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STATE OF NEW MEXICO
BEFORE THE ENVIRONMENTAL IMPROVEMENT BOARD

IN THE MATTER OF THE PETITION FOR
HEARING ON AIR QUALITY PERMIT NO.
9295, ROPER CONSTRUCTION INC.'S
ALTO CONCRETE BATCH PLANT **No. EIB 22-34**

Roper Construction Inc.,
Petitioner

NOTICE OF FILING FINAL EXHIBITS

COMES NOW, the New Mexico Environment Department ("Department") and respectfully submits this Notice of Filing of Final Exhibits, pursuant to the Hearing Officer's Order. The Department hereby withdraws NMED EIB Rebuttal Exhibit 4. Copies of all relevant exhibits are attached hereto. The Department submits the following:

Exhibit #	Subject
NMED Exhibit 1	Deepika Saikrishnan Direct Testimony
NMED Exhibit 2	Deepika Saikrishnan Resume
NMED Exhibit 3	Eric Peters Direct Testimony
NMED Exhibit 4	Eric Peters Resume
NMED Exhibit 5	Rhonda Romero Resume
NMED Exhibit 6	Kathleen Primm Resume
NMED Exhibit 7	New Mexico Modeling Guidelines
NMED EIB Exhibit 1	Rhonda Romero Direct Testimony
NMED EIB Exhibit 2	Eric Peters Direct Testimony

NMED EIB Exhibit 3	Notice of Hearing in English
NMED EIB Exhibit 4	Notice of Hearing in Spanish
NMED EIB Exhibit 5	*Ruidoso News* Affidavits of publication
NMED EIB Exhibit 6	*Albuquerque Journal* Affidavits of publication
NMED EIB Exhibit 7	Docketed Matters Webpost
NMED EIB Exhibit 8	Notice of Hearing Emails
NMED EIB Exhibit 9	Email Request for Postal Mailout, List and labels
NMED EIB Exhibit 10	Wind Speed Graph
NMED EIB Exhibit 11	Draft Permit
NMED EIB Amended Rebuttal Exhibit 1	Rhonda Romero Rebuttal Testimony
NMED EIB Amended Rebuttal Exhibit 2	Kathleen Primm Rebuttal Testimony
NMED EIB Amended Rebuttal Exhibit 3	Eric Peters Rebuttal Testimony
NMED EIB Rebuttal Exhibit 5	AP 42- Chapter 13.2.1 Paved Roads
NMED EIB Rebuttal Exhibit 6	AP-42 Chapter 13.2.2 Unpaved Roads
NMED EIB Rebuttal Exhibit 7	AP 42- Chapter 13.2.1 Paved Roads Background Document
NMED EIB Rebuttal Exhibit 8	AP-42 Chapter 13.2.2 Unpaved Roads Background Document
NMED EIB Rebuttal Exhibit 9	NMED Guidance on Aggregate Handling, Storage Pile, and Haul Road Emissions

Respectfully Submitted,

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/s/ Chris Vigil
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CERTIFICATE OF SERVICE

I hereby certify that a copy of the foregoing New Mexico Environment Department's *Notice of Filing* was served via electronic mail on the following parties of record on October 27, 2022:

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STATE OF NEW MEXICO
BEFORE THE DEPUTY SECRETARY OF ENVIRONMENT

IN THE MATTER OF THE APPLICATION
OF ROPER CONSTRUCTION, INC.
FOR AN AIR QUALITY PERMIT **AQB 21-57 (P)**

TECHNICAL TESTIMONY OF DEEPIKA SAIKRISHNAN

I. INTRODUCTION

My name is Deepika Saikrishnan. I am a Permit Specialist in the Technical Services Unit of the Permitting Section of the Air Quality Bureau ("AQB or Bureau") of the New Mexico Environment Department ("NMED" or "Department"). I present this written testimony on behalf of the Department for the public hearing on the permit application submitted by Roper Construction, Inc. ("RCI"). Citizens challenge the Department's issuance of Air Quality Permit No. 9295 to Roper Construction, Inc. for the Alto Concrete Batch Plant ("Alto CBP") in Lincoln County, New Mexico. RCI's air permit application 9295 ("Application 9295") for its Alto Concrete Batch Plant was received by the New Mexico Environment Department on June 22, 2021. **[AR No. 1, Bates 0001-0190]**. Citizens contend that the Department's issuance of the proposed RCI permit would have negative impacts on air quality; endanger public health; increase noise and vehicle traffic on public roads; impact the night sky with light pollution; degrade natural beauty and quality of life for residents; and threaten wildlife, tourism, water quality, water conservation and property values.

As a Permit Writer, it is my responsibility to conduct a complete and thorough review of an air quality permit application, including an administrative review and a technical review. I coordinate with various stakeholders including the public, industry, consultants, Air Quality Bureau staff, and other regulatory agencies to provide quality customer service and aid in the permitting process. If parts of the application are incomplete or inaccurate, it is my responsibility to contact the applicant and request clarifications or corrections, as necessary. Updates to the original application are often required, and it is my responsibility to review all updates for completeness and accuracy. I write technical support documents and a legally enforceable air permit, initially based on standardized AQB template language and monitoring protocols. The template language and monitoring protocols are consistent for similar types of facilities. Unique permitting conditions or modifications to standard template language are typically required for site specific operations and equipment, based on information provided in the application. I customize the permit to the specifics of the application with site specific conditions and the recommendations of the air dispersion modeling staff to ensure the facility will operate as represented in the company's application and comply with all applicable state and federal regulations and ambient air quality standards.

My testimony will address the following topics: my qualifications, a summary of Application 9295, an overview of the construction permits authorized under 20.2.72 NMAC, my administrative review of Application 9295, the technical review of Application 9295, AQB's public outreach efforts throughout various stages of this permitting action, and the basis for conditions in the 2021-12-30 version of Draft Permit 9295 for RCI's proposed facility.

II. QUALIFICATIONS

I have been an employee of the Bureau for approximately three years, working as a Permit Specialist. As a Permit Specialist, I perform technical and regulatory review of complex Air Quality Bureau permit applications within regulatory deadlines. I verify emissions calculations; determine applicable state regulations and federal regulations; coordinate with various stakeholders including the public, industry, consultants, and AQB staff; review air permit applications and technical support documents for the administrative record; enter data into the

AQB database; and complete various special projects to achieve AQB goals. I have worked on over 430 permitting actions for the Bureau

My full background and qualifications are set forth in my resume. [**AR No. 11, Bates 0397-0399**].

III. SUMMARY OF APPLICATION 9295

RCI's Alto Concrete Batch Plant is proposed to be located approximately 0.35 miles east of the intersection of Highways 48 and 220 north of Ruidoso, NM in Lincoln County. If the permit application is approved, RCI intends to construct a 125 cubic yards per hour and 500,000 cubic yards per year concrete batch plant. The facility will include a feeder hopper, feeder conveyor, four (4) overhead aggregate bins, aggregate weigh batcher, aggregate weigh conveyor, truck-loading with baghouse, cement/fly ash weigh batcher, cement split silo, fly ash split silo, aggregate/sand storage piles and three (3) concrete batch plant heaters. RCI certifies that Alto CBP will have hours of operation of 7AM-6PM from November through February, 5AM-7PM March and October, 4AM-9PM April and September and 3AM-9PM May through August. RCI also certifies that the facility will limit the hourly production rate to 125 cubic yards per hour and yearly production rate to 500,000 cubic yards per year. The annual emissions are controlled by limiting the hours of operation and annual throughput of the facility.

IV. OVERVIEW OF CONSTRUCTION PERMITS UNDER 20.2.72 NMAC

Pursuant to 20.2.72 NMAC, Construction Permits are required in New Mexico for all facilities with a potential emission rate either greater than 10 pounds per hour (lb/hr) or 25 tons per year (TPY) for pollutants with a national or state ambient air quality standard. Once the application has demonstrated compliance with all state and federal requirements, the Department drafts a permit that will ensure the facility operates as stated in their application. This is achieved through monitoring, recordkeeping, and reporting protocols prescribed in the permit.

The Clean Air Act ("CAA"), 42 U.S.C. §7401, et seq. (2018), is the comprehensive federal law that regulates air emissions from stationary and mobile sources. The CAA was last amended in 1990 and requires the Environmental Protection Agency ("EPA") to set National Ambient Air Quality Standards, 40 C.F.R. Part 50, for pollutants considered harmful to public health and the environment. Section 109 of the CAA identifies two types of national ambient air quality standards ("NAAQS"). 42 U.S.C. § 7409 (2018). Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. Both primary and secondary NAAQS specify the maximum concentrations of these pollutants that can be present in the ambient air (https://www.epa.gov/criteria-air-pollutants/naaqs-table [accessed January 19, 2022, 9: 48 AM.]). These standards are based on scientific and medical studies of pollutant effects. The EPA has set NAAQS for six principal pollutants, which are called criteria air pollutants. Criteria pollutants include carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO2), ozone (O3), particulate matter (PM10, PM2.5), and sulfur dioxide (SO2) (https://www.epa.gov/criteria-air-pollutants [January 19, 2022, 9:51 AM]). Periodically, the standards are reviewed and may be revised.

New Mexico and other states do not have the resources to conduct the extensive scientific reviews that EPA conducts to determine the state of the science on what doses of pollution cause unwanted health effects. The extensive review EPA conducts is designed for the entire country. While EPA requires all states comply with the air quality standards that they develop, states are allowed to develop standards that allow lower amounts of exposure to pollution than the federal standards, but all must at least meet the federal NAAQS. 42 U.S.C. §§ 7409-7410 (2018). The New Mexico ambient air quality standards (NMAAQS) have some standards more stringent than the NAAQS. 20.2.3 NMAC.

New Source Review (NSR) is a CAA program that requires permittees to submit a permit application and document types and quantities of air emissions that will be emitted from industrial facilities before they begin construction or modification. 42 U.S.C. §§ 7401-7431, 7501-7515 (2018). The resulting NSR permit is a legal document specifying all applicable state and federal regulations, required emissions controls, emission limits, and assurances of adherence to these limits. These assurances are in the form of monitoring, recordkeeping, reporting, and testing requirements that are incorporated into the permit to make it enforceable. An NSR permit places restrictions on what construction is allowed, what air emission limits must be met, and how a facility can be operated.

NSR permits are coordinated under 20.2.72 NMAC, per 20.2.72.201 NMAC. NMED's authority to condition a permit is stated in 20.2.72.210 NMAC. Permit conditions are based on the contents of the permit application and conditions necessary to demonstrate compliance with applicable air quality regulations and ambient standards.

The Clean Air Act and state regulations do not provide the AQB legal authority to regulate impacts that are not specifically related to air quality.

V. ADMINISTRATIVE REVIEW

Application 9295 was received by the New Mexico Environment Department on June 22, 2021. Pursuant to 20.2.72.207(A) NMAC, the Department had 30 days to review the application and determine whether it was administratively complete.

On June 3, 2021, the Bureau received a call from a citizen concerned about this application. There were several letters and calls from citizens concerned in the following days. Upon receipt of the hard copy application on June 22, 2021, on June 23,2021, I requested RCI's consultant Paul Wade to provide the electronic version of the documents due to the mandatory teleworking policy in place at that time. Paul Wade provided the electronic documents to me and the modeling files to the Bureau's Modeling Section. A copy of Application 9295 was posted on the AQB web page for permit applications with public interest on June 23, 2021 [**AR No. 94, Bates 1741**].

The administrative review of an application is not a technical review, but a review of the presence of the required parts of the application, including the applicant's modeling analysis and the applicant's proof of public notice. All required contents of the application are listed in 20.2.72.203 NMAC. On June 28, 2021, I received an email from AQB's Modeling Section manager Sufi Mustafa confirming that Application 9295 could be ruled complete from a modeling perspective [**AR No. 89, Bates 0965-0966**]. On July 19, 2021, I sent an email to RCI's consultant Paul Wade, requesting the property tax record, the certified mail receipt for Reynaldo Cervantes, and an example of the letter sent to the landowners [**AR No. 36, Bates 0481**]. Mr. Paul Wade responded on July 19, 2021, providing the list provided by the Lincoln County Assessor's office, the certified mail receipt for Reynaldo Cervantes's Mexico address which was already present in the original application, and a statement that the letter sent to the government officials was also sent to the landowners [**AR No. 37, Bates 0482-0487**].

After I calculated the permit fee for RCI's application 9295 based on fee units in 20.2.75 NMAC and applicable regulations, AQB's administrative staff generated an invoice for the permit fee. On July 22, 2021, I ruled application 9295 administratively complete [**AR No. 38, Bates 0488-0493**]. I sent the completion determination letter, including a copy of the Department's Legal

Notice, and invoice for the permit fee to the applicant on July 22, 2021[**AR No. 38, Bates 0488-0493**]. I also sent the Department's Legal Notice to EPA Region 6, Erica LeDoux, and Mary Layton at EPA [**AR No. 97, Bates 1839-1841**]. I sent an email on July 22, 2021 to Ms. Christina Thompson, Recreation/Lands/Minerals Staff Officer, Forest Service, Lincoln National Forest, Smokey Bear Ranger District requesting the contact details for the appropriate authority to notify Class I area-White Mountain Wilderness [**AR No. 96, Bates 1835-1836**]. She responded providing the contact details of the appropriate authority [**AR No. 96, Bates 1837**]. I then sent the Department's Legal Notice to Lincoln National Forest and Smokey Bear Ranger District; Christina Thompson, Camille Howes, Travis Moseley and Andres Bolanos [**AR No. 97, Bates 1839-1841**]. The Department's Legal Notice was posted on the AQB website on the web page for permit applications with public interest [**AR No. 106, Bates 2020**]. AQB's administrative staff sent the Department's Legal Notice to *Ruidoso News* for publication, and it was published in that newspaper on July 28, 2021[**AR No. 104, Bates 1980**].

VI. TECHNICAL REVIEW

I began the technical review of RCI's application 9295 after I determined it was administratively complete. The technical review requires verification of emission calculations and a determination of applicable federal regulations and state regulations.

While performing the technical review, it was determined that the emissions represented for Unit 12 were from 3 heaters combined and since there were 3 units, an additional fee was calculated and an invoice for the additional two heaters was sent to the applicant on August 5, 2021. While I performed my technical review, I noticed that Section 1D-question 7 and question 11(not answered) were not reflective of the notification provided to Mescalero Tribe in the original application (page 105 of the original application) **[AR No. 1, Bates 0001-0190]** and requested the updates for those questions from Paul Wade on August 7, 2021 **[AR No. 43, Bates 0515-0516]** and I received the updates on August 10, 2021. I verified emission calculations by confirming the correct emission factors and formulas were used in calculating emission for all sources [**AR No. 5, Bates 0208-0241**]. If methods and calculations were not clear, I asked the consultant for further explanation on updates as necessary. I also verified the emission totals from the calculations matched the emissions total in Section 2 of the application.

RCI's consultant, Paul Wade, submitted several updates to the original RCI application 9295 throughout the review process. Below is a list of dates of application updates:

08/10/21 Section 1- 1C, 1D, Section 2- 2A, 2D and 2E, Section 5, Section 6-page 3, Section 16 **[AR No. 45, Bates 0518-0602]**.

09/22/21 Section 2- 2D,2E, 2H, 2I and 2J **[AR No. 70, Bates 0712-0798]**.

11/5/21 Section 11- 11A **[AR No. 75, Bates 0811-0813]**.

11/17/21 Section 3, 4, 6 and 13 **[AR No. 77, Bates 0871-0821; AR No. 108, Bates 2029-2053].**

12/21/21 Section 1 **[AR No. 78, Bates 0822-0824]**.

12/29/21 Section 16 **[AR No. 83, Bates 0861-0880]**.

12/30/21 Section 1 **[AR No. 84, Bates 0881-0883]**.

1/4/22 Section 9 **[AR No. 86, Bates 0887-0896]**.

1/13/22 Section 6, Section 7 **[AR No. 87, Bates 0897-0960]**.

I requested some of these updates while doing my technical review of the calculations. I requested other updates if discrepancies in the application became apparent while writing the Draft Permit 9295.

The Department has reviewed the emission calculations submitted in the application for all regulated equipment and the emission factors are based upon US EPA's AP 42 Compilation of Air

Emission Factors **[AR No. 1, 0001-0190; AR No. 5, 208-241]**. AP-42 is the EPA's compilation of emission factors for various industries. Emission factors are representative values that relate the quantity of a pollutant released to the ambient air with an activity associated with the release of that pollutant. (https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors [January 19, 2022, 9:53 AM]). These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant. The factors are expressed in units such as pounds per ton of material processed and pounds per hour. Such factors facilitate estimation of emissions from various sources of air pollution. In most cases, these factors are averages of all available data of acceptable quality and are generally assumed to be representative of long-term averages.

The emission factors used in the calculations are appropriate for this source type and are, thus, approved by the Department. The approved calculated emission rates were used as inputs into the Department's air dispersion modeling analysis. The air dispersion model conservatively predicts concentrations of the National Ambient Air Quality Standards (NAAQS) based upon the approved emission rates.

As I performed my technical review, I began to write the Draft Permit and the Draft Statement of Basis. The Statement of Basis is a permitting record that includes a description and history of the facility, public response received by the Department, a regulatory compliance discussion, and unique conditions in the permit. After completing the initial draft permit version 2021-09-13, I sent it to Paul Wade for comments on September 13, 2021 **[AR No. 68, Bates 0678-0693]** and I received a response on the draft permit on September 15, 2021**[AR No. 69, Bates 0694-0711]**. The applicant requested updates to condition A108B monitoring and record keeping, condition A112 Haul Roads, condition A502 Process Equipment and to condition A503C. I also sent the draft permit version 2021-12-16 to Paul Wade for comments on December 22, 2021**[AR No. 80, Bates 0826-0841]** and received a response on December 23, 2021 **[AR No. 81, Bates 0842-0860].** The draft permit version December 8, 2021, and December 30, 2021 were provided to the Compliance and Enforcement (C&E) section of AQB for comments **[AR No. 8, Bates 0333-0337].** The comment on condition A108B was addressed by clarification from Paul Wade (Paul Wade email 10/15/2021) **[AR No. 74, Bates 0806-0810]**. In addition, the Department did a further analysis to ensure enforceability of the permit condition. A permit extension request was made by the Bureau on October 14, 2021 and the permit extension request was approved by the Environment Protection Division Director on October 14, 2021.

VII. PUBLIC OUTREACH

This application had significant public interest and concern of citizens represented via phone calls, emails and hard copy letters sent through postal service since June 3, 2021. I reached out to several of the callers, responded to emails, and explained the permitting process. I also sent out emails to concerned citizens on June 24, 2021, indicating that the application was received, outlining the permitting process, and indicating that their concerns were recorded. I sent out initial citizen letters to concerned citizens on record on June 30, 2021, July 1, 2021, July 22, 2021, and September 17, 2021**[AR No. 95, Bates 1742-1835]**. I also sent an email to citizens on record providing more clarity on the permitting process on July 22, 2021**[AR No. 103, Bates 1968-1979]**. On July1, 2021 and July 23, 2021, I provided a list of hard copy citizen letters that required to be mailed out to citizens who did not provide an email address **[AR No. 95, Bates 1742-1835]**. The Initial Citizen letter is a template letter developed to comply with requirements in 20.2.72.206.B(1) NMAC. **[AR No. 95, Bates 1749]** The letter confirms citizens' written comments will be included as part of the permit application record. The letter also provides general information about the permit process, the pending availability of the Department's analysis, and the option to request a public hearing. Once the public notice was published interested persons were allowed thirty (30) days to express an interest in writing in the permit application per 20.2.72.206(A)(5) NMAC. Because the public notice was published in the newspaper on July 28, 2021, the end of the 30-day comment period was August 27, 2021**[AR No. 104, Bates 1980]**. There were several requests for public hearing to be held for RCI's application 9295 and the Bureau sent a Hearing Determination request to the office of the Cabinet Secretary, NMED on August 3, 2021 **[AR No. 92, 0982-1271; AR No. 93, 1272-1667]**. The Cabinet Secretary concurred with the Bureau's recommendation for a public hearing to be held for application 9295, based on significant public interest, on August 11, 2021. I relayed this information to the concerned citizens with email addresses on record via email **[AR No. 94, Bates 1712]**. Several more concerned citizens letters and emails were received after the result of hearing determination and I sent Initial Citizen letters on September 17, 2021, to citizens who had sent their comments after July 23, 2021 **[AR No. 95, Bates 1742-1834]**.

The Department's analysis (Version 2021-09-17), including the Statement of Basis (2021-09-17-2021) and modeling review report were posted on the RCI section of the new Department webpage for public notices under Lincoln County **[AR No. 106, Bates 2002-2023].** On September 21, 2021, AQB sent out Second Citizen letters to all citizens who had expressed an interest in the application in writing up to date. The Second Citizen letter is a template letter to notify citizens the Department's analysis is available for review. The letter had a link to the Department's analysis, including the Statement of Basis and modeling review report, which were posted on the RCI section of the new Department webpage for public notices under Lincoln County. **[AR No. 98, Bates 1851-1916]**. Per 20.2.72.206.B(2) NMAC, the proposed permit could not be issued until at least 30 days after the Department's analysis was available for review. The draft permit was written after incorporating all the calculation updates provided by the consultant. Updates related to typographic errors, address update for the facility and incorrect unit number references were provided by the applicant later and all the updates were posted on the Department's webpage for public notices under Lincoln County **[AR No. 106, Bates 2002 -2023]**.

An updated version of the draft permit named Draft Permit Version 2021-12-30 **[AR No. 9, Bates 0338-0395],** updated version of the draft Statement of Basis named Statement of Basis Version 2021-12-30 **[AR No. 2, Bates 0191-0198]** and the draft Database Summary version 2021-12-30 **[AR No. 3, Bates 0199-0203]** were posted on the Department's webpage for public notices under Lincoln County. AQB created a document titled Frequently asked Questions in response to citizens' comments and questions and posted it on the Department's webpage for public notices under Lincoln County on 12-30-2021. **[AR No. 99-102, Bates 1917-1967; AR No. 106, Bates 2002 -2023].** The FAQs were developed by grouping like-kind public comment questions into 19 FAQs with answers **[AR No.103, Bates 1968-1979].** The Scheduling Order for the hearing date stated that the hearing is scheduled for February 9, 2022 and may continue through February 11, 2022. AQB staff made arrangements for a Spanish interpreter to be present at the hearing and for a court reporter to be present at the hearing. AQB staff wrote a notice of Hearing per requirements in 20.1.4 NMAC. The Notice of hearing was translated into Spanish and received by AQB on December 21, 2021. On December 30, 2021 the Notices of Hearing both English and Spanish were posted on the Department's webpage for public notices under Lincoln County under Roper Construction Inc's documents. AQB Administrative staff e-mailed requests for publication of the Notice of Hearing in English and the Notice of Hearing in Spanish to *The Albuquerque Journal* and *Ruidoso News* on December 30, 2021. The Notice of Hearing was published in English and in Spanish in *The Albuquerque Journal* and *Ruidoso News on* January 5, 2022 **[AR No. 104, Bates**

1980-1997]. On January 3, 2022, I sent e-mails with the Notice of Hearing in English attached and the Notice of Hearing Spanish attached to EPA Region 6, Erica LeDoux and Mary Layton at EPA, the County Clerk, Lincoln County, the Village Clerk, Village of Ruidoso, City Clerk, City of Ruidoso Downs, Village Clerk, Capitan Village and to Christina Thompson, Travis Moseley, Camille Howes, Andres Bolanos, Laura Rabon and Sean Donaldson at the White Mountain Wilderness/Lincoln National Forest and Smokey Bear Ranger District **[AR No. 101, Bates 1949-1956].** On January 3, 2022, I e-mailed the AQB administrative team a list of Citizens and their mailing addresses attached, a cover letter attached, the Notice of Hearing in English attached, and the Notice of Hearing in Spanish attached and requested them to mail out hardcopies of the cover letter, the Notice of Hearing and Notice of Hearing in Spanish in an envelope to each citizen on the list I provided **[AR No. 99, Bates 1917-1937]**. These Citizens had submitted written comments only by postal service and did not provide their email addresses in their comment letters. AQB Administrative staff delivered these envelopes, each containing both notices of hearing, to the Runnels Building on January 4, 2022, so they could reach Administrative Services Division (ASD) for postage and mailout on January 5, 2022. On January 3, 2022, and January 4, 2022, I emailed all the citizens who had provided written comment via email (or) provided their email address in there mailed letter as of January 3, 2021, the Notice of Hearing in English attached, and Notice of Hearing in Spanish attached **[AR No.100, Bates 1938-1948]**.

VIII. BASIS FOR PERMIT CONDITIONS

The Department’s authority to include conditions in an Air Quality permit is stated in 20.2.72.210 NMAC Permit Conditions. If a permit is issued, it will specify what equipment is authorized to be installed and operated, will place limits on air pollutants, and place requirements on how equipment will be operated. A permit is an enforceable legal document, and will include emission limits, methods for determining compliance on a regular basis, and will place monitoring, recordkeeping, and reporting requirements to ensure and verify compliance with the requirements of the permit.

Conditions in Part A of the permit are Facility Specific Requirements, unique to the facility. They are site-specific and based on information provided in the application. Conditions in Part B of the permit are General Conditions and standard language which generally apply to all sources. Part C is also standard language about supporting on-line documents, definitions, and acronyms which apply to all sources.

A draft permit is a dynamic working document subject to updates throughout the review process. Draft Permit 9295 began with standardized language in an AQB permit template and standardized AQB monitoring protocols added as necessary for the sources of emissions and control devices at RCI's proposed facility. I wrote unique permitting conditions for site specific operations and equipment, based on information provided in the application.

The draft permit was then sent to the applicant and consultant to provide an opportunity to review and comment. The applicant proposed changes to monitoring requirements for facility throughput and visible emissions **[AR No. 69, Bates 0694-0711]**. AQB reviewed the proposed changes and confirmed that the requests would be enforceable and made edits to the conditions that the Department agreed with. The Department did not agree with all the requests the applicant submitted. In the updated Draft Permit version 2021-12-30 Monitoring and record keeping requirements for Condition A108B facility throughput and visible emissions were revised from hourly to daily after further review and explanation by the applicant regarding the maximum physical production limits. (Paul wade email: 10/15/21) **[AR No. 74, Bates 0806-0810]**. In the Draft Permit version 2021-12-30, for condition A503C monitoring the Bureau determined that the most reasonable requirement would be for the company to do, at minimum a weekly monitoring requirement as opposed to the monthly requirement requested by the company and the daily requirement posted in the previous permit draft. In the draft permit version 2021-12-30 condition A503D was also updated the recordkeeping requirement (2) with respect to differential pressure was updated from daily to each time cement (unit 9) or fly ash (Unit 10) loading takes place. (Paul wade email: 12/23/2021) **[AR No. 81, Bates 0842-0860].**

Permit conditions establish ongoing testing and monitoring requirements for processes and pieces of equipment to ensure the equipment is operating in accordance with the permitted emission limits.

IX. CONCLUSION

The technical review of application 9295 has been completed by the Bureau. The facility as described and represented in the application demonstrates compliance with federal and state air quality regulations. The facility's operations as represented in RCI's application and modeling report do not cause or significantly contribute to any exceedances of applicable air quality standards. These results are on the modeling analysis and emissions calculations for Carbon Monoxide (CO), Nitrogen Dioxide (NO2), Volatile Organic Compounds (VOC), Particulate matter 10 micrometers of less in aerodynamic diameter (PM10), Particulate matter (2.5 micrometers or less) (PM 2.5), and Sulfur Dioxide (SO2). The Clean Air Act and state regulations do legally authorize AQB to regulate impacts that are not air quality related. Therefore, AQB does not have the ability to deny any application made for an air quality permit on the basis of non-air quality aspects. AQB also does not have authorization to regulate mobile sources and to make decisions regarding commercial zoning laws in counties and municipalities. The Air Quality

Bureau recommends that the Secretary uphold the Bureau’s decision to approve the issuance of the permit.

DEEPIKA SAIKRISHNAN

Santa Fe, New Mexico

Environmental Scientist and Specialist -Advanced (2019- present)
Technical Services – Permitting Section
Air Quality Bureau,
New Mexico Environment Department
Santa Fe, New Mexico USA.

Faculty- Chemistry (2016-2017)
Central New Mexico Community College
Albuquerque, New Mexico, USA.

EDUCATION

PhD (Biochemistry), 2014
University of Hertfordshire, United Kingdom
Research Title: 'Cellulose Based Genoassays for the Detection of Pathogen DNA'

MS (Analytical & Separation Science), 2009
University of Manchester, United Kingdom

BS (Chemistry), 2008
University of Madras, India

EXPERIENCE

Regulatory and Technical Work

- Substantial experience in performing technical and regulatory review of the most complex construction air quality permit applications and associated calculations
- Experienced in state and federal air quality regulations, and drafting legally enforceable air permits and technical support documents
- Experienced in dealing with applications with public interest
- Reviewed and issued more than 300 minor source general construction air quality permits with regulatory deadlines at the New Mexico Environment Department and processed several administrative permitting actions
- Provided extensive technical support to internal customers from various teams within the bureau such as report generation, database records management and quality control
- Experienced in extensive external customer support via response to questions from public and providing documentation for records request
- Experience in software pilot testing for automating application process
- Contribution to business process improvements and developments through process updates, drafting and editing SOPs.
- Coordination and brainstorming of alternative methods to ensure operational efficiency amongst various teams within the bureau
- Experienced in providing technical training to new co-workers and permitting section staff

NMED EXHIBIT 2

PhD Research

- Successful development of proposed novel colorimetric genoassay (for Tuberculosis), first assay to use homogeneously modified cellulose as substrate to chemically attach bioprobes. Scope of Assay - a wide range of pathogen DNA
- Novel assay development using minimal equipment, experimental design
- Ability to troubleshoot experimental design flaws
- Effective scientific writing skills
- Experienced in writing peer reviewed journal article
- Experience in research at the interface of biochemistry and analytical chemistry
- Laboratory techniques and Instrumentation: DNA extraction, isolation, microbial plating techniques, aseptic techniques, PCR, gel electrophoresis, UV-Visible spectrometry, ATR-FTIR, fluorimetry, fluorescence microscopy, Assays for biochemical/microbial analysis
- Familiar with SRS, ORF, BLAST, SWISS PROT, ENSEMBL, ExPASy, ClustalW software tools

Journal Publication: Deepika Saikrishnan**,** Madhu Goyal, Sharon Rossiter, Andreas Kukol. A cellulose-based bioassay for the colorimetric detection of pathogen DNA. *Analytical and Bioanalytical Chemistry***,** 2014**,** 406(30), 7887-7898

MS & BS

- MS: Use of novel imaging mass spectrometric techniques to provide 'chemical maps' of tissue sections. Successful comparison between reference mixtures of four lipids with those in mouse brain samples using Time of Flight Secondary Ion Mass Spectrometry.
- Experience in writing feasibility reports, and research reports for experiments
- Analytical chemistry theoretical and laboratory modules
- BS: Theoretical and laboratory modules in organic, inorganic, physical, analytical, environmental, and computational chemistry.

Industrial Training

- Madras Pharmaceuticals, Chennai, India, Quality Control department (February–March 2010) Analysis of pharmaceutical products -qualitative and quantitative analysis, photometry, UV-VIS spectrometry, volumetric analysis, physical parameters, and preparation of documentation for the analyses.

Teaching

- Taught General Chemistry lecture and laboratory courses at Central New Mexico Community College (2016-2017)
- Certified in online teaching Introduction to teaching and learning online and Online curriculum design and instruction courses

PRESENTATIONS

- Air Quality Bureau wide presentation on Tanks and Control Devices - Oil and Gas Industry (2019)
- 'Cellulose Bioassays for the Colorimetric Detection of Pathogens' ACS meeting Spring 2015, Denver, USA
- 'Cellulose Bioassays for the Colorimetric Detection of Pathogen DNA', Annual Research Day, School of Life and Medical Sciences, 2014, University of Hertfordshire, UK
- 'Cellulose Bioassays for the Colorimetric Detection of Pathogens' Annual Research Day, School of Life and Medical Sciences, 2013, University of Hertfordshire, UK

- ‘Cellulose Biosensors for the Colorimetric Detection of Pathogen DNA’ at The Point of Care Diagnostics Workshop (Biochemical Society and Royal Society of Chemistry collaboration) London, UK, December 2012

LEADERSHIP

- Customer Experience Certificate Program Advisory Panel Member, University of Houston, C.T. Bauer College of Business (2021 Spring - ongoing)
- Student representative for research students, Biosciences Department, University of Hertfordshire, UK, 2012-2014
- Member of the Editorial board of annual departmental magazine, Stella Maris College, India, 2007-2008 (participated in number of inter-collegiate competitions)

OTHER ACHIEVEMENTS

- University of Hertfordshire Research Studentship ($85,000).
- 1st prize, oral presentation of PhD research work, Annual Research Day, School of Life and Medical Sciences, University of Hertfordshire, UK, 2014 (Cash prize $100)
- 3rd prize for poster presentation of PhD research work in Annual Research Day, School of Life and Medical Sciences, University of Hertfordshire, UK, 2013 (Cash prize $50)
- Won prizes in inter-collegiate chemistry quiz competitions, Loyola College and JBAZ College, India, 2008, respectively
- Won several interschool cultural competitions

STATE OF NEW MEXICO
BEFORE THE SECRETARY OF ENVIRONMENT

IN THE MATTER OF THE APPLICATION
OF ROPER CONSTRUCTION, INC. **AQB 21-57 (P)**
FOR AN AIR QUALITY PERMIT

TECHNICAL TESTIMONY OF ERIC PETERS

My name is Eric Peters. I have Bachelor of Science degrees in Mechanical Engineering and Biology from the University of Illinois, and a Master of Science degree in Environmental Engineering from the University of Kansas.

I work for the Air Quality Bureau ("AQB" or "Bureau") of the New Mexico Environment Department ("NMED" or "Department") as an Air Dispersion Modeler. I have worked in the Modeling Section for over twenty-four years. One of my primary duties is the review of air dispersion modeling for New Source Review permit applications to determine if they will comply with air quality standards and other modeling-related requirements. Air dispersion modeling is a computer simulation that predicts air concentrations of pollutants after a facility is constructed. EPA develops models for this purpose to ensure quality analyses and equal protection under the law.

The Department reviewed the modeling submitted by Roper Construction, Inc. for permit 9295, which is known as "Alto Concrete Batch Plant" (the facility). [AR No. 1]. The Department verified that the facility followed appropriate modeling practices, as informed by the New Mexico Modeling Guidelines. [NMED Exhibit 7]. Details of the modeling are described in the Modeling Review Report, which is contained in the Administrative Record. [AR No. 6].

NMED EXHIBIT 3

In order to be issued an NSR permit, the applicant must demonstrate that construction of the proposed facility will not cause or contribute to any violations of National or New Mexico Ambient Air Quality Standards, Prevention of Significant Deterioration (PSD) Increments, or State Air Toxic pollutant requirements. National Ambient Air Quality Standards are periodically reviewed by the Environmental Protection Agency and are designed to protect the most sensitive individuals. PSD increments are designed to maintain the air quality of pristine areas. Toxic permitting thresholds prevent neighbors from being exposed to more than one percent of the amount that has been deemed acceptable for workers to be exposed to throughout the day. The requirement to demonstrate compliance with these air quality measures is contained in 20.2.72.203(A)(4) NMAC.

The Department maintains the New Mexico Modeling Guidelines to provide a basis for acceptable modeling analyses. These guidelines incorporate and interpret the most recent version of EPA's Guideline on Air Quality Models, which was published in the Federal Register, Vol. 82, No. 10. The New Mexico Modeling Guidelines also incorporate other information and guidance, such as EPA memorandums.

Alto Concrete Batch Plant modeling was performed in accordance with the New Mexico Modeling Guidelines. If the facility operates in compliance with the terms and conditions of the draft permit, then it will not cause or contribute to any concentrations above state or federal ambient air quality standards or PSD increments. The facility has satisfied all modeling requirements and the permit may be issued.

ERIC C. PETERS

📫 525 Camino de Los Marquez ❑ Santa Fe, NM 87505 💻 Eric.Peters@state.nm.us ☎(505)629-5299

Air Dispersion Modeler

PROFILE

Knowledgeable, understanding, diplomatic builder of teamwork with a passion for innovation and adaptation. I have great motivation and good experience writing and using computer programs and databases as well as experience in environmental management areas such as air dispersion modeling and hazardous waste remediation. I communicate well both orally and in writing.

CAREER HIGHLIGHTS

New Mexico Environment Department/Air Quality Bureau ❑ Santa Fe, NM ❑ **Environmental Specialist/Computer System Analyst** ❑ November 1997 to present

- Analyzed and performed air dispersion modeling for over 100 projects involving use of ISCST3, Calpuff, AERMOD, CTScreen, and other modeling software for evaluation of power plants, mining operations, and numerous other facility types.
- Worked with groups to develop and implement regulations for prescribed burning and general permits.
- Created MergeMaster program using Microsoft Access and Visual Basic. The program analyzes and transforms input data into formats needed to efficiently run computer models and draws maps using the data.
- Created database to store and manage emissions inventory and permit tracking for the state of New Mexico.
- Mapped and migrated data to Oracle and MS Access databases from various relational database formats.
- Extracted, analyzed, and transformed data from Oracle databases using SQL programming scripts.
- Trained employees to run air dispersion models and to use the emissions inventory database.
- Also proficient in the following software: ArcGIS, AERMOD, SASEM, Surfer, Excel, Word, Power Point.

Desert Research Institute ❑ Las Vegas, NV ❑ **Technical Temporary** ❑ Sept. 2003- March 2007 (part time)

- Designed MS Access database tools to describe and analyze visibility and pollutant monitoring stations.
- Programmed database to export data in HTML format for use in web pages.
- Wrote Visual Basic program to convert HYSPLIT output text files into GIS Shapefiles for use in ArcGIS.

Santa Fe Striders ❑ Santa Fe, NM ❑ **President** ❑ December 2000 to December 2002 (part time)

- Made management decisions for 100-member running club.
- Coordinated volunteers, police protection, insurance, sponsors, and technical support for races.
- Created database to track membership and race entries.

Environmental Protection Agency ❑ Kansas City, KS ❑ **Environmental Engineer** ❑Jun.1992 to Sept. 1994

- Managed Pilot Projects to develop guidance on selecting treatment technologies for Superfund sites contaminated by polychlorinated biphenyls (PCBs), manufactured gas plants, or grain fumigation.
- Helped develop, procure, and manage contracts.
- Researched treatment techniques for PCB, manufactured gas plant, and grain fumigation sites.
- Compiled and analyzed data and wrote reports and guidance documents for treatment of site types.

University of Illinois ❑ Urbana-Champaign, IL ❑ **Research Assistant** ❑ 1991

- Simulated protein folding by molecular dynamics using Silicon Graphics and Cray supercomputers.
- Analyzed and created computer codes written in Fortran using UNIX and Macintosh operating systems.

EDUCATION

Master of Science in Environmental Engineering
University of Kansas ❑ Lawrence, Kansas ❑ June, 1995

Bachelor of Science in Mechanical Engineering
Bachelor of Science in Honors Biology with a minor in Chemistry
University of Illinois ❑ Champaign-Urbana, Illinois ❑ December, 1991

NMED EXHIBIT 4

RHONDA V. ROMERO

525 Camino de Los Marquez, Suite 1, Santa Fe, NM 87505, 505-476-4354, Rhonda.romero@state.nm.us

Education

Master of Science: Natural Sciences- Geology May 2014
New Mexico Highlands University - Las Vegas, NM

Bachelor of Science: Environmental Geology July 2010
New Mexico Highlands University - Las Vegas, NM

Work History

Staff Manager - Environmental Science 07/2018 to Current
New Mexico Environment Department- Air Quality Bureau – Santa Fe, NM

- Environmental permitting with a high level of understanding of local, state and federal air quality regulations.
- Manage the Air Quality Bureau Minor Source Permit Program.
- Supervise 6 staff with implementation of the Clean Air Act and New Mexico Administrative Code Environmental regulations.
- Continuously developing and establishing policies and guidance documents.
- Develop standard operating procedures.
- Determination and implementation of program requirements.
- Coordinate and guide the interface of staff with federal EPA, other state agencies, and clients.
- Evaluate and determine eligibility for Minor Source and Title V air quality permit applications under 20.2.72 NMAC and 20.2.70 NMAC.
- Emission calculation evaluations
- Review, provide oversight, and draft advanced technical permits for complex facilities in New Mexico.

Environmental Scientist & Specialist- Advanced 08/2014 to 01/2018
New Mexico Environment Department- Air Quality Bureau – Santa Fe, NM

- Served as acting minor source section permitting manager for 5 months.
- Environmental permitting with a moderate level of experience with of local, state and federal air quality regulations.
- Evaluated and determined eligibility for Minor Source and Title V air quality permit applications under 20.2.72 NMAC and 20.2.70 NMAC.
- Emission calculation evaluations
- Drafted advanced technical permits for some of the most complex facilities in New Mexico.
- Developed advanced and effective communication skills to interact with the public, industry, and consultants

NMED EXHIBIT 5

regarding technical matters.

Environmental Scientist & Specialist - Operational 01/2014 to 08/2014
New Mexico Environment Department – Santa Fe, NM

- In depth knowledge and understanding of state and federal air quality regulations.
- Evaluate and determine eligibility for Minor Source and Title V air quality permit applications under 20.2.72 NMAC and 20.2.70 NMAC.
- Typically took on 2-3 extra permits outside of normal workload per month.
- Possess technical ability to evaluate complicated industrial facilities throughout the State, including but not limited to the Mining Industry, and the Oil and Gas Industry.

Environmental Scientist & Specialist - Basic 02/2013 to 01/2014
New Mexico Environment Department- Air Quality Bureau – Santa Fe, NM

- Gained basic knowledge and understanding of state and federal air quality regulations.
- Evaluate and determine eligibility for Minor Source and Title V air quality permit applications under 20.2.72 NMAC -Possess technical ability to evaluate industrial facilities throughout the State, including but not limited to the Mining Industry, and the Oil and Gas Industry.
- Took on additional permitting actions out of the assigned workloads.

Graduate Research Assistant 01/2010 to 01/2012
New Mexico Highlands University – Las Vegas, NM

- Lead instruction in introductory level biology, geology, and hydrology courses and science labs with 25 - 100 students.
- Planned and lead class and lab lectures, grading and monitored student progress.
- Liaised between faculty and students to answer questions and optimize faculty time.

Intern - Environmental Science 05/2005 to 08/2005
Los Alamos National Security LLC – Los Alamos, NM

- Collected Data for fire risk assessment model after the Cerro Grande Fire of 2000.
- Performed environmental surveys, which included setting up plots to analyze tree, soil, and area characteristics.
- Performed analysis of the data statistically and ensured quality assurance and control -compiled and analyzed all data.
- Verified data integrity and accuracy.

Intern - Health Physics 01/2000 to 01/2004
Los Alamos National Security LLC – Los Alamos, NM

- Implemented training, research, and monitoring programs to protect personnel from radiological hazards.
- Helped develop criteria for modification of health physics detection equipment, such as germanium detectors.
- Implemented bioassay sample program successfully, following instructions set out by regulation and management.

NMED EXHIBIT 5

Kathleen Primm
1312 Don Diego Ave.
Santa Fe, NM 87505
kathleen.primm@state.nm.us (505) 480-4377

CAREER QUALIFICATIONS

Experience: federal and NM air quality regulations; Clean Air Act; technical training; supervising staff; peer review; administrative and technical analysis; complex calculations using science, math and chemistry; developing guidance documents and policies; writing federally and practically enforceable permits; cross-training and coordinating with other sections at AQB; collaborating with legal staff; attending public meetings; testifying as an expert witness in public hearings; internal and external customer service; outlining objectives and developing plans to streamline procedures; conducting hiring interviews; data entry; and computer software including daily use of Microsoft Office
Skills: organization, communicating with clarity and accuracy, problem solving, attention to detail, technical writing, reviewing and editing documents, maintaining quality notes for reference, time management, and professional demeanor

PROFESSIONAL DEVELOPMENT AND TRAINING COURSES

APTI 454 Effective Permit Writing; APTI 452 Air Pollution Control; APTI 400 Introduction to Hazardous Air Pollutants; APTI 427 Combustion Evaluation; WESTAR Intermediate NSR/PSD Training; NACT Courses on Engines, NOx Control Technology, CAM, Turbines/Power Plants, Asphalt Facilities, Coatings, and Baghouses; ProMax Training BRE 101, 102, 121; H_2S Safety Training; Bleiker Training on Citizen Participation for Public Officials and Other Professionals Serving the Public; NMED Civil Rights Training; and site visits to a range of industrial sources of air pollution

EMPLOYMENT HISTORY

Environmental Scientist & Specialist – Supervisor NM Environment Department Air Quality Bureau (4/21 - present)

- Managing staff in all aspects of the NSR construction permit program
- Regularly meeting with staff to provide guidance and explore various means of complex problem solving
- Reviewing work products of permitting staff to ensure quality and consistency
- Managing assigned staff in the Minor Source Program in operational activities including planning and direction of the Program and coordinating with other sections in the Bureau
- Managing assigned staff in the Minor Source Program in regulatory and technical activities including providing consultation to other program managers and staff, the Bureau chief, legal staff, consultants, industry, citizens, and the EPA regarding questions pertaining to Minor Source Permitting procedures, permitting actions, regulations, applicability determinations, and technical analyses
- Tracking regulatory deadlines and ensuring staff meet regulatory deadlines
- Creating and improving guidance documents and Department forms

NMED EXHIBIT 6

- Providing technical training to staff and managing staff trainings
- Preparing staff for public hearings
- Establishing policy and procedures
- Determining and implementing Minor Source program requirements
- Cooperating with PSD and Title V operating permit program managers and Technical Services manager
- Coordinating with various stakeholders including the public, industry, consultants, Bureau staff, and other regulatory agencies
- Assigning, tracking, and reviewing special projects and deliverables to achieve organizational goals
- Reviewing lists of candidates for hiring
- Approving time reporting and completing staff evaluations
- Attending management trainings, including Strategies for Positive Management and Managing Employee Performance
- Maintaining familiarity with federal and New Mexico air quality regulations, including Clean Air Act
- Communicating with EPA and upper management

Environmental Scientist & Specialist – Advanced, NM Environment Department Air Quality Bureau (1/18 - 4/21)

- Performed technical and regulatory review of multiple complex Minor Source Air Quality Bureau permit applications within regulatory deadlines by checking completeness; verified the accuracy of calculations of pollutants using science, math and chemistry; wrote applicability determinations for federal regulations and state regulations; and drafted legally enforceable air permits and technical support documents with standardized Air Quality Bureau templates and protocols
- Developed solutions and strategies to complex Minor Source problems through analysis and evaluation of the facts, distinguishing issues and circumstances that made each case distinct, formulated alternative solutions, and balanced the relative benefits and consequences of possible courses of action
- Served as Acting Minor Source manager to supervise staff and serve as the point of contact for daily operations when the manager was unavailable
- Provided technical training and mentoring for internal staff and developed guidance documents to assist new team members with the details of various permitting action types, regulations, and Air Quality Bureau policies
- Provided peer review for new or inexperienced staff to support their learning and ensure they had the necessary resources to deliver a quality product
- Coordinated with various stakeholders including public citizens, industry, consultants, applicants, Air Quality Bureau staff, EPA, and other regulatory agencies to provide quality customer service and aid in the permitting process
- Attended public meetings, open houses, and public hearings to represent the Department

- Promptly entered data and attached documents into the Air Quality Bureau database in accordance with standard operating procedures, guidelines, and policies to compile a quality administrative record
- Performed special assignments to achieve organizational goals for the Air Quality Bureau
- Attended trainings and toured industrial sites to gain knowledge in specific topics including regulations, equipment, and how to make permits federally and practically enforceable
- Responded to IPRA requests

Environmental Scientist & Specialist – Operational, NM Environment Department Air Quality Bureau (5/12 – 1/18)

- Performed technical and regulatory review of multiple complex Air Quality Bureau permit applications within regulatory deadlines by checking completeness; verifying the accuracy of calculations of pollutants using science, math and chemistry; determining applicable federal regulations and state regulations; and drafting legally enforceable air permits and technical support documents with standardized Air Quality Bureau templates and protocols
- Assisted in developing the GCP-6, a new general construction permit to provide industry with additional timely and cost-effective options for obtaining federally enforceable emissions limits while increasing the Air Quality Bureau's efficiency
- Coordinated with various stakeholders including the public, industry, consultants, Air Quality Bureau staff, and other regulatory agencies to provide quality customer service and aid in the permitting process
- Performed special assignments to achieve organizational goals for the Air Quality Bureau
- Promptly entered data and attach documents into the Air Quality Bureau database in accordance with SOP's, guidelines, policies, and standards to compile a quality administrative record
- Attended trainings and site tours to gain knowledge in specific topics including regulations, equipment, and how to make permits federally and practically enforceable
- Trained new or inexperienced staff on the details of various permitting action types, regulations, and Air Quality Bureau policies

Environmental Scientist & Specialist – Basic, NM Environment Department Air Quality Bureau (6/08 – 5/12)

- Performed technical and regulatory review of multiple complex Air Quality Bureau permit applications within regulatory deadlines. This review included checking completeness, verifying the accuracy of emissions calculations, determining applicable federal regulations and state regulations, and drafting legally enforceable air permits and technical support documents with standardized Air Quality Bureau templates and protocols
- Coordinated with various stakeholders including the public, industry, consultants, Air Quality Bureau staff, and other regulatory agencies to provide quality customer service and aid in the permitting process
- Performed special assignments to achieve organizational goals for the Air Quality Bureau, as assigned

- Promptly entered data and attach documents into the Air Quality Bureau database in accordance with SOP's, guidelines, policies, and standards to compile a quality administrative record
- Attended trainings to gain knowledge in specific topics including regulations, equipment, and how to make permits federally and practically enforceable
- Assessed annual fees for the Title V Permitting Program
- Wrote meeting minutes for weekly Minor Source staff meetings and distributed them to staff, for their records

Manager of Seed Department, Plants of the Southwest, Santa Fe, NM (2/03 – 6/08)

- Managed seed department for multi-location retail and mail-order nursery including stocking, ordering, organizing, packaging and shipping of seeds
- Evaluated projects ranging from backyard gardens to wildlife management and protecting water resources
- Hired seasonal employees and trained them in standard operating procedures
- Followed requirements to obtain permits and performed tests to assure USDA compliance and certification
- Developed annual seed department budget and processed department’s financial documents, including operating budgets and fiscal reports
- Provided customer service in identifying appropriate native species and seeding rates
- Coordinated with various entities including the public, industry, staff, and seed companies to customize seed orders based on location, cost, area, and seeding rate calculations
- Monitored asset inventory and coordinated procurement, stocking, shipping, and off-site collection of seeds
- Revised and updated annual seed catalog and employee guidelines

Assistant (part-time), Hydra Aquatic, Tijeras, NM (2/03 – 5/04)

- Sole employee of a busy, family-owned plant propagation and installation company
- Installed wetland and riparian plants for reclamation projects, treating water resources, and wildlife management in NM, CO, and CA
- Maintained nursery stock, facilities, grounds, and equipment
- Packaged and shipped mail orders based on contractual agreements

Maintenance Crew Member, WaterWise Landscapes, Inc., Albuquerque, NM (7/01 – 2/03)

- Installed, inspected, and maintained residential landscapes based on contractual agreements

Manager of Greenhouse, Rocky Mountain Native Plants Co., Rifle, CO (1/99 – 6/01)

- Supervised 5-10 employees
- Trained employees in standard operating procedures and team communication
- Treated and sowed native seed for reclamation jobs based on germination protocols and production schedules
- Organized orders for customers based on contractual agreements and monitored inventory
- Led elementary school tours and developed accompanying educational curricula

Nursery Assistant, Siskiyou Rare Plant Nursery, Medford, OR (7/98 – 12/98)

- Propagated plants by division, cuttings, and seed; and applied biocontrol techniques to minimize pests

Crop Technician, Colorado Greenhouse – Estancia Division, Estancia, NM (1/98 – 6/98)

- Monitored water quality, viruses, diseases, and insect populations in hydroponic tomato plants
- Implemented biocontrol program to minimize pests

Lab Assistant, NMSU Plant Physiology Lab, Las Cruces, NM (1/96 – 12/97)

- Technical analysis of chile samples for vitamin A research and tocopherol research
- Technical analysis of onion samples for onion pungency research
- Coordinated ordering lab supplies from distributors for graduate student research

EDUCATION

New Mexico State University, Las Cruces, NM
Bachelor of Science in Agriculture, December 1997
MAJOR: Horticulture, MINOR: Biology
Dean’s Award of Excellence (April 1997), Crimson Scholar (1993 – 1997), Dean’s List (1993 – 1997), Regents Scholarship (1993 – 1997)

COMMUNITY INVOLVEMENT

President of Carlos Gilbert Elementary School’s PTK (Parents, Teachers, Kids) Board (May 2020-present)
Volunteer for Carlos Gilbert PTK (2014-May 2020)
Secretary position on Board of Directors – Garcia Street Club (2013-2016)
Volunteer – Many Mothers (2007-2008)

New Mexico Air Quality Bureau

Air Dispersion Modeling Guidelines

Revised October 26, 2020

Recent changes to the Modeling Guidelines are described in Appendix A at the end of this document.

Notes:
EPA in-stack ratio database:
https://www.epa.gov/scram/nitrogen-dioxidenitrogen-oxide-stack-ratio-isr-database

Significance levels for PM2.5 and ozone:
https://www.epa.gov/sites/production/files/2016-08/documents/pm2_5_sils_and_ozone_draft_guidance.pdf
2017 Appendix W:
https://www3.epa.gov/ttn/scram/appendix_w/2016/AppendixW_2017.pdf

Bureau Modeling Staff:
Sufi Mustafa (505) 476-4318
Eric Peters (505) 476-4327
Angela Raso (505) 476-4345
Rhett Zyla (505) 476-4304

NMED EXHIBIT 7

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1.0 INTRODUCTION

1.1 Introductory Comments

Air pollution has been proven to have serious adverse impacts on human health and the environment. In response, governments have developed air quality standards designed to protect health and secondary impacts. The only way to predict compliance with these standards by a facility or modification that does not yet exist is to use models to simulate the impacts of the project. Regulatory models strike a balance between cost-effectiveness and accuracy, though the field of air quality prediction is not necessarily an inexpensive or a highly accurate field. The regulatory model design is an attempt to apply requirements in a standard way such that all sources are treated equally and equitably.

It is the duty of the NMED/Air Quality Bureau (the Bureau) to review modeling protocols and the resulting modeling analyses to ensure that air quality standards are protected and to ensure that regulations are applied consistently. This document is an attempt to document clear and consistent modeling procedures in order to achieve these goals. Occasionally, a situation will arise when it makes sense to deviate from the guidelines because of special site-specific conditions. Suggested deviations from the guidelines should be documented in a modeling protocol and submitted to the Bureau for approval prior to submission of modeling.

In general, the procedures in the latest version of the EPA document, Guideline On Air Quality Models[1] should be followed when conducting the modeling analysis. This EPA document provides complete guidance on appropriate model applications. The purpose of this document is to provide clarification, additional guidance, and to highlight differences between the EPA document and New Mexico State modeling requirements.

Please do not hesitate to call the Bureau modeling staff with any questions you have before you begin the analysis. We are here to help; however, we will not conduct modeling courses. There are many courses offered which teach the principles of dispersion modeling. These courses provide a much better forum for learning about modeling than the Bureau modeling staff can provide.

1.2 The Modeling Review Process

1.2.1 Modeling Protocol Review

A modeling protocol should be submitted and approved before submitting a permit application. The Bureau will make every attempt to approve, conditionally approve, or reject the protocol within two weeks. Details regarding the protocol are described in section 6.0, Modeling Protocols. Protocols will be archived in the modeling archives in the protocol section until they can be stored with the files for the application.

1.2.2 Permit Modeling Evaluation

When a permit application involving air dispersion modeling is received, modeling staff has 30 days to determine whether the modeling analysis is administratively complete. The modeling section staff will make a quick determination to see if the modeling analysis appears complete. This involves checking to see if

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[1] Environmental Protection Agency, 40 CFR Part 51, Revision to the Guideline on Air Quality Models https://www.epa.gov/sites/production/files/2020-09/documents/appw_17.pdf

modeling files are attached and readable and verifying that application forms and modeling report are present. If the analysis is incomplete, the staff will inform the applicant of the deficiencies as quickly as possible. This will halt the permitting process until sufficient information is submitted. Deficiencies not resolved prior to the completeness determination deadline may result in ruling the application incomplete.

After the application has been ruled complete, Bureau staff will perform a complete review of the modeling files. This analysis includes a review to make sure that information in the modeling files are consistent with the information in the permit application and may involve the emission rate of each emission point, the elevation of sources, receptors, and buildings, evaluation and modification of DEM data, property fence line, or other aspects of the modeling inputs. If the dispersion modeling analysis submitted with the permit application adequately demonstrates that ambient air concentrations will be below air quality standards and/or Prevention of Significant Deterioration (PSD) increments, the Bureau modeler will summarize the findings and provide the information to the permit writer. If dispersion modeling predicts that the construction or modification causes or significantly contributes to an exceedance of a New Mexico or National Ambient Air Quality Standard (NMAAQS or NAAQS) or PSD increment, the permit cannot be issued under the normal permit process. For nonattainment modeling, refer to 20.2.72.216 NMAC, 20.2.79 NMAC, or contact the Bureau for further information.

The application (including modeling) is expected to be complete and in good order at the time it is received. However, the Bureau will accept general modifications or revisions to the modeling before the modeling is reviewed provided that the changes do not conflict with good modeling practices. Once the modeling review begins, only changes to correct problems or deficiencies uncovered during the review of the modeling will normally be accepted, and the Bureau will provide a deadline by which changes need to be submitted to allow for them to be reviewed and for the permit to be issued. No changes to modeling will be allowed after the review has been completed.

2.0 MODELING REQUIREMENTS AND STANDARDS

2.1 Regulatory Requirement for Modeling

The requirements to perform air dispersion modeling are detailed in New Mexico Administrative Code (NMAC) **20.2.70.300.D.10 NMAC** (Operating Permits), **20.2.72.203.A.4 NMAC** (Construction Permits), and **20.2.74.305 NMAC** (Permits - Prevention of Significant Deterioration), and 20.2.79 NMAC (Nonattainment). The language from these sections is listed below for easy reference.

Basically, with a construction permit application, an analysis of air quality standards is required, which normally requires air dispersion modeling. In some cases, previous modeling may satisfy this requirement. In these cases, the applicant may seek a modeling waiver from the Bureau. In any case, it is the responsibility of the applicant to provide the modeling, or the justification for the modeling waiver, or the air quality analysis for nonattainment areas. Title V sources that have not demonstrated compliance with a standard or increment are required to come into compliance with this applicable requirement. This may be accomplished by modeling to show the area is in attainment with this standard or increment. If they are not able to model compliance, then a compliance plan will be needed.

2.1.1 Title V Operating Permits

Federal air quality standards are applicable requirements for sources required to have an operating permit. Modeling is usually not required to issue a Title V operating permit. If a facility is not required to have a construction permit (e.g., some landfills and “Grandfathered” facilities) then it will need to model any new emissions or changes that could increase ambient pollutant concentrations.

Selected Title V regulatory language applying to modeling is copied below for easy reference.

> **20.2.70.7 NMAC DEFINITIONS:** In addition to the terms defined in 20.2.2 NMAC (definitions), as used in this part the following definitions shall apply.
>
> E. "Applicable requirement" means all of the following, as they apply to a Part 70 source or to an emissions unit at a Part 70 source (including requirements that have been promulgated or approved by the board or US EPA through rulemaking at the time of permit issuance but have future-effective compliance dates).
>
> (11) Any national ambient air quality standard.
>
> (12) Any increment or visibility requirement under Part C of Title I of the federal act, but only as it would apply to temporary sources permitted pursuant to Section 504(e) of the federal act.

Note: The PSD increment analysis is required for the development of general permits for temporary Title V sources but is not an applicable requirement for regular Title V permit modeling. PSD increment modeling is required for Title V sources that are satisfying their modeling requirements through 20.2.72 NMAC modeling.

> **20.2.70.201 NMAC REQUIREMENT FOR A PERMIT:**
>
> D, Requirement for permit under 20.2.72 NMAC.
>
> (1) Part 70 sources that have an operating permit and do not have a permit issued under 20.2.72 NMAC or 20.2.74 NMAC shall submit a complete application for a permit under 20.2.72 NMAC within 180 days of September 6, 2006. The department shall consider and may grant reasonable requests for extension of this deadline on a case-by-case basis.

(2) Part 70 sources that do not have an operating permit or a permit under 20.2.72 NMAC upon the effective date of this subsection shall submit an application for a permit under 20.2.72 NMAC within 60 days after submittal of an application for an operating permit.

(3) Paragraphs 1 and 2 of this subsection shall not apply to sources that have demonstrated compliance with both the national and state ambient air quality standards through dispersion modeling or other method approved by the department and that have requested incorporation of conditions in their operating permit to ensure compliance with these standards.

20.2.70.300.D.10 NMAC

(10) Provide certification of compliance, including all of the following.

(a) A certification, by a responsible official consistent with Subsection E of 20.2.70.300 NMAC, of the source's compliance status for each applicable requirement. For national ambient air quality standards, certifications shall be based on the following.

(i) For first time applications, this certification shall be based on modeling submitted with the application for a permit under 20.2.72 NMAC.

(ii) For permit renewal applications, this certification shall be based on compliance with the relevant terms and conditions of the current operating permit.

2.1.2 New Source Review (NSR) Permitting for Minor Sources

For new permits, a demonstration of compliance with air quality standards, PSD increments, and toxic air pollutants subject to 20.2.72.403.A(2) is required for all pollutants emitted by the facility. For significant revisions, a demonstration of compliance with air quality standards, PSD increments, and toxic air pollutants subject to 20.2.72.403.A(2) is required for all pollutants affected by the modification or permit revision. For technical revisions involving like kind replacement, as specified in 20.2.72.219B(1)(d), a demonstration that the replacement unit has stack parameters which are at least as effective in the dispersion of air pollutants is required (provided previous modeling determined the area to be in compliance with air quality standards). Permits for sources not in attainment with standards should refer to 20.2.72.216 NMAC, NONATTAINMENT AREA REQUIREMENTS.

If previous modeling has demonstrated compliance for each averaging period of each pollutant with a state or federal ambient air quality standard or toxic air pollutant, and that modeling used current modeling practices and is up-to-date for that area, then a modeling waiver may be used as the discussion demonstrating compliance. Otherwise, new modeling is required. For other minor source permitting actions, modeling is not part of the permitting process. Modeling waivers do not apply to nonattainment areas.

Selected NSR regulatory language applying to modeling is copied below for easy reference.
Definition of modification:

20.2.72.7 DEFINITIONS: In addition to the terms defined in 20.2.2 NMAC (Definitions) as used in this Part:

P. "Modification" means any physical change in, or change in the method of operation of, a stationary source which results in an increase in the potential emission rate of any regulated air contaminant emitted by the source or which results in the emission of any regulated air contaminant not previously emitted, but does not include:

(1) a change in ownership of the source;

(2) routine maintenance, repair or replacement;

(3) installation of air pollution control equipment, and all related process equipment and materials necessary for its operation, undertaken for the purpose of complying with regulations adopted by the board or pursuant to the Federal Act; or

(4) unless previously limited by enforceable permit conditions:

(a) an increase in the production rate, if such increase does not exceed the operating design capacity of the source;

(b) an increase in the hours of operation; or

(c) use of an alternative fuel or raw material if, prior to January 6, 1975, the source was capable of accommodating such fuel or raw material, or if use of an alternate fuel or raw material is caused by any natural gas curtailment or emergency allocation or any other lack of supply of natural gas.

Requirements for permit:

20.2.72.200 APPLICATION FOR CONSTRUCTION, MODIFICATION, NSPS, AND NESHAP - PERMITS AND REVISIONS:

A. Permits must be obtained from the Department by:

(1) Any person constructing a stationary source which has a potential emission rate greater than 10 pounds per hour or 25 tons per year of any regulated air contaminant for which there is a National or New Mexico Ambient Air Quality Standard. If the specified threshold in this subsection is exceeded for any one regulated air contaminant, all regulated air contaminants with National or New Mexico Ambient Air Quality Standards emitted are subject to permit review. Within this subsection, the potential emission rate for nitrogen dioxide shall be based on total oxides of nitrogen;

(2) Any person modifying a stationary source when all of the pollutant emitting activities at the entire facility, either prior to or following the modification, emit a regulated air contaminant for which there is a National or New Mexico Ambient Air Quality Standard with a potential emission rate greater than 10 pounds per hour or 25 tons per year and the regulated air contaminant is emitted as a result of the modification. If the specified threshold in this subsection is exceeded for any one regulated air contaminant, all regulated air contaminants with National or New Mexico Ambient Air Quality Standards emitted by the modification are subject to permit review. Within this subsection, the potential emission rate for nitrogen dioxide shall be based on total oxides of nitrogen;

Like-kind-replacement required modeling:

20.2.72.219 PERMIT REVISIONS:

B. Technical Permit Revisions:

(1) Technical permit revision procedures may be used only for:

(d) Modifications that replace an emissions unit for which the allowable emissions limits have been established in the permit, provided that the new emissions unit:

(i) Is equivalent to the replaced emissions unit, and serves the same function within the facility and process;

(ii) Has the same or lower capacity and potential emission rates;

(iii) Has the same or higher control efficiency, and stack parameters which are at least as effective in the dispersion of air pollutants;

(vi) Would not, when operated under applicable permit conditions, cause or contribute to a violation of any National or New Mexico Ambient Air Quality Standard; and

Modeling requirements for new permits or significant revisions:

20.2.72.203.A.4 NMAC

Contain a regulatory compliance discussion demonstrating compliance with each applicable air quality regulation, ambient air quality standard, prevention of significant deterioration increment, and provision of 20.2.72.400 NMAC - 20.2.72.499 NMAC. The discussion must include an analysis, which may require use of US EPA-approved air dispersion model(s), to (1) demonstrate that emissions from routine operations will not violate any New Mexico or National Ambient Air Quality Standard or prevention of significant deterioration increment, and (2) if required by 20.2.72.400 NMAC - 20.2.72.499 NMAC, estimate ambient concentrations of toxic air pollutants.

NMED EXHIBIT 7

2.1.3 NSR Permitting for PSD Major Sources

PSD major sources and major modifications have additional modeling requirements beyond those of minor sources. PSD major source modeling authority is contained here:

> **20.2.74.305 NMAC AMBIENT AIR QUALITY MODELING:** All estimates of ambient concentrations required by this Part shall be based on applicable air quality models, data bases, and other requirements as specified in EPA's Guideline on Air Quality Models (EPA-450/2-78-027R, July, 1986), its revisions, or any superseding EPA document, and approved by the Department. Where an air quality impact model specified in the Guideline on Air Quality Models is inappropriate, the model may be modified or another model substituted. Any substitution or modification of a model must be approved by the Department. Notification shall be given by the Department of such a substitution or modification and the opportunity for public comment provided for in fulfilling the public notice requirements in subsection B of 20.2.74.400 NMAC. The Department will seek EPA approval of such substitutions or modifications.

2.2 Air pollutants

Emissions of Sulfur Dioxide (SO_2), Particulate matter with an aerodynamic diameter of less than or equal to 10 micrometers (PM_{10}), Particulate matter with an aerodynamic diameter of less than or equal to 2.5 micrometers ($PM_{2.5}$), Carbon Monoxide (CO), Nitrogen Dioxide (NO_2), Lead (Pb), Hydrogen sulfide (H_2S), and air toxics as listed in 20.2.72 NMAC are pollutants that may require modeling. Ozone and Volatile Organic Compound (VOC) emissions do not currently require a modeling analysis for a PSD minor source. If NO_X or VOCs are subject to PSD review, you should contact NMED and the EPA Regional Office to determine current ozone modeling requirements.

2.3 Modeling Exemptions and Reductions

2.3.1 Modeling waivers

In some cases, the demonstration that ambient air quality standards and PSD increments will not be violated can be satisfied with a discussion of previous modeling. If emissions have been modeled using current modeling procedures and air quality standards, and this modeling is still valid for the current standards, then the modeling waiver form may be submitted to request approval of a modeling waiver. The Bureau will determine on a case-by-case basis if the modeling waiver can be granted. The waiver discussion and written waiver approval should be included in the modeling section of the application.

The Bureau has performed generic modeling to demonstrate that the following small sources do not need modeling. The application must include a modeling waiver form to document the basis of the waiver. Permitting staff must approve the total emission rates during the permitting process for any waiver to be valid.

Table 1. Very small emission rate modeling waiver requirements

Pollutant	If all emissions come from stacks 20 feet or greater in height and there are no horizontal stacks or raincaps (lb/hr)	If not all emissions come from stacks 20 feet or greater in height, or there are horizontal stacks, raincaps, volume, or area sources (lb/hr)
CO	50	2
H_2S (Pecos-Permian Basin)	0.1	0.02
H_2S (Not in Pecos-Permian Basin)	0.01	0.002
Lead	Waiver not available.	Waiver not available.
NO_2	2	0.025
PM2.5	0.3	0.015
PM10	1.0	0.05
SO_2	2	0.025
Reduced sulfur (Pecos-Permian Basin)	0.033	Waiver not available.
Reduced sulfur (Not in Pecos-Permian Basin)	Waiver not available.	Waiver not available.

2.3.2 General Construction Permits (GCPs)

General Construction Permits do not require modeling. General modeling was performed in the development of these permits.

2.3.3 Streamlined Compressor Station Modeling Requirements

Compressor stations may be eligible for streamlined permits under the authority of **20.2.72.300-399 NMAC**. Streamlined permits have reduced modeling analysis requirements.

Streamlined Compressor Station Location Requirements

Restrictions preventing use of streamlined permits in certain locations are listed in **20.2.72.301 NMAC**. Those restrictions dealing with location are described below.

According to **20.2.72.301.B.4 NMAC**, the facility cannot co-locate with petroleum refineries, chemical manufacturing plants, bulk gasoline terminals, natural gas processing plants, or at any facility containing sources in addition to IC engines and/or turbines for which an air quality permit is required through state or federal air quality regulations.

20.2.72.301.B.5 NMAC restricts the location of streamlined permit in areas predicted by air quality monitoring or modeling to have more than 80% of state or federal ambient air quality standards or PSD increments consumed. Table 2, below, is a list of these areas. This restriction means that any streamlined permit applicant wishing to locate in a nonattainment area or those areas listed in Table 2 must demonstrate, using air dispersion modeling, that the entire facility will not produce any concentrations above significance levels.

Table 2. Areas Where Streamlined Permits Are Restricted

County	Latitude	Longitude	Radius (m)
San Juan	36.73120	-107.9608189	3000
San Juan	36.48296	-108.1200487	1000

* Locations within 150 meters of a facility that emits 25 tons per year of NO_X are restricted areas for streamlined compressor station permits unless modeling is performed.

20.2.72.301.B.6 NMAC prohibits the location of streamline permit from use in areas if the nearest property boundary will be located less than:
(a) 1 kilometer (km) from a school, residence, office building, or occupied structure. Buildings and structures within the immediate industrial complex of the source are not included.
(b) 3 km from the property boundary of any state park, Class II wilderness area, Class II national wildlife refuge, national historic park, state recreation area, or community with a population of more than twenty thousand people.

