition on purchase of new diesel-powered vehicles.

Colorado

Colorado DOT (CDOT) indicates that its primary concerns on construction projects are the generation of fugitive dust from ground disturbance activities such as hauling and stock piling; on-site processing emissions such as asphalt batch plants and concrete plants; and secondarily construction emissions from diesel vehicles and equipment. Nevertheless, CDOT considers construction emissions to be temporary in nature.

CDOT reports that it has not developed any policies, technical guidance, and/or qualitative or quantitative procedures for analyzing construction emissions. Other than a qualitative statement for NEPA assessments, CDOT projects are not analyzed for specific construction project emissions unless generated emissions exceed prescribed levels for stationary/area sources. In large complex highway construction/demolition projects such as the I-25 TREX project and most recently the I-70 Twin Tunnels project, construction monitoring of PM emissions has/is being employed to signal unacceptable emissions caused by tunnel blasting and related construction activities, rather than predicting operational vehicle emissions.

CDOT reports that it does not plan to complete any construction emissions analyses in the near term. However, CDOT's Environmental Programs is planning to develop potential post-project award construction emissions plans to better define and control construction emissions, but has not yet funded this proposal. The intent would be to control emissions rather than to do quantitative emissions analyses.

CDOT notes, however, that since non-road engines, among others, release criteria and non-criteria air pollutants, such as NOx, PM, CO, non-methane hydrocarbons (NMHC), sulfur dioxides (SOx), and hazardous air pollutants (HAPs), the Colorado Department of Public Health and Environment's (CDPHE) Air Pollution Control Division (APCD) regulate these pollutants. In Colorado, owners or operators of these engines may be required to

submit an Air Pollutant Emissions Notice (APEN), and obtain an air permit from the APCD.[35] Air quality regulations for these engines generally include permitting, emissions control, monitoring, recordkeeping and reporting requirements. General APEN "permits" require a dust control plan and require that dust control best management practices (BMPs) be implemented on most projects. CDOT indicates that currently only general BMPs suggesting vehicle emissions controls on vehicle and equipment are generally listed as NEPA mitigation. CDOT anticipates that as crankcase and tailpipe emissions are further regulated, new standards for construction operating equipment will be needed beyond the general air quality requirements of the State's APEN permit system.

Since CDOT has not completed any construction emissions analyses, it has not discussed or developed any specific interagency consultation procedures for such analyses, or determined what issues may be determined through an interagency consultation process.

Maryland

The Maryland State Highway Administration (SHA) indicates that construction emissions are not normally an issue in the State. Consequently, rather than quantifying construction emissions, the SHA usually puts a paragraph in its Project-Level Air Quality Reports that references Maryland SHA's Standard Specifications for Construction. Below is a sample statement that is typically used:

> *"The construction phase of the proposed project has the potential to impact the local ambient air quality by generating fugitive dust through activities such as demolition and materials handling. The State Highway Administration has addressed this possibility by establishing 'Specifications for Construction and Materials' which specifies procedures to be followed by contractors involved in site work. The Maryland Air and Radiation Management Administration was consulted to determine the adequacy of the 'Specifications' in terms of satisfying the requirements of the 'Regulations Governing the Control of Air Pollution in the State of Maryland'. The Maryland Air and Radiation Management Administration found the specifications to be consistent with the requirements of these regulations. Therefore, during the construction period, all appropriate measures (Code of Maryland Regulations 10.18.06.03 D) would be incorporated to minimize the impact of the proposed transportation improvements on the air quality of the area."*[36]

On the recent Intercounty Connector project, which is a major project costing approximately $2.6 billion, Maryland SHA did include a requirement for the contractors to use equipment that meets more recent emissions requirements either by purchasing new equipment or by retrofitting existing equipment.

Maryland SHA does not anticipate any problems with future construction emissions from a policy point of view, considering its standard specifications. However, the additional

requirements for the Intercounty Connector were the result of public involvement, so it's conceivable that construction emissions could become more of an issue on future projects.

Minnesota

MNDOT reports that emissions on construction projects may become an issue. The areas of concern include re-entrained dust from unpaved roads, fugitive dust from earth moving activities, exhaust emissions from construction equipment, and concrete saw cutting operations. Managing the construction emissions is attempted through specifications in the contracting documents that require dust suppression, etc.

MNDOT has not developed qualitative or quantitative procedures for analyzing construction emissions, nor has it completed any construction emissions analyses as part of its environmental analyses. However, MNDOT indicates that it is possible they may be required to do so in the future especially if any area in Minnesota goes into nonattainment for $PM_{2.5}$. In this case, Minnesota may also be required to consider some control measures to regulate construction emissions on its projects.

MNDOT participated in a series of facilitated stakeholder events, consisting of leaders from business, government and nonprofit sectors that identified the challenges Minnesota may face with more stringent air quality standards and proposed strategies to address them. This process referred to as Minnesota's Clean Air Dialogue builds upon longstanding public-private partnerships that have worked together for many years.[37] The goals for this project are to educate, motivate and engage a wider community of stakeholders on the issues of air quality and the potential for nonattainment of new federal air quality standards. This environmental initiative includes Work Groups, consisting of technical and issue experts, which have developed a series of emission reduction strategies to consider in each of six categories, including Mobile Diesel that will include, among other things, non-road strategies for public works projects.

In particular, one of the proposed emission reduction initiatives, under "Support for New or Expanded Action" is proposal #12, Model Contract for Public Works Projects.[38] Through this effort MNDOT will attempt to develop a model contract for use by public agencies containing emissions performance specifications for projects above a certain size/cost threshold. At this time it has not been decided what it will entail, (i.e., set emission limits, equipment and vehicle performance requirements, and/or a point system or incentive type program for retrofitted equipment, alternative fuel use, etc.)

If MNDOT develops a construction emissions analysis procedure in the future or a model contract with emissions controls it will work through an interagency consultation process. Depending on what type of process is proposed, and assuming that Minnesota does not go into nonattainment for $PM_{2.5}$, the following groups may be involved: Minnesota Clean Air Dialogue Stakeholder Group (which includes representatives from a wide range of private companies, public agencies, non-profits, etc.), Minnesota Pollution Control Agency (MPCA), EPA, Metropolitan Council, Association of General Contractors, Minnesota Interagency Air Quality and Transportation Planning Committee, FHWA, etc. MNDOT

indicates that if analyzing construction emissions is required in the future the process and methods for determining model selection, model inputs, etc. would be either determined by EPA, the MPCA and/or determined through its interagency consultation process.

New York

Background

New York State Department of Transportation (NYSDOT) indicates that the main concerns with construction emissions are road dust, fugitive dust from off-road equipment, and exhaust emissions from construction equipment associated with large scale construction projects that are in close proximity to sensitive receptors in higher populated project locations.

NYSDOT developed PM guidance for transportation projects in 2003. While the primary purpose of the guidance was to provide a consistent methodology based on available quantitative tools to address on-road particulate matter emissions as part of the State Environmental Quality Review Act (SEQRA) and NEPA process, it also included recommendations on how to evaluate construction emissions impacts. Under the guidance, projects with a construction emission burden of greater than 15 tons per year (tpy), based on the highest cost year of construction and construction intensity based emissions factors, were considered to have potentially significant PM impacts. For projects that exceeded the 15 tpy screening threshold, the guidance recommended use of the EPA NONROAD emissions model to do a more detailed emissions burden estimate at a point prior to construction when specific equipment and hours of operation become available. If the NONROAD analysis predicted an emissions burden of 15 tpy or more, project mangers were encouraged to mitigate below the 15 tpy level as practicable and usually through the use of clean construction specifications such as low sulfur diesel, diesel particulate filters and control devices on equipment, dust suppression, etc.

In January 2013, new NYSDOT guidance[39] was issued to address on-road PM emissions in environmental documents and the 2003 PM guidance was rescinded. This new guidance recommends the use of the EPA quantitative hot-spot guidance for PM with MOVES to screen and, as appropriate, evaluate PM emissions. The new guidance does not specifically address construction emissions. Thus, guidance in existing NYSDOT Environmental Procedures Manual Chapter 1.1 Section 15[40] is the only written guidance to address construction emissions. This long- standing guidance only addresses on-road emissions from construction diversions and detours.

Thus, NYSDOTs official approach to addressing construction emissions from transportation projects is addressed on a case-by-case basis. Green Construction Practices, which are contained in Engineering Instruction 09-009 (EI),[41] are followed for all NYSDOT projects to minimize air quality impacts during construction. Under these provisions all new construction contracts will: 1) require the use of ultra-low sulfur diesel fuel in construction equipment; 2) include provisions banning the idling of diesel equipment for longer than three minutes, with certain exceptions, 3) include provisions to

protect air intakes for buildings and/or facilities from the impacts of diesel exhaust fumes, and 4) include additional requirements for dust control.

When construction emissions are expected to be substantial, or there is substantial concern from the public regarding construction emissions for a project, NYSDOT indicates that it requires quantification of the emissions to confirm that no violation of the air quality standards will occur during construction. NYSDOT also indicates that it has analyzed construction emissions for the Diesel Emissions Reduction Act (DERA) grant program. EPA's DEQ procedures were used for these analyses.

New NY Bridge (formerly Tappan Zee Hudson River Crossing Project)

A quantitative construction emissions analysis was performed as part of the environmental analysis of the New NY Bridge. This project includes an extensive analysis of construction emissions as part of the General Conformity Analysis[42] and in the Construction Impacts Chapter of the EIS[43] for the project. A general conformity analysis was done for this project since it requires permits from the Corps of Engineers and the U.S. Coast Guard, and it exceeds certain total annual direct and indirect emissions thresholds. The analysis indicates that the engine exhaust emission factors for NOx, CO, PM_{10}, and $PM_{2.5}$ from on-site construction engines were developed using EPA's NONROAD2008 emissions model. If EPA emission factors were not available for specific on-site construction engines, specifically developed emission factors were used. With respect to truck engines, emission rates for NO_X, CO, PM_{10}, and $PM_{2.5}$ were developed using MOBILE6. Tugboat emissions were estimated according to the latest emission factors and methodologies delineated by EPA. Estimates of PM fugitive emissions generated by material handling activities such as loading/drop operations for fill materials and excavation, truck transports, and concrete batching operations were developed based on EPA's AP-42 procedures. Stationary source emissions were simulated as point sources.

The AERMOD dispersion model was used to project NO_2, CO, PM_{10}, and $PM_{2.5}$ concentration increments resulting from the construction of the project. The meteorological data set consisted of five consecutive years of meteorological data. The surface data was collected at LaGuardia Airport (2006–2010) and concurrent upper air data was collected at Brookhaven, New York. Receptor locations were placed along the sidewalks closest to the construction sites that would be publicly accessible, at residential and other sensitive uses at both ground-level and elevated locations, and at open spaces. The results showed that the maximum predicted total concentrations, which includes the concentration levels from the construction project summed together with background concentration levels, for PM_{10}, $PM_{2.5,}$ CO, and annual-average NO_2 would not exceed the NAAQS.

Interagency Coordination

NYSDOT reports that State and local DOTs and FHWA will take the lead in any construction emissions analysis. The State air quality agency, the State Health Department, and EPA will serve as resource agencies. Screening processes, model

selection, and model inputs and parameters are determined thru the interagency consultation process. Consultation is also held on meteorological data, background concentration levels, and receptor placement. Meetings, emails, and other informal communication are used to address any issues of agency concern prior to the formal agency consultation during draft NEPA document reviews.

Texas

Control of construction emissions are generally addressed through programmatic approaches some of which occur post NEPA. In addition, Texas has the Texas Emission Reduction Program (TERP)[44] that funds diesel retrofits and most construction projects are less than 5 years in duration at any individual site, so TxDOT does not typically quantitatively analyze construction emissions in NEPA documents. As a result TxDOT reports it has not developed qualitative or quantitative procedures for such analysis.

TxDOT reports that if construction emissions become a public concern it will consider conducting a more detailed qualitative or quantitative emissions analysis. In this case, TxDOT would likely contract with the Texas Transportation Institute (TTI) for any modeling work that would be required.