Table 3. List of state parks, Class I areas, Class II wilderness areas, Class II national wildlife refuges, national historic parks, and state recreation areas

County	Name	Type	Min. Distance (km)
Bernalillo	Sandia Mountain Wilderness	State Wilderness	3
Catron	Gila Wilderness	Class I Area	30
Catron	Gila Cliff Dwelling	National Monuments	3
Catron	Datil Well	Recreation Sites	3
Chaves	Bottomless Lake	Class II State Parks	3
Chaves	Salt Creek Wilderness Area	Class I Area	30
Chaves	Bitter Lake National W.R.	Class II Wildlife Refuge	3
Cibola	Bluewater Lake	Class II State Parks	3
Cibola	El Malpais	National Monuments	3
Cibola	El Morro	National Monuments	3
Colfax	Cimarron Canyon	Class II State Parks	3
Colfax	Maxwell National W.R.	Class II Wildlife Refuge	3
Colfax	Capulin	National Monuments	3
DeBaca	Sumner Lake	Class II State Parks	3
DeBaca	Ft. Sumner	State Monuments	3
Dona Ana	Leesburg Dam	Class II State Parks	3
Dona Ana	Aguirre Springs	Recreation Sites	3
Dona Ana	Ft. Seldon	State Monuments	3
Eddy	Carlsbad Caverns National Park	Class I Area	30
Eddy	Living Desert	Class II State Parks	3
Grant	Gila Wilderness	Class I Area	30
Grant	City of Rocks	Class II State Parks	3
Guadalupe	Santa Rosa Lake	Class II State Parks	3
Harding	Chicosa Lakes	Class II State Parks	3
Harding	Kiowa National Grasslands	National Grasslands	3
Lea	Harry McAdams	Class II State Parks	3
Lincoln	White Mountain Wilderness	Class I Area	30
Lincoln	Valley of Fires	Class II State Parks	3
Lincoln	Lincoln	State Monuments	3

County	Name	Type	Min. Distance (km)
Luna	Pancho Villa	Class II State Parks	3
Luna	Rock Hound	Class II State Parks	3
McKinley	Red Rock	Class II State Parks	3
Mora	Coyote Creek	Class II State Parks	3
Mora	Ft. Union	National Monuments	3
Otero	Oliver Lee	Class II State Parks	3
Otero	White Sands	National Monuments	3
Otero	Three Rivers Petro	Recreation Sites	3
Quay	Ute Lake	Class II State Parks	3
Rio Arriba	San Pedro Parks Wilderness	Class I Area	30
Rio Arriba	El Vado Lake	Class II State Parks	3
Rio Arriba	Heron Lake	Class II State Parks	3
Rio Arriba	Navajo Lake (Sims)	Class II State Parks	3
Rio Arriba	Chama River Canyon Wilderness	State Wilderness	3
Roosevelt	Oasis	Class II State Parks	3
Roosevelt	Grulla National W. R.	Class II Wildlife Refuge	3
San Juan	Navajo (Pine)	Class II State Parks	3
San Juan	Chaco Canyon	National Historic Park	3
San Juan	Aztec Ruins	National Monuments	3
San Juan	Angel Peak (National)	Recreation Area	3
San Miguel	Conchas Lake	Class II State Parks	3
San Miguel	Storey Lake	Class II State Parks	3
San Miguel	Villanueva	Class II State Parks	3
San Miguel	Las Vegas National W. R.	Class II Wildlife Refuge	3
San Miguel	Pecos	National Monuments	3
Sandoval	Bandelier Wilderness	Class I Area	30
Sandoval	Coronado	Class II State Parks	3
Sandoval	Rio Grande Gorge/Fenton Lake	Class II State Parks	3
Sandoval	Bandelier	National Monuments	3
Sandoval	Sandia Crest (State)	Recreation Area	3
Sandoval	Coronado	State Monuments	3
Sandoval	Jemez	State Monuments	3
Sandoval	Sandia Mountain Wilderness	State Wilderness	3
Santa Fe	Hyde Memorial	Class II State Parks	3
Sierra	Caballo Lake	Class II State Parks	3
Sierra	Elephant Butte Lake	Class II State Parks	3
Sierra	Percha Dam	Class II State Parks	3
Socorro	Bosque del Apache Wilderness	Class I Area	30
Socorro	Sevillita National W.R.	Class II Wildlife Refuge	3
Taos	Pecos Wilderness	Class I Area	30
Taos	Wheeler Park Wilderness	Class I Area	30
Taos	Kit Carson	Class II State Parks	3
Taos	Rio Grande Gorge	Recreation Sites	3
Taos	Latir Peak Wilderness	State Wilderness	3
Torrance	Manzano Mountain	Class II State Parks	3
Torrance	Grand Guivira	National Monuments	3

County	Name	Type	Min. Distance (km)
Torrance	Quarai at Salinas	National Monuments	3
Torrance	Abo at Salinas	State Monuments	3
Torrance	Manzano Mountain Wilderness	State Wilderness	3
Union	Clayton Lake	Class II State Parks	3
Valencia	Sen. Willie Chavez	Class II State Parks	3
Valencia	Manzano Mountain Wilderness	State Wilderness	3

(c) 10 km from the boundary of any community with a population of more than forty-thousand people, or
(d) 30 km from the boundary of any Class I area;

20.2.72.301.B.7 NMAC prohibits the location of streamline permit in Bernalillo County or within 15 km of the Bernalillo County line.

Streamlined Compressor Station Modeling and Public Notice Requirements

Modeling and public notice requirements for streamlined compressor station permits depend on the amount of emissions from the facility. Refer to the table below, using the maximum of the Potential to Emit (PTE) of each regulated contaminant from all sources at the facility to determine applicability. The potential to emit for nitrogen dioxide shall be based on total oxides of nitrogen. The effects of building downwash shall be included in modeling if there are buildings at the site.

Table 4. Streamlined Permit Applicability Requirements for facilities with less than 200 tons/year PTE

Applicable Regulation	PTE (TPY)	Modeling Requirements (from 20.2.72.301 D NMAC)
20.2.72.301 D (1)	<40	• None
20.2.72.301 D (2)	<100	• The impact on ambient air from all sources at the facility shall be less than the ambient significance levels.
20.2.72.301 D (3)	<200	• Air quality impacts must be less than 50% of all applicable NAAQS, NMAAQS and PSD increments. • There shall be no adjacent sources emitting the same air contaminant(s) as the source within 2.5 km of the modeled NO_2 impact area. • The sum of all potential emissions for NO_X from all adjacent sources within 15 km of the NO_X ROI must be less than 740 tons/year. • The sum of all potential emissions for NO_X from all adjacent sources within 25 km of the NO_X ROI must be less than 1540 tons/year.

There are other criteria that must be met for streamlined permits for compressor stations. Please refer to **20.2.72.300-399 NMAC** for more information.

2.3.4 Minor NSR Exempt Equipment

Exempt equipment under 20.7.72.202 NMAC do not need to be included in modeling for 20.2.72 NMAC permits. The exemption does not exclude them from modeling requirements under other types of permits, such as 20.2.70 NMAC or 20.2.74 NMAC.

2.4 Levels of Protection

2.4.1 Significance Levels

Modeling significance levels are thresholds below which the source is not considered to contribute to any predicted exceedance of air quality standards or PSD increments. The definition of 'source' can apply to the whole facility or to the modifications at the facility. For a new facility or an unpermitted facility, NMED considers the entire facility to be the 'source'. For other cases, 'source' includes only the new equipment or new emissions increases described in the current application. Equipment that replaces other equipment is part of the new equipment.

Example of source to model for permitting:
The entire facility was modeled for annual NO_2 and 1-hour and 8-hour CO in 1999 but was never modeled for 1-hour NO_2. The facility applies to replace a widget. If this widget emits only NO_2 and CO, then modeling review is applicable for these pollutants. For CO and for NO_2, the applicant may model only the replacement widget. If the impacts from the widget alone are below significance levels, then modeling is done for that pollutant/averaging period. If the impacts from the widget alone are above significance levels, then the entire facility plus nearby sources must be modeled for comparison with air quality standards and PSD increments.

Significance levels are listed in **20.2.72.500 NMAC** and are repeated in the sections below. Always use the maximum predicted concentration from the source for radius of impact/significance level determination. Even if the form of the standard allows it to be exceeded several times per period, that fraction is based on cumulative concentration and cannot be related to partial concentrations. If multiple years of meteorological data are used, then the average of those concentrations is compared with the significance level, except for $PM_{2.5}$ and 1-hour SO_2, for which the maximum across multiple years is compared with the significance level.

Use of the $PM_{2.5}$ significant ambient concentration level or significant monitoring concentration for PSD major modifications or new PSD major sources is not allowed. This significant ambient concentration level may still be used for minor source permitting.

2.4.2 Air Quality Standards

Air quality standards are maximum allowable concentrations that are designed to protect the most sensitive individuals from harm from airborne pollutants. National Ambient Air Quality Standards (NAAQS) and New Mexico Ambient Air Quality Standards (NMAAQS) are explained below. Unless otherwise noted, standards are not to be exceeded.

2.4.3 Prevention of Significant Deterioration (PSD) Increments

To prevent relatively clean areas from degrading to levels just barely in compliance with the air quality standards, limits on the change have been established in the form of PSD increments. Compliance demonstrations for PSD increments demonstrate that the deterioration is less than the allowable increment.

List of State air quality standards:
http://www.nmcpr.state.nm.us/nmac/parts/title20/20.002.0003.htm

2.5 Concentration Conversions

Many of the air quality standards are written in the form of parts per million (ppm) or parts per billion (ppb), but the models generally give output in units of micrograms per cubic meter ($\mu g/m^3$). EPA has verbally communicated to NMED that AERMOD output is expressed at Standard Temperature and Pressure (STP) conditions. Therefore, most air quality standards can be compared to modeled concentration without corrections for elevation (and associated low pressure). If a need for elevation correction arises, a method to adjust for elevation is listed below.

2.5.1 Gaseous Conversion Factor for Elevation and Temperature Correction

The following equation calculates the conversion from $\mu g/m^3$ to ppm, with corrections for temperature and pressure (elevation):

$$ppm = 4.553 \times 10^{-5} \times \frac{C \times T}{M_w} \times 10^{Z \times 1.598 \times 10^{-5}}$$

or, rearranged to calculate $\mu g/m^3$:

$$C = ppm \text{ x } M_W /(T \text{ x } (4.553 \text{ E } -5) \text{ x } (10^{Z \text{ x } 1.598 \text{ E } -5}))$$

where:

C = component concentration in $\mu g/m^3$.
T = average summer morning temperature in Rankin at site (typically 530 R).
M_w = molecular weight of component.
Z = site elevation, in feet.

2.5.2 Gaseous Conversion Factor at Standard Temperature and Pressure (STP) Conditions

Federal standards are expressed as mass per unit volume or ppm or ppb under standard temperature and pressure.

> "40 CFR 50.3 Reference conditions.
> All measurements of air quality that are expressed as mass per unit volume (e.g., micrograms per cubic meter) other than for particulate matter (PM2.5) standards contained in §§ 50.7 and 50.13 and lead standards contained in § 50.16 shall be corrected to a reference temperature of 25 (deg) C and a reference pressure of 760 millimeters of mercury (1,013.2 millibars)."

If a monitored or modeled concentration has been adjusted to STP, then the following equation calculates the conversion from ppm to $\mu g/m^3$ for NAAQS:

$$C = ppm \text{ x } M_w \text{ x } 40.8727$$

or, rearranged to calculate ppm:

$$\text{ppm} = C / (M_w \times 40.8727)$$

where:

C = component concentration in $\mu g/m^3$.
M_w = molecular weight of component.

$$p = p_0 \cdot \left(1 - \frac{L \cdot h}{T_0}\right)^{\frac{g \cdot M}{R \cdot L}} \approx p_0 \cdot \exp\left(-\frac{g \cdot M \cdot h}{R \cdot T_0}\right),$$

Parameter	**Description**	**Value**
p_0	sea level standard atmospheric pressure	101325 Pa
L	temperature lapse rate	0.0065 K/m
T_0	sea level standard temperature	288.15 K
g	Earth-surface gravitational acceleration	9.80665 m/s^2
M	molar mass of dry air	0.0289644 kg/mol
R	universal gas constant	8.31447 J/(mol•K)

$$[PM10]_{STP} = [PM10]_{modeled} (P_{standard})(T_{measured})/((P_{calculated\ by\ elevation})(T_{standard}))$$

2.6 Modeling the Standards and Increments

Unless otherwise specified, the discussion of the standards assumes one year of representative meteorological data is used. For multiple years of data, some pollutants use the average of the values predicted for each year as the design value. Others (including PM2.5, CO, and Pb) use the maximum value from the multiple years of data. Verify the form of the standard in regulations and EPA memos if multiple years of meteorological data are being used. Background concentrations are averaged over three years unless otherwise specified.

In cases where all the emissions of the pollutant in question are emitted from permitted sources, the nearby sources may be modeled instead of adding the background concentration. CO, NO_2, and SO_2 may use this substitution if they are over 20 km from the center of Albuquerque and El Paso. To use this substitution, include all nearby sources. Particulate matter sources and sources within 20 km of the center of Albuquerque or El Paso should include both surrounding sources and monitored background concentrations.

2.6.1 Carbon Monoxide (CO) Standards

Table 5A: Carbon Monoxide Air Quality Standards

Averaging Period	Significance Level (μg/m^3)	NAAQS (ppm)	NAAQS (μg/m^3)	NMAAQS (ppm)	NMAAQS (μg/m^3)
8-hour	500	9	10,303.6	8.7	9,960.1
1-hour	2,000	35	40,069.6	13.1	14,997.5

2.6.1.1 Design value of CO standard.

CO NAAQS are not to be exceeded more than once per year. NMAAQS are not to be exceeded. Demonstration of compliance with CO NMAAQS automatically demonstrates compliance with NAAQS.

2.6.1.2 Modeling for the CO design value.

Tier 1, 1-hour NMAAQS: Model the entire facility to determine the high 1-hour concentration. Add the high 1-hour background concentration to the high 1-hour predicted concentration to determine the total design concentration for comparison to the 1-hour NMAAQS.

Tier 1, 8-hour NMAAQS: Model the entire facility to determine the high 8-hour concentration. Add the high 8-hour background concentration to the high 8-hour predicted concentration to determine the total design concentration for comparison to the 8-hour NMAAQS.

Optionally, all nearby sources may be modeled instead of adding a background concentration, if the facility is over 20 km from the center of Albuquerque and El Paso.

Tier 2: Hourly background concentrations may be added instead of the maximum concentrations for each averaging period.

2.6.2 Hydrogen sulfide (H_2S) Standards

Table 5B: Hydrogen Sulfide Air Quality Standards

Averaging Period	Significance Level (μg/m^3)	NMAAQS (ppm)	NMAAQS (μg/m^3)	Notes
1-hour	1.0	0.010	13.9	For the state, except for the Pecos-Permian Basin Intrastate AQCR. Not to be exceeded more than once per year.
1/2-hour	5.0	0.10	139.3	For the Pecos-Permian Basin Intrastate AQCR
1/2-hour	5.0	0.030	41.8	for within 5-miles of the corporate limits of municipalities within the Pecos-Permian Basin AQCR

Design value of standard: For modeling ½-hour H_2S NMAAQS, use the 1-hour averaging time because the models cannot resolve less than one-hour increments.

Model the entire facility and any nearby sources and compare the high 1-hour concentration to the standard for that region. No background concentration is added.

2.6.3 Lead (Pb) Standards

Table 5C: Lead Air Quality Standards

Averaging Period	Significance Level (μg/m^3)	NAAQS (μg/m^3)
Quarterly	0.03	0.15

Design value of standard: For modeling quarterly lead averages, use the monthly averaging period as a conservative approach, unless the model being used has a quarterly averaging period or post-processing is desired to calculate quarterly values. Model the entire facility without surrounding sources and compare the high month concentration to the standard. No background concentration is added.

2.6.4 Nitrogen Dioxide (NO_2) Standards

Table 5D: NO_2 Air Quality Standards

Averaging Period	Significance Level (μg/m^3)	NAAQS (ppb)	NAAQS (μg/m^3)	NMAAQS (ppb)	NMAAQS (μg/m^3)	Class II PSD Increment (μg/m^3)	Class I PSD Significance Level (μg/m^3)	Class I PSD Increment (μg/m^3)
annual	1.0	53	99.66	50	94.02	25	0.1[8]	2.5
24-hour	5.0			100	188.03			
1-hour	7.52[1]	100	188.03					

[1] EPA proposed significance level of 4 ppb corrected to a reference temperature of 25°C and a reference pressure of 760 millimeters of mercury.

2.6.4.1 Design value of NO_2 standard

Demonstration of compliance with 1-hour standard is automatically a demonstration of compliance with the 24-hour NMAAQS. Otherwise, the 24-hour NO_2 standard is compared with the highest 24-hour average calculated by the model.

The annual NMAAQS design value is determined by modeling the entire facility and adding the annual background concentration. The total is compared to the standard. Optionally, to determine the total design value, the facility and all nearby sources may be modeled instead of adding a background concentration if the facility is over 20 km from the center of Albuquerque and El Paso.

The annual NO_2 PSD increment is compared with the annual average calculated by the model.

The 1-hour NO_2 standard is compared with the 3-year average of the 98th-percentile of the annual distribution of daily maximum 1-hour concentrations. If one year of on-site meteorological data is used, the 98th-percentile value associated with the 1-year period of meteorological data modeled is the design value. Each day of modeling, the maximum 1-hour concentration is determined for each receptor. The high-eighth-high value at each receptor is calculated, and the maximum of these is compared with the standard. If multiple years are modeled, the maximum value is averaged over the span of years before comparing with standards.

2.6.4.2 NO_2 Reactivity

Combustion processes emit nitrogen oxides in the forms of nitrogen oxide (NO) and nitrogen dioxide (NO_2). Only the concentration of NO_2 is regulated by air quality standards; however, emissions of nitrogen oxides (NO_X = NO + NO_2) must be modeled to estimate total NO_2 concentrations because nitrogen oxides change form in the atmosphere.

Two key reactions are most important in determining the equilibrium (or quasi-equilibrium) ratio of NO_2 to NO.

$$NO + O_3 \rightarrow NO_2 + O_2$$

$$NO_2 + h\nu \text{ (energy)} \rightarrow NO + O$$

Many other reactions participate in the determination of the atmospheric concentration of NO_2. As the plume travels away from the stack, more and more ozone diffuses into the plume, enabling the relatively quick reaction to form NO_2.

2.6.4.3 Estimating NO_2 concentrations

The Bureau has approved techniques, described below, for estimating NO_2 concentrations from NO_X point sources. Note that NO_2 emissions reported by the emissions inventory are actually NO_X emissions.

Tier 1, Total Conversion Technique: 100% conversion
This technique assumes all the NO_X is converted to NO_2. This simple technique is suitable for small facilities where compliance with standards is not a problem.

Tier 2, Ambient Ratio Method 2 (ARM2) Technique
ARM2 method is included as an option in AERMOD. This method is approved without the need for EPA approval. 0.5 is the national default for minimum ambient ratio. A minimum ambient ratio as low as 0.2 may be used by providing evidence that the in-stack ratio of the modeled emission units is equal to or lower than the minimum ambient ratio used. The default maximum ratio is 0.9.

Tier 3, Ozone Reaction Techniques
Two methods account for the ozone that mixes into the plumes and encourages NO_2 formation: Ozone Limiting Method (OLM) and Plume Volume Molar Ratio Method (PVMRM). Both these techniques are accepted and are built into AERMOD.
OLM assumes an NO_2 plume and an NO plume are each dispersing. The in-stack ratio of NO_2/NO_X is used to determine the amount of nitrogen dioxide initially in each plume. The concentration of NO at each receptor is assumed to react stoichiometrically with the background ozone concentration at that time to form NO_2. Contributions from both plumes are added to get the NO_2 concentration at that time.

PVMRM works similarly to OLM but uses the total volume of the plume by the time it reaches the receptor to calculate how much ozone is available for reaction. Both methods result in greater conversion with greater distance from the source but use different approximations for determining how much ozone has dispersed into the plume.

Both methods require additional information.
For the equilibrium NO_2/NO_X ratio, the value of 0.9 is approved.

For the in-stack NO_2/NO_X ratio, values lower than 0.5 must be justified with data. Combustion involving excess oxygen results in higher in-stack NO_2/NO_X ratios than do stoichiometric reactions. The facility may use an in-stack ratio of 0.5 without justification. Surrounding sources, if required, may be modeled with an in-stack ratio of 0.3 without justification.

Recent ozone data representative of the area should be used. See the section on background concentrations for more information.

Special techniques are required to model PSD increment with OLM or PVMRM if increment-expanding sources are being modeled. No negative emission rates can be used. See *ADDENDUM, USER'S GUIDE FOR THE AMS/EPA REGULATORY MODEL – AERMOD (EPA-454/B-03-001, September 2004),* Pg. 25, for more details on the PSDCREDIT option**.** **(http://www.rflee.com/RFL_Pages/AERMOD_USERGUIDE_ADDENDUM_06341.pdf)**

Combined-Plume Option vs. Individual-Plume Option
AERMOD provides two options for calculating ozone-limited NO_2 concentrations, the "plume-by-plume" (INDVDL) calculation, and the combined plume (SRCGRP) calculation. The Bureau has accepted a general demonstration that if two plumes are impacting the same receptor at the same time, then the two plumes have merged. If the plumes do not impact the same receptor at the same time, then the plumes have not merged, but both options will calculate the same concentration for that hour. Therefore, the Bureau will accept either INDVL or SRCGP option without additional demonstrations.

2.6.4.4 Modeling for the 1-hour NO_2 design value

Model the entire facility and add the 98th percentile 1-hour background concentration to compare to the design value. Optionally, all nearby sources may be modeled instead of adding a background concentration if the facility is over 20 km from the center of Albuquerque and El Paso, Texas. Refined hourly background concentrations may be used instead of the maximum 1-hour concentration as described in the section on background concentrations.

Before attempting to calculate the design value, first locate the areas with highest overall concentrations. Place a few receptors in these areas and re-run the model in these areas. The maximums will occur in nearly the same places.

Maximum modeled concentration may also be used as a conservative approximation of the design value.

"The highest of the average 8th-highest (98th-percentile) concentrations across all receptors, based on the length of the meteorological data period, represents the modeled 1-hour NO_2 design value based on the form of the standard."

2.6.4.5 Modeling for the annual NO_2 NMAAQS design value

Model the entire facility and add the annual background concentration to compare to the design value. Optionally, all nearby sources may be modeled instead of adding a background concentration if the facility is over 20 km from the center of Albuquerque and El Paso, Texas. (Use of hourly background concentrations does not affect the result for an annual average).

2.6.4.6 Modeling for the annual NO_2 PSD increment design value

Model all increment-consuming parts of the facility and increment-consuming nearby sources of the facility (or nearby sources of the Class I area for Class I analysis). Compare the result to the design value. All sources (not just increment affecting sources) will need to be modeled in order to take credit for increment expanding sources using OLM or PVMRM. See the AERMOD User's Guide Addendum for more details. Optionally, a monitored background value may be substituted for the modeled surrounding sources as a conservative approach to the increment consumption.

2.6.5 Ozone (O_3) Standards

Ozone is normally only modeled for regional compliance demonstrations and does not need to be modeled for air quality permits. However, permit applicants for PSD applications that apply to NO_X or VOCs should contact NMED and the EPA Regional Office to determine how to complete the ozone ambient impact analysis.

Table 5E: O_3 Air Quality Standards

Averaging Period	**Significance Level** (μg/m^3)	**NAAQS (ppm)**	**NAAQS** (μg/m^3)
8-hour	1.96 [2]	0.07[1]	137.3

[1] To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.07 ppm.

[2] 1.0 ppb, Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program, EPA, April 17, 2018

Ozone concentrations may be estimated using the following method derived from the MERP guidance[2].

[O3] = ((NO_X emission rate (tons/year) /184) + (VOC emission rate (tons/year) /1049)) x 1.96 μg/m^3

> "Simulation of ozone formation and transport is a highly complex and resource intensive exercise. Control agencies with jurisdiction over areas with ozone problems are encouraged to use photochemical grid models, such as the Models-3/Community Multi-scale Air Quality (CMAQ) modeling system, to evaluate the relationship between precursor species and ozone." --68234 Federal Register / Vol. 70, No. 216 / Wednesday, November 9, 2005 / Rules and Regulations

In accordance with this guidance, NMED performs ozone modeling on a regional scale as need arises, rather than requiring permit applicants to quantify their contribution to a regional ozone concentration. Comprehensive ozone modeling is too resource intensive to attach this expense to a typical permit application, and screening modeling on an affordable scale currently cannot quantify a source's impacts to ambient ozone concentrations.

Regional ozone modeling for the Four Corners area was done in 2009 (see http://www.nmenv.state.nm.us/aqb/4C/Modeling.html) and the Air Quality Bureau is continuing to analyze ozone in the region.

2.6.6 Particulate matter less than 2.5 micrometers in aerodynamic diameter ($PM_{2.5}$) Standards

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[2] Guidance on the Development of Modeled Emission Rates for Precursors (MERPS) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program, Richard A. Wayland, EPA, December 2, 2016.

Table 5F: $PM_{2.5}$ Air Quality Standards[3]

Averaging Period	Significance Level [4] ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Class II PSD Increment[3] ($\mu g/m^3$)	Class I PSD Significance Level ($\mu g/m^3$)	Class I PSD Increment[3] ($\mu g/m^3$)
annual	0.2	12 [1]	4	0.05	1
24-hour	1.2	35 [2]	9	0.27	2

[1] To attain this standard, the 3-year average of the annual arithmetic mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 12.0 ug/m^3.
[2] To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 ug/m^3.
[3] For any period other than an annual period, the applicable maximum allowable increase may be exceeded during one such period per year at any one location.
[4] Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program, EPA, April 17, 2018.

$PM_{2.5}$ secondary formation concentrations may be estimated using the following method derived from the MERP guidance[4].

$$[PM_{2.5}]_{annual} =$$
$$((NO_X \text{ emission rate (tons/year) } /3184) + (SO_2 \text{ emission rate (tons/year) } /2289)) \times 0.2\ \mu g/m^3$$

$$[PM_{2.5}]_{24\text{-hour}} =$$
$$((NO_X \text{ emission rate (tons/year) } /1155) + (SO_2 \text{ emission rate (tons/year) } /225)) \times 1.2\ \mu g/m^3$$

Secondary formation from the project should be added to the modeled value. Refined factors for certain geographic areas may be developed using the MERP guidance.

2.6.6.1 $PM_{2.5}$ design value

The 24-hour design value is the 98th percentile of the combined concentrations from all sources. The annual design value is the annual average.

2.6.6.2 Modeling for the 24-hour $PM_{2.5}$ design value

AERMOD and current emissions inventories currently do not account for secondary formation of $PM_{2.5}$ in the atmosphere. Sources that emit at least 40 tons per year of NO_X or at least 40 tons per year of SO_2 are

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[3] Prevention of Significant Deterioration (PSD) for Particulate Matter Less Than 2.5 Micrometers ($PM_{2.5}$) – Increments, Significant Impact Levels (SILs) and Significant Monitoring Concentration (SMC), ENVIRONMENTAL PROTECTION AGENCY
40 CFR Parts 51 and 52, RIN 2060-AO24 http://www.epa.gov/nsr/documents/20100929finalrule.pdf

[4] Guidance on the Development of Modeled Emission Rates for Precursors (MERPS) as a Tier 1 Demonstration Tool for Ozone and PM2.5 under the PSD Permitting Program, Richard A. Wayland, EPA, December 2, 2016.

considered to emit significant amounts of precursors. Sources with significant increases of $PM_{2.5}$ precursors must qualitatively and/or quantitatively account for secondary formation of $PM_{2.5}$.[5]

Two tiers of modeling are available for $PM_{2.5}$ modeling. Both tiers include modeling the facility and nearby sources and adding secondary formation and a background concentration to that. Particulate sources typically have impacts in the immediate vicinity of the source that are not represented in background monitors, so double-counting of background concentrations is expected to be limited.

Add the design value of the modeled direct $PM_{2.5}$ to the design value of the secondary $PM_{2.5}$ and the design value of the background $PM_{2.5}$.

Tier 1: To the modeled concentration(s), add the secondary $PM_{2.5}$ and the 98th percentile 24-hour monitored background concentration.
Tier 2: Add the secondary $PM_{2.5}$ and the monthly or quarterly maximum background concentrations to daily modeled concentrations. Compare the high-eighth-high combined concentration with the 24-hour standard. If multiple years of meteorological data are used, then the high-eighth-high combined concentration is compared with the standard.

2.6.6.3 Modeling for the 24-hour $PM_{2.5}$ PSD increment design value

Model the high-second-high concentration of all increment-consuming sources at the facility and at nearby sources. Calculate secondary formation from NO_X and SO_2 increases after the appropriate baseline date and add that to the modeled concentration. Compare the total with the 24-hour PSD increment.

2.6.6.4 Modeling for the annual $PM_{2.5}$ PSD increment design value

Model all increment-consuming sources at the facility and at nearby sources. Calculate secondary formation from NO_X and SO_2 increases after the appropriate baseline date and add that to the modeled concentration. Compare the total predicted annual average concentration with the allowable increment.

2.6.7 Particulate matter less than 10 micrometers in aerodynamic diameter (PM_{10}) Standards

Table 5G: PM_{10} Air Quality Standards

Averaging Period	Significance Level (µg/m^3)	NAAQS (µg/m^3)	PSD Increment[2] Class II (µg/m^3)	PSD Class I Significance Level (µg/m^3)	PSD Class I Increment[2] (µg/m^3)
annual	1.0		17	0.2[1]	4
24-hour	5.0	150	30	0.3[1]	8

[1] EPA proposed significance level
[2] For any period other than an annual period, the applicable maximum allowable increase may be exceeded during one such period per year at any one location.

2.6.7.1 Modeling for the 24-hour PM_{10} NAAQS design value

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[5] Guidance for PM2.5 Permit Modeling, Stephen D. Page, May 20, 2014. http://www.epa.gov/ttn/scram/guidance/guide/Guidance_for_PM25_Permit_Modeling.pdf

If PM2.5 emission rates are modeled as equal to PM10 emission rates, then the PM2.5 NAAQS demonstration will satisfy the requirement for demonstration of compliance with PM10 NAAQS. However, PM10 PSD increment demonstration is not necessarily satisfied by any PM2.5 modeling.

The 24-hour NAAQS is not to be exceeded more than once per year.
Use high second high and a single year of representative meteorological data. This is approximately equivalent to the high fourth high specified in the multi-year analysis.
"…[W]hen n years are modeled, the (n+1)th highest concentration over the n-year period is the design value, since this represents an average or expected exceedance rate of one per year."
http://www.epa.gov/ttn/scram/guidance/guide/appw_05.pdf

Two tiers of modeling are available for PM$_{10}$ NAAQS modeling. Both tiers include modeling the facility and nearby sources and adding a background concentration to that. Particulate sources typically have impacts in the immediate vicinity of the source that are not represented in background monitors, so double-counting of background concentrations is expected to be limited.

Tier 1, option 1: Use highest predicted concentration (instead of the high second high) and a single year of representative meteorological data. To the modeled concentration, add the high second high 24-hour monitored background concentration.

Tier 1, option 2: Use high second high predicted concentration and a single year of representative meteorological data. To the modeled concentration, add the highest 24-hour monitored background concentration.

Tier 2: Add monthly maximum background concentrations to daily modeled concentrations. The high-second-high combined concentration may be compared with the 24-hour standard.

2.6.7.2 Modeling for the 24-hour PM$_{10}$ PSD increment design value

Model all increment-consuming sources at the facility and at nearby sources. Compare the high-second-high predicted concentration with the allowable increment.

2.6.7.3 Modeling for the annual PM$_{10}$ PSD increment design value

Model all increment-consuming sources at the facility and at nearby sources. Compare the predicted annual average concentration with the allowable increment.

2.6.8 Sulfur Dioxide (SO$_2$) Standards

Table 5I: SO$_2$ Air Quality Standards

Averaging Period	Significance Level (μg/m^3)	NAAQS (ppb)	NAAQS (μg/m^3)	NMAAQS (ppb)	NMAAQS (μg/m^3)	PSD Class II Increment[3] (μg/m^3)	PSD Class I Significance Level (μg/m^3)	PSD Class I Increment[3] (μg/m^3)
annual	1.0			20	52.4	20	0.1[2]	2
24-hour	5.0			100	261.9	91	0.2[2]	5
3-hour	25.0	500	1309.3			512	1.0[2]	25
1-hour	7.8[1]	75	196.4					

[1] EPA proposed 1-hour significance level of 3 ppb corrected to a reference temperature of 25ºC and a reference pressure of 760 millimeters of mercury.

[2] EPA proposed significance level.
[3] For any period other than an annual period, the applicable maximum allowable increase may be exceeded during one such period per year at any one location.

2.6.8.1 SO_2 design value

In NMAC, the SO_2 standards for the area within 3.5 miles of the Chino Mines Company smelter furnace stack at Hurley are set equal to the federal standards. However, since this stack no longer exists, the distance is irrelevant. The NMAAQS listed in table 5I apply for the entire state.
Demonstration of compliance with 1-hour standard will also demonstrate compliance with the other standards, but not necessarily the PSD increments.

The form is the 3-year average of the 99th percentile of the annual distribution of daily maximum 1-hour average concentrations.

2.6.8.2 Modeling for the 1-hour SO_2 NAAQS

The standard is calculated similarly to the NO_2 1-hour standard instructions in section 2.6.4.4, but the fourth highest is used in place of the eighth highest (and 99th percentile is substituted for 98th percentile). All sulfur oxides are assumed to be in the form of SO_2. If multiple years are modeled, the resulting high-fourth-high values at each receptor are averaged over the years modeled and the maximum average value is compared with the standard.

Tier 1: Add the 99th percentile 1-hour background concentration to 99th percentile modeling for the entire facility (without neighboring sources) and compare the total with the 1-hour NAAQS. Optionally, to determine the total design value, the facility and all nearby sources may be modeled instead of adding a background concentration if the facility is over 20 km from the center of Albuquerque and El Paso.

Tier 2: Add the hourly 1-hour background concentrations (as described in the background concentration section) to each hour of the modeling results and compare the 99th percentile of the totals with the 1-hour NAAQS. Optionally, to determine the total design value, the facility and all nearby sources may be modeled instead of adding a background concentration if the facility is over 20 km from the center of Albuquerque and El Paso.

2.6.8.3 Modeling for the 3-hour SO_2 PSD increment

Model the increment consuming emissions at the facility and at nearby sources and compare the high-second-high 3-hour average with the allowable PSD increment. Optionally, a monitored background value may be substituted for the modeled surrounding sources as a conservative approach to the increment consumption.

2.6.8.4 Modeling for the 24-hour SO_2 PSD increment

Model the increment consuming emissions at the facility and at nearby sources and compare the high-second-high 24-hour average with the allowable PSD increment. Optionally, a monitored background value may be substituted for the modeled surrounding sources as a conservative approach to the increment consumption.

2.6.8.5 Modeling for the annual SO_2 PSD increment

Model the increment consuming emissions at the facility and at nearby sources and compare the predicted annual average with the allowable PSD increment. Optionally, a monitored background value may be substituted for the modeled surrounding sources as a conservative approach to the increment consumption.

2.6.9 Total Reduced Sulfur Except For Hydrogen Sulfide Standards

Table 5J: Total Reduced Sulfur except for H_2S Air Quality Standards

Averaging Period	NMAAQS (ppm)	Notes
1/2-hour	0.003	for the state, except for the Pecos-Permian Basin Intrastate AQCR
1/2-hour	0.010	for the Pecos-Permian Basin Intrastate AQCR
1/2-hour	0.003	For within corporate limits of municipalities within the Pecos-Permian Basin Intrastate Air Quality Control Region.
1/2-hour	0.003	For within five miles of the corporate limits of municipalities having a population of greater than twenty thousand and within the Pecos-Permian Basin Intrastate Air Quality Control Region

2.6.9.1 Total Reduced Sulfur design value

EPA test methods suggest that reduced sulfur compounds in some cases consist primarily of carbon disulfide (CS_2), carbonyl sulfide (COS), and hydrogen sulfide (H_2S). To calculate the parts per million of reduced sulfur, use the average molecular weight in the sample. For example, 1-heptanethiol ($CH_3[CH_2]6SH$) has a molecular weight of 132.3.

For modeling ½-hour total reduced sulfur NMAAQS, use the 1-hour averaging time because the models cannot resolve less than one hour increments.

2.6.9.2 Modeling the Total Reduced Sulfur ½-hour NMAAQS

Model the entire facility and compare the 1-hour predicted concentration with the ½-hour NMAAQS. Surrounding sources and background concentrations are not added.

Table 6A. Air Quality Standard Summary (Without Notes).

Pollutant	Avg. Period	Sig. Lev. (μg/m^3)	Class I Sig. Lev. (μg/m^3)	NAAQS (μg/m^3)	NMAAQS (μg/m^3 unless noted)	PSD Increment Class I (μg/m^3)	PSD Increment Class II (μg/m^3)
CO	8-hour	500		10,303.6	9,960.1		
	1-hour	2,000		40,069.6	14,997.5		
H_2S	1-hour	1.0			13.9		
	1/2-hour	5.0			139.3		
	1/2-hour	5.0			41.8		
Pb	Quarterly	0.03		0.15			
NO_2	annual	1.0	0.1	99.66	94.02	2.5	25
	24-hour	5.0			188.03		
	1-hour	7.52		188.03			
O_3	8-hour	1.96		137.3			
$PM_{2.5}$	annual	0.2	0.05	12		1	4
	24-hour	1.2	0.27	35		2	9
PM_{10}	annual	1.0	0.2			4	17
	24-hour	5.0	0.3	150		8	30
SO_2	annual	1.0	0.1		52.4	2	20
	24-hour	5.0	0.2		261.9	5	91
	3-hour	25.0	1.0	1309.3		25	512
	1-hour	7.8		196.4			
Reduced S	1/2-hour				3 ppb		
	1/2-hour				10 ppb		

Table 6B. Standards for which Modeling is not Required.

Standard not Modeled	Surrogate that Demonstrates Compliance
CO 8-hour NAAQS	CO 8-hour NMAAQS
CO 1-hour NAAQS	CO 1-hour NMAAQS
NO_2 annual NAAQS	NO_2 annual NMAAQS
NO_2 24-hour NMAAQS	NO_2 1-hour NAAQS
O_3 8-hour	Regional modeling
SO_2 annual NMAAQS	SO_2 1-hour NAAQS
SO_2 24-hour NMAAQS	SO_2 1-hour NAAQS
SO_2 3-hour NAAQS	SO_2 1-hour NAAQS

Table 6C. Modeling the Design Value Summary (Default Modeling).

Averaging Period	Add Nearby Sources?	Add Background Concentration?	Modeled Concentration
CO 8-hour NMAAQS	No* (Yes)	Yes* (high 8 hour) (No)	high 8 hour
CO 1-hour NMAAQS	No* (Yes)	Yes* (high 1 hour) (No)	high 1 hour
H_2S 1-hour or ½-hour NMAAQS	Yes	No	high 1 hour
Pb Quarterly NMAAQS	No	No	high month
NO_2 annual NMAAQS	No* (Yes)	Yes* (annual average) (No)	annual average
NO_2 annual PSD increment	Yes	No	annual average
NO_2 1-hour NAAQS	No* (Yes)	Yes* (1-hr 98th percentile) (No)	98th-percentile 1 hour
$PM_{2.5}$ annual NAAQS	Yes	Yes (annual average)	annual average
$PM_{2.5}$ annual PSD increment	Yes	No	annual average
$PM_{2.5}$ 24-hour NAAQS	Yes	Yes (24-hr 98th percentile)	98th-percentile 24 hour
$PM_{2.5}$ 24-hour PSD increment	Yes	No	high 24 hour
PM_{10} annual PSD increment	Yes	No	annual average
PM_{10} 24-hour NAAQS	Yes	Yes (high 24 hour)	high second high 24 hour
PM_{10} 24-hour PSD increment	Yes	No	high second high 24 hour
SO_2 annual PSD increment	Yes	No	annual average
SO_2 24-hour PSD increment	Yes	No	high second high 24 hour
SO_2 3-hour PSD increment	Yes	No	high second high 3 hour
SO_2 1-hour NAAQS	No* (Yes)	Yes* (high 1 hour) (No)	99th-percentile 1 hour
Reduced S ½-hour NMAAQS	No	No	high 1 hour

* Standards marked with an asterisk normally offer the choice to either model nearby sources or add a representative background concentration.

2.7 PSD Increment Modeling

2.7.1 Air Quality Control Regions and PSD Baseline Dates

Any facility that is required to provide an air dispersion modeling analysis with its construction permit application is required to submit a PSD increment consumption analysis unless none of its sources consume PSD increment. Table 7 serves as a tool to determine which sources to include in PSD increment modeling.

Table 7: PSD Increment Consumption and Expansion

Sources that do not consume PSD increment	• Temporary emissions (sources involved in a project that will be completed in a year or less). • Any facility or modification to a facility constructed before the PSD major source baseline date. • Any minor source constructed before the PSD minor source baseline date.
Sources that consume PSD increment	• Any new emissions or increase in emissions after the PSD Minor Source Baseline date (for that AQCR and pollutant). • Any new emissions or increase in emissions at a PSD Major source that occurs after the Major Source Baseline Date.
Sources that expand PSD increment	• A permanent reduction in actual emissions from a baseline source.

Notes:

- EPA memos written before the publication of the Draft NSR Workshop Manual indicate that PSD regulations were not intended to apply to temporary pilot projects. The memo clearly indicated that the pilot project did not need a PSD permit.
- If a minor source facility once existed but shut down before the minor source baseline date, then it would not be considered to be part of the baseline.
- Haul road emissions are treated the same way other sources of emissions are treated.
- An increase in emissions due to increased utilization of a facility, such as de-bottlenecking, are treated as any other increase in emissions.
- The Bureau interprets temporary emissions to mean emissions at the location that will occur for less than one year or emissions of standby or emergency equipment that operates less than 500 hours per year. For example, if a series of three gravel crushers operate at a mine for more than one year, PSD increment modeling should be performed because the mining operations at the location are not temporary in nature, even though none of the of individual crushers remained on-site for an entire year.

Table 8: Minor Source Baseline Dates by Air Quality Control Region

AQCR	NO_2 Date	SO_2 Date	PM_{10} Date	$PM_{2.5}$ Date
12	8/10/1995	8/10/1995	8/10/1995	Not established
14	6/6/1989	8/7/1978	8/7/1978	Not established
152	3/26/1997	5/14/1981	3/26/1997	2/11/2013
153	8/2/1995	Not established	6/16/2000	Not established
154	Not established	Not established	Not established	Not established
155	3/16/1988	7/28/1978	2/20/1979	11/13/2013
156	Not established	8/4/1978	8/4/1978	Not established
157	Not established	Not established	Not established	Not established

Table 9: Major Source Baseline Dates and Trigger Dates

Pollutant	Major Source Baseline Date	Trigger Date
PM	January 6, 1975	August 7, 1977
SO_2	January 6, 1975	August 7, 1977
NO_2	February 8, 1988	February 8, 1988
$PM_{2.5}$	October 20, 2010	October 20, 2011

2.7.2 PSD Class I Areas

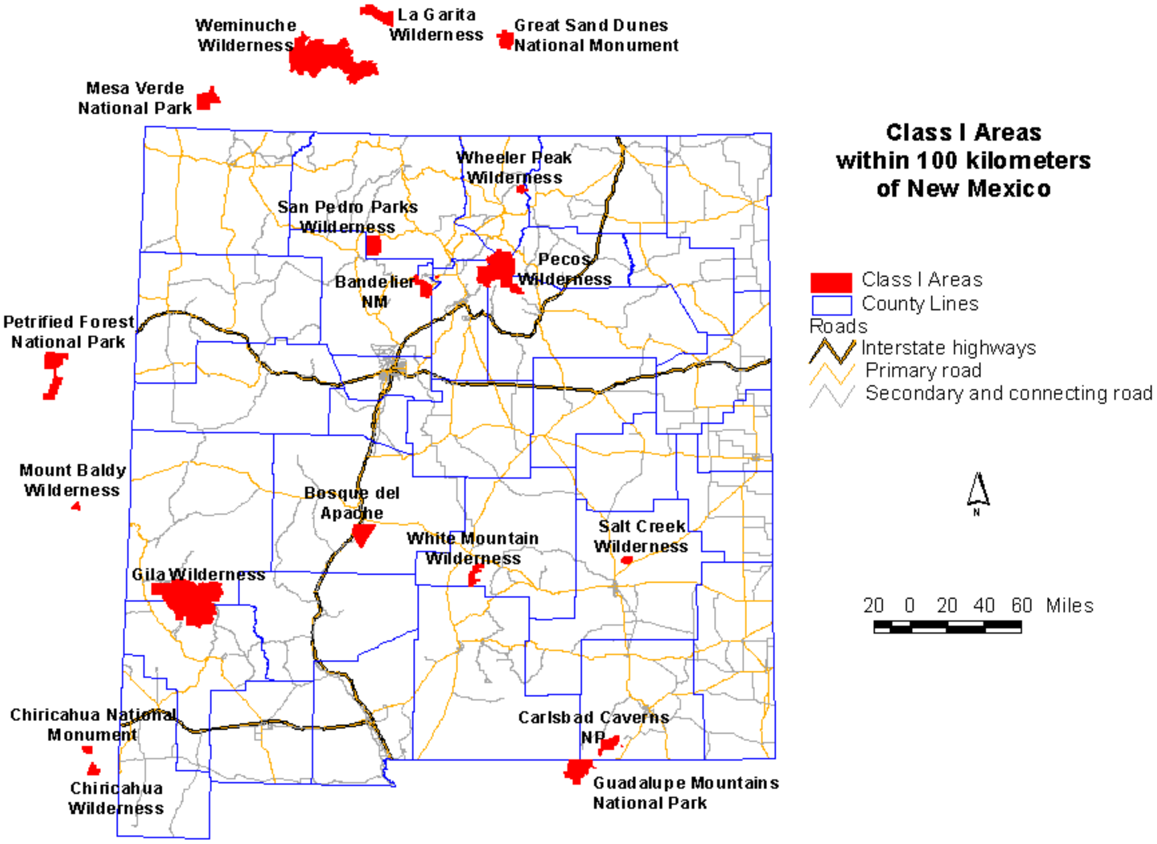

Figure 1: Class I areas

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2.7.3 PSD Class I Area Proposed Significance Levels

The Environmental Protection Agency (EPA) has proposed significance levels for PSD Class I areas. No significance levels have been promulgated, but the Federal land managers (FLMs) are currently accepting the use of this value.

Table 10. Class I Prevention of Significant Deterioration Significance Levels

Pollutant	Averaging Period	Significance Level (μg/m^3)	PSD Class I Increment (μg/m^3)
Sulfur Dioxide (SO_2)	annual [a] 24-hour 3-hour	0.1 [b] 0.2 [b] 1.0 [b]	2 5 25
PM_{10}	annual [a] 24-hour	0.2 [b] 0.3 [b]	4 8
Nitrogen Dioxide (NO_2)	annual [a]	0.1 [b]	2.5
$PM_{2.5}$	annual 24-hour	0.06 0.07	1 2

[a] annual arithmetic mean

[b] EPA proposed significance level

2.8 New Mexico State Air Toxics Modeling

Modeling must be provided for any toxic air pollutant sources that may emit any toxic pollutant in excess of the emission levels specified in **20.2.72.502 NMAC -** Permits for Toxic Air Pollutants. Sources may use a correction factor based on release height for the purpose of determining whether modeling is required. Divide the emission rate for each release point by the correction factor for that release height on Table 11 and add the total values together to determine the total adjusted emission rate. If the total adjusted emission rate is higher than the emission rate in pounds per hour listed in **20.2.72.502 NMAC**, then modeling is required. The controlled emission rate (not the adjusted emission rate) of the toxic pollutant should be used for the dispersion modeling analysis.

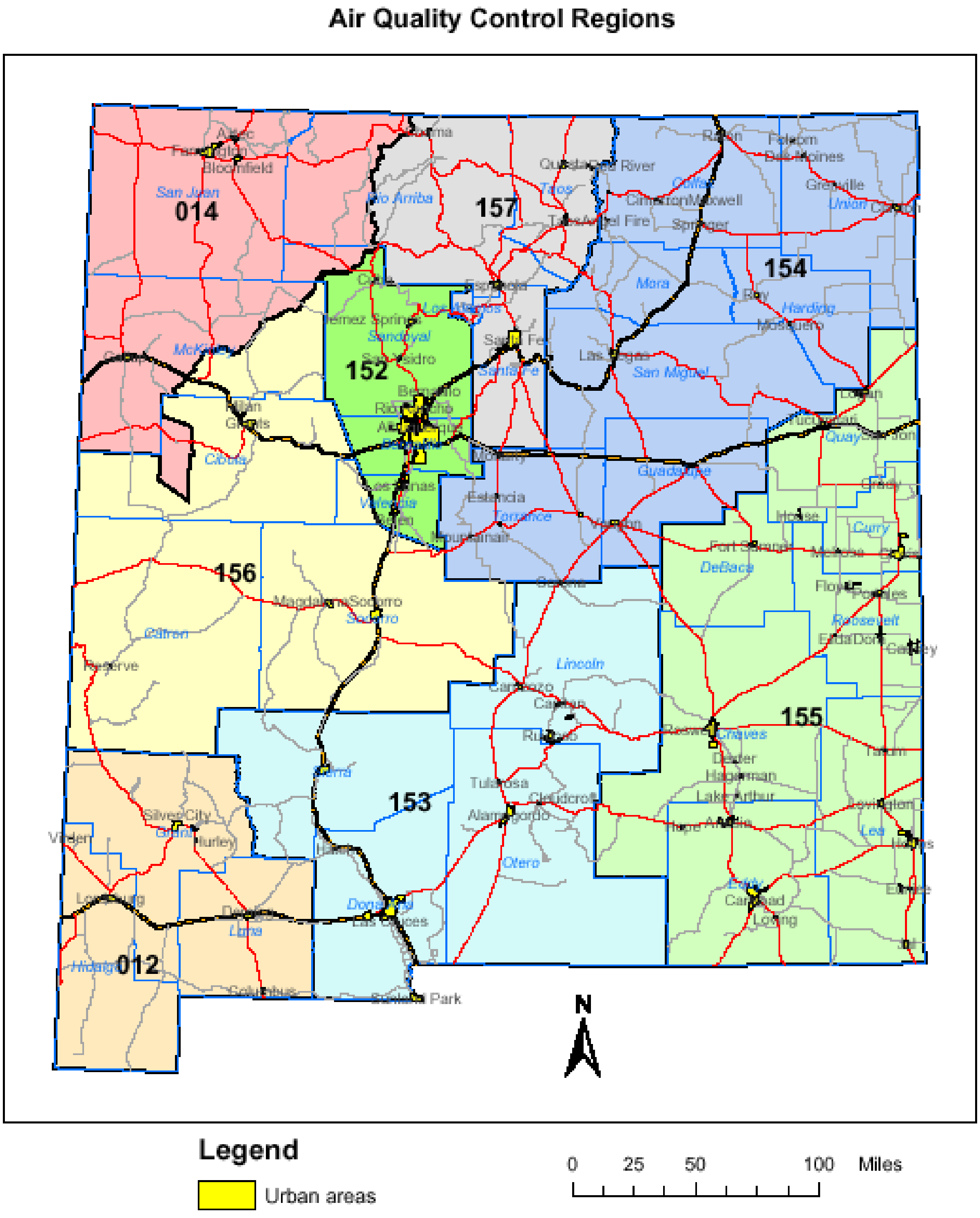

Figure 2: Air quality control regions (each AQCR has a different color)

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Table 11: Stack Height Release Correction Factor (adapted from 20.2.72.502 NMAC)

Release Height in Meters	Correction Factor
0 to 9.9	1
10 to 19.9	5
20 to 29.9	19
30 to 39.9	41
40 to 49.9	71
50 to 59.9	108
60 to 69.9	152
70 to 79.9	202
80 to 89.9	255
90 to 99.9	317
100 to 109.9	378
110 to 119.9	451
120 to 129.9	533
130 to 139.9	617
140 to 149.9	690
150 to 159.9	781
160 to 169.9	837
170 to 179.9	902
180 to 189.9	1002
190 to 199.9	1066
200 or greater	1161

The table below lists a few of the commonly encountered State Air Toxics in New Mexico. This is not the complete list, which is too expansive to reprint here.

Table 12: A few common state air toxics and modeling thresholds (from 20.2.72.502 NMAC)

Pollutant	OEL (mg/m^3)	1% OEL (μg/m^3)	Emission Rate Screening Level (pounds/hour)
Ammonia	18	180	1.20
Asphalt (petroleum) fumes	5.00	50	0.333
Carbon black	3.50	35	0.233
Chromium metal	0.500	5.00	0.0333
Glutaraldehyde	0.700	7.0	0.0467
Nickel Metal	1.00	10.0	0.0667
Wood dust (certain hard woods as beech & oak)	1.00	10.0	0.0667
Wood dust (soft wood)	5.00	50.0	0.333

If modeling shows that the maximum eight-hour average concentration of each toxic pollutant is less than one one hundredth of its Occupational Exposure Level (OEL) listed in **20.2.72.502 NMAC**, then the analysis is finished. For a source of any known or suspected human carcinogens (per **20.2.72.502 NMAC**) which will cause an impact greater than one-one hundredth of the OEL, the source must demonstrate that best available control technology will be used to control the carcinogen. If modeling shows that the impact of a toxic which is not a known or suspected human carcinogen (per **20.2.72.502 NMAC**) is greater than one-one hundredth of the OEL, the application must contain a health assessment for the toxic pollutant that includes: source to potential receptor data and modeling, relevant environmental pathway and effects data, available health effects data, and an integrated assessment of the human health effects for projected exposures from the facility.

2.9 Hazardous Air Pollutants

Hazardous Air Pollutants (HAPs) do not require modeling, as they are regulated by means other than air quality standards. Sources should be aware of the Title V major source thresholds of 10 tons/year for any Hazardous Air Pollutants (HAP) and 25 tons/year for total HAPs, which will require an operating permit to be obtained from the department under **20.2.70 NMAC**- Operating Permits.

2.10 Nonattainment and Maintenance Areas

In nonattainment areas and for those sources outside of the nonattainment area that significantly contribute to concentrations in a nonattainment area, the modeling analysis required is a demonstration of an air quality benefit. Regular modeling is required in maintenance areas, however. Further information on nonattainment area modeling is in section 7.4, Nonattainment Area Requirements. Nonattainment areas are described at https://www.env.nm.gov/air-quality/nonattainment-areas/.

3.0 MODEL SELECTION

3.1 What dispersion models are available?

The Bureau accepts the use of EPA approved models for dispersion analysis. Commercial or parallel versions of these models are fine as long as they produce the same results. This section of the modeling guidelines is designed to describe the models that are available and provide some guidance on which situations are the most appropriate for which regulatory modeling situations.

Two types of models are currently in use for air dispersion modeling: probability density function (PDF) models, and puff models. Probability density function models apply a probability function from each emission release point to calculate the concentration at a receptor based on the location of the receptor, wind speed and direction, stability of the atmosphere, and other factors. The plume is assumed to extend all the way out to the most distant receptor, no matter how far that receptor is from the emission source. Because of this characteristic, PDF models suffer in accuracy when modeling distant concentrations or unstable conditions. SCREEN3, ISCST3, ISC_OLM, CTSCREEN, ISC-PRIME, and AERMOD are all PDF models. All but AERMOD use a Gaussian, or normal, distribution for their probability density function. AERMOD uses a PDF that varies depending on nearby terrain and other factors. Currently, AERMOD and CTSCREEN are EPA-approved models for near-field modeling. As of November 9, 2006, SCREEN3, ISCST3, and ISC_OLM are no longer considered EPA-approved models. The Federal Register notice detailing the promulgation of AERMOD is located at: http://www.epa.gov/scram001/guidance/guide/appw_05.pdf

CALPUFF is a puff model, meaning that it tracks puffs, or finite elements of pollution, after they are released from their source. This strategy makes the model ideal for tracking pollution over long distances or in conditions that are not stable, and also allows chemical reactions within the plume to be modeled. Unfortunately, puff models require large amounts of computing time. CALPUFF is an EPA-approved model for modeling long range transport and/or complex non-steady-state meteorological conditions.

3.2 EPA Modeling Conferences and Workshops

EPA Modeling Conference presented a wealth of information about recent regulatory modeling developments. The EPA web page with the details is https://www.epa.gov/scram/air-modeling-conferences-and-workshops.

3.3 Models Most Commonly Used in New Mexico

Most analyses reviewed by the Bureau will begin with an AERMOD analysis, and possibly CALPUFF for Class I analyses. For dispersion modeling within 50 kilometers of the source, AERMOD should be used. CALPUFF should be used only for PSD Class I area analyses, per the Interagency Workgroup Air Quality Modeling (IWAQM) Phase II report, but may be approved for use on a case-by-case basis for other analyses.

3.3.1 AERMOD

- AERMOD is intended to be the standard regulatory model. The PRIME building downwash algorithm is used by the model. Both the Ozone Limiting Method (OLM) and the Plume Volume Molar Ratio Method (PVMRM) algorithms for nitrogen conversion are built into the model.
- AERMOD has greater accuracy in complex terrain than CTSCREEN.
- AERMOD is suggested for extremely complex terrain.

See the section on nitrogen oxides for more information and options.

3.3.2 CALPUFF

- CALPUFF is a puff model designed to calculate concentrations at distances up to and beyond 50 kilometers. The model is significantly more difficult to run than the other models discussed in these guidelines. Use of CALPUFF for NAAQS, NMAAQS, or PSD increment modeling must be approved by the Bureau before submitting the modeling.
- CALPUFF is required for additional impact analyses when Federal Land Managers require additional impact analyses for Class I areas near PSD major sources. Typically, CALPUFF light is used for this modeling.

3.3.3 CTSCREEN

- CTSCREEN is applicable only for modeling receptors above stack height.
- CTSCREEN is a difficult model to run because of the difficulty in obtaining hill contour profiles.
- CTSCREEN uses screening meteorology.
- AERMOD produced greater accuracy than CTDMPLUS (the full implementation of CTSCREEN) when modeling the data that was used to develop CTSCREEN/CTDMPLUS.
- CTSCREEN is typically used to model the terrain on top of a hill that did not pass when using AERMOD.

The following list can be used to correct 1-hour CTSCREEN concentrations to 3-hour, 24-hour and annual concentrations by multiplying by the appropriate conversion factor for the averaging period.

Table 13: CTSCREEN Correction factors for 1-hour concentration.

Averaging Period	Correction factor
3-hour	0.7
24-hour	0.15
Annual	0.03

3.3.4 AERSCREEN

- AERSCREEN is a screening version of AERMOD.

4.0 MODEL INPUTS AND ASSUMPTIONS

Models should be used with the technical options recommended in the Guideline on Air Quality Models (http://www.epa.gov/ttn/scram/guidance/guide/appw_05.pdf) except as noted in this document or approved by the Bureau.

Unless otherwise noted, information and procedures in this section refer to all of the models listed above.

4.1 Operating Scenarios

4.1.1 Emission Rates

All averaging periods shall be modeled using the maximum short-term emission rate allowed in the permit. The preferred method of modeling all averaging periods is to use maximum short-term emission rates and to use the hours of operation model input option to limit the facility's emissions.

4.1.2 Hours of Operation

If the facility is limited to operating certain hours of the day or has other operating restrictions, limiting the operating hours in the model can normally reduce the concentration produced by the model. Hours of operation can only be modeled by models that use actual meteorology, but not by screening models. Use screening models only to model facilities as if the maximum operating rate were emitting continuously.

4.1.3 Time Scenarios

Sometimes a facility has unusual operating times, for example, if the facility is allowed to operate 12 hours per day, but the hours are not specified. The facility may model as if it operates continuously, but as an option, the facility can model different time periods at the amount of time allowed per day as different operating scenarios, making sure that the maximums are modeled. In the 12 hour example, the facility might model three scenarios: 7AM to 7PM. 7PM to 7AM. And 5PM to 5AM. This way, all the hours of the day were modeled, and the modeler can be fairly certain that the maximum was modeled because the worst-case scenarios would occur when the calm blocks of time were modeled together. All scenarios should be modeled at maximum hourly emission rates.

4.1.4 Operating at Reduced Load

Some sources (like engines and boilers) can produce higher concentrations of pollution in ambient air when they are operating below maximum load than when they are at maximum load. The applicant shall analyze various feasible operating scenarios (100%, 75%, and 50% are typical) to determine the worst-case impacts, and then use that worst-case scenario for the entire modeling analysis. This requirement is in section 8.1 of Appendix W of EPA's Guideline.

4.1.5 Alternate Operating Scenario

If the permit application contains multiple operating scenarios (such as use of different fuels or different engines) then the applicant shall model each of the scenarios for the radius of impact analysis. Whichever scenario produces the greatest impacts on ambient air shall be used for the cumulative analysis, if required. If it is unclear which operating scenario produces the greatest impacts, each scenario shall be modeled for cumulative impact analysis.

4.1.6 Startup, Shutdown, Maintenance (SSM), and Other Short-term Emissions

If startup, shutdown, maintenance, or other temporary events have the potential for producing short-term impacts greater than the normal operating scenarios, then the applicant shall model each of the scenarios to demonstrate compliance with the ambient air quality standard.

If it is probable that an adjacent facility will have emissions higher than normal operation during the time the applicant's facility has increased emissions, then those emissions should also be accounted for in the modeling. Otherwise, model surrounding sources at their normal operating rate. Because of the short nature of the SSM emissions, modeling does not have to demonstrate compliance with annual standards or annual increment consumption. Highest hourly SSM emission rate should be modeled for NAAQS, NMAAQS and for increment consumption modeling.

Whichever scenario produces the greatest impacts on ambient air shall be used for the cumulative analysis, if required. If it is unclear which operating scenario produces the greatest impacts, each scenario shall be modeled for cumulative impact analysis.

4.2 Plume Depletion and Deposition

Dry plume depletion may be used to reduce concentrations of particulate matter. Appropriate particle characteristics for the specific type of source being modeled should be used. Check the web page for sample particle size distributions. Because of the length of time required to run a model with plume depletion, the Bureau recommends only applying plume depletion to receptors that are modeled to be above standards when the model is run without plume depletion.

The wet deposition option should not be used for the modeling analysis unless data are available and the use of wet deposition has been previously approved.

4.3 Meteorological Data.

4.3.1 Selecting Meteorological Data.

The meteorological data used in the modeling analysis should be representative of the meteorological conditions at the specific site of proposed construction or modification, or else use screening meteorological data, which contains worst-case data.

Representative, on-site data is obviously the best data to use; however, for many sources on-site data is not available. Bureau modeling staff can supply preferred meteorological data sets for various locations around the state. The National Weather Service also collects data throughout the country. These data sets are available through the National Climatic Data Center. It is mandatory that Bureau modeling staff approve the chosen meteorological data before the analysis is submitted. PSD permits contain more rigorous requirements relating to the collection of representative, on-site meteorological data. Either 1 year of representative data which serves as on-site data or 5 years of appropriate off-site data must be used. Please contact the Bureau as soon as possible if you anticipate the need to collect on-site meteorological or ambient monitoring data for a PSD permit.

Setback distance modeling for portable sources may require separate meteorological data than that used in the rest of the modeling for that facility. Preliminary analysis indicates that the Substation meteorological data set is appropriate for locations throughout the State. Contact the Bureau for guidance on relocation meteorological data selection.

The goal of modeling is to use site-specific meteorological data. In cases where the form of the standard allows the standard to be exceeded a number of times per year, this is based on site-specific data. If the equivalent of site-specific data is not available, then the highest concentration estimate should be considered the design value unless multiple years of data are used. (68238 Federal Register / Vol. 70, No. 216 / Wednesday, November 9, 2005 / Rules and Regulations)

For example, no meteorological monitoring stations are available near Raton, New Mexico, and there are terrain features that may make Raton meteorology different from other places. The Bureau will still recommend meteorological data to use for modeling in Raton, but the PM_{10} standard is not allowed to be exceeded at all because the meteorological data is not completely representative of the area.

For concentration monitoring data, proximity to the monitor is normally the driving factor for selection of a representative monitor. For meteorological data, the similarity of the terrain (including canyon and valley directions) is more important than finding the closest monitor. Unless otherwise noted, AQB staff will need the exact location of the facility to select or approve a set of meteorological data representative of the location. Staff will compare wind roses with prominent terrain features that influence drainage patterns or otherwise influence wind directions.

Processed meteorological data is available on the web page: https://www.env.nm.gov/air-quality/meteorological-data/.

4.4 Background Concentrations

> “Background concentrations should be determined for each critical (concentration) averaging time.” (68242 Federal Register / Vol. 70, No. 216 / Wednesday, November 9, 2005 / Rules and Regulations)

The background concentrations listed below were derived from information downloaded from http://aqsdr1.epa.gov/aqsweb/aqstmp/airdata/download_files.html.

4.4.1 Uses of Background Concentrations

Background concentrations are added to the modeled concentrations or are used for stoichiometric modeling applications such as OLM or PVMRM. Normally, a background concentration associated with the averaging period being modeled is added after the model (with all facility and nearby sources) is completed. Sometimes this approach proves too conservative to demonstrate compliance with standards. If so, monthly, daily, or hourly concentration profiles can be developed using representative sets of monitoring data appropriate for the modeling domain. Adding refined background concentrations normally requires post-processing of hourly output files.

It is very important to use recent monitoring data, because concentration trends are likely to change over time (much more so than weather patterns). If hourly meteorological data does not match hourly monitoring data, then the following methods can be used to produce a concentration profile for the refined modeling exercise.

Choose the highest background for each period for the region that best describes the modeling domain, unless adequate justification can be made that a specific monitor is most representative. For rural areas that do not match the regional descriptions above, use a monitor from Eastern NM or Southwestern NM.

4.4.1.1 Refined background concentrations

Background concentrations may be refined to take into account patterns in daily and monthly fluctuations in concentration. Since background concentrations are added to the model after dispersion is complete, there is no point mathematically in determining refined background concentrations shorter than the averaging period of the air quality standard. 24-hour concentrations do not need 1-hour background concentrations (except for ozone limiting of NO_2 concentrations, which happens during dispersion).

4.4.1.2 Developing 24-hour refined background concentrations

Each of the 12 months is represented by the maximum 24-hour concentration occurring during that month. If three years of data are available, average the three values for each month and use the average for the background. If a given month has a low maximum concentration due to the small number of samples collected that month, then the concentration from that month is not used and the average of the maximums of the two other years will be used as the 24-hour background for that month.

Example: Roswell $PM_{2.5}$ (This example uses outdated data and should not be used for new modeling).

$PM_{2.5}$ has a 24-hour averaging period and an annual averaging period. The annual average uses the annual value in the standard background tables, but it is appropriate to use refined background concentrations for the 24-hour period. The Partisol sampler in Roswell is a Federal Reference Method sampler for $PM_{2.5}$. The filters are collected about every three days, so there is not data available for every day. Over three years of data are available, and 2007 through 2009 are presented in the following table.

January, 2007 had a maximum reported concentration of 10.0 $\mu g/m^3$. January 2008 and 2009 had maximum concentrations of 18.0 and 11.7, respectively. The average of these three values is 13.2. After the model has run, every day in January adds a background concentration of 13.2 $\mu g/m^3$. Care must be taken to identify the greatest sum of modeled concentration plus background, since background concentration varies each month – the highest modeled concentration may no longer be the highest when the background values are added.

Table 14: Roswell $PM_{2.5}$ Monitoring Data (2007-2009)

Year	Month	$PM_{2.5}$ concentration. (µg/m^3)											Max	3-year avg.
2007	1	2.33	3.67	9.50	6.25	10.00	6.25	4.67	5.58	7.25			10.00	**13.2**
2007	2	5.92	5.50	25.5	9.00	13.75	2.67	2.42	5.67	2.25			25.50	**14.7**
2007	3	1.67	2.92	4.42	4.17	3.42	12.25	8.00	9.29	2.67	5.58	2.67	12.25	**12.8**
2007	4	4.75	9.58	4.83	5.86	3.67	5.75	8.00	2.75	5.83	6.00		9.58	**9.2**
2007	5	4.58	3.42	4.00	8.33	6.08	4.00	3.75	4.33				8.33	**10.0**
2007	6	7.00	6.92	8.25	4.00	5.19	5.67	9.29	13.7	6.58			13.67	**11.5**
2007	7	8.58	8.28	8.17	5.75	7.92	8.67	7.33	7.28				8.67	**9.2**
2007	8	11.92	3.08	7.50	11.83	18.50	8.67	7.92	6.33	6.00	7.83		18.50	**13.2**
2007	9	11.75	4.00	4.75	6.75	9.17	4.08	4.08	3.17	4.42	4.08		11.75	**11.1**
2007	10	5.25	6.00	6.08	6.92	4.33	5.08						6.92	**7.0**
2007	11	7.75	7.58	8.75	7.25	5.42	8.33	7.83	7.25	18.58	8.33		18.58	**10.4**
2007	12	3.17	4.08	4.25	3.17	5.83	10.50	5.58	4.33	2.25			10.50	**10.8**
2008	1	5.3	8.2	3.6	4.4	3.0	4.9	18.0	13.4	4.2	2.6		18.0	
2008	2	2.2	3.8	3.3	3.3	7.4	3.5	9.3	4.6				9.3	
2008	3	6.8	3.7	14.8	4.9	5.8	5.8						14.8	
2008	4	3.7	5.5	10.7	2.9	6.7	6.2	5.2	9.5				10.7	
2008	5	6.8	7.4	4.3	5.2	11.6	6.2	6	5.3				11.6	
2008	6	6.3	7.1	4.8	5.2	6.3	14	4.9	4.9				14.0	
2008	7	6.7	6.4	4.8	4.0	7.0	6.1	9.2	9.2	9.8			9.8	
2008	8	6.5	6.7	9.2	3.6	5.6	4.3	5.2	7.8				9.2	
2008	9	7.6	7.6	2.3	4.8	5.0	8.8	8.8	11.1	8.9			11.1	
2008	10	7.2	2.8	4.6	4.8	3.2	4.3	7.9	3.5	4.0			7.9	
2008	11	5.5	6.2	4.1									6.2	
2008	12	3.8	4.6	7.8	5.2								7.8	
2009	1	5.2	3.7	1.8	11.7	10.0	5.6	4.1	7.3				11.7	
2009	2	5.8	5.6	9.3	3.4	8.1	9.0	4.2	5.4	4.7			9.3	
2009	3	4.1	6.0	11.4	2.8	4.1	3.8	11.3	6.2	9.7	4.0	4.2	11.4	
2009	4	7.2	4.4	6.2	1.8	4.8	1.8	3.1	6.6				7.2	
2009	5	6.4	3.2	10.0	6.7	3.9							10.0	
2009	6	6.4	3.9	4.7	5.0	6.7	5.3						6.7	
2009	7	4.8	8.9	4.5	5.7	6.0	8.6	9.2	5.8	8.5	8.1	8.4	9.2	
2009	8	8.4	10.5	7.6	5.0	6.1	11.8	7.0	4.3				11.8	
2009	9	7.9	3.9	4.9	5.3	10.3	1.7	6.5					10.3	
2009	10	2.2	6.2	1.9	1.9	3.0	3.6						6.2	
2009	11	6.2	5.3	6.1	2.8	5.5	5.0	6.3	2.6				6.3	
2009	12	14.2	5.5	4.3	7.7	4.9	5.3						14.2	

4.4.1.3 Developing 1-hour refined background concentrations

From the geographically nearest full set of monitoring data to the facility to be modeled, determine the maximum one-hour concentration that occurs during each hour of the day for each month. The result will be twelve different 24-hour profiles that will be repeated for the entire month that each represents. This profile can be used for all averaging periods. If three years of data are available, average the three values for each month and use the average for the background. POST files may be used to add hourly background concentrations to receptors.

Example: Determine the maximum concentration for hour 1 (midnight to 1AM) in January. Use this for hour 1 for each day in January. Determine the maximum concentration for hour 2 (1AM to 2AM) in January. Use this for hour 2 for each day in January. … Determine the maximum concentration for hour 24 (11PM to midnight) in December. Use this for hour 24 for each day in December. Complete the entire year in this manner, with hour and month-specific data.

4.4.1.4 Eliminating double-counting of emissions in background

In some cases the addition of a background concentration may result in double-counting of some of the emissions, if the reference monitor is very close to the modeling domain. This effect may be reduced by placing a receptor at the monitor location and modeling the sources in the model that existed at the time of the monitoring. The modeled concentration at the monitor may be subtracted from the background (with a minimum background of zero). The averaging period should be the same as the one used for the background calculation, and must be temporally correlated if the maximum monitored concentration is not being used.

4.4.2 CO Background Concentration

Ambient CO monitors to represent New Mexico are very limited. Concentrations near Sunland Park are best represented by monitors in El Paso. Monitors operated by Albuquerque should be conservative for the rest of New Mexico.

Table 15: Carbon Monoxide Background Concentration

Region	ID	Location	1-hour ($\mu g/m^3$)	8-hour ($\mu g/m^3$)	Latitude	Longitude	Notes
The rest of New Mexico	350010023	Del Norte High School	2203	1524	35.1343	-106.585	4700a San Mateo NE, Albuquerque, NM
Albuquerque	350010029	South Valley	2746	1566	35.01708	-106.657	201 Prosperity SE, Albuquerque, NM
Sunland Park	481410044	El Paso Chamizal	4677	2834	31.76569	-106.455	800 S San Marcial Street, El Paso, TX

Concentrations are the average of the maximum concentrations for 2015-2017.

4.4.3 H_2S Background Concentration

NMED has no H_2S monitors. The standards are generally designed to protect against noticeable changes in concentration above the background concentration for the region, and no background concentration is added.

4.4.4 Lead Background Concentration

Reformulation of gasoline and other control measures have virtually eliminated ambient lead concentrations. NMED has no lead monitors. Treat as zero background.

4.4.5 NO_2 Background Concentration

Note: No 24-hour averages were calculated. Compliance with 1-hour NAAQS automatically demonstrates compliance with 24-hour NMAAQS.

Table 16: NO_2 Background Concentration

Region	ID	Location	1-hour Background (µg/m^3)	1-hour 98th %ile (µg/m^3)	Annual Background (µg/m^3)	Latitude	Longitude	Address
4-Corners	1ZB, 350450009	Bloomfield	85.1	67.3	19.6	36.74222	-107.977	162 Hwy 544, Bloomfield NM 87413
4-Corners	1NL, 350450018	Navajo Dam	62.2	52.1	11.0	36.80973	-107.652	423 Hwy 539, Navajo Dam, NM 87419
4-Corners	350451233	Dine College	73.3	54.9	11.3	36.8071	-108.695	Dine College, GIS Lab
Albuquerque	350010023	Del Norte High School	94.2	83.8	20.2	35.1343	-106.585	4700A San Mateo NE
South Central	6ZM, 350130021	Sunland Park	100.4	85.7	12.5	31.79611	-106.584	5935A Valle Vista, Sunland Park, NM
South Central	6ZN, 350130022	US-Mexico Border Crossing	102.9	77.5	8.5	31.78778	-106.683	104-2 Santa Teresa International Blvd, NM
Eastern NM	5ZR, 350151005	Outside Carlsbad	60.3	38.7	5.0	32.38	-104.262	Holland St, SE of Water Tank, Carlsbad, NM
Eastern NM	5ZS, 350250008	Hobbs-Jefferson	83.2	64.2	8.1	32.72666	-103.123	2320 N. Jefferson St, Hobbs, NM
Southwestern NM[1]	7E, 350290003	Deming	62.052	53.277	6.966	32.2558	-107.723	310 Airport Road, Deming, NM88030

Annual background is the average of three annual averages of monitoring data from 2015 to 2017. The maximum 1-hour NO_2 concentrations from each of three years were averaged to determine the 1-hour background concentration, using monitoring data from 2015 to 2017

Refined 1-hour background profiles may be developed using the guidance described in “Refined Background Concentrations”, above.

[1] Based on 2013 -2015 averages.

4.4.6 Total Reduced Sulfur Background Concentration

NMED has no total reduced sulfur monitors. The standards are generally designed to protect against noticeable changes in concentration above the background concentration for the region, and no background concentration is added.