Rather than relying on quantification of construction emissions as part of environmental analysis or regional analysis, TxDOT relies on a programmatic approach such as through construction specifications to limit dust and idling emissions at construction sites and to require use of recycled products and/or warm mix asphalt, both of which reduce the total lifecycle emission footprint of construction activities. Texas also has State and Federal programs, such as the Department of Energy's Clean Cities Programs and EPA's NAAQS Advance Programs**,** in place to reduce emissions. The State TERP program offers financial incentives to eligible individuals, businesses or local governments to reduce emissions from polluting vehicles and equipment and has funded diesel retrofits in nonattainment and near nonattainment areas. The TERP program includes a number of grant programs that are relevant to construction emissions such as:

- Emissions Reduction Incentive Grants which, among other things, encourage entities to upgrade or replace heavy duty on-road vehicles, non-road equipment, locomotives, stationary equipment, on-site electrification and idle reduction infrastructure, etc. to reduce NO_x emissions by at least 25% from high emitting diesel engines; and

- The American Recovery and Reinvestment Act Rebate Grants Program which is intended to upgrade or replace heavy-duty vehicles and/or non-road equipment. Under these grants on-road replacement vehicles may be powered by diesel, natural gas, or propane. On non-road projects older diesel engines may only be replaced with a newer diesel engine.

TxDOT has analyzed construction emissions for programs such as CMAQ, and for DERA grants via emissions analysis using an engine dynamometer and portable emissions measurement systems (PEMs), via modeling, or via tools developed by TTI.[45]

While TxDOT notes that near-road monitors and ongoing near-road research may identify issues of concern in the future with regard to construction emissions, it states that construction specifications, and programmatic approaches together with vehicle technological improvements may be sufficient to address the issues over time.

Since TXDOT has not quantitatively analyzed construction emissions, it currently does not have a specific interagency consultation process in place for this type of analysis. However, if such an analysis is required in the future, TxDOT notes that the transportation conformity consultation process, or something equivalent to it, would most likely be used. This would include all the Federal, State, and local agencies typically involved in the transportation conformity process. Through the interagency consultation process TxDOT would propose the methodology, models, and data sets and inputs for consultation concurrence. For exhaust emissions TxDOT would likely develop construction drive cycles and use PEMs exhaust analysis to further refine emissions models for Texas specific application.

Washington

Washington State DOT (WSDOT) has not developed a formal quantitative methodology for consistently analyzing construction emissions. However, WSDOT did complete a quantitative analysis for the SR 520, I-5 to Medina: Bridge Replacement and HOV Project which it feels is a reasonable approach. This analysis is included in the Air Quality Discipline Report Addendum and Errata for the Final Environmental Impact Statement (FEIS) for the project.[46]

A qualitative discussion of construction impacts was initially included in the Supplemental Draft Environmental Impact Statement (SDEIS). However, recent construction schedules for the Preferred Alternative suggest that construction activities could exceed five years in duration in several locations. Consequently, in accordance with the transportation conformity requirements, a quantitative analysis was conducted at these locations. While not required, WSDOT decided to expand the analysis to other areas as well in response to public comments on the SDEIS.

While the project is located in a CO maintenance area and attainment for all other pollutants, the Air Quality Discipline Report provides construction emissions estimates for all criteria pollutants at six different locations for each year of construction (2012 through 2018). Detailed summary tables of the emissions estimates are included in Attachment 2 of the Report.

The Air Quality Discipline Report outlines how it was impossible to estimate the exact schedule of construction activities at the time the report was developed. Therefore, the emissions calculations represent annual totals in tons/per year for all emissions types.

Summary tables show the peak year of emissions for each area, identify the area with the potential for the greatest emissions, and describe the temporary nature of construction related pollutant emissions.

The Report quantifies construction PM_{10} and $PM_{2.5}$ emissions using the South Coast Air Quality Management District's (SCAQMD) recommended methodology. Fugitive dust emissions were estimated using an uncontrolled PM_{10} emission factor of 20 pounds per acre per day consistent with CARB's URBEMIS2007 model. Since it was assumed that the disturbed areas would be watered at least twice a day, the fugitive dust emissions were reduced by 50 percent. The maximum disturbed area was assumed to be 0.2 to 8 acres per day. The $PM_{2.5}$ emissions were assumed to be 21 percent of PM_{10} emissions, using the $PM_{2.5}$ fraction recommended by SCAQMD.[47]

The Report also indicates that off-road construction equipment emission factors for CO, NOx, VOCs, SOx, PM_{10} and $PM_{2.5}$ were calculated using the EPA NONROAD program, and that exhaust emission factors of haul trucks and worker commute vehicles were estimated using EPA's MOBILE6.2 model. The MOBILE6.2 model inputs were provided by the Puget Sound Regional Council. For asphalt paving, the default emission factor of 2.62 pounds per acre in URBEMIS2007 was used to calculate VOC emissions for the acreage provided by the transportation team at each construction location.

The Report clarifies that BMPs will be used to minimize construction emissions and that State law requires construction site owners and/or operators to take reasonable precautions to prevent fugitive dust from becoming airborne. It further clarifies that WSDOT will comply with the procedures outlined in the Memorandum of Agreement between WSDOT and the Puget Sound Clean Air Agency for controlling fugitive dust which could include such items as watering exposed soil, using phased development to keep disturbed areas to a minimum, locating construction equipment and truck staging areas away from sensitive receptors, etc.[48]

$PM_{10,}$ $PM_{2.5}$, VOCs, NOx, and CO emissions will be minimized to the extent possible by keeping construction equipment and machinery engines in good mechanical condition. SO_2 and PM emissions from these engines will also be reduced by using ultra-low-sulfur diesel fuel in on-road trucks and construction equipment. WSDOT encourages its contractors to reduce idling time of equipment and vehicles and to use newer construction equipment or equipment with add-on emission controls.

As a result of the construction emissions analysis, WSDOT concluded that the emissions from construction activities would be temporary and that no adverse effects are expected after avoidance and minimization measures are applied during construction.

RESEARCH, REPORTS, AND WEBSITES

The following is a summary of selected research documents, reports, and websites that are relevant to the analysis of construction emissions. In addition, as mentioned at the beginning of this report, the COP previously developed a report entitled, *Short Term Impacts from Construction Equipment and Operations* in March 2010. This report includes a number of research activities, including several by the North Carolina State University, that relate to the analysis of construction emissions. The reader of this report is encouraged to also review this previous report at http://environment.transportation.org/pdf/communities_of_practice/airqualconstr.pdf as the research activities included in that report are not repeated below.

EPA - *Diesel Retrofits: Quantifying and Using Their Benefits in SIPs and Conformity - Guidance for State and Local Air and Transportation Agencies:*[49] This document provides guidance on quantifying and using emission reductions from highway and non-road diesel vehicles, engines, and equipment that have been retrofitted with emission reduction technology in 8-hour ozone, $PM_{2.5}$, PM_{10}, and CO nonattainment and maintenance areas. It indicates that diesel retrofit technologies can reduce pollution from the existing diesel engine fleet by up to 90% for PM, up to 50% for NOx, and up to 90% for VOCs. The guidance also indicates that, among other things, the emission reductions resulting from implementing a retrofit project can be used in transportation conformity determinations. The guidance further states that retrofit projects provide a unique and cost-effective opportunity for State and local governments to reduce pollution from highway and non-road diesel vehicle and equipment fleets.

EPA - Diesel Retrofit Technology - *An Analysis of the Cost-Effectiveness of Reducing Particulate Matter and Nitrogen Oxides Emissions from Heavy-Duty Non-road Diesel Engines Through Retrofits*:[50] The purpose of this technical analysis was to evaluate the cost effectiveness of retrofitting existing heavy-duty diesel non-road engines to reduce PM and NOx emissions. The report includes an evaluation of the costs and emissions benefits of retrofitting non-road equipment such as tractors/loaders/backhoes, excavators, cranes, generator sets, agricultural tractors, crawler tractors/dozers and off-highway trucks with diesel oxidation catalysts and catalyzed diesel particulate filters. EPA's report indicates the cost effectiveness for both diesel oxidation catalyst and catalyzed diesel particulate filter retrofits ranged from $18,700 to $87,600 per ton of PM reduced. In addition, the cost effectiveness for both selective catalytic reduction systems and engine upgrade kits ranged from $1,900 to $19,000 per ton of NOx reduced. The study thus concludes that retrofits can be a cost effective way to reduce air pollution and health impacts associated with diesel emissions.

EPA - *Emission Standards Reference Guide:*[51] This guide contains federal emission standards for on-road and non-road vehicles and engines, and related fuel sulfur standards. Each table includes information on items such as the standards, useful life, warranty period, etc. For example the Non-road Compression-Ignition Engines -- Exhaust Emission Standards table includes the emissions standards, useful life, and warranty period for various engines sizes. The guide indicates that it is for reference purposes only and that

the regulated community should refer to the Code of Federal Regulations for complete information on all standards to ensure compliance.

FHWA – *Multi-Pollutant Emissions Benefits of Transportation Strategies:*[52] The purpose of this report is to help practitioners consider appropriate strategies for reducing transportation-related emissions of concern and to determine the emissions effects of these strategies. This report provides an overview of the impacts of different types of transportation strategies including, among others, vehicle technology and fuels strategies that focus on reducing vehicle emission rates by changing vehicle characteristics or fuel composition; non-road transportation strategies which includes transportation construction and related equipment; and road dust reduction strategies that focus on reducing fugitive dust emissions from paved and unpaved roads. For each strategy, the document reports on the direction of emissions impacts that typically are expected for each pollutant. It also includes calculations of emissions impacts for sample projects, based on real project examples, and identifies EPA guidance documents that should be referenced and sample methodologies for calculating impacts.

NCHRP 25-25, Task 42 [Completed] – *Alternative Methods For Determining Emissions For Re-Entrained Road Dust On Transportation Projects:*[53] The purpose of this research effort was to identify alternative approaches to the AP-42 methodology for determining more reliable emission factors for re-entrained road dust for application to transportation projects. The report indicates that the traditional AP-42 methodology, which has been in place for more than 30 years, relies on difficult and costly road surface sampling to gather critical information for input into the AP-42 emission factor equations. This research began with an analysis of the current practice of applying the AP-42 methodology and its deficiencies. This included not only the requirement of road surface sampling, which the report indicates limits the feasibility of full method application, but also the use and limitations of default dust ("silt") loading tables that can be used in place of road surface sampling. The research then shifted to an evaluation of the mobile monitoring and the specific configurations that have been tested. Finally, a new set of hybrid combinations of mobile monitoring and the AP-42 methodology were developed, with accuracies equal to or greater than the AP-42 methodology alone, but with significantly lower costs of implementation.

California Department of Transportation - *Measuring and Modeling PM Emissions from Heavy-Duty Construction Equipment:*[54] The purpose of this project is to expand on the measurement and modeling work currently being done by the University of California (UC) Riverside on construction equipment. The project's focus will be on PM emissions for which the proposal indicates there are currently no commercially available instruments for use in the field. This program will use the instrumentation that is being developed at UC Riverside to expand the existing model to include PM emissions.

Alan M. Voorhees Transportation Center, Rutgers University - *Planning Level Assessment of Greenhouse Gas Emissions for Alternative Transportation*:[55] This research proposal indicates that the University, in collaboration with NJ DOT and NJ Transit, developed a spreadsheet tool that allows engineers to estimate GHG emissions

associated with specific transportation construction practices for both highway and rail projects, including emissions from material inputs, construction equipment activity, life-cycle maintenance, and project staging inputs over the lifetime of a project. The research states that the spreadsheet tool, which is referred to as the Greenhouse Gas Assessment Spreadsheet for Transportation Capital Projects (GASCAP), will allow NJDOT personnel and potentially contractors to input project data from bid sheets and specify a maintenance plan for the life of the facility. This process provides estimates that allow project engineers to compare how different project construction decisions may affect overall life-cycle GHG emissions. The research proposal further indicates that while the current GASCAP model provides project specific estimates; the goal of this proposal is to provide a technique whereby estimates of GHG emissions can be estimated from basic information such as lane-miles or track-miles constructed, or rehabilitated, and to compare the GHG emissions associated with alternative construction and maintenance materials, practices, and techniques that are typically used in projects. This will allow an assessment of a wider range of alternative transportation construction projects to inform higher-level decision making by policy-makers.