4.4.7 Ozone Background Concentration

Ozone background concentrations are required for NO_2 modeling using PVMRM or OLM.

Table 17: Ozone Background Concentration

Region	ID	Location	1-hour Background (µg/m^3)	Latitude	Longitude	Address
4-Corners	1ZB, 350450009	Bloomfield	146.1	36.74222	-107.977	162 Hwy 544, Bloomfield NM 87413
4-Corners	1NL, 350450018	Navajo Dam	156.9	36.80973	-107.652	423 Hwy 539, Navajo Dam, NM 87419
4-Corners[1]	350450020	Chaco Culture National Historical Park	144.8	36.03022	-107.910	1808 County Road 7950, Nageezi, NM 87037
4-Corners	1H, 350451005	Shiprock Substation	145.4	36.79667	-108.473	Usbr Shiprock Substation (Farmington)
4-Corners	350451233	Dine College	151.8	36.8071	-108.695	Dine College, GIS Lab
Albuquerque	2ZJ, 350431001	Highway Department, Bernalillo	148.6	35.29944	-106.548	Highway Dept. Yard Near Bernalillo
Albuquerque	2LL, 350610008	Los Lunas	140.4	34.8147	-106.74	1000 W. Main St, Los Lunas, NM 87031
Albuquerque	350010023	Del Norte High School	153.1	35.1343	-106.585	4700A San Mateo NE
Albuquerque	350010029	South Valley	145.4	35.01708	-106.657	201 Prosperity SE
Albuquerque	350011012	Foothills	152.4	35.1852	-106.508	8901 Lowell NE
South Central	6O, 350013008	La Union	161.3	31.93056	-106.631	St Lukes Episcopal Ch Rt 1 (La Union)
South Central	6ZK, 350130020	Chaparral Middle School	170.2	32.04111	-106.409	680 McCombs, Chaparral, NM
South Central	6ZM, 350130021	Desert View Elementary School	175.9	31.79611	-106.584	5935A Valle Vista, Sunland Park
South Central	6ZN, 350130022	US-Mexico Border Crossing	169.0	31.78778	-106.683	104-2 Santa Teresa International Blvd, NM
South Central	6ZQ, 350130023	NM Highway Dept. Yards In Las Cruces	149.9	32.3175	-106.768	750 N. Solano Drive, Las Cruces, NM
Southwestern NM[2]	7T, 350171003	Hurley Smelter	139.294	32.69194	-108.124	Chino Blvd near Hurley Park, Hurley, NM
Eastern NM	5ZS, 350025008	Hobbs-Jefferson	150.5	32.72666	-103.123	2320 N. Jefferson St, Hobbs, NM
Eastern NM	5ZR, 350151005	Outside Carlsbad	155.6	32.38	-104.262	Holland St, SE of Water Tank, Carlsbad, NM
Eastern NM	350153001	Carlsbad Caverns	145.4	32.1783	-104.441	Carlsbad Caverns National Park
North Central	350390026	Coyote	140.4	36.18774	-106.698	21 New Mexico 96, Coyote, NM, 87012
North Central	3SFA, 350490021	Santa Fe Airport	139.7	35.61975	-106.08	2001 Aviation Drive, Santa Fe, New Mexico 87507

[1] Based on 2017 only
[2] Based on 2013-2015 averages.

The hourly maximum ozone concentration from the nearest ozone monitor may be used for ozone limiting. Unless otherwise noted, the maximum 1-hour O_3 concentrations from each of three years were averaged to determine the 1-hour background concentration, using monitoring data from 2015 to 2017.

Refined 1-hour background profiles may be developed using the guidance described in "Refined Background Concentrations", above. Ozone files typically use the format, "(4I2,5X,F8.3)". Hourly concentrations use µg/m^3 to avoid elevation errors.

4.4.8 $PM_{2.5}$ Background Concentration

Table 18: $PM_{2.5}$ Background Concentration

Region	ID	Location	24-hour Background 100th%ile (µg/m^3)	24-hour Background 98th%ile (µg/m^3)	Annual Background (µg/m^3)	Latitude	Longitude	Address
Albuquerque	350010023	Del Norte High School	11.5	10.8	4.6	35.1343	-106.5852	4700A San Mateo NE
Albuquerque[1]	350010029	South Valley	22.6	18.20	7.43	35.01708	-106.6574	201 Prosperity SE
South Central[2]	6CM, 350130016	Anthony	18.4	17.0	7.6	32.00361	-106.5992	SE Corner Of Anthony Elem. School Yard
South Central	6ZM, 350130021	Sunland Park	25.9	24.3	7.3	31.79611	-106.5839	5935A Valle Vista, Sunland Park
South Central	6Q, 350130025	Las Cruces District Office of NMED	16.1	14.9	5.1	32.32194	-106.7678	2301 Entrada Del Sol, Las Cruces
Eastern NM	5ZS, 350250008	Hobbs-Jefferson	15.8	13.4	5.9	32.72666	-103.1229	2320 N. Jefferson St, Hobbs
4-Corners[1]	1FO, 350450019	Farmington Environment Department Office	14.13	11.77	4.19	36.77416	-108.165	3400 Messina Drive Suite 5000 Farmington
North Central[1]	3HM, 350490020	Santa Fe	16.55	9.45	4.32	35.67111	-105.9536	Runnels Bldg. 1190 St. Francis Dr.

[1] Based on 2013-2015 averages

[2] Based on average of 2013, 2014, and 2017

Concentrations are the average of three years of maximum data from 2015 to 2017. Some monitors may not represent background concentrations. Anomalously high values were eliminated before calculating aggregate concentrations. Use the highest 98th percentile background concentration from the region in which the facility is located, unless another monitor is more representative of the local area. Refined 24-hour background profiles may be developed using the guidance described in “Refined Background Concentrations”, above.

Monthly background concentrations for Southeastern New Mexico from Hobbs are listed below. These were collected from January 2015 to December 2018.

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Table 18B: Hobbs Refined $PM_{2.5}$ Background Concentration

Month	**Monthly 24-hour Maximum** (μg/m^3)
1	**12.1**
2	**10.2**
3	**21.1**
4	**17.5**
5	**16.5**
6	**16.1**
7	**17.6**
8	**13.3**
9	**15.6**
10	**10.3**
11	**13.2**
12	**17.7**

4.4.9 PM_{10} Background Concentration

Table 19: PM_{10} Background Concentration

Region	ID	Location	Annual Background (µg/m^3)	24-hour Background Maximum (µg/m^3)	24-hour Background Second High (µg/m^3)	Latitude	Longitude	Address
Albuquerque	350010026	Jefferson	24.3	74.0	70.3	35.1443	-106.6047	3700 Singer
Albuquerque	350010029	South Valley	33.7	152.0	132.2	35.01708	-106.6574	201 Prosperity SE
4-Corners[1]	1ZB, 350450009	Bloomfield	13.0	55.0	50.0	36.74222	-107.977	162 Hwy 544, Bloomfield NM 87413
South Central	6CM, 350130016	Anthony	22.0	50.7	44.7	32.003611	-106.5992	SE Corner of Anthony Elem. School Yard
South Central	6ZK, 350130020	Chaparral Middle School	25.3	120.0	112.3	32.041111	-106.4092	680 McCombs, Chaparral
South Central[1]	6ZM, 350130021	Sunland Park	26.0	78.0	73.0	31.796111	-106.5839	5935A Valle Vista, Sunland Park
South Central	6WM, 350130024	Las Cruces City Well #46	15.3	94.7	83.3	32.278056	-106.8644	South of I-10 at Las Cruces Well #46
Southwestern[2]	7D, 350029001	Deming	16.2	56.5	46.5	32.267222	-107.7553	Post Office Pine St
Southwestern[2]	7E, 350029003	Deming Airport	22.7	128.7	109.3	32.2558	-107.7227	310 Airport Road, Deming
Eastern NM	5ZS, 350250008	Hobbs-Jefferson	24.0	100.7	37.3	32.726656	-103.1229	2320 N. Jefferson St, Hobbs
North Central[2]	3HM, 350490020	Santa Fe	9.0	23.0	20.7	35.671111	-105.9536	Runnels Bldg. 1190 St. Francis Dr.
North Central[2]	3ZD, 350055005	Taos	14.2	52.0	40.5	36.383333	-105.5833	Fire Station Santiago Road

Concentrations are averaged from 2015 to 2017. Some monitors, such as 350010026 and 350010029, are located near industrial sources or in disturbed areas and do not represent ambient background concentrations.

[1] Monitor 350450009 was missing 2015 data. Monitor 350130021 was missing 2016 data. These monitors used two year averages.

[2] Based on 2013-2015 averages

Refined 24-hour background profiles may be developed using the guidance described in “Refined Background Concentrations”, above.

Anomalously high values were eliminated before calculating aggregate concentrations.

Monthly background concentrations for Southeastern New Mexico from Hobbs are listed below. These were collected from July 2011 to June 2014. The monitor was discontinued after June 2014.

Table 20: Hobbs Refined PM_{10} Background Concentration

Month	**Monthly 24-hour Maximum** (µg/m^3)
1	43.0
2	46.0
3	62.7
4	58.0
5	62.3
6	82.3
7	86.7
8	61.3
9	60.0
10	74.3
11	48.7
12	39.7

4.4.10 SO_2 Background Concentration

Table 21: SO_2 Background Concentrations

Region	ID	Location	1-hour Background (μg/m^3)	1-hour Background 99th Percentile (μg/m^3)	Annual (μg/m^3)	Latitude	Longitude	Address
Albuquerque	350010023	Del Norte High School	15.8	13.2	1.75	35.1343	-106.585	4700A San Mateo NE
Southwest New Mexico[1]	7T, 350171003	Hurley Smelter	6.11	1.75	0.0183	32.69194	-108.124	Chino Blvd Near Hurley Park, Hurley, NM
The rest of New Mexico	1ZB, 350450009	Bloomfield	8.84	5.31	0.219	36.74222	-107.977	162 Hwy 544, Bloomfield NM 87413
Between Farmington and Shiprock	1H, 350451005	Shiprock Substation	41.6	22.1	0.389	36.79667	-108.473	Usbr Shiprock Substation (Farmington)
4-Corners west of Shiprock	350451233	Dine College	37.3	19.5	1.48	36.8071	-108.695	Dine College, GIS Lab
Eastern New Mexico	483751025	Amarillo, 24th Ave	68.3	47.0	0.670	35.2367	-101.787	4205 NE 24th Ave, Amarillo TX

Background concentrations are from 2015 to 2017
[1] Based on 2013-2015 averages

Refined 1-hour background profiles may be developed using the guidance described in “Refined Background Concentrations”, above.

4.5 Location and Elevation

Important: Use the same UTM zone and datum for the entire facility. Facilities on the border between two UTM zones must convert all information into one zone or the other.

Make sure that the source location and parameters are the same as those listed in the application form!! This is the most common mistake we see.

4.5.1 Terrain Use

Terrain classifications are defined as follows:
- **Flat terrain** – Terrain with all elevations equal to the base of the source
- **Simple terrain** – Terrain with elevations below stack height
- **Complex terrain** – Terrain with elevations above stack height

- **Intermediate (Complex) terrain** – Terrain with elevations between stack height and plume height (a subset of complex terrain).

Flat terrain should be used if the source base is higher than all the surrounding terrain or if the facility consists primarily of non-buoyant fugitive sources. Simple and complex terrain should be used for all other scenarios.

4.5.2 Obtaining Elevation

Elevation data for receptors, sources, and buildings should be obtained from Digital Elevation Model (DEM) files or National Elevation Dataset (NED) files with a resolution of 30 meters or better. USGS DEMs are available for New Mexico in either 7.5-minute or 1-degree formats. It is strongly suggested that the 7.5-minute data be used in dispersion modeling rather than the coarse resolution 1-degree data. Keep in mind that the USGS DEMs can be in one of two horizontal datums. Older DEMs were commonly in NAD27 (North American Datum of 1927) while many of the latest versions in NAD83 (North American Datum of 1983). It is important to use the same source of data for all elevations. Even USGS 7.5-minute maps and USGS 7.5-minute DEM data may differ. Surrounding sources' elevations provided by the Bureau have been determined using 7.5-minute DEM data (NAD83), where available, and 1-degree DEM data elsewhere.

Elevations should be included for at least all receptors within 10 km of your facility or within your facility's ROI (whichever is smaller). Your source's elevation may be used for receptors beyond 10 km, but it may be wiser to use actual DEM elevations for the entire ROI because surrounding sources are provided with actual elevations.

4.6 Receptor Placement

4.6.1 Elevated Receptors on Buildings

Elevated receptors should be placed on nearby buildings at points of public access where elevated concentrations may be predicted. Use flagpole receptors in areas with multi-story buildings to model state and federal standards. In cases where nearby buildings have publicly accessible balconies, rooftops, or similar areas, the applicant should consult with the Bureau modeling staff to ensure proper receptor placement. PSD increment receptors are limited to locations at ground level.[6]

4.6.2 Ambient Air

Ambient air is defined as any location at or beyond the fence line of the facility. The fence line must restrict public access by a continuous physical barrier, such as a fence or a wall. If plant property is accessible to the public or if any residence is located within the restricted area, receptors should be located on-property.[7] Public access is interpreted to include housing, schools, hospitals, and similar areas that are frequented by family members of employees, but the remainder of the restricted area is excluded from public access if such family members do not have access to excluded areas. For example, receptors would not be placed in dormitories on military bases, but would be placed in family housing areas.

4.6.3 Receptor Grids

"Receptor sites for refined modeling should be utilized in sufficient detail to estimate the highest concentrations and possible violations of a NAAQS or a PSD increment. In designing a receptor network,

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[6] NSR Workshop Manual, page C.42

[7] NSR Workshop Manual, Page C.42

the emphasis should be placed on receptor resolution and location, not total number of receptors.” (68238 Federal Register / Vol. 70, No. 216 / Wednesday, November 9, 2005 / Rules and Regulations)

The modeling domain can be defined using a Cartesian grid with 1000 meter spacing. Fine grids or fence line receptors with 50 to 100 meter spacing should fill any areas of the domain with potential to contain the highest concentration and/or any possible exceedances of NMAAQS, NAAQS, or PSD increment for the refined modeling. 50 meter spacing is recommended for fence line receptors for most sources, but 100 meters is recommended for expansive sources like coal mines, copper mines, or large military bases. (Grids with 50 meter spacing and 2 km side width are recommended for medium or large neighboring point sources. 50 meter spacing and 1 km width grids are recommended for hilltops or small neighboring sources.) Once these areas of potential high concentrations have been refined, the remaining receptors may be discarded.

For sources with an ROI greater than 50 kilometers, the grid should not extend beyond 50 km, as is noted in the NSR Workshop Manual.

4.6.4 PSD Class I Area Receptors

A modeling analysis of the PSD increment consumed at the nearest Class I areas must be performed by increment-consuming sources in AQCRs where the PSD minor source baseline date has been established, or in any AQCR where a new PSD-major source is to be installed. One receptor at the near boundary of the Class I area is normally sufficient for modeling to compare with Class I significance levels. 1000 meter spacing is recommended within the Class I areas for facilities with significant concentrations. If concentrations are above 75% of the PSD increment, then 50 to 100 meter spacing should be used near the hot spots. See Figure 1 for locations of Class I areas.

4.6.5 PSD Class II Area Receptors

Other than areas that are designated as PSD Class I areas, the entire state of New Mexico is a Class II area. The receptor grid for the PSD Class II increment analysis should be the same as the one for the cumulative run.

4.7 Building Downwash and Cavity Concentrations

Building downwash should be included in the analysis when stack height is less than good engineering practice (GEP) stack height and there are buildings, tanks, fans or other obstacles near the facility. All buildings and structures should be identified and analyzed for potential downwash effects. NMED requires the use of BPIP-Prime or equivalent for this analysis. GEP stack height should be determined as per 40 CFR 51.100. For receptors very near buildings, a cavity region analysis may be required. Modelers should consult with the Bureau modeling staff.

As summarized from 40 CFR 51.100:
GEP stack height is the greater of:
1) 65 meters, measured from the ground-level elevation at the base of the stack
or
2) H + 1.5L
Where
H = Height of nearby structure(s) measured from the ground-level elevation at the base of the stack.

L = The lesser of the height or the projected width (width seen by the stack) of nearby structures. Nearby structures can be as far as 5 times the lesser of the width or height dimension of the structure, but not greater than 0.8 km.

Stacks taller than GEP stack height should be modeled as if they were GEP stack height.

4.8 Neighboring Sources/Emission Inventory Requirements

> "The number of nearby sources to be explicitly modeled in the air quality analysis is expected to be few except in unusual situations. In most cases, the few nearby sources will be located within the first 10 to 20 km from the source(s) under consideration." (Federal Register / Vol. 82, No. 10 / Tuesday, January 17, 2017 / Rules and Regulations)

4.8.1 Neighboring Sources Data

The Emissions Inventory of neighboring sources is used as input data in air quality models. This data will be provided by the Bureau within a few days of request. E-mail the UTM coordinates of the location(s) to be modeled to the Bureau to request source data.

4.8.1.1 Determining which sources to include

This section functions as a definition for "nearby sources" as used in this document. The definition varies based on context, as illustrated below.

The contributions of distant sources are included in the background concentration. If the background concentration is added and includes all neighboring sources or a conservative approximation of them, then surrounding source modeling is not required for modeling of NAAQS or NMAAQS. For particulate matter or cases where the background concentration does not include all neighboring sources, then include all sources within 10 km of the facility in the model, and discard sources beyond 10 km from the facility. PSD increment is modeled, not monitored. (PSD increment may optionally add a background concentration instead of modeling the more distant sources.) For cases where background concentrations are not added, retain all sources within 25 km of the facility, plus sources emitting over 1000 pounds per hour within 50 km of the facility. For PSD Class I increment analysis, retain all sources within 25 km of the Class I area, plus sources emitting over 1000 pounds per hour within 50 km of the Class I area.

Table 22: Surrounding Source Retention Example for a Source Near Bloomfield.

Pollutant and averaging period	Neighboring source notes:
NO_2 1-hour NAAQS	Do not include surrounding sources. (Optionally, instead of adding background concentrations, include all sources within 25 km of the facility, plus sources emitting over 1000 pounds per hour within 50 km of the facility.)
$PM_{2.5}$ 24-hour NAAQS	Retain sources within 10 km of facility.
NO_2 annual Class II PSD increment	Retain sources within 25 km of the facility, plus sources emitting over 1000 pounds per hour within 50 km of the facility..
NO_2 annual Class I PSD increment	Retain sources within 25 km of Mesa Verde National Park, plus sources emitting over 1000 pounds per hour within 50 km of Mesa Verde.

4.8.1.2 Surrounding source format

The Bureau provides AERMOD input files with the surrounding sources (*.INP) and reference tables (*.XLS) to describe the sources in more detail. The AERMOD input files can be imported in GUI programs or edited manually. The Excel files are for reference only, and should not be used as the basis for modeling.

Sources numbered 0-49,999 belong in the NAAQS/NMAAQS analysis. Sources numbered 10,000 and above belong in the PSD increment analysis. (Notice overlap of two groups). Numbering in the reference tables may not include the 50,… or 10,… prefix for the counting numbers.

Unless otherwise noted, units of measure used in the surrounding sources files are the metric units associated with model input format. Emissions designated as NO_2 are actually total oxides of nitrogen (NO_X).

4.8.1.3 Handling errors in surrounding source files

Please contact the Bureau if you see suspicious data in the inventory. We know that there are errors in our database and we would like to correct them.

If you find a piece of equipment that has unusual stack parameters, document the error and corrected values in your modeling report. Please also report the error to Joe Kimbrell (Joseph.Kimbrell@state.nm.us) as well for database correction. Include MASTER_AI_ID, SUBJECT_ITEM_CATEGORY_CODE, and SUBJECT_ITEM_ID in the documentation.
Please document the reason the error is suspected.

The following parameters may be substituted for missing or invalid data. Determine the type of source that best matches the types below. For example, engines use the "other" category. Find the smallest emission rate in the table that is greater than or equal to the emission rate of the emission unit. That column contains the parameters that may be used for the parameters that are missing. (These parameters are based on modeling for general construction permits or on existing source data for control devices.)

Table 23: Missing Stack Parameter Substitutions for Turbines.

NO_2 Rate (lb/hr)	Height (m)	Temperature (K)	Velocity (m/s)	Diameter (m)
21.7	7	588	10	0.7
21	6	588	10	0.7
20	5	588	10	0.7
19	5	588	10	0.6
18	4.5	588	10	0.6
17	4.5	588	10	0.6
16	4.5	588	10	0.5
15	4.5	588	10	0.5
14	4.5	588	10	0.5
13	4	588	10	0.5
12	4	588	10	0.5
11	3.5	588	10	0.5
10	3.5	588	10	0.5
9	3.5	588	10	0.5
8	3.5	588	10	0.4
7	3	588	10	0.4
6	3	588	10	0.4
5	2.5	588	10	0.4
4	2.5	588	10	0.4
3	2	588	10	0.35
2	1.8	588	10	0.24
1	1.8	588	10	0.24

Table 24: Missing Stack Parameter Substitutions for Flares.

SO_2 Rate (lb/hr)	Height (m)	Temperature (K)	Velocity (m/s)	Diameter (m)
5000	18	1273	20	20.80618
4500	16	1273	20	19.73848
4000	14	1273	20	18.60962
3500	12	1273	20	17.4077
3000	9	1273	20	16.1164
2500	6	1273	20	14.71219
2100	6	1273	20	13.48395
2000	6	1273	20	13.15899
1900	6	1273	20	12.82579
1800	6	1273	20	12.48371
1700	6	1273	20	12.13198
1600	6	1273	20	11.76975
1500	6	1273	20	11.39602
1400	6	1273	20	11.0096
1300	6	1273	20	10.60911
1200	6	1273	20	10.19291
1100	6	1273	20	9.758965
1050	6	1273	20	9.534591
1000	6	1273	20	9.304808
950	6	1273	20	9.069204
900	6	1273	20	8.827315
850	6	1273	20	8.578609
800	6	1273	20	8.322474
750	6	1273	20	8.0582
700	6	1273	20	7.784961
650	6	1273	20	7.501776
600	6	1273	20	7.207473
550	6	1273	20	6.90063
500	6	1273	20	6.579493
450	6	1273	20	6.241855
400	6	1273	20	5.884877
350	6	1273	20	5.504798
300	6	1273	20	5.096453
250	6	1273	20	4.652404
200	6	1273	20	4.161237
150	6	1273	20	3.603737
100	6	1273	20	2.942439
90	6	1273	20	2.791442
80	6	1273	20	2.631797
70	6	1273	20	2.461821
60	6	1273	20	2.279203
50	6	1273	20	2.080618
40	6	1273	20	1.860962
30	6	1273	20	1.61164
29	6	1273	20	1.584552
28	6	1273	20	1.556992
27	6	1273	20	1.528936
26	6	1273	20	1.500355
25	6	1273	20	1.471219
24	6	1273	20	1.441495
23	6	1273	20	1.411144
22	6	1273	20	1.380126
21	6	1273	20	1.348395
20	6	1273	20	1.315899
19	4	1273	20	1.282579
18	4	1273	20	1.248371
17	4	1273	20	1.213199
16	4	1273	20	1.176975
15	4	1273	20	1.139602
14	4	1273	20	1.10096
13	4	1273	20	1.060911
12	4	1273	20	1.019291
11	4	1273	20	0.9758965
10	4	1273	20	0.9304808
9	3.5	1273	20	0.8827316
8	3.5	1273	20	0.8322473
7	3.5	1273	20	0.7784961
6	3.5	1273	20	0.7207473
5	3.5	1273	20	0.6579493
4	3	1273	20	0.5884877
3	3	1273	20	0.5096453
2	2.5	1273	20	0.4161237
1	2	1273	20	0.2942439

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Table 25: Missing Stack Parameter Substitutions for Particulate Control Devices.

PM10 Rate (lb/hr)	Height (m)	Temperature (K)	Velocity (m/s)	Diameter (m)
22	19	0	28	4.6
21	18	0	27	4.6
20	17	0	26	4.4
19	16	0	25	4.2
18	15	0	24	4
17	14	0	23	3.8
16	14	0	22	3.6
15	13	0	21	3.4
14	13	0	20	3.2
13	12	0	19	3
12	12	0	18	2.8
11	11	0	17	2.6
10	11	0	16	2.4
9	10	0	15	2.2
8	10	0	14	2
7	10	0	13	1.8
6	9	0	12	1.6
5	9	0	11	1.4
4	9	0	10	1.2
3	9	0	9	1
2	9	0	8	0.8
1	9	0	7	0.6

Table 26: Missing Stack Parameter Substitutions for Other Point Sources.

NO_2 Rate (lb/hr)	Height (m)	Temperature (K)	Velocity (m/s)	Diameter (m)
21.7	7	730	28	0.3
21	6	730	28	0.3
20	5.5	730	28	0.3
19	4.5	730	28	0.3
18	4.5	730	27	0.3
17	4.5	730	27	0.3
16	4.5	730	27	0.25
15	4.5	730	27	0.25
14	4.5	700	22	0.25
13	4.5	700	22	0.25
12	4.5	700	22	0.2
11	4.5	700	22	0.2
10	4.5	700	22	0.2
9	4.5	700	20	0.2
8	4.5	700	18	0.2
7	4.5	700	14	0.2
6	4.5	650	14	0.2
5	4.5	500	5	0.2
4	4	500	5	0.1
3	3.5	500	5	0.1
2	3	500	5	0.0762
1	2	500	5	0.0762

For GCP 2, 3, and 5 permits with 95 tons/year of $PM_{2.5}$ emissions, use the following values:
TSP emission rate = 95 TPY
PM_{10} emission rate = 71.25 TPY (TSP X 0.75)
$PM_{2.5}$ emission rate = 17.875 TPY (PM_{10} X 0.25) = (TSP X 0.1875)

For volume sources with missing parameters:
Maximum release height = 10 m
Minimum release height = 1 m
Missing release height = PM10 Rate x 20 m/(lb/hr)
Initial vertical dimension = release height x 0.93
No limit to the maximum lateral dimension.
Lateral dimension = PM10Rate x 10 m/(lb/hr)
Minimum Lateral Dimension = 0.47 m

4.8.1.4 Refining Surrounding Sources

In some cases, it will be possible to use actual emissions to model surrounding sources instead of the maximum values allowed in the permit. If actual emission rates from the most recent two years is available, then the following optional technique may be used.

Annual averaging period: For the most recent two consecutive years of operation, if that period is representative of normal operation, the emission rate for each hour (in pounds per hour) is the total tons emitted for those two years divided by 8.76 (lb x year/ton x hour).

Other averaging periods: The unit is assumed to operate continuously unless there is a permit condition or physical limitation that prevents it from operating certain hours of the day or days of the year. If data is available for the most recent two years (Continuous Emissions Monitoring (CEM) data, for example) then a temporally representative level when operating may be used. For example, a generator that provides more power during peak hours could be modeled such that the maximum emission rate would be emitted during the peak hours of the day and the minimum operating emission rate would be emitted during the lowest-demand hours and the hours the unit would normally be off.[8]

4.8.2 Source Groups

It often saves considerable analysis time to set the model up to run with multiple source groups. The following groups are recommended.

- **Source alone group** – contains the sources at the facility that are used to compare with significance levels for the pollutant and averaging period being modeled. This group determines if the facility is above significance levels at the location and time.
- **Cumulative sources group** – contains all allowable emissions of the source and surrounding sources. This group is used to determine compliance with NAAQS and NMAAQS.
- **PSD sources group** – contains all sources that consume or expand PSD increment. This group is used to determine compliance with PSD increment regulations.

Impacts from different groups can be compared to determine if a source contributes significant concentrations if there is a problem complying with air quality standards.

4.8.3 Co-location with a GCP for aggregate processing facilities, asphalt plants, or concrete batch plants

At this time, General Construction Permits (GCPs) for aggregate processing facilities, asphalt plants, and concrete batch plants currently have the requirement that no visible emissions shall cross the fence line, which has been demonstrated to show compliance with all particulate matter air quality standards and PSD increments. NMED has allowed co-located facilities operating under a GCP to rely upon the GCP modeling demonstration for when co-located facilities operate at the same time, since all facilities at the location are required to have the same, no visible emissions, requirement at the fence line. However, if a source operating under a regular construction permit, and not a GCP, co-locates with a GCP source, it must show compliance with all particulate matter air quality standards through air dispersion modeling. The modeling for the source operating under a regular construction permit shall include all sources other than the co-located GCP sources. Gaseous pollutant modeling shall include the co-located GCP(s).

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[8] **Federal Register,** Vol. 82, No. 10, pg. **5220** / Tuesday, January 17, 2017 / Rules and Regulations

5.0 EMISSIONS SOURCE INPUTS

This section describes appropriate modeling for many types of sources. Additional guidance can be found in the User's Guide for the AMS/EPA Regulatory Model - AERMOD (EPA, 2004, http://www.epa.gov/scram001/dispersion_prefrec.htm).

5.1 Emission Sources

There are two general types of sources:

Sources that come from a stack or vent – stack sources, or point sources;
And sources that don't – fugitive sources.

5.2 Stack Emissions/Point Sources

All stacks should be modeled as point sources, as detailed below.

5.2.1 Vertical Stacks

Stacks that vent emissions vertically should be modeled as point sources with stack parameters that will simulate the manner in which emissions are released to the atmosphere:

Stack exit velocity, V_s = average upward velocity of emissions at the top of the stack;
Stack diameter, d_s = stack exit diameter;
Stack exit temperature, T_s = average temperature of emissions at the top of the stack;
Stack height, H_s = stack release height.

5.2.2 Stacks with Rain Caps and Horizontal Stacks

Stacks with capped stacks should be modeled in AERMOD using the POINTCAP source type.

Horizontal stacks should be modeled in AERMOD using the POINTHOR source type.

AERMOD will set the temperature to ambient temperature if the stack exit temperature is set to 0 K. If the model being used does not do this, then set the temperature to ambient temperature or to a close approximation thereof.

5.2.3 Flares

Both process and emergency flares should be modeled for comparisons with NAAQS and NMAAQS. If parts of the facility will be shut down when the flare operates then those emission units may be omitted from the flare modeling.

Flares should be treated as point sources with the following parameters:

Stack velocity = 20 m/s = 65.617 ft/s
Stack temperature = 1000°C = 1832°F
Stack height = height of the flare in meters
Effective stack diameter in meters= $D = \sqrt{10^{-6} q_n}$
where $q_n = q(1 - 0.048\sqrt{MW})$
and q is the gross heat release in cal/sec
MW is the weighted by volume average molecular weight of the mixture being burned.
(SCREEN3 Model User's Guide, 1995)

Flares in the surrounding sources inventory from the Bureau should already have an effective diameter calculated; so the parameters in the inventory can be entered directly into your model input "as is". There are

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other methods for analyzing impacts of flares; if you wish to use another method, check with the Bureau modeling staff first.

NOTE: The NAAQS cannot be violated, even during upset conditions. All emergency flares should be modeled to show compliance with the NAAQS short-term standards under upset conditions. Emergency flares should be modeled with surrounding sources, but not including neighboring emergency flares and other sources that operate less than 500 hours per year.

5.2.4 Cool Stacks

Filters, cooling towers, or other sources without raised temperature should be modeled at ambient temperature. AERMOD will set the temperature to ambient temperature if the stack exit temperature is set to 0 K. If the model being used does not do this, then set the temperature to ambient temperature or to a close approximation thereof.

5.3 Fugitive Sources

5.3.1 Aggregate Handling

Aggregate handling emissions consist of three separate activities, namely: loading material to and from piles, transportation of material between work areas, and wind erosion of storage piles.

Loading material to and from piles should be modeled as volume sources representative of the loading or unloading operation. Emissions for loading and unloading are calculated using AP-42 Section 13.2.4. The loading and unloading each involve dropping the material onto a receiving surface, whether being dropped by a dump truck, a front-end loader, or a conveyor. Each drop should be modeled as described in Fugitive Equipment Sources, below.

Transportation of material between work areas should be modeled according to haul road methodology if vehicles are used to transport the material, or using transfer point methodology if conveyors are used to transport the material, as described in Fugitive Equipment Sources, below.

Modeling of wind erosion of storage piles is optional, as it says in AP42 not to use the equations for wind erosion in a steady state model.

For the following example facility, aggregate is handled 6 times:

1- a pile in front of the mine face is created,
2- a pile in front of the mine face is loaded into trucks or conveyors,
3- a pile in front of the processing equipment (crusher or HMA) is created,
4- loading the equipment (crusher or HMA),
5- a pile after the equipment, and
6- loading the truck

1 and 2 would not apply if on-site mining does not occur.
5 may be considered a transfer point (conveyor) instead of aggregate handling if controls are applied.
5 and 6 may not apply for HMA plant, as material is bound in asphalt.
6 would not apply if the waste pile is left on site.

5.3.2 Fugitive Equipment Sources

Emissions coming from equipment such as crushers, screens, or material transfer points should be modeled as volume sources. Emission rates are normally calculated using AP42 factors.

The release height (H) is the distance from the center of the volume to the surface of the ground. The base of each volume source must be square. For elongated sources, use a series of volume sources with square bases. Determine the apparent size of a volume source by estimating how large the plume would look to an observer. Consider the movement of the plume source during the course of an hour when determining the apparent size. For example, if the source of emissions is from disturbances on a pile, and the entire pile is disturbed at some point in the hour, then use the size of the pile as the apparent size instead of the area of the pile that would be disturbed at any one instant. The reason for this is that the model operates in one-hour blocks of time, so using instantaneous sizes could inaccurately target nearby receptors with elevated emission concentrations.

For a single volume source, divide the apparent length by 4.3 to determine the initial lateral dimension (σ_{Yo}) to input into the model. For a line source represented by a series of volume sources, divide the distance between the centers of adjacent sources by 2.15 to determine σ_{Yo}.

For a source on the ground, divide the vertical dimension of the source by 2.15 to determine the initial vertical dimension (σ_{Zo}) to input into the model. For a source on or connected to a building, divide the height of the building by 2.15 to determine the σ_{Zo}. For an isolated elevated source, divide the vertical dimension of the source by 4.3 to determine the σ_{Zo}.

Example sources are described in the table below. Some sources will vary from the characteristics listed in the table.

Table 27: Example Dimensions of Fugitive Sources

Source Type	Height of Volume (m)	σ_{Zo} (m)	Release Height (m)	Width of Volume (m)	σ_{Yo} (m)
Crusher	5	2.33	6	5	1.16
Screen	5	2.33	4	5	1.16
Transfer point	2	0.93	2	2	0.47
Elevated transfer point	4	0.93	4	2	0.47
High Elevated transfer point	4	0.93	8	2	0.47
Concrete truck loading	5	2.33	4	5	1.16

5.3.3 Haul Roads

Traffic carrying materials mined or processed at the facility must be modeled as part of the facility. Haul roads to be modeled include the portion of roads that are not publicly accessible. The Bureau recommends haul road modeling to be consistent with Regional/State/Local Haul Road Workgroup Recommendations, as described below. Haul road emissions should be modeled as a series of adjacent volume sources, except that area sources should be used for modeling haul roads where receptors located within source dimensions are important. A procedure to develop model input parameters follows. The applicant can use other procedures on a case-by-case basis but must demonstrate that those procedures would be appropriate.

Road Source Characterization: Follow the instructions described below.

Plume height:

The height of the volume (H) or plume height will be equal to 1.7 times the height of the vehicle generating the emissions. Use the same for top of plume height for area sources.
The initial vertical sigma (σ_{Zo}) is determined by dividing the height of the plume by 2.15.
The release height is determined by dividing the height of the volume by two. This point is in the center of the volume.

Table 28: Example Haul Road Vertical Dimensions

Vehicle size	Truck Height	Height of Volume	σ_{Zo}	Release Height
Large trucks	4 m (13.1 ft)	6.8 m (22.3 ft)	3.16 m (10.4 ft)	3.4 m (11.1 ft)
Small trucks	2 m (6.6 ft)	3.4 m (11.2 ft)	1.58 m (5.2 ft)	1.7 m (5.6 ft)

RH = H/2 = Release Height above the ground (m). It's the center of the volume source. Also use this for the source height of the area source, if using the area source alternative.
σ_{Zo} = H/2.15 = initial vertical dimension of the volume (m)

Road width:

The adjusted width of the road (W) is the actual width of the road plus 6 meters. The additional width represents turbulence caused by the vehicle as it moves along the road. This width will represent a side of the base of the volume. Use W for the width of the area source, if using the area source alternative.

The initial horizontal sigma (σ_{Yo}) for each volume is determined as follows:

- If the road is represented by a single volume, divide W by 4.3.
- If the road is represented by adjacent volumes, divide W by 2.15.
- If the road is represented by alternating volumes, divide the distance between the center point of one volume to the center point of the next volume by 2.15. $\sigma_{Yo} =$ 2W/2.15 This representation is only recommended for very long roads.
- If using area sources, the aspect ratio (i.e., length/width) should be less than 100 to 1. Subdivide the sources if they are too long.
- If using area sources, model each road segment as a straight line. Do not create a road segment with a bend in the road – divide the road into different segments when bends occur.

Road length:

The sum of the length of all volume sources should be about equal to the actual road length, unless the road is very long and half the segments are skipped to save time. The volume sources should be evenly spaced along the road and should be of equal size for a given road. It is acceptable to artificially end the haul road up to 50 meters before the intersection with a public road. The reduced length of the road is due to the observation that vehicles normally slow down or stop before exiting the property. All emissions from haul roads must be modeled, however. Emissions from the reduced road length are added to other road segments.

The two lateral dimensions (length and width) of a volume source should be equal. The number of volume sources, N, is determined by dividing the length of the road (optionally minus 50 meters) by W. The result is the maximum number of volume sources that could be used to represent the road. If N is very large, modeling time can be reduced by using alternating volume sources to reduce the number of sources.

Table 29: Example Haul Road Horizontal Dimensions

Vehicle size	Width of Volume	Length of Volume	σ_{Yo}
Large trucks	13 m (42.65 ft)	13 m (42.65 ft)	W/2.15 = 6.05 m (19.85 ft)
Small trucks	10 m (32.8 ft)	10 m (32.8 ft)	W/2.15 = 4.65 m (15.26 ft)

Road location:

The UTM coordinates for the volume source are in the center of the base of the volume. This location must be at least one meter from the nearest receptor.

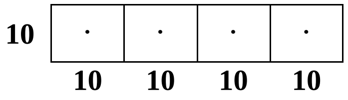
Emission Rate:

Divide the total emission rate equally among the individual volumes used to represent the road, unless there is a known spatial variation in emissions. Use the emissions calculated from the entire road length, even if you artificially end the road volume sources early before exiting the facility.

Example sources:

Use of the following modeling parameters should result in acceptable haul road modeling. Different facilities have different sized trucks, roads, and other variables. It is acceptable to use facility-specific parameters

Example One-Way Road Source



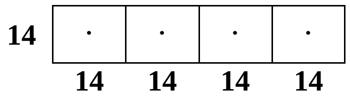
(looking from above)

Width = W = 10 m (32.8 ft)

σ_{Yo} = W/2.15 = 4.65 m (15.26 ft)

Figure 3: One-Way Road Source

Two-Way Road Source



(looking from above)

Width = W = 14 m (45.9 ft)

σ_{Y_o} = W/2.15 = 6.51 m (21.4 ft)

Figure 4: Two-Way Road Source

Additional guidance can be found in Volume II of the User's Guide for ISC3 model (EPA, 1995).

5.3.4 Area Sources

Sources that have little plume rise may be modeled as area sources. Examples are: storage pile emissions, waste lagoon emissions, or gaseous emissions from landfills. Area source types include rectangle, circle, and irregularly shaped polygon. The model uses only the portion of the area source that is upwind of the receptor for calculating emissions for the hour, so it is safe to put receptors inside the area source without overly magnifying concentrations. The ISC input file uses emissions per area, but front-end programs for developing input files may calculate this for you based on total emissions from the source. For additional information, see the ISC User’s Guide (EPA, 1995d).

Extremely long or odd-shaped (like a giant “L”) area sources should be broken up into smaller area sources or modeled as a series of volume sources, because they may misrepresent emissions. Area sources, such as AREACIRC sources, may require many times as long to run the model as do volume or point sources in AERMOD.

5.3.5 Open Pits

The open pit source type should only be used to model open pits (not elevated trash dumpsters or anything else that somewhat resembles an open pit). The elevation of the pit entered into the model is the elevation of the top of the pit, which should be ground level.

The model calculates the effective depth of the pit by dividing the pit volume by the length and width of the pit. Release height above the base of the pit must be smaller than this value. Emissions from the bottom of the pit are expressed with a release height of zero.

Pit length should be less than 10 times the pit width. However, a pit cannot be sub-divided because the model needs to calculate mixing done throughout the pit. If the pit is irregular in shape, use the actual area of the top of the pit to calculate a rectangular shape with the same area.

Do not place receptors inside a pit.

The model input file requires pit emission rates to be expressed in mass per time per area [i.e., $g/(s \cdot m^2)$]. Model input front-end programs may convert actual emission rate into area-based emission rates automatically, however.

5.3.6 Landfill Offgas

Decomposition of landfill material can result in the release of gasses such as H_2S. If these gases are not collected using a negative pressure system and flared, then the area of the landfill that is releasing gas can be modeled as an area or a circular area source. If gas is collected by a negative pressure collection system and flared, then model the flare the same way other flares are modeled. Place large area sources in areas that have little effect from the negative pressure collection system. In either case, elevation of the source should be equal to that of the surface, and release height should be zero because they are released from the ground and are not significantly affected by turbulence caused by vehicles traveling over the off-gasses.

6.0 MODELING PROTOCOLS

6.1 Submittal of Modeling Protocol

A modeling protocol should be submitted prior to the performance of a dispersion modeling analysis. For PSD applications, a modeling protocol is mandatory, and must be sent to NMED/AQB for review and comment. Consultation with Bureau modeling staff regarding appropriate model options, meteorological data, background concentrations, and neighboring sources is recommended for minor sources also, and can be accomplished in writing or by phone. The applicant should allow two weeks for the Bureau to review and respond to the written protocol. To avoid delays caused by misinterpretation or misunderstanding, we strongly recommend consultation with our staff on the following topics:

a.) Choice of models;
b.) Model input options;
c.) Terrain classification (flat or simple and complex);
d.) Receptor grids;
e.) Source inventory data;
f.) Minor source baseline dates for modeling increment consumption;
g.) Nearby Class I areas;
h.) Appropriate meteorological data;
i.) Background concentrations;
j.) Setback distance calculation if a proposed facility is a portable fugitive source;
k.) Any possible sources of disagreement;

Important: Modeling that substantially deviates from guidelines may be rejected if it is not accompanied by a written approved modeling protocol.

The input data to the models will be unique to the source. Data will usually consist of 1) emission rates and stack parameters for the proposed source at maximum load capacity and at reduced load capacity; 2) emission parameters of sources in the area; 3) model options; 4) suitable meteorological data; 5) definition of source operation which creates the greatest air quality impacts if other than maximum load conditions; and 6) terrain information, if applicable. Very important: **The emission parameters used in the modeling analysis of the proposed source are normally the same as those in the permit application. Any difference between the two should be clearly documented and explained.** Failure to adhere to this rule may result in an incomplete analysis.

6.2 Protocol ingredients

The shortest acceptable modeling protocol would be a statement that the modeling guidelines will be followed and a statement of what meteorological data will be used. Ask the modeling section or check the web page for the latest sample protocols.

6.3 How to submit the protocol

E-mail the modeling protocol to the modeling manager: Sufi.Mustafa@state.nm.us

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7.0 DISPERSION MODELING PROCEDURE

Note: The basic steps for performing the modeling are presented in sequential format. Sometimes, it will make sense to perform some of the steps out of order. The sequential modeling steps are designed as an aid to modeling, not a mandatory requirement.

It is important to have an approved modeling protocol before proceeding. Modeling that substantially deviates from guidelines may be rejected if it is not accompanied by a written approved modeling protocol.

7.1 Step 1: Determining the Radius of Impact

A facility's significance area is defined as all locations outside of its fence line where the source produces concentrations that are above the significance levels listed in Table 6. The source is deemed culpable for concentrations that exceed air quality standards or PSD increments that occur at a receptor if the source's contribution is above the significance level at the same time that the exceedance of air quality standards or PSD increments occurs.

The Bureau uses the Radius of Impact (ROI) to make sure the entire significance area is analyzed. The ROI is defined as the greatest distance from the center of the facility to the most distant receptor where concentrations are greater than significance levels.

An illustration of determining an ROI from modeling output is shown in Figure 5, below. Note that the entire ROI is completely contained within the receptor grid, as required.

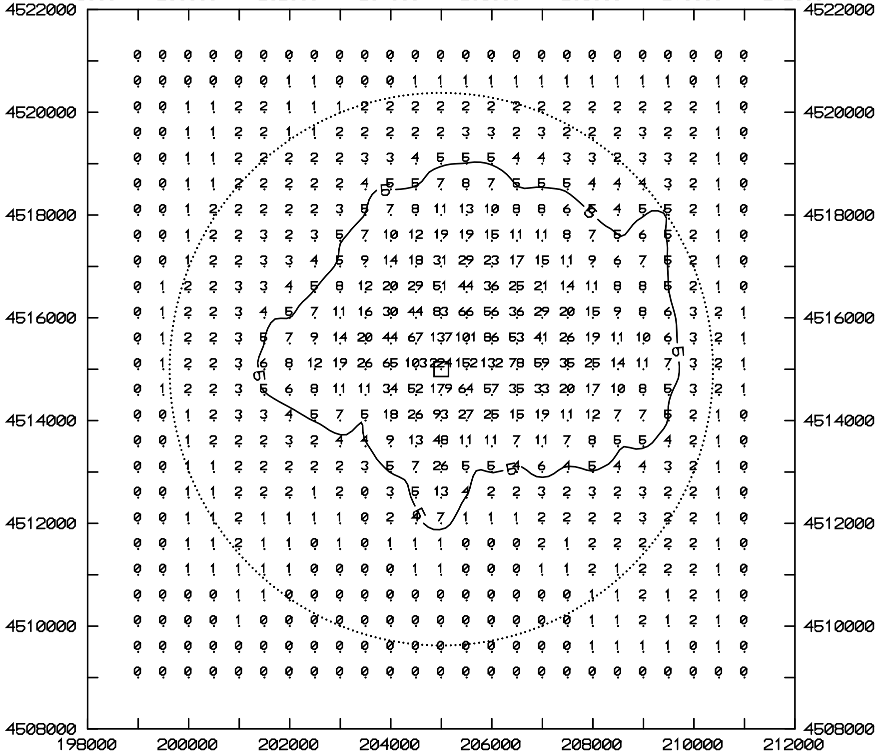

Figure 5. Plot of pollutant concentrations showing the 5 μg/m^3 significance level and the radius of impact (dashed line circle), determined from the greatest lineal extent of the significance level from the source.

7.1.1 Prepare the ROI analysis as follows:

I. Select the model that will be used for the analysis. It is usually quicker in the long run to use the same model for the radius of impact analysis as will be used for the refined analysis.
II. Model the entire source, as defined in section 2.4.1. Suggestion: Plot your sources to verify locations and identify typographical errors.
III. Set up the receptors as described above. Make sure the receptor grid extends far enough in every direction to capture the entire ROI, subject to the maximum radius of 50km.
IV. Optional step: Calculate the elevations of all sources, receptors, and buildings. This complex terrain analysis is optional for the ROI run, but it may save time to do it now.
V. Optional step: Add buildings and analyze them with BPIP or equivalent programs. This building downwash analysis is optional for the ROI run, but it may save time to do it now.
VI. Choose modeling options, as appropriate.
VII. Make sure that all sources and operating scenarios are modeled according to the guidelines in sections 4 and 5, above.
VIII. Run the model.

7.1.2 Analyze modeling results to determine ROI

I. Determine a radius of impact for each pollutant for each applicable averaging period. The largest ROI may be designated as the ROI for that pollutant, or each averaging period determined independently.
II. The ROI for NO_2 may be determined using Ambient Ratio Method 2 (ARM2).
III. Concentrations inside the facility's fence line can be ignored when determining the ROI.
IV. If no concentrations of a pollutant are above the significance levels for that pollutant, then the ROI for that pollutant is 0. Skip to Step 3 for that pollutant.
V. It is acceptable to scale impacts from one pollutant to determine impacts from another pollutant if several pollutants vent from the same stack and the ratios of emission rates and the averaging periods are the same.

Proceed to Step 2 for each pollutant with an ROI greater than zero.

7.2 Step 2: Refined Analysis

The entire area of significance must be included in the analyses for all averaging periods for each pollutant. If the ROI was determined using coarse grids, then add fine grid spacing to the potential areas of maximum concentration or concentrations above standards. If the ROI was determined using appropriate grid spacing, elevations, and building downwash (if applicable), then only the significant receptors need to be modeled for the refined analysis.

Once the ROI is determined for a specific source, neighboring sources need to be included and a cumulative impact analysis needs to be performed. As the ROI analysis is concerned with significance levels, the refined analysis is concerned with NAAQS, NMAAQS, and PSD Class I and Class II increments. The concentrations produced by the facility plus surrounding sources must be demonstrated to be below these levels in order to issue a permit under the regular permitting process.

7.2.1 Prepare the Refined Analysis as Follows:

I. If a screening model was used to determine ROI, the modeler may wish to use a refined model to reduce the area of significant impact. If so, return to *Step 1* and repeat the step with the new model.
II. Prepare a new modeling input file from the ROI file.

III. Fill the ROI with receptors with appropriate spacing (or discard receptors below significance levels if appropriate spacing was used for the ROI analysis).
IV. Add receptors near areas of high concentration if these areas are not contained within a fine grid. The modeling run must definitively demonstrate that the maximum impact has been identified. Concentrations should “fall off” from the center of the fine grid.
V. Add surrounding sources to the input file, if appropriate, as described in *Neighboring Sources/Emission Inventory Requirements*, above. Include $PM_{2.5}$ surrounding sources if particulate modeling is required. Suggestion: set up source groups so that impacts from the source alone, from the PSD increment consuming sources, and from all sources can be analyzed in a single run and compared with each other for determination of culpability.
VI. Building downwash analysis must be included in the refined analysis, if applicable.
VII. Terrain elevations must be included in the refined analysis, if applicable.

7.2.2 Analyze the Refined Modeling Results

I. Make sure the maximum impacts for each averaging period fall within a fine enough receptor grid to identify true maximums. Include fine grids near adjacent sources and in “hot spots”.
II. Compare the highest short-term and annual impacts from all sources with NAAQS and NMAAQS.
III. Determine if there is an exceedance of PSD Class II increment within the area defined by the radius of impact by the group containing all PSD increment consuming sources.
IV. Determine if there is an exceedance of PSD Class I increment within any Class I area.
V. If the facility alone will violate any NAAQS, NMAAQS, or PSD increment, then the permit cannot be issued through the normal process. Please contact the Bureau for further information.
VI. If there are exceedances of the NMAAQS or NAAQS at any receptors within the ROI, the next step is to determine if the facility being modeled significantly contributes (see significance levels in Table 6) to the exceedance at those receptors during the same time period(s) that the exceedance occurs. If so, the permit cannot be issued through the normal process. See nonattainment area requirements, below.
VII. If no exceedances are found, or if the facility does not contribute amounts above significance levels to the exceedances, then the facility can be permitted per the modeling analysis.

7.2.3 NMAAQS and NAAQS

All sources are required to submit NMAAQS and NAAQS modeling. The total concentrations of all facilities and background sources are required to be below the NAAQS. The steps required for this analysis are outlined above.

7.2.4 PSD Class II increment

PSD Increment modeling applies to both minor and major sources. If the minor source baseline date has been established in the Air Quality Control Region (AQCR) in which the facility will be located, then PSD increment consumption modeling must be performed. If the minor source baseline date has not been established in that region, then only PSD major sources must perform this analysis.

Portable sources that are not located at a single location continuously for more than one year are not required to model PSD increment consumption.

The steps required for this analysis are outlined above.
The same significance levels that apply to NAAQS and NMAAQS standards are assumed to apply to PSD Class II increment as well.

7.2.5 PSD Class I increment

If a PSD Class II increment analysis is required and the proposed construction of a minor source is within 50 km of a Class I area (see Figure 1), then PSD increment consumption at the Class I area(s) must be determined and compared with the Class I PSD increment. If the proposed construction of a PSD major source is within 100 km of a Class I area, then PSD increment consumption at the Class I area(s) must be determined and compared with the Class I PSD increment. The PSD permit process requires a more thorough Class I analysis, which is described in *Step 6*.

See *Receptor Placement*, above, for receptor instructions.

Proceed with the Class I area analysis similarly to the other analyses described above. Class I significance levels apply for determining whether or not a facility contributes significantly to an exceedance in a PSD Class I area and for determining the Class I ROI.

7.3 Step 3: Portable Source Fence Line Distance Requirements for Initial Location and Relocation

Skip this step if the facility is not a portable source.

Portable sources should model fence line distance requirements for relocation purposes and for setback distances within the initial property. If the facility wants to be able to move equipment around within the property, or move to a new location, permit conditions will be required to ensure the facility continues to demonstrate compliance with air quality standards as it moves. For this modeling, use meteorological data that the Bureau has approved for relocation modeling, which may be different from that used for the rest of the modeling for the facility. Model the facility with a haul road length at least as long as the setback distance and a number of truck trips equal in number to the count at the original location. Surrounding sources may be ignored, but include co-located facilities if the desire is to be able to co-locate with other facilities at the new locations. To determine setback distance, draw a line connecting the concentrations where they drop off to the point that are just under the ambient air standard or PSD increment. Make sure to add background concentration before determining the isopleths for ambient air standards. From each point on the isopleth line, determine the distance to the nearest source (excluding haul road sources). The setback distance is the largest of these distances. Setback distance is typically rounded up to the nearest meter that is above the calculated value. An example setback distance determination is pictured in Figure 6, below.

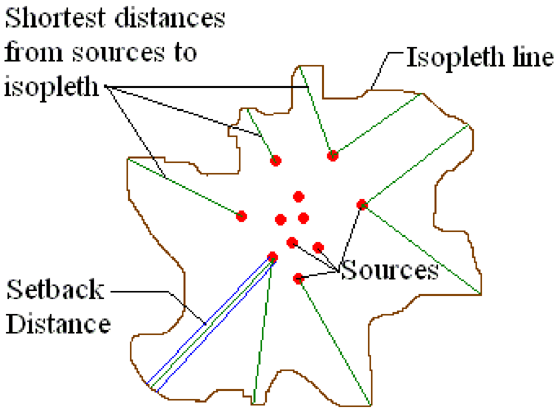

Figure 6: Setback Distance Calculation

Fine spacing is suggested within the property boundary for relocation requirement modeling.

If the applicant does not perform fence line distance modeling, relocation distance will be assumed to be the distance from the edge of a facility operations to the most distant point on the initial fence line. An irregular or elongated fence line shape can result in relocation requirements that require very large properties to be fenced off in order to relocate there without submitting modeling for each new location of the facility.

7.4 Step 4: Nonattainment Area Requirements

Skip this step if all modeled concentrations are below NAAQS, NMAAQS, and PSD Increments.

If the modeling analysis of a source predicts that the impact from any regulated air contaminant will exceed the significance level concentrations at any receptor which does not meet the NMAAQS or NAAQS, the source will be required to demonstrate a net air quality benefit and meet the requirements of 20.2.72.216 NMAC or 20.2.79 NMAC. The net air quality benefit is a reduction of at least 20% of the maximum modeled concentration from the facility or the emission sources being modified. The 20 percent reduction shall be calculated as the projected impact subtracted from the existing impact divided by the existing impact. The existing impact for the net air quality benefit must be based on the lowest enforceable emission rate, or the actual emission rate if a unit has no enforceable emission rate. The offsets used to meet the net air quality benefit must be quantifiable, enforceable, and permanent. For more information regarding nonattainment permit requirements, see **20.2.72.216 NMAC** and **20.2.79 NMAC** – Nonattainment Areas.

7.5 Step 5: Modeling for Toxic Air Pollutants

Skip this step if there are no toxics to model at this facility. See section 2, “New Mexico State Air Toxics Modeling”, to determine if modeling of toxics is required and for other details about toxics regulatory requirements.

I. Model the toxic air pollutants similar to the way the other pollutants were modeled, as described above in steps 1 and 2. Use an 8-hour averaging period, complex terrain, and building downwash.
II. No surrounding source inventory exists for the toxics, so model only your source.
III. Make sure a fine grid is used in the area of maximum concentration.
IV. If more than one toxic pollutant is being modeled and they use the same stacks at the same ratio of emission rates, it is allowable to scale the results of the first pollutants by the emission rate ratio to determine the concentration of the other toxics.

If modeling shows that the maximum eight-hour average concentration of all toxics is less than one percent of the Occupational Exposure Level (OEL) for that toxic, then the analysis of that toxic pollutant is finished. Report details about the maximum concentrations in the modeling report. Otherwise, perform BACT analysis or health assessments, as required. Contact the Bureau on how to proceed if the 1/100th of the OEL is exceeded.

7.6 Step 6: PSD Permit Application Modeling

Skip this step if the facility is not a PSD major source.

PSD sources and requirements are defined in NMAC 20.2.74.303 to 305. New PSD major sources and major modifications to PSD major sources must submit the following modeling requirements in addition to the NSR minor source modeling requirements. Minor modifications to PSD major sources

are only subject to NSR minor source modeling requirements listed above, as required under NMAC 20.2.72.

Due to a court ruling, the use of the $PM_{2.5}$ significant monitoring concentration for PSD major modifications or new PSD major sources is not allowed. This significant ambient concentration level may still be used for minor source and nonattainment permitting.

Sources subject to PSD requirements should consult with the Bureau to determine how to proceed in the application process. For PSD applications, a modeling protocol is required for review. Please refer to EPA's *New Source Review Workshop Manual.* The following items are required for PSD permit applications and supersede other modeling requirements in this document.

7.6.1 Meteorological Data

Applicants may need to collect one year of on-site meteorological and ambient data to satisfy PSD requirements. In some cases, it may be advantageous to begin collecting on-site meteorological and ambient data to ensure that it is available at a site that may become PSD in the future. A company considering a monitoring program is advised to consult with the Bureau as early as possible so that an acceptable data collection process, including instrument parameters, can be started. Generally, the following meteorological parameters will be measured: wind direction, wind speed, ambient air temperature, solar insolation, ΔT, and σ_θ. For further information on meteorological monitoring Refer to EPA's *Guideline on Air Quality Models* and *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. Refer to *Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD)* for ambient monitoring guidance. In addition, a monitoring protocol and QA plan **must** be submitted and approved prior to beginning collection of data for a PSD application if these data are to be used for the analysis.

In the absence of actual on-site data, the Bureau may approve the use of off-site data that the Bureau believes mimics on-site data for that location or the Bureau may approve the use of data produced by the model MM5.

7.6.2 Ambient Air Quality Analysis

The ambient air quality analysis is the same as described above, with the exception of the following points.

- The PSD project is defined as the future potential emission rate minus the past actual emission rate.
- If the maximum ambient impact is less than EPA's significant concentration levels (see Table 6), then a full analysis is not required.
- Nearby sources must be considered. Discarding sources is discussed in the section on "neighboring sources data".
- A total air quality analysis must also be performed for each appropriate Class I area if the facility produces concentrations greater than the Class I significance levels in Table 6. All sources near the Class I area must be considered. The inventories for the analysis near the facility and the inventory for the analysis near Class I areas may be quite different because they are centered on different locations.
- If subject to 20.2.74.403 NMAC (Sources impacting Federal Class I Areas), an analysis of Air Quality Related Values must be included in the PSD application. If the facility will have no impact on the AQRV, then that must be stated in the application (NSR Workshop Manual, Chapter D).
- There may be additional analyses required by the Federal Land Managers (FLM) for Air Quality Related Values (AQRVs). See **F**ederal **L**and **M**anagers' **A**ir Quality Related Values Work

Group (FLAG) for more information at:
http://www2.nature.nps.gov/air/Permits/flag/index.cfm

7.6.3 Additional Impact Analysis (NMAC 20.2.74.304)

The owner or operator of the proposed major stationary source or major modification shall provide an analysis of the impact that would occur as a result of the source or modification and general commercial, residential, industrial, and other growth associated with the source or modification. This analysis is in addition to the Class I analysis, but may use some of the same techniques that were used in the Class I analysis. The analysis required for a National Environmental Policy Act (NEPA) review may work to satisfy some requirements of this section.

- Visibility Analysis: A Class II Visibility Analysis is required to determine impact the facility will have upon Class II areas. Analyze the change in visibility of a nearby peak or mountain for this analysis. In the absence of nearby mountains, analyze the visibility of clear sky from nearby state or local parks.
- Soils analysis: What changes will occur to soil pH, toxicity, susceptibility to erosion, or other soil characteristics as a result of the project and indirect growth related to the project?
- Vegetation analysis: What changes will occur to type, abundance, vulnerability to parasites, or other vegetation characteristics as a result of the project and indirect growth related to the project? The owner or operator need not provide an analysis of the impact on vegetation having no significant commercial or recreational value.
- Growth analysis: The owner or operator shall also provide an analysis of the air quality impact projected for the area as a result of general commercial, residential, industrial, and other growth associated with the source or modification.

7.6.4 Increment Analysis

- If the facility produces ambient concentrations greater than the significance levels in Table 6, then the Class II PSD increment analysis for the facility must use the inventory of all increment consuming sources near the facility. Sources in other states should be obtained from the agency in the surrounding state.
- If there is a Class I area within 100 km of the facility (or any distance, if requested by the FLM), then receptors must be located at the Class I area.
- If the facility produces ambient concentrations greater than the Class I significance levels in Table 6 in a Class I area, then the increment analysis for the Class I areas should use the inventory of all increment consuming sources near the Class I area, including those sources in other states. Sources in other states should be obtained from the agency in the surrounding state.

7.6.5 Emission Inventories

- The most current inventory of sources must be used. It should contain all sources currently under review by the Bureau that would be located within the appropriate inventory area. The applicant should check with the modeling staff to ensure that the inventory is up to date.

7.6.6 BACT analysis

- The analysis must follow current EPA procedures and guidelines.

7.7 Step 7: Write Modeling Report

A narrative report describing the modeling performed for the facility is required to be submitted with the permit application using Universal Application form 4 (UA4). This report should be written to provide the public and the Bureau with sufficient information to determine that the proposed construction does not cause or contribute to exceedances of air quality standards. The report needs to contain enough information to allow a reviewer to determine that modeling was done in a manner consistent and defensible with respect to available modeling guidance. Do not include raw modeling output in the report, only summaries and descriptions of the output or input.

This outline may be used as a checklist to determine if the analysis is complete.

I. Applicant and consultant information
  a. Name of facility and company.
  b. Permit numbers currently registered for the facility.
  c. Contact name, phone number, and e-mail address for the Bureau to call in case of modeling questions.

II. Facility and operations description
  a. A narrative summary of the purpose of the proposed construction, modification, or revision.
  b. Brief physical description of the location.
  c. Duration of time that the facility will be located at this location.
  d. A map showing UTM coordinates and the location of the proposed facility, on-site buildings, emission points, and property boundaries. Include UTM zone and datum.

III. Modeling requirements description
  a. List of pollutants at this facility requiring NAAQS and/or NMAAQS modeling.
  b. AQCR facility is located in and resulting list of pollutants requiring PSD increment (Class I and II) modeling. Include distances to Class I areas in discussion.
  c. List of State Air Toxic pollutants requiring modeling.
  d. PSD, NSPS, and NESHAP applicability and any additional modeling requirements that result if those regulations are applicable to the facility.
  e. State whether or not the facility is in a federal Nonattainment area, and any special modeling requirements or exemptions due to this status.
  f. Any special modeling requirements, such as streamline permit requirements.

IV. Modeling inputs
  a. General modeling approach
    i. The models used and the justification for using each model.
    ii. Model options used and why they were considered appropriate to the application.
    iii. Ozone limiting model options discussion, if used for NO_2 impacts.
    iv. Background concentrations.
  b. Meteorological data
    i. A discussion of the meteorological data, including identification of the source of the data.
    ii. Discussion of how missing data were handled, how stability class was determined, and how the data were processed, if the Bureau did not provide the data.
  c. Receptor and terrain discussion
    i. Description of the spacing of the receptor grids.
    ii. List fence line coordinates and describe receptor spacing along fence.
    iii. PSD Class I area receptor description.
    iv. Flat and complex terrain discussion, including source of elevation data.
  d. Emission sources
    i. Description of sources at the facility, including:

            1. A cross-reference from the model input source numbers/names to the sources listed in the permit application for the proposed facility.
            2. Determination of sigma-Y and sigma-Z for fugitive sources.
            3. Description and list of PSD increment consuming sources, baseline sources, and retired baseline sources.
            4. Describe treatment of operating hours
            5. Particle size characteristics, if plume depletion is used.
            6. If the modeled stack parameters are different from the stack parameters in the application, an explanation must be provided as to what special cases are being analyzed and why.
            7. Partial operating loads analysis description.
            8. Flare calculations used to determine effective stack parameters.
            9. In-stack NO_2/NO_X ratio determination, if using OLM or PVMRM.
        ii. Surrounding sources:
            1. The date of the surrounding source retrieval.
            2. Details of any changes or corrections that were made to the surrounding sources.
            3. Description of adjacent sources eliminated from the inventory.
    e. Building downwash
        i. Dimensions of buildings

V. Modeling files description
    a. A list of all the file names in the accompanying CD and description of these files.
    b. Description of the scenarios represented by each file.

VI. Modeling results
    a. A discussion of the radius of impact determination.
    b. A summary of the modeling results including the maximum concentrations, location where the maximum concentration occurs, and comparison to the ambient standards.
    c. Source, cumulative, and increment impacts.
    d. Class I increment impact.
    e. A table showing concentrations and standards corrected for elevation.
    f. If ambient standards are exceeded because of surrounding sources, please include a culpability analysis for the source and show that the contribution from your source is less than the significance levels for the specific pollutant.
    g. Toxics modeling results, if needed.

VII. Summary/conclusions
    a. A statement that modeling requirements have been satisfied and that the permit can be issued.

Ask the modeling section or check the web page for a sample modeling reports. The modeling report documents details the standard format for the modeling report.

7.8 Step 8: Submit Modeling Analysis

Submit the following materials to the Bureau:

A CD containing the following:

I. An electronic copy (in MS Word format) of the modeling report.
II. Input and output files for all model runs. Include BEEST, ISC-View, or BREEZE files, if available.
III. Building downwash input and output files.

IV. Fence line coordinates.
V. Meteorological data, if not Bureau-supplied.
VI. A list of the surrounding sources at the time the facility was modeled.
VII. An electronic copy of the approved modeling protocol.

Do not include paper copies of modeling input and output files.

8.0 List of Abbreviations

Table 30: List of Abbreviations

ACRONYM	DESCRIPTION
AQB	Air Quality Bureau
AQCR	Air Quality Control Region
AQCR	Air Quality Control Regulation (CURRENTLY NOT USED)
AQRV	Air Quality Related Values
ARM2	Ambient Ratio Method 2
BACT	Best Available Control Technology
CO	Carbon monoxide
DEM	Digitized Elevation Model
EPA	Environmental Protection Agency
FLAG	**F**ederal **L**and **M**anagers' **A**ir Quality Related Values Work **G**roup
FEM	Federal Equivalent Method
FRM	Federal Reference Method
GEP	Good Engineering Practice
H_2S	Hydrogen sulfide
ISCST3	Industrial Source Complex Short Term Model version 3
NAAQS	National Ambient Air Quality Standards
NED	National Elevation Dataset
NO_2	Nitrogen dioxide
NO_X	Nitrogen oxides
NMAAQS	New Mexico Ambient Air Quality Standards
NMAC	New Mexico Administrative Code
O_3	Ozone
OEL	Occupational Exposure Level
OLM	Ozone limiting method
Pb	Lead
PDF	Probability density function
$PM_{2.5}$	Particulate matter equal to or under 2.5 μm in aerodynamic diameter
PM_{10}	Particulate matter equal to or under 10 μm in aerodynamic diameter
PPM	Parts per million (volume ratio)
PSD	Prevention of Significant Deterioration
PVMRM	Plume Volume Molar Ratio Method
ROI	Radius of Impact
SO_2	Sulfur dioxide
TSP	Total suspended particulates
UTM	Universal Trans Mercator
VOC	Volatile organic compounds

9.0 References

Ensor, D.S. and M.J., Pilat (1971). Calculation of smoke plume opacity from particulate air pollutant properties. J.Air Poll.Cont.Assoc. 21(8): 496-501.

EPA (1995). User's Guide for the Industrial Source Complex (ISC3) Dispersion Model, Volume I - User Instructions. EPA-454/B-95-003a. September 1995.

Joseph A. Tikvart (1993). "MEMORANDUM: Proposal for Calculating Plume Rise for Stacks with Horizontal Releases or Rain Caps for Cookson Pigment, Newark, New Jersey", Joseph A. Tikvart (Model Clearinghouse), July 9, 1993.

SCREEN3 Model User's Guide (1995). SCREEN3 Model User's Guide, EPA-454/B-95-004, September, 1995. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Emissions, Monitoring, and Analysis Division, Research Triangle Park, NC.

NSR Workshop Manual, Chapter D – Air Quality Related Values

Federal Land Manager (FLM) Resources for Permit Applicants: https://www.nps.gov/subjects/air/permitresources.htm

New Mexico Administrative Code (NMAC) Air Quality Regulations: http://www.srca.nm.gov/chapter-2-air-quality-statewide/

EPA, 1995d*: User's Guide for the Industrial Source Complex (ISC3) Dispersion Models*, EPA-454/B-95-003a, September, 1995. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Emissions, Monitoring, and Analysis Division, Research Triangle Park, NC.

Texas 1999: ***Air Quality Modeling Guidelines***, TNRCC-New Source Review Permits Division, RG-25 (Revised), February 1999

"The Plume Volume Molar Ratio Method [(PVMRM)] for Determining NO_2/NOx Ratios in Modeling", by Pat Hanrahan of the Oregon DEQ. The paper appeared in the November 1999 issue of the AWMA journal.

Links:

Environmental Protection Agency, 40 CFR Part 51, Revision to the Guideline on Air Quality Models Appendix W: https://www.epa.gov/sites/production/files/2020-09/documents/appw_17.pdf

Support Center for Regulatory Atmospheric Modeling (SCRAM): https://www.epa.gov/scram

10.0 INDEX

Appendix A: Recent changes to the NM Modeling Guidelines

Note of changes made in 2020:

October 26, 2020:
Reference to old EPA Modeling Guideline was updated to 2017 version.
Clarification that PSD increment modeling is not normally an applicable requirement for Title V.
Sources within 20 km from the center of Albuquerque or El Paso should include both modeled sources and monitored concentrations (changed from 10 km because the cities are larger than 10 km in radius).
Option to use monitored background in lieu of surrounding sources for PSD increment presented.
Language was changed to reflect that capped and horizontal point sources are no longer beta options and do not need stack-tip downwash turned off.
Cool stack section added to explain the modeling of sources at ambient temperature.
Obsolete references and links were updated.

Note of changes made in 2019:

February 7, 2019: An error in summary Table 6C was corrected to make it match the full text in section 2.6.4.4.

Note of changes since 2016 version:

Source definition was changed to better match EPA definitions.

Original:

> Modeling significance levels are thresholds below which the source is not considered to contribute to any predicted exceedance of air quality standards or PSD increments. The definition of ‘source’ can apply to the whole facility or to the modifications at the facility. In cases where a particular averaging period has not been modeled for a pollutant, or was modeled, but predicted concentrations were above 95% of air quality standards or PSD increments, then NMED considers the entire facility to be the ‘source’ for those pollutants and periods. For other cases, ‘source’ includes only the modification described in the current application plus all contemporaneous emissions increases in the past 5 years since the entire facility was last modeled.

New:

> Modeling significance levels are thresholds below which the source is not considered to contribute to any predicted exceedance of air quality standards or PSD increments. The definition of ‘source’ can apply to the whole facility or to the modifications at the facility. For a new facility or an unpermitted facility, NMED considers the entire facility to be the ‘source’. For other cases, ‘source’ includes only the new equipment or new emissions increases described in the current application. Equipment that replaces other equipment is part of the new equipment.

Meteorological data recommendations have changed to reflect recent data. AQB has processed new meteorological data and has retired some old data that may be out of date. The processed data is available on the meteorological data webpage (https://www.env.nm.gov/air-quality/meteorological-data/). At the time of this writing, Substation has replaced Bloomfield data for permitting sources to be located in unknown locations (portable source relocation modeling). This change was based on a comparison of modeling results for existing sets of meteorological data.

NO_2 conversion using Ambient Ratio Method (ARM) has been replaced with Ambient Ratio Method 2 (ARM2). EPA no longer mentions the use of ARM in Appendix W. Instead, that appendix described details about what ratios can be used for the ARM2 method, which is now built into AERMOD as a default option.

Title V sources that have not demonstrated compliance with NAAQS or PSD increments are required to model for these standards and increments or produce a compliance plan to come into compliance.

SO_2 background concentrations were added for the annual averaging period.

PM2.5 Class I significance levels were updated.

TSP standards were repealed November 30, 2018.

Background concentrations were updated to 2015-2017.

Areas Where Streamlined Permits Are Restricted were updated.

Secondary formation of ozone and PM2.5 were updated to reflect current Appendix W and MERP guidance.

Note of changes that were made in 2016:

1-hour NO_2 and SO_2 modeling is now required for all sizes of facilities with NO_2 or SO_2 emissions.

ARM2 method of NO_2 modeling has been added to the approved options.

AERMOD output is considered to be expressed at Standard Temperature and Pressure (STP), eliminating most of the need for concentration conversion.

Emission rates for the very small emission rate modeling waivers have changed.

The modeling report form, Universal Application 4 (UA4), is available.

Background concentrations have been updated to 2013-2015 monitoring results.

(Hobbs PM2.5 background concentration was corrected from the July 8, 2016 version).
(September 1, 2016: PM2.5 annual standard was corrected in Table 5F)

Errors in summary Tables 6A and 6C that did not match the instructions in the pollutant-specific standards sections were corrected.

STATE OF NEW MEXICO
ENVIRONMENTAL IMPROVEMENT BOARD

IN THE MATTER OF THE PETITION FOR HEARING
ON AIR QUALITY PERMIT
NO. 9295, ROPER CONSTRUCTION INC.'S
ALTO CONCRETE BATCH PLANT **EIB No. 22-34**

Roper Construction Inc.,
Petitioner

TECHNICAL TESTIMONY OF RHONDA ROMERO

I. INTRODUCTION

Please state your name and job title for the Record.

My name is Rhonda Romero. I am the Manager for the Minor Source Unit of the Permitting Section of the Air Quality Bureau ("AQB" or "Bureau") of the New Mexico Environment Department ("NMED" or "Department"). I present written testimony on behalf of the Department for the public hearing on the appeal petition filed by Roper Construction Inc. ("Petitioner" or RCI) in EIB 22-34. The Petitioner challenges the denial of Air Quality Permit No. 9295. The Department issued the Final Order, denying Air Quality Permit No. 9295 on June 22, 2022 based on the Hearing Officer's Report and Findings of Fact and Conclusions of Law in Case No. AQB 21-57 (P). The Petitioner contends its air quality permit application "complied with all applicable state and federal requirements for approval, but was denied by the Deputy Secretary based on several misapplications of law and facts." Petition at 2.

Can you tell use about the general nature of your testimony?

The NSR application was reviewed by Deepika Saikrishnan, Ph.D. She reviewed the permit application and prepared the draft permit in accordance with Bureau policies and procedures. She coordinated with the Petitioner's staff and consultants to obtain necessary updates for the permit application. She was also the contact for citizens related to the permit application and draft permit.

However, Dr. Saikrishnan has since left the Department and is not available to testify in this matter. As the Manager of the Minor Source Unit, I collaborated with her and advised her throughout the permitting process. In addition to my involvement throughout the permitting process at the time of review, I have reviewed the administrative record in preparation for this hearing.

My testimony will address the following topics: my qualifications, a summary of the proposed Alto Concrete Batch Plant (CBP), a summary of the administrative and technical review of the permit application, public outreach for the EIB 22-34 hearing, and responses to permitting related issues in RCI's petition.

II. QUALIFICATIONS

Can you please give your qualifications and job duties with NMED?

I have worked for NMED AQB for the past 9.5 years. I worked as a permit specialist until July 2018, when I was promoted to my current position as the Manager of the Minor Source Unit. As a permit specialist I worked on 521 air quality permitting actions, including numerous complex industrial facility air quality permits. As a Permit Specialist, I performed technical and regulatory review of complex Air Quality Bureau permit applications within regulatory deadlines. I verified emissions calculations; determined applicable state and federal regulations; coordinated with various stakeholders including the public, industry, consultants, other air agencies, and AQB staff; wrote legally enforceable air permits and technical support documents for the administrative record; entered data into the AQB database; and completed various special projects to achieve AQB goals. As Section Manager, I oversee the air quality permitting process for Minor Sources in the state of New Mexico. I manage 8 Full-Time Equivalent (FTE) positions.

I received my Bachelor of Science in Environmental Geology from New Mexico Highlands University and my Master of Science in Geology from New Mexico Highlands University.

My complete background and qualifications are listed in my resume, which is marked as [**NMED Exhibit 5**].

III. SUMMARY OF THE PROPOSED ALTO CBP

Can you provide a summary of what the Permittee's application seeks in this matter?

RCI proposed the Alto Concrete Batch Plant to be located approximately 0.35 miles east of the intersection of Highways 48 and 220 north of Ruidoso, NM in Lincoln County. According to the application, the facility would include a feeder hopper, feeder conveyor, four (4) overhead aggregate bins, aggregate weigh batcher, aggregate weigh conveyor, truck-loading with baghouse, cement/fly ash weigh batcher, cement split silo, fly ash split silo, aggregate/sand storage piles and three (3) concrete batch plant heaters. RCI certified that Alto CBP would have hours of operation of 7AM-6PM from November through February, 5AM-7PM March and October, 4AM-9PM April and September, and 3AM-9PM May through August. RCI also certified that the facility would limit the hourly production rate to 125 cubic yards per hour and yearly production rate to 500,000 cubic yards per year. The annual emissions would be controlled by limiting the hours of operation and annual throughput of the facility.

IV. SUMMARY OF THE ADMINISTRATIVE AND TECHNICAL REVIEW OF APPLICATION 9295

Could you provide a summary of the administrative and technical review the Department did for Application 9295?

Dr. Saikrishnan detailed the administrative and technical review of the application in her testimony **[NMED Exhibit 1].** In summary, Dr. Saikrishnan reviewed the application for administrative completeness within the regulatory deadline. She engaged with citizens throughout the public participation period and created additional outreach documents with details about the permitting process. The administrative completeness review consists of identifying that all the applicable sections of the application are present, including an air dispersion modeling analysis and proof of public notice.

Subsequent to the administrative completeness determination, the Department conducted public notice in accordance with 20.2.72.206.A NMAC.

The technical review period began as soon as the application was ruled administratively complete. Dr. Saikrishnan verified the emission calculations and evaluated applicability of federal and state regulations. Throughout the technical review period Dr. Saikrishnan requested clarification on issues that needed clarification and requested updates to the application when appropriate.

After the technical review was completed, Dr. Saikrishnan began drafting the permit and associated technical documents. The draft permit was reviewed by multiple levels of management and was made available for comment to the public as well as RCI. The draft permit is a working document and updates are made if legitimate issues are raised.

In my assessment, Dr. Saikrishnan did a complete and thorough review of the application and drafted the permit and supporting technical documents in accordance with AQB policies and procedures and state and federal regulations.

V. PUBLIC OUTREACH FOR EIB 22-34

Can you describe the public outreach undertaken by the Department in this matter?

Dr. Saikrishnan detailed public outreach for the permit application and the February 2022 hearing before the NMED Deputy Secretary in her testimony **[NMED Exhibit 1].** Dr. Saikrishnan met all the AQB public notice requirements.

For the EIB 22-34hearing, AQB staff wrote the Notice of Hearing per the requirements of 20.1.2 NMAC and arranged to have it translated into Spanish by Ana Maria MacDonald, Translation Program Manager for NMED **[NMED EIB Exhibits 3 and 4]**. I created the Notice of Hearing in English **[NMED EIB Exhibit 3]** and the Notice of Hearing in Spanish **[NMED EIB Exhibit 4]** on EIB letterhead.

I requested the AQB administrative staff mail out hard copies of the Notice of Hearing in English and the Notice of Hearing in Spanish on September 7, 2022. They prepared envelopes with labels to be mailed by the U.S. Postal Service to citizens who submitted written comments to AQB by US Postal Service and did not provide an electronic mail address prior to the February 2022 public hearing.

AQB administrative staff delivered these envelopes, each containing Notices of Hearing in English and in Spanish, to the Runnels Building on September 14, 2022, for postage and mailout.

I sent the Notices of Hearing in English and in Spanish to the Office of Public Facilitation (OPF) via email on September 7, 2022. OPF posted the Notice of Hearing in English and in Spanish on the Department's Docketed Matters website under the Environmental Improvement Board dropdown, in the section for EIB 22-34 Appeal Petition – Permit No. 9295 Roper Construction Inc. on September 9, 2022 **[NMED EIB Exhibit 7]**.

The Notice of Hearing was published in English and in Spanish in *The Albuquerque Journal* on September 10, 2022 **[NMED EIB Exhibit 6]**. The Notice of Hearing was published in English and in Spanish in *Ruidoso News* on September 14, 2022. **[NMED EIB Exhibit 5]**.

On September 9, 2022, I sent out emails with the Notices of Hearing in English and in Spanish attached. The email messages announced the date for the public hearing before the EIB and provided the link to the Department's Docketed Matters website under the Environmental Improvement Board dropdown, in the section for EIB 22-34 for more information. **[NMED EIB Exhibit 8]**. These emails with Notices in English and Spanish attached were sent to the same email lists used for sending out the Notices of Hearing for the February 2022 public hearing. Emails with attached Notices in English and in Spanish were sent to EPA Region 6, Erica LeDoux, and Mary Layton at EPA [**NMED EIB Exhibit 8**]. I emailed the Department's Notices in English and Spanish to Lincoln National Forest and Smokey Bear Ranger District; Christina Thompson, Camille Howes, Travis Moseley and Andres Bolanos [**NMED EIB Exhibit 8**]. I also emailed the Notices in English and Spanish to the Village Clerk of Ruidoso, the Village of Capitan Clerk, the Lincoln County Clerk, the Mescalero Apache Tribe, and the Ruidoso Downs contact [**NMED EIB Exhibit 8**].

VI. RESPONSES TO RCI'S PETITION

Can you provide the Department's response to the Petition in this matter?

The following responses are related solely to issues brought up related to the draft permit. Issues related to the modeling report will be addressed in by Eric Peter's in his testimony [**NMED EIB Exhibit 2**]. The AQB does not have a position on the issues related to the application of law by the Hearing Officer or the Deputy Secretary in the Case No. AQB 21-57.

1. HAUL ROAD SILT LOADING EMISSION FACTOR FROM AP-42

In the draft permit, the paved haul road emissions were limited through more than one permit condition. Conditions A112.A, A112.B and A112.C included requirements to limit the amount of haul road trips and to control particulate emissions from the haul roads. In addition, Conditions A108.A and A108.B limited the hours of operation at the facility and the facility throughput. The applicant used the most appropriate silt loading emission factor from Chapter 13, Table 13.2.1-2. The AP-42 emission factor value of 0.6 g/m2 is appropriate because it applies to paved roads with less than 500 trips per day. The draft permit limited the amount of truck traffic to 305 haul road trips per day. In addition, draft permit Condition A112.B required that the haul road be maintained to minimize silt buildup to reduce particulate emissions through the application of water or other control measures such as sweeping. The AP-42 silt loading emission factor from Chapter 13, Table 13.2.1-3 for concrete batching plants is not appropriate because it applies to uncontrolled paved roads. The haul road at the Alto CBP would be required to reduce particulate emissions by maintaining the paved road to reduce silt buildup, limiting truck traffic, and limiting the hours of operation and throughput at the facility.

2. WATER RESOURCES AND WATER AVAILABILITY

The applicant opted to control emissions from material handling using water and thus used controlled emission factors from AP-42 in calculations. In addition, prior to submittal of the air quality permit application the applicant had the application notarized and certified that the information and data submitted in the application are as true and accurate as possible. Based on the emission factors used to calculate emissions, the AQB included draft permit conditions requiring the use of the control measures represented in the application in order to make the use of the controlled emission factors enforceable.

The AQB is not required to identify the water source the applicant will be using to achieve the emission controls. The AQB does not have the jurisdiction in determining where the water used to comply with permit conditions is sourced. Water availability is under the jurisdiction of The Office of the State Engineer. It is the responsibility of the applicant to determine the availability of water resources for complying with permit conditions. Issuance of an air quality permit does not interfere with the applicant’s obligations to comply with other applicable laws and regulations. See 20.2.72.209 NMAC.

If a permit holder could not obtain water to comply with permit conditions, they would not be authorized to operate the activities that require water for emission controls. A permit holder cannot change the method of controlling particulate emissions unless an application for a permit revision was approved by the Department. If a permit holder does not have sufficient water resources to comply with permit conditions, but continues to operate without the use of water, they may be subject to enforcement action.

3. ALTO CBP APPLICATION

The permit application submitted by the applicant complied with all applicable state and federal requirements for approval.

VII. CONCLUSION

The AQB verified the contents of the air quality permit application and application updates. The draft permit was based on the contents of the Alto CBP application and included conditions necessary to demonstrate compliance with applicable air quality regulations and ambient air quality standards. If the applicant complied with the requirements in the draft permit, compliance would be achieved through monitoring, recordkeeping, and reporting protocols detailed in the draft permit. The facility as described and represented in the Alto CBP application demonstrated compliance with federal and state air quality regulations.

STATE OF NEW MEXICO
BEFORE THE ENVIRONMENTAL IMPROVEMENT BOARD

IN THE MATTER OF THE PETITION FOR HEARING ON AN AIR QUALITY PERMIT NO. 9295, ROPER CONSTRUCTION, INC.'S ALTO CONCRETE BATCH PLANT **EIB 22-34 (P)**

TECHNICAL TESTIMONY OF ERIC PETERS

Can you please state your name and qualifications for the record?

My name is Eric Peters. I have Bachelor of Science degrees in Mechanical Engineering and Biology from the University of Illinois, and a Master of Science degree in Environmental Engineering from the University of Kansas.

Can you describe your job title and duties with the Air Quality Bureau?

I work for the Air Quality Bureau ("AQB" or "Bureau") of the New Mexico Environment Department ("NMED" or "Department") as an Air Dispersion Modeler. I have worked in the Modeling Section for over twenty-four years. One of my primary duties is the review of air dispersion modeling for New Source Review permit applications to determine if they will comply with air quality standards and other modeling-related requirements. Air dispersion modeling is a computer simulation that predicts air concentrations of pollutants after a facility is constructed. U. S. Environmental Protection Agency (EPA) develops models for this purpose to ensure quality analyses and equal protection under the law.

Can you tell us about the review of the modeling submitted for Permit 9295?

The Department reviewed the modeling submitted by Roper Construction, Inc. for permit 9295, which is known as "Alto Concrete Batch Plant" (the facility). [AR No. 1, BATES 151 to 186]. The Department verified that the facility followed appropriate modeling practices, as informed by the New Mexico Modeling Guidelines. [NMED Exhibit 7, BATES 250 to 332]. Details of the modeling are described in the Modeling Review Report, which is contained in the Administrative Record. [AR No. 6, BATES 242 to 249].

In order to be issued an NSR permit, the applicant must demonstrate that construction of the proposed facility will not cause or contribute to any violations of National or New Mexico Ambient Air Quality Standards, Prevention of Significant Deterioration (PSD) Increments, or State Air Toxic pollutant requirements. National Ambient Air Quality Standards are periodically reviewed by the Environmental Protection Agency and are designed to protect the most sensitive individuals. PSD increments are designed to maintain the air quality of pristine areas. Toxic permitting thresholds prevent neighbors from being exposed to more than one percent of the amount that has been deemed acceptable for workers to be exposed to throughout the day. The requirement to demonstrate compliance with these air quality measures is contained in 20.2.72.203(A)(4) NMAC.

The Department maintains the New Mexico Modeling Guidelines to provide a basis for acceptable modeling analyses. These guidelines incorporate and interpret the most recent version of EPA's Guideline on Air Quality Models, which was published in the Federal Register, Vol. 82, No. 10. The New Mexico Modeling Guidelines also incorporate other information and guidance, such as EPA memorandums.

Alto Concrete Batch Plant modeling was performed in accordance with the New Mexico Modeling Guidelines. If the facility operates in compliance with the terms and conditions of the draft permit, then it will not cause or contribute to any concentrations above state or federal ambient air quality standards or PSD increments. The facility has satisfied all modeling requirements and the Bureau's recommendation that the permit be issued may be adopted by the Board.

The Hearing Officer's report in the permit hearing before the Secretary included a discussion of Inversions. Can you respond to the Hearing Officer's report on this issue, and describe how the modeling accounts for inversions?

Inversions occur when the temperature of the ground is lower than the temperature of the air above and the temperature continues to increase as the height increases, creating stable conditions that minimize turbulence. Most places have inversions every night while the ground is cooled by exchanging radiation with deep space. Solar radiation during the day frequently breaks up the inversions during the day because the ground absorbs the solar radiation much more quickly than the air, causing the ground to be hotter than the surrounding air. On infrequent occasions the inversion will persist during the day. Inversions are also associated with low wind speeds because the energy to create winds is low when conditions are that stable.

The modeling accounts for inversions in two ways. AERMOD, the model EPA and NMED require for permit modeling, quantifies the inversion by including the mixing height readings from upper air measurements. Mixing height is included in the dispersion calculations, so the concentration of each source for each hour is affected by the inversion for the modeled concentrations. The second way that inversions are included is by adding background concentrations from monitoring sites, which would include inversions as part of the set of data considered when looking for maximum concentrations. The maximum monitored concentrations are added to the maximum modeled concentrations.

The claim that the Applicant's modeling did not consider inversions is not correct. Applicants are required to use a specific model, AERMOD, which considers inversions as part of the model formulation. NMED does not have the authority to require an alternative model.

The Hearing Officer's report in the permit hearing before the Secretary included a discussion of high wind speeds. Can you respond to the Hearing Officer's report on this issue, and describe how wind speeds affect the modeling?

Best-case conditions for modeling (conditions that predict low ambient concentrations of pollution) are when wind is high, among other favorable conditions for dispersion. An example that illustrates this phenomenon is the graph of maximum daily modeled concentration vs. maximum daily wind speed [NMED EIB Exhibit 10], which I produced based on the 2020 Sierra Blanca Regional Airport meteorology and the Facility PM10 modeling. None of the high concentrations occurred at high wind speeds. The low winds are associated with low turbulence, so the pollution moves from the sources to the locations where concentrations are predicted with minimal dilution.

The Hearing Officer's report in the permit hearing before the Secretary included a discussion of meteorology selection requirements. Can you respond to the Hearing Officer's report on this issue, and describe the requirements and guidance for selecting meteorology in the modeling?

Many states do not require modeling for minor sources. Estimates I have seen or heard suggest one half to one third of states don't require minor sources to do any modeling. For example, the State of Colorado has contacted me for advice on how to implement minor source modeling because they expect to need to do this in the future. New Mexico does require modeling demonstrations for new sources that are minor with respect to PSD, such as this facility.

Consider the following language from EPA’s Guideline on Air Quality Models (‘‘Guideline’’) [5182 Federal Register / Vol. 82, No. 10 / Tuesday, January 17, 2017 / Rules and Regulations]:

> In this action, the Environmental Protection Agency (EPA) promulgates revisions to the Guideline on Air Quality Models (‘‘Guideline’’). The Guideline provides EPA’s preferred models and other recommended techniques, as well as guidance for their use in estimating ambient concentrations of air pollutants. It is incorporated into the EPA’s regulations, satisfying a requirement under the Clean Air Act (CAA) for the EPA to specify with reasonable particularity models to be used in the Prevention of Significant Deterioration (PSD) program.
>
> A. Does this action apply to me?
>
> This action applies to federal, state, territorial, local, and tribal air quality management agencies that conduct air quality modeling as part of State Implementation Plan (SIP) submittals and revisions, New Source Review (NSR) permitting (including new or modifying industrial sources under Prevention of Significant Deterioration (PSD)), conformity, and other air quality assessments required under EPA regulation.

Examination of this language and the rest of the document reveals that the Guideline is not a regulatory requirement for minor source permitting. The Guideline can be used as “guidance” for minor source permitting but is not required. Scientific judgement and experience can be applied to modify modeling procedures recommended by the guidance. For example, if the guidance says to use five years of complete, representative, meteorological data, but that data is not available then substitutions are acceptable. The point here is that the judgement of the modeler can out-weigh the letter of the "guidance".

Holloman AFB data was selected for the modeling of this facility because it was relatively nearby the facility location and had five years of complete data. Sierra Blanca Regional Airport data had too many missing readings and a complete five years of data could not be produced.

The Guideline discusses meteorological data selection on page 5223 [5223 Federal Register / Vol. 82, No. 10 / Tuesday, January 17, 2017 / Rules and Regulations]:

> The model user should acquire enough meteorological data to ensure that worst-case meteorological conditions are adequately represented in the model results. The use of 5 years of adequately representative NWS or comparable meteorological data, at least 1 year of site-specific, or at least 3 years of prognostic meteorological data, are required. If 1 year or more, up to 5 years, of site-specific data are available, these data are preferred for use in air quality analyses. Depending on completeness of the data record, consecutive years of NWS, site-specific, or prognostic data are preferred. Such data must be subjected to quality assurance procedures as described in section 8.4.4.2.

The "worst-case meteorological conditions" are the conditions that produce the highest concentrations. "Adequately representative" means, in this context, that the conditions that produce the highest concentrations are included in the meteorological data.

With respect to this facility, the Sierra Blanca Regional Airport data contains the worst-case meteorological conditions, and the more distant Holloman AFB data contains conditions that are worse than worst-case. The Applicant would not be required to use Holloman AFB data because it predicts unrealistically high concentrations. A permit could not be denied on the basis of a data set that predicts unrealistically high concentrations, however, so long as the data set demonstrates compliance with air quality standards.

The Guideline contains additional guidance specific to AERMET and AERMOD on page 5232 [5232 Federal Register / Vol. 82, No. 10 / Tuesday, January 17, 2017 / Rules and Regulations]:

> (i) Data used as input to AERMET should possess an adequate degree of representativeness to ensure that the wind, temperature and turbulence profiles derived by AERMOD are both laterally and vertically representative of the source impact area. The adequacy of input data should be judged independently for each variable. The values for surface roughness, Bowen ratio, and albedo should reflect the surface characteristics in the vicinity of the meteorological tower or representative grid cell when using prognostic data, and should be adequately representative of the modeling domain. Finally, the primary atmospheric input variables, including wind speed and direction, ambient temperature, cloud cover, and a morning upper air sounding, should also be adequately representative of the source area when using observed data.

Again, the language, “adequately representative” refers to the operational definition above that both protects the public from violations of air quality standards and protects applicants from unreasonable meteorology selection requirements.

As noted in the Hearing Officer’s report (item 38), Paul Wade ran the model with the worst-case meteorology, which was from Holloman AFB. He also ran it with the best-case meteorology, which was from Sierra Blanca Regional Airport. [Hrg. Tr. at 33:23-34:14 (Wade); 49:21-50:1 (Wade).] Both sets of data demonstrated compliance with air quality standards and PSD increments.

In preparation for this hearing, I re-ran the PM10 modeling with Sierra Blanca Regional Airport data. I found the total concentrations from the Sierra Blanca Regional Airport data to produce concentrations about one half to two-thirds of the concentrations reported for Holloman AFB (before adding background concentrations), depending on the averaging period and air quality standard.

The application used acceptable meteorological data that adequately represented worst-case meteorological conditions. The Applicant chose to use data that predicted unrealistically high concentrations, which is an acceptable choice. The original modeling analysis justifies the issuance of the permit. In addition, the Applicant did a supplemental modeling analysis using the different meteorological data requested by Sonterra. That analysis alone would also justify the issuance of the permit. (More than one year of complete data was found). The combination of these analyses leaves no doubt that modeling demonstrates compliance with air quality standards and PSD increments. The facility has satisfied all modeling requirements and the Bureau’s recommendation that the permit be issued may be adopted by the Board.

STATE OF NEW MEXICO
ENVIRONMENTAL IMPROVEMENT BOARD
Harold Runnels Building, Suite S-2102
1190 St. Francis Drive
Santa Fe, New Mexico 87505
Phone: (505) 827-2428

NEW MEXICO ENVIRONMENTAL IMPROVEMENT BOARD

NOTICE OF PUBLIC HEARING

EIB 22-34

IN THE MATTER OF THE PETITION FOR HEARING ON AIR QUALITY PERMIT NO. 9295, ROPER CONSTRUCTION INC.'S ALTO CONCRETE BATCH PLANT

The New Mexico Environmental Improvement Board ("Board") will hold a public hearing beginning at 9:00 a.m. MDT on October 18, 2022, and continuing on consecutive days, as needed. The hearing is in a hybrid manner, where individuals may participate virtually via the web application WebEx or in person at the Larrazolo Auditorium in the Harold Runnels Building at 1190 S. St. Francis Drive, Santa Fe, NM 87502. At the time of the hearing, if any restrictions are in place by the Governor's Executive Orders or various emergency public health orders designed to protect the public and prevent the spread of COVID-19, those restrictions will apply at the in-person location. Those interested in attending virtually or in person should contact the Board Administrator or visit the NMED Events Calendar at www.env.nm.gov/events-calendar/. Go to the start date of the hearing and click on the entry about this hearing for instructions on how to participate. The purpose of the hearing is to consider the following appeal petition filed by Roper Construction Inc.

Petitioners challenge the denial for Air Quality Permit No. 9295. The New Mexico Environment Department ("Department") denied the Air Quality Permit No. 9295 based on the hearing officers report and the Deputy Secretaries written, final order. Petitioners contend the Department's decision did not follow protocol for permit issuance and that the permit application and information therein met all regulations and Department policy and procedure for a permit to be issued.

The Petitions and related documents may be viewed on the Department's docketed matters web page www.env.nm.gov/opf/docketed-matters/. Look under the Environmental Improvement Board (EIB) dropdown, for EIB 22-34: In The Matter of the Petition for Hearing on Air Quality Permit No. 9295, Roper Construction Inc.'s Alto Concrete Batch Plant.

The Hearing will be conducted in accordance with the Board's Adjudicatory Procedures (20.1.2 NMAC); the New Mexico Air Quality Control Act, NMSA 1978, Sections 74-2-1 through -22; the State Rules Act, NMSA 1978, Section 14-4-5.3; and other applicable procedures.

All interested persons will be given a reasonable opportunity at the hearing to submit relevant evidence, data, views, and arguments, orally and in writing; to introduce exhibits; and to examine witnesses. Any person wishing to submit a non-technical written statement for the record in lieu of oral testimony must file such statement prior to the close of the hearing.

TECHNICAL TESTIMONY

Any person who wishes to present technical evidence at the hearing shall file a statement of intent by September 21, 2022. The statement of intent to present technical evidence shall include: (i) the name of the person filing the statement; (ii) an indication of whether the person filing the statement supports or opposes the petition at issue; (iii) the name of each witness; (iv) an estimate of the length of the direct

NMED EIB EXHIBIT 3

testimony of each witness; (v) a list of exhibits, if any, to be offered into evidence at the hearing; and (vi) a summary or outline of the anticipated direct testimony of each witness.

ENTRY OF APPEARANCE

Any person who wishes to be treated as an interested participant and to cross-examine witnesses at the hearing shall file and serve upon all parties an entry of appearance on or before September 21, 2022. A timely statement of intent shall be considered an entry of appearance. The entry of appearance must identify the person wishing to be treated as an interested participant and any individual who may appear on behalf of that person.

Use the Public Comment Portal to submit all non-technical testimony and comments, including: relevant evidence, data, views, arguments, written statements in lieu of oral testimony at the hearing, or public comment. Access the Public Comment Portal via a link on the Department's docketed matters web page www.env.nm.gov/opf/docketed-matters/. Look under the Environmental Improvement Board (EIB) dropdown, for EIB 22-34: In The Matter of the Petition for Hearing on Air Quality Permit No. 9295, Roper Construction Inc.'s Alto Concrete Batch Plant. (The direct link to the Public Comment Portal is http://nmed.commentinput.com/comment/search). Alternatively, non-technical testimony or comments may be emailed to Pamela.Jones@state.nm.us. Oral public comments will be accepted on October 18, 2022, at approximately 12:00 PM and 5:00 PM, and on subsequent days (as necessary) at approximately 9:00 AM, 12:00 PM, and 5:00 PM. Public comment is limited to five (5) minutes per individual.

If any person requires assistance, any interpreter other than Spanish, or an auxiliary aid to participate in this process, please contact the Board Administrator no later than October 3, 2022, at 1190 St. Francis Drive, P.O. Box 5469, Santa Fe, NM 87502, telephone (505) 660-4305, or email Pamela.Jones@state.nm.us (TDD or TTY users please access the number via the New Mexico Relay Network, 1-800-659-1779 (voice); TTY users: 1-800-659-8331).

Notice of Nondiscrimination

The Department does not discriminate on the basis of race, color, national origin, disability, age or sex in the administration of its programs or activities, as required by applicable laws and regulations. The Department is responsible for coordination of compliance efforts and receipt of inquiries concerning non-discrimination requirements implemented by 40 C.F.R. Part 7, including Title VI of the Civil Rights Act of 1964, as amended; Section 504 of the Rehabilitation Act of 1973; the Age Discrimination Act of 1975, Title IX of the Education Amendments of 1972, and Section 13 of the Federal Water Pollution Control Act Amendments of 1972. If you have any questions about this notice or any of the Department's non-discrimination programs, policies or procedures, you may contact: Kathryn Becker, Non-Discrimination Coordinator, New Mexico Environment Department, 1190 St. Francis Dr., Suite N4050, P.O. Box 5469, Santa Fe, NM 87502, (505) 827-2855, nd.coordinator@state.nm.us. If you believe that you have been discriminated against with respect to a Department program or activity, you may contact the Non-Discrimination Coordinator identified above. You may also visit the Department's website at www.env.nm.gov/non-employee-discrimination-complaint-page/ to learn how and where to file a complaint of discrimination.

NMED EIB EXHIBIT 3

STATE OF NEW MEXICO
ENVIRONMENTAL IMPROVEMENT BOARD
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JUNTA DE MEJORA AMBIENTAL DE NUEVO MÉXICO
AVISO DE AUDIENCIA PÚBLICA
EIB 22-34
EN EL ASUNTO DE LA PETICIÓN DE AUDIENCIA SOBRE EL PERMISO DE CALIDAD DE AIRE NÚM. 9295, ROPER CONSTRUCTION INC.'S ALTO CONCRETE BATCH PLANT

La Junta de Mejora Ambiental de Nuevo México ("Junta") celebrará una audiencia pública que comenzará a las 9:00 a. m., MDT (hora de verano de la montaña), el 18 de octubre de 2022 y continuará en días consecutivos, según sea necesario. La audiencia es de forma híbrida, donde las personas pueden participar virtualmente a través de la aplicación web WebEx o en persona en el Auditorio Larrazolo en el edificio Harold Runnels en 1190 S. St. Francis Drive, Santa Fe, NM 87502. A la hora de la audiencia, si existen restricciones establecidas por las órdenes ejecutivas de la gobernadora o varias órdenes de salud pública de emergencia diseñadas para proteger al público y prevenir la propagación de COVID-19, esas restricciones se aplicarán en el lugar en persona. Todos aquellos interesados en asistir virtualmente o en persona deben comunicarse con la administradora de la Junta o visitar el Calendario de eventos de NMED en www.env.nm.gov/events-calendar/. Vaya a la fecha de inicio de la audiencia y haga clic en la entrada sobre esta audiencia para obtener instrucciones sobre cómo participar. El propósito de la audiencia es considerar la siguiente petición de apelación presentada por Roper Construction Inc.

Los peticionarios impugnan la denegación del Permiso de Calidad del Aire Núm. 9295. El Departamento de Medio Ambiente de Nuevo México ("Departamento") denegó el Permiso de Calidad del Aire Núm. 9295 basándose en el informe de los funcionarios de audiencias y la orden final por escrito de las subsecretarias. Los peticionarios sostienen que la decisión del Departamento no siguió el protocolo para la emisión de permisos y que la solicitud del permiso y la información que contiene cumplieron con todos los reglamentos y la política y el procedimiento del Departamento para la emisión del permiso.

Las Peticiones y los documentos relacionados se pueden ver en la página web de asuntos registrados del Departamento en www.env.nm.gov/opf/docketed-matters/. Busque en el menú desplegable de la Junta de Mejora Ambiental (EIB, por sus siglas en inglés) el EIB 22-34: El Asunto de la Petición de Audiencia sobre el Permiso de Calidad del Aire Núm. 9295, Roper Construction Inc.'s Alto Concrete Batch Plant.

La audiencia se llevará a cabo de acuerdo con los Procedimientos de adjudicación de la Junta (20.1.2 NMAC); la Ley de Control de Calidad del Aire de Nuevo México, NMSA 1978, Secciones 74-2-1 a -22; la Ley de Normas Estatales, NMSA 1978, Sección 14-4-5.3; y otros procedimientos aplicables.

Todas las personas interesadas tendrán una oportunidad razonable en la audiencia para presentar pruebas, datos, puntos de vista y argumentos pertinentes, de forma oral y por escrito; presentar pruebas instrumentales; y para interrogar a los testigos. Cualquier persona que desee presentar una declaración escrita no técnica para el registro en lugar de un testimonio oral debe presentar dicha declaración antes del cierre de la audiencia.

TESTIMONIO TÉCNICO

Cualquier persona que desee presentar pruebas técnicas en la audiencia deberá presentar una declaración de intención a más tardar hasta el 21 de septiembre de 2022. La declaración de intención de presentar pruebas técnicas deberá incluir: (i) el nombre de la persona que presenta la declaración; (ii) una indicación de si la

NMED EIB EXHIBIT 4

persona que presenta la declaración apoya o se opone a la petición en cuestión; (iii) el nombre de cada testigo; (iv) una estimación de la duración del testimonio directo de cada testigo; (v) una lista de las pruebas pertinentes, si las hubiere, que se ofrecerán como evidencia en la audiencia; y (vi) un resumen o descripción del testimonio directo anticipado de cada testigo.

REGISTRO DE COMPARECENCIA

Cualquier persona que desee ser tratada como un participante interesado e interrogar a los testigos en la audiencia deberá presentar y notificar a todas las partes una declaración de comparecencia a más tardar hasta el 21 de septiembre de 2022. Una declaración de intención oportuna se considerará un registro de comparecencia. El registro de comparecencia debe identificar a la persona que desea ser tratada como participante interesado y cualquier individuo que pueda comparecer en nombre de esa persona.

Utilice el Portal de comentarios públicos para enviar todos los testimonios y comentarios no técnicos, incluidos: pertinentes pruebas, datos, puntos de vista, argumentos, declaraciones por escrito en lugar de testimonios orales en la audiencia o comentarios públicos. Acceda al Portal de comentarios públicos a través del enlace en la página web de asuntos registrados del Departamento www.env.nm.gov/opf/docketed-matters/. Busque en el menú desplegable de la Junta de Mejora Ambiental (EIB, por sus siglas en inglés) el EIB 22-34: El Asunto de la Petición de Audiencia sobre el Permiso de Calidad del Aire Núm. 9295, Roper Construction Inc.'s Alto Concrete Batch Plant. (El enlace directo al Portal de comentarios públicos es http://nmed.commentinput.com/comment/search). Alternativamente, se pueden enviar por correo electrónico testimonios o comentarios no técnicos a Pamela.Jones@state.nm.us. Los comentarios orales del público se aceptarán el 18 de octubre de 2022, aproximadamente a las 12:00 p.m. y a las 5:00 p.m., y en los días posteriores (según sea necesario) aproximadamente a las 9:00 a.m. Los comentarios públicos están limitados a cinco (5) minutos por persona.

Si alguna persona requiere asistencia, un intérprete que no sea de español o un dispositivo auxiliar para participar en este proceso, comuníquese con la administradora de la Junta a más tardar el 3 de octubre de 2022, en 1190 St. Francis Drive, P.O. Box 5469, Santa Fe, NM 87502, teléfono (505) 660-4305, o correo electrónico Pamela.Jones@state.nm.us (los usuarios de TDD o TTY, pueden acceder al número a través de New Mexico Relay Network, 1-800-659- 1779 (voz); usuarios de TTY: 1-800-659-8331).

Aviso de no discriminación

El NMED no discrimina por motivos de raza, color, nacionalidad, discapacidad, edad o sexo en la administración de sus programas o actividades, como lo exigen las leyes y reglamentos aplicables. El NMED es responsable de la coordinación de los esfuerzos de cumplimiento y la recepción de las consultas relativas a los requisitos de no discriminación implementados por 40 C.F.R. Partes 5 y 7, incluyendo el Título VI de la Ley de Derechos Civiles de 1964, con sus enmiendas; la Sección 504 de la Ley de Rehabilitación de 1973; la Ley de Discriminación por Edad de 1975, el Título IX de las Enmiendas de Educación de 1972, y la Sección 13 de las Enmiendas de la Ley Federal de Control de Contaminación del Agua de 1972. Si tiene alguna pregunta sobre este aviso o cualquiera de los programas, políticas o procedimientos de no discriminación del NMED, o si cree que ha sido discriminado con respecto a un programa o actividad del NMED, puede ponerse en contacto con: Kathryn Becker, coordinadora de no discriminación, NMED, 1190 St. Francis Dr., Suite N4050, P.O. Box 5469, Santa Fe, NM 87502, (505) 827-2855, nd.coordinator@state.nm.us. También puede visitar nuestro sitio web en https://www.env.nm.gov/non-employee-discrimination-complaint-page/ para saber cómo y dónde presentar una queja por discriminación.

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Affidavit of Publication

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SANTA FE, NM 87505-1816

I, being duly sworn, on my oath say that I am the Legal Coordinator of the **Ruidoso News**, a newspaper of twice weekly circulation. The paper is published in the English language at the town of Ruidoso, Lincoln County, State of New Mexico, and that there is no daily paper published, in the said county, nor was there on the dates herein mentioned. Ruidoso News has been regularly published and issued for more than nine months prior to the date of the first publication hereinafter mentioned.

09/14/2022

Legal Clerk

Subscribed and sworn before me this September 21, 2022:

Kathleen Allen

State of WI, County of Brown
NOTARY PUBLIC

1-7-25

My commission expires

KATHLEEN ALLEN
Notary Public
State of Wisconsin

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NMED EIB EXHIBIT 5

NEW MEXICO ENVIRONMENTAL IMPROVEMENT BOARD
NOTICE OF PUBLIC HEARING
EIB 22-34
IN THE MATTER OF THE PETITION FOR HEARING ON AIR QUALITY PERMIT NO. 9295, ROPER CONSTRUCTION INC.'S ALTO CONCRETE BATCH PLANT

The New Mexico Environmental Improvement Board ("Board") will hold a public hearing beginning at 9:00 a.m. MDT on October 18, 2022, and continuing on consecutive days, as needed. The hearing is in a hybrid manner, where individuals may participate virtually via the web application WebEx or in person at the Larrazolo Auditorium in the Harold Runnels Building at 1190 S. St. Francis Drive, Santa Fe, NM 87502. At the time of the hearing, if any restrictions are in place by the Governor's Executive Orders or various emergency public health orders designed to protect the public and prevent the spread of COVID-19, those restrictions will apply at the in-person location. Those interested in attending virtually or in person should contact the Board Administrator or visit the NMED Events Calendar at **www.env.nm.gov/events-calendar/.** Go to the start date of the hearing and click on the entry about this hearing for instructions on how to participate. The purpose of the hearing is to consider the following appeal petition filed by Roper Construction Inc. Petitioners challenge the denial for Air Quality Permit No. 9295. The New Mexico Environment Department ("Department") denied the Air Quality Permit No. 9295 based on the hearing officers report and the Deputy Secretaries written, final order. Petitioners contend the Department's decision did not follow protocol for permit issuance and that the permit application and information therein met all regulations and Department policy and procedure for a permit to be issued.

The Petitions and related documents may be viewed on the Department's docketed matters web page **www.env.nm.gov/opf/docketed-matters/** . Look under the Environmental Improvement Board (EIB) dropdown, for EIB 22-34: In The Matter of the Petition for Hearing on Air Quality Permit No. 9295, Roper Construction Inc.'s Alto Concrete Batch Plant.

The Hearing will be conducted in accordance with the Board's Adjudicatory Procedures (20.1.2 NMAC); the New Mexico Air Quality Control Act, NMSA 1978, Sections 74-2-1 through -22; the State Rules Act, NMSA 1978, Section 14-4-5.3; and other applicable procedures.

All interested persons will be given a reasonable opportunity at the hearing to submit relevant evidence, data, views, and arguments, orally and in writing; to introduce exhibits; and to examine witnesses. Any person wishing to submit a non-technical written statement for the record in lieu of oral testimony must file such statement prior to the close of the hearing.

TECHNICAL TESTIMONY

Any person who wishes to present technical evidence at the hearing shall file a statement of intent by September 21, 2022. The statement of intent to present technical evidence shall include: (i) the name of the person filing the statement; (ii) an indication of whether the person filing the statement supports or opposes the petition at issue; (iii) the name of each witness; (iv) an estimate of the length of the direct testimony of each witness; (v) a list of exhibits, if any, to be offered into evidence at the hearing; and (vi) a summary or outline of the anticipated direct testimony of each witness.

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Oral public comments will be accepted on October 18, 2022, at approximately 12:00 PM and 5:00 PM, and on subsequent days (as necessary) at approximately 9:00 AM, 12:00 PM, and 5:00 PM. Public comment is limited to five (5) minutes per individual.

If any person requires assistance, any interpreter other than Spanish, or an auxiliary aid to participate in this process, please contact the Board Administrator no later than October 3, 2022, at 1190 St. Francis Drive, P.O. Box 5469, Santa

NMED EIB EXHIBIT 5

Fe, NM 87502, telephone (505) 660-4305, or email **Pamela.Jones@state.nm.us** (TDD or TTY users please access the number via the New Mexico Relay Network, 1-800-659-1779 (voice); TTY users: 1-800-659-8331).

Notice of Nondiscrimination

The Department does not discriminate on the basis of race, color, national origin, disability, age or sex in the administration of its programs or activities, as required by applicable laws and regulations. The Department is responsible for coordination of compliance efforts and receipt of inquiries concerning non-discrimination requirements implemented by 40 C.F.R. Part 7, including Title VI of the Civil Rights Act of 1964, as amended; Section 504 of the Rehabilitation Act of 1973; the Age Discrimination Act of 1975, Title IX of the Education Amendments of 1972, and Section 13 of the Federal Water Pollution Control Act Amendments of 1972. If you have any questions about this notice or any of the Department's non-discrimination programs, policies or procedures, you may contact: Kathryn Becker, Non-Discrimination Coordinator, New Mexico Environment Department, 1190 St. Francis Dr., Suite N4050, P.O. Box 5469, Santa Fe, NM 87502, (505) 827-2855, nd.coordinator@state.nm.us. If you believe that you have been discriminated against with respect to a Department program or activity, you may contact the Non-Discrimination Coordinator identified above. You may also visit the Department's website at **www.env.nm.gov/non-employee-discrimination-complaint-page/** to learn how and where to file a complaint of discrimination.
#0005406291, Ruidoso News, September 14, 2022

NMED EIB EXHIBIT 5

Ruidoso News
PART OF THE USA TODAY NETWORK

Affidavit of Publication

Ad # 0005406293

This is not an invoice

NM ENVIRONMENTAL DEP T./AIR QUALITY
525 CAMINO DE LOS MARQUEZ # 1

SANTA FE, NM 87505-1816

I, being duly sworn, on my oath say that I am the Legal Coordinator of the **Ruidoso News**, a newspaper of twice weekly circulation. The paper is published in the English language at the town of Ruidoso, Lincoln County, State of New Mexico, and that there is no daily paper published, in the said county, nor was there on the dates herein mentioned. Ruidoso News has been regularly published and issued for more than nine months prior to the date of the first publication hereinafter mentioned.

09/14/2022

Legal Clerk

Subscribed and sworn before me this September 21, 2022:

Kathleen Allen

State of WI, County of Brown
NOTARY PUBLIC

1-7-25

My commission expires

KATHLEEN ALLEN
Notary Public
State of Wisconsin

Ad # 0005406293
PO #: 38844
# of Affidavits: 1

This is not an invoice

NMED EIB EXHIBIT 5

JUNTA DE MEJORA AMBIENTAL DE NUEVO MÉXICO
AVISO DE AUDIENCIA PÚBLICA
EIB 22-34
EN EL ASUNTO DE LA PETICIÓN DE AUDIENCIA SOBRE EL PERMISO DE CALIDAD DE AIRE NÚM. 9295, ROPER CONSTRUCTION INC.'S ALTO CONCRETE BATCH PLANT

La Junta de Mejora Ambiental de Nuevo México ("Junta") celebrará una audiencia pública que comenzará a las 9:00 a. m., MDT (hora de verano de la montaña), el 18 de octubre de 2022 y continuará en días consecutivos, según sea necesario. La audiencia es de forma híbrida, donde las personas pueden participar virtualmente a través de la aplicación web WebEx o en persona en el Auditorio Larrazolo en el edificio Harold Runnels en 1190 S. St. Francis Drive, Santa Fe, NM 87502. A la hora de la audiencia, si existen restricciones establecidas por las órdenes ejecutivas de la gobernadora o varias órdenes de salud pública de emergencia diseñadas para proteger al público y prevenir la propagación de COVID-19, esas restricciones se aplicarán en el lugar en persona. Todos aquellos interesados en asistir virtualmente o en persona deben comunicarse con la administradora de la Junta o visitar el Calendario de eventos de NMED en **www.env.nm.gov/events-calendar/** . Vaya a la fecha de inicio de la audiencia y haga clic en la entrada sobre esta audiencia para obtener instrucciones sobre cómo participar. El propósito de la audiencia es considerar la siguiente petición de apelación presentada por Roper Construction Inc.

Los peticionarios impugnan la denegación del Permiso de Calidad del Aire Núm. 9295. El Departamento de Medio Ambiente de Nuevo México ("Departamento") denegó el Permiso de Calidad del Aire Núm. 9295 basándose en el informe de los funcionarios de audiencias y la orden final por escrito de las subsecretarias. Los peticionarios sostienen que la decisión del Departamento no siguió el protocolo para la emisión de permisos y que la solicitud del permiso y la información que contiene cumplieron con todos los reglamentos y la política y el procedimiento del Departamento para la emisión del permiso.

Las Peticiones y los documentos relacionados se pueden ver en la página web de asuntos registrados del Departamento en **www.env.nm.gov/opf/docketed-matters/.** Busque en el menú desplegable de la Junta de Mejora Ambiental (EIB, por sus siglas en inglés) el EIB 22-34: El Asunto de la Petición de Audiencia sobre el Permiso de Calidad del Aire Núm. 9295, Roper Construction Inc.'s Alto Concrete Batch Plant.

La audiencia se llevará a cabo de acuerdo con los Procedimientos de adjudicación de la Junta (20.1.2 NMAC); la Ley de Control de Calidad del Aire de Nuevo México, NMSA 1978, Secciones 74-2-1 a -22; la Ley de Normas Estatales, NMSA 1978, Sección 14-4-5.3; y otros procedimientos aplicables.

Todas las personas interesadas tendrán una oportunidad razonable en la audiencia para presentar pruebas, datos, puntos de vista y argumentos pertinentes, de forma oral y por escrito; presentar pruebas instrumentales; y para interrogar a los testigos. Cualquier persona que desee presentar una declaración escrita no técnica para el registro en lugar de un testimonio oral debe presentar dicha declaración antes del cierre de la audiencia.

TESTIMONIO TÉCNICO

Cualquier persona que desee presentar pruebas técnicas en la audiencia deberá presentar una declaración de intención a más tardar hasta el 21 de septiembre de 2022. La declaración de intención de presentar pruebas técnicas deberá incluir: (i) el nombre de la persona que presenta la declaración; (ii) una indicación de si la persona que presenta la declaración apoya o se opone a la petición en cuestión; (iii) el nombre de cada testigo; (iv) una estimación de la duración del testimonio directo de cada testigo; (v) una lista de las pruebas pertinentes, si las hubiere, que se ofrecerán como evidencia en la audiencia; y (vi) un resumen o descripción del testimonio directo anticipado de cada testigo.

REGISTRO DE COMPARECENCIA

Cualquier persona que desee ser tratada como un participante interesado e interrogar a los testigos en la audiencia deberá presentar y notificar a todas las partes una declaración de comparecencia a más tardar hasta el 21 de septiembre de 2022. Una declaración de intención oportuna se considerará un registro de comparecencia. El registro de comparecencia debe identificar a la persona que desea ser tratada como participante interesado y cualquier individuo que pueda comparecer en nombre de esa persona.

Utilice el Portal de comentarios públicos para enviar todos los testimonios y comentarios no técnicos, incluidos: pertinentes pruebas, datos, puntos de vista, argumentos, declaraciones por escrito en lugar de testimonios orales en la audiencia o comentarios públicos. Acceda al Portal de comentarios públicos a través del enlace en la página web de asuntos registrados del Departamento **www.env.nm.gov/opf/docketed-matters/.** Busque en el menú desplegable de la Junta de Mejora Ambiental (EIB, por sus siglas en inglés) el EIB 22-34: El Asunto de la Petición de Audiencia sobre el Permiso de Calidad del Aire Núm. 9295, Roper Construction

NMED EIB EXHIBIT 5

Permiso de Calidad del Aire Núm. 9295, Roper Construction Inc.'s Alto Concrete Batch Plant. (El enlace directo al Portal de comentarios públicos es **http://nmed.commentinput.com/comment/search).** Alternativamente, se pueden enviar por correo electrónico testimonios o comentarios no técnicos a **Pamela.Jones@state.nm.us** . Los comentarios orales del público se aceptarán el 18 de octubre de 2022, aproximadamente a las 12:00 p.m. y a las 5:00 p.m., y en los días posteriores (según sea necesario) aproximadamente a las 9:00 a.m. Los comentarios públicos están limitados a cinco (5) minutos por persona.

Si alguna persona requiere asistencia, un intérprete que no sea de español o un dispositivo auxiliar para participar en este proceso, comuníquese con la administradora de la Junta a más tardar el 3 de octubre de 2022, en 1190 St. Francis Drive, P.O. Box 5469, Santa Fe, NM 87502, teléfono (505) 660-4305, o correo electrónico **Pamela.Jones@state.nm.us** (los usuarios de TDD o TTY, pueden acceder al número a través de New Mexico Relay Network, 1-800-659- 1779 (voz); usuarios de TTY: 1-800-659-8331).

Aviso de no discriminación

El NMED no discrimina por motivos de raza, color, nacionalidad, discapacidad, edad o sexo en la administración de sus programas o actividades, como lo exigen las leyes y reglamentos aplicables. El NMED es responsable de la coordinación de los esfuerzos de cumplimiento y la recepción de las consultas relativas a los requisitos de no discriminación implementados por 40 C.F.R. Partes 5 y 7, incluyendo el Título VI de la Ley de Derechos Civiles de 1964, con sus enmiendas; la Sección 504 de la Ley de Rehabilitación de 1973; la Ley de Discriminación por Edad de 1975, el Título IX de las Enmiendas de Educación de 1972, y la Sección 13 de las Enmiendas de la Ley Federal de Control de Contaminación del Agua de 1972. Si tiene alguna pregunta sobre este aviso o cualquiera de los programas, políticas o procedimientos de no discriminación del NMED, o si cree que ha sido discriminado con respecto a un programa o actividad del NMED, puede ponerse en contacto con: Kathryn Becker, coordinadora de no discriminación, NMED, 1190 St. Francis Dr., Suite N4050, P.O. Box 5469, Santa Fe, NM 87502, (505) 827-2855, **nd.coordinator@state.nm.us** . También puede visitar nuestro sitio web en **https://www.env.nm.gov/non-employee-discrimination-complaint-page/** para saber cómo y dónde presentar una queja por discriminación.

#0005406293, Ruidoso News, September 14, 2022

NMED EIB EXHIBIT 5

AFFIDAVIT OF PUBLICATION

STATE OF NEW MEXICO

County of Bernalillo SS

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OBREELPERMISODEC
ALIDADDEAIRENUM

David Montoya, the undersigned, authorized Representative of the Albuquerque Journal, on oath states that this newspaper is duly qualified to publish legal notices or advertisements within the meaning of Section 3, Chapter 167, Session Laws of 1937, that payment therefore has been made of assessed as court cost; and that the notice, copy of which is hereto attached, was published in said paper in the regular daily edition, for 1 time(s) on the following date(s):

09/10/2022

David Montoya

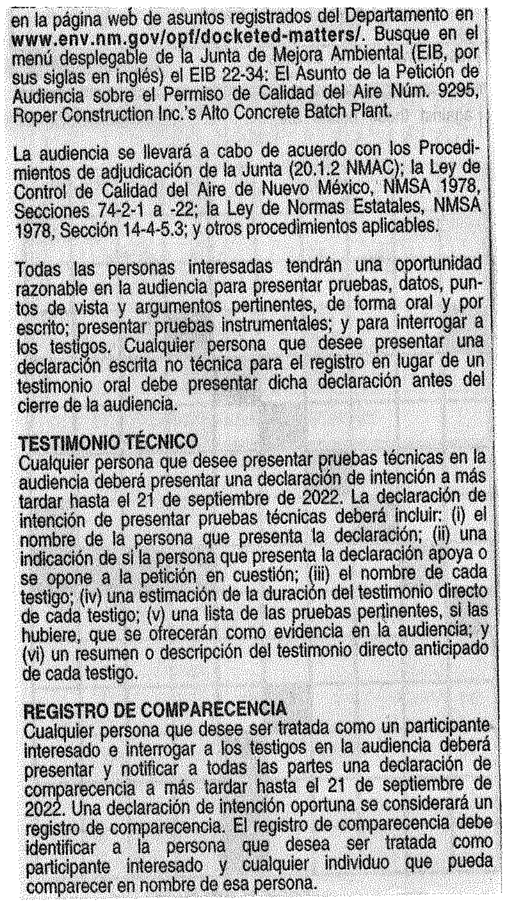
CHRISTINA MARIE WHITE
Notary Public - State of New Mexico
Commission # 1122050
My Comm. Expires Jul 26, 2026

Sworn and subscribed before me, a Notary Public, in and for the County of Bernalillo and State of New Mexico this 12 day of September of 2022

PRICE $503.88

Statement to come at the end of month.

ACCOUNT NUMBER 1089544



en la página web de asuntos registrados del Departamento en **www.env.nm.gov/opf/docketed-matters/**. Busque en el menú desplegable de la Junta de Mejora Ambiental (EIB, por sus siglas en inglés) el EIB 22-34: El Asunto de la Petición de Audiencia sobre el Permiso de Calidad del Aire Núm. 9295, Roper Construction Inc.'s Alto Concrete Batch Plant.

La audiencia se llevará a cabo de acuerdo con los Procedimientos de adjudicación de la Junta (20.1.2 NMAC); la Ley de Control de Calidad del Aire de Nuevo México, NMSA 1978, Secciones 74-2-1 a -22; la Ley de Normas Estatales, NMSA 1978, Sección 14-4-5.3; y otros procedimientos aplicables.

Todas las personas interesadas tendrán una oportunidad razonable en la audiencia para presentar pruebas, datos, puntos de vista y argumentos pertinentes, de forma oral y por escrito; presentar pruebas instrumentales; y para interrogar a los testigos. Cualquier persona que desee presentar una declaración escrita no técnica para el registro en lugar de un testimonio oral debe presentar dicha declaración antes del cierre de la audiencia.

TESTIMONIO TÉCNICO
Cualquier persona que desee presentar pruebas técnicas en la audiencia deberá presentar una declaración de intención a más tardar hasta el 21 de septiembre de 2022. La declaración de intención de presentar pruebas técnicas deberá incluir: (i) el nombre de la persona que presenta la declaración; (ii) una indicación de si la persona que presenta la declaración apoya o se opone a la petición en cuestión; (iii) el nombre de cada testigo; (iv) una estimación de la duración del testimonio directo de cada testigo; (v) una lista de las pruebas pertinentes, si las hubiere, que se ofrecerán como evidencia en la audiencia; y (vi) un resumen o descripción del testimonio directo anticipado de cada testigo.

REGISTRO DE COMPARECENCIA
Cualquier persona que desee ser tratada como un participante interesado e interrogar a los testigos en la audiencia deberá presentar y notificar a todas las partes una declaración de comparecencia a más tardar hasta el 21 de septiembre de 2022. Una declaración de intención oportuna se considerará un registro de comparecencia. El registro de comparecencia debe identificar a la persona que desea ser tratada como participante interesado y cualquier individuo que pueda comparecer en nombre de esa persona.

NMED EIB EXHIBIT 6

AFFIDAVIT OF PUBLICATION

STATE OF NEW MEXICO

County of Bernalillo SS

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David Montoya, the undersigned, authorized Representative of the Albuquerque Journal, on oath states that this newspaper is duly qualified to publish legal notices or advertisements within the meaning of Section 3, Chapter 167, Session Laws of 1937, that payment therefore has been made of assessed as court cost; and that the notice, copy of which is hereto attached, was published in said paper in the regular daily edition, for 1 time(s) on the following date(s):

09/10/2022

David Montoya

Sworn and subscribed before me, a Notary Public, in and for the County of Bernalillo and State of New Mexico this 12 day of September of 2022

CHRISTINA MARIE WHITE
Notary Public - State of New Mexico
Commission # 1122050
My Comm. Expires Jul 26, 2026

PRICE $448.41

Statement to come at the end of month.

ACCOUNT NUMBER 1089544

op/docketed-matters/. Look under the Environmental Improvement Board (EIB) dropdown, for EIB 22-34: In The Matter of the Petition for Hearing on Air Quality Permit No. 9295, Roper Construction Inc.'s Alto Concrete Batch Plant.

The Hearing will be conducted in accordance with the Board's Adjudicatory Procedures (20.1.2 NMAC); the New Mexico Air Quality Control Act, NMSA 1978, Sections 74-2-1 through -22; the State Rules Act, NMSA 1978, Section 14-4-5.3; and other applicable procedures.

All interested persons will be given a reasonable opportunity at the hearing to submit relevant evidence, data, views, and arguments, orally and in writing; to introduce exhibits; and to examine witnesses. Any person wishing to submit a non-technical written statement for the record in lieu of oral testimony must file such statement prior to the close of the hearing.

TECHNICAL TESTIMONY
Any person who wishes to present technical evidence at the hearing shall file a statement of intent by September 21, 2022. The statement of intent to present technical evidence shall include: (i) the name of the person filing the statement; (ii) an indication of whether the person filing the statement supports or opposes the petition at issue; (iii) the name of each witness; (iv) an estimate of the length of the direct testimony of each witness; (v) a list of exhibits, if any, to be offered into evidence at the hearing; and (vi) a summary or outline of the anticipated direct testimony of each witness.

ENTRY OF APPEARANCE
Any person who wishes to be treated as an interested participant and to cross-examine witnesses at the hearing shall file and serve upon all parties an entry of appearance on or before September 21, 2022. A timely statement of intent shall be considered an entry of appearance. The entry of appearance must identify the person wishing to be treated as an interested participant and any individual who may appear on behalf of that person.

NMED EIB EXHIBIT 6

EIB 22-34 : In The Matter of the Petition for Hearing on Air Quality Permit No. 9295, Roper Construction Inc.'s Alto Concrete Batch Plant

Hearing Transcript	02/09/2022
Notice of Transcript Filing	02/21/2022
Applicant Roper Construction Inc.'s Petition for Hearing Before the Board	07/22/2022
Sonterra's Unopposed Motion to Vacate Hearing set for September and re-set for October	08/08/2022
Order of Hearing Determination and Appointment of Hearing Officer	08/15/2022
Alto CEP Entry of Appearance	08/22/2022
Answer of Alto Coalition for Environmental Preservation to Roper's Petition for Hearing	08/22/2022
NMED Answer to Petition	08/22/2022
NMED Entry of Appearance	08/23/2022
Hearing Officer's Order on Motion to Vacate	08/24/2022
Notice of Pre-Hearing Conference	08/24/2022
Notice of Filing List of Persons Expressing Interest	08/31/2022
Hearing Officer's Scheduling and Procedural Order	09/02/2022
Administrative Record Index Pursuant to 20.2.72.207 (D) NMAC	09/02/2022
Administrative Record Bates 0001-0125	
Administrative Record Bates 0126-0375	
Administrative Record Bates 0376-0750	
Administrative Record Bates 0751-1000	
Administrative Record Bates 1001-1250	
Administrative Record Bates 1251-1375	
Administrative Record Bates 1376-1500	
Administrative Record Bates 1501-1625	
Administrative Record Bates 1626-1875	
Administrative Record Bates 1876-2000	
Administrative Record Bates 2001-2125	
Administrative Record Bates 2126-2250	
Administrative Record Bates 2251-2325	
Administrative Record Bates 2326-2375	
Administrative Record Bates 2376-2625	
Administrative Record Bates 2626-3000	
Administrative Record Bates 3001-3500	
Administrative Record Bates 3501-3978	
Administrative Record Bates 3979-3980	
Public Notice – English	
Public Notice – Spanish	
Submit Comments Here	

NMED EIB EXHIBIT 7

From: Romero, Rhonda, ENV
To: Romero, Rhonda, ENV
Bcc: 111margaret@att.net; akbiz133@gmail.com; albertwight207@gmail.com; ambermwalker15@gmail.com; anthonystevens397@gmail.com; antilla.nancy@yahoo.com; archboss@flash.net; asg5456@gmail.com; astout1251@yahoo.com; barbarayount@sbcglobal.net; bjohn731@att.net; bksmart10@gmail.com; bljlreed@yahoo.com; bluejay41@sbcglobal.net; bluespruce.th@gmail.com; boeingguy2@yahoo.com; bowen@dfn.com; brdavis138@yahoo.com; brenda@ruihomes.com; brendarospa@gmail.com; brittneym@netscape.com; bsmart10@hotmail.com; btamminga@austin.rr.com; dtamminga@austin.rr.com; bventura@lincolncountynm.org; bwatson50@rocketmail.com; carol.kingsly@msn.com; carolruthwade@gmail.com; cegordon5@gmail.com; ceikle@live.com; chefwolf1@icloud.com; cherrywoodacademy@gmail.com; chollenb2@charter.net; christina.thompson@usda.gov; cjgot60@yahoo.com; Clong0401@gmail.com; cmoegle@aol.com; cpafirm_8@hotmail.com; crafterdeb@gmail.com; cs_beale@yahoo.com; cwcathey47@gmail.com; daleantilla@windstream.net; dallan575@gmail.com; darrell@ruihomes.com; dcombs.combs8@gmail.com; patsycombs4@gmail.com; debi_wilcox@yahoo.com; decker.alexism@gmail.com; delmonte108@hotmail.com; delvinjones25@gmail.com; desdmona@brickbarn.com; desdmona@brickbarn.com; det@brickbarn.com; diorly_s@yahoo.com; djhigdon@ruihomes.com; djmiehls@gmail.com; dkv37@yahoo.com; donna25r@gmail.com; donnierw76@gmail.com; dpe1903@gmail.com; dpry@comcast.net; dunanalto151@gmail.com; EarlDWebb@yahoo.com; elsonteam@yahoo.com; Empson52@yahoo.com; evlanelli@yahoo.com; falcon.debra@gmail.com; fleharty@valornet.com; flindahl@att.net; gahenry@windstream.net; garymackay60@gmail.com; Nuknee1112@gmail.com; gcf88345@gmail.com; gfc88345@gmail.com; gheathington@gmail.com; glynna@moutonlaw.com; grammylady55@yahoo.com; gsull@utep.edu; harvey@usa.net; hclandscapesco@gmail.com; heartwood@ymail.com; helms_donna@hotmail.com; hightowerellen@yahoo.com; james.lucero77@yahoo.com; jameswaylonc@gmail.com; janisloverin@hotmail.com; jasisom@yahoo.com; jctajohnson@gmail.com; jeannine.isom@yahoo.com; jenfinstad@gmail.com; jensen.julie06@gmail.com; jensen.julie06@gmail.com; jethroruthrauff@yahoo.com; jewelkid@earthlink.net; jlholden2011@gmail.com; jni02@yahoo.com; jobull98@yahoo.com; jpmccain@windstream.net; judgeclchapman@yahoo.com; katlewis.3@gmail.com; kbottari@att.net; kimkuhar@yahoo.com; kraftyblue1959@att.net; kschut@sbcglobal.net; ktbmx48@hotmail.com; kyrasweep@me.com; laura.mccabe7@gmail.com; lbfhome@comcast.net; lcatalano1@yahoo.com; lebudd@hotmail.com; letha@thebarnes.net; liamgrif@gmail.com; lidavis@peoplepc.com; lindaschreiber869@gmail.com; littlecreek51@gmail.com; liz@ruihomes.com; lorilytlecoleman@gmail.com; lorri@scottnorthamcpa.com; lou.goode@yahoo.com; lou.goode@yahoo.com; amygoode1@yahoo.com; lowrysandra2020@gmail.com; lrgreen81@yahoo.com; lromano56@gmail.com; maggiehornsby@windstream.net; mandctrout@yahoo.com; mandotrowt@yahoo.com; mark.wilson09@ey.com; mary@ruihomes.com; miaowens@hotmail.com; mikelbrown@att.net; mildic@windstream.net; mr.tilty@att.net; mstambaugh42@gmail.com; mwade56@yahoo.com; mydelgado70@hotmail.com; ncbgthall@gmail.com; nesbittcj69@gmail.com; paplus259@hotmail.com; pappyb@earthlink.net; pattipark@sbcglobal.net; paul.herman7@gmail.com; pillpgh@windstream.net; plviolette@yahoo.com; r.lane95@yahoo.com; ramfille@gmail.com; revance58@gmail.com; rexcin@icloud.com; rick-preston@msn.com; robingilton@readbetternow.org; rockriver223@hotmail.com; roxannrich1953@gmail.com; ruidosoflowershop@yahoo.com; sabeer@windstream.net; sassfrankcoe@live.com; SDBQ@protonmail.com; shenstewcat@gmail.com; shep777@gmail.com; shogara3@aol.com; skinnerj@windstream.net; smathis2009@gmail.com; soareagles46@yahoo.com; soesws@yahoo.com; sogoldice@yahoo.com; stephen.rath@gmail.com; SueCatterton@yahoo.com; susan.frederickson@gmail.com; susan.frederickson@gmail.com; susandimotta@aol.com; susannajade@valornet.com; suzysanto@gmail.com; tedsmith8883@gmail.com; tfhansen88220@gmail.com; THnasko@hinklelawfirm.com; thomas.j.owen.iii@gmail.com; tkelson@outlook.com; tomandry@aol.com; trains@mindspring.com; travelingzesty@gmail.com; trinitransfer@hotmail.com; trustservices125@gmail.com; unicornneuf@yahoo.com; vocalev@gmail.com; wagnerstephanie003@gmail.com; wbillhorton@yahoo.com; weaselprods@yahoo.com; willbhorton@yahoo.com; yankeedizzy@yahoo.com; zach@zachcook.com; zachryfamily@gmail.com
Subject: Notice of Hearing: October 18, 2022, EIB 22-34 Appeal Petition - Permit No. 9295 Roper Construction Inc.
Date: Friday, September 9, 2022 4:55:00 PM
Attachments: Letterhead Notice Spanish (002).pdf
Letterhead Notice English (002).pdf

Good afternoon.

The New Mexico Environmental Improvement Board will hold a public hearing beginning at 9:00 a.m. MST on October 18, 2022 and continuing on consecutive days as needed via the web application WebEx. The purpose of the hearing is to consider the following appeal petition filed by Roper Construction Inc (Petitioner). The Petitioner challenges the denial for Air Quality Permit No. 9295. The New Mexico Environment Department ("Department") denied the Air Quality Permit No. 9295 based on the hearing officers report and the Deputy Secretaries written, final order. Petitioners contend the Department's decision did not follow protocol for permit issuance and that the permit application and information therein met all regulations and Department policy and procedure for a permit to be issued .

NMED EIB EXHIBIT 8

Attached are Notices of Hearing, one in English and one in Spanish. Please read these to find information about thein EIB 22-34 hearing and steps for public participation.

These Notices of Hearing, along with other information are available for your review on the New Mexico Environment Department's Docketed Matters website under the Environmental Improvement Board dropdown, in the section for EIB 22-34 Appeal Petition – Roper Construction Inc., Permit No. 9295, Alto Concrete Batch Plant. The Department's docketed matters website is at https://www.env.nm.gov/opf/docketed-matters/.

Please let me know if you have any questions. If you have procedural hearing questions email Pamela Jones at Pamela.Jones@state.nm.us.

Thank you,

Rhonda V. Romero
Minor Source Section Manager
New Mexico Environment Department
Air Quality Bureau
525 Camino de los Marquez Suite 1
Santa Fe, NM 87505
Cell (505) 629-3934
Email: Rhonda.romero@state.nm.us
www.env.nm.gov

"Innovation| Science | Collaboration |Compliance"

From:	Romero, Rhonda, ENV
To:	r6airpermits@epa.gov
Cc:	Layton, Elizabeth; LeDoux, Erica
Subject:	Notice of Hearing: October 18, 2022, EIB 22-34 Appeal Petition - Permit No. 9295 Roper Construction Inc.
Date:	Friday, September 9, 2022 4:55:00 PM
Attachments:	Letterhead Notice Spanish (002).pdf Letterhead Notice English (002).pdf

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Good afternoon.

The New Mexico Environmental Improvement Board will hold a public hearing beginning at 9:00 a.m. MST on October 18, 2022 and continuing on consecutive days as needed via the web application WebEx. The purpose of the hearing is to consider the following appeal petition filed by Roper Construction Inc (Petitioner). The Petitioner challenges the denial for Air Quality Permit No. 9295. The New Mexico Environment Department ("Department") denied the Air Quality Permit No. 9295 based on the hearing officers report and the Deputy Secretaries written, final order. Petitioners contend the Department's decision did not follow protocol for permit issuance and that the permit application and information therein met all regulations and Department policy and procedure for a permit to be issued .

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Please let me know if you have any questions. If you have procedural hearing questions email Pamela Jones at Pamela.Jones@state.nm.us.

Thank you,

Rhonda V. Romero
Minor Source Section Manager
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Air Quality Bureau
525 Camino de los Marquez Suite 1
Santa Fe, NM 87505
Cell (505) 629-3934
Email: Rhonda.romero@state.nm.us
www.env.nm.gov

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NMED EIB EXHIBIT 8

From: Romero, Rhonda, ENV
To: gaguilar@mescaleroapachetribe.com; thora@mescalerodrmp.org
Subject: Notice of Hearing: October 18, 2022, EIB 22-34 Appeal Petition - Permit No. 9295 Roper Construction Inc.
Date: Friday, September 9, 2022 4:55:00 PM
Attachments: Letterhead Notice Spanish (002).pdf
Letterhead Notice English (002).pdf

To: To whom it may concern, Mescalero Apache Tribe

Good afternoon.

The New Mexico Environmental Improvement Board will hold a public hearing beginning at 9:00 a.m. MST on October 18, 2022 and continuing on consecutive days as needed via the web application WebEx. The purpose of the hearing is to consider the following appeal petition filed by Roper Construction Inc (Petitioner). The Petitioner challenges the denial for Air Quality Permit No. 9295. The New Mexico Environment Department ("Department") denied the Air Quality Permit No. 9295 based on the hearing officers report and the Deputy Secretaries written, final order. Petitioners contend the Department's decision did not follow protocol for permit issuance and that the permit application and information therein met all regulations and Department policy and procedure for a permit to be issued .

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Thank you,

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NMED EIB EXHIBIT 8

From:	Romero, Rhonda, ENV
To:	agiron@ruidosodowns.us
Subject:	Notice of Hearing: October 18, 2022, EIB 22-34 Appeal Petition - Permit No. 9295 Roper Construction Inc.
Date:	Friday, September 9, 2022 4:55:00 PM
Attachments:	Letterhead Notice Spanish (002).pdf Letterhead Notice English (002).pdf

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Thank you,

Rhonda V. Romero
Minor Source Section Manager
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Air Quality Bureau
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NMED EIB EXHIBIT 8

From: Romero, Rhonda, ENV
To: "clerk@ruidoso-nm.gov"
Subject: Notice of Hearing: October 18, 2022, EIB 22-34 Appeal Petition - Permit No. 9295 Roper Construction Inc.
Date: Friday, September 9, 2022 4:55:00 PM
Attachments: Letterhead Notice Spanish (002).pdf
Letterhead Notice English (002).pdf

To: Village Clerk, Village of Ruidoso

Good afternoon.

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NMED EIB EXHIBIT 8

From:	Romero, Rhonda, ENV
To:	Capitan, Village of
Subject:	Notice of Hearing: October 18, 2022, EIB 22-34 Appeal Petition - Permit No. 9295 Roper Construction Inc.
Date:	Friday, September 9, 2022 4:55:00 PM
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Minor Source Section Manager
New Mexico Environment Department
Air Quality Bureau
525 Camino de los Marquez Suite 1
Santa Fe, NM 87505
Cell (505) 629-3934
Email: Rhonda.romero@state.nm.us
www.env.nm.gov

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NMED EIB EXHIBIT 8

From:	Romero, Rhonda, ENV
To:	christina.thompson@usda.gov; andres.bolanos@usda.gov; Camille.Howes@usda.gov; travis.moseley@usda.gov
Subject:	Notice of Hearing: October 18, 2022, EIB 22-34 Appeal Petition - Permit No. 9295 Roper Construction Inc.
Date:	Friday, September 9, 2022 4:54:00 PM
Attachments:	Letterhead Notice Spanish (002).pdf Letterhead Notice English (002).pdf

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Cell (505) 629-3934
Email: Rhonda.romero@state.nm.us
www.env.nm.gov

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NMED EIB EXHIBIT 8

From: Romero, Rhonda, ENV
To: Whittaker, Whitney
Subject: Notice of Hearing: October 18, 2022, EIB 22-34 Appeal Petition - Permit No. 9295 Roper Construction Inc.
Date: Friday, September 9, 2022 4:55:00 PM
Attachments: Letterhead Notice Spanish (002).pdf
Letterhead Notice English (002).pdf

To: County Clerk, Lincoln County

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Cell (505) 629-3934
Email: Rhonda.romero@state.nm.us
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NMED EIB EXHIBIT 8

From:	Romero, Rhonda, ENV
To:	NMENV-AQB.A.Team
Cc:	Sobehrad, Kirsten, ENV; Romero, Dawn, ENV; Kathleen NMENV Primm (Kathleen.Primm@state.nm.us)
Subject:	Mailout Request: Roper Construction Inc., Permit No. 9295
Date:	Wednesday, September 7, 2022 3:10:00 PM
Attachments:	List of Addresses.xlsx Address Labels 3 of 3.docx Address Labels 1 of 3.docx Address Labels 2 of 3.docx Copy of Work Distribution Form (WDF-FY23) 07.14.2022 PN Citizen mailout.xlsx Letterhead Notice Spanish (002).pdf Letterhead Notice English (002).pdf

---

Good afternoon A-Team,

I've got a large mailout request. Please arrange to mail out these notices to the attached citizen list. I attached the address labels that you already created for ease of access. Let me know if you need help putting these together. I can ask a few of my staff to help.