Song Bai, Douglas Eisinger, Paul Benson, and Stephen Reid, Sonoma Technology, Inc.; Deb Niemeier, University of California, Davis; and Beverly Chenausky, Arizona Department of Transportation - ***Modeling In-Use Construction Equipment Emissions for Highway Projects: Framework, Methodology, and Case Analysis:***[56] This TRB paper describes a construction emissions modeling framework and construction methodologies to help estimate emissions from highway construction activities. The paper indicates that the modeling framework builds linkages between material quantities, equipment in-use hours, and pollutant emissions by using bid data and field data collected from a range of highway construction projects. The paper further indicates that data calculation and processing methodologies can assist project analysts in creating emissions estimates across various construction operations early in the project's environmental assessment. A hypothetical freeway widening case study was used to demonstrate the application of the modeling framework and calculation methodologies and illustrates the framework's ability to disaggregate emissions by construction operation. The paper encourages project analysts to develop and update modeling data as a project progresses. The paper concludes by stating that further data collection and research is needed to refine activity statistics by project type and to prioritize equipment types by their emissions contribution.

The Louis Berger Group Inc. - ***Templates for Project-Level Analyses Using MOVES,*** **CAL3QHC/R** ***and AERMOD:***[57] The purpose of this project was to develop a project-level analysis air quality technical report template for use by State DOTs in the preparation of project-level analyses for PM and other pollutants to address transportation conformity and NEPA requirements. The report indicates that while the focus of the template was on PM and CO hot-spot analyses, it also was designed to briefly address the topics of road dust and construction air quality impacts, mobile source air toxics and indirect effects and cumulative impacts to air quality. The report indicates that road dust emissions were calculated using the emission factor equation and adjustments described in EPA's AP-42 document for a sample project. It indicates the data needed for the road dust calculations included the road silt loading, the average vehicle weight traveling over the link, and a

precipitation adjustment. The report states that: 1) the site-specific silt loading data must be consistent with the data used in regional emissions analyses and needs to be adjusted using AP-42; 2) data for the precipitation adjustment should be available from the regional analysis of road dust emissions; and 3) the average weight can be estimated based on the mix of traffic by vehicle type and an assumption of the average weight of each vehicle type. The report also states that once all these data were gathered, a spreadsheet was prepared for the sample project to compute the road dust emission rates for each link, hour and month included in the project.

Sonoma Technology, Inc. - *Construction Activity, Emissions, and Air Quality Impacts: Real-World Observations from an Arizona Road-Widening Case Study:*[58] ADOT sponsored this investigation to gain insight into construction-related emissions of PM, the near-road pollutant concentration impacts that result from those emissions, and opportunities to mitigate potential impacts. Although the study focused on assessing $PM_{2.5}$, the report indicates that the research yielded insight into other pollutants related to construction activities, including PM_{10}, CO_2, oxides of nitrogen, and black carbon. The report indicates that the study assessed activity, emissions, and air quality impacts associated with construction activities for the widening of a four mile segment of SR 92 from two-lanes to five-lanes.

The study indicates that emissions estimates were prepared based on construction equipment activity collected using global positioning system units and fuel consumption logs, combined with emission factors available from EPA. Near-field pollutant concentrations were characterized through the collection of air quality and meteorological data at four monitoring stations near the roadway. Work also included a literature assessment of construction-related activity, emissions, and mitigation opportunities. The study concludes that construction activity increased PM_{10} concentrations at downwind receptors, and that the predominant contributor to these impacts was fugitive dust, as opposed to exhaust emissions. In contrast to the PM_{10} findings, the study results indicate that construction work did not substantively affect near-field $PM_{2.5}$ concentrations.

ICF International - *Greenhouse Gas Mitigation Measures for Transportation Construction, Maintenance, and Operations Activities:*[59] The report states that the primary product that was developed is a spreadsheet-based calculator tool referred to as the Greenhouse Gas Calculator for State Departments of Transportation (GreenDOT). The spreadsheet-based calculator tool calculates CO_2 emissions from the operations, construction, and maintenance activities of State DOTs for geographical areas ranging from a single project to an entire State, and over time periods ranging from one day to several years. The report further indicates that GreenDOT calculates emissions in: 1) the Electricity Module which calculates emissions from electricity used in street lights, street lamps, signs, and other roadway appurtenances, and estimates the impact of mitigation strategies such as more efficient lighting technologies and reducing the amount of lighting used; 2) the On-Road Module which calculates emissions from cars and trucks and estimates the impact of mitigation strategies such as VMT reduction, measures to improve the fuel economy of vehicles, and alternative fuels and vehicle types; 3) the Off-Road Module which calculates emissions from construction and maintenance equipment, and

estimates the impact of mitigation strategies such as activity reduction, measures to improve the fuel economy of equipment, and alternative fuels and vehicle types; and 4) the Materials Module which calculates emissions based on volumes and types of materials used in roadways, and estimates the impact of mitigation strategies such as using recycled materials and warm mix asphalt.

Kable, Justin Mark, University of California, Davis - ***Collecting Construction Equipment Activity Data from Caltrans Project Records:***[60] This research effort included the collection of construction diaries from 30 completed Caltrans projects and included six typical Caltrans project types. Projects types included projects such as resurfacing existing highways, constructing freeways/roads, pavement rehabilitation/widening, etc. The paper indicates that the equipment activity for every project in the sample was categorized with an equipment category, a project phase category and a percent of project completion category in order to estimate the equipment use based on type of highway project. This research resulted in a database with analytic capabilities and output tables for the average equipment activity for each project type. The paper indicates the data can be used as crude equipment activity estimation models, or can help quality check predictive models.

Texas Transportation Institute - ***Characterization of In-Use Emissions from TxDOT's Non-Road Equipment Fleet:***[61] This study characterizes in-use emissions of TxDOT's non-road diesel equipment. This document: 1) presents literature reviews of emission reduction technologies and emission control measures; 2) discusses selection of TxDOT's non-road equipment and emission reduction technologies for emissions testing, 3) and by using portable emission measurement systems shows the in-use emissions of TxDOT's diesel equipment before and after installing and utilizing hydrogen enrichment and fuel additive technologies. The report indicates that emissions measurements and data comparison and analysis were performed, and that they did not show either statistically significant NOx emissions reductions or any emissions reduction benefits for other pollutants with the selected technologies. The report further states, however, that an optimization model was also developed as part of this research and can be used to maximize the benefit of deploying other emission reduction technologies, which have proven to be effective, among TxDOT's non-road diesel fleet.