Thank you,

Rhonda V. Romero
Minor Source Section Manager
New Mexico Environment Department
Air Quality Bureau
525 Camino de los Marquez Suite 1
Santa Fe, NM 87505
Cell (505) 629-3934
Email: Rhonda.romero@state.nm.us
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Welton M. Allen
108 Paseo De Aguayo
Alto, NM 88312

Carol Anderson
PO Box 76
Alto, NM 88312

Alice Aparis
130 Whisper Ct
Alto, NM 88312

David and Diane Ballard
126 San Mateo Drive
Alto, NM 88312

Mary Bancroft
and Richard Murphy
110 Cottage Grove Lane
Alto, NM 88312-9604

Lynn Beckworth
137 Pecos Court
Alto, NM 88312

Lorenzo Bellocchio
3332 Florida Street
Hollywood, FL 33021-8314

Libby and Daniel Berry
TV Ranch Land LLP
PO Box 160
Eunice, NM 88231

Bruce Boshard
159 Las Estrelas
Alto, NM 88312

Bruce Boshard
PO Box 2431
Alto, NM 88312

Debra Motto Boshard
PO Box 2431
Alto, NM 88312

Debra Motto Boshard
Ranches of Sonterra
Lot 329 & 330
Alto, NM 88312

David A. Bromley
129 San Mateo Dr
Alto, NM 88312

Scott Buehler
2585 Winding Ridge Trail NE
Rockford, MI 49341

Bob and Joann Bullard
286 State Highway 220
Alto, NM 88312

Jeri Bundy
916 Cedar St
Alexandria, MN 56308

Roy Butler
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Alto, NM 88312

Roy Butler
4105 Prince Andrew Lane
Austin, TX 78730

Frank Canella
124 Blazing Star Trail
Alto, NM 88345

Margaret Canella
124 Blazing Star Trail
Alto, NM 88345

Margaret T. Cannella
125 Blazing Star Trail
Alto, NM 88345

Frank Cannella
126 Blazing Star Trail
Alto, NM 88345

Lou Celusniak
225 Sonterra Drive
Alto, NM 88312

David A. Crawford Jr.
314 Santiago Circle
Alto, NM 88312

David A. Crawford Jr.
1703 Sudderth Drive #483
Ruidoso, NM 88345

Sandra Lewis Davis, DC and
Bill Querin, ND
147 Hidden Valley Road
Alto, NM 88312

Jimmy and Nancy Freeman
PO Box 567
Edgewater, FL 32132

Lisa French
PO Box 4321
Ruidoso, NM 88355

JoAnn Givens
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Alto, NM 88312

Sharon G. Grant-Foster
PO Box 2418
Alto, NM 88312

NMED EIB EXHIBIT 9

Jack and Seliece Gray
118 Santiago Circle
Alto, NM 88312

Gregg and Levonne Griffin
132 Mescalero Trail
Ruidoso, NM 88345

Levonne Griffin
132 Mescalero Trail
Ruidoso, NM 88345

Gregg Griffin
132 Mescalero Trail
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Dr. William H. Hale
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Ray and Donna Harvey
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McLoud, OK 74851

Ann Henry
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Rex and Cindy Hill
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Alto, NM 88312

Susan Jones
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Alto, NM 88312

Susan Jones
111 La Cueva Ct
Alto, NM 88312

Judy Justus
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Alto, NM 88312

Kavan P. King
244 Airport Rd
Alto, NM 88312

K'Aun Kingsley
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Alto, NM 88312

Larry Kingsley
122 Legacy Lane
Alto, NM 88312

Bob Koehler
Alto North Water Cooperative
PO Box 373
Alto, NM 88312

Larry and Teri Lacy
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Dripping Springs, TX 78620

Doyle and Vicki Lovell
105 Coyote Mesa Trail
Alto, NM 88312

Lawrence and Clare Mather
PO Box 1432
Alto, NM 88312

Lawrence and Clare Mather
130 Winterhawk Hts.
Alto, NM 88312

Phillip and Tammy Mattingly
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Alto, NM 88312

James McKellar
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Alto, NM 88312

Laura Bartlett McPhaul
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Richard and Leticia Mooney
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Robert S. Moroney
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Print W. Mundy
Crown Real Estate
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Erick Nelson
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John A. Novosad
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Alto, NM 88312

Bill B. Owen
135 Santiago Circle
Alto, NM 88312

Melee Panol
7425 E Champion Circle
Wichita, KS 67226

Melee Panol
114 Conida De Rio
Alto, NM 88312

NMED EIB EXHIBIT 9

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Patricia B. Park
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Martha Parks
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Alto, NM 88312

Lisa Perkowski
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Alto, NM 88312

Randall Pierce
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Alto, NM 88312

Nina Poanessa
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Robert Priest
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Steven Rogers
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Alto, NM 88312

Larry Sallee
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Alto, NM 88312

Gary and Janice Sawyer
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Alto, NM 88312

Alan and Linda Schalk
28 Camino Valle Verde
Alamogordo, NM 88310

Larry and Joyce Scripter
PO Box 366
Belen, NM 87002

Bob and Carolyn Siffermann
1309 Northridge Drive
Southlake, TX 76092

James and Margaret Skelton
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Alto, NM 88312

Laura and George Smearman
4053 N Wilmot Rd
Tucson, AZ 85750

John T. and
Sue Harkness Soden
1086 State Highway 48
Alto, NM 88312

Sharon Stewart
113 Sugar Bush
Alto, NM 88312

Lauren Swangstu
113 Grindstone Canyon Rd
Ruidoso, NM 88345

John and Jane Terrell
353 Sudderth Drive
Ruidoso, NM 88345

John and Jane Terrell
354 Sudderth Drive
Ruidoso, NM 88345

Tom and Pam Thornton
1141 Twin Lakes Lane
San Angelo, TX 76904

Tom and Pam Thornton
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Alto, NM 88312

Cindy and Mark Tibbs
163 Sonterra Drive
Alto, NM 88312

Ron and Diane Travis
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Alto, NM 88312

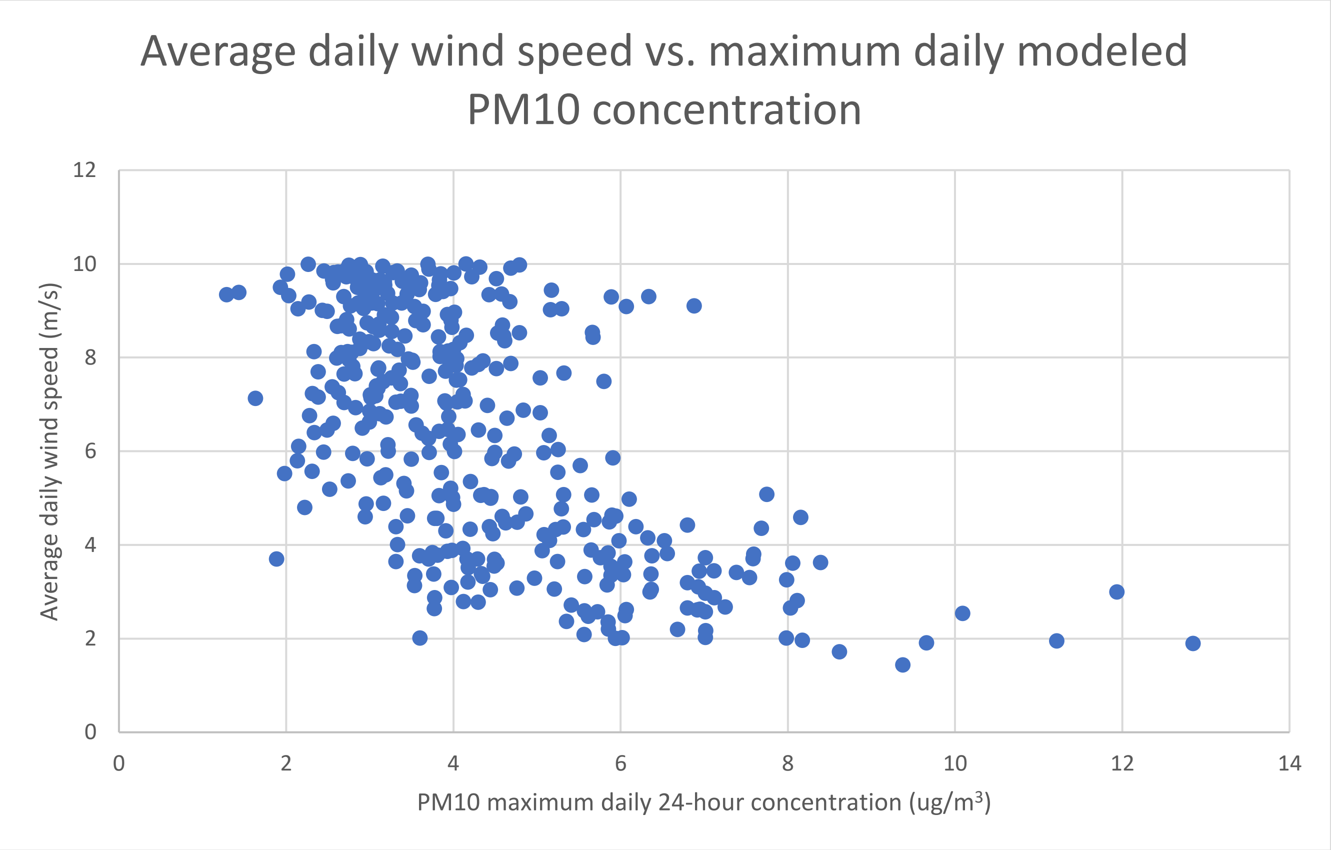
Ron and Diane Travis
PO Box 1191
Alto, NM 88312

Robert and Barbara Watson
3905 Futura Dr
Roswell, NM 88201-6797

Robert and
Margaret Whittemore
133 Pecos Ct
Alto, NM 88312

Floyd
187 Linda Vista Lane
Alto, NM 88312

The following graph provides an example that illustrates the relationship between wind speed and predicted model concentration. This graph is based on the 2020 Sierra Blanca Regional Airport meteorology and the PM10 modeling for Roper Construction Inc.'s Alto Concrete Batch Plant, permit number 9295. Receptors on the fence line were used. The average wind speed for each day was calculated and matched in time with the maximum concentration at any receptor on that day.



Graph produced by Eric Peters

NMED EIB EXHIBIT 10

MICHELLE LUJAN GRISHAM
GOVERNOR

JAMES C. KENNEY
CABINET SECRETARY

AIR QUALITY BUREAU
NEW SOURCE REVIEW PERMIT
Issued under 20.2.72 NMAC

Sent by Certified Mail
Return Receipt Requested

NSR Permit No:	9295
Facility Name:	Alto Concrete Batch Plant
Facility Owner/Operator:	Roper Construction, Inc.
Mailing Address:	P.O. Box 969 Alto, New Mexico 88312
TEMPO/IDEA ID No:	40076-PRN20210001
AIRS No:	35-027-0299
Permitting Action:	Regular New
Source Classification:	Synthetic Minor
Facility Location:	438,240 m E by 3,697,950 m N, Zone 13; Datum NAD83
County:	Lincoln County
Air Quality Bureau Contact	Deepika Saikrishnan
Main AQB Phone No.	(505) 476-4300

______________________________ ______________________________

Liz Bisbey-Kuehn
Bureau Chief
Air Quality Bureau

Date

Template version: 06/30/2021

TABLE OF CONTENTS

PART B GENERAL CONDITIONS (Attached)

PART C MISCELLANEOUS: Supporting On-Line Documents; Definitions; Acronyms (Attached)

PART A FACILITY SPECIFIC REQUIREMENTS

A100 Introduction

A. This is a new permit.

A101 Permit Duration (expiration)

A. The term of this permit is permanent unless withdrawn or cancelled by the Department.

A102 Facility: Description

A. The 125 cubic yard per hour concrete batch plant.

B. This facility is located approximately 5.1 miles north of Ruidoso, New Mexico in Lincoln County.

C. Tables 102.A and Table 102.B show the total potential emission rates (PER) from this facility for information only. This is not an enforceable condition and excludes emissions from Minor NSR exempt activities per 20.2.72.202 NMAC.

Table 102.A: Total Potential Emission Rate (PER) from Entire Facility

Pollutant	Emissions (tons per year)
Nitrogen Oxides (NOx)	0.3
Carbon Monoxide (CO)	0.2
Volatile Organic Compounds (VOC)	0.03
Sulfur Dioxide (SO_2)	0.003
Particulate Matter 10 microns or less (PM_{10})	1.7
Particulate Matter 2.5 microns or less ($PM_{2.5}$)	0.3

Table 102.B: Total Potential Emissions Rate (PER) for Hazardous Air Pollutants (HAPs) that exceed 1.0 ton per year

Pollutant	Emissions (tons per year)
Total HAPs	<1.0

A103 Facility: Applicable Regulations

A. The permittee shall comply with all applicable sections of the requirements listed in Table 103.A.

Table 103.A: Applicable Requirements

Applicable Requirements	Federally Enforceable	Unit No.
20.2.1 NMAC General Provisions	X	Entire Facility
20.2.3 NMAC Ambient Air Quality Standards	X	Entire Facility
20.2.7 NMAC Excess Emissions	X	Entire Facility
20.2.61 NMAC Smoke and Visible Emissions	X	Units 12, 13, and 14
20.2.72 NMAC Construction Permit	X	Entire Facility
20.2.73 NMAC Notice of Intent and Emissions Inventory Requirements	X	Entire Facility
20.2.75 NMAC Construction Permit Fees	X	Entire Facility
20.2.80 NMAC Stack Heights	X	Units 12, 13, and 14
40 CFR 50 National Ambient Air Quality Standards	X	Entire Facility

A104 Facility: Regulated Sources

A. Table 104.A lists the emission units authorized for this facility. Emission units identified as exempt activities (as defined in 20.2.72.202 NMAC) and/or equipment not regulated pursuant to the Act are not included.

Table 104.A: Regulated Sources List

Unit No.	Source Description	Make	Model	Serial No.	Construction/ Reconstruction Date	Manufacture Date	Permitted Capacity
1	Haul Road	NA	NA	NA	NA	NA	305 trips per day
2	Feeder Hopper	JEL Manufacturing	TBD	TBD	TBD	TBD	187.5 tph
3	Feeder Hopper Conveyor	JEL Manufacturing	TBD	TBD	TBD	TBD	187.5 tph
4	Overhead Aggregate Bins (4)	JEL Manufacturing	TBD	TBD	TBD	TBD	187.5 tph
5	Aggregate Weigh Batcher	JEL Manufacturing	TBD	TBD	TBD	TBD	187.5 tph
6	Aggregate Weigh Conveyor	JEL Manufacturing	TBD	TBD	TBD	TBD	187.5 tph
7	Truck Loading with Baghouse	JEL Manufacturing	TBD	TBD	TBD	TBD	125 yd^3 per hour
8	Cement/Fly Ash weigh Batcher	JEL Manufacturing	TBD	TBD	TBD	TBD	38.8 tph
9	Cement Split Silo	JEL Manufacturing	TBD	TBD	TBD	TBD	30.6 tph

Table 104.A: Regulated Sources List

Unit No.	Source Description	Make	Model	Serial No.	Construction/ Reconstruction Date	Manufacture Date	Permitted Capacity
10	Fly Ash Split Silo	JEL Manufacturing	TBD	TBD	TBD	TBD	8.25 tph
11	Aggregate/Sand Storage Piles	NA	NA	NA	NA	NA	187.5 tph
12,13, 14	Concrete Batch Plant Heaters (3 in total)	TBD	TBD	TBD	TBD	TBD	0.6 MMBtu/hr (total)

1. All TBD (to be determined) units and like-kind engine replacements must be evaluated for applicability to NSPS and MACT requirements.

A105 Facility: Control Equipment

A. Table 105.A lists all the pollution control equipment required for this facility. Each emission point is identified by the same number that was assigned to it in the permit application.

Table 105.A: Control Equipment List:

Control Equipment Unit No.	Control Description	Pollutant being controlled	Control for Unit Number(s)[1]
3b	Wet Dust Suppression System	PM_{10}, $PM_{2.5}$	3
4b	Wet Dust Suppression System	PM_{10}, $PM_{2.5}$	4
5b	Wet Dust Suppression System	PM_{10}, $PM_{2.5}$	5
6b	Wet Dust Suppression System	PM_{10}, $PM_{2.5}$	6
7b	Baghouse	PM_{10}, $PM_{2.5}$	7, 8
9b	Baghouse	PM_{10}, $PM_{2.5}$	9
10b	Baghouse	PM_{10}, $PM_{2.5}$	10

1. Control for unit number refers to a unit number from the Regulated Equipment List

A106 Facility: Allowable Emissions

A. The following Section lists the emission units and their allowable emission limits. (40 CFR 50, 20.2.72.210.A and B.1 NMAC).

Table 106.A: Allowable Emissions

Unit No.	NO$_x$[1] pph	NO$_x$ [1]tpy	CO pph	CO tpy	VOC pph	VOC tpy	SO$_2$ pph	SO$_2$ tpy	PM$_{10}$ pph	PM$_{10}$ tpy	PM$_{2.5}$ pph	PM$_{2.5}$ tpy
1	-	-	-	-	-	-	-	-	0.1	0.3	0.03	0.07
2	-	-	-	-	-	-	-	-	0.4	0.6	0.06	0.08
3	-	-	-	-	-	-	-	-	0.009	0.02	0.002	0.005
4	-	-	-	-	-	-	-	-	0.009	0.02	0.002	0.005
5	-	-	-	-	-	-	-	-	0.009	0.02	0.002	0.005
6												
7	-	-	-	-	-	-	-	-	0.02	0.04	0.003	0.006
8												
9	-	-	-	-	-	-	-	-	0.01	0.03	0.003	0.006
10	-	-	-	-	-	-	-	-	0.009	0.02	0.002	0.004
11	-	-	-	-	-	-	-	-	0.5	0.7	0.08	0.1
12	0.06	0.3	0.05	0.2	0.007	0.03	0.0007	0.003	0.005	0.02	0.005	0.02
13												
14												

[1] Nitrogen dioxide emissions include all oxides of nitrogen expressed as NO$_2$
"-" indicates the application represented emissions of this pollutant are not expected.

[2] To report excess emissions for sources with no pound per hour and/or ton per year emission limits, see condition B110F.

A107 Facility: Allowable Startup, Shutdown, & Maintenance (SSM)

A. Separate allowable SSM emission limits are not required for this facility since the SSM emissions are predicted to be less than the limits established in Table 106.A. The permittee shall maintain records in accordance with Condition B109.C.

A108 **Facility: Allowable Operations**

A. Allowable Hours of Operation (Facility)

Requirement: Compliance with the emission limiting in Table 106. shall be demonstrated by restricting this facility, including all permitted equipment and related activities such as truck traffic involving movement of product, to operate no more than the hours described below Allowable Hours of Operation 7AM-6PM from November through February, 5AM-7PM March and October, 4AM-9PM April and September and 3AM-9PM May through August.
Monitoring: Daily, the permittee shall monitor the date, startup time, shutdown time, and the total hours of operation of the facility.
Recordkeeping: Daily, the permittee shall record the date, startup time, shutdown time, and the total hours of operation of the facility. The permittee shall maintain records in accordance with Section B109.
Reporting: The permittee shall report in accordance with Section B110.

B. Facility Throughput (Facility)

Requirement: Compliance with the allowable emission limits in table 106.A shall be demonstrated by limiting the facility production rates to 125 cubic yards per hour and 500000 cubic yards per year. 1) The concrete production rates shall not exceed 125 cubic yards per hour and 1125 cubic yards per day from November through February. 2) The concrete production rates shall not exceed 125 cubic yards per hour and 1500 cubic yards per day in March and October. 3) The concrete production rates shall not exceed 125 cubic yards per hour and 1750 cubic yards per day in April and September. 4) The concrete production rates shall not exceed 125 cubic yards per hour and 1875 cubic yards per day from May through August. These production rates were specified in the permit application and are the basis for the Department's modeling analysis to determine compliance with the applicable ambient air quality standards.
Monitoring: The permittee shall monitor the daily total production, and, each calendar month, the monthly rolling 12-month total production.
Recordkeeping: The permittee shall: 1) Each day, record the date, start time, and end time of any production activity. 2) Daily, record the daily production total by summing the hourly production totals for that day. 3) Each calendar month, calculate and record the total monthly production and the monthly rolling 12-month total production, and

4) Maintain on site all records necessary for the calculation of the required hourly, daily, and monthly rolling 12-month production totals.

Reporting: The permittee shall report in accordance with Section B110. This report shall be generated upon request.

C. If the facility ceases operations for any reason for longer than 30 days, the owner or operator shall notify the Permit Program Manager within 45 days of ceasing operations, the reason for ceasing operations, and provide a restart date if the cessation is temporary.

A109 Facility: Reporting Schedules

A. The permittee shall report according to the Specific Conditions and General Conditions of this permit.

A110 Facility: Fuel and Fuel Sulfur Requirements

A. Fuel and Fuel Sulfur Requirements (Units 12, 13 and 14)

Requirement: All combustion emission units shall combust only natural gas containing no more than 0.75 grains of total sulfur per 100 dry standard cubic feet.

Monitoring: No monitoring is required. Compliance is demonstrated through records.

Recordkeeping:

1) The permittee shall demonstrate compliance with the natural gas or fuel oil limit on total sulfur content by maintaining records of a current, valid purchase contract, tariff sheet or transportation contract for the gaseous or liquid fuel, or fuel gas analysis, specifying the allowable limit or less.
2) If fuel gas analysis is used, the analysis shall not be older than one year.
3) Alternatively, compliance shall be demonstrated by keeping a receipt or invoice from a commercial fuel supplier, with each fuel delivery, which shall include the delivery date, the fuel type delivered, the amount of fuel delivered, and the maximum sulfur content of the fuel.

Reporting: The permittee shall report in accordance with Section B110.

A111 Facility: 20.2.61 NMAC Opacity

A. 20.2.61 NMAC Opacity Limit (Units 12, 13 and 14)

Requirement: Visible emissions from all stationary combustion emission stacks shall not equal or exceed an opacity of 20 percent in accordance with the requirements at 20.2.61.109 NMAC.

Monitoring:

1) Use of natural gas fuel constitutes compliance with 20.2.61 NMAC unless opacity equals or exceeds 20% averaged over a 10-minute period. When any visible emissions are observed during operation other than during startup mode, opacity shall be measured over a 10-minute period, in accordance with the procedures at 40 CFR 60, Appendix A, Reference Method 9 (EPA Method 9) as required by 20.2.61.114 NMAC, or the operator will be allowed to shut down the equipment to perform maintenance/repair to eliminate the visible emissions. Following completion of equipment maintenance/repair, the operator shall conduct visible emission observations following startup in accordance with the following procedures:
   - (a) Visible emissions observations shall be conducted over a 10-minute period during operation after completion of startup mode in accordance with the procedures at 40 CFR 60, Appendix A, Reference Method 22 (EPA Method 22). If no visible emissions are observed, no further action is required.
   - (b) If any visible emissions are observed during completion of the EPA Method 22 observation, subsequent opacity observations shall be conducted over a 10-minute period, in accordance with the procedures at EPA Method 9 as required by 20.2.61.114 NMAC.

For the purposes of this condition, *Startup mode* is defined as the startup period that is described in the facility's startup plan.

Recordkeeping:

1) If any visible emissions observations were conducted, the permittee shall keep records in accordance with the requirements of Section B109 and as follows:
   - (a) For any visible emissions observations conducted in accordance with EPA Method 22, record the information on the form referenced in EPA Method 22, Section 11.2.
   - (b) For any opacity observations conducted in accordance with the requirements of EPA Method 9, record the information on the form referenced in EPA Method 9, Sections 2.2 and 2.4.

Reporting: The permittee shall report in accordance with Section B110.

A112 Facility: Haul Roads

A. Truck Traffic

Requirement: Compliance with the allowable particulate emissions in Table 106.A shall be demonstrated by limiting the number of paved haul road round trips to 305 round trips per day.
Monitoring: The permittee shall monitor the total number of paved haul road round trips per day.
Recordkeeping: The permittee shall keep daily records of the total number of haul road trips per day.

Reporting: The permittee shall report in accordance with Section B110.

B. Haul Road Control

Requirement: Truck traffic areas and haul roads going in and out of the plant site shall be paved and maintained to minimize silt buildup to control particulate emissions. This condition demonstrates compliance with the AP-42, Section 13.2.1 (ver. 01/11) “Paved Roads” emission equation used in the permit application.

This control measure shall be used on roads as far as the nearest public road.

Monitoring: The permittee shall monitor the frequency, quantity, and location(s) of the water application, or equivalent control measures, such as sweeping.

Recordkeeping: The permittee shall keep daily records of the frequency, quantity, and location(s) of the water application, or equivalent control measures, such as sweeping.

Reporting: The permittee shall report in accordance with Section B110.

C. Nighttime Truck Traffic

Requirement: Nighttime operation of haul trucks is authorized providing the following requirements are met for the trafficked roads.

Haul truck surfaces are paved and maintained to minimize silt buildup.

Monitoring:

1) The permittee shall monitor:
   - (a) the date, time, and water truck odometer/hour meter reading at the commencement of watering activities or date and time of road sweeping;
   - (b) the date, time, and water truck odometer/hour meter reading at the completion of watering activities or date and time of road sweeping;
   - (c) the quantity of water applied;
   - (d) the date and time of commencement and completion of night traffic operations.

2) For each hour of night operation in which the traffic areas were not maintained to minimize silt buildup, the permittee shall monitor the road and off-road surfaces to see if dust is rising higher than the headlights or taillights of a standard haul truck.

Recordkeeping: The permittee shall make a record of each hourly dust monitoring activity to see if additional maintenance is necessary. At a minimum the record shall include the date, the time of the observation, the roads and surfaces observed, the results of the observation, and the name of the person making the observation.

Reporting: Records shall be made available according to reporting requirements of this permit, if the Department requests them.

A113 Facility: Initial Location Requirements

A. Initial Setback Distance – Not required

B. Co-location

This facility shall not co-locate with another facility without submitting air dispersion modeling and revising the permit.

A114 Facility: Relocation Requirements

A. This facility shall not be relocated.

A115 Governing Requirements During Source Construction, Source Removal, and/or Change in Emissions Control -Not Required

EQUIPMENT SPECIFIC REQUIREMENTS

OIL AND GAS INDUSTRY

A200 Oil and Gas Industry – Not Required

CONSTRUCTION INDUSTRY - AGGREGATE

A300 Construction Industry – Aggregate – Not Required

CONSTRUCTION INDUSTRY – ASPHALT

A400 Construction Industry – Asphalt -Not Required

CONSTRUCTION INDUSTRY - CONCRETE

A500 Construction Industry – Concrete

A. This section has common equipment related to most concrete operations.

A501 Equipment Substitutions

A. Substitution of aggregate handling equipment is authorized provided the replacement equipment is functionally equivalent and has the same or lower process capacity as the piece of equipment it is replacing in the most recent permit. The replacement equipment shall comply with the opacity requirements in this permit.

B. The Department shall be notified within fifteen (15) days of equipment substitutions using the Equipment Substitution Form provided by the Department and available online.

A502 Process Equipment – Conveyors, Bins, Weigh Batchers and Storage Piles (Units 3, 4, 5, 6 and 11)

A. Wet Dust Suppression System (Units 3, 4, 5, 6 and 11)

Requirement: Compliance with allowable particulate emission limits in Table 106.A shall be demonstrated by:

1) Feeder Hopper Conveyor (Unit 3), Overhead Aggregate Bins (Unit 4), Aggregate Weigh Batcher (Unit 5), Aggregate Weigh Conveyor (Unit 6) shall have a Wet Dust Suppression System installed or additional moisture added at the aggregate/sand storage piles (Unit 11) to minimize fugitive emissions to the atmosphere from emission points and to meet the emission limitations contained in this permit.
2) At any time, if visible emissions at material transfer points are observed, additional water sprays shall be added or if already installed, turned on, or additional moisture will be added to the aggregate/sand storage piles (Unit 11) to minimize the visible emissions.
3) Each Wet Dust Suppression System shall be turned on and properly function at all times the facility is operating or additional moisture shall be added at the aggregate/sand storage piles (Unit 11), unless rain or snow precipitation achieves an equivalent level of dust control. Any problems with the control devices shall be corrected before commencement of operation.

Monitoring:

1) On each day of operation at the commencement of operation of the Wet Dust Suppression System, the permittee shall inspect the Wet Dust Suppression System. At a minimum, the visual inspection shall include checks for malfunctions and deficiencies in dust control effectiveness, such as breaches in the physical barriers controlling dust emissions; spray nozzle clogs; misdirected sprays; insufficient water pressure; and/or any other dust control equipment deficiencies or malfunctions, or

2) On each day of operation when additional moisture is added to the aggregate/sand storage piles, daily visible inspections will be made to determine the additional moisture is adequate to minimize visible emissions.

Recordkeeping:

1) A daily record shall be made of the Wet Dust Suppression System inspection and any maintenance activity that resulted from the inspection. The permittee shall record in

accordance with Section B109 of this permit and shall also include a description of any malfunction and any corrective actions taken. The record shall be formatted with a description of what shall be inspected to ensure the inspector understands the inspection responsibilities. If the Wet Dust Suppression System is turned off due to rain or snow precipitation that achieve the equivalent level control as the Water Spray Units, it shall be so noted in the daily record.

2) Daily visible observation logs will be maintained and at a minimum the record shall include the date, the time of the observation, the emission point observed, the results of the observation, and the name of the person making the observation.

Reporting: The permittee shall report in accordance with Section B110.

B. Fugitive Dust Control Plan (FDCP)

Requirement: The permittee shall develop a Fugitive Dust Control Plan (FDCP) for minimizing emissions from areas such as aggregate feeders, conveyors, bins, bin scales, storage piles, overburden removal, disturbed earth, buildings, truck loading/unloading, or active pits.

Sites of overburden removal and active pit areas shall be watered, dependent on existing wind speeds and soil moisture content, as necessary to minimize dust emissions.

Stockpiles must be kept adequately moist to control dust during storage and handling or covered at all times to minimize emissions.

Monitoring: Once each calendar month, the permittee shall inspect each area to ensure that fugitive dust is being minimized and determine if the FDCP plan needs updating.

Any observations of visible dust emissions from the above areas shall be considered an indication of the need to update the FDCP.

Recordkeeping: Monthly, the permittee shall make a record of each monthly inspection of each area and revise the plan to address past shortcomings as well as future activities. If no changes are needed, then the permittee shall make a record that the plan needs no changes. The permittee shall make a record of any action taken to minimize emissions as a result of the FDCP or monthly inspections. The permittee shall maintain records in accordance with Section B109.

Reporting: The permittee shall report in accordance with Section B110.

A503 Material Handling –Truck Loading from Batch Conveyor and Silos

A. Silos: (Units 9 and 10)

Requirement: Compliance with the allowable particulate emissions in Table 106.A shall be demonstrated by:

1) Ensuring Emissions from each silo (Units Cement Split Silo and Fly Ash Split Silo) shall at all times be routed to and controlled by the Silo Baghouses (Units 9b and 10b).
2) The Silo baghouse shall be equipped with a differential pressure gauge.

3) The gauge shall be maintained, replaced and calibrated per manufacturer’s specifications so that it consistently provides correct and accurate readings.

Monitoring: Once, during each loading event, compliance with Table 106.A limits shall be demonstrated by ensuring the Silo Baghouse (Unit 9b and 10b) differential pressure meets the differential pressure requirement of this condition. If a deviation(s) from this requirement is noted, the permittee shall document actions taken to rectify the problem(s) and whether the repairs were successful.

Recordkeeping:
During each loading of Silo (Unit 9 or 10), the monitored differential pressure shall be recorded for each loading operation.

The permittee shall maintain records of the maintenance checks on the silo baghouses , a record of the date and time of each check, the results of the check and if the check indicates whether the silo baghouse is operating as required by this condition and as represented in the application and in accordance with the manufacturer recommendations and the actions taken to repair the silo baghouse.

The permittee shall maintain records of operational inspections, maintenance performed, and each gauge calibrations and in accordance with Section B109.

Reporting: The permittee shall report in accordance with Section B110.

B. Truck Loading -Loading of Aggregate, Sand, Cement and Fly Ash (Unit 7)

Requirement: Compliance with the particulate emission limits in Table 106.A shall be demonstrated by limiting the loading rate of the aggregate, sand, cement, fly ash and water to 125 cubic yards per hour.

The truck loading of materials shall be equipped with a central dust control system (Unit 7b) that captures fugitive emissions.

Monitoring: The permittee shall monitor the daily loading rates.

Recordkeeping: The permittee shall:
1) Measure and record the daily loading rate,
2) Date of concrete loading,
3) Determine or calculate the daily and hourly loading rate. Calculate the hourly load rate by dividing the daily loading rate by the total hours of operation per day.
4) Maintain the records necessary to support the calculation of the daily load rate.

Reporting: The permittee shall report in accordance with Section B110.

C. No Visible Emissions (Units 7, 8, 9 and 10)

Requirement: Compliance with the emission limits in Table 106.A shall be demonstrated by each transfer point exhibiting no visible emissions except for ten (10) seconds during a six minute period as determined by EPA Reference Method 22. The Units (7, 8, 9, and 10) shall be controlled by the associated control devices identified in Table 105.A.

Monitoring: Weekly, during operation of each unit, the permittee shall perform a visible emissions check, if the observer sees visible emissions from a transfer point lasting longer than ten (10) seconds in a six (6) minute period as determined by EPA Reference Method 22 , the permittee shall perform a maintenance check on the control devices/methods and perform any necessary maintenance activities to ensure the controls are maintained per manufacturers specifications and to achieve no visible emissions.

Recordkeeping: The permittee shall maintain the following information: records of visible emission observations and/or repairs and the date and time, occurring as a result of those observations.

Reporting: N/A

D. Requirements for Baghouses (Units 9b and 10b)

Requirement: Compliance with the emission limits in table 106.A shall be demonstrated by maintaining a differential pressure across each baghouse within the manufacturer recommended differential pressure range for that dust collector. Units 7, 8, 9, and 10 shall be controlled by the associated control devices as identified in table 105.A.

Each baghouse shall be equipped with a differential pressure gauge.

Gauges shall be maintained in good operating condition per manufacturer maintenance recommendations. Gauges shall be replaced and calibrated as needed to ensure accurate performance as needed to ensure accurate performance and per manufacturer maintenance recommendations.

Operations shall cease immediately if the pressure drop is not within the manufacturer specified normal operating range. Operations shall not commence until the cause of the deviation is determined and rectified.

Monitoring: The differential pressure (inches of water) across each dust collector shall be continuously indicated using a differential pressure gauge and shall be monitored once each day.

Recordkeeping: The permittee shall maintain the following information:

1) The manufacturer specified normal differential pressure range for each bag house.
2) Each time cement (Unit 9) or fly ash (Unit 10) silos are loaded, record a reading of the differential pressure during normal operations for each bag house and the name of the person making the record.
3) Any deviation in differential pressure from the manufacturers recommended range, the cause of deviation, the time operations ceased for repairs, the time operations commenced after repairs and the corrective actions taken.
4) Maintain a copy of the manufacturer specification sheet.

Reporting: The permittee shall report in accordance with Section B110.

PART B GENERAL CONDITIONS (Attached)

PART C MISCELLANEOUS: Supporting On-Line Documents; Definitions;

Acronyms (Attached)

AIR QUALITY BUREAU
NEW SOURCE REVIEW PERMIT
Issued under 20.2.72 NMAC

GENERAL CONDITIONS AND MISCELLANEOUS

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PART B GENERAL CONDITIONS

B100 Introduction

A. The Department has reviewed the permit application for the proposed construction/modification/revision and has determined that the provisions of the Act and ambient air quality standards will be met. Conditions have been imposed in this permit to assure continued compliance. 20.2.72.210.D NMAC, states that any term or condition imposed by the Department on a permit is enforceable to the same extent as a regulation of the Environmental Improvement Board.

B101 Legal

A. The contents of a permit application specifically identified by the Department shall become the terms and conditions of the permit or permit revision. Unless modified by conditions of this permit, the permittee shall construct or modify and operate the Facility in accordance with all representations of the application and supplemental submittals that the Department relied upon to determine compliance with applicable regulations and ambient air quality standards. If the Department relied on air quality modeling to issue this permit, any change in the parameters used for this modeling shall be submitted to the Department for review. Upon the Department's request, the permittee shall submit additional modeling for review by the Department. Results of that review may require a permit modification. (20.2.72.210.A NMAC)

B. Any future physical changes, changes in the method of operation or changes in restricted area may constitute a modification as defined by 20.2.72 NMAC, Construction Permits. Unless the source or activity is exempt under 20.2.72.202 NMAC, no modification shall begin prior to issuance of a permit. (20.2.72 NMAC Sections 200.A.2 and E, and 210.B.4)

C. Changes in plans, specifications, and other representations stated in the application documents shall not be made if they cause a change in the method of control of emissions or in the character of emissions, will increase the discharge of emissions or affect modeling results. Any such proposed changes shall be submitted as a revision or modification. (20.2.72 NMAC Sections 200.A.2 and E, and 210.B.4)

D. The permittee shall establish and maintain the property's Restricted Area as identified in plot plan submitted with the application. (20.2.72 NMAC Sections 200.A.2 and E, and 210.B.4)

E. Applications for permit revisions and modifications shall be submitted to:

Program Manager, Permits Section
New Mexico Environment Department

Air Quality Bureau
525 Camino de los Marquez, Suite 1
Santa Fe, NM 87505

F. The owner or operator of a source having an excess emission shall, to the extent practicable, operate the source, including associated air pollution control equipment, in a manner consistent with good air pollutant control practices for minimizing emissions. (20.2.7.109 NMAC). The establishment of allowable malfunction emission limits does not supersede this requirement.

B102 Authority

A. This permit is issued pursuant to the Air Quality Control Act (Act) and regulations adopted pursuant to the Act including Title 20, Chapter 2, Part 72 of the New Mexico Administrative Code (NMAC), (20.2.72 NMAC), Construction Permits and is enforceable pursuant to the Act and the air quality control regulations applicable to this source.

B. The Department is the Administrator for 40 CFR Parts 60, 61, and 63 pursuant to the delegation and exceptions of Section 10 of 20.2.77 NMAC (NSPS), 20.2.78 NMAC (NESHAP), and 20.2.82 NMAC (MACT).

B103 Annual Fee

A. The Department will assess an annual fee for this Facility. The regulation 20.2.75 NMAC set the fee amount at $1,500 through 2004 and requires it to be adjusted annually for the Consumer Price Index on January 1. The current fee amount is available by contacting the Department or can be found on the Department’s website. The AQB will invoice the permittee for the annual fee amount at the beginning of each calendar year. This fee does not apply to sources which are assessed an annual fee in accordance with 20.2.71 NMAC. For sources that satisfy the definition of “small business” in 20.2.75.7.F NMAC, this annual fee will be divided by two. (20.2.75.11 NMAC)

B. All fees shall be remitted in the form of a corporate check, certified check, or money order made payable to the “NM Environment Department, AQB” mailed to the address shown on the invoice and shall be accompanied by the remittance slip attached to the invoice.

B104 Appeal Procedures

A. Any person who participated in a permitting action before the Department and who is adversely affected by such permitting action, may file a petition for hearing before the Environmental Improvement Board. The petition shall be made in writing to the

Environmental Improvement Board within thirty (30) days from the date notice is given of the Department's action and shall specify the portions of the permitting action to which the petitioner objects, certify that a copy of the petition has been mailed or hand-delivered and attach a copy of the permitting action for which review is sought. Unless a timely request for hearing is made, the decision of the Department shall be final. The petition shall be copied simultaneously to the Department upon receipt of the appeal notice. If the petitioner is not the applicant or permittee, the petitioner shall mail or hand-deliver a copy of the petition to the applicant or permittee. The Department shall certify the administrative record to the board. Petitions for a hearing shall be sent to: (20.2.72.207.F NMAC)

For Mailing:
Administrator, New Mexico Environmental Improvement Board
P.O. Box 5469
Santa Fe, NM 87502-5469

For Hand Delivery:
Administrator, New Mexico Environmental Improvement Board
1190 St. Francis Drive, Harold Runnels Bldg.
Santa Fe, New Mexico 87505

B105 Submittal of Reports and Certifications

A. Stack Test Protocols and Stack Test Reports shall be submitted electronically to Stacktest.AQB@state.nm.us or as directed by the Department.

B. Excess Emission Reports shall be submitted as directed by the Department. (20.2.7.110 NMAC)

C. Routine reports shall be submitted to the mailing address below, or as directed by the Department:

Manager, Compliance and Enforcement Section
New Mexico Environment Department
Air Quality Bureau
525 Camino de los Marquez, Suite 1
Santa Fe, NM 87505

B106 NSPS and/or MACT Startup, Shutdown, and Malfunction Operations

A. If a facility is subject to a NSPS standard in 40 CFR 60, each owner or operator that installs and operates a continuous monitoring device required by a NSPS regulation shall comply with the excess emissions reporting requirements in accordance with 40 CFR 60.7(c), unless specifically exempted in the applicable subpart.

B. If a facility is subject to a NSPS standard in 40 CFR 60, then in accordance with 40 CFR 60.8(c), emissions in excess of the level of the applicable emission limit during periods of startup, shutdown, and malfunction shall not be considered a violation of the applicable emission limit unless otherwise specified in the applicable standard.

C. If a facility is subject to a MACT standard in 40 CFR 63, then the facility is subject to the requirement for a Startup, Shutdown and Malfunction Plan (SSM) under 40 CFR 63.6(e)(3), unless specifically exempted in the applicable subpart.

B107 Startup, Shutdown, and Maintenance Operations

A. The establishment of permitted startup, shutdown, and maintenance (SSM) emission limits does not supersede the requirements of 20.2.7.14.A NMAC. Except for operations or equipment subject to Condition B106, the permittee shall establish and implement a plan to minimize emissions during routine or predictable start up, shut down, and scheduled maintenance (SSM work practice plan) and shall operate in accordance with the procedures set forth in the plan. (SSM work practice plan) (20.2.7.14.A NMAC)

B108 General Monitoring Requirements

A. These requirements do not supersede or relax requirements of federal regulations.

B. The following monitoring requirements shall be used to determine compliance with applicable requirements and emission limits. Any sampling, whether by portable analyzer or EPA reference method, that measures an emission rate over the applicable averaging period greater than an emission limit in this permit constitutes noncompliance with this permit. The Department may require, at its discretion, additional tests pursuant to EPA Reference Methods at any time, including when sampling by portable analyzer measures an emission rate greater than an emission limit in this permit; but such requirement shall not be construed as a determination that the sampling by portable analyzer does not establish noncompliance with this permit and shall not stay enforcement of such noncompliance based on the sampling by portable analyzer.

C. If the emission unit is shutdown at the time when periodic monitoring is due to be completed, the permittee is not required to restart the unit for the sole purpose of conducting the monitoring. Using electronic or written mail, the permittee shall notify the Department's Compliance and Enforcement Section of a delay in emission tests prior to the deadline for completing the tests. Upon recommencing operation, the permittee shall submit pre-test notification(s) to the Department's Compliance and Enforcement Section and shall complete the monitoring.

D. The requirement for monitoring during any monitoring period is based on the percentage of time that the unit has operated. However, to invoke the monitoring period exemption at B108.D(2), hours of operation shall be monitored and recorded.

(1) If the emission unit has operated for more than 25% of a monitoring period, then the permittee shall conduct monitoring during that period.

(2) If the emission unit has operated for 25% or less of a monitoring period then the monitoring is not required. After two successive periods without monitoring, the permittee shall conduct monitoring during the next period regardless of the time operated during that period, except that for any monitoring period in which a unit has operated for less than 10% of the monitoring period, the period will not be considered as one of the two successive periods.

(3) If invoking the monitoring **period** exemption in B108.D(2), the actual operating time of a unit shall not exceed the monitoring period required by this permit before the required monitoring is performed. For example, if the monitoring period is annual, the operating hours of the unit shall not exceed 8760 hours before monitoring is conducted. Regardless of the time that a unit actually operates, a minimum of one of each type of monitoring activity shall be conducted during any five-year period.

E. For all periodic monitoring events, except when a federal or state regulation is more stringent, three test runs shall be conducted at 90% or greater of the unit's capacity as stated in this permit, or in the permit application if not in the permit, and at additional loads when requested by the Department. If the 90% capacity cannot be achieved, the monitoring will be conducted at the maximum achievable load under prevailing operating conditions except when a federal or state regulation requires more restrictive test conditions. The load and the parameters used to calculate it shall be recorded to document operating conditions and shall be included with the monitoring report.

F. When requested by the Department, the permittee shall provide schedules of testing and monitoring activities. Compliance tests from previous NSR and Title V permits may be re-imposed if it is deemed necessary by the Department to determine whether the source is in compliance with applicable regulations or permit conditions.

G. If monitoring is new or is in addition to monitoring imposed by an existing applicable requirement, it shall become effective 120 days after the date of permit issuance. For emission units that have not commenced operation, the associated new or additional monitoring shall not apply until 120 days after the units commence operation. All pre-existing monitoring requirements incorporated in this permit shall continue to apply from the date of permit issuance.

H. Unless otherwise indicated by Specific Conditions or regulatory requirements, all instrumentation used for monitoring in accordance with applicable requirements including emission limits, to measure parameters including but not limited to flow, temperature, pressure and chemical composition, or used to continuously monitor emission rates and/or other process operating parameters, shall be subject to the following requirements:

(1) The owner or operator shall install, calibrate, operate and maintain monitoring instrumentation (monitor) according to the manufacturer's procedures and specifications and the following requirements.

- (a) The monitor shall be located in a position that provides a representative measurement of the parameter that is being monitored.
- (b) At a minimum, the monitor shall complete one cycle of operation (sampling, analyzing, and data recording) for each successive 15-minute period.
- (c) At a minimum, the monitor shall be spanned to measure the normal range +/- 5% of the parameter that is being monitored.
- (d) At least semi-annually, perform a visual inspection of all components of the monitor for physical and operational integrity and all electrical connections for oxidation and galvanic corrosion.
- (e) Recalibrate the monitor in accordance with the manufacturer's procedures and specifications at the frequency specified by the manufacturer, or every two years, whichever is less.

(2) Except for malfunctions, associated repairs, and required quality assurance or control activities (including calibration checks and required zero and span adjustments), the permittee shall operate and maintain all monitoring equipment at all times that the emissions unit or the associated process is operating.

(3) The monitor shall measure data for a minimum of 90 percent of the time that the emissions unit or the associated process is in operation, based on a calendar monthly average.

(4) The owner or operator shall maintain records in accordance with Section B109 to demonstrate compliance with the requirements in B108H (1)-(3) above, as applicable.

B109 General Recordkeeping Requirements

A. The permittee shall maintain records to assure and verify compliance with the terms and conditions of this permit and any other applicable requirements that become effective after permit issuance. The minimum information to be included in these records is as follows:

(1) Records required for testing and sampling:

- (a) equipment identification (include make, model and serial number for all tested equipment and emission controls)
- (b) date(s) and time(s) of sampling or measurements
- (c) date(s) analyses were performed

(d) the qualified entity that performed the analyses

(e) analytical or test methods used

(f) results of analyses or tests

(g) operating conditions existing at the time of sampling or measurement

(2) Records required for equipment inspections and/or maintenance required by this permit:

(a) equipment identification number (including make, model and serial number)

(b) date(s) and time(s) of inspection, maintenance, and/or repair

(c) date(s) any subsequent analyses were performed (if applicable)

(d) name of the person or qualified entity conducting the inspection, maintenance, and/or repair

(e) copy of the equipment manufacturer's or the owner or operator's maintenance or repair recommendations (if required to demonstrate compliance with a permit condition)

(f) description of maintenance or repair activities conducted

(g) all results of any required parameter readings

(h) a description of the physical condition of the equipment as found during any required inspection

(i) results of required equipment inspections including a description of any condition which required adjustment to bring the equipment back into compliance and a description of the required adjustments

B. Except as provided in the Specific Conditions, records shall be maintained on-site or at the permittee's local business office for a minimum of two (2) years from the time of recording and shall be made available to Department personnel upon request. Sources subject to 20.2.70 NMAC "Operating Permits" shall maintain records on-site for a minimum of five (5) years from the time of recording.

C. Unless otherwise indicated by Specific Conditions, the permittee shall keep the following records for malfunction emissions and routine or predictable emissions during startup, shutdown, and scheduled maintenance (SSM):

(1) The owner or operator of a source subject to a permit shall establish and implement a plan to minimize emissions during routine or predictable startup, shutdown, and scheduled maintenance through work practice standards and good air pollution control practices. This requirement shall not apply to any affected facility defined in and subject to an emissions standard and an equivalent plan under 40 CFR Part 60 (NSPS), 40 CFR Part 63 (MACT), or an equivalent plan under 20.2.72 NMAC - Construction Permits, 20.2.70 NMAC - Operating Permits, 20.2.74 NMAC -

Permits - Prevention of Significant Deterioration (PSD), or 20.2.79 NMAC - Permits - Nonattainment Areas. The permittee shall keep records of all sources subject to the plan to minimize emissions during routine or predictable SSM and shall record if the source is subject to an alternative plan and therefore, not subject to the plan requirements under 20.2.7.14.A NMAC.

(2) If the facility has allowable SSM emission limits in this permit, the permittee shall record all SSM events, including the date, the start time, the end time, a description of the event, and a description of the cause of the event. This record also shall include a copy of the manufacturer's, or equivalent, documentation showing that any maintenance qualified as scheduled. Scheduled maintenance is an activity that occurs at an established frequency pursuant to a written protocol published by the manufacturer or other reliable source. The authorization of allowable SSM emissions does not supersede any applicable federal or state standard. The most stringent requirement applies.

(3) If the facility has allowable malfunction emission limits in this permit, the permittee shall record all malfunction events to be applied against these limits. The permittee shall also include the date, the start time, the end time, and a description of the event. **Malfunction means** any sudden and unavoidable failure of air pollution control equipment or process equipment beyond the control of the owner or operator, including malfunction during startup or shutdown. A failure that is caused entirely or in part by poor maintenance, careless operation, or any other preventable equipment breakdown shall not be considered a malfunction. (20.2.7.7.E NMAC) The authorization of allowable malfunction emissions does not supersede any applicable federal or state standard. The most stringent requirement applies. This authorization only allows the permittee to avoid submitting reports under 20.2.7 NMAC for total annual emissions that are below the authorized malfunction emission limit.

(4) The owner or operator of a source shall meet the operational plan defining the measures to be taken to mitigate source emissions during malfunction, startup or shutdown. (20.2.72.203.A(5) NMAC)

B110 <u>General Reporting Requirements</u>

(20.2.72 NMAC Sections 210 and 212)

A. Records and reports shall be maintained on-site or at the permittee's local business office unless specifically required to be submitted to the Department or EPA by another condition of this permit or by a state or federal regulation. Records for unmanned sites may be kept at the nearest business office.

B. The permittee shall notify the Department's Compliance Reporting Section using the current Submittal Form posted to NMED's Air Quality web site under Compliance and Enforcement/Submittal Forms in writing of, or provide the Department with (20.2.72.212.A and B):

(1) the anticipated date of initial startup of each new or modified source not less than thirty (30) days prior to the date. Notification may occur prior to issuance of the permit, but actual startup shall not occur earlier than the permit issuance date;

(2) after receiving authority to construct, the equipment serial number as provided by the manufacturer or permanently affixed if shop-built and the actual date of initial startup of each new or modified source within fifteen (15) days after the startup date; and

(3) the date when each new or modified emission source reaches the maximum production rate at which it will operate within fifteen (15) days after that date.

C. The permittee shall notify the Department's Permitting Program Manager, in writing of, or provide the Department with (20.2.72.212.C and D):

(1) any change of operators or any equipment substitutions within fifteen (15) days of such change;

(2) any necessary update or correction no more than sixty (60) days after the operator knows or should have known of the condition necessitating the update or correction of the permit.

D. Results of emission tests and monitoring for each pollutant (except opacity) shall be reported in pounds per hour (unless otherwise specified) and tons per year. Opacity shall be reported in percent. The number of significant figures corresponding to the full accuracy inherent in the testing instrument or Method test used to obtain the data shall be used to calculate and report test results in accordance with 20.2.1.116.B and C NMAC. Upon request by the Department, CEMS and other tabular data shall be submitted in editable, MS Excel format.

E. The permittee shall submit reports of excess emissions in accordance with 20.2.7.110.A NMAC.

F. Allowable Emission Limits for Excess Emissions Reporting for Flares and Other Regulated Sources with No Pound per Hour (pph) and/or Ton per Year (tpy) Emission Limits.

(1) When a flare has no allowable pph and/or tpy emission limits in Sections A106 and/or A107, the authorized allowable emissions include only the combustion of pilot and/or purge gas. Compliance is demonstrated by limiting the gas stream to the flare to only pilot and/or purge gas.

(2) For excess emissions reporting as required by 20.2.7 NMAC, the allowable emission limits are 1.0 pph and 1.0 tpy for each regulated air pollutant (except for H2S) emitted by that source as follows:

(a) For flares, when there are no allowable emission limits in Sections A106 and/or A107.

(b) For regulated sources with emission limits in Sections A106 or A107 represented by the less than sign ("<").

(c) For regulated sources that normally would not emit any regulated air pollutants, including but not limited to vents, pressure relief devices, connectors, etc.

(3) For excess emissions reporting as required by 20.2.7 NMAC for H2S, the allowable limits are 0.1 pph and 0.44 tpy for each applicable scenario addressed in paragraph (2) above.

B111 General Testing Requirements

Unless otherwise indicated by Specific Conditions or regulatory requirements, the permittee shall conduct testing in accordance with the requirements in Sections B111A, B, C, D and E, as applicable.

A. Initial Compliance Tests

The permittee shall conduct initial compliance tests in accordance with the following requirements:

(1) Initial compliance test requirements from previous permits (if any) are still in effect, unless the tests have been satisfactorily completed. Compliance tests may be re-imposed if it is deemed necessary by the Department to determine whether the source is in compliance with applicable regulations or permit conditions. (20.2.72 NMAC Sections 210.C and 213)

(2) Initial compliance tests shall be conducted within sixty (60) days after the unit(s) achieve the maximum normal production rate. If the maximum normal production rate does not occur within one hundred twenty (120) days of source startup, then the tests must be conducted no later than one hundred eighty (180) days after initial startup of the source.

(3) The default time period for each test run shall be **at least** 60 minutes and each performance test shall consist of three separate runs using the applicable test method. For the purpose of determining compliance with an applicable emission limit, the arithmetic mean of results of the three runs shall apply. In the event that a sample is accidentally lost or conditions occur in which one of the three runs must be discontinued because of forced shutdown, failure of an irreplaceable portion of the sample train, extreme meteorological conditions, or other circumstances, beyond the owner or operator's control, compliance may, upon the Department approval, be determined using the arithmetic mean of the results of the two other runs.

(4) Testing of emissions shall be conducted with the emissions unit operating at 90 to 100 percent of the maximum operating rate allowed by the permit. If it is not possible to test at that rate, the source may test at a lower operating rate

(5) Testing performed at less than 90 percent of permitted capacity will limit emission unit operation to 110 percent of the tested capacity until a new test is conducted.

(6) If conditions change such that unit operation above 110 percent of tested capacity is possible, the source must submit a protocol to the Department within 30 days of such change to conduct a new emissions test.

B. EPA Reference Method Tests

The test methods in Section B111.B(1) shall be used for all initial compliance tests and all Relative Accuracy Test Audits (RATAs), and shall be used if a permittee chooses to use EPA test methods for periodic monitoring. Test methods that are not listed in Section B111.B(1) may be used in accordance with the requirements at Section B111.B(2).

(1) All compliance tests required by this permit shall be conducted in accordance with the requirements of CFR Title 40, Part 60, Subpart A, General Provisions, and the following EPA Reference Methods as specified by CFR Title 40, Part 60, Appendix A:

(a) Methods 1 through 4 for stack gas flowrate

(b) Method 5 for particulate matter (PM)

(c) Method 6C SO_2

(d) Method 7E for NO_X (test results shall be expressed as nitrogen dioxide (NO_2) using a molecular weight of 46 lb/lb-mol in all calculations (each ppm of NO/NO_2 is equivalent to 1.194 x 10-7 lb/SCF)

(e) Method 9 for visual determination of opacity

(f) Method 10 for CO

(g) Method 19 for particulate, sulfur dioxide and nitrogen oxides emission rates. In addition, Method 19 may be used in lieu of Methods 1-4 for stack gas flowrate. The permittee shall provide a contemporaneous fuel gas analysis (preferably on the day of the test, but no earlier than three months prior to the test date) and a recent fuel flow meter calibration certificate (within the most recent quarter) with the final test report.

(h) Method 7E or 20 for Turbines per §60.335 or §60.4400

(i) Method 22 for visual determination of fugitive emissions from material sources and smoke emissions from flares

(j) Method 25A for VOC reduction efficiency

(k) Method 29 for Metals

(l) Method 30B for Mercury from Coal-Fired Combustion Sources Using Carbon Sorbent Traps

(m) Method 201A for filterable PM_{10} and $PM_{2.5}$

(n) Method 202 for condensable PM

(o) Method 320 for organic Hazardous Air Pollutants (HAPs)

(2) Permittees may propose test method(s) that are not listed in Section B111.B(1). These methods may be used if prior approval is received from the Department.

C. Periodic Monitoring and Portable Analyzer Requirements for the Determination of Nitrogen Oxides, Carbon Monoxide, and Oxygen Concentrations in Emissions from Reciprocating Engines, Combustion Turbines, Boilers, and Process Heaters

Periodic emissions tests (periodic monitoring) shall be conducted in accordance with the following requirements:

(1) Periodic emissions tests may be conducted in accordance with EPA Reference Methods or by utilizing a portable analyzer. Periodic monitoring utilizing a portable analyzer shall be conducted in accordance with the requirements of the current version of ASTM D 6522. However, if a facility has met a previously approved Department criterion for portable analyzers, the analyzer may be operated in accordance with that criterion until it is replaced.

(2) The default time period for each test run shall be **at least** 20 minutes.

Each performance test shall consist of three separate runs. The arithmetic mean of results of the three runs shall be used to determine compliance with the applicable emission limit.

(3) Testing of emissions shall be conducted in accordance with the requirements at Section B108.E.

(4) During emissions tests, pollutant and diluent concentration shall be monitored and recorded. Fuel flow rate shall be monitored and recorded if stack gas flow rate is determined utilizing Reference Method 19. This information shall be included with the test report furnished to the Department.

(5) Stack gas flow rate shall be calculated in accordance with Reference Method 19 utilizing fuel flow rate (scf) determined by a dedicated fuel flow meter and fuel heating value (Btu/scf). The permittee shall provide a contemporaneous fuel gas analysis (preferably on the day of the test, but no earlier than three months prior to the test date) and a recent fuel flow meter calibration certificate (within the most recent quarter) with the final test report. Alternatively, stack gas flow rate may be determined by using EPA Reference Methods 1-4.

(6) The permittee shall submit a notification and protocol for periodic emissions tests upon the request of the Department.

D. Initial Compliance Test and RATA Procedures

Permittees required to conduct initial compliance tests and/or RATAs shall comply with the following requirements:

(1) The permittee shall submit a notification and test protocol to the Department's Program Manager, Compliance and Enforcement Section, at least thirty (30) days before the test date and allow a representative of the Department to be present at the test. Proposals to use test method(s) that are not listed in Section B111.B(1) (if applicable) shall be included in this notification.

(2) Contents of test notifications, protocols and test reports shall conform to the format specified by the Department's Universal Test Notification, Protocol and Report Form and Instructions. Current forms and instructions are posted to NMED's Air Quality web site under Compliance and Enforcement Testing.

(3) The permittee shall provide (a) sampling ports adequate for the test methods applicable to the facility, (b) safe sampling platforms, (c) safe access to sampling platforms and (d) utilities for sampling and testing equipment.

(4) Where necessary to prevent cyclonic flow in the stack, flow straighteners shall be installed

E. General Compliance Test Procedures

The following requirements shall apply to all initial compliance and periodic emissions tests and all RATAs:

(1) Equipment shall be tested in the "as found" condition. Equipment may not be adjusted or tuned prior to any test for the purpose of lowering emissions, and then returned to previous settings or operating conditions after the test is complete.

(2) The stack shall be of sufficient height and diameter and the sample ports shall be located so that a representative test of the emissions can be performed in accordance with the requirements of EPA Reference Method 1 or the current version of ASTM D 6522, as applicable.

(3) Test reports shall be submitted to the Department no later than 30 days after completion of the test.

B112 Compliance

A. The Department shall be given the right to enter the facility at all reasonable times to verify the terms and conditions of this permit. Required records shall be organized by date and subject matter and shall at all times be readily available for inspection. The permittee, upon verbal or written request from an authorized representative of the Department who appears at the facility, shall immediately produce for inspection or copying any records required to be maintained at the facility. Upon written request at other times, the permittee shall deliver to the Department paper or electronic copies of any and all required records maintained on site or at an off-site location. Requested records shall be copied and delivered at the permittee's expense within three business days from receipt of request unless the Department allows additional time. Required records may include records required by permit and other information necessary to demonstrate compliance with terms and conditions of this permit. (NMSA 1978, Section 74-2-13)

B. A copy of the most recent permit(s) issued by the Department shall be kept at the permitted facility or (for unmanned sites) at the nearest company office and shall be made available to Department personnel for inspection upon request. (20.2.72.210.B.4 NMAC)

C. Emissions limits associated with the energy input of a Unit, i.e. lb/MMBtu, shall apply at all times unless stated otherwise in a Specific Condition of this permit. The averaging time for each emissions limit, including those based on energy input of a Unit (i.e. lb/MMBtu) is one (1) hour unless stated otherwise in a Specific Condition of this permit or in the applicable requirement that establishes the limit.

B113 Permit Cancellation and Revocation

A. The Department may revoke this permit if the applicant or permittee has knowingly and willfully misrepresented a material fact in the application for the permit. Revocation will be made in writing, and an administrative appeal may be taken to the Secretary of the Department within thirty (30) days. Appeals will be handled in accordance with the Department's Rules Governing Appeals From Compliance Orders.

B. The Department shall automatically cancel any permit for any source which ceases operation for five (5) years or more, or permanently. Reactivation of any source after the five (5) year period shall require a new permit. (20.2.72 NMAC)

C. The Department may cancel a permit if the construction or modification is not commenced within two (2) years from the date of issuance or if, during the construction or modification, work is suspended for a total of one (1) year. (20.2.72 NMAC)

B114 Notification to Subsequent Owners

A. The permit and conditions apply in the event of any change in control or ownership of the Facility. No permit modification is required in such case. However, in the event of any such change in control or ownership, the permittee shall notify the succeeding owner of the permit and conditions and shall notify the Department’s Program Manager, Permits Section of the change in ownership within fifteen (15) days of that change. (20.2.72.212.C NMAC)

B. Any new owner or operator shall notify the Department’s Program Manager, Permits Section, within thirty (30) days of assuming ownership, of the new owner’s or operator’s name and address. (20.2.73.200.E.3 NMAC)

B115 Asbestos Demolition

A. Before any asbestos demolition or renovation work, the permittee shall determine whether 40 CFR 61 Subpart M, National Emissions Standards for Asbestos applies. If required, the permittee shall notify the Department's Program Manager, Compliance and Enforcement Section using forms furnished by the Department.

B116 Short Term Engine Replacement

A. The following Alternative Operating Scenario (AOS) addresses engine breakdown or periodic maintenance and repair, which requires the use of a short term replacement engine. The following requirements do not apply to engines that are exempt per 20.2.72.202.B(3) NMAC. Changes to exempt engines must be reported in accordance with 20.2.72.202.B NMAC. A short term replacement engine may be substituted for any engine allowed by this permit for no more than 120 days in any rolling twelve month period per permitted engine. The compliance demonstrations required as part of this AOS are in addition to any other compliance demonstrations required by this permit.

(1) The permittee may temporarily replace an existing engine that is subject to the emission limits set forth in this permit with another engine regardless of manufacturer, model, and horsepower without modifying this permit. The permittee shall submit written notification to the Department within 15 days of the date of engine substitution according to condition B110.C(1).

(a) The potential emission rates of the replacement engine shall be determined using the replacement engine's manufacturer specifications and shall comply with the existing engine's permitted emission limits.

(b) The direction of the exhaust stack for the replacement engine shall be either vertical or the same direction as for the existing engine. The replacement engine's stack height and flow parameters shall be at least as effective in the dispersion of air pollutants as the modeled stack height and flow parameters for the existing permitted engine. The following equation may be used to show that the replacement engine disperses pollutants as well as the existing engine. The value calculated for the replacement engine on the right side of the equation shall be equal to or greater than the value for the existing engine on the left side of the equation. The permitting page of the Air Quality Bureau website contains a spreadsheet that performs this calculation.

<u>EXISTING ENGINE</u> <u>REPLACMENT ENGINE</u>

$$\frac{[(g) \text{ x } (h1)] + [(v1)^2/2] + [(c) \text{ x } (T1)]}{q1} \mathrel{<=} \frac{[(g) \text{ x } (h2)] + [(v2)^2/2] + [(c) \text{ x } (T2)]}{q2}$$

Where
g = gravitational constant = 32.2 ft/sec^2
h1 = existing stack height, feet
v1 = exhaust velocity, existing engine, feet per second
c = specific heat of exhaust, 0.28 BTU/lb-degree F
T1 = absolute temperature of exhaust, existing engine = degree F + 460
q1 = permitted allowable emission rate, existing engine, lbs/hour
h2 = replacement stack height, feet
v2 = exhaust velocity, replacement engine, feet per second
T2 = absolute temperature of exhaust, replacement engine = degree F + 460
q2 = manufacturer's potential emission rate, replacement engine, lbs/hour

The permittee shall keep records showing that the replacement engine is at least as effective in the dispersion of air pollutants as the existing engine.

(c) Test measurement of NOx and CO emissions from the temporary replacement engine shall be performed in accordance with Section B111 with the exception of Condition B111A(2) and B111B for EPA Reference Methods Tests or Section B111C for portable analyzer test measurements. Compliance test(s) shall be conducted within fifteen (15) days after the unit begins operation, and records of the results shall be kept according to section B109.B. This test shall be performed even if the engine is removed prior to 15 days on site.

  i. These compliance tests are not required for an engine certified under 40CFR60, subparts IIII, or JJJJ, or 40CFR63, subpart ZZZZ if the permittee demonstrates that one of these requirements causes such engine to comply with all emission limits of this permit. The permittee shall submit this demonstration to the Department within 48 hours of placing the new unit into operation. This submittal shall include documentation that the engine is certified, that the engine is within its useful life, as defined and specified in the applicable requirement, and shall include calculations showing that the applicable emissions standards result in compliance with the permit limits.

  ii. These compliance tests are not required if a test was conducted by portable analyzer or by EPA Method test (including any required by 40CFR60, subparts IIII and JJJJ and 40CFR63, subpart ZZZZ) within the last 12 months. These previous tests are valid only if conducted at the same or lower elevation as the existing engine location prior to commencing operation as a temporary replacement. A copy of the test results shall be kept according to section B109.B.

(d) Compliance tests for NOx and CO shall be conducted if requested by the Department in writing to determine whether the replacement engine is in compliance with applicable regulations or permit conditions.

(e) Upon determining that emissions data developed according to B116.A.1(c) fail to indicate compliance with either the NOx or CO emission limits, the permittee shall notify the Department within 48 hours. Also within that time, the permittee shall implement one of the following corrective actions:

i. The engine shall be adjusted to reduce NOx and CO emissions and tested per B116.A.1(c) to demonstrate compliance with permit limits.

ii. The engine shall discontinue operation or be replaced with a different unit.

(2) Short term replacement engines, whether of the same manufacturer, model, and horsepower, or of a different manufacturer, model, or horsepower, are subject to all federal and state applicable requirements, regardless of whether they are set forth in this permit (including monitoring and recordkeeping), and shall be subject to any shield afforded by this permit.

(3) The permittee shall maintain a contemporaneous record documenting the unit number, manufacturer, model number, horsepower, emission factors, emission test results, and serial number of any existing engine that is replaced, and the replacement engine. Additionally, the record shall document the replacement duration in days, and the beginning and end dates of the short term engine replacement.

(4) The permittee shall maintain records of a regulatory applicability determination for each replacement engine (including 40CFR60, subparts IIII and JJJJ and 40CFR63, subpart ZZZZ) and shall comply with all associated regulatory requirements.

B. Additional requirements for replacement of engines at sources that are major as defined in regulation 20.2.74 NMAC, Permits – Prevention of Significant Deterioration, section 7.AG. For sources that are major under PSD, the total cumulative operating hours of the replacement engine shall be limited using the following procedure:

(1) Daily, the actual emissions from the replacement engine(s) of each pollutant regulated by this permit for the existing engine shall be calculated and recorded.

(2) The sum of the total actual emissions since the commencement of operation of the replacement engine(s) shall not equal or exceed the significant emission rates in Table 2 of 20.2.74 NMAC, section 502 for the time that the replacement engine is located at the facility.

C. All records required by this section shall be kept according to section B109.

PART C MISCELLANEOUS

C100 Supporting On-Line Documents

A. Copies of the following documents can be downloaded from NMED's web site under Compliance and Enforcement or requested from the Bureau.

(1) Excess Emission Form (for reporting deviations and emergencies)

(2) Universal Stack Test Notification, Protocol and Report Form and Instructions

C101 Definitions

A. **"Daylight"** is defined as the time period between sunrise and sunset, as defined by the Astronomical Applications Department of the U.S. Naval Observatory. (Data for one day or a table of sunrise/sunset for an entire year can be obtained at http://aa.usno.navy.mil/. Alternatively, these times can be obtained from a Farmer's Almanac or from http://www.almanac.com/rise/).

B. **"Decommission"** and **"Decommissioning"** applies to units left on site (not removed) and is defined as the complete disconnecting of equipment, emission sources or activities from the process by disconnecting all connections necessary for operation (i.e. piping, electrical, controls, ductwork, etc.).

C. **"Exempt Sources"** and **"Exempt Activities"** is defined as those sources or activities that are exempted in accordance with 20.2.72.202 NMAC. Note; exemptions are only valid for most 20.2.72 NMAC permitting actions.

D. **"Fugitive Emission"** means those emissions which could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening.

E. **"Insignificant Activities"** means those activities which have been listed by the department and approved by the administrator as insignificant on the basis of size, emissions or production rate. Note; insignificant activities are only valid for 20.2.70 NMAC permitting actions.

F. **"Malfunction"** for the requirements under 20.2.7 NMAC, means any sudden and unavoidable failure of air pollution control equipment or process equipment beyond the control of the owner or operator, including malfunction during startup or shutdown. A failure that is caused entirely or in part by poor maintenance, careless operation, or any other preventable equipment breakdown shall not be considered a malfunction. (20.2.7.7.E NMAC)

G. **"Natural Gas"** is defined as a naturally occurring fluid mixture of hydrocarbons that contains 20.0 grains or less of total sulfur per 100 standard cubic feet (SCF) and is either composed of at least 70% methane by volume or has a gross calorific value of between 950 and 1100 Btu per standard cubic foot. (40 CFR 60.631)

H. **"Natural Gas Liquids"** means the hydrocarbons, such as ethane, propane, butane, and pentane, that are extracted from field gas. (40 CFR 60.631)

I. **"National Ambient air Quality Standards"** means, unless otherwise modified, the primary (health-related) and secondary (welfare-based) federal ambient air quality standards promulgated by the US EPA pursuant to Section 109 of the Federal Act.

J. **"Night"** is the time period between sunset and sunrise, as defined by the Astronomical Applications Department of the U.S. Naval Observatory. (Data for one day or a table of sunrise/sunset for an entire year can be obtained at http://aa.usno.navy.mil/. Alternatively, these times can be obtained from a Farmer's Almanac or from http://www.almanac.com/rise/).

K. **"Night Operation** or **Operation at Night"** is operating a source of emissions at night.

L. **"NO2"** or "Nitrogen dioxide" means the chemical compound containing one atom of nitrogen and two atoms of oxygen, for the purposes of ambient determinations. The term **"nitrogen dioxide,"** for the purposes of stack emissions monitoring, shall include nitrogen dioxide (the chemical compound containing one atom of nitrogen and two atoms of oxygen), nitric oxide (the chemical compound containing one atom of nitrogen and one atom of oxygen), and other oxides of nitrogen which may test as nitrogen dioxide and is sometimes referred to as NOx or NO_2. (20.2.2 NMAC)

M. "**NOx**" see NO_2

N. "**Paved Road**" is a road with a permanent solid surface that can be swept essentially free of dust or other material to reduce air re-entrainment of particulate matter. To the extent these surfaces remain solid and contiguous they qualify as paved roads: concrete, asphalt, chip seal, recycled asphalt and other surfaces approved by the Department in writing.

O. **"Potential Emission Rate"** means the emission rate of a source at its maximum capacity to emit a regulated air contaminant under its physical and operational design, provided any physical or operational limitation on the capacity of the source to emit a regulated air contaminant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored or processed, shall be treated as part of its physical and operational design only if the limitation or the effect it would have on emissions is enforceable by the department pursuant to the Air Quality Control Act or the federal Act.

P. "**Restricted Area**" is an area to which public entry is effectively precluded. Effective barriers include continuous fencing, continuous walls, or other continuous barriers approved by the Department, such as rugged physical terrain with a steep grade that would require special equipment to traverse. If a large property is completely enclosed by fencing, a restricted area within the property may be identified with signage only. Public roads cannot be part of a Restricted Area.

Q. **"Shutdown"** for requirements under 20.2.72 NMAC, means the cessation of operation of any air pollution control equipment, process equipment or process for any purpose, except routine phasing out of batch process units.