Texas Transportation Institute - ***Activity and Emissions Associated with Highway Construction Projects: Case Studies in Dallas/Fort Worth, Texas:***[62] This study included an assessment of highway construction project emissions at five study sites in Dallas/Fort Worth, Texas. The report indicates that several types of information were collected from: 1) field trucks which are light duty diesel, gasoline, or low emissions pick-up trucks used to travel around the construction site; 2) materials trucks which are trucks that deliver and remove materials from the construction site; and 3) construction equipment. Vehicles were classified according to MOBILE definitions, and the remaining equipment was classified according to AP-42 definitions. Engine starts and stops, fuel types used, and the initial odometer readings were recorded from field trucks. Engine starts, operating hours, and the frequency and duration of transient events were recorded for materials trucks and construction equipment. The activity levels from both the field and materials trucks and construction equipment were used to estimate the emissions produced at each study site.

The report states that these emissions estimates were then compared to the vehicle miles of travel for the general vehicle fleet in the region. An additional comparison was then made by expanding the highway construction activity and resulting emissions over the two-county region and comparing this to the emissions generated from on-road mobile sources. The report states that the results of this study show that highway construction emissions contribute less than 1% of the on-road mobile source CO and HC emissions inventories, and less than 3% of the on-road mobile source NOx emissions inventory.

Michigan Technological University - *The Project Emissions Estimator (PE-2): A Tool To Aid Contractors and Agencies Assess GHG Emissions of Highway Construction Projects:*[63] This report indicates the study developed and implemented a project based life cycle framework that can be used to estimate the carbon footprint for typical construction work items found in reconstruction, rehabilitation and Capital Preventive Maintenance projects. According to the report: 1) the framework applies existing life cycle assessment methods and inventories using data collected from 14 highway construction, rehabilitation and maintenance projects in the State of Michigan; and 2) the carbon footprint for each of the projects was calculated in terms of CO_2 equivalents of GHG emissions. The primary emissions include life cycle emissions of products and processes involved in the raw material acquisition and manufacturing phase, and the pavement construction phase. The framework also estimates emissions due to vehicular use and maintenance operations during the service life of the pavements. PE-2, which is a web-based tool, was developed to implement the framework and can be used to benchmark the CO_2 footprint of highway construction projects. The research suggests ways of implementing the PE-2 tool to benchmark and help reduce the CO_2 footprint of highway construction projects. This web based tool can be found at http://www.construction.mtu.edu:8000/cass_reports/webpage/index.html

Future Research/Technical Assistance Needs - AASHTO Survey Responses

In the AASHTO survey, States were asked what additional research and technical assistance, if any, they needed to more efficiently conduct qualitative or quantitative analysis of construction emissions. Most States did not offer specific recommendations to these questions because for the most part States have not been required to analyze construction emissions, especially at the project level. Responses that were received identified the following needs:

- Conduct research to determine best modeling practices for construction emissions and for mitigation strategies, and to develop interface software to assist with the application of best modeling practices.

- Conduct research on State or regional-specific silt loading factors for re-entrained road dust.

- Develop simplified emissions quantification techniques that help approximate project level construction emissions. This could include screening thresholds for various types of projects; template protocols and examples of template results;

exploring appropriate emissions models for project level construction emission analysis; and default equipment assumptions based on size of project, phasing of work, and type of activity.

- Develop a better understanding of the costs of emissions control programs in the construction arena, as well as pragmatic emissions solutions for use of older construction equipment and vehicles.

- Develop a clear definition on what constitutes "construction emissions" and how the state DOT should consider doing an analysis. The definition should indicate whether it primarily includes earth moving activities, equipment use, tailpipe emissions, etc, or if it also includes every phase of a construction project which could be very difficult to analyze.

- Develop additional technical modeling expertise, training, and tools for conducting construction emissions analysis.

The COP has developed a research proposal specifically focused on construction emissions analysis procedures. The details of this proposal are contained in Appendix B.

SUMMARY

The topic of *Construction Emissions Analysis* was selected because State DOTs are interested in minimizing short term emissions impacts from construction activities and equipment. Construction activities can result in fugitive dust emissions from various types of activities, as well as exhaust emissions from heavy duty construction equipment. Also, since EPA recently revised the air quality standards for NO_2 and $PM_{2.5,}$ State DOTs want to ensure that construction emissions do not contribute to violations of these new standards. This report, therefore, highlights EPA and FHWA/FTA requirements and guidance documents related to analyses procedures for construction emissions; current and planned practices of selected State DOTs for conducting these analyses; technical details such as which models States are using or plan to use; and current and completed research, as well as additional research or technical assistance States DOT's may need to more efficiently conduct these analyses.

EPA's Transportation Conformity regulations indicate when construction emissions must be included in project level hot-spot analysis and regional conformity analysis. The analysis of construction emissions are not required as part of hot-spot analyses unless a construction phase lasts more than five years at any individual site. This is not the case for most transportation projects. In addition, PM_{10} and $PM_{2.5}$ dust emissions associated with highway and transit project construction are not required as part of the regional conformity analysis unless they are identified in the SIP as a significant contributor to the nonattainment problem.

On the other hand, EPA's General Conformity regulations implicitly require federal agencies to include emissions from construction activities in conformity evaluations. EPA states this is because general conformity is concerned about localized impacts of direct and indirect impacts of particular actions or projects, while transportation conformity is primarily concerned with the regional impacts of long-term use of the roads, and secondarily concerned with short-term and localized impacts.

FHWA and FTA jointly administer the CMAQ program which can help fund the types of projects that will help reduce construction emissions. In fact, MAP-21 indicates that in $PM_{2.5}$ nonattainment or maintenance areas States and MPOs must give CMAQ funding priority to projects that are proven to reduce $PM_{2.5}$ emissions, including diesel retrofits. FHWA is also currently working on a *Planning-Level Assessment of Construction and Maintenance Emissions* spreadsheet tool for evaluating the GHG emissions associated with roadway construction and maintenance activities at the planning level, and the emission reduction potential of construction and maintenance strategies.

Since most States have not yet completed a construction emissions analysis, the AQ COP members decided to send out an AASHTO survey to the States that are members of this COP, to get a broader representation of current and planned State procedures. In response to the survey, most States reported that they have not completed, nor do they have underway, any construction emissions analyses since construction emissions are considered to be temporary in nature. However, one State is working on a spreadsheet tool similar to a spreadsheet tool developed by one of its municipalities to estimate construction emissions, but more focused on that particular State's construction practices. Rather than quantifying construction emissions most States control them through standard specifications; programs that help fund diesel retrofits for construction vehicles and equipment; use of ultra-low sulfur diesel fuel in construction equipment; idling restrictions on diesel equipment; protecting air intakes for buildings and/or facilities from the impacts of diesel exhaust fumes; etc.

Two States, however, did complete comprehensive project-level construction emissions analyses. One of the States, NYSDOT, completed an analysis for a project under the general conformity provisions because it required permits from both the Corp of Engineers and the U.S. Coast Guard. The analysis used on-site construction engine exhaust emission factors from EPA's NONROAD2008 emissions model, truck engine emission factors from the MOBILE6 emissions model, and AP-42 procedures to estimate PM fugitive emissions generated by material handling activities such as loading/drop operations for fill materials and excavation, truck transports, and concrete batching operations. The AERMOD dispersion model was used to project NO_2, CO, PM_{10}, and $PM_{2.5}$ concentration increments resulting from the construction of the project.

The other State, WSDOT, completed a quantitative analysis on a project because it anticipated that construction activities would exceed five years at several of the project's construction sites. In addition, the State expanded its analysis to other construction sites even though construction activities were expected to be less than five years in duration because of public comments received during project development. Fugitive dust

emissions were estimated using an emission factor consistent with CARB's URBEMIS2007 model; off-road construction equipment emission factors for CO, NOx, VOCs, SOx, PM_{10} and $PM_{2.5}$ were estimated using EPA's NONROAD program; and exhaust emission factors of haul trucks and worker commute vehicles were estimated using EPA's MOBILE6.2 model. States could consider the NYSDOT and WSDOT analysis procedures if they plan, or are required, to complete a construction emissions analysis in the future.

States that have completed a construction emissions analysis, either on an individual project or as part of a CMAQ project or DERA grant application, typically coordinate with agencies such as MPOs, State and Local Air Quality Agencies, State Health Departments, FHWA, FTA, and EPA. Several States indicated that the transportation conformity consultation process, or something equivalent to it, was or will be used. Other States indicated that if they do construction emissions analysis for projects in the future a consultation process would need to be developed.

While the summary notes that various tools exist, the case studies also indicate that estimating construction emissions for individual vehicles and construction activities is difficult at the environmental review stage of project development due to a lack of detailed information about the number, types, and usage of equipment on a particular project. There remains a lack of project specific activity estimates on the following:

- number and types of construction equipment used, and the purpose, hours and duration of their use;
- the project duration across individual construction operations;
- the in-use fuel consumption and emissions characteristics of various pieces of construction equipment;
- material quantities commonly used; and
- emissions reductions from various mitigation strategies such as from diesel exhaust after-treatment technologies.

ACRONYMS AND ABBREVIATIONS

The following acronyms and abbreviations are used in this report:

AASHTO - American Association of State Highway and Transportation Officials
ADOT - Arizona Department of Transportation
AERMOD – Air Quality Dispersion Model
APCD - Air Pollution Control Division
APEN - Air Pollutant Emissions Notice
AP-42 – EPA document that includes a compilation of air pollutant emission factors
BMP - Best Management Practices
CalEEMod - California Emissions Estimator Model
Caltrans – California Department of Transportation
CARB - California Air Resources Board
CDOT – Colorado Department of Transportation

CDPHE - Colorado Department of Public Health and Environment
CEQA – California Environmental Quality Act
CEQ - Council on Environmental Quality
CMAQ - Congestion Mitigation and Air Quality Improvement Program
CO - Carbon Monoxide
CO_2 – Carbon Dioxide
COP – Community of Practice
DEQ - Diesel Emissions Quantifier
DERA - Diesel Emissions Reduction Act
DOT – Department of Transportation
EI – NYSDOT Engineering Instruction 09-009
EMFAC – California's emission factor model that can estimate emission rates for on-road mobile sources and is used for SIP and transportation conformity purposes.
EO – Executive Order
EPA – US Environmental Protection Agency
FEIS – Final Environmental Impact Statement
FHWA – Federal Highway Administration
FTA – Federal Transit Administration
GASCAP - Greenhouse Gas Assessment Spreadsheet for Transportation Capital Projects
GDOT – Georgia Department of Transportation
GHG – Greenhouse Gases
GreenDOT - Greenhouse Gas Calculator for State Departments of Transportation
HAPs - Hazardous Air Pollutants
HC – Hydrocarbons
IDOT – Illinois Department of Transportation
ISTEA - Intermodal Surface Transportation Efficiency Act
MAP-21 - Moving Ahead for Progress in the 21st Century Act
MDOT - Maryland Department of Transportation
MNDOT – Minnesota Department of Transportation
MOBILE6.2 – EPA Emission Factor Model
MOVES – EPA Motor Vehicle Emission Simulator Model
MPCA - Minnesota Pollution Control Agency
MPO – Metropolitan Planning Organization
MSAT - Mobile Source Air Toxics
NAAQS – National Ambient Air Quality Standards
NCDOT – North Carolina Department of Transportation
NCHRP - National Cooperative Highway Research Program
NEPA - National Environmental Policy Act
NJDOT – New Jersey Department of Transportation
NMHC - Non-Methane Hydrocarbons
NMIM – EPA National Mobile Inventory Model
NJ Transit - New Jersey Transit
NYSDOT - New York State Department of Transportation
NONROAD – EPA Emissions Model for Non-Road Mobile Sources
NO_2 – Nitrogen Dioxide
NO_x – Nitrogen Oxides