R. **"SSM"** for requirements under 20.2.7 NMAC, means routine or predictable startup, shutdown, or scheduled maintenance.

(1) **"Shutdown"** for requirements under 20.2.7 NMAC, means the cessation of operation of any air pollution control equipment or process equipment.

(2) **"Startup"** for requirements under 20.2.7 NMAC, means the setting into operation of any air pollution control equipment or process equipment.

S. **"Startup"** for requirements under 20.2.72 NMAC, means the setting into operation of any air pollution control equipment, process equipment or process for any purpose, except routine phasing in of batch process units.

C102 Acronyms

2SLB	2-stroke lean burn
4SLB	4-stroke lean burn
4SRB	4-stroke rich burn
acfm	actual cubic feet per minute
AFR	air fuel ratio
AP-42	EPA Air Pollutant Emission Factors
AQB	Air Quality Bureau
AQCR	Air Quality Control Region
ASTM	American Society for Testing and Materials
Btu	British thermal unit
CAA	Clean Air Act of 1970 and 1990 Amendments
CEM	continuous emissions monitoring
cfh	cubic feet per hour
cfm	cubic feet per minute
CFR	Code of Federal Regulation
CI	compression ignition
CO	carbon monoxides
COMS	continuous opacity monitoring system
EIB	Environmental Improvement Board
EPA	United States Environmental Protection Agency
gr/100 cf	grains per one hundred cubic feet
gr/dscf	grains per dry standard cubic foot
GRI	Gas Research Institute
HAP	hazardous air pollutant
hp	horsepower
H_2S	hydrogen sulfide
IC	internal combustion
KW/hr	kilowatts per hour

lb/hr	pounds per hour
lb/MMBtu	pounds per million British thermal unit
MACT	Maximum Achievable Control Technology
MMcf/hr	million cubic feet per hour
MMscf	million standard cubic feet
N/A	not applicable
NAAQS	National Ambient Air Quality Standards
NESHAP	National Emission Standards for Hazardous Air Pollutants
NG	natural gas
NGL	natural gas liquids
NMAAQS	New Mexico Ambient Air Quality Standards
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMSA	New Mexico Statues Annotated
NOx	nitrogen oxides
NSCR	non-selective catalytic reduction
NSPS	New Source Performance Standard
NSR	New Source Review
PEM	parametric emissions monitoring
PM	particulate matter (equivalent to TSP, total suspended particulate)
PM_{10}	particulate matter 10 microns and less in diameter
$PM_{2.5}$	particulate matter 2.5 microns and less in diameter
pph	pounds per hour
ppmv	parts per million by volume
PSD	Prevention of Significant Deterioration
RATA	Relative Accuracy Test Assessment
RICE	reciprocating internal combustion engine
rpm	revolutions per minute
scfm	standard cubic feet per minute
SI	spark ignition
SO_2	sulfur dioxide
SSM	Startup Shutdown Maintenance (see SSM definition)
TAP	Toxic Air Pollutant
TBD	to be determined
THC	total hydrocarbons
TSP	Total Suspended Particulates
tpy	tons per year
ULSD	ultra low sulfur diesel
USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator Coordinate system
UTMH	Universal Transverse Mercator Horizontal
UTMV	Universal Transverse Mercator Vertical
VHAP	volatile hazardous air pollutant
VOC	volatile organic compounds

STATE OF NEW MEXICO
ENVIRONMENTAL IMPROVEMENT BOARD

IN THE MATTER OF THE PETITION FOR HEARING
ON AIR QUALITY PERMIT
NO. 9295, ROPER CONSTRUCTION INC.'S
ALTO CONCRETE BATCH PLANT **EIB No. 22-34**

Roper Construction Inc.,
Petitioner

TECHNICAL REBUTTAL TESTIMONY OF RHONDA ROMERO

I. INTRODUCTION

Please state your name and job title for the Record.

My name is Rhonda Romero. I am the Manager for the Minor Source Unit of the Permitting Section of the Air Quality Bureau ("AQB" or "Bureau") of the New Mexico Environment Department ("NMED" or "Department"). I present written rebuttal testimony on behalf of the Bureau for the public hearing on the appeal petition filed by Roper Construction Inc. ("Petitioner" or RCI) in EIB 22-34. The Petitioner challenges the denial of Air Quality Permit No. 9295. The Department issued the Final Order, denying Air Quality Permit No. 9295 on June 22, 2022 based on the Hearing Officer's Report and Findings of Fact and Conclusions of Law in Case No. AQB 21-57 (P). The Petitioner contends its air quality permit application "complied with all applicable state and federal requirements for approval, but was denied by the Deputy Secretary based on several misapplications of law and facts." **[Petition at 2]**. The Alto Coalition for Environmental Preservation ("CEP") filed a Statement of Intent ("Alto CEP SOI") to present technical testimony, including direct written testimonies from various witnesses.

Can you tell us the general nature of your rebuttal testimony?

My testimony will address the following topics: my qualifications and the Bureau's responses to portions of written testimonies of Carlos Ituarte-Villarreal, Brad Sohm, and Breanna

Bernal. **[Alto CEP Exhibit 1, pages 4, 5, 8, 9, 10, 12-13; Exhibit 14, pages 2-5; and Exhibit 16, page 3].**

II. QUALIFICATIONS

Can you please give your qualifications and job duties with NMED?

I have worked for NMED AQB for the past 9.5 years. I worked as a permit specialist until July 2018, when I was promoted to my current position as the Manager of the Minor Source Unit. As a permit specialist I worked on 521 air quality permitting actions, including numerous complex industrial facility air quality permits. As a Permit Specialist, I performed technical and regulatory review of complex Air Quality Bureau permit applications within regulatory deadlines. I verified emissions calculations; determined applicable state and federal regulations; coordinated with various stakeholders including the public, industry, consultants, other air agencies, and AQB staff; wrote legally enforceable air permits and technical support documents for the administrative record; entered data into the AQB database; and completed various special projects to achieve AQB goals. As Section Manager, I oversee the air quality permitting process for Minor Sources in the state of New Mexico. I manage eight (8) Full-Time Equivalent (FTE) positions.

I received my Bachelor of Science in Environmental Geology from New Mexico Highlands University and my Master of Science in Geology from New Mexico Highlands University.

My complete background and qualifications are listed in my resume, which is marked as **[NMED Exhibit 5].**

III. RESPONSES TO PORTIONS OF DR. ITUARTE-VILLARREAL'S TESTIMONY

Dr. Ituarte-Villareal stated, "The silt loading refers to the mass of silt-size material per unit area of travel surface, which is expressed as grams per meter squared (ug/m2). The

U.S. EPA has calculated specific silt loading factors for particular haul roads associated with industrial facilities, including concrete batch plants." [Alto CEP Exhibit 1, page 4]. Can you respond to this statement?

Silt loading is defined in AP-42 Chapter 13.2.1 for Paved Roads as the mass of silt sized material (equal to or less than 75 micrometers [µm] in physical diameter) per unit area of travel surface in grams per square meter (g/m2).**[NMED EIB Rebuttal Exhibit 5, page 2]**. Dr. Ituarte-Villareal frequently references the unit of measure for the silt loading emission factor in his oral testimony as micrograms per square meter (ug/m2), but the unit of measure is grams per square meter (g/m2) in AP-42 Chapter 13.2.1.

Dr. Ituarte-Villareal stated, "that there is a particular silt loading emission factor used for concrete batch plants by the U.S. EPA expressed as 12 µg/m2." [Alto CEP Exhibit 1, page 5]. Can you elaborate on this silt loading emission factor?

AP-42 Chapter 13.2.1 does contain a specific silt loading emission factor for concrete batch plants, but the emission factor is based on three (3) tests on uncontrolled haul roads. **[NMED EIB Rebuttal Exhibit 7, page 35]**. The proposed haul road at the proposed RCI-Alto Concrete Batch Plant (CBP) is currently unpaved but will be paved and silt build up will be minimized by either sweeping or watering to control particulate matter diameters of 10 µm or smaller (PM 10) and particulate matter diameters of 2.5 µm or smaller (PM2.5).

Dr. Ituarte-Villareal stated, "NMED witnesses likewise were unfamiliar with the use of that loading factor." [Alto CEP Exhibit 1, page 5] In addition, Dr. Ituarte-Villareal stated, "My recollection is that Ms. Romero who is responsible for reviewing all applicable regulations, presented no testimony about the correct emission factor for the concrete batch plant haul roads as set forth in AP-42. The Hearing Officer Specifically noted this omission

in paragraph 96 of his findings of fact." [Alto CEP Exhibit 1, page 8]. Can you address the Bureau's familiarity with the silt loading emission factor in question and the subsequent statement?

Dr. Deepika Saikrishnan evaluated every calculation and input (including emission factors) for appropriateness in the air quality permit application for the RCI- Alto CBP and she discussed the use of this specific emission factor with her managers. As mentioned in my direct written technical testimony **[NMED EIB Exhibit 1, pages 6-7]** there were multiple reasons the Bureau accepted the silt loading emission factor for the haul road emission calculations in the original application **[AR 1, Bates 0040]** that was submitted by RCI.

The question related to the silt loading factor was brought up by Mr. Hnasko to Mr. Eric Peters in the initial 2-9-2022 hearing. Eric Peters was not the appropriate witness to be questioned on the emission calculations. He is an air dispersion modeler. The permit specialist has the responsibility of vetting the emission calculations. Mr. Peters appropriately excused himself from responding to the question about the silt loading emission factor. Mr. Peters responded to the question bringing awareness that he was not the appropriate witness to answer the question and pointed out that the permit writer was the appropriate witness to respond to that question. **[2-9-22 1 Tr. 170: 17-25, 171: 1-25, 172: 1-25, and 173:1-25]** The question was never re-routed to the appropriate witness.

Dr. Ituarte-Villareal stated, "The number of anticipated trips is irrelevant to using the correct emission factor. The number of trips will influence the total daily emissions, but will not have any influence on the appropriate silt loading factor to be used in the per trip basis. There is no justification for the NMED's statement in this regard." [Alto CEP Exhibit 1, page 8]. Can you elaborate on this?

AP-42 Chapter 13.2.1, Table 13.2.1-2 assigns categories for average daily traffic (ADT). RCI's consultant initially used the ADT category of less than 500 trucks with an associated ubiquitous baseline silt loading emission factor of 0.6 g/m2. This is not the only reason the Bureau accepted the emission factor. In the draft permit version 2021-12-30 **[NMED EIB Exhibit 11]** the paved haul road emissions were limited through more than one permit condition. Conditions A112.A, A112.B and A112.C included requirements to limit the amount of haul road trips and to control particulate emissions from the haul roads. In addition, Conditions A108.A and A108.B limited the hours of operation at the facility and the facility throughput. The applicant used the most appropriate silt loading emission factor from Chapter 13, Table 13.2.1-2. In addition, the AP-42 emission factor value of 0.6 g/m2 is appropriate because it applies to paved roads with less than 500 trips per day. Table 13.2.1-2 considers an average daily traffic (ADT) characterization within it and the category that the Alto CBP haul road was appropriately pulled into was the <500 ADT per day. The draft permit version 2021-12-30 **[NMED EIB Exhibit 11]** limited the amount of truck traffic to 305 haul road trips per day. In addition, more specifically, draft permit Condition A112.B required that the haul road be maintained to minimize silt buildup to reduce particulate emissions through the application of water or other control measures such as sweeping. The AP-42 silt loading emission factor from Chapter 13, Table 13.2.1-3 for concrete batching plants is not appropriate because it applies to uncontrolled paved roads. The proposed haul road at the Alto CBP would be required to reduce particulate emissions by maintaining the paved road to reduce silt buildup, limiting truck traffic, and limiting the hours of operation and throughput at the facility.

Dr. Ituarte-Villareal stated, "NMED does have guidance, although it is not specific to paved haul roads within a concrete batching facility, as set forth in AP-42. The guidance requires for haul road emissions to be calculated using the methodology set forth in EPA's

AP-42 Chapter 13.2.2 for unpaved haul roads. NMED's guidance also specifies the use of a surface material silt content default value of 4.8%, and the Department accepted control efficiencies for various haul road control measures." Can you address this statement?

The Department has issued guidance titled "Department Accepted Values for: Aggregate Handling, Storage Pile, and Haul Road Emissions" **[NMED EIB Rebuttal Exhibit 9]** that is meant to apply solely to emission calculations being prepared from AP-42 Chapter 13.2.2 and does not apply to emission calculations prepared from AP-42 Chapter 13.2.1.

Dr. Ituarte-Villareal stated, "the emission factor for silt content in the Department's guidance is less than the AP-42 Chapter 13.2.1 silt loading emission factor." [Alto CEP Exhibit 1, page 8-9]. Can you address this?

Silt loading and silt content are represented in two different units of measurement when comparing both AP-42 chapters. The silt loading emission factor variable is represented in g/m2 in AP-42 Chapter 13.2.1 **[NMED EIB Rebuttal Exhibit 5]** and silt content is represented as a percentage in AP-42 Chapter 13.2.2 **[NMED EIB Rebuttal Exhibit 6]**.

Dr. Ituarte-Villareal stated, "The NMED apparently did not even use its own guidance when reviewing this particular application, but allowed Roper to use an emission rate applicable to paved public roads of 0.6 µg/m2." [Alto CEP Exhibit 1, page 9]. Can you explain the relevance of the Bureau's issued guidance to AP-24 Chapter 13.2.1?

The guidance titled "Department Accepted Values for: Aggregate Handling, Storage Pile, and Haul Road Emissions" posted January 1, 2017 **[NMED EIB Rebuttal Exhibit 9]** was written specifically for applicants utilizing the Unpaved Roads Chapter 13.2.2 of AP-42 to calculate emissions. RCI utilized the Paved Road AP-42 Chapter 13.2.1 **[NMED EIB Rebuttal Exhibit 5]** to calculate haul road emissions. The guidance **[NMED EIB Rebuttal Exhibit 9]** for Chapter

13.2.2 of AP-42 is not pertinent. To clarify, application of the guidance is not a requirement. The applicant may choose to rely on data that is more representative of facility operations. The applicant may decide to rely on AP-42, test results, or other calculation methodologies pre-approved by the Bureau.

Dr. Ituarte-Villareal was asked in his oral testimony, " Do you know any basis for the NMED to depart from its own guidance in determining haul road emissions or not using the specific standards set forth in AP-42 for haul roads within concrete batch plants?" [Alto CEP Exhibit 1, page 10]. He responded "No, I do not. That was never explained by Roper or by any NMED witness at the hearing. Based on my experience, it is not justifiable to depart from this common emission standards for this type of facility." Can you elaborate further on this?

As mentioned previously, the Bureau determined that the silt loading emission factor of 12 g/m2 in Table 13.2.1-3 was not appropriate because the proposed haul road will be controlled and this emission factor did not take into consideration control measures applied to haul roads. AP-42, Chapter 13.2.1 specifically addresses that controls on paved haul roads will affect the silt loading and suggest that controlled emission factors may be obtained by substituting controlled silt loading values in the equation **[NMED EIB Rebuttal Exhibit 5, page 11].** Also mentioned previously, the Department guidance was not relied upon because the guidance does not apply to emission calculations prepared from AP-42 Chapter 13.2.1.

IV. RESPONSES TO PORTIONS OF MR. BRAD SOHM'S TESTIMONY

Mr. Sohm states, "I provided expert testimony regarding the proposed plant during a preliminary injunction hearing before Judge John Sugg in the Twelfth Judicial District Court in May and June earlier this year in an action to enforce deed restrictions placed on

certain lots, including Roper's lot, which prevent any use that would cause a nuisance to adjoining landowners by virtue of, among other things, noise." [Alto CEP Exhibit 14, page 2]. Can you discuss the relevance of the deed restriction injunction hearing to the air quality permit application?

The NMED-AQB was not involved in this hearing and has no jurisdiction over deed restrictions or proceedings related to them. In addition, the Bureau does not have any jurisdiction over nuisances such as noise.

Mr. Sohm states, "I provided testimony regarding the noise impacts of the concrete batch plant on behalf of the owners of the tracts adjacent to the lots where Roper intends to construct and operate the plant." [Alto CEP Exhibit 14, page 3]. Again, can you discuss the relevance of the deed restriction injunction hearing to the air quality permit application?

The NMED-AQB was not involved in this hearing and has no jurisdiction over deed restrictions or proceedings related to them. In addition, the Bureau does not have any jurisdiction over nuisances that are not specifically related to air quality, such as noise.

Mr. Sohm states, "In an effort to reduce the noise impacts from the operation of the CBP at the adjoining lots, Roper and the noise expert claimed that CBP plant would only operate from 7 am until 3 pm. However, the Application demonstrates that Roper's proposed CBP plant hours of operation are 3 am until 9 pm for May through August, 4 am until 9 pm from April and September, 5 am until 7 pm for March and October, and 7 am until 6 pm for January, February, November, and December. This information is found in Table 3-1 in Section 3 and in Section 16-k of the Application. In addition, Roper and the noise expert claimed there would only be approximately 2 trucks per hour, not the 20 trucks per hour represented in Table 2-A of the Application." [Alto CEP Exhibit 14, page 3].

The draft permit **[NMED EIB Exhibit 11]** is based on what was presented in the air quality permit application and the applicant is required to operate in accordance with the requirements in the permit based on what is represented in the permit application. The Bureau did not compare the information from the nuisance hearing to what they represented in their air quality permit application. The Bureau does not have jurisdiction over deed restrictions related to noise. The data and information in the permit application is what is considered in the permitting process.

If the applicant chooses to operate outside of what is allowed in the permit, they may be subject to enforcement action.

Mr. Sohm was questioned in his oral testimony "In your experience, do applicants change operations in the manner suggested by Roper and the noise expert while an application is still pending?" He responded "No. Under all statutory and regulatory schemes governing air quality permits, an applicant must provide accurate information, including duration of operations and number of trucks traveling on the haul roads. Modeling is then conducted to determine the maximum hourly emissions at the maximum capacity requested by the applicant to ensure compliance with applicable air quality standards. The information utilized to analyze and model a proposed facility comes from the application, which is why the information in an application must be accurate." [Alto CEP Exhibit 14, page 4]. Can you elaborate on this topic?

The information must be accurate in the permit application. The information provided at the nuisance hearing is not pertinent to the air quality permit application or the draft permit.

The AQB did not review the information provided at the nuisance hearing. The Bureau solely reviewed the air quality permit application and incorporated those updates into the draft permit as appropriate.

Mr. Sohm was asked in his oral testimony, "Is there a requirement that an applicant provide accurate information in an application for an air quality construction permit?" He responded "Yes. Section 22 of the Application is a Certification, sworn before a notary public, that "the information and date submitted in this Application are true and as accurate as possible…" Ryan Roper signed this Certification for this Application, swearing that the information and data was accurate." [Alto CEP Exhibit 14, page 4]. Is this correct?

Yes. the certification is required to be signed by the applicant before a notary public certifying that the contents of the application are true and as accurate as possible.

Mr. Sohm was questioned in his oral testimony, "What is the effect of the application's proposed hours of operations and proposed truck trips?" He responded "The NMED has in fact authorized Roper to operate for 18 hours a day for four (4) months out of the year, as requested in the Application. This is demonstrated in the Draft Permit, Condition A108(A). The NMED has also authorized 20.3 truck trips per hour as demonstrated in Condition A112(A). If the NMED Draft Permit is issued to Roper, Roper will be able to operate during the hours authorized and will be able to process 20 trucks per hour at the CPB plant." [Alto CEP Exhibit 14, pages 4 - 5]. Can you address this topic?

Yes. These hours of operation and the amount of hourly trucks were represented as maximum hours of operation and trucks per hour in the permit application. To clarify the 18-hour timeframe mentioned by Mr. Sohm, based on the throughput limits in permit condition A108.A (daily throughput divided by hourly capacity) **[NMED EIB Exhibit 11]** RCI would be limited to 15 hours a day, but could operate any hour within that 18-hour timeframe.

Mr. Sohm was questioned in his oral testimony, "In your opinion, is it appropriate to make significant changes to an application after the modeling for the project has been submitted

to a federal or state agency for approval?" He responded "No, it is not. As I mentioned before, the Applicant must attest that the Application contains information and data that is accurate. If the Applicant makes changes to the operations in the Application, the Applicant has a duty to amend the Application and submit revised supporting information regarding those changes." [Alto CEP Exhibit 14, page 5]. Can you respond to this topic?

It is not appropriate to make updates to the application without making the appropriate updates to the air dispersion modeling. As mentioned previously, the information provided at the nuisance hearing is not pertinent to the air quality permit application. The Bureau relies on the information provided in the air quality permit application.

V. RESPONSES TO A PORTION OF MS. BREANNA BERNAL'S TESTIMONY

Ms. Bernal stated, "I also testified regarding the Applicant's choice to decline to employ emission control methods or technology to control emissions on haul roads as demonstrated in Section 6, p.8 of the Application. In the NMED Draft Permit, however, Condition A112, Section B, requires Roper to maintain the haul roads to minimize silt buildup to control emissions by applying water to the haul roads, sweeping the haul roads would be the only alternative to comply with the NMED-imposed condition to minimize silt buildup on the haul roads. The Applicant did not supply any evidence regarding either applying water to the haul roads or sweeping the haul roads. Accordingly, there is no evidence that the Applicant will or can, comply with the Draft Permit Condition." [Alto CEP Exhibit 16, page 3]. Can you respond to this?

To clarify, when an applicant uses emission control methods in their emission calculations, and they certify to those emission calculations in Section 22 of the application, then the Bureau implements the requirements for controls in the draft permits and the applicant is required to comply with the requirements in the permit. "Kathleen Primm will discuss issues related to water availability in her rebuttal testimony. **[NMED EIB Rebuttal Exhibit 2].**

VIII. CONCLUSION

What are your conclusions on the air quality permit application and draft permit for the proposed Alto CBP?

The AQB verified the contents of the air quality permit application and application updates. The draft permit was based on the contents of the Alto CBP application and included conditions necessary to demonstrate compliance with applicable air quality regulations and ambient air quality standards. If the applicant complies with the requirements in the draft permit, compliance would be achieved through monitoring, recordkeeping, and reporting protocols detailed in the draft permit. The facility as described and represented in the Alto CBP application demonstrates compliance with applicable federal and state air quality regulations.

STATE OF NEW MEXICO
ENVIRONMENTAL IMPROVEMENT BOARD

IN THE MATTER OF THE PETITION FOR
HEARING ON AIR QUALITY PERMIT NO.
9295, ROPER CONSTRUCTION, INC.'S
ALTO CONCRETE BATCH PLANT **No. EIB 22-34**

Roper Construction Inc.,
Petitioner

TECHNICAL REBUTTAL TESTIMONY OF KATHLEEN PRIMM

I. INTRODUCTION

Please state your name and job title for the Record.

My name is Kathleen Primm. I am a Supervisor in the Minor Source Unit of the Permitting Section of the Air Quality Bureau ("AQB") of the New Mexico Environment Department ("Department"). I present this written technical rebuttal testimony on behalf of the AQB for the public hearing on the appeal petition filed by Roper Construction, Inc. ("Petitioner" or "RCI"). The Petitioner challenges the denial of Air Quality Permit No. 9295 for RCI's proposed Alto Concrete Batch Plant ("CBP") in Lincoln County, New Mexico. The Department issued the Final Order, denying Air Quality Permit No. 9295 on June 22, 2022 based on the Hearing Officer's Report and Findings of Fact and Conclusions of Law in Case No. AQB 21-57 (P). The Petitioner contends its air quality permit application "complied with all applicable state and federal requirements for approval but was denied by the Deputy Secretary based on several misapplications of law and facts." **[Petition at 2].**

Can you tell us about the general nature of your testimony?

The Alto Coalition for Environmental Preservation ("CEP") filed a Statement of Intent ("Alto CEP SOI") to present technical testimony, including direct written testimonies from various witnesses. My testimony will present my qualifications and the AQB's responses to portions of written testimonies of Carlos Ituarte-Villarreal, Breanna Bernal, and Eluid L. Martinez. **[Alto CEP Exhibit 1, page 13; Exhibit 16, pages 2-6; and Exhibit 20, pages 2-4].**

II. QUALIFICATIONS

Can you please give your qualifications and job duties with the Air Quality Bureau (AQB)?

I have been an employee of the AQB for more than fourteen years, working as a Permit Specialist and a Supervisor. Before being promoted to the Supervisor position in April 2021, I was a Permit Writer in the Minor Source Unit of the Permitting Section of the AQB. As a Permit Writer, I performed technical and regulatory review of complex Air Quality Bureau permit applications within regulatory deadlines. I verified emissions calculations; determined applicable state regulations and federal regulations; coordinated with various stakeholders including the public, industry, consultants, and AQB staff; wrote legally enforceable air permits and technical support documents for the administrative record; entered data into the AQB database; and completed various special projects to achieve AQB goals. I have worked on over 600 permitting actions for the Bureau and trained new staff on regulations, Bureau policies, and application review requirements and procedures for various types of permitting actions. As a Supervisor now, I manage assigned staff in the Minor Source Unit of the Permitting Section of the AQB.

My full background and qualifications are set forth in my resume. **[NMED Exhibit 6].**

III. RESPONSE TO PORTION OF DR. ITUARTE-VILLARREAL'S TESTIMONY

Can you respond to the following statement from Dr. Ituarte-Villarreal? He stated, "the application is unreliable because it does not disclose how many trips water trucks will be made. We also do not know the source of the water to be transported on-site, nor do we know the quantity of water to be used to effectuate the emission controls." [Alto CEP Exhibit 1, page 13].

Water trucks were not excluded from the 305 truck round trips per day limit in Condition A112.A of Draft Permit 9295 version 2021-12-30. **[AR 9, Bates 0366].** [redacted]

Under 20.2.72 of the New Mexico Administrative Code (NMAC), the AQB does not have authority to require RCI to prove what water resource will be used to control particulate emissions as represented in the Alto CBP application. The AQB can, however, enforce on the failure to apply water as represented in the Alto CBP application and emission calculations, and as required by the permit.

The exact amount of water required to control fugitive particulate emissions depends on multiple variables such as precipitation, wind, and temperature. The application specifies additional moisture content to control PM_{10} and $PM_{2.5}$, as listed in Table 2-C: Emissions Control Equipment. **[AR1, Bates 10**[redacted]**].** The application states, "Fugitive dust emissions from material handling sources (Units 3, 4, 5, 6) will be controlled by adding water sprays at the exit of the aggregate/sand feed hopper (EPA AP-42 control efficiency of 95.82%). **[AR 87, Bates 0319**[redacted]**].** The emissions calculations for Units 3-6 were based on controlled emission factors in EPA's AP-42, Section 11.19.2 (08/04), Table 11.19.2-2. **[AR 45, Bates 524**[redacted]**].** The controlled emission factors are based on wet suppression to reduce emissions.

Allowable PM_{10} and $PM_{2.5}$ emission limits for Units 3-6 are based on the emissions calculations with wet suppression controls and established in Table 106.A of the permit. **[AR 9, Bates 0363**[redacted]**].** Compliance with allowable PM_{10} and $PM_{2.5}$ emission limits for Units 3-6 is demonstrated by complying with the requirements in Condition A502.A of the permit. For example, the second requirement in this condition states that if, at any time, visible emissions are observed, additional moisture shall be added to minimize visible emissions. Another example in this condition is the monitoring requirement for inspections to determine the additional moisture is adequate to minimize visible emissions. **[AR. 9, Bates 0369-0370**[redacted]**].** In addition, Condition A502.B of the draft permit requires a Fugitive Dust Control Plan for minimizing emissions from areas such as aggregate feeders, conveyors, storage piles, and other types of fugitive dust emitting sources. **[AR 9, Bates 0370**[redacted]**].**

IV. RESPONSES TO PORTIONS OF MS. BERNAL'S TESTIMONY

Ms. Bernal discussed pre-controlled particulate emissions at Units 3-6 compared to controlled particulate emissions for Units 3-6 and concluded, "The amount of particulate matter emissions from these process units would be higher than the Applicant claims without adequate water controls." [Alto CEP Exhibit 16, pages 2-3]. What is your response?

Water controls were used in emissions calculations for Units 3-6, so they are required by the permit. As stated in the previous response, allowable PM_{10} and $PM_{2.5}$ emission limits for Units 3-6 are based on calculations with wet suppression controls and established in the permit. **[AR 9,**

Bates 0363[redacted] [redacted]**].** Requirements in Conditions A502.A and A502.B are enforceable. **[AR 9, Bates 0369-0370**[redacted]**].**

Can you respond to the following statement from Ms. Bernal? She stated, "The Application has not specified the method and type of water sprays that Roper will use. The Draft Permit requires a "Wet Dust Suppression System" but Roper has not provided any information regarding such a system. Again, there is no evidence that the Application will, or can, comply with the Draft Permit condition requiring a wet dust suppression system." [Alto CEP Exhibit 16, pages 3-4].

Again, the application states, "Fugitive dust emissions from material handling sources (Units 3, 4, 5, 6) will be controlled by adding water sprays at the exit of the aggregate/sand feed hopper (EPA AP-42 control efficiency of 95.82%). **[AR 87, Bates 0319**[redacted] [redacted]**].** The Wet Dust Suppression System (WDSS) requirements, monitoring, recordkeeping, and reporting are addressed in Condition A502.A of the permit. **[AR 9, Bates 0369-0370**[redacted] [redacted]**].** The WDSS includes water sprays or the addition of moisture to minimize fugitive emissions to the atmosphere for those specific units. The WDSS must be operational and functioning properly at all times the facility is operating. If visual emissions are observed at material transfer points, the permit requires that the WDSS be turned on. If there are still visible emissions while the WDSS is on, the permit requires that additional moisture be added. The permit also requires that the WDSS be inspected daily to ensure that the dust control is working efficiently. In addition, there are recordkeeping requirements associated with the WDSS. Records must be kept of all inspections on a daily basis to ensure that the system has been inspected.

Per 20.2.72.200.E NMAC, “For all sources subject to this part, applications for permits shall be filed prior to the commencement of the construction, modification or installation. Regardless of the anticipated commencement date, no construction, modification or installation shall begin prior to issuance of the permit.” Exact makes and models of equipment are not always known when an application is submitted for a facility that requires a permit before it can be constructed.

Ms. Bernal included Alto CEP Exhibit 18 with her direct testimony, as an example of a wet dust suppression system. She stated, “Roper has provided no testimony or evidence, in the Application or otherwise, that it intends to install and operate a system comparable to the system described in this exhibit. Without using water suppression technology, Roper will not achieve the 95.82% control efficiency claimed in the Application.” [Alto CEP Exhibit 16, page 4]. What is your response?

Again, RCI is required to operate according to conditions in the permit which require water controls as represented in the application.

Ms. Bernal provided her calculations regarding the water usage at Units 3-6 and the amount of water necessary to produce the amount of concrete represented in the application. [Alto CEP Exhibit 16, pages 4-5]. Did you see those?

I did see those. Not all of Ms. Bernal’s assumptions were correct. For example, she based water acre feet per day on 18 hours per day when operating at max capacity. **[Alto CEP Exhibit 16, page 5].** The facility throughput is limited by Condition A108.B in the permit. In Draft Permit version 2021-12-30, at a maximum capacity of 125 cubic yards per hour, the maximum hours per day would have been capped at 15 hours per day, and that was only during May through August. Throughputs were lower during other months of the year. **[AR 9, Bates 0364].** [redacted]

[redacted]

Ms. Bernal also provided her calculations regarding how many water trucks per day RCI will need to produce concrete and achieve the claimed 95.82% emission control efficiency. She stated, "The amount of water trucks necessary for the proposed plant's water usage needs will add fugitive dust emissions due to increased vehicle traffic and Roper has not accounted for this increase in truck traffic on the haul roads." [Alto CEP Exhibit 16, page 6]. What is your response?

Again, not all of Ms. Bernal's assumptions were correct. For example, she assumed a 10,000 gallon water tanker truck was used. [redacted] Calculations are complex and include multiple variables. The applicant certified, before a notary of the State of NM, that the information and data submitted are true and as accurate as possible. **[AR 9, Bates 0189].**

V. RESPONSES TO MR. MARTINEZ'S TESTIMONY

Mr. Martinez listed three "potential sources of water that could be provided to the proposed concrete batch plant." He discussed permitted use of water and the process for filing an application to transfer water rights then concluded that "trucking water is the only viable option to provide water to the facility in the near future." [Alto CEP Exhibit 20, pages 2-3]. What is your response?

It's my understanding that water will be trucked to this facility.

Can you respond to the following statement from Mr. Martinez? He stated, "The Applicant has not identified the existence of water storage tanks at the facility. Accordingly, the water

necessary for the operation of the facility and for emissions control must be delivered on a daily basis." [Alto CEP Exhibit 20, page 3].

Water storage tanks were not represented in the Alto CBP application and are not included in the permit because they are not regulated sources of emissions.

Mr. Martinez also stated, "Without an identification of the amount of water that will be consumed to effectuate the emission controls for these four (4) units, there is no way to determine if the Applicant can actually achieve the emission controls identified in the Application." [Alto CEP Exhibit 20, page 3]. What is your response?

Meeting the conditions of the permit demonstrates emission controls identified in the application are met. The applicant certified, before a notary of the State of NM, that the information and data submitted are true and as accurate as possible. **[AR 9, Bates 0189].** Per Condition B101.A of Draft Permit 9295, the contents of a permit application become the terms and conditions of the permit. The permittee shall construct and operate the Facility in accordance with all representations of the application and supplemental submittals that the Department relied upon to determine compliance with applicable regulations and ambient air quality standards. **[AR 9, Bates 0375[redacted]].** On each day of operation, Condition A502.A requires inspection of the WDSS for malfunctions and deficiencies in dust control effectiveness. Any problems with the control devices must be corrected before commencement of operation. **[AR 9, Bates 0369-0370[redacted] [redacted]].**

Mr. Martinez provided his calculations with respect to the amount of water necessary to achieve the emission controls represented in the application. He arrived at "14 acre-feet per year above and beyond the water necessary for the production of concrete." [Alto CEP Exhibit 20, page 4]. What is your response?

Mr. Martinez did not include the specifics of the calculations he used to arrive at 14 acre-feet per year, but this value differed from the value of 9.33 acre-feet per year for process units in Ms. Bernal's testimony.

IV. CONCLUSION

What are your conclusions on the Alto CBP air quality application and the [redacted] Draft Permit for the proposed Alto CBP?

The AQB cannot deny any applicant an air quality permit based on non-air quality issues. The AQB does not have the authority to require RCI to prove that water resources are available to control the emissions as represented in the Alto CBP application. The AQB does, however, have the regulatory authority to enforce on the failure to apply water as represented in the Alto CBP application and as required by the [redacted] Draft Permit. The [redacted] Draft Permit is based on the contents of the Alto CBP application and contains conditions to demonstrate compliance with applicable air quality regulations and ambient standards. The [redacted] Draft Permit ensures the facility operates as stated in the Alto CBP application. This is achieved through monitoring, recordkeeping, and reporting protocols detailed in the [redacted] Draft Permit. The facility as described and represented in the Alto CBP application demonstrates compliance with applicable federal and state air quality regulations, and the [redacted] Draft Permit may be issued.

STATE OF NEW MEXICO
BEFORE THE ENVIRONMENTAL IMPROVEMENT BOARD

IN THE MATTER OF THE PETITION FOR HEARING ON AN AIR QUALITY PERMIT NO. 9295, ROPER CONSTRUCTION, INC.'S ALTO CONCRETE BATCH PLANT — **EIB 22-34 (P)**

TECHNICAL REBUTTAL TESTIMONY OF ERIC PETERS

Can you tell us about the general nature of your testimony?

I will discuss the recent modeling performed by Alto CEP. This modeling is described in the direct testimony and associated exhibits of the parties for the EIB hearing.

REGARDING TESTIMONY AND EXHIBITS OF ALTO CEP'S WITNESS, DR. ITUARTE-VILLARREAL

Page 6 of Dr. Ituarte-Villarreal's written testimony contains the following sentence, "In reviewing a number of applications in the state of Texas, we determined that the concrete batching facilities routinely use the specific loading factor set forth in the U.S. EPA AP-42, which is 12 grams ug*[sic]*/m2". Could you describe the relevance of this testimony to this hearing?

It appears that the point he was trying to make is that concrete batch plants default to higher haul road emission rates in Texas than the calculations that were used in the original application and modeling for this proposed facility. I have not reviewed the evidence to see if it is true that applicants use this uncontrolled emission factor to calculate their haul road emissions because no evidence was provided. The number of facilities examined, their haul road descriptions, and their identities were not provided.

If it is true that concrete batch plants in Texas use 12 g/m^2 silt loading to estimate haul road emissions, it is not relevant in this case. When concrete batch plants like this one are permitted in Texas, they use a permit by rule **[NMED EIB Rebuttal Exhibit 20]**. Page 3 of this permit says, “Owners or operators are not required to submit air dispersion modeling as a part of this concrete batch plant standard permit registration.”

It is no problem for the Texas permit applicants to over-estimate their emissions by using uncontrolled factors because there are no modeling requirements to satisfy. They do not need to read the background documents that describe the haul roads of the single concrete batch plant facility tested as “uncontrolled” **[NMED EIB Rebuttal Exhibit 7, page 35]**. They can simply accept the high rates without doing any additional analysis. An applicant that is required to do modeling will be more likely to need to use accurate emission rates instead of unrepresentatively high emission rates.

The written testimony of Dr. Ituarte-Villarreal is very confusing with respect to the inconsistent and inappropriate use of units of measure. Pages 4 through 7 of his written testimony contains eleven silt loading unit of measure errors.

Silt loading on an impervious surface uses units of grams per square meter, which is abbreviated g/m^2. Pollution concentrations in the air are typically reported in units of micrograms per cubic meter, which is abbreviated $\mu g/m^3$. The letter “u” is frequently used instead of the Greek letter mu (μ), so frequently concentration in air is written as ug/m^3. One gram is exactly one million micrograms.

To visualize the silt loading of 12 g/m^2, one may sprinkle just under a tablespoon of baking powder over a square meter of pavement and then imagine that density extends throughout the entire road. Visualizing air concentrations is much harder because the unit of mass used is a million times smaller.

In conclusion, the evidence does not support the assertion that the original haul road calculations were inappropriate.

Dr. Ituarte-Villarreal testified that he performed modeling starting on page 6 of his testimony. Could you describe your review of his modeling?

Modeling is complicated, and there are many places where errors could occur. Normally when I review modeling, I go through an extensive review process. In this case, neither the emissions calculations nor the total emission rate of the haul roads was provided for anyone to check to see if the calculations were correct. Modeling files were not provided for independent re-running of the models or for examining the inputs or outputs.

AERMOD is the required model for this application and is supplied by EPA. For some pollutants, AERMOD can run a block of five years of meteorological data and built-in post-processing will ensure the correct design value is calculated. For PM10, each of the five years would need to be run separately to get the true high-second-high concentration for each year before those individual results are further processed with other applications, such as spreadsheets.

Dr. Ituarte-Villarreal's testimony and exhibits do not discuss whether the years of data were run as a long block, which would over-estimate concentrations, or were run individually. If they were run individually, no information is provided regarding whether the results from each year were averaged. Dr. Ituarte-Villarreal provided modeling results in the form of plots labeled Alto Exhibits 4 through 7 and a summary table labeled Alto Exhibit 8. The only clues as to how these analyses were done are the file names at the bottom of each exhibit, but this information is mostly covered up with exhibit identification stickers. The plots do indicate that the high-second-high was used, which is correct, if the individual years are treated separately. The high-second-high is the result when the highest concentration at each location, or receptor, is eliminated and the highest of the remaining concentrations is chosen. The reason this is used is that short-term PSD increments, such as the 24-hour PM10 increment, are allowed to be exceeded once per year. Alto Exhibit 8 does not provide the results of each individual year.

Based on the eleven unit of measure errors in his testimony, it is not clear that Dr. Ituarte-Villarreal or anyone else checked his work. Neither modeling files nor sufficient descriptions of methodology were provided for verification. The evidence does not support the suggestion that the facility would cause or contribute to violations of air quality standards or PSD increments.

Page 4 of Dr. Ituarte-Villarreal's written testimony contains the following sentence, "We have been able to re-run the model used my Mr. Wade, but only with the Holloman Air Force data, which we do not believe to be representative." Could you describe the relevance of this testimony to this hearing?

By the time he performed this modeling, he should have also had access to the Sierra Blanca Regional Airport meteorological data. It is interesting that he chose to use the Holloman Air Force Base data that produces higher estimated concentrations instead of the Sierra Blanca Regional Airport data that he indicated was representative if he is interested in accurately representing the facility.

Each facility configuration and meteorological data set that was provided with enough details for my review demonstrated compliance with all applicable air quality standards and PSD increments.

CONCLUSIONS

What are your conclusions considering all the modeling and other the testimony provided?

The facility has satisfied all modeling requirements and the Bureau's recommendation that the permit be issued may be adopted by the Board.

13.2.1 Paved Roads

13.2.1.1 General

Particulate emissions occur whenever vehicles travel over a paved surface such as a road or parking lot. Particulate emissions from paved roads are due to direct emissions from vehicles in the form of exhaust, brake wear and tire wear emissions and resuspension of loose material on the road surface. In general terms, resuspended particulate emissions from paved roads originate from, and result in the depletion of, the loose material present on the surface (i.e., the surface loading). In turn, that surface loading is continuously replenished by other sources. At industrial sites, surface loading is replenished by spillage of material and trackout from unpaved roads and staging areas. Figure 13.2.1-1 illustrates several transfer processes occurring on public streets.

Various field studies have found that public streets and highways, as well as roadways at industrial facilities, can be major sources of the atmospheric particulate matter within an area.[1-9] Of particular interest in many parts of the United States are the increased levels of emissions from public paved roads when the equilibrium between deposition and removal processes is upset. This situation can occur for various reasons, including application of granular materials for snow and ice control, mud/dirt carryout from construction activities in the area, and deposition from wind and/or water erosion of surrounding unstabilized areas. In the absence of continuous addition of fresh material (through localized track out or application of antiskid material), paved road surface loading should reach an equilibrium value in which the amount of material resuspended matches the amount replenished. The equilibrium surface loading value depends upon numerous factors. It is believed that the most important factors are: mean speed of vehicles traveling the road; the average daily traffic (ADT); the number of lanes and ADT per lane; the fraction of heavy vehicles (buses and trucks); and the presence/absence of curbs, storm sewers and parking lanes.[10]

The particulate emission factors presented in a previous version of this section of AP-42, dated October 2002, implicitly included the emissions from vehicles in the form of exhaust, brake wear, and tire wear as well as resuspended road surface material. EPA included these sources in the emission factor equation for paved roads since the field testing data used to develop the equation included both the direct emissions from vehicles and emissions from resuspension of road dust.

This version of the paved road emission factor equation only estimates particulate emissions from resuspended road surface material[28]. The particulate emissions from vehicle exhaust, brake wear, and tire wear are now estimated separately using EPA's MOVES[29] model. This approach eliminates the possibility of double counting emissions. Double counting results when employing the previous version of the emission factor equation in this section and MOVES to estimate particulate emissions from vehicle traffic on paved roads. It also incorporates the decrease in exhaust emissions that has occurred since the paved road emission factor equation was developed. Earlier versions of the paved road emission factor equation includes estimates of emissions from exhaust, brake wear, and tire wear based on emission rates for vehicles in the 1980 calendar year fleet. The amount of PM released from vehicle exhaust has decreased since 1980 due to lower new vehicle emission standards and changes in fuel characteristics.

NMED EIB Rebuttal Exhibit 5

13.2.1.2 Emissions And Correction Parameters

Dust emissions from paved roads have been found to vary with what is termed the "silt loading" present on the road surface. In addition, the average weight and speed of vehicles traveling the road influence road dust emissions. The term silt loading (sL) refers to the mass of silt-size material (equal to or less than 75 micrometers [µm] in physical diameter) per unit area of the travel surface. The total road surface dust loading consists of loose material that can be collected by broom sweeping and vacuuming of the traveled portion of the paved road. The silt fraction is determined by measuring the proportion of the loose dry surface dust that passes through a 200-mesh screen, using the ASTM-C-136 method. Silt loading is the product of the silt fraction and the total loading, and is abbreviated "sL". Additional details on the sampling and analysis of such material are provided in AP-42 Appendices C.1 and C.2.

The surface sL provides a reasonable means of characterizing seasonal variability in a paved road emission inventory. In many areas of the country, road surface loadings [11-21] are heaviest during the late winter and early spring months when the residual loading from snow/ice controls is greatest. As noted earlier, once replenishment of fresh material is eliminated, the road surface loading can be expected to reach an equilibrium value, which is substantially lower than the late winter/early spring values.

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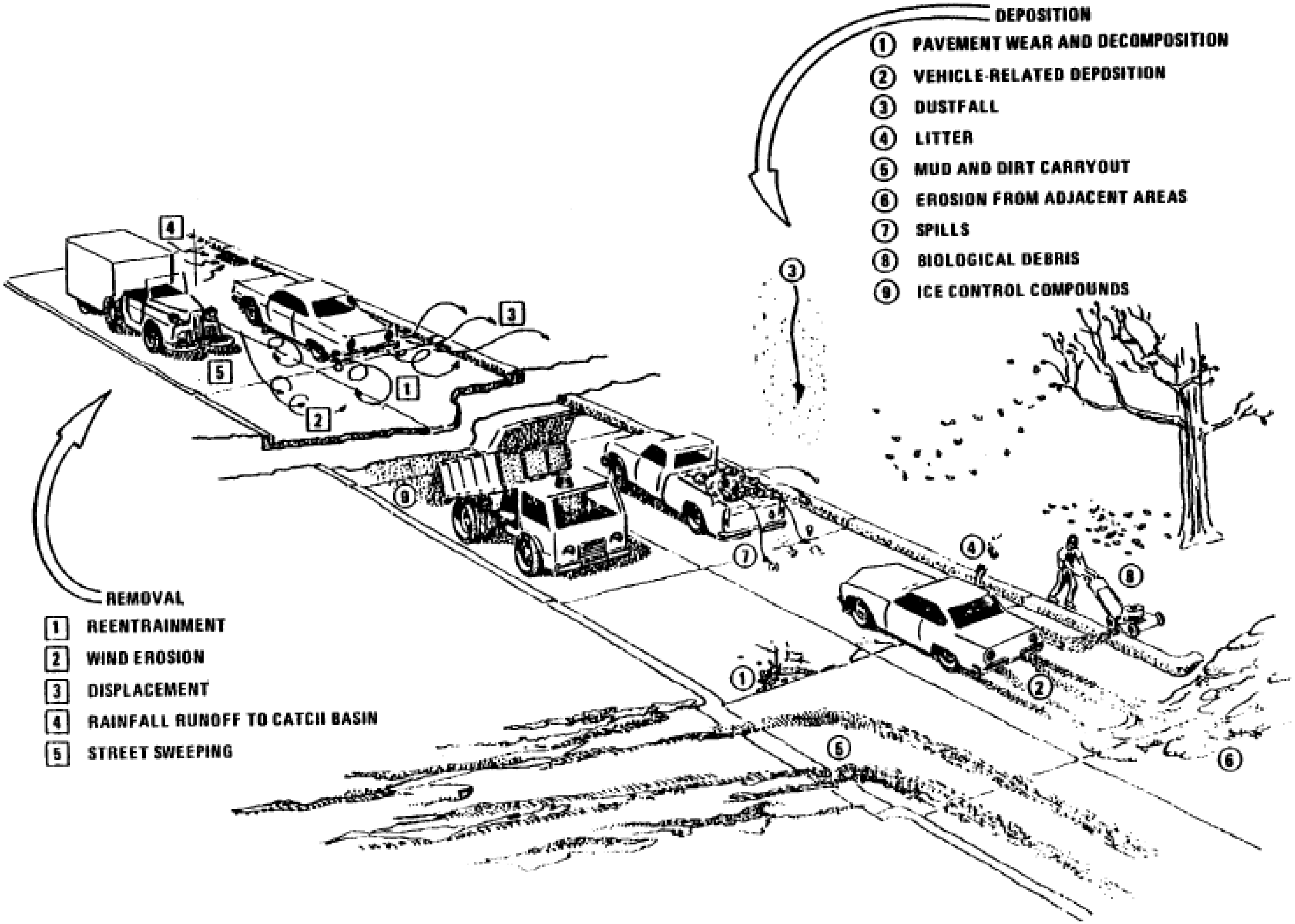

Figure 13.2.1-1. Deposition and removal processes.

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13.2.1.3 Predictive Emission Factor Equations[10,29]

The quantity of particulate emissions from resuspension of loose material on the road surface due to vehicle travel on a dry paved road may be estimated using the following empirical expression:

$$E = k\,(sL)^{0.91} \times (W)^{1.02} \qquad (1)$$

where: E = particulate emission factor (having units matching the units of k),

k = particle size multiplier for particle size range and units of interest (see below),

sL = road surface silt loading (grams per square meter) (g/m^2), and

W = average weight (tons) of the vehicles traveling the road.

It is important to note that Equation 1 calls for the average weight of all vehicles traveling the road. For example, if 99 percent of traffic on the road are 2 ton cars/trucks while the remaining 1 percent consists of 20 ton trucks, then the mean weight "W" is 2.2 tons. More specifically, Equation 1 is *not* intended to be used to calculate a separate emission factor for each vehicle weight class. Instead, only one emission factor should be calculated to represent the "fleet" average weight of all vehicles traveling the road.

The particle size multiplier (k) above varies with aerodynamic size range as shown in Table 13.2.1-1. To determine particulate emissions for a specific particle size range, use the appropriate value of k shown in Table 13.2.1-1.

To obtain the total emissions factor, the emissions factors for the exhaust, brake wear and tire wear obtained from either EPA's MOBILE6.2 [27] or most recent MOVES [29] software model should be added to the emissions factor calculated from the empirical equation.

Table 13.2.1-1. PARTICLE SIZE MULTIPLIERS FOR PAVED ROAD EQUATION

Size range[a]	Particle Size Multiplier k[b]		
	g/VKT	g/VMT	lb/VMT
PM-2.5[c]	0.15	0.25	0.00054
PM-10	0.62	1.00	0.0022
PM-15	0.77	1.23	0.0027
PM-30[d]	3.23	5.24	0.011

[a] Refers to airborne particulate matter (PM-x) with an aerodynamic diameter equal to or less than x micrometers.

[b] Units shown are grams per vehicle kilometer traveled (g/VKT), grams per vehicle mile traveled (g/VMT), and pounds per vehicle mile traveled (lb/VMT). The multiplier k includes unit conversions to produce emission factors in the units shown for the indicated size range from the mixed units required in Equation 1.

[c] The k-factors for $PM_{2.5}$ were based on the average $PM_{2.5}$:PM_{10} ratio of test runs in Reference 30.

[d] PM-30 is sometimes termed "suspendable particulate" (SP) and is often used as a surrogate for TSP.

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Equation 1 is based on a regression analysis of 83 tests for PM-10.[3, 5-6, 8, 27-29, 31-36] Sources tested include public paved roads, as well as controlled and uncontrolled industrial paved roads. The majority of tests involved freely flowing vehicles traveling at constant speed on relatively level roads. However, 22 tests of slow moving or "stop-and-go" traffic or vehicles under load were available for inclusion in the data base.[32-36] Engine exhaust, tire wear and break wear were subtracted from the emissions measured in the test programs prior to stepwise regression to determine Equation 1.[37, 39] The equations retain the quality rating of A (D for PM-2.5), if applied within the range of source conditions that were tested in developing the equation as follows:

Silt loading:	0.03 - 400 g/m^2 0.04 - 570 grains/square foot (ft^2)
Mean vehicle weight:	1.8 - 38 megagrams (Mg) 2.0 - 42 tons
Mean vehicle speed:	1 - 88 kilometers per hour (kph) 1 - 55 miles per hour (mph)

The upper and lower 95% confidence levels of equation 1 for PM_{10} is best described with equations using an exponents of 1.14 and 0.677 for silt loading and an exponents of 1.19 and 0.85 for weight. Users are cautioned that application of equation 1 outside of the range of variables and operating conditions specified above, e.g., application to roadways or road networks with speeds above 55 mph and average vehicle weights of 42 tons, will result in emission estimates with a higher level of uncertainty. In these situations, users are encouraged to consider an assessment of the impacts of the influence of extrapolation to the overall emissions and alternative methods that are equally or more plausible in light of local emissions data and/or ambient concentration or compositional data.

To retain the quality rating for the emission factor equation when it is applied to a specific paved road, it is necessary that reliable correction parameter values for the specific road in question be determined. With the exception of limited access roadways, which are difficult to sample, the collection and use of site-specific silt loading (sL) data for public paved road emission inventories are strongly recommended. The field and laboratory procedures for determining surface material silt content and surface dust loading are summarized in Appendices C.1 and C.2. In the event that site-specific values cannot be obtained, an appropriate value for a paved public road may be selected from the values in Table 13.2.1-2, but the quality rating of the equation should be reduced by 2 levels.

Equation 1 may be extrapolated to average uncontrolled conditions (but including natural mitigation) under the simplifying assumption that annual (or other long-term) average emissions are inversely proportional to the frequency of measurable (> 0.254 mm [0.01 inch]) precipitation by application of a precipitation correction term. The precipitation correction term can be applied on a daily or an hourly basis [26, 38].

For the daily basis, Equation 1 becomes:

$$E_{ext} = [\, k\,(sL)^{0.91} \times (W)^{1.02}\,]\,(1 - P/4N) \qquad (2)$$

where k, sL, W, and S are as defined in Equation 1 and

E_{ext} = annual or other long-term average emission factor in the same units as k,

P = number of "wet" days with at least 0.254 mm (0.01 in) of precipitation during the averaging period, and

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N = number of days in the averaging period (e.g., 365 for annual, 91 for seasonal, 30 for monthly).

Note that the assumption leading to Equation 2 is based on analogy with the approach used to develop long-term average unpaved road emission factors in Section 13.2.2. However, Equation 2 above incorporates an additional factor of "4" in the denominator to account for the fact that paved roads dry more quickly than unpaved roads and that the precipitation may not occur over the complete 24-hour day.

For the hourly basis, equation 1 becomes:

$$E_{ext} = [\, k\,(sL)^{0.91} \times (W)^{1.02}\,]\,(1 - 1.2P/N) \qquad (3)$$

where k, sL, W, and S are as defined in Equation 1 and

E_{ext} = annual or other long-term average emission factor in the same units as k,
P = number of hours with at least 0.254 mm (0.01 in) of precipitation during the averaging period, and
N = number of hours in the averaging period (e.g., 8760 for annual, 2124 for season 720 for monthly)

Note: In the hourly moisture correction term (1-1.2P/N) for equation 3, the 1.2 multiplier is applied to account for the residual mitigative effect of moisture. For most applications, this equation will produce satisfactory results. Users should select a time interval to include sufficient "dry" hours such that a reasonable emissions averaging period is evaluated. For the special case where this equation is used to calculate emissions on an hour by hour basis, such as would be done in some emissions modeling situations, the moisture correction term should be modified so that the moisture correction "credit" is applied to the first hours following cessation of precipitation. In this special case, it is suggested that this 20% "credit" be applied on a basis of one hour credit for each hour of precipitation up to a maximum of 12 hours.

Note that the assumption leading to Equation 3 is based on analogy with the approach used to develop long-term average unpaved road emission factors in Section 13.2.2.

Figure 13.2.1-2 presents the geographical distribution of "wet" days on an annual basis for the United States. Maps showing this information on a monthly basis are available in the *Climatic Atlas of the United States*[23] . Alternative sources include other Department of Commerce publications (such as local climatological data summaries). The National Climatic Data Center (NCDC) offers several products that provide hourly precipitation data. In particular, NCDC offers *Solar and Meteorological Surface Observation Network 1961-1990* (SAMSON) CD-ROM, which contains 30 years worth of hourly meteorological data for first-order National Weather Service locations. Whatever meteorological data are used, the source of that data and the averaging period should be clearly specified.

It is emphasized that the simple assumption underlying Equations 2 and 3 has not been verified in any rigorous manner. For that reason, the quality ratings for Equations 2 and 3 should be downgraded one letter from the rating that would be applied to Equation 1.

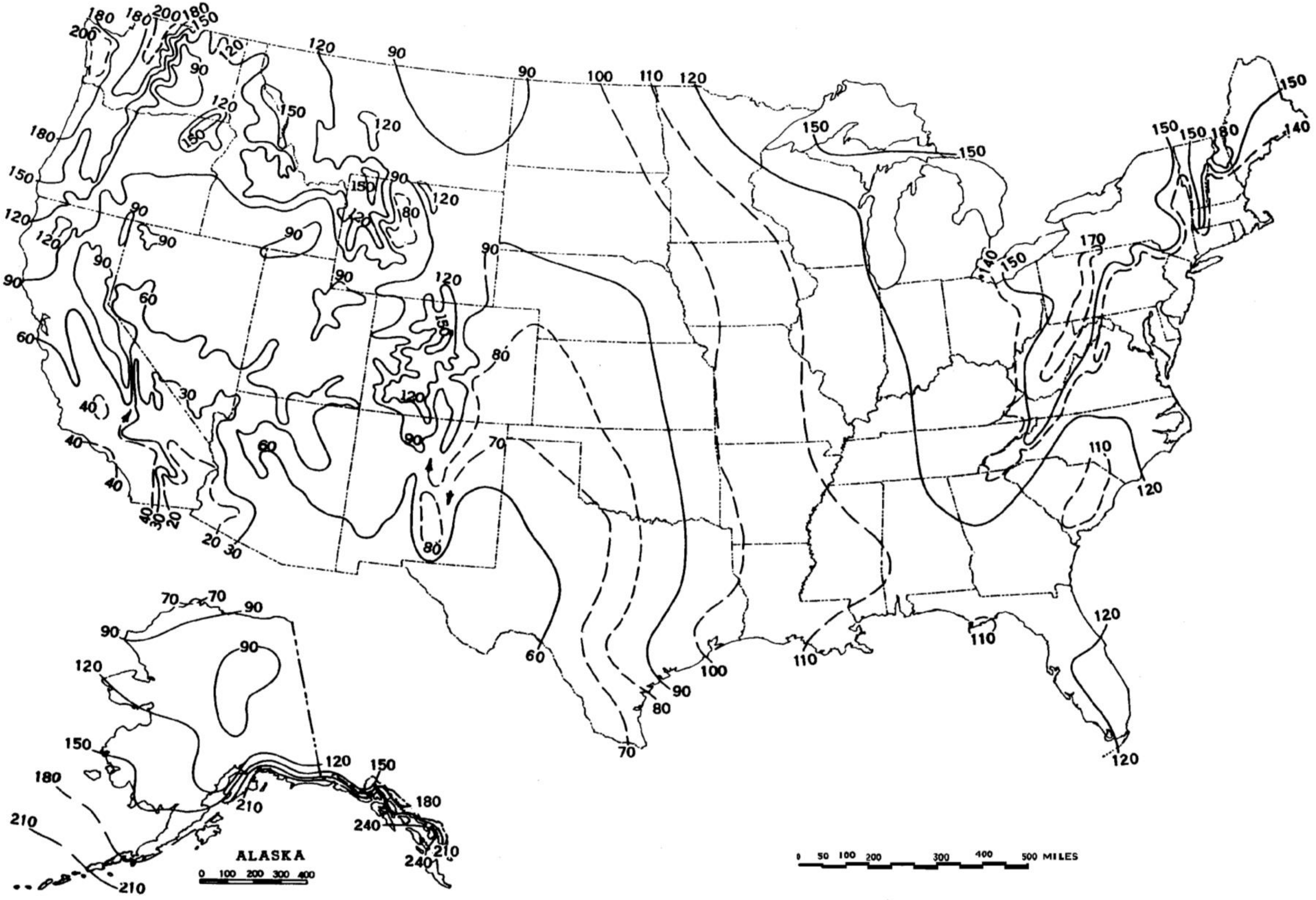

Figure 13.2.1-2. Mean number of days with 0.01 inch or more of precipitation in the United States.

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Table 13.2.1-2 presents recommended default silt loadings for normal baseline conditions and for wintertime baseline conditions in areas that experience frozen precipitation with periodic application of antiskid material[24]. The winter baseline is represented as a multiple of the non-winter baseline, depending on the ADT value for the road in question. As shown, a multiplier of 4 is applied for low volume roads (< 500 ADT) to obtain a wintertime baseline silt loading of 4 X 0.6 = 2.4 g/m^2.

Table 13.2.1-2. Ubiquitous Silt Loading Default Values with Hot Spot Contributions from Anti-Skid Abrasives (g/m^2)

ADT Category	< 500	500-5,000	5,000-10,000	> 10,000
Ubiquitous Baseline g/m^2	0.6	0.2	0.06	0.03 0.015 limited access
Ubiquitous Winter Baseline Multiplier during months with frozen precipitation	X4	X3	X2	X1
Initial peak additive contribution from application of antiskid abrasive (g/m^2)	2	2	2	2
Days to return to baseline conditions (assume linear decay)	7	3	1	0.5

It is suggested that an additional (but temporary) silt loading contribution of 2 g/m^2 occurs with each application of antiskid abrasive for snow/ice control. This was determined based on a typical application rate of 500 lb per lane mile and an initial silt content of 1 % silt content. Ordinary rock salt and other chemical deicers add little to the silt loading, because most of the chemical dissolves during the snow/ice melting process.

To adjust the baseline silt loadings for mud/dirt trackout, the number of trackout points is required. It is recommended that in calculating PM_{10} emissions, six additional miles of road be added for each active trackout point from an active construction site, to the paved road mileage of the specified category within the county. In calculating $PM_{2.5}$ emissions, it is recommended that three additional miles of road be added for each trackout point from an active construction site.

It is suggested the number of trackout points for activities other than road and building construction areas be related to land use. For example, in rural farming areas, each mile of paved road would have a specified number of trackout points at intersections with unpaved roads. This value could be estimated from the unpaved road density (mi/sq. mi.).

The use of a default value from Table 13.2.1-2 should be expected to yield only an order-of-magnitude estimate of the emission factor. Public paved road silt loadings are dependent

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upon: traffic characteristics (speed, ADT, and fraction of heavy vehicles); road characteristics (curbs, number of lanes, parking lanes); local land use (agriculture, new residential construction) and regional/seasonal factors (snow/ice controls, wind blown dust). As a result, the collection and use of site-specific silt loading data is highly recommended. In the event that default silt loading values are used, the quality ratings for the equation should be downgraded 2 levels.

Limited access roadways pose severe logistical difficulties in terms of surface sampling, and few silt loading data are available for such roads. Nevertheless, the available data do not suggest great variation in silt loading for limited access roadways from one part of the country to another. For annual conditions, a default value of 0.015 g/m^2 is recommended for limited access roadways.[9,22] Even fewer of the available data correspond to worst-case situations, and elevated loadings are observed to be quickly depleted because of high traffic speeds and high ADT rates. A default value of 0.2 g/m^2 is recommended for short periods of time following application of snow/ice controls to limited access roads.[22]

The limited data on silt loading values for industrial roads have shown as much variability as public roads. Because of the variations of traffic conditions and the use of preventive mitigative controls, the data probably do not reflect the full extent of the potential variation in silt loading on industrial roads. However, the collection of site specific silt loading data from industrial roads is easier and safer than for public roads. Therefore, the collection and use of site-specific silt loading data is preferred and is highly recommended. In the event that site-specific values cannot be obtained, an appropriate value for an industrial road may be selected from the mean values given in Table 13.2.1-3, but the quality rating of the equation should be reduced by 2 levels.

The predictive accuracy of Equation 1 requires thorough on-site characterization of road silt loading. Road surface sampling is time-consuming and potentially hazardous because of the need to block traffic lanes. In addition, large number of samples is required to represent spatial and temporal variations across roadway networks. Mobile monitoring is a new alternative silt loading or road dust emission characterization method for either paved or unpaved roads. It utilizes a test vehicle that generates and monitors its own dust plume concentration (mass basis) at a fixed sampling probe location. A calibration factor is needed for each mobile monitoring configuration (test vehicle and sampling system), to convert the relative dust emission intensity to an equivalent silt loading or emission factor. Typically, portable continuous particle concentration monitors do not comply with Federal Reference Method (FRM) standards. Therefore, a controlled study must be performed to correlate the portable monitor response to the road silt loading or size specific particle concentration measured with an approved FRM sampling system. In the calibration tests, multiple test conditions should be performed to provide an average correlation with known precision and to accommodate variations in road silt loading, vehicle speed, road dust characteristics and other road conditions that may influence mobile monitoring measurements or emissions characteristics. Because the paved road dust emissions are also dependent on the average vehicle weight for the road segment, it is important that the weight of the test vehicle correspond closely to the average vehicle weight for the road segment or be adjusted using the average vehicle weight relationship in Equation 1. In summary, it is believed that the Mobile Monitoring Method will provide improved capabilities to provide reliable temporally and spatially resolved silt loading or emissions factors with increased coverage, improved safety, reduced traffic interference and decreased cost.[40, 41, 42]

Table 13.2.1-3 (Metric And English Units). TYPICAL SILT CONTENT AND LOADING VALUES FOR PAVED ROADS AT INDUSTRIAL FACILITIES [a]

Industry	No. of Sites	No. Of Samples	Silt Content (%)		No. of Travel Lanes	Total Loading x 10^{-3}			Silt Loading (g/m^2)	
			Range	Mean		Range	Mean	Units[b]	Range	Mean
Copper smelting	1	3	15.4-21.7	19.0	2	12.9 - 19.5	15.9	kg/km	188-400	292
						45.8 - 69.2	55.4	lb/mi		
Iron and steel production	9	48	1.1-35.7	12.5	2	0.006 - 4.77	0.495	kg/km	0.09-79	9.7
						0.020 -16.9	1.75	lb/mi		
Asphalt batching	1	3	2.6 - 4.6	3.3	1	12.1 - 18.0	14.9	kg/km	76-193	120
						43.0 - 64.0	52.8	lb/mi		
Concrete batching	1	3	5.2 - 6.0	5.5	2	1.4 - 1.8	1.7	kg/km	11-12	12
						5.0 - 6.4	5.9	lb/mi		
Sand and gravel processing	1	3	6.4 - 7.9	7.1	1	2.8 - 5.5	3.8	kg/km	53-95	70
						9.9 - 19.4	13.3	lb/mi		
Municipal solid waste landfill	2	7		-	2	-			1.1-32.0	7.4
Quarry	1	6		-	2	-			2.4-14	8.2
Corn wet mills	3	15		-	2	-			0.05 – 2.9	1.1

[a] References 1-2,5-6,11-13. Values represent samples collected from *industrial* roads. Public road silt loading values are presented in Table-13.2.1-2. Dashes indicate information not available.[b] Multiply entries by 1000 to obtain stated units; kilograms per kilometer (kg/km) and pounds per mile (lb/mi).

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13.2.1.4 Controls[6,25]

Because of the importance of the silt loading, control techniques for paved roads attempt either to prevent material from being deposited onto the surface (preventive controls) or to remove from the travel lanes any material that has been deposited (mitigative controls). Covering of loads in trucks, and the paving of access areas to unpaved lots or construction sites, are examples of preventive measures. Examples of mitigative controls include vacuum sweeping, water flushing, and broom sweeping and flushing. Actual control efficiencies for any - of these techniques can be highly variable. Locally measured silt loadings before and after the application of controls is the preferred method to evaluate controls. It is particularly important to note that street sweeping of gutters and curb areas may actually increase the silt loading on the traveled portion of the road. Redistribution of loose material onto the travel lanes will actually produce a short-term increase in the emissions.

In general, preventive controls are usually more cost effective than mitigative controls. The cost-effectiveness of mitigative controls falls off dramatically as the size of an area to be treated increases. The cost-effectiveness of mitigative measures is also unfavorable if only a short period of time is required for the road to return to equilibrium silt loading condition. That is to say, the number and length of public roads within most areas of interest preclude any widespread and routine use of mitigative controls. On the other hand, because of the more limited scope of roads at an industrial site, mitigative measures may be used quite successfully (especially in situations where truck spillage occurs). Note, however, that public agencies could make effective use of mitigative controls to remove sand/salt from roads after the winter ends.

Because available controls will affect the silt loading, controlled emission factors may be obtained by substituting controlled silt loading values into the equation. (Emission factors from controlled industrial roads were used in the development of the equation.) The collection of surface loading samples from treated, as well as baseline (untreated), roads provides a means to track effectiveness of the controls over time. The use of Mobile Monitoring Methodologies provide an improved means to track progress in controlling silt loading values.

13.2.1.5 Changes since Fifth Edition

The following changes were made since the publication of the Fifth Edition of AP-42:

October 2002

1) The particle size multiplier for $PM_{2.5}$ was revised to 25% of PM_{10}. The approximately 55% reduction was a result of emission testing using FRM monitors. The monitoring was specifically intended to evaluate the PM-2.5 component of the emissions.

2) Default silt loading values were included in Table 13.2.1-2 replacing the Tables and Figures containing silt loading statistical information.

3) Editorial changes within the text were made indicating the possible causes of variations in the silt loading between roads within and among different locations. The uncertainty of using the default silt loading value was discussed.

4) Section 13.2.1.1 was revised to clarify the role of dust loading in resuspension. Additional minor text changes were made.

5) Equations 2 and 3, Figure 13.2.1-2, and text were added to incorporate natural mitigation into annual or other long-term average emission factors.

December 2003

1) The emission factor equation was adjusted to remove the component of particulate emissions- from exhaust, brake wear, and tire wear. A parameter C representing these emissions was included in the predictive equation. The parameter C varied with aerodynamic size range of the particulate matter. Table 13.2.1-2 was added to present the new coefficients.

2) The default silt loading values in Table 13.2.1-3 were revised to incorporate the results from a recent analysis of silt loading data.

November 2006

1) The $PM_{2.5}$ particle size multiplier was revised to 15% of PM_{10} as the result of wind tunnel studies of a variety of dust emitting surface materials.

2) References were rearranged and renumbered.

January 2011

1) The empirical predictive equation was revised. The revision is based upon stepwise regression of 83 profile emissions tests and an adjustment of individual test data for the exhaust; break wear and tire wear emissions prior to regression of the data.

2) The C term is removed from the empirical predictive equation and Table 13.2.1-2 with the C term values is removed since the exhaust; break wear and tire wear emissions were no longer part of the regressed data.

3) The $PM_{2.5}$ particle size multiplier was revised to 25% of PM_{10} since the PM_{10} test data used to develop the equation did not meet the necessary PM_{10} concentrations for a ratio of 15%.

4) The lower speed of the vehicle speed range supported by the empirical predictive equation was revised to 1 mph.

5) Information was added on an improved methodology to develop spatially and temporally resolved silt loadings or emissions factors by Mobile Monitoring Methodologies.

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13.2.2 Unpaved Roads

13.2.2.1 General

When a vehicle travels an unpaved road, the force of the wheels on the road surface causes pulverization of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed.

The particulate emission factors presented in the previous draft version of this section of AP-42, dated October 2001, implicitly included the emissions from vehicles in the form of exhaust, brake wear, and tire wear as well as resuspended road surface material[25]. EPA included these sources in the emission factor equation for unpaved public roads (equation 1b in this section) since the field testing data used to develop the equation included both the direct emissions from vehicles and emissions from resuspension of road dust.

This version of the unpaved public road emission factor equation only estimates particulate emissions from resuspended road surface material [23, 26]. The particulate emissions from vehicle exhaust, brake wear, and tire wear are now estimated separately using EPA's MOBILE6.2 [24]. This approach eliminates the possibility of double counting emissions. Double counting results when employing the previous version of the emission factor equation in this section and MOBILE6.2 to estimate particulate emissions from vehicle traffic on unpaved public roads. It also incorporates the decrease in exhaust emissions that has occurred since the unpaved public road emission factor equation was developed. The previous version of the unpaved public road emission factor equation includes estimates of emissions from exhaust, brake wear, and tire wear based on emission rates for vehicles in the 1980 calendar year fleet. The amount of PM released from vehicle exhaust has decreased since 1980 due to lower new vehicle emission standards and changes in fuel characteristics.

13.2.2.2 Emissions Calculation And Correction Parameters[1-6]

The quantity of dust emissions from a given segment of unpaved road varies linearly with the volume of traffic. Field investigations also have shown that emissions depend on source parameters that characterize the condition of a particular road and the associated vehicle traffic. Characterization of these source parameters allow for "correction" of emission estimates to specific road and traffic conditions present on public and industrial roadways.

Dust emissions from unpaved roads have been found to vary directly with the fraction of silt (particles smaller than 75 micrometers [μm] in diameter) in the road surface materials.[1] The silt fraction is determined by measuring the proportion of loose dry surface dust that passes a 200-mesh screen, using the ASTM-C-136 method. A summary of this method is contained in Appendix C of AP-42. Table 13.2.2-1 summarizes measured silt values for industrial unpaved roads. Table 13.2.2-2 summarizes measured silt values for public unpaved roads. It should be noted that the ranges of silt content vary over two orders of magnitude. Therefore, the use of data from this table can potentially introduce considerable error. Use of this data is strongly discouraged when it is feasible to obtain locally gathered data.

Since the silt content of a rural dirt road will vary with geographic location, it should be measured for use in projecting emissions. As a conservative approximation, the silt content of the parent soil in the area can be used. Tests, however, show that road silt content is normally lower than in the surrounding parent soil, because the fines are continually removed by the vehicle traffic, leaving a higher percentage of coarse particles.

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Other variables are important in addition to the silt content of the road surface material. For example, at industrial sites, where haul trucks and other heavy equipment are common, emissions are highly correlated with vehicle weight. On the other hand, there is far less variability in the weights of cars and pickup trucks that commonly travel publicly accessible unpaved roads throughout the United States. For those roads, the moisture content of the road surface material may be more dominant in determining differences in emission levels between, for example a hot, desert environment and a cool, moist location.