OFFROAD - California Air Resources Board Model for Off-Road Vehicle Emissions
O_3 - Ozone
PEMS - Portable Emissions Measurement System
PennDOT – Pennsylvania Department of Transportation
PE-2 - Project Emission Estimator
PM - Particle Matter
$PM_{2.5}$ - Particle matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers
PM_{10} - Particle matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers
PPM - Parts per Million
ROG - Reactive Organic Gases
SAFETEA-LU - Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SCAQMD - South Coast Air Quality Management District
SDEIS - Supplemental Draft Environmental Impact Statement
SEQRA – NY State Environmental Quality Review Act
SHA – State Highway Administration
SIP – State Implementation Plan
SO_2 – Sulfur Dioxide
SOx - Sulfur Oxides
TERP - Texas Emission Reduction Program
TPY - Tons per Year
TTI - Texas Transportation Institute
TxDOT – Texas Department of Transportation
UC – University of California
URBEMIS – Emissions model used to calculate on-road and off-road vehicle emissions
VDOT – Virginia Department of Transportation
VOC - Volatile Organic Compounds
WisDOT – Wisconsin Department of Transportation
WRAP - Western Regional Air Partnership
WSDOT – Washington State Department of Transportation

APPENDIX A - AASHTO Survey on State Practices on Construction Emissions Analysis

Background:

The AASHTO Air Quality Community of Practice (COP), which consists of representatives from thirteen State DOTs, are researching current and planned State practices on *Construction Emissions Analysis*. This research effort is intended to identify: 1) EPA and FHWA/FTA requirements and guidance documents for conducting construction emissions analyses; 2) current and planned practices of selected State DOTs for conducting these analyses; 3) technical details such as which models States are using or plan to use, including utility software that will help streamline and facilitate the modeling process; and 4) current and completed research, as well as additional research or technical assistance States DOT's may need to more efficiently conduct the analyses.

This survey is being sent to all AQ COP member States in order to assist in this research effort, and to solicit your ideas for future research and technical assistance needs to help identify effective construction emissions analyses procedures.

If you have any comments or questions on this survey, please contact Jen Brickett (JBrickett@aashto.org; 202-624-8815); Tim Sexton (sextont@wsdot.wa.gov; 206-440-4549); or James Shrouds (j.shrouds@verizon.net; 703-455-7413).

Survey Questions for Construction Emissions Analyses Procedures:

1) Are construction emissions and/or impacts an issue in your State? If so, what are the main concerns (i.e. re-entrained dust from unpaved roads, fugitive dust from earth moving activities, exhaust emissions from construction equipment, etc.)?

2) Has your State developed (or plan to develop) any policies, technical guidance, and/or qualitative or quantitative procedures for analyzing construction emissions as part of its environmental analyses? If so, please send in a copy or short description of, or provide a link to, any such policies, guidance, and/or procedures to the contacts noted above.

3) Have any counties or municipalities in your State developed (or plan to develop) any policies, technical guidance, and/or qualitative or quantitative procedures for analyzing

construction emission that your State DOT may, or would be required to, follow? If so, please send in a copy or short description of, or provide a link to, any such policies, guidance, and/or procedures to the contacts noted above.

4) Has your State analyzed construction emissions for grant programs such as CMAQ, DERA (Diesel Emissions Reduction Act), etc.? If so, what tools/methods did you use?

5) Has your State completed, or in the process of completing, any construction emissions analyses as part of its environmental analyses? If so, how many have you completed and/or have underway? Please send in a copy or short description of, or provide a link to, the analysis.

6) If you have not completed, or are not in the process of completing, any construction emissions analyses, do you plan to do so in the future?

7) Does your State anticipate any problems/concerns with future construction emissions or impacts? If so, what issues do you anticipate?

8) What agencies are, or will be, involved in the construction emissions analyses procedures?

9) If other agencies are involved, what interagency consultation procedures will be used in your construction emissions analyses?

10) What issues will be determined thru interagency consultation (i.e. model selection, model inputs, etc.)?

11) What models have you used or plan to use? Is your State experienced with the use of these models? Do you anticipate any problems using these models?

12) Have you used, or plan to use, any vendors or utility software, that will help streamline and facilitate the modeling process? If so, please list the vendors, and give a brief description of the software and its intended use.

13) Have you incorporated construction emissions into any regional or project-level hot-spot conformity analyses?

14) What additional research, if any, do State DOTs need to more efficiently conduct qualitative or quantitative procedures for analyzing construction emissions?

15) What additional technical assistance do State DOTs need to more efficiently conduct qualitative or quantitative procedures for analyzing construction emissions?

Contact Information:

Please provide your contact information: name, State DOT, title, phone number, and e-mail address.

APPENDIX B – COP Research Proposal

Title

Construction Emissions Analysis Procedures

Research Idea:

Background: Construction activities can produce fugitive dust and exhaust emissions of criteria pollutants from heavy duty construction equipment. The AASHTO Air Quality Community of Practice issued State of the Practice reports on *Short Term Impacts from Construction Equipment and Operations*; and *Construction Emissions Analysis* that summarize the current State DOT practices for addressing these emissions along with selected research documents, reports, and online resources. While various tools do exist, the States' experiences highlight the difficulties estimating emissions for individual equipment and construction activities at the environmental review stage of project development. During this stage, there is typically very limited data available on the number, types, and usage of equipment. The reports also note the need for best modeling practices to predict construction emissions and evaluate mitigation strategies.

Scope: The purpose of this research is to:

1) Collect emissions information for specific construction equipment and activities for various project types, including existing information;

2) Determine the best modeling practices to predict construction emissions;

3) Evaluate cost and benefits for various mitigation strategies; and

4) Develop a streamlined emissions analysis technique to estimate project level construction emissions. The procedure could include screening thresholds, template protocols, default equipment assumptions, or interface modeling software.

Urgency and Payoff

Despite no regulatory requirement (for projects lasting less than five years), projects around the county are already analyzing construction emissions because of State directives or public requests to do so. This research would develop the tool(s) to allow State DOTs to efficiently and consistently evaluate construction-related emissions of criteria pollutants.

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