The PM-10 and TSP emission factors presented below are the outcomes from stepwise linear regressions of field emission test results of vehicles traveling over unpaved surfaces. Due to a limited amount of information available for PM-2.5, the expression for that particle size range has been scaled against the result for PM-10. Consequently, the quality rating for the PM-2.5 factor is lower than that for the PM-10 expression.

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Table 13.2.2-1. TYPICAL SILT CONTENT VALUES OF SURFACE MATERIAL ON INDUSTRIAL UNPAVED ROADS[a]

Industry	Road Use Or Surface Material	Plant Sites	No. Of Samples	Silt Content (%)	
				Range	Mean
Copper smelting	Plant road	1	3	16 - 19	17
Iron and steel production	Plant road	19	135	0.2 - 19	6.0
Sand and gravel processing	Plant road	1	3	4.1 - 6.0	4.8
	Material storage area	1	1	-	7.1
Stone quarrying and processing	Plant road	2	10	2.4 - 16	10
	Haul road to/from pit	4	20	5.0-15	8.3
Taconite mining and processing	Service road	1	8	2.4 - 7.1	4.3
	Haul road to/from pit	1	12	3.9 - 9.7	5.8
Western surface coal mining	Haul road to/from pit	3	21	2.8 - 18	8.4
	Plant road	2	2	4.9 - 5.3	5.1
	Scraper route	3	10	7.2 - 25	17
	Haul road (freshly graded)	2	5	18 - 29	24
Construction sites	Scraper routes	7	20	0.56-23	8.5
Lumber sawmills	Log yards	2	2	4.8-12	8.4
Municipal solid waste landfills	Disposal routes	4	20	2.2 - 21	6.4

[a] References 1,5-15.

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The following empirical expressions may be used to estimate the quantity in pounds (lb) of size-specific particulate emissions from an unpaved road, per vehicle mile traveled (VMT):

For vehicles traveling on unpaved surfaces at industrial sites, emissions are estimated from the following equation:

$$E = k\ (s/12)^a (W/3)^b \qquad (1a)$$

and, for vehicles traveling on publicly accessible roads, dominated by light duty vehicles, emissions may be estimated from the following:

$$E = \frac{k\ (s/12)^a (S/30)^d}{(M/0.5)^c} - C \qquad (1b)$$

where k, a, b, c and d are empirical constants (Reference 6) given below and

E = size-specific emission factor (lb/VMT)
s = surface material silt content (%)
W = mean vehicle weight (tons)
M = surface material moisture content (%)
S = mean vehicle speed (mph)
C = emission factor for 1980's vehicle fleet exhaust, brake wear and tire wear.

The source characteristics s, W and M are referred to as correction parameters for adjusting the emission estimates to local conditions. The metric conversion from lb/VMT to grams (g) per vehicle kilometer traveled (VKT) is as follows:

1 lb/VMT = 281.9 g/VKT

The constants for Equations 1a and 1b based on the stated aerodynamic particle sizes are shown in Tables 13.2.2-2 and 13.2.2-4. The PM-2.5 particle size multipliers (k-factors) are taken from Reference 27.

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Table 13.2.2-2. CONSTANTS FOR EQUATIONS 1a AND 1b

Constant	Industrial Roads (Equation 1a)			Public Roads (Equation 1b)		
	PM-2.5	PM-10	PM-30*	PM-2.5	PM-10	PM-30*
k (lb/VMT)	0.15	1.5	4.9	0.18	1.8	6.0
a	0.9	0.9	0.7	1	1	1
b	0.45	0.45	0.45	-	-	-
c	-	-	-	0.2	0.2	0.3
d	-	-	-	0.5	0.5	0.3
Quality Rating	B	B	B	B	B	B

*Assumed equivalent to total suspended particulate matter (TSP)
"-" = not used in the emission factor equation

Table 13.2.2-2 also contains the quality ratings for the various size-specific versions of Equation 1a and 1b. The equation retains the assigned quality rating, if applied within the ranges of source conditions, shown in Table 13.2.2-3, that were tested in developing the equation:

Table 13.2.2-3. RANGE OF SOURCE CONDITIONS USED IN DEVELOPING EQUATION 1a AND 1b

Emission Factor	Surface Silt Content, %	Mean Vehicle Weight		Mean Vehicle Speed		Mean No. of Wheels	Surface Moisture Content, %
		Mg	ton	km/hr	mph		
Industrial Roads (Equation 1a)	1.8-25.2	1.8-260	2-290	8-69	5-43	4-17[a]	0.03-13
Public Roads (Equation 1b)	1.8-35	1.4-2.7	1.5-3	16-88	10-55	4-4.8	0.03-13

[a] See discussion in text.

As noted earlier, the models presented as Equations 1a and 1b were developed from tests of traffic on unpaved surfaces. Unpaved roads have a hard, generally nonporous surface that usually dries quickly after a rainfall or watering, because of traffic-enhanced natural evaporation. (Factors influencing how fast a road dries are discussed in Section 13.2.2.3, below.) The quality ratings given above pertain to the mid-range of the measured source conditions for the equation. A higher mean vehicle weight and a higher than normal traffic rate may be justified when performing a worst-case analysis of emissions from unpaved roads.

The emission factors for the exhaust, brake wear and tire wear of a 1980's vehicle fleet (*C*) was obtained from EPA's MOBILE6.2 model [23]. The emission factor also varies with aerodynamic size range as shown in Table 13.2.2-4

Table 13.2.2-4. EMISSION FACTOR FOR 1980'S VEHICLE FLEET EXHAUST, BRAKE WEAR AND TIRE WEAR

Particle Size Range[a]	*C*, Emission Factor for Exhaust, Brake Wear and Tire Wear[b] lb/VMT
$PM_{2.5}$	0.00036
PM_{10}	0.00047
PM_{30}[c]	0.00047

[a] Refers to airborne particulate matter (PM-x) with an aerodynamic diameter equal to or less than x micrometers.

[b] Units shown are pounds per vehicle mile traveled (lb/VMT).

[c] PM-30 is sometimes termed "suspendable particulate" (SP) and is often used as a surrogate for TSP.

It is important to note that the vehicle-related source conditions refer to the average weight, speed, and number of wheels for all vehicles traveling the road. For example, if 98 percent of traffic on the road are 2-ton cars and trucks while the remaining 2 percent consists of 20-ton trucks, then the mean weight is 2.4 tons. More specifically, Equations 1a and 1b are *not* intended to be used to calculate a separate emission factor for each vehicle class within a mix of traffic on a given unpaved road. That is, in the example, one should *not* determine one factor for the 2-ton vehicles and a second factor for the 20-ton trucks. Instead, only one emission factor should be calculated that represents the "fleet" average of 2.4 tons for all vehicles traveling the road.

Moreover, to retain the quality ratings when addressing a group of unpaved roads, it is necessary that reliable correction parameter values be determined for the road in question. The field and laboratory procedures for determining road surface silt and moisture contents are given in AP-42 Appendices C.1 and C.2. Vehicle-related parameters should be developed by recording visual observations of traffic. In some cases, vehicle parameters for industrial unpaved roads can be determined by reviewing maintenance records or other information sources at the facility.

In the event that site-specific values for correction parameters cannot be obtained, then default values may be used.In the absence of site-specific silt content information, an appropriate mean value from Table 13.2.2-1 may be used as a default value, but the quality rating of the equation is reduced by two letters. Because of significant differences found between different types of road surfaces and between different areas of the country, use of the default moisture content value of 0.5 percent in Equation 1b is discouraged. The quality rating should be downgraded two letters when the default moisture content value is used. (It is assumed that readers addressing industrial roads have access to the information needed to develop average vehicle information in Equation 1a for their facility.)

The effect of routine watering to control emissions from unpaved roads is discussed below in Section 13.2.2.3, “Controls”. However, all roads are subject to some natural mitigation because of rainfall and other precipitation. The Equation 1a and 1b emission factors can be extrapolated to annual average uncontrolled conditions (but including natural mitigation) under the simplifying assumption that annual average emissions are inversely proportional to the number of days with measurable (more than 0.254 mm [0.01 inch]) precipitation:

$$E_{ext} = E\ [(365 - P)/365] \tag{2}$$

where:

E_{ext} = annual size-specific emission factor extrapolated for natural mitigation, lb/VMT

E = emission factor from Equation 1a or 1b

P = number of days in a year with at least 0.254 mm (0.01 in) of precipitation (see below)

Figure 13.2.2-1 gives the geographical distribution for the mean annual number of "wet" days for the United States.

Equation 2 provides an estimate that accounts for precipitation on an annual average basis for the purpose of inventorying emissions. It should be noted that Equation 2 does not account for differences in the temporal distributions of the rain events, the quantity of rain during any event, or the potential for the rain to evaporate from the road surface. In the event that a finer temporal and spatial resolution is desired for inventories of public unpaved roads, estimates can be based on a more complex set of assumptions. These assumptions include:

1. The moisture content of the road surface material is increased in proportion to the quantity of water added;
2. The moisture content of the road surface material is reduced in proportion to the Class A pan evaporation rate;
3. The moisture content of the road surface material is reduced in proportion to the traffic volume; and
4. The moisture content of the road surface material varies between the extremes observed in the area. The CHIEF Web site (http://www.epa.gov/ttn/chief/ap42/ch13/related/c13s02-2.html) has a file which contains a spreadsheet program for calculating emission factors which are temporally and spatially resolved. Information required for use of the spreadsheet program includes monthly Class A pan evaporation values, hourly meteorological data for precipitation, humidity and snow cover, vehicle traffic information, and road surface material information.

It is emphasized that <u>the simple assumption underlying Equation 2 and the more complex set of assumptions underlying the use of the procedure which produces a finer temporal and spatial resolution</u> have not been verified in any rigorous manner. For this reason, the quality ratings for either approach should be downgraded one letter from the rating that would be applied to Equation 1.

13.2.2.3 Controls[18-22]

A wide variety of options exist to control emissions from unpaved roads. Options fall into the following three groupings:

1. <u>Vehicle restrictions</u> that limit the speed, weight or number of vehicles on the road;

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2. Surface improvement, by measures such as (a) paving or (b) adding gravel or slag to a dirt road; and
3. Surface treatment, such as watering or treatment with chemical dust suppressants.

Available control options span broad ranges in terms of cost, efficiency, and applicability. For example, traffic controls provide moderate emission reductions (often at little cost) but are difficult to enforce. Although paving is highly effective, its high initial cost is often prohibitive. Furthermore, paving is not feasible for industrial roads subject to very heavy vehicles and/or spillage of material in transport. Watering and chemical suppressants, on the other hand, are potentially applicable to most industrial roads at moderate to low costs. However, these require frequent reapplication to maintain an acceptable level of control. Chemical suppressants are generally more cost-effective than water but not in cases of temporary roads (which are common at mines, landfills, and construction sites). In summary, then, one needs to consider not only the type and volume of traffic on the road but also how long the road will be in service when developing control plans.

Vehicle restrictions. These measures seek to limit the amount and type of traffic present on the road or to lower the mean vehicle speed. For example, many industrial plants have restricted employees from driving on plant property and have instead instituted bussing programs. This eliminates emissions due to employees traveling to/from their worksites. Although the heavier average vehicle weight of the busses increases the base emission factor, the decrease in vehicle-miles-traveled results in a lower overall emission rate.

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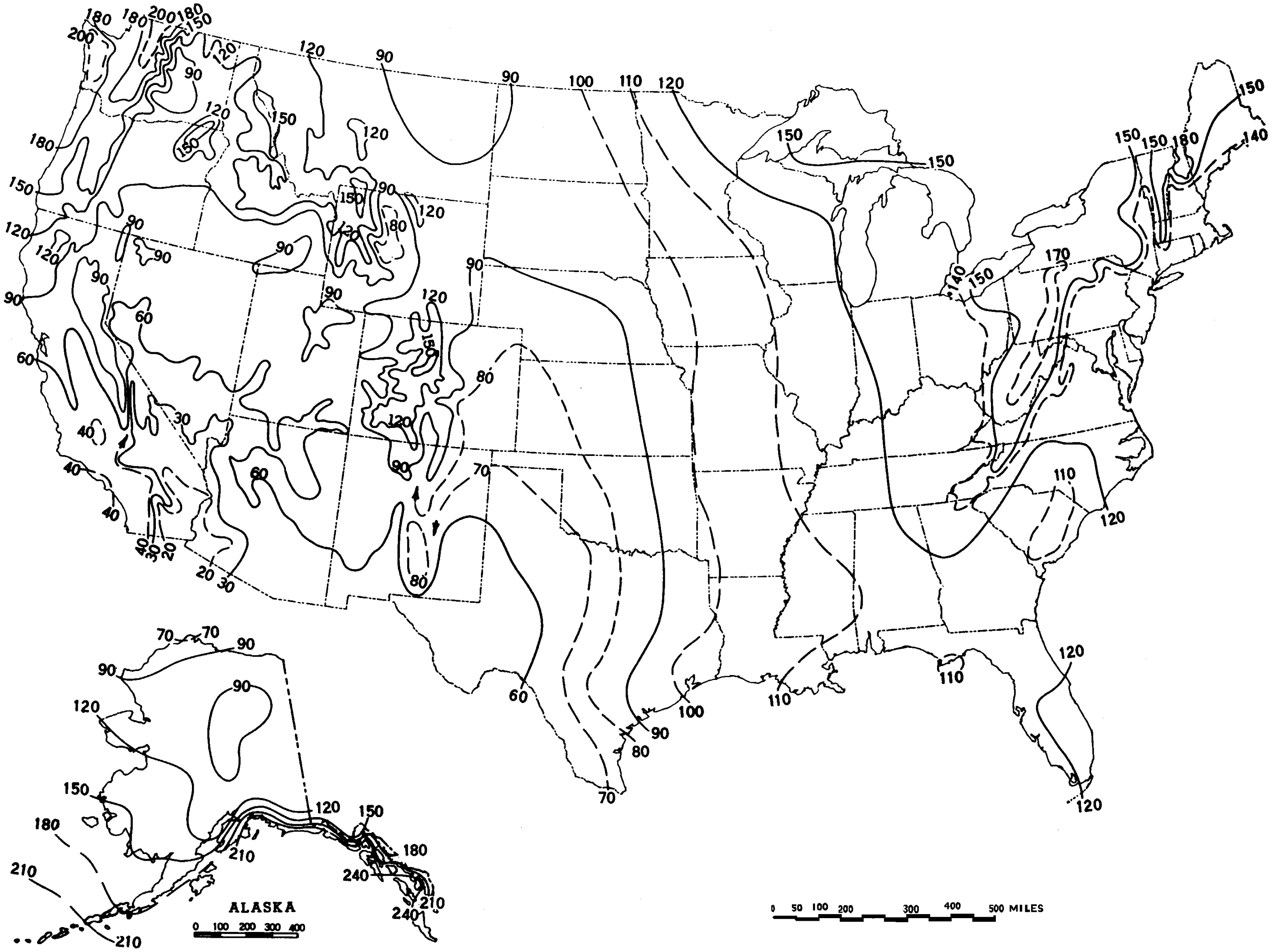

Figure 13.2.2-1. Mean number of days with 0.01 inch or more of precipitation in United States.

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Surface improvements. Control options in this category alter the road surface. As opposed to the "surface treatments" discussed below, improvements are relatively "permanent" and do not require periodic retreatment.

The most obvious surface improvement is paving an unpaved road. This option is quite expensive and is probably most applicable to relatively short stretches of unpaved road with at least several hundred vehicle passes per day. Furthermore, if the newly paved road is located near unpaved areas or is used to transport material, it is essential that the control plan address routine cleaning of the newly paved road surface.

The control efficiencies achievable by paving can be estimated by comparing emission factors for unpaved and paved road conditions. The predictive emission factor equation for paved roads, given in Section 13.2.1, requires estimation of the silt loading on the traveled portion of the paved surface, which in turn depends on whether the pavement is periodically cleaned. Unless curbing is to be installed, the effects of vehicle excursion onto unpaved shoulders (berms) also must be taken into account in estimating the control efficiency of paving.

Other improvement methods cover the road surface with another material that has a lower silt content. Examples include placing gravel or slag on a dirt road. Control efficiency can be estimated by comparing the emission factors obtained using the silt contents before and after improvement. The silt content of the road surface should be determined after 3 to 6 months rather than immediately following placement. Control plans should address regular maintenance practices, such as grading, to retain larger aggregate on the traveled portion of the road.

Surface treatments refer to control options which require periodic reapplication. Treatments fall into the two main categories of (a) "wet suppression" (i. e., watering, possibly with surfactants or other additives), which keeps the road surface wet to control emissions and (b) "chemical stabilization/ treatment", which attempts to change the physical characteristics of the surface. The necessary reapplication frequency varies from several minutes for plain water under summertime conditions to several weeks or months for chemical dust suppressants.

Watering increases the moisture content, which conglomerates particles and reduces their likelihood to become suspended when vehicles pass over the surface. The control efficiency depends on how fast the road dries after water is added. This in turn depends on (a) the amount (per unit road surface area) of water added during each application; (b) the period of time between applications; (c) the weight, speed and number of vehicles traveling over the watered road during the period between applications; and (d) meteorological conditions (temperature, wind speed, cloud cover, etc.) that affect evaporation during the period.

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Figure 13.2.2-2 presents a simple bilinear relationship between the instantaneous control efficiency due to watering and the resulting increase in surface moisture. The moisture ratio "M" (i.e., the x-axis in Figure 13.2.2-2) is found by dividing the surface moisture content of the watered road by the surface moisture content of the uncontrolled road. As the watered road surface dries, both the ratio M and the predicted instantaneous control efficiency (i.e., the y-axis in the figure) decrease. The figure shows that between the uncontrolled moisture content and a value twice as large, a small increase in moisture content results in a large increase in control efficiency. Beyond that, control efficiency grows slowly with increased moisture content.

Given the complicated nature of how the road dries, characterization of emissions from watered roadways is best done by collecting road surface material samples at various times between water truck passes. (Appendices C.1 and C.2 present the sampling and analysis procedures.) The moisture content measured can then be associated with a control efficiency by use of Figure 13.2.2-2. Samples that reflect average conditions during the watering cycle can take the form of either a series of samples between water applications or a single sample at the midpoint. It is essential that samples be collected during periods with active traffic on the road. Finally, because of different evaporation rates, it is recommended that samples be collected at various times during the year. If only one set of samples is to be collected, these must be collected during hot, summertime conditions.

When developing watering control plans for roads that do not yet exist, it is strongly recommended that the moisture cycle be established by sampling similar roads in the same geographic area. If the moisture cycle cannot be established by similar roads using established watering control plans, the more complex methodology used to estimate the mitigation of rainfall and other precipitation can be used to estimate the control provided by routine watering. An estimate of the maximum daytime Class A pan evaporation (based upon daily evaporation data published in the monthly Climatological Data for the state by the National Climatic Data Center) should be used to insure that adequate watering capability is available during periods of highest evaporation. The hourly precipitation values in the spreadsheet should be replaced with the equivalent inches of precipitation (where the equivalent of 1 inch of precipitation is provided by an application of 5.6 gallons of water per square yard of road). Information on the long term average annual evaporation and on the percentage that occurs between May and October was published in the Climatic Atlas (Reference 16). Figure 13.2.2-3 presents the geographical distribution for "Class A pan evaporation" throughout the United States. Figure 13.2.2-4 presents the geographical distribution of the percentage of this evaporation that occurs between May and October. The U. S. Weather Bureau Class A evaporation pan is a cylindrical metal container with a depth of 10 inches and a diameter of 48 inches. Periodic measurements are made of the changes of the water level.

The above methodology should be used only for prospective analyses and for designing watering programs for existing roadways. The quality rating of an emission factor for a watered road that is based on this methodology should be downgraded two letters. Periodic road surface samples should be collected and analyzed to verify the efficiency of the watering program.

As opposed to watering, chemical dust suppressants have much less frequent reapplication requirements. These materials suppress emissions by changing the physical characteristics of the existing road surface material. Many chemical unpaved road dust suppressants form a hardened surface that binds particles together. After several applications, a treated road often resembles a paved road except that the surface is not uniformly flat. Because the improved surface results in more grinding of small particles, the silt content of loose material on a highly controlled surface may be substantially higher than when the surface was uncontrolled. For this reason, the models presented as Equations 1a and 1b cannot be used to estimate emissions from chemically stabilized roads. Should the road be allowed to return to an

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uncontrolled state with no visible signs of large-scale cementing of material, the Equation 1a and 1b emission factors could then be used to obtain conservatively high emission estimates.

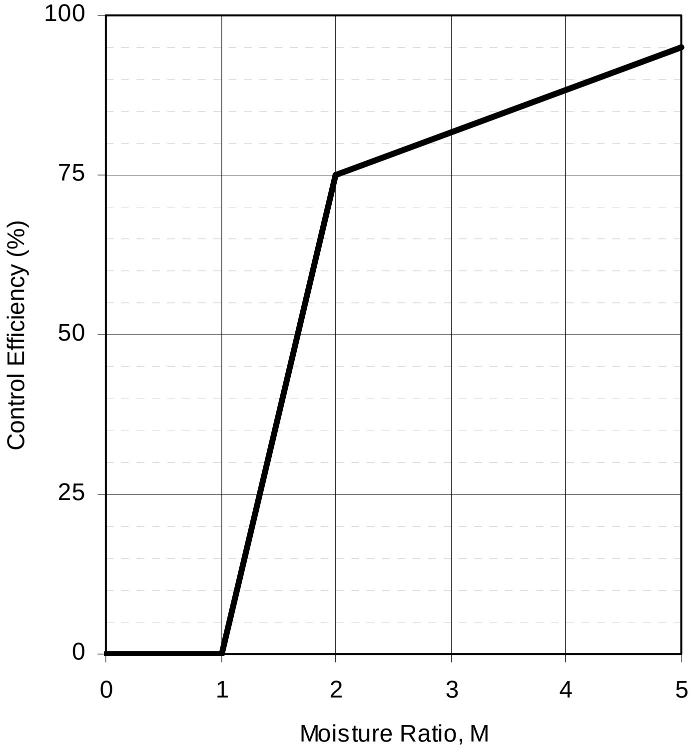

Figure 13.2.2-2. Watering control effectiveness for unpaved travel surfaces

The control effectiveness of chemical dust suppressants appears to depend on (a) the dilution rate used in the mixture; (b) the application rate (volume of solution per unit road surface area); (c) the time between applications; (d) the size, speed and amount of traffic during the period between applications; and (e) meteorological conditions (rainfall, freeze/thaw cycles, etc.) during the period. Other factors that affect the performance of dust suppressants include other traffic characteristics (e. g., cornering, track-on from unpaved areas) and road characteristics (e. g., bearing strength, grade). The variabilities in the above factors and differences between individual dust control products make the control efficiencies of chemical dust suppressants difficult to estimate. Past field testing of emissions from controlled unpaved roads has shown that chemical dust suppressants provide a PM-10 control efficiency of about 80 percent when applied at regular intervals of 2 weeks to 1 month.

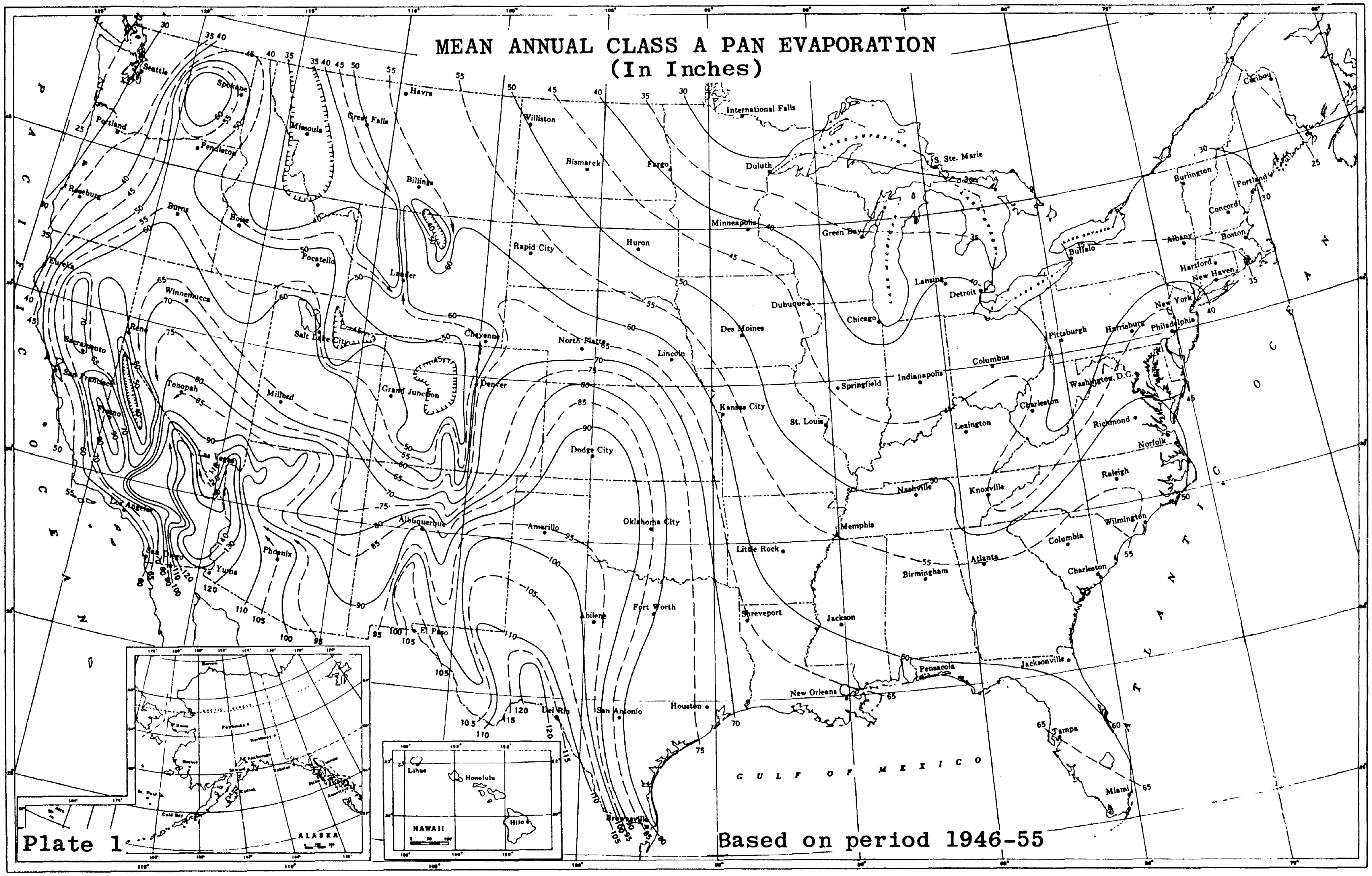

Figure 13.2.2-3. Annual evaporation data.

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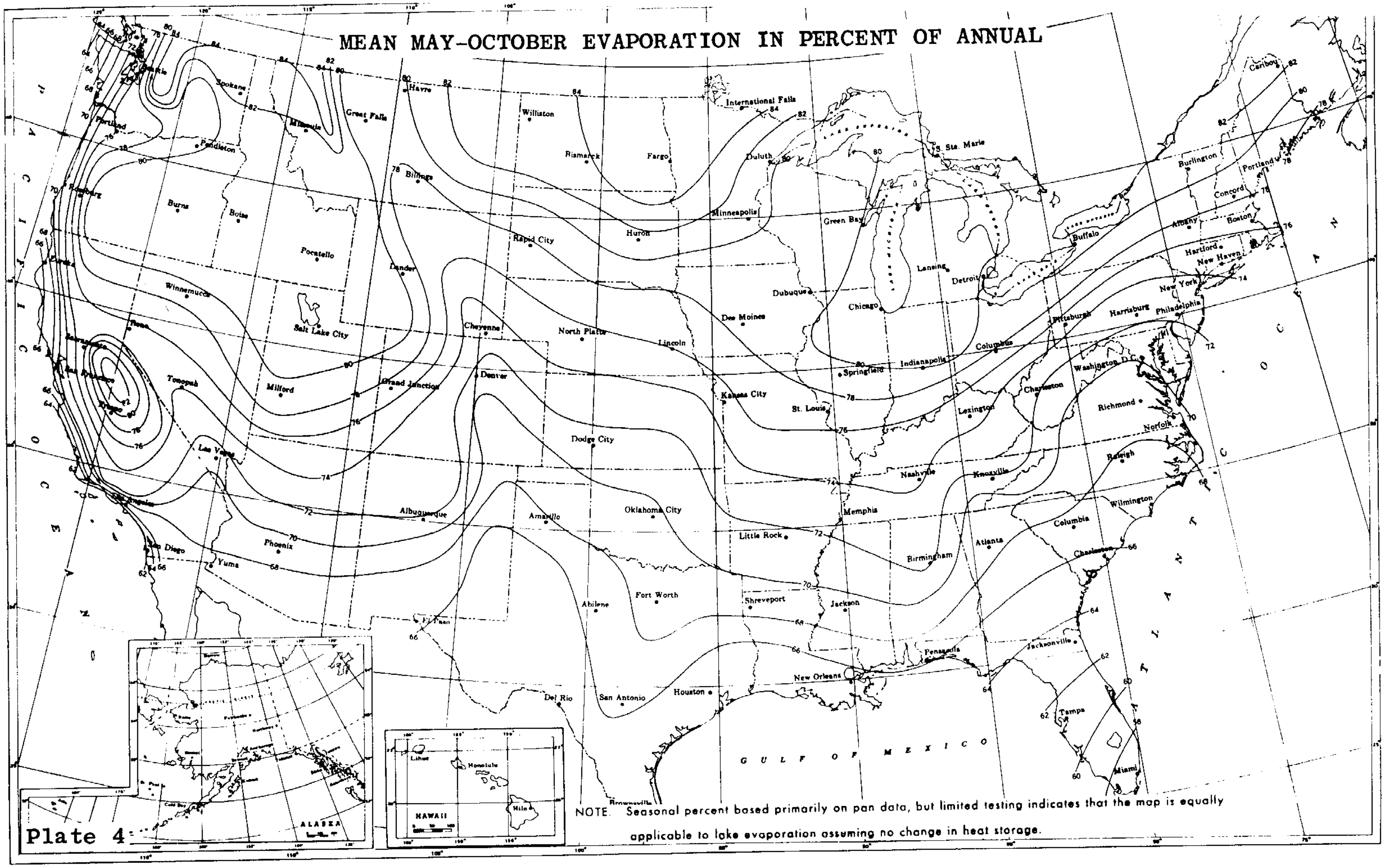

NOTE. Seasonal percent based primarily on pan data, but limited testing indicates that the map is equally applicable to lake evaporation assuming no change in heat storage.

Figure 13.2.2-4. Geographical distribution of the percentage of evaporation occurring between May and October.

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Petroleum resin products historically have been the dust suppressants (besides water) most widely used on industrial unpaved roads. Figure 13.2.2-5 presents a method to estimate average control efficiencies associated with petroleum resins applied to unpaved roads.[20] Several items should be noted:

1. The term "ground inventory" represents the total volume (per unit area) of petroleum resin concentrate (*not solution*) applied since the start of the dust control season.

2. Because petroleum resin products must be periodically reapplied to unpaved roads, the use of a time-averaged control efficiency value is appropriate. Figure 13.2.2-5 presents control efficiency values averaged over two common application intervals, 2 weeks and 1 month. Other application intervals will require interpolation.

3. Note that zero efficiency is assigned until the ground inventory reaches 0.05 gallon per square yard (gal/yd^2). Requiring a minimum ground inventory ensures that one must apply a reasonable amount of chemical dust suppressant to a road before claiming credit for emission control. Recall that the ground inventory refers to the amount of petroleum resin concentrate rather than the total solution.

As an example of the application of Figure 13.2.2-5, suppose that Equation 1a was used to estimate an emission factor of 7.1 lb/VMT for PM-10 from a particular road. Also, suppose that, starting on May 1, the road is treated with 0.221 gal/yd^2 of a solution (1 part petroleum resin to 5 parts water) on the first of each month through September. Then, the average controlled emission factors, shown in Table 13.2.2-5, are found.

Table 13.2-2-5. EXAMPLE OF AVERAGE CONTROLLED EMISSION FACTORS FOR SPECIFIC CONDITIONS

Period	Ground Inventory, gal/yd^2	Average Control Efficiency, %[a]	Average Controlled Emission Factor, lb/VMT
May	0.037	0	7.1
June	0.073	62	2.7
July	0.11	68	2.3
August	0.15	74	1.8
September	0.18	80	1.4

[a] From Figure 13.2.2-5, ≤10 µm. Zero efficiency assigned if ground inventory is less than 0.05 gal/yd^2. 1 lb/VMT = 281.9 g/VKT. 1 gal/yd^2 = 4.531 L/m^2.

Besides petroleum resins, other newer dust suppressants have also been successful in controlling emissions from unpaved roads. Specific test results for those chemicals, as well as for petroleum resins and watering, are provided in References 18 through 21.

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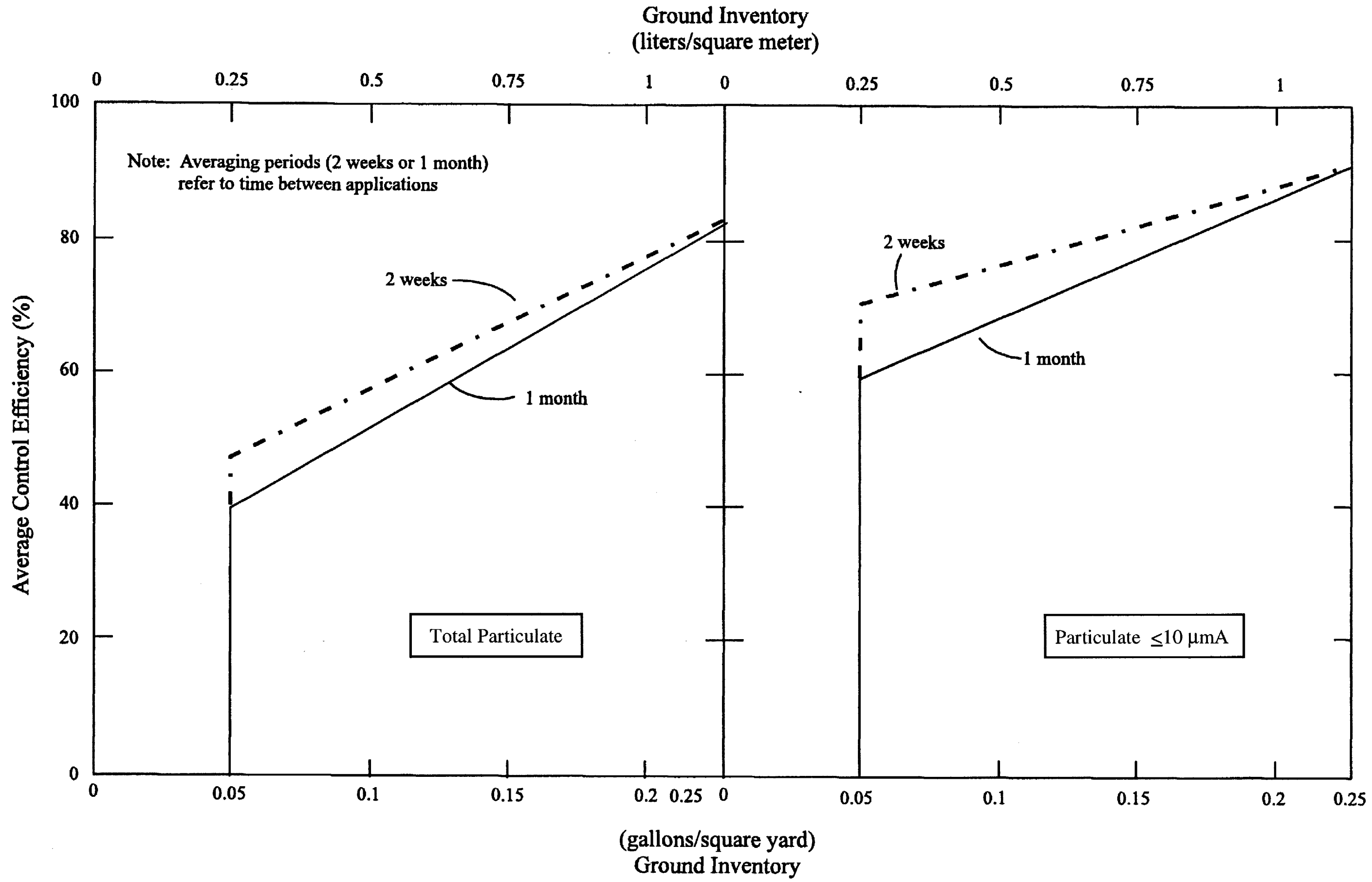

Figure 13.2.2-5. Average control efficiencies over common application intervals.

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13.2.2.4 Updates Since The Fifth Edition

The Fifth Edition was released in January 1995. Revisions to this section since that date are summarized below. For further detail, consult the background report for this section (Reference 6).

October 1998 (Supplement E)– This was a major revision of this section. Significant changes to the text and the emission factor equations were made.

October 2001 – Separate emission factors for unpaved surfaces at industrial sites and publicly accessible roads were introduced. Figure 13.2.2-2 was included to provide control effectiveness estimates for watered roads.

December 2003 – The public road emission factor equation (equation 1b) was adjusted to remove the component of particulate emissions from exhaust, brake wear, and tire wear. The parameter C in the new equation varies with aerodynamic size range of the particulate matter. Table 13.2.2-4 was added to present the new coefficients.

January 2006 – The PM-2.5 particle size multipliers (i.e., factors) in Table 13.2.2-2 were modified and the quality ratings were upgraded from C to B based on the wind tunnel studies of a variety of dust emitting surface materials.

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Emission Factor Documentation for AP-42, Section 13.2.1

Paved Roads

Measurement Policy Group
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency

January 2011

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Emission Factor Documentation for AP-42, Section 13.2.1

Paved Roads

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U.S. Environmental Protection Agency

January 2011

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NOTICE

The information in this document has been funded by the Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency (EPA). This final report has been subjected to the Agency's review, and it has been approved for publication as an EPA document. Mention of trade names or commercial products is not intended to constitute endorsement or recommendation for use.

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SECTION 1

INTRODUCTION

The document "Compilation of Air Pollutant Emissions Factors" (AP-42) has been published by the U.S. Environmental Protection Agency (EPA) since 1968. Supplements to AP-42 have been routinely published to add new emission source categories and to update existing emission factors. AP-42 is periodically updated by EPA to respond to new emission factor needs of EPA, State, and local air pollution control programs and industry.

An emission factor relates the quantity (weight) of pollutants emitted to a unit of activity of the source. The uses for the emission factors reported in AP-42 include:

1. Estimates of area-wide emissions.
2. Estimates of emissions for a specific facility.
3. Evaluation of emissions relative to ambient air quality.

The purpose of this report is to compile the existing background report and supplements into a single report, provide an update of the background information from test reports and other information to support preparation of a revised AP-42 section to replace existing Section 13.2.1, "Paved Roads," dated November 2006.

The principal pollutant of interest in this report is “particulate matter” (PM), with special emphasis placed on “PM_{10}” - particulate matter no greater than 10μmA (micrometers in aerodynamic diameter) and $PM_{2.5}$. PM_{10} and $PM_{2.5}$ form the basis for the current National Ambient Air Quality Standards (NAAQSs) for particulate matter. PM_{10} and $PM_{2.5}$ thus represent the two size ranges of particulate matter that are of greatest regulatory interest. Nevertheless, formal establishment of PM_{10} and $PM_{2.5}$ as the standard basis is relatively recent, and many emission tests have referenced other particle size ranges. Other size ranges employed in this report are:

TSP Total Suspended Particulate, as measured by the standard high-volume (hi-vol) air sampler. TSP was the basis for the previous NAAQSs for particulate matter. TSP consists of a relatively coarse particle size fraction. While the particle capture characteristics of the hi-vol sampler are dependent upon approach wind velocity, the effective D50 (i.e., 50% of the particles are captured and 50% are not) varies roughly from 25 to 50 μmA.

SP Suspended Particulate, which is used as a surrogate for TSP. Defined as PM no greater than 30 μmA. SP also may be denoted as “PM_{30}.”

IP Inhalable Particulate, defined as PM no greater than 15 μmA. Throughout the late 1970s and the early 1980s, it was clear that EPA intended to revise the NAAQSs to reflect a particle size range finer than TSP. What was not clear was the size fraction that would be eventually used, with values between 7 and 15 μmA frequently mentioned. Thus, many field

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studies were conducted using IP emission measurements because it was believed that IP would be the basis for the new NAAQS. IP may also be represented by "PM_{15}."

FP Fine Particulate, defined as PM no greater than 2.5µmA. FP also may be denoted as "$PM_{2.5}$."

This background report consists of five sections. Section 1 provides an introduction to the report. Section 2 presents descriptions of the paved road source types and emissions from those sources as well as a brief history of the current AP-42 emission factors. Section 3 is a review of emissions data collection and analysis procedures; it describes the literature search, the screening of emission test reports, and the quality rating system for both emission data and emission factors. Section 4 details the development of paved road emission factors for the draft AP-42 section; it includes the review of specific data sets and the results of data analysis. Section 5 presents the AP-42 section for paved roads.

SECTION 2

SOURCE DESCRIPTION

Particulate emissions occur whenever vehicles travel over a paved surface, such as public and industrial roads and parking lots. These emissions may originate from material previously deposited on the travel surface, resuspension of material carried by the vehicle, deposits from undercarriages, engine exhaust gases or tire and brake wear. Depending on the road surface characteristics, vehicle mix, the most significant emissions may arise from the surface material loading (measured as mass of material per unit area), or a combination of engine exhaust, brake and tire emissions. Surface loading is in turn replenished by other sources (e.g., pavement wear, deposition of material from vehicles, deposition from other nearby sources, carryout from surrounding unpaved areas, and litter). Because of the importance of the surface loading, available control techniques either attempt to prevent material from being deposited on the surface or to remove (from the travel lanes) any material that has been deposited.

2.1 PUBLIC AND INDUSTRIAL ROADS

While the mechanisms of particle deposition and resuspension are largely the same for public and industrial roads, there can be major differences in surface loading characteristics, emission levels, traffic characteristics, and viable control options. For the purpose of estimating particulate emissions and determining control programs, the distinction between public and industrial roads is not a question of ownership but rather a question of surface loading and traffic characteristics.

Although public roads generally tend to have lower surface loadings than industrial roads, the fact that these roads have far greater traffic volumes may result in a substantial contribution to the measured air quality in certain areas. In addition, public roads in industrial areas can be often heavily loaded and traveled by heavy vehicles. In that instance, better emission estimates might be obtained by treating these roads as industrial roads through the use of a silt loading and average vehicle weight appropriate for the road segment. In extreme cases, public roads, industrial road, or parking lots may have such a high surface loadings that the paved surface is covered with loose material and in extreme cases is mistaken for an unpaved surface. In that event, use of a paved road emission factor may actually result in a higher estimate than that obtained from the unpaved road emission factor, and the road is better characterized as unpaved in nature rather than paved.

2.2 REVIEW OF PAST AND CURRENT PAVED ROAD EMISSION FACTORS

2.2.1 September 1985 through January 1995.

From September 1985 through January 1995, AP-42 currently contained two sections concerning paved road fugitive emissions. The first, Section 11.2.5, is entitled "Urban Paved Roads" and was first drafted in 1984 using test results from public paved roads. Emission factors are given in the form of the following equation:

$$E = k\,(sL/0.5)^{p} \qquad (2\text{-}1)$$

where:
E = particulate emission factor (g/VKT)
s = surface material content silt, defined as particles < 75 µm diameter (%)
L = surface material loading, defined as mass of particles per unit area of the travel surface (g/m^2)
k = base emission factor (g/VKT)
p = exponent (dimensionless)

The factors k and p are given by

Particle size fraction	k (g/VKT)	p
TSP	5.87	0.9
PM_{15}	2.54	0.8
PM_{10}	2.28	0.8
$PM_{2.5}$	1.02	0.6

The form of the emission factor model is reasonably consistent throughout all particle size fractions of interest.

The urban paved road emission factors represented by Equation 2-1 did not change since their inclusion in the 4th Edition (September 1985) and the January 1995 revision. It should be noted that these emission factors were not quality rated "A" through "E." (See Section 3 for an overview of the AP-42 quality rating scheme.)

Section 11.2.6, "Industrial Paved Roads," was first published in 1983 and was slightly modified in Supplement B (1988) to the 4th Edition. Section 11.2.6 contained three distinct sets of emission factor models as described below.

$$E = 0.022 I \left(\frac{4}{n}\right)\left(\frac{s}{10}\right)\left(\frac{L}{280}\right)\left(\frac{W}{2.7}\right)^{0.7} \qquad (2\text{-}2)$$

For TSP, the following equation is recommended:

where:
E = emission factor (kg/VKT)
I = industrial augmentation factor (dimensionless)
n = number of traffic lanes (dimensionless)
s = surface material silt content (%)
L = surface material loading across all traffic lanes (kg/km)
W = average vehicle weight (Mg)

The basic form of Equation 2-2 dates from a 1979 report and was originally included in Supplement 14 to AP-42 (May 1983). The version used in AP-42 was slightly revised in that

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the leading term (i.e., 0.022 in Eq. [2-2]) was reduced by 14%. The industrial road augmentation factor (I) was included to take into account for higher emissions from industrial roads than from urban roads; it varied from 1 to 7. The emission factor equation was rated "B" for cases with I =1 and "D" otherwise.

For smaller particle size ranges, models somewhat similar to those in Eq. (2-1) were recommended:

$$E = k\,(sL/12)^{0.3} \qquad (2\text{-}3)$$

where:
E = emission factor (kg/VKT)
k = base emission factor (kg/VKT), see below
sL = road surface silt loading (g/m2)

The base emission factor (k) above varied with aerodynamic size range as follows:

Particle size fraction	k (g/VKT)
PM_{15}	0.28
PM_{10}	2.22
$PM_{2.5}$	0.081

These models represented by Equation 2-3 were first developed in 1984 from 15 emission tests of uncontrolled paved roads and they were rated "A."

During the development of Eq. (2-3), tests of light-duty traffic on heavily loaded road surfaces were identified as a separate subset, for which separate single-valued emission factors were developed. Section 11.2.6 recommended the following for light-duty (less than 4 tons) vehicles traveling over roads where the surface material was dry and the road was heavily loaded (silt loading greater than 15 g/m^2):

$$E = k \qquad (2\text{-}4)$$

where:
E = emission factor (kg/VKT)
k = single-valued factor depending on particle size range of interest (see below)

Particle size fraction	k (g/VKT)
PM_{15}	0.12
PM_{10}	0.093

The single-valued emission factors was quality rated "C."

During the time that AP-42 had four methods for estimating emissions from paved roads (Sections 11.2.5 and 11.2.6, AP-42 Fourth Edition, 1993), users of AP-42 noted difficulty selecting the appropriate emission factor model to use in their applications. For example, inventories of industrial facilities (particularly of iron and steel plants) conducted throughout the 1980s yielded measured silt loading values substantially lower than those in the Section 11.2.6 data base. In extreme cases when the models were used with silt loading values outside the range for which they were developed, estimated PM10 emission factors were larger than the corresponding TSP emission factors.

Furthermore, the distinction between "urban" and "industrial" paved roads was blurred. For the purpose of estimating emissions, it was gradually realized that source emission levels are not a question of ownership but rather a question of surface loading and traffic characteristics. Confirmatory evidence was obtained in a 1989 field program[29] which found that paved roads at an iron and steel facility far more closely resembled "urban" roads rather than "industrial" roads in terms of emission characteristics.

Finally, it was unknown how well the emission factors of that time performed for cases of increased surface loading on public roads, such as after application of antiskid materials or within areas of trackout from unpaved areas.[14] These situations were of considerable interest to several state and local regulatory agencies, most notably in the western United States.

2.2.2 January 1995 through October 2002

The January 1995 update attempted to correct as many of the shortcomings of the previous versions as possible. To that end, the update employed an approach slightly different than that used in the past. In addition to reviewing test data obtained since the September 1988 update[8], the test data used for both of the 1988 sections were also included for reexamination in the final data set. In assembling the data base, no distinction was made between public and industrial roads or between controlled and uncontrolled tests, with the anticipation that the reformulated emission factor will be applicable over a far greater range of source conditions.

The inclusion of controlled tests represented a break with EPA previous guidelines for preparing AP-42 sections[9]. Those guidelines presented a clear preference that only uncontrolled tests be used to develop an emission factor. However, the principal control measures for paved roads seek to reduce the value of an independent variable in the emission factor equation, i.e., the silt loading.

The revised emissions factor equation published in the January 1995 update of the paved road section included silt loading, average vehicle weight and a particle size multiplier as independent variables. The resulting equation was:

$$E = k\,(sL/2)^{0.65}\,(W/3)^{1.5} \qquad (2\text{-}5)$$

where: E = particulate emission factor (having units matching the units of k)
k = particle size multiplier for particle size range and units of interest (see below),
sL = road surface silt loading (grams per square meter) (g/m2), and
W = average weight (tons) of the vehicles traveling the road.

The selection of the value for the independent variable for the particle size multiplier was based upon the units of the emissions factor desired and the size range for the emissions.

Particle Size Multipliers for Paved Road Equation

Size Range	Multiplier k		
	g/VKT	g/VMT	lb/VMT
$PM_{2.5}$	2.1	3.3	0.0073
PM_{10}	4.6	7.3	0.016
PM_{15}	5.5	9.0	0.020
PM_{30}	24	38	0.082

2.2.3 October 2002 through December 2003

Prior to October 2002, the basis of the particle sizing information for paved roads emissions factors was high volume sampler impactors data. While the initial particle sizing was performed by cyclones, subsequent particle sizing was performed by slotted impactors. The impactor data had biases created by particle bounce and reintrainment. As such particle sizing below 10 µm was questioned. In October 2002, a three city paved and unpaved road emissions study was completed that evaluated particle sizing at 10 and 2.5µm and assessed the default values for silt loading. The results of the three city study formed the basis for revising the $PM_{2.5}$ particle size multiplier k from 2.1 g/VKT (3.3 g/VMT or 0.0073 lb/VMT) to 1.1 g/VKT (1.8 g/VMT or 0.0040 lb/VMT). The form of the predictive equation and the exponents for silt loading and average vehicle weight were unchanged. The changes in the October 2002 revision provided recommended default silt loading data for normal and worst case public paved roads based upon the updated silt loading values for public paved roads. The remaining numerical revisions that were made in the emissions factor for paved roads included an adjustment for the normal mitigation effects due to rain events. For long term average conditions, a 25% reduction in the particulate emissions was included for every day that there was measureable rain for that day. A similar adjustment was included that used hourly time intervals rather that a daily time interval.

2.2.4 December 2003 through November 2006

The December 2003 revision of the AP-42 Section for paved roads incorporated a constant in the predictive equation for particulate emissions factors. The AP-42 equations prior to December 2003 estimated PM emissions from re-entrained road dust, and vehicle exhaust, brake wear and tire wear emissions. In the December 2003 revision of the section, the component of emissions due to exhaust, brake wear and tire wear were separated from the composite fugitive dust emission factor equation. The first stated reason for the separation was to eliminate the possibility of double counting emissions. With the introduction of EPA’s Mobile6.2 model, estimates of PM emissions from exhaust, brake wear and tire wear were calculated based upon the vehicle mix, vehicle speed and road class. The double counting of emissions was a possibility when both the fugitive dust emission factors from AP-42 and Mobile6.2 were used to estimate emissions from vehicle traffic on paved roads. The second stated reason was to incorporate decreases in particulate matter emissions from the exhaust of newer vehicle models and fuel sources. Since the majority of data supporting the paved road emission factor equation was developed at the time prior to when the vehicles in the fleet incorporated significant reductions of particulate matter emissions. A technical memorandum provided the basis for estimating PM emissions due to exhaust, break wear and tire wear. The technical memorandum used estimated emissions from a 1980's model year vehicle fleet since the emissions tests supporting the emissions factors equation were performed in the early 1980's to early 1990's. It was believed that since 1980, there have been and will continue to be improvements in vehicles and fuel that will result in a decrease in PM emissions from engine exhaust. Depending on the emissions factors units desired, the constant that was included in the emissions factor equation had values of 0.2119 g/VKT, 0.1317 g/VMT or 0.00047 lb/VMT for PM_{30}, PM_{15} and PM_{10} emissions. For $PM_{2.5}$ emissions, depending on the required emissions factors units, the constant used in the equation had values of 0.1617 g/VKT, 0.1005 g/VMT or 0.00036 lb/VMT.

2.2.5 November 2006 through May 2010

In November 2006, the particle size multiplier k was lowered to 0.66 g/VKT, 1.1 g/VMT or 0.0024 depending on the needed units for the emissions factor. The revision was based upon a broad based assessment of the biases associated with the cyclone/impactor method for particulate sizes less than 10 μm in aerodynamic diameter. While the December 2003 update revised the particle size multiplier, the update was based upon limited test data. In addition, the impact of biased emissions factor ratios for $PM_{2.5}$ impacted fugitive sources other than paved roads. The impact was due to particle bounce from the cascade impactor stages to the backup filter potentially inflating $PM_{2.5}$ concentrations. The impact was possible even though steps were taken to minimize particle bounce in the earlier studies. The assessment study was sponsored by the Western Regional Air Partnership and conducted by the Midwest Research Institute (MRI). The testing was conducted at MRI's Aerosol Test Facility (ATF) in Deramus Field Station in Grandview, Missouri using surface dust collected from seven locations in five western states. The tests provided the basis for comparing the average $PM_{2.5}$ concentration and the collocated PM_{10} concentration. The study compared the fine fraction ratios derived from FRM samplers to those derived from the cyclone/impactor method. The cyclone/impactor samplers and operating method used in the study were the same as those that generated the original AP-42 emission factors and associated $PM_{2.5}$ / PM_{10} ratios. The study consisted of 100 test runs covering PM_{10}concentration from approximately 0.3 mg/m^3 to 7 mg/m^3.

2.2.6 May 2010

This update recommends an updated equation for paved roads that is based upon additional test data that was conducted on roads with slow moving traffic and stop and go traffic. The emissions tests were performed for the Corn Refiners Association by Midwest Research Institute (MRI). The testing focused on PM_{10} emissions at four corn processing facilities. Unlike the development of earlier paved road equations, the equation development for this version adjusts the individual test data measured emissions by excluding exhaust emissions, tire wear emissions and brake wear emissions prior to the equation development. As a result, different values are subtracted from the results of each test based upon the average vehicle weights, average vehicle speed, ambient temperature, year of test and estimated mix of light duty and heavy duty vehicles.

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SECTION 3

GENERAL DATA REVIEW AND ANALYSIS

To reduce the amount of literature collected to a final group of references from which emission factors could be developed, the following general criteria were used:

1. Emissions data must be from a primary reference:
    a. Source testing must be from a referenced study that does not reiterate information from previous studies.
    b. The document must constitute the original source of test data. For example, a technical paper was not included if the original study was contained in the previous document. If the exact source of the data could not be determined, the document was eliminated.

2. The referenced study must contain test results based on more than one test run.

3. The report must contain sufficient data to evaluate the testing procedures and source operating conditions.

A final set of reference materials was compiled after a thorough review of the pertinent reports, documents, and information according to these criteria.

3.1 LITERATURE SEARCH AND SCREENING

Review of available literature identified three paved road testing programs (presented later as Table 4-1) since the time of the last Section 11.2 update.[8] The individual programs are discussed in detail in the next section. In addition, as discussed at the end of Section 2, earlier controlled industrial road test data were reexamined. The previous update[8] noted that Eq. (2-4) yielded quite good estimates for emissions from vacuum swept and water flushed roads. Furthermore, it became apparent that previous distinctions between "industrial" and "urban" roads had become blurred as interest focused on heavily loaded urban roads (e.g., after snow/ice controls) and on cleaner industrial roads (as the result of plant-wide control programs).

3.2 EMISSION DATA QUALITY RATING SYSTEM

As part of the analysis of the emission data, the quantity and quality of the information contained in the final set of reference documents were evaluated. The following data are to be excluded from consideration:

1. Test series averages reported in units cannot be converted to the selected reporting units.

2. Test series representing incompatible test methods (i.e., comparison of EPA Method 5 front-half with EPA Method 5 front- and back-half).

3. Test series of controlled emissions for which the control device is not specified.

4. Test series in which the source process is not clearly identified and described.

5. Test series in which it is not clear whether the emissions were measured before or after the control device.

Test data sets that were not excluded were assigned a quality rating. The rating system used was that specified by EPA for preparing AP-42 sections.[9] The data were rated as follows:

A Multiple tests that were performed on the same source using sound methodology and reported in enough detail for adequate validation. These tests do not necessarily conform to the methodology specified in EPA reference test methods, although these methods were used as a guide for the methodology actually used.

B Tests that were performed by a generally sound methodology, but lack enough detail for adequate validation.

C Tests that were based on an untested or new methodology or that lacked a significant amount of background data.

D Tests that were based on a generally unacceptable method but may provide an order-of-magnitude value for the source.

The following criteria were used to evaluate source test reports for sound methodology and adequate detail:

1. Source operation. The manner in which the source was operated is well documented in the report. The source was operating within typical parameters during the test.

2. Sampling procedures. The sampling procedures conformed to a generally acceptable methodology. If actual procedures deviated from accepted methods, the deviations are well documented. When this occurred, an evaluation was made of the extent such alternative procedures could influence the test results.

3. Sampling and process data. Adequate sampling and process data are documented in the report, and any variations in the sampling and process operation are noted. If a large spread between test results cannot be explained by information contained in the test report, the data are suspect and were given a lower rating.

4. Analysis and calculations. The test reports contain original raw data sheets. The nomenclature and equations used were compared to those (if any) specified by EPA to establish equivalency. The depth of review of the calculations was

dictated by the reviewer's confidence in the ability and conscientiousness of the tester, which in turn was based on factors such as consistency of results and completeness of other areas of the test report.

3.3 EMISSION FACTOR QUALITY RATING SYSTEM

The quality of the emission factors developed from analysis of the test data was rated utilizing the following general criteria:

A—Excellent: Developed only from A-rated test data taken from many randomly chosen facilities in the industry population. The source category is specific enough so that variability within the source category population may be minimized.

B—Above average: Developed only from A-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industries. The source category is specific enough so that variability within the source category population may be minimized.

C—Average: Developed only from A- and B-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. In addition, the source category is specific enough so that variability within the source category population may be minimized.

D—Below average: The emission factor was developed only from A- and B-rated test data from a small number of facilities, and there is reason to suspect that these facilities do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of the emission factor are noted in the emission factor table.

E—Poor: The emission factor was developed from C- and D-rated test data, and there is reason to suspect that the facilities tested do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of these factors are always noted.

The use of these criteria is somewhat subjective and depends to an extent on the individual reviewer.

3.4 METHODS OF EMISSION FACTOR DETERMINATION

Fugitive dust emission rates and particle size distributions are difficult to quantify because of the diffuse and variable nature of such sources and the wide range of particle size involved including particles which deposit immediately adjacent to the source. Standard source testing methods, which are designed for application to confined flows under steady state, forced-flow conditions, are not suitable for measurement of fugitive emissions unless the plume can be draw into a forced-flow system. The following presents a brief overview of applicable measurement techniques. More detail can be found in earlier AP-42 updates.[8,10]

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3.4.1 Mass Emission Measurements

Because it is usually impractical to enclose open dust sources or to capture the entire emissions plume, only the upwind-downwind and exposure profiling methods are suitable for measurement of particulate emissions from most open dust sources.[10] These two methods are discussed separately below.

The basic procedure of the upwind-downwind method involves the measurement of particulate concentrations both upwind and downwind of the pollutant source. The number of upwind sampling instruments depends on the degree of isolation of the source operation of concern (i.e., the absence of interference from other sources upwind). Increasing the number of downwind instruments improves the reliability in determining the emission rate by providing better plume definition. In order to reasonably define the plume emanating from a point source, instruments need to be located at two downwind distances and three crosswind distances, at a minimum. The same sampling requirements pertain to line sources except that measurement need not be made at multiple crosswind distances.

Net downwind (i.e., downwind minus upwind) concentrations are used as input to dispersion equations (normally of the Gaussian type) to back calculate the particulate emission rate (i.e., source strength) required to generate the pollutant concentration measured. Emission factors are obtained by dividing the calculated emission rate by a source activity rate (e.g., number of vehicles, or weight of material transferred per unit time). A number of meteorological parameters must be concurrently recorded for input to this dispersion equation. At a minimum the wind direction and speed must be recorded on-site.

While the upwind-downwind method is applicable to virtually all types of sources, it has significant limitations with regard to development of source-specific emission factors. The major limitations are as follows:

1. In attempting to quantify a large area source, overlapping of plumes from upwind (background) sources may preclude the determination of the specific contribution of the area source.

2. Because of the impracticality of adjusting the locations of the sampling array for shifts in wind direction during sampling, it cannot be assumed that plume position is fixed in the application of the dispersion model.

3. The usual assumption that an area source is uniformly emitting does not allow for realistic representation of spatial variation in source activity.

4. The typical use of uncalibrated atmospheric dispersion models introduces the possibility of substantial error (a factor of three according to Reference 11) in the calculated emission rate, even if the stringent requirement of unobstructed dispersion from a simplified (e.g., constant emission rate from a single point) source configuration is met.

The other measurement technique, exposure profiling, offers distinct advantages for

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source-specific quantification of fugitive emissions from open dust sources. The method uses the isokinetic profiling concept that is the basis for conventional (ducted) source testing. The passage of airborne pollutant immediately downwind of the source is measured directly by means of simultaneous multipoint sampling over the effective cross section of the fugitive emissions plume. This technique uses a mass-balance calculation scheme similar to EPA Method 5 stack testing rather than requiring indirect calculation through the application of a generalized atmospheric dispersion model.

For measurement of nonbuoyant fugitive emissions, profiling sampling heads are distributed over a vertical network positioned just downwind (usually about 5 m) from the source. If total particulate emissions are to be measured, sampling intakes are pointed into the wind and sampling velocity is adjusted to match the local mean wind speed, as monitored by anemometers distributed over height above ground level.

The size of the sampling grid needed for exposure profiling of a particular source may be estimated by observation of the visible size of the plume or by calculation of plume dispersion. Grid size adjustments may be required based on the results of preliminary testing. Particulate sampling heads should be symmetrically distributed over the concentrated portion of the plume containing about 90% of the total mass flux (exposure). For example, assuming that the exposure from a point source is normally distributed, the exposure values measured by the samplers at the edge of the grid should be about 25% of the centerline exposure.

To calculate emission rates using the exposure profiling technique, a conservation of mass approach is used. The passage of airborne particulate (i.e., the quantity of emissions per unit of source activity) is obtained by spatial integration of distributed measurements of exposure (mass/area) over the effective cross section of the plume. The exposure is the point value of the flux (mass/area/time) of airborne particulate integrated over the time of measurement.

3.4.2 Emission Factor Derivation

Emissions factors are typically derived from the ratio of the emissions to an activity level. It is assumed that the emissions are linearly proportional to the selected activity level. Usually the final emission factor for a given source operation, is the arithmetic average of the individual emission factors calculated from each test of that source type. In rare instances, the range of individual emission factor values is also presented.

As an improvement over the presentation of a final emission factor as a single-valued arithmetic mean, an emission factor may be presented in the form of a predictive equation derived by regression analysis of test data. The use of a predictive equation with a relatively good correlation coefficient (R^2) provides a means for improving the accuracy of the emissions factor in estimating the actual emissions when the independent variables are known. Such an equation mathematically relates emissions to parameters when characterize source conditions. These parameters may be grouped into three categories:

1. Measures of source activity or energy expended (e.g., the speed and weight of a vehicle traveling on an unpaved road).

2. Properties of the material being disturbed (e.g., the content of suspendable fines

in the surface material on an unpaved road).

3. Climatic parameters (e.g., number of precipitation-free days per year on which emissions tend to be at a maximum).

An emission factor equation is useful if it is successful in "explaining" much of the observed variance in emission factor values on the basis of corresponding variance sin specific source parameters. This enables more reliable estimates of source emissions on a site-specific basis.

A generic emission factor equation is one that is developed for a source operation defined on the basis of a single dust generation mechanism which crosses industry lines. An example would be vehicular traffic on unpaved roads. To establish its applicability, a generic equation should be developed from test data obtained in different industries.

3.5 EMISSION FACTOR QUALITY RATING SCHEME USED IN THIS STUDY

The uncontrolled emission factor quality rating scheme used in this study is somewhat different than was used in earlier updates[8,11] of this section and represents a refinement of the rating system developed by EPA for AP-42 emission factors, as described in Section 3.3. The scheme entails the use of the same rating assessment of source test data quality followed by an initial rating assessment of the emission factor(s) based on the number and quality of the underlying source test data.

Test data that were developed from well documented, sound methodologies were assigned an A rating. Data generated by a methodology that was generally sound but either did not meet a minimum test system requirements or lacked enough detail for adequate validation received a B rating.

In evaluating whether an upwind-downwind sampling strategy qualified as a sound methodology, the following minimum test system requirements were used. At least five particulate measuring devices must be operated during a test, with one device located upwind and the other located at two downwind and three crosswind distances. The requirement of measurements at crosswind distances is waived for the case of line sources. Also wind direction and speed must be monitored concurrently on-site.

The minimum requirements for a sound exposure profiling program were the following. A one-dimensional, vertical grid of at least three samplers is sufficient for measurement of emissions from line or moving point sources while a two-dimensional array of at least five samplers is required for quantification of fixed virtual point source missions. At least one upwind sampler must be operated to measure background concentration, and wind speed must be measured on-site.

Neither the upwind-downwind nor the exposure profiling method can be expected to produce A-rated emissions data when applied to large, poorly defined area sources, or under very light and variable wind flow conditions. In these situations, data ratings based on degree of compliance with minimum test system requirements were reduced one letter.

Following the assignment of the individual source test quality ratings, the factor quality rating of the single-valued emission factor will be evaluated. Recently approximately 20 “A” and “B” rated source test reports have been required to justify a factor quality rating of “A”. Each halving of the number of source test reports results in a one letter grade reduction in the final factor quality rating. Several of the source test reports used as the basis for the emissions factor development include measurements conducted at different locations. To the extent that there are more than two tests at the different locations and that the different locations within a given reference represent differences in source conditions, each of the different source conditions will be counted as an independent test. The development of the paved road emissions factor differs from typical in that it includes the use of stepwise multiple non linear regression. Following the initial factor quality rating, the adjusted correlation coefficient will be used to increase the emissions factor quality rating. Only correlation coefficients above 0.4 will be used to increase the emissions factor quality rating.

SECTION 4

AP-42 SECTION DEVELOPMENT

4.1 REVISIONS TO SECTION NARRATIVE

The AP-42 presented later in this background document is intended to replace the current version of Section 13.2.1 "Paved Roads" in AP-42. The last update of this section is dated November 2006. The general form of the emissions factor equation presented in the paved road section has been consistent since the January 1995 major revision. Since this date revisions have been made addressing the influence of rain events, estimating default silt loading levels for various classes of roads, separating particulate emissions associated with the roads verses those associated with the vehicles and addressing biases in the measurement of $PM_{2.5}$ with devices that use impactors to perform particulate sizing.

4.2 POLLUTANT EMISSION FACTOR DEVELOPMENT

This update to Sections 13.2.1 is planned to address the application of the emissions factor equation addressing only the component associated with paved road surface materials and at speeds lower than 10 miles per hour. In order to achieve this goal, the following general approach was taken

1. Assemble the available test data for paved roads in a single data base, making no distinction between public and industrial roads or between controlled and uncontrolled roads.
2. Develop PM_{10} and $PM_{2.5}$ engine, tire wear and brake ware emissions estimates for each of the available data sets. For each of the available data sets, estimate the emissions associated with the road surface material by subtracting the engine, tire wear and brake wear from the measured PM_{10} emissions.
2. Conduct a series of stepwise linear regression analyses of the revised and adjusted data base to assess the most critical parameters and to develop an emission factor model with:
    - silt loading,
    - mean vehicle weight, and,
    - mean travel speeds

   as potential correction parameters.
3. Conduct an appropriate validation study of the reformulated model.

4.2.1 Review of Specific Data Sets

4.2.1.1 Street Sanding Emissions And Control Study, PEI Associates, Inc., Cincinnati, OH, October 1989. (Reference 15)

This test program was undertaken to characterize PM_{10} emissions from six streets that were periodically sanded for anti-skid control within the Denver area. The primary objective was given as development of a predictive algorithm for clean and sanded streets, with a secondary objective stated as defining the effectiveness of control measures. Summary information is given in Table 4-1.

Sampling employed six to eight 8 PM_{10} samplers equipped with volumetric flow control. Samplers were arranged in two upwind/downwind configurations. The "basic" configuration consisted of six samplers arranged in identical patterns upwind and downwind of the test road, with one sampler and one pair of samplers at nominal distances of 20 and 5 m, respectively, from the road.

The second configuration was used for tests of control measure effectiveness. The road segment was divided into two halves, corresponding to the treated and experimental control (untreated) portions. Identical sampling arrays were again used upwind and downwind on both halves, at nominal distances of 20 and 5 m. Because this array employed all eight samplers available, no collocation was possible for the second configuration.

In addition to the PM_{10} concentration measurements, several other types of samples were collected:

- Wind speed/direction and incoming solar radiation were collected on-site, and the results were combined to estimate atmospheric stability class needed to calculate emission factors.
- Colorado Air Pollution Control Division (APCD) representatives collected traffic data, including traffic counts, travel speeds, and percentage of heavy-duty vehicles.
- Vacuums with disposable paper bags were used to collect the loose material from the road surface. In addition to samples taken from the travel lanes, the field crew took daily samples of material adjacent to curbs and periodic duplicate samples.

The study collected PM_{10} concentration data on 24 different days and calculated a total of 69 different emission rates for baseline, sanded and controlled paved road surfaces. Emission factors were obtained by back-calculation from the CALINE3 dispersion model[12] together with a series of assumptions involving mixing widths and heights and an effective release height. Although data collected at the 20 m distance were used to evaluate results, the test report did not describe any sensitivity analysis to determine how dependent the emission rates were on the underlying assumptions.

TABLE 4-1. SUMMARY INFORMATION FOR REFERENCE 15

					PM_{10} emission factor (g/VKT)	
Operation	Location	State	Test dates	No. of tests	Geom. mean	Range
Vehicle traffic	Colfax	Colorado	3-4/89	17	1.33	0.53-9.01
Vehicle traffic	York St.	Colorado	4/89	1	1.07	1.07
Vehicle traffic	Belleview	Colorado	4/89	4	1.62	1.10-4.77
Vehicle traffic	I-225	Colorado	4/89	9	0.31	0.17-0.51
Vehicle traffic	Evans	Colorado	5-6/89	29	1.06	0.21-7.83
Vehicle traffic	Louisiana	Colorado	6/89	7	0.96	0.42-1.73

The testing program found difficulty in defining "upwind" concentrations for several of the runs, including cases with wind reversals or winds nearly parallel to the roadway orientation. A total of eight of the 69 tests required that either an average concentration from other test days or a downwind concentration be used to define "upwind" conditions. In addition, the test report described another seven runs as invalid for reasons such as wet road surfaces, nearby dust sources or concentrations increasing with downwind distance.

A series of stepwise regression analyses were conducted, with different predictive equations presented for (a) baseline conditions, (b) sanded roads, and (c) roads swept to remove the sand applied, and (d) all conditions combined. In each case, only one independent variable was included in the predictive equation: silt loading, for cases (a) and (d); and time since treatment, for (b) and (c).

In general, Reference 15 is reasonably well documented in terms of describing test conditions, sampling methodology, data reduction and analysis. A chief limitation lies in the fact that neither sampling configuration fully met minimum requirements for the upwind-downwind method presented in Section 3.4. Specifically, only two or three samplers were used downwind rather than the minimum of four.

Furthermore, a later report[6] drawing upon the results from Reference 15 and 17 effectively eliminated 24% of the combined baseline tests because of wind directions. In addition, the later report[6] noted that the baseline data should be considered as "conservatively high" because roughly 70% of the data were calculated assuming the most unstable atmospheric class (which results in the highest back calculated emission factor). Because of these limitations, the emission data have been given an overall rating of "D."

4.2.1.2 RTP Environmental Associates 1990. Street Sanding Emissions and Control Study, prepared for the Colorado Department of Health. July 1990. (Reference 17)

This test program was quite similar to that described in Reference 15 cited in paragraph 4.2.1.1 and used an essentially identical methodology. In fact, the two test reports are very similar in outline, and many passages in the two reports are identical. The primary objective was given as expanding the data base in Reference 15 to further develop predictive algorithms for clean and sanded streets. Summary information is given in Table 4-2.

The test program employed the same two basic PM_{10} sampling arrays as did Reference 15. A third configuration was used for "profile" tests, in which additional samplers were placed at 10 and 20 ft heights. (Analysis of results from elevated samplers is not presented in Reference 17.)

As was the case in Reference 15, additional samples were collected including:

- Wind speed/direction were collected on-site, and the results used in estimating atmospheric stability class needed to calculate emissions factors. (Unlike Reference 15, solar radiation measurements were not collected.)
- Traffic data, including traffic counts, travel speeds, and percentages of heavy-duty vehicles were collected.
- Vacuums with disposable paper bags were used to collect the loose material

from the road surface. The program developed an extensive set of collocated samples of material along the edges of the roadway.

The study collected PM_{10} concentration data on 33 days and calculated a total of 131 different emission rates for baseline, sanded and controlled paved road surfaces. Emission factors were obtained by back-calculation from the CALINE3 dispersion model[12] together with essentially the same assumptions as those in Reference 15. This report also noted the same difficulty as Reference 15 in defining "upwind" concentrations in cases with wind reversals or winds nearly parallel to the roadway orientation. Unlike Reference 15, however, this report does not provide readily available information on how many tests used either an average concentration from other test days or a downwind concentration to define "upwind" conditions. Reference 6 does, however, describe seven tests as invalid because of filter problems or because upwind concentrations were higher than downwind values.

As with the Reference 15 program, a series of stepwise regression analyses were conducted. This test program combined data from Reference 15 and 17 and considered predictive equations for (a) baseline conditions, (b) sanded roads, and (c) roads swept to remove the sand applied, and (d) all conditions combined.

Unlike Reference 15, however, Reference 17 appears to present silt loading values that are based on wet sieving (see page 8 of the test report) rather than the dry sieving technique (as described in Appendix E to AP-42) routinely used in fugitive dust tests. (MRI could not obtain any clarifying information during telephone calls to the testing organization and the laboratory that analyzed the samples.) Wet sieving disaggregates composite particles and results from the two types of sieving are not comparable.

There is additional confusion over the silt loading values given in Reference 17 for cleaning tests. Specifically, the same silt loading value is associated with both the treatment and the experimental control. This point could not be clarified during telephone conversation with the testing organization. Attempts to clarify using test report appendices were unsuccessful. Two appendices appear to interchange silt loading with silt percentage. More importantly, it could not be determined whether the surface sample results reported in Appendix D to Reference 17 pertain to treated or the experimental control segment, and with which emission rate a silt loading should be associated.

TABLE 4-2. SUMMARY INFORMATION FOR REFERENCE 17

Operation	Location	State	Test dates	No. of test	PM_{10} emission factor (g/VKT) Geom. mean	Range
Vehicle traffic	Mexico	Colorado	2/90	3	2.75	1.08-6.45
Vehicle traffic	State Hwy 36	Colorado	1-3/90	13	1.31	0.14-4.18
Vehicle traffic	Colfax	Colorado	2-4/90	41	1.32	0.27-5.04
Vehicle traffic	Park Rd.	Colorado	4/90	11	1.26	0.69-3.33
Vehicle traffic	Evans	Colorado	2-3/90	11	2.10	0.87-7.27
Vehicle traffic	Louisiana	Colorado	1,3/90	9	3.24	1.40-5.66
Vehicle traffic	Jewell	Colorado	1/90	1	6.36	6.36
Vehicle traffic	Bryon	Colorado	4/90	3	8.38	5.53-14.72

Reference 17 contains substantial amounts of information, but is not particularly well documented in terms of describing test conditions, sampling methodology, data reduction and analysis. In addition, the same limitations mentioned in connection with Reference 15 are equally applicable to Reference 17, as follows:

- not meeting the minimum number of samplers.
- numerous tests conducted under variable wind conditions.
- frequent use (70% to 80% of the tests) of the most unstable atmospheric stability class in the CALINE 3 model which will result in the highest calculated emission rate.

Because of these limitations, emission rate data have been given an overall rating of "D." Furthermore, the silt loading data in this report are considered suspect for reasons noted above.

4.2.1.3 T. Cuscino, Jr., et al., *Iron And Steel Plant Open Source Fugitive Emission Control Evaluation,* EPA 600/2 83 110, U. S. Environmental Protection Agency, Cincinnati, OH, October 1983. (Reference 6, ref_06c13s0201_2011.pdf)

This study evaluated paved road control techniques at two different iron and steel plants. (See Tables 9 and 10 in Reference 8.) Data were quality rated as "A," and uncontrolled test results were incorporated into the data base for Section 11.2.6 published in 1983. The only use of the controlled test results, however, was the following addition to Section 11.2.6.4 in 1988:

> "Although there are relatively few quantitative data on emissions from controlled paved roads, those that are available indicate that adequate estimates generally may be obtained by substituting controlled loading values into .. [Equations (2-2) and (2-3)].... The major exception to this is water flushing combined with broom sweeping. In that case, the equations tend to overestimate emissions substantially (by an average factor of 4 or more)."

In the current update, the controlled emission factors have been used as part of the overall data base to develop predictive models. Although PM_{10} emission data are not specifically presented in the report, appropriate values were previously developed by log-normal interpolation of the PM_{15} and $PM_{2.5}$ factors.[8]

4.2.1.4. G. E. Muleski, *Measurement of Fugitive Dust Emissions from Prilled Sulfur Handling, Final Report,* MRI Project No. 7995-L, Prepared for Gardinier, Inc., June 1984 (Reference 45)

This was first report identified to suggest that heavily loaded paved roads may be better considered as unpaved in terms of emission estimates. The program produced three tests of emissions from end-loader travel over paved surfaces. Two of the three tests were conducted on very heavily loaded surface, while the third was on a cleaned paved surface. (See Tables 20 and 21 of the 1987 update.)[8]

No PM_{10} emission factors were reported; results were presented for total particulate (TP) and suspended particulate (SP, or PM_{30}). Data were quality rated "A" in the 1987 report.

Because no PM_{10} data were given, Test Report 5 data were most directly useful as independent data against which the TSP emission factor model (Eq. (2-2)) could be assessed. This comparison showed generally good agreement between predicted and observed with agreement becoming better as source conditions approached those in the underlying data base.

The 1987 update[8] developed PM_{10} emission factors based on information contained in the test report. When compared to the single valued factors (Equation [2-4]), agreement for the first two tests was within a factor of approximately two. The third test — that of the cleaned surface — could not be used to assess the performance of either Eq. (2-1) or Eq. (2-3) because the surface loading value could not be converted to the necessary units with information presented in the report.

4.2.1.5 T. F. Eckle and D. L. Trozzo, *Verification of the Efficiency of a Road-Dust Emission-Reduction Program by Exposure Profile Measurement,* Presented at EPA/AISI Symposium on Iron and Steel Pollution Abatement, Cleveland, Ohio, October 1984. (Reference 46)

This paper discussed the development of an exposure profiling system as well as an evaluation of the effectiveness of a paved road vacuum sweeping program. Because no reference is made to an earlier test report, this paper is considered to be the original source of the test data. Although ten uncontrolled and five controlled tests are mentioned, test data are reported only in terms of averages. (See Tables 24 and 25 in Reference 8.) Only TSP emission factors are presented. Although data were obtained using a sound methodology, data were rated "C" because of inadequate detail in the paper.

Averaged data from Test Report 8 were used in an independent assessment of Eq. (2-2). Although only average emission levels could be compared, the data suggested that TSP emissions could be estimated within very acceptable limits.

4.2.1.6 Roadway Emissions Field Tests at U.S. Steel's Fairless Works, U.S. Steel Corporation, Fairless Hills, PA, USX Purchase Order No. 146-0001191-0068, May 1990. (Reference 31, ref_31c13s0201_2011.pdf).

This 1989 field program used exposure profiling to characterize emissions from paved roads at an integrated iron and steel plant near Philadelphia, Pennsylvania, in November 1989. In many respects, this program arose because of uncertainties with paved road emission factor models used outside their range of applicability. During the preparation of an alternative emission reduction ("bubble") plan for the plant, questions arose about the use of AP-42 equations and other EPA guidance[13] in estimating roadway emissions involved in the emissions trade. This program provided site-specific data to support the bubble plan. This testing program also represented the first exposure profiling data to supplement the AP-42 paved road data base since the 1984 revision. Site "C" was located along the main access route and had a mix of light- and medium-duty vehicles. Site "E" was located near the southwest corner of the plant and the traffic consisted mostly of plant equipment. Table 4-3 provides summary information and Table 4-4 provides detailed information.

The program involved two paved road test sites. The first (site "C") was along the four-lane main access route to the plant. Average daily traffic (ADT) had been estimated as more than 4,000 vehicle passes per day, with most vehicles representative of "foreign" equipment (i.e., cars, pickups, and semi-trailers rather than plant haul trucks and other equipment). Site "E," on the other hand, was located near the iron- and steel-making facilities and had both lower ADT and heavier vehicles than site "C." The plant regularly vacuum swept paved roads, and two cleaning frequencies (two times and five times per week) were considered during the test program.

Eight tests were conducted at Site C-1 and four tests were conducted at Site E-2. The paved road test sites were considered uncontrolled. The road width, moisture content, and mean number of wheels were not reported. The test data are assigned an "A" rating. Table 4-3 presents summary information and Table 4-4 presents detailed test information. Warm wire anemometers at two heights measured wind speed.

Depending on traffic characteristics of the road being tested, a 6 to 7.5 m high profiling array was used to measure downwind mass flux. This array consisted of four or five total particulate sampling heads spaced at 1.5 m heights and was positioned at a nominal 5 m distance downwind from the road. A high-volume sampler with a parallel-slot cascade impactor and a cyclone preseparator (cutpoint of 15 µmA) was employed to measure the downwind particle size distribution, and a standard high-volume sampler was utilized to determine the downwind mass fraction of total suspended particulate matter (TSP). The height for downwind sizing devices (2.2 m) was selected after review of prior test results. It approximated the height in a roadway dust plume at which half the mass emissions pass above and half below. The upwind (background) particle size distribution was determined with a high-volume cyclone/ impactor combination. Warm wire anemometers at two heights measured wind speed.

Additional samples included:

- Average wind speeds at two heights and wind direction at one height were recorded during testing to maintain isokinetic sampling.
- Traffic data, including traffic counts, travel speeds, and vehicle class were recorded manually.
- Vacuums with disposable paper bags were used to collect the loose material from the road surface.

The sampling equipment met the requirements of a sound exposure profiling methodology specified in Section 3.4 so that the emission test data are rated "A." The test report presents emission factors for total particulate (TP), total suspended particulate (TSP) and PM_{10}, for the ten paved road emission tests conducted.

Reference 31 found that the emission factors and silt loadings more closely resembled those in the "urban" rather than the "industrial" data base. That is to say, emissions agreed more closely with factors estimated by the methods of September 1985 AP-42 Section 11.2.5 than by methods in Section 11.2.6. Given the traffic rate of 4000 vehicles per day at Site "C," this finding was not terribly surprising. What was far more surprising was that emissions at Site "E" were also more "urban" than "industrial." Although the TSP and PM_{10} models in Section 11.2.5 showed a slight tendency to underpredict, the Section 11.2.6 PM_{10} model overestimated measured emissions by at least an order of magnitude. The performance of the industrial TSP model, on the other hand, was only slightly poorer than that for the urban TSP model.

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4.2.1.7 Midwest Research Institute, Paved Road Particulate Emissions - Source Category Report, for U.S. EPA, July 1984. (Reference 8, ref_08c13s0201_2011.pdf)

This document reports the results of testing of paved roads conducted in 1980 at sites in Kansas City, MO, St. Louis, MO, Tonganoxie, KS, and Granite City, IL. Paved road test sites included commercial/industrial roads, commercial/residential roads, expressways, and a street in a rural town. The expanded measurement program reported in this document was used to develop emission factors for paved roads and focused on the following particle sizes: PM_{15} (inhalable particulate matter [IP]), PM_{10}, and $PM_{2.5}$.

Total airborne PM emissions were characterized using an exposure profiler containing four sampling heads. High-volume samplers with size selective inlets (SSI) having a cutpoint of 15 µmA were used to characterize upwind and downwind PM_{15} concentrations. A high- volume sampler with a SSI and a cascade impactor was also located downwind to characterize particle size distribution within the PM_{15} component. Upwind and downwind standard high- volume samplers measured TSP concentrations. Warm wire anemometers at two heights measured wind speed.

A total of 19 paved road emission tests were conducted in four cities. These included four tests of commercial/industrial paved roads, ten tests of commercial/residential paved roads, four expressway tests, and one test of a street in a rural town. Additionally, as part of this study, 81 dust samples were collected in 12 cities. The mean number of vehicle wheels was not reported. The test data are assigned an A rating. Table 4-5 presents summary test data and Table 4-6 presents detailed test information.

TABLE 4-3. SUMMARY INFORMATION FOR REFERENCE 31

Operation	Location	State	Test dates	No. of tests	TSP emission factor, lb/VMT		PM_{10} emission factor, lb/VMT	
					Geom. mean	Range	Geom. mean	Range
Vehicle traffic	AU-X (Unpaved road)	PA	11/89	2	0.61	0.39-0.96	0.16	0.14-0.18
Vehicle traffic	Paved road	PA	11/89	6	0.033	0.012-0.12	0.0095	0.0009-0.036
Vehicle traffic	Paved road	PA	11/89	4	0.078	0.033-0.30	0.022	0.0071-0.036

1 lb/VMT = 281.9 g/VKT.

TABLE 4-4. DETAILED INFORMATION FROM PAVED ROAD TESTS FOR REFERENCE 31

Test runs	PM_{10} emission factor, lb/VMT	Duration, min	Meteorology		Vehicle characteristics			Silt loading, g/m^2	Silt, %
			Temperature, °F	Mean wind speed, mph	No. of vehicle passes	Mean vehicle weight, ton	Mean vehicle speed[a]		
AU-C-3	0.00497	103	50	12	836	5.5	(27)	0.42	10
AU-C-4	0.0355	147	63	11	1057	6.0	25	0.52	12
AU-C-5	0.0337	120	62	14	963	3.9	29	0.23	9.7
AU-C-6	0.00816[c]	187	39	14	685	6.2	(27)	0.23[b]	8.6
AU-C-7	0.000887	96	42	12	703	3.0	(27)	0.26[b]	7.7
AU-C-8	0.0174	218	40	15	779	2.0	(27)	0.15[b]	9.9
AU-E-1	0.00709	154	43	12	210	12	15	4.0	17
AU-E-2	0.0234	89	44	13	373	5.1	16	4.0	17
AU-E-3	0.0355	118	41	9.3	330	2.6	(15)	2.2	18
AU-E-4	0.0199	130	41	9.3	364	2.6	(15)	1.3	15

a Value in parentheses is the average speed measured for test road during the field exercise.

b Test conducted on a paved road surface vacuum-swept five times per week.

c Mean TSP/TP or PM_{10}/TP ratio applied.

1 lb/VMT = 281.9 g/VKT.

1 g/m^2 = 1.434 gr/ft^2

TABLE 4-5. SUMMARY INFORMATION FOR REFERENCE 8

Operation	State	Test dates	No. of tests	PM_{15} emission factor, lb/VMT		PM_{10} emission factor, lb/VMT		$PM_{2.5}$ emission factor, lb/VMT	
				Geom. mean	Range	Geom. mean	Range	Geom. mean	Range
Commercial/ Industrial	MO	2/80	4	0.0078	0.0036 - 0.013	0.0068	0.0034 - 0.011	0.0045	0.0030 - 0.0063
Commercial/ Residential	MO, IL	2/80	10	0.0021	0.0006 - 0.012	0.0017	0.0004 - 0.0093	0.0011	0.0002 - 0.0037
Expressway	MO	5/80	4	0.0004	0.0002 - 0.0008	0.0004	0.0002 - 0.0007	0.0002	0.0001 - 0.0003
Rural Town	KS	3/80	1	0.031	0.031	0.025	0.025	0.005	0.005

1 lb/VMT = 281.9 g/VKT.

TABLE 4-6. DETAILED INFORMATION FROM PAVED ROAD TESTS FOR REFERENCE 8

Category	Run test No.	PM_{10} emission factor, lb/VMT	Duration, min.	Temp., °F	Mean wind speed, mph	Road width, ft	No. of vehicle passes	Mean vehicle speed, mph	Mean vehicle weight, tons	Silt loading, g/m^2	Silt (%)
Commercial/Industrial	M-1	0.0110	120	28	7.4	44	2,627	30	5.6	0.46	10.7
Commercial/Industrial	M-2	0.00340	86	27	6.5	44	2,166	30	3.8	0.26	6.2
Commercial/Industrial	M-3	0.00781	120	28	7.8	44	2,144	30	4.5	0.15	3.5
Commercial/Industrial	M-9	0.00712	136	50	7.4	44	3,248	30	4.1	0.29	12.2
Commercial/Residential	M-4	0.000400	240	38	7.8	36	2,763	35	2.1	0.43	18.8
Commercial/Residential	M-5	0.00153	226	53	2.2	36	2,473	35	2.2	1.00	21.4
Commercial/Residential	M-6	0.00304	281	35	5.6	36	3,204	30	2.1	0.68	21.7
Commercial/Residential	M-13	0.000680	194	60	2.7	22	5,190	35	2.7	0.11	13.7
Commercial/Residential	M-14	0.00301	178	55	9.2	22	3,940	35	2.7	0.079	-
Commercial/Residential	M-15	0.00323	135	77	11.4	22	4,040	35	2.7	0.047	8.1
Commercial/Residential	M-17	0.00582	150	75	4.0	40	3,390	30	2.0	0.83	5.7
Commercial/Residential	M-18	0.000800	172	75	5.1	40	3,670	30	2.0	0.73	7.1
Commercial/Residential	M-19	0.000390	488	70	2.7	20	5,800	30	2.4	0.93	8.6
Expressway	M-10	0.000390	182	60	2.9	96	11,148	55	4.5	0.022	-
Expressway	M-11	0.000700	181	56	8.7	96	11,099	55	4.8	0.022	-
Expressway	M-12	0.000190	150	65	4.7	96	9,812	55	3.8	0.022	-
Expressway	M-16	0.000530	254	70	4.0	96	15,430	55	4.3	0.022	-
Rural Town	M-8	0.0247	345	50	4.7	30	1,975	20	2.2	2.50	14.5

1 lb/VMT = 281.9 g/VKT.
1 g/m2 = 1.434 gr/ft2

4.2.1.8 Midwest Research Institute, *Size Specific Particulate Emission Factors for Uncontrolled Industrial and Rural Roads,* for U. S. EPA, January 1983. (Reference 7, ref_07c13s0201_2011.pdf).

This document reports the results of testing conducted in 1981 and 1982 at industrial unpaved and paved roads and at rural unpaved roads. Unpaved industrial roads were tested at a sand and gravel processing facility in Kansas, a copper smelting facility in Arizona, and both a concrete batch and asphalt batch plant in Missouri. The study was conducted to increase the existing data base for size-specific PM emissions. The following particle sizes were of specific interest for the study: PM_{15}, PM_{10}, and $PM_{2.5}$.

Exposure profiling was utilized to characterize total PM emissions. Five sampling heads, located at heights of up to 5 m, were deployed on the profiler. A standard high-volume sampler and a high-volume sampler with an SSI (cutpoint of 15 µmA) were also deployed downwind. In addition, two high-volume cyclone/impactors were operated to measure particle size distribution. A standard high-volume sampler, a high-volume sampler with an SSI, and a high-volume cyclone/impactor were utilized to characterize the upwind TSP and PM_{15} concentrations and the particle size distribution within the PM_{15} fraction. Wind speed was monitored with warm wire anemometers.

A total of 18 paved road tests and 21 unpaved road tests are completed. The test data are assigned an A rating. Industrial paved road tests were conducted as follows: three unpaved road tests at the sand and gravel processing plant, three paved road tests at the copper smelting plant, four paved road tests at the asphalt batch facility, and three paved road tests at the concrete batch facility. The industrial road tests were considered uncontrolled and were conducted with heavy duty vehicles at the sand and gravel processing plant and with medium duty vehicles at the asphalt batch, concrete batch, and copper smelting plants. Table 4-7 presents summary test data and Table 4-8 presents detailed test information.

TABLE 4-7. SUMMARY OF PAVED ROAD EMISSION FACTORS FOR REFERENCE 7

Industrial category	Type	TP, lb/VMT		PM_{15}, lb/VMT		PM_{10}, lb/VMT		$PM_{2.5}$, lb/VMT	
		Geo. mean	Range	Geo. mean	Range	Geo. mean	Range	Geo. mean	Range
Asphalt Batching	Medium duty	1.83	0.750-3.65	0.437	0.124-0.741	0.295	0.0801-0.441	0.130	0.0427-0.214
Concrete Batching	Medium duty	4.74	2.25-7.23	1.66	0.976-2.34	1.17	0.699-1.63	0.381	0.200-0.562
Copper Smelting	Medium duty	11.2	7.07-15.7	4.01	2.02-5.56	2.78	1.35-3.86	0.607	0.260-0.846
Sand and Gravel Processing	Medium Duty	5.50	4.35-6.64	1.02	0.783-1.26	0.633	0.513-0.753	0.203	0.194-0.211

1 lb/VMT = 281.9 g/VKT.

TABLE 4-8. DETAILED INFORMATION FROM PAVED ROAD TESTS FOR REFERENCE 7

Run No.	Industrial category	Traffic	PM_{10} emission factor, lb/VMT	Duration, min.	Mean wind speed, mph	Road width, ft	No. of vehicle passes	Vehicle characteristics			Moisture content, %	Silt loading, g/m^2	Silt, %
								Mean vehicle weight, tons	No. of wheels	Mean vehicle speed, mph			
Y-1	Asphalt Batching	Medium Duty	0.257	274	5.37	13.8	47	3.6	6	10	0.22	91	2.6
Y-2	Asphalt Batching	Medium Duty	0.401	344	4.70	14.1	76	3.7	7	10	0.51	76	2.7
Y-3	Asphalt Batching	Medium Duty	0.0801	95	6.04	14.1	100	3.8	6.5	10	0.32	193	4.6
Y-4	Asphalt Batching	Medium Duty	0.441	102	5.59	14.1	150	3.7	6	10	0.32	193	4.6
Z-1	Concrete Batching	Medium Duty	0.699	170	6.71	24.3	149	8.0	10	10	a	11.3	6.0
Z-2	Concrete Batching	Medium Duty	1.63	143	9.84	24.9	161	8.0	10	15	a	12.4	5.2
Z-3	Concrete Batching	Medium Duty	4.01	109	9.62	24.9	62	8.0	10	15	a	12.4	5.2
AC-4	Copper Smelting	Medium Duty	3.86	38	8.72	34.8	45	5.7	7.4	10	0.43	287	19.8
AC-5	Copper Smelting	Medium Duty	3.13	36	9.62	34.8	36	7.0	6.2	15	0.43	188	15.4
AC-6	Copper Smelting	Medium Duty	1.35	33	4.92	34.8	42	3.1	4.2	20	0.53	400	21.7
AD-1	Sand and Gravel	Heavy Duty	3.27	110	7.61	12.1	11	42	11	23	a	94.8	6.4
AD-2	Sand and Gravel	Heavy Duty	0.753	69	5.15	12.1	16	39	17	23	a	63.6	7.9
AD-3	Sand and Gravel	Heavy Duty	0.513	76	3.13	12.1	20	40	15	23	a	52.6	7.0

1 lb/VMT = 281.9 g/VKT.

1 g/m^2 = 1.434 gr/ft^2

[a] Not measured

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4.2.1.9. Midwest Research Institute, *Iron and Steel Plant Open Source Fugitive Emission Control Evaluation*, for U. S. EPA, August 1983, (Reference 6, ref_06c13s0201_2011.pdf).

This test report centered on the measurement of the effectiveness of different control techniques for PM emissions from fugitive dust sources in the iron and steel industry. The test program was performed at two integrated iron and steel plants, one located in Houston, Texas, and the other in Middletown, Ohio. Control techniques to reduce emissions from paved roads, unpaved roads, and coal storage piles were evaluated. For paved roads, control techniques included vacuum sweeping, water flushing, and flushing with broom sweeping. Particle emission sizes of interest in this study were total PM, PM_{15}, and $PM_{2.5}$.

The exposure profiling method was used to measure paved road particulate emissions at the Iron and Steel plants. For this study, a profiler with four or five sampling heads located at heights of 1 to 5 m was deployed. Two high-volume cascade impactors with cyclone preseparators (cutpoint of 15 μmA), one at 1 m and the other at 3 m, measured the downwind particle size distribution. A standard high-volume sampler and an additional high-volume sampler fitted with a SSI (cutpoint of 15 μmA) were located downwind at a height 2 m. One standard high-volume sampler and two high-volume samplers with SSIs were located upwind for measurement of background concentrations of TSP and PM_{15}.

Twenty-three paved road tests of controlled and uncontrolled emissions were performed. These included 11 uncontrolled tests, 4 vacuum sweeping tests, 4 water flushing tests, and 4 flushing and broom sweeping tests. For paved roads, this test report does not present vehicle speeds, mean number of wheels, or moisture contents. Because vehicle speeds above 15 MPH and moisture content are not expected to influence the emissions equation, the test data are assigned an A rating. Table 4-9 presents summary test data and Table 4-10 presents detailed test information. The PM_{10} emission factors presented in Table 4-10 were calculated from the PM_{15} and $PM_{2.5}$ data using logarithmic interpolation.

After vacuum sweeping, emissions were reduced slightly more than 50 percent for two test runs and less than 16 percent for two test runs. Water flushing applied at 0.48 gal/yd^2 achieved emission reductions ranging from 30 percent to 70 percent. Flushing at 0.48 gal/yd^2 combined with broom sweeping resulted in emission reductions ranging from 35 percent to 90 percent.

TABLE 4-9. SUMMARY OF PAVED ROAD EMISSION FACTORS FOR REFERENCE 6

Control method	Location	State	Test date	No. of tests	TP, lb/VMT		PM_{15}, lb/VMT		$PM_{2.5}$, lb/VMT	
					Geo mean	Range	Geo mean	Range	Geo mean	Range
None	A,D,F,J	OH	7/80, 10/80, & 11/80	7	1.22	0.29-5.50	0.38	0.13-2.14	0.10	0.04-0.52
Vacuum Sweeping	A	OH	10/80 & 11/80	4	0.87	0.53-1.46	0.45	0.27-0.87	0.14	0.08-0.26
Water Flushing	D,L	TX	6/81	4	1.43	1.30-1.74	0.47	0.32-0.65	0.08	0.08-0.09
Flushing & Broom Sweep	K,L,M	TX	6/81	4	0.96	0.54-2.03	0.20	0.10-0.49	0.07	0.04-0.13
None	L,M	TX	6/81	4	3.12	0.83-5.46	0.92	0.31-1.83	0.26	0.06-0.62

1 lb/VMT = 281.9 g/VKT.

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TABLE 4-10. DETAILED INFORMATION FROM PAVED ROAD TESTS FOR REFERENCE 6

Site	Test Run No.	Control method	PM_{10} emission factor, (lb/VMT)	Duration (min.)	Temp., (°F)	Mean wind speed, (mph)	No. of vehicle passes	Mean vehicle weight, (tons)	Silt loading, (g/m^2)	Silt, %
A	F-34	None	0.536	62	90	4.2	79	28	2.79	16
A	F-35	None	0.849	127	90	7.5	130	25	2.03	10.4
A	F-36	VS	0.147	335	50	5.9	263	8.3	0.202	18.3
A	F-37	VS	0.209	241	50	4.8	199	17	0.043	26.4
A	F-38	VS	0.430	127	50	4.5	141	18	0.217	27.9
A	F-39	VS	0.686	215	50	6.4	190	18	0.441	19.6
D	F-61	None	1.35	108	40	11.0	93	40	17.9	21.0
D	F-62	None	0.929	77	45	12.1	94	36	14.4	20.3
D	F-74	WF	1.32	205	50	9.0	67	29	5.59	9.45[a]
F	F-27	None	0.357	91	100	9.5	158	14	17.7	35.7
F	F-45	None	0.608	135	50	4.0	172	16	5.11	28.4
J	F-32	none	0.144	259	90	5.8	301	14	0.117	13.4
K	B-52	FBS	0.0946	60	90	2.9	119	12	7.19	34.3
L	B-50	FBS	0.230	104	90	5.6	123	9.4	13.6	28.2[b]
L	B-51	FBS	0.435	93	90	4.2	127	11	13.6	28.2[b]
L	B-54	WF	0.268	101	90	5.4	118	10	3.77	22.6
L	B-55	WF	0.575	82	90	8.5	98	11	6.29	19.6[a]
L	B-56	WF	0.398	61	90	6.3	118	9.2	2.40	11.2
L	B-58	None	1.08	96	90	6.7	67	18	10.4	17.9
M	B-53	FBS	0.161	81	90	5.3	72	20	--	9.94
M	B-57	0.554	None	101	90	3.6	68	12	2.32	6.45[a]
M	B-59	0.993	None	114	90	6.1	67	11	2.06	14.0[a]
M	B-60	1.18	None	112	90	5.0	50	12	3.19	13.5

[a] Average of 2+ values

[b] Sample used for more than 1 run.

[c] PM_{10} emission factors were calculated from the PM_{15} and $PM_{2.5}$ data using logarithmic interpolation.

VS = Vacuum sweeping; WF = Water flushing; FBS = Water flushing and broom sweeping; 1 lb/VMT = 281.9 g/VKT; 1 g/m^2 = 1.434 gr/ft^2

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4.2.1.10. Midwest Research Institute, *Fugitive Particulate Matter Emissions* for U.S. Environmental Protection Agency, Emission Factor and Inventory Group, April 15, 1997. (Reference 30, ref_30c13s0201_2011.pdf).

This reference documents the performance of six field studies characterizing the vehicle emissions from three unpaved roads and three paved roads. Testing of unpaved roads was performed in Kansas City, MO; Raleigh, NC; and Reno, NV. Testing of paved roads was performed in Denver, CO; Raleigh, NC; and Reno, NV. Midwest Research Institute measured the emission rates for PM_{10} and $PM_{2.5}$ at all six locations based upon a plume profiling methodology. The test data are assigned an A rating.

Plume profiling calculates emission rates using a conservation of mass approach. The passage of airborne particulate (i.e., the quantity of emissions per unit of source activity) is obtained by spatial integration of distributed measurements of exposure (mass/area) over the effective cross section of the plume. Exposure is the point value of the flux (mass/area time) of airborne particulate integrated over the time of measurement or, equivalently, the net particulate mass passing through a unit area normal to the mean wind direction during the test. The steps in the calculation procedure are as follows. The concentration of PM_{10} measured by a sampler is compared to the wind speed and corrected to standard conditions. The concentration for each sampler is multiplied by the wind velocity and sampling duration to obtain the exposure for each sampling height. The exposure is integrated over the plume-effective cross section. The quantity obtained represents the total passage of airborne particulate matter (i.e., mass flux) due to the source. The exposure is set to zero at the maximum effective height of the plume where the net concentration equals zero). The maximum effective height of the plume is found by linear extrapolation of the uppermost net concentrations to a value of zero. Although at ground level the wind velocity is zero, for calculation, the exposure value at ground level is set equal to the value at a height of 1 m. The integration is then performed from 1 m to the plume height, H, using Simpson's approximation.

Testing in Denver CO was conducted to characterize emissions from a high speed (55 mph speed limit) limited access interstate road and a medium speed (40 mph speed limit) one lane road (two lanes with a wide median). For this part of the study, a profiler with four or five sampling heads located at heights of 1, 3, 5 and 7 m were deployed. One high-volume cascade impactor with cyclone preseparators (cutpoint of 10 µmA) and two dichotomous samplers were used to measured the downwind particle size distribution. All of the particle sizing samplers were located at 2 m above ground level. A single set of the same sampling equipment was located at 2 m above ground level and upwind for measurement of background concentrations of TSP, PM_{10} and $PM_{2.5}$. To the extent possible, each of the emission tests was performed during periods following snowfall, after the test road surface had dried. In most cases, sand application was ordered, because the relatively light snow conditions characteristic of the 1996 winter did not trigger routine sand application.

This test program also assessed the potential bias associated with particle sizing using the historical impactors that followed the cyclone pre-separator. The use of the dichotomous samplers consistently yielded a lower ratio of $PM_{2.5}$ to PM_{10} ratio than were measured by the cyclone/impactor samplers. The $PM_{2.5}$/ PM_{10} ratios measured by the dichotomous samplers are presented to the right of the PM_{10} emissions factors column in Table 4-11. Where two values are presented in the column, these are the ratios measured at two different heights. The ratios range from 0.26 to 0.37. As a result of this study, the constant in the $PM_{2.5}$ emissions factor equation was revised to 25% of the PM_{10} constant.

4.2.1.11. Paved Road Modifications to AP-42, Background Documentation For Corn Refiners Association, Inc. Washington, DC 20006 MRI Project No. 310842, May 20, 2008. (Reference 32, ref_32c13s0201_2011.pdf).

The Corn Refiners Association (CRA) funded four paved road PM_{10} test programs because site conditions did not match source conditions underlying the AP-42 emission factor equation. The sites enforce speed limits of 5 or 15 mph and employ road sweeping programs to manage the build up of silt on the roadways. In addition, plants experience traffic queues (i.e., stop-and-go traffic) during periods with high corn receipts. The combination of heavy trucks (delivering corn to the facilities) and fairly low silt loading (sL) values on the plant roads was not typical of the AP-42 data base. Given these differences, the member companies undertook testing to develop more representative emission factors. Midwest Research Institute designed and conducted the test programs at all four facilities.

Reference 32 compiles test data and information from references 33, 34, 35 & 36. In addition, reference 32 proposes an expansion of the allowable speed parameters supported in the paved road equation. Lastly, reference 32 proposes a revised equation for paved roads to reflect the expanded test information. The data upon which the proposed equation was based included emissions associated with the trucks (engine exhaust, tire wear and brake wear) and with material deposited on the roadway. Since testing documented in references 7 through 10 were conducted at facilities with very similar operating conditions using test procedures that were nearly identical, the following description provides background for all four test programs.

All four testing programs employed the same exposure profiling method used to develop the test data underlying the emission factor predictive equations for both paved and unpaved roads. In each program, a test plan was submitted to the state agency for comment and review prior to the start of testing. The final test reports and supporting information were also submitted to state agencies. Because low emission levels were expected (due to low sL and slow speeds), several precautions were taken to assure reliable quantification. First, long sampling durations were employed. Samplers were operated up to 5 hours to collect adequate sample mass. Second, to ensure adequate traffic during test periods, the facilities provided “drone” passes by corn semi-trailers. Drone traffic mimicked the actual traffic except those trucks returned to staging areas without emptying corn. In addition, testing applied “lessons learned” throughout the programs. For example, when it became apparent how difficult it could be to separate net PM_{10} concentrations (i.e., due to traffic on the road) from background (upwind) concentrations, changes were made in equipment deployment. The use of identical upwind and downwind vertical sampling arrays permitted better definition of the net contribution of roadway emissions.

TABLE 4-11. DETAILED INFORMATION FROM PAVED ROAD TESTS FOR REFERENCE 30

Site	Test Run No.	Road Speed [1]	PM_{10} emission factor, (g/VKT)	$PM_{2.5}$/ PM_{10} Ratio	Duration, min.	Temp., °F	Mean wind speed, mph	No. of vehicle passes	Mean vehicle weight, tons	Silt loading, g/m^2	Silt, %
CO	BH-1	55	1.08	0.20	163	18	2.7	6,561	2.2	0.184	9.4
CO	BH-2	55	0.102	0.34	360	37	17.0	17,568	2.2	0.0127	41.0
CO	BH-3	55	-	0.16	360	46	17.2	14,616	-	0.0127	41.0
CO	BH-4	55	-		Blank	-	-	-	-	-	-
CO	BH-5	40	-		Blank	-	-	-	-	-	-
CO	BH-6	40	4.68	0.03	240	48	3.1	3,112	2.2	1.47	1.2
NC	BJ-6	45	0.301	0.27/0.34	450	71	8.2	14,670	2.2	0.060	52
NC	BJ-7	45	1.94	0.44/0.44	143	68	9.4	3,748	2.2	0.060	52
NC	BJ-9	45		0.6/0.14	178	71	5.3	4,616	2.2	0.060	52
NC	BJ-10	45		0.44/0.33	288	68	3.7	10,218	2.2	0.060	52
NV	BJ-11	45		0.68/0.47	387	75	5.1	13,216	2.2	0.060	52
NV	BK-7	45	0.57	0.29/0.33	420	89	7.3	7,394	2.2	0.082	3.4
NV	BK-8	45	0.44	0.26/0.34	270	87	6.1	5,747	2.2	0.082	3.4
NV	BK-9	45	-	0.13/0.38	240	90	2.6	4,622	-	0.082	3.4

[1] Road Speed is the posted speed limit for the road segment.

In addition to PM_{10} concentrations, each sampling program samples included:

- Measurement of average wind speeds at two heights and wind direction at one height for 5-minute intervals throughout the test period.
- Manual recording of traffic counts by vehicle type. The host facilities provided information on vehicle weights and corn receipts.
- Collection of road surface material by vacuums with disposable paper bags. The material collected within the bag was sieved to determine the surface silt loading.

Reference 32 states that the four test programs conducted by CRA produced 14 and 8 PM_{10} emission factor values for slowly moving and stop-and-go traffic, respectively. Other observations in this report includes: that in all but one of the 22 cases, the AP-42 emission factor overestimated the measured value; that for some tests, "stop-and-go" emission factors were substantially greater than the "slowly moving" factor (presumably because of the diesel exhaust as trucks moved from a dead stop) but that there was no significant difference between "slowly moving" and "stop-and-go" results on average.

Furthermore, Tables 4-12, 4-13, and 4-15 use bold font to indicate those tests that used identical upwind and downwind vertical sampling arrays. Those tests provided better definition of net PM_{10} mass thus producing more accurate emission factors. Although these test results tended to be lower than the other emission factors, the two sets on average did not differ significantly.

4.2.1.12 Midwest Research Institute, *Emission Tests of Paved Road Traffic at Minnesota Corn Processors Marshall, Minnesota Facility,* McVehil-Monnett Associates, July 6, 2001. (Reference 33, ref_33c13s0201_2011.pdf).

Truck traffic flow at the Minnesota Corn Processor's (MCP's) Marshall, Minnesota facility was characterized as either slowly moving (5 mph enforced speed limit) or stop-and-go in nature. In this testing program, data was collected over 5 days during April of 2001. During this period, three stop-and-go traffic situations and six slowly moving traffic instances were examined. Truck traffic progressing through the test site was held to two lanes for queued traffic. Silt content (sL, measured by MCP), truck weight, and number of passes, along with other pertinent data was recorded for each run. For all runs, a vertical network of samplers was operated downwind. The last test period used a vertical array of samplers upwind to better characterize upwind concentrations and to provide a more accurate calculation of the net PM_{10} emission factor.

The results of this testing program are summarized in Table 4-12. The test data are assigned an A rating. The test report remarked that the emission factors obtained were far below the value (0.453 lb/VMT) used in the plant emission inventory. Use of test-specific silt loading and vehicle weight did not significantly improve the predictive accuracy of the AP-42 factor. The tests found no discernable relationship between emission levels and either silt loading or vehicle weight. Finally, it was noted that the shape of the exposure profile was more likely due to diesel exhaust than re-entrained road dust.

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Table 4-12. Summary of Emissions Data from MCP's Marshall, Minnesota Facility (Reference 33)

Run	Test condition	Traffic rate (veh/hr)	Traffic speed (mph)[a]	Mean vehicle weight, W (tons)	Surface silt loading, sL (g/m^2)	Measured PM_{10} emission factor (lb/VMT)
CE-1	Stop-and-go	38	NA	36	1.16	0.059
CE-2	Stop-and-go	32	NA	36	0.86	0.14
CE-11	Slowly moving	35	5	12	1.34	0.34
CE-3	Stop-and-go	47	NA	39	0.86	0.10
CE-13	Slowly moving	48	5	13	1.34	0.051
CE-15	Slowly moving	30	5	40	1.91	0.14
CE-16	Slowly moving	28	5	40	1.41	0.17
CE-17	Slowly moving	29	5	40	2.93	0.091
CE-19	**Slowly moving**	**61**	**5**	**38**	**0.76**	**0.041**

[a] Vehicle speed was maintained at the plant limit of 5 mph. NA = Not applicable.
Bold entries indicate that identical vertical sampling arrays were used to better isolate the source contribution.

4.2.1.12. Midwest Research Institute, *Emission Tests of Paved Road Traffic at Minnesota Corn Processors Columbus, Nebraska Facility*, McVehil-Monnett Associates, July 13, 2001. (Reference 34, ref_34c13s0201_2011.pdf).

Truck traffic flow at MCP's Columbus, Nebraska facility was characterized as either slowly moving (5 mph enforced speed limit) or stop-and-go in nature. Between June 12 and 15, 2001, four tests each of stop-and-go and slowly moving traffic were performed. Trucks entered by the north gate and traveled past a vertical sampling array en route to a staggered queue at which a second vertical sampling array was positioned. In this way, testing evaluated both source conditions (stop-and-go and slowing moving) at once. Building on experience from testing at the MCP Marshall facility, the last two runs, CF-4 and CF-5, used identical upwind and downwind vertical sampling arrays to better characterize background concentrations. In that case, only one condition could be evaluated during a test. The results of the MCP Columbus test program are summarized in Table 4-13. The test data are assigned an "A" rating.

4.2.1.13. Midwest Research Institute, *Emission Tests of Paved Road Traffic at Cargill Sweeteners North America Blair, Nebraska Facility*, McVehil-Monnett Associates, November 27, 2002. (Reference 35, ref_35c13s0201_2011.pdf).

This report describes a testing program conducted at Cargill's Blair, Nebraska facility during August 2002. The plant used a regular sweeping program to reduce surface loadings on paved roads. Testing relied on regular corn truck traffic at the site, although the plant provided a limited amount of “drone” traffic. The test data are assigned an “A” rating.

Eight PM_{10} emission tests were attempted. The test report describes difficulty encountered in isolating net PM_{10} mass due to traffic on the test road. During test plan review, the Nebraska Department of Environmental Quality requested a change in test site to allow two trucks to pass by at the same time. The original site would have permitted upwind monitoring in the immediate vicinity of the tests road, but this was not possible at the second location. Furthermore, steeply sloping ground on the upwind side of the test road prevented use of a vertical background sampling array (as used at the two MCP plants) to better isolate the source contribution.

The results are summarized in Table 4-14. Only two tests (CI-7 and CI-8) had net mass attributed to the source. In the remaining instances, the measured downwind PM_{10} concentrations were lower than upwind values. It was stated that this was believed to be an undesired result from moving the test source. Runs CI-7 and CI-8 showed the measured emission factor to be much lower than that predicted by the AP-42 equation. Comments in the report indicated that exposure profiles showed a maximum more likely due to diesel exhaust than from re-entrained surface road dust.

4.2.1.14. Midwest Research Institute, *Emission Tests of Paved Road Traffic at ADM’s Marshall, Minnesota Facility*, McVehil-Monnett Associates, December 5, 2003. (Reference 36, ref_36c13s0201_2011.pdf).

The test program at ADM’s Marshall MN facility represented the last test by the Corn Refiners Association. By September 2003, the Marshall facility had implemented a road sweeping program. Three tests of PM_{10} emissions were conducted, one from stop-and-go traffic and two from slowly moving traffic. Because of experience gained from the earlier tests, identical vertical networks of samplers were operated downwind and upwind during each test.

The results of this testing program are summarized in Table 4-15. The test data are assigned an A rating. Measured emission factors were all significantly lower than that predicted by the AP-42 equation. The test report also remarked that the measured emission rates were independent of traffic rate, while the AP-42 factor implies a linear dependency between the emission and traffic rates.

The results are summarized in Table 4-14. Only two tests (CI-7 and CI-8) had net mass attributed to the source. In the remaining instances, the measured downwind PM_{10} concentrations were lower than upwind values. It was stated that this was believed to be an undesired result from moving the test source. Runs CI-7 and CI-8 showed the measured emission factor to be much lower than that predicted by the AP-42 equation. Comments in the report indicated that exposure profiles showed a maximum more likely due to diesel exhaust than from re-entrained surface road dust.

Table 4-13. Summary of Emissions Data from MCP's Columbus, Nebraska Facility (Reference 34)

Run[a]	Test condition	Traffic rate (veh/hr)	Traffic speed (mph)[b]	Mean vehicle weight, W (tons)	Surface silt loading, sL (g/m^2)	Measured PM$_{10}$ emission factor (lb/VMT)
CF-1/N	Low Speed	47	5.0	40	0.97	0.011
CF-1/S	Stop-and-go	47	NA	40	0.97	0.043
CF-2/N	Slowly moving	66	5.3	41	0.81	0.036
CF-2/S	Stop-and-go	66	NA	41	0.81	0.14
CF-3/N	Slowly moving	54	5.1	41	0.63	0.0024
CF-3/S	Stop-and-go	54	NA	41	0.63	0.051
CF-4/N	**Slowly moving**	**86**	**4.7**	**41**	**1.1**	**0.0068**
CF-5/N	**Stop-and-go**	**52**	**NA**	**41**	**1.4**	**0.036**

[a] Suffix indicates whether tests was conducted on the North or South portion of the corn haul road. Trucks were held in a queue toward the south; trucks entering the north gate traveled passed the north sampling array to reach the queue.

[b] Speed of moving trucks determined by accumulating time required to travel a measured distance. NA = not applicable.

Bold entries indicate that identical vertical sampling arrays were used to better isolate the source contribution.

Table 4-14. Summary of Emissions Data from Cargill's Blair, Nebraska Facility (Reference 35)

Run	Test condition	Traffic rate (veh/hr)	Traffic speed (mph)[a]	Mean vehicle weight, W (tons)	Surface silt loading, sL (g/m^2)[b]	Measured PM$_{10}$ emission factor (lb/VMT)[c]
CI-1	Low Speed	45	13.4 / 16.8 12.8 / 16.9	26	0.06	-
CI-2	Low Speed	45		26	0.06	-
CI-3	Slowly moving	60[d]	13.6 / 12.7 13.5 / 15.5	27	0.06	-
CI-4	Low Speed	60[d]		27	0.06	-
CI-7	Slowly moving	47	15.2 / 16.2 13.6 / 16.1	27	0.05	0.0036
CI-8	Low Speed	47		27	0.05	0.0066
CI-11	Low Speed	56	13.5 / 12.7	27	0.025	-
CI-12	Low Speed	56		27	0.25	-

[a] Vehicle speed for inbound (loaded) /outbound (empty) trucks determined by accumulating time required to travel a measured distance.

[b] Surface silt loading sample information provided by Cargill.

[c] "-" indicates that no net mass was attributed to the test road traffic.

[d] Twenty of 238 total passes were by "drone" trucks.

Table 4-15. Summary of Emissions Data from ADM's Marshall, Minnesota Facility (Reference 36)

Run	Test Condition	Traffic rate (veh/hr)	Traffic speed (mph)[a]	Mean vehicle weight, W (tons)	Surface silt loading, sL (g/m^2)	Measured PM$_{10}$ emission factor (lb/VMT)
CM-1	**Slowly moving**	**154**	**NA**	**40**	**0.72**	**0.014**
CM-2	**Stop-and-go**	**42**	**NA**	**40**	**0.72**	**0.14**
CM-4	**Slowly moving**	**156**	**5**	**40**	**0.70**	**0.016**

[a] Vehicles speeds maintained at plant limit of 5 mph. NA = not applicable.

Bold entries indicate that identical vertical sampling arrays were used to better isolate the source contribution.

4.2.1.15. E.H. Pechan & Associates, Inc., *Recommendations for Emission Factor Equations in AP-42 Paved Roads Section: TECHNICAL MEMORANDUM* August 21, 2003. (Reference 28, ref_28c13s0201_2011.pdf).

This technical memorandum documents the procedure that was used to separate the various components of paved road particulate matter emissions into two components. One component includes the emissions from exhaust, brake wear and tire wear. The other component includes the particulate matter reentrained from the road surface. The combined paved road particulate matter emissions were estimated with the empirical equation published in the October 2002 AP-42 Section for Paved Roads. The vehicle exhaust, brakewear and tirewear emission factors were obtained from the MOBILE6.2 model. A typical vehicle fleet and fuel source from 1980 was utilized for the model runs. The assumption included a vehicle fleet for July 1980, a gasoline sulfur content of 300 ppm, a diesel sulfur content of 500 ppm and no use of reformulated gas. The vehicle fleet assumptions used in the analysis are presented in Table 4-16. The model was run to estimate PM_{10} and $PM_{2.5}$ emission factors in g/VMT for each vehicle class at speeds of 25, 30, 35, 40, 45, 50, 55, and 60 mph. Within vehicle classes, the greatest standard deviation was lower than 0.04% of the emissions factor. Based on the low relative standard deviation, it was assumed that the vehicle speed was not a factor in exhaust, brakewear and tirewear PM emissions. Table 4-16 presents the vehicle fleet characteristics used in the model and the calculated average PM_{10} and $PM_{2.5}$ emission factors for exhaust, brakewear and tirewear for each class of vehicle.

Table 4-16: Vehicle Fleet Assumptions Used in 2003 MOBILE6.2 Model

VehicleType	LDGV	LDGT12	LDGT34	LDGT	HDGV	LDDV	LDDT	HDDV	MC
GVWR	3,075	4,105	7,000		35,000	3,705	6,000	70,000	550
VMT Distribution	0.6748	0.1477	0.0758		0.0365	0.0088	0.0118	0.0352	0.0094
PM_{10} Emissions Factor	0.1053	0.1061	0.2746	0.1632	0.3825	0.7206	0.7206	2.1227	0.0922
$PM_{2.5}$ Emissions Factor	0.0686	0.0690	0.1851	0.1084	0.2576	0.6519	0.6521	1.9272	0.0590

The contractor developed “AP-42 Composite” PM_{10} and $PM_{2.5}$ emission factors using the October 2002 AP-42 paved roads emission factor equation with the mean vehicle weight set at 3.74 tons (a value they indicated was typical of the 1980 paved road vehicle fleet. The contractor used silt loadings ranging from 0.02 to 400 g/m^2 for calculating the emissions factors. The contractor also calculated the fleet average PM_{10} and $PM_{2.5}$ emission factors for exhaust, brakewear and tirewear by summing the products of the VMT Distribution ratio and the PM_{10} and $PM_{2.5}$ emission factors for each vehicle class. The calculated fleet average values were 0.2119 for PM_{10} and 0.1617 for $PM_{2.5}$. The contractor then subtracted the fleet average emissions factors for exhaust, brakewear and tirewear from the “AP-42 Composite” emissions factors to produce an emission factor for only the re-entrained road dust component. The contractor noted that the while the stated applicable silt loadings for the October 2002 AP-42 paved road equation ranged from 0.02 to 400 g/m^2 the $PM_{2.5}$ emissions factor became negative at silt loadings less than 0.029 g/m^2. They stated that since negative emissions were not physically possible, the equation they recommended was only valid for silt loading ranging from 0.03 to 400 g/m^2. While no test data are associated with this report, the report does provide estimates of engine exhaust, tire wear and brake wear derived from an EPA emissions model which is based upon emissions testing by a validated test method on multiple vehicles for each type of vehicle. As a result, emissions estimates by vehicle class are assigned an A rating. Because the use of a national average vehicle fleet emissions estimate does not provide emissions that are representative of the mix of vehicle classes measured during the above test reports, the composite emissions estimates are assigned a C rating.

4.2.1.16. E-mail communication between Ron Myers of EPA/OAQPS/SPPD/MPG, RTP, NC and Prashanth Gururaja and Ed Glover of EPA/OTAQ/ASD/HDOC re. Diesel exhaust, tire and brake wear for low speed stop and go traffic; January 2009 through May 2009. (Reference 37, ref_37c13s0201_2011.pdf).

This e-mail communication and spreadsheet file concerns estimates of PM_{10} emissions associated with slow moving and stop and go diesel engine semi-trailer trucks. The purpose of the request was to provide a means to disaggregate the consolidated PM emissions measured of trucks during delivery of product at corn storage and transfer facilities. The request stated that the trucks were 18 wheel semitrailers of about ten years of age, were queued for the delivery of their load to a transfer or processing facility and that the estimated vehicle speed averaged about 1 mph but that they were stopped most of the time. $PM_{2.5}$ emissions were estimated using the MOVES mobile source emissions model. The trucks modeled were approximately ten years old, traveling at an average of 1.5 mph on level pavement. Emissions were estimated at 11.06035 g/hour or 8.789778 g/VMT. PM_{10} emissions were estimated to be approximately 3% greater than $PM_{2.5}$ emissions. While no test data are associated with this report, the report does provide estimates of engine exhaust, tire wear and brake wear derived from an EPA emissions model which is based upon emissions testing by a validated test method on multiple vehicles for the specific type of vehicle measured during the Corn Refiners Association Studies. As a result, emissions estimates for slow moving trucks are assigned an A rating.

4.2.1.17. E-mail communication between Ron Myers of EPA/OAQPS/SPPD/MPG, RTP, NC and Gary Dolce, David Brzezinski and Rudolph Kapichak of EPA/OTAQ/ASD/HDOC re. vehicle exhaust, tire and brake wear for urban unrestricted road-types; October 2010 through December 2010. (Reference 39, ref_39c13s0201_2011.pdf).

This e-mail communication and spreadsheet files concern improved estimates of PM_{10} emissions associated engine exhaust, tire wear and brake wear for free flowing traffic. The purpose of the estimates was to update the emissions estimates produced by E. H. Pechan using the 2003 version of MOBILE6.2. The emissions model used for this updated emissions estimates was the 2010 version of the MOVES model. Like the MOBILE6.2 model, the emissions predicted with the MOVES model provide a means for disaggregating the emissions measured during the paved road field studies that measured emissions due to road surface dust, vehicle exhaust, break wear and tire wear.

It is explained in the documentation that in order to develop an equation for road dust alone, estimates of the particulate emissions from vehicle exhaust, brake wear and tire wear were required. The e-mail documentation states that the MOVES model includes significant new data about PM emissions from both light duty and heavy duty on-road vehicles which allow MOVES to account for the influences of ambient temperature, vehicle speed, and vehicle deterioration on emissions. The documentation further states that none of those factors are accounted for in MOBILE6.2.

Documentation includes information provided to OTAQ on the test date (sometimes month and year, sometimes just year), vehicle speed, ambient temperature, and average vehicle weight for each of the paved road field studies. The documentation states that OTAQ created a MOVES2010a model input file that approximated the information for the paved road field studies as closely as possible. The documentation also states that since MOVES2010a provides output for calendar years 1990 and 1999-2050 alternative scenarios were developed to estimate emissions for years which MOVES2010a is not programmed to provide.

The documentation states that the speed and ambient temperature measured during the field study provided additional independent variables used in the MOBILE2010a model to estimate emissions. The documentation indicates that an emissions estimate was produced for each of the individual tests by allocating all of the vehicle activity to a single MOBILE2010a speed bin which included the vehicle speed observed in the test. To reduce the number of number of total runs needed, temperatures for the individual tests were rounded to the nearest multiple of 5 degrees. In a small number of cases, vehicle speed or temperature data were not available for particular tests. In those cases, a vehicle speed of 25 mph or an ambient temperature of 75 degrees was used. All other inputs to MOVES were national defaults.

All vehicle and fuel type combinations (except for electric vehicles) were included. Emissions were generated only for the urban unrestricted road-type. Emissions were generated for all PM10 pollutants (primary exhaust PM_{10} total, primary PM_{10} brake wear, and primary PM_{10} tire wear. Only running exhaust and crankcase running exhaust processes were included in the exhaust emissions calculations as the test sites did not include any starting or idling activity. Inventory results generated by MOVES source type (vehicle type) were divided by VMT to get emission factors by source type for each speed and temperature bin in the original test data.

Emissions estimates for free flowing light duty vehicles and trucks are assigned an B rating since most of the test data were for model years which an alternative emissions scenario (year, vehicle mix and assumed degradion level) was used as the independent variables used in the MOVES model input file. While it is likely that vehicle emissions prior to 1990 had tailpipe emissions very similar to the 1990 model year, this can not be verified. Also, while the emissions for each test are comprised of a large number of vehicles and the emissions factor produced by the MOVES model are based upon a large number of supporting tests, it is unclear that the MOVES model is an accurate and precise indication of the vehicle exhaust, tire wear and brake wear emissions during each test series.

4.2.1.18. Midwest Research Institute; *Analysis of the Fine Fraction of Particulate Matter in Fugitive Dust*; Western Governors' Association - Western Regional Air Partnership (WRAP); October 12, 2005. (Reference 43, ref_43c13s0201_2011.pdf).

This project was conducted by Midwest Research Institute for the Western Regional Air Partnership to provide more accurate $PM_{2.5}$ and PM_{10} fugitive dust emissions inventories for regional haze regulatory purposes to address the significant contribution of fugitive dust to visibility impairment. The results of this project were expected to affect the quantity of dust apportioned to the fine versus coarse size modes. It was stated that the results would be helpful in developing accurate emission inventories for PM nonattainment, maintenance, and action plan areas in the WRAP region. Finally, it was stated that the results may be used to seek modifications to the EPA's AP-42 emission factors to ensure widespread availability of the information developed in the study.

During the first testing phase of the project, $PM_{2.5}$ measurements using the high-volume cascade impactors were compared to simultaneous measurements obtained using EPA reference- method samplers for $PM_{2.5}$. The tests were conducted in a flow-through wind tunnel and exposure chamber, where concentration level and uniformity were controlled. With the same test setup, a second phase of testing was performed with reference method samplers, for the purpose of measuring $PM_{2.5}$ to PM_{10} ratios for fugitive dust from different geologic sources in the West. The testing provided information on the magnitude and variability of $PM_{2.5}$ to PM_{10} ratios for source materials that were recognized as problematic with regard to application of mitigative dust control measures.

Three dust source materials were tested under the first Phase of the study. The three dust source materials included an Owens Dry Lake surface soil, and two Arizona road dust reference standards (one coarse and one fine fraction material). Fixed PM_{10} concentration levels in the range of 1, 2.5, and 5 milligrams per cubic meter (each with its naturally occurring $PM_{2.5}$ level) were tested. It was stated that those PM_{10} concentration levels were selected as representative of dust plume concentrations under which major particle mass contributions to plume samples occur in emission factor development. The ratios of $PM_{2.5}$ to PM_{10} for fugitive dust from different geologic soil types were measured. A total of seven source materials were tested. The materials included Alaska river bed sediment, Arizona alluvial channel, Arizona agricultural soil, New Mexico unpaved landfill road dust, New Mexico grazing soil, California Salton Sea shoreline soil, and Wyoming unpaved road surface material. Test results included the calculation of the average $PM_{2.5}$ concentration and the collocated PM_{10} concentration. It was intended that any variation in $PM_{2.5}$/ PM_{10} ratio be evaluated as a function of the test soil properties (for example, position in soil texture triangle).

A total of 100 individual tests were performed, including 17 blank runs (for quality assurance purposes). The results of the testing are well documented and the documentation is sufficient to assess that the study was well designed and implemented. This was a laboratory study designed to assess those emissions sources that were considered to have the greatest influence in PM_{10} and $PM_{2.5}$ non attainment areas. As a result, the study is assigned a quality rating of B when applied within the bounds of the type of surface material that was available and for dust generation characteristics comparable to those used in the study. The study included no paved road surface material and was weighted toward higher particulate matter concentrations. Since the study was a laboratory study, did not include any paved road surface materials, and was weighted toward higher particulate concentrations, it is assigned a quality rating of "D" when used for paved roads.

The results of the Phase I testing indicated that the $PM_{2.5}$ concentrations measured by the cyclone/impactor system were consistently biased by a factor of about 2 relative the $PM_{2.5}$ concentrations measured by the Partisol samplers. While there was some data separation of different test materials, the second phase testing showed a tendency of the measured $PM_{2.5}$/ PM_{10} ratio to decrease with increasing PM_{10} concentration. At PM_{10} concentrations above 1.0 mg/m3 the $PM_{2.5}$/ PM_{10} ratio was between 0.1 and 0.15. The $PM_{2.5}$/ PM_{10} ratio increased to about 0.35 as the PM_{10} concentration approached about 0.5 mg/m3.

4.2.1.19. Midwest Research Institute; *Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors*; Western Governors' Association - Western Regional Air Partnership (WRAP); November 1, 2006. (Reference 44, http://www.epa.gov/ttn/chief/ap42/ch13/bgdocs/b13s02.pdf).

This report summarizes the results of the October 2005 WRAP study which evaluated the $PM_{2.5}$/ PM_{10} ratio measured by the cyclone/impactor system and measured by the Partisol samplers. While no additional analyses of the laboratory study were performed, suggested $PM_{2.5}$/ PM_{10} ratios were made for use in revising existing AP-42 emissions factor parameters for $PM_{2.5}$ dust emissions factor equations in Sections 13.2.1 (paved roads), 13.2.2 (unpaved roads), 13.2.3 (material transfer and storage piles), 13.2.4 (windblown dust) and 13.2.5 (industrial wind erosion). A revised $PM_{2.5}$/PM_{10} ratio of 0.15 was recommended for the paved roads emissions factor.

4.2.1.20. Technical Memorandum from William B. Kuykendal to File, Subject: *Decisions on Final AP-42 Section 13.2.1 "Paved Roads"*, October 10, 2002. (Reference 38, ref_38c13s0201_2011.pdf).

This technical memorandum to the files summarizes and responds to comments on an October 2001, EPA proposed revision of Section 13.2.1 "Paved Roads" for AP-42 and request for comments. The memorandum also presents EPA's decisions and rational supporting these decisions for the final changes leading to the final section. The proposed revisions to the section included an adjustment for rain events (comparable to the adjustment in the unpaved road section) which in essence "zeroed" the emissions on days that more than 0.01 inch of rain was recorded. In addition, the proposed revisions included the separation of vehicle engine exhaust, breakwear and tirewear as recommended in the E. H. Pechan Technical Memorandum of August 21, 2003. The memorandum includes attachments with the detailed comments that lead to the final revision of the emissions factor equation. The final changes to the emissions factor equation included:

- the subtraction of 0.2119 g/VMT for engine exhaust, brakewear and tirewear,
- an adjustment of (1- (P/4N)) for rain events (P = number of rain days and N = number of days in period), and
- an adjustment of (1- (1.2P/N)) for rain events (P = number of rain hours and N =

number of hours in period).

4.2.1.21. ***Clark County (Nevada) Paved Road Dust Emission Studies in Support of Mobile Monitoring Technologies*****; R. Langston, R.S. Merle Jr, V. Etyemezian, H. Kuhns, J. Gillies, D. Zhu, D. Fitz, K. Bumiller, D.E. James and H. Teng; Clark County Department of Air Quality and Environmental Management, Desert Research Institute, University of California, Riverside, University of Nevada, Las Vegas; December 22, 2008.**
(Reference 42, http://www.epa.gov/ttn/chief/ap42/ch13/related/Final_Test_Report.pdf).

This report documents the fourth phase of a study by Clark County to investigate alternative ways of estimating PM_{10} emissions of surface dust entrained from paved roads. A new vehicle-mounted mobile sampling technology was tested in comparison with the traditional AP-42 method and its associated road surface sampling. In addition, the plume flux profiling method, was used to calibrate the mobile monitoring technology.

Two versions of the mobile monitoring technology were tested—TRAKER and SCAMPER. Both technologies involve on-board sampling of the dust plume generated by a test vehicle. Both use continuous optical based PM_{10} particle monitors in conjunction with GPS systems, so that dust plume concentrations can be mapped on to the road system traveled by the test vehicle. The SCAMPER samples the plume in the wake of the test vehicle. The TRAKER I and II test vehicles sample the plumes from the front wheel wells of the respective vehicles. TRAKER II has a dilution system to provide for use on unpaved roads. All three units have samplers that monitor the PM10 concentration in front of the vehicle so that “background” PM_{10} can be subtracted.

The referenced study evaluated mobile monitoring technologies in comparison with the traditional AP-42 methodology, but in a controlled measurement environment that included restricted vehicle movement, controlled vehicle speeds and controlled road surface material loadings. This was accomplished by dedicating half of a divided roadway as the test course for the 5-day field study. The stated specific study objectives were as follows:

- Comparison of SCAMPER and TRAKER system measurements with emission measurements using a downwind flux tower.
- Determination of the relationship between roadway silt loading and SCAMPER and TRAKER measurements at several standard vehicle speeds (25, 35 and 45 mph).
- Comparison of SCAMPER and TRAKER measurements to AP-42 emission estimates.
- Characterization of road surface silt depletion rate as a function of the number of vehicle passes.
- Characterization of quantified emissions vs. quantified silt loading mass.
- Data assessment and review for recommendations on performance specifications for vehicle-mounted mobile sampling systems.

Particle concentration measurements formed the basis for the mobile monitoring technologies as well as the roadside emission flux measurements. A continuously recording optical light scattering particle monitor (DustTrak Model 8520, TSI Inc., Shoreview MN) was the basic instrument used for PM_{10} readings. A collocated mass-based reference monitor was used to correct the DustTrak readings to equivalent PM_{10} mass-based concentrations, using a plume profiling tower with various reference, reference equivalent and DustTrak monitors at different heights. Canister vacuum cleaners with hard-floor inlets were used to recover applied soil from the roadway sites into pre-tared vacuum bags. Three soil recovery techniques were used during the study. Road dust emission factors were then calculated for the silt loadings using the 2006 AP-42 emission factor equation. A weight of 2.88 tons, based on the arithmetic average of the reported weights of the three mobile source vehicles was used to calculate the AP-42 emission factors from the silt loadings.

Thirteen different experimental test conditions were performed. Most consisted of approximately 30 vehicle passes, with each pass identified by the mobile sampling technology. Each run consisted of three passes by each mobile sampling technology. Cross-comparisons were performed to determine the ratio between the DustTrak reading and the PM_{10} mass-based concentration measured by a collocated reference sampler. The correlation between the DustTrak and TEOM showed that DustTrak values would have to be multiplied by a factor of 2.8 ± 0.6 to obtain mass-equivalent PM_{10}. A controlled laboratory tests was also used to obtain a relationship between the DustTrak measurements and mass-based measurements. These tests generated a DustTrak correction multiplier of 2.4, which was chosen for use in this program.

Two conclusions were made from the test results obtained in the study, when comparing mobile monitoring technologies with the AP-42 methodology:

- The calibrated mobile methods measured emission factors that were about 1.5 times higher than found with the AP-42 methodology when higher silt loadings were applied to the test road.
- The mobile methods tracked each other quite well under most conditions.

It was concluded that a different silt mobilization process occurred as a result of silt being distributed on top the embedded road surface aggregates and hence being more easily entrained by vehicle mechanical and aerodynamic shear. It was also stated that aged silt found on most roads is more likely to be embedded between the road surface aggregates. Another conclusion identified in the field study was that implementation of mobile monitoring technologies provide for much easier representation of spatially distributed roadway emission characteristics, while eliminating the need to divert traffic.

4.2.1.22. *Technical Support Document for Mobile Monitoring Technologies*; Prepared For Clark County Department of Air Quality and Environmental Management; Chatten Cowherd; Midwest Research Institute; January 9, 2009. (Reference 41, http://www.epa.gov/ttn/chief/ap42/ch13/related/Mobile_Monitoring_TSD_010909.pdf).

This report states that it documents a peer review process conducted to determine whether the mobile monitoring method is a suitable alternative to the traditional AP-42 method for developing road dust emission factors. The report identifies seven individuals which were requested to review the series of Clark County test reports and to judge the value of mobile monitoring technologies in relation to the traditional approach for determining paved road dust emission factors.

The items addressed in this document include:

- A summary of road dust entrainment dynamics,
- A brief discussion of the basis of the current road dust emissions estimating method. Also described were the methods used to characterize the road surface silt loadings, the statistical methods used in developing the AP-42 emission factor equations and the use of roadside plume exposure profiling to quantify mass emissions rates.
- A brief discussion of the methods used to estimate independent variables required for the AP-42 emissions factor equations, associated restrictions and the resulting limitations and a subjective assessment of the uncertainties.
- A more in depth discussion of the two mobile monitoring technologies (the Desert Research Institute (DRI) and the CE-CERT version) is provided. The report identifies the presence of high background dust concentration and high wind speeds as two restrictions for the use of mobile monitoring. The report discusses the subjectively established calibration requirements for mobile monitoring. Calibration requirements identified include determining the relationship between concentrations measured by the instrument used for mobile monitoring and the Federal Register Measurement Method, the relationship between the concentrations measured at different vehicle speeds, different road dust characteristics and different vehicle weight during mobile monitoring and mass emissions measured by plume profiling.
- The report provides a discussion comparing of the implementation of the traditional application of the emissions factor and the use of mobile monitoring to develop emissions inventories.
- Lastly, the report provides the charge provided to the reviewers, an overview of comments by the reviewers and an indication of what changes will be made to address the reviewers concerns in a Specification for Mobile Monitoring document.

While this document states that the purpose is to demonstrate that mobile monitoring is equivalent or superior to the traditional AP-42 methodology, it provides only subjective opinions of the author and the selected reviewers. While there were no quantitative indicators to compare the precision or accuracy of the mobile monitoring technologies over the normal range of road conditions (silt loadings, mix of vehicle weights, vehicle speed) and resultant emissions produced, the author and the majority of the reviewers concluded that the method was more accurate and precise than the traditions measurement and monitoring methods. The review does reveal that there is an understanding that there is a lack of precision and understanding of independent variables other than silt loading, weight and speed which influence road dust emissions. Several reviewers highlight the potential of mobile monitoring methods to replace or supplement the resource intensive and dangerous collection of representative silt loading information. Several reviewers also highlight the need for further development and standardization of mobile monitoring such that the method could be used for managing the road dust emissions where required.

4.2.1.23. Mobile Monitoring Method Specifications; Prepared For Clark County Department of Air Quality and Environmental Management; Chatten Cowherd; Midwest Research Institute; February 6, 2009. (Reference 40, http://www.epa.gov/ttn/chief/ap42/ch13/related/MM_Method_Specifications_020609.pdf).

This document provides instructions for performing a standardized methodology for the construction of a mobile sampling platform, specifications for instrumentation used with

Federal Register Methods for PM10 or PM2.5, calibrations required to correlate the combined sampling platform and instrumentation with standardized plume profiling testing used to quantify mass emissions from roads and procedures for collecting information for use in road surface characteristics or emissions.

4.2.2. EMISSIONS FACTOR DEVELOPMENT.

A total of 103 individual tests are available. All tests quantified PM_{10} emissions. Lastly, plume profiling was the test method. Of these, 81 emissions tests included mean vehicle weight, road silt loading, and vehicle speed. The remaining tests included all of these parameters except vehicle speed. These emissions tests measured PM_{10} emissions associated with engine exhaust, tire wear, brake wear and material deposited on the road surface. Policy decisions within EPA make it necessary to separate particulate matter emissions associated with the operation of the vehicles (engine exhaust, tire wear and brake wear) and those associated with the road surface characteristics. These policy decisions are based in part on the recent and future efforts to control engine exhaust emissions. Many of the emissions tests performed to quantify particulate matter emissions from paved roads were conducted in the mid 1980's to middle 1990's. Several of the emissions studies have experienced comparable upwind and downwind concentrations with downwind particulate that appears to consist of a large percentage of organic or carbonaceous material. The first separation of vehicle associated emissions and pavement associated emissions was in the 2003 update. This update used the national VMT weighted fleet average PM_{10} emissions factor of 0.2119 g/VMT to subtract from the existing emissions factor equation as a means of separating the emissions from engine exhaust, tire wear and brake wear from the composite paved road emissions factor. A fleet average vehicle weight of 3.75 tons is associated with this emissions factor. Since the average vehicle weight used in the development of the paved road emissions factor equation was about 10 tons, the PM_{10} emissions factor for engine exhaust, tire wear and brake wear probably underestimated these emissions. In addition, because of the range and variation in mean vehicle weight, the use of an average for adjustment value introduces excessive error in the estimated road dust emissions estimates. Improved test specific adjustments for vehicle exhaust, tire wear and brake wear can be made since (1) average vehicle weights are available for each test series, (2) PM_{10} emissions factors estimates for each vehicle class are available using the MOVES model and (3) PM_{10} emissions estimates for slowly moving and stop and go truck traffic are available. By subtracting the estimated test specific vehicle emissions from the measured emissions prior to performing the stepwise multiple regression, emissions associated with the road surface material will be isolated.

4.2.2.1. Compilation and Adjustment of Final Data Base.

In keeping with the results from the data set review, a final data base was compiled by combining the following sets:

1. The January 1983 EPA data base,
2. the August 1983 EPA data base,
3. the July 1984 EPA data base,
4. the May 1990 USX data base,

5. the April 1997 EPA data base, and
6. the May 2008 CRA data base.

While several of the test reports include detailed information on the number of light duty vehicles, moderate weight trucks and heavy weight trucks, none provide detailed information on vehicle class as used to estimate emissions of vehicle exhaust, tire wear and break wear. For this assessment the vehicle classes will be separated into two vehicle classes. One group of vehicle class will include the six classes of light duty vehicles/trucks and motorcycles. The other group of vehicle class includes gas and diesel heavy duty trucks. Other assumptions used to estimate vehicle associated emissions include:

- The test fleet includes a mixture of light duty vehicles, heavy duty gas trucks and heavy duty diesel trucks when the average vehicle weight is less than 23 tons.
- The test fleet includes a mixture of light duty vehicles and heavy duty diesel trucks when the average vehicle weight is between 23 tons and 35 tons.
- The test fleet includes only heavy duty diesel trucks when the average vehicle weight is more than 35 tons.

First, the average vehicle weight and emissions are determined for the two classes of vehicles used to estimate the adjustment for the measured emissions. The vehicle weights and VMT distribution presented in Table 4-16 are used to calculate the average vehicle weight. The VMT adjusted gross vehicle weight is calculated for each class of vehicle by multiplying the VMT distribution by the average gross vehicle weight for the class. The individual vehicle class VMT adjusted gross vehicle weights are summed to arrive at the two VMT adjusted gross vehicle weights used in this assessment. For light duty vehicles, the VMT adjusted gross vehicle weight is 3320 pounds. For heavy duty trucks, the VMT adjusted gross vehicle weight is 3742 pounds. The sums of the VMT distributions for these two classes of vehicles are obtained by summing the individual VMT distributions for the two classes of vehicles used in this assessment. For light duty vehicles, the VMT distribution is 0.928. For heavy duty trucks, the VMT distribution is 0.0717. Dividing the VMT adjusted gross vehicle weights by the VMT distributions and converting to tons yields the average vehicle weights for the two classes of vehicles. For light duty vehicles, the average gross vehicle weight is 1.79 tons. For the combination of heavy duty gas and diesel trucks, the average gross vehicle weight is 26.09 tons.

Next, an algorithm is developed to provide test run specific ratios of light duty vehicles and heavy duty trucks. The algorithm is developed by solving the following two equations.

$$W_t = (R_{LD} \text{ x } W_{LD}) + (R_{HD} \text{ x } R_{HD})$$

$$1.00 = R_{LD} + R_{HD}$$

where: W_t = Test report average vehicle weight

W_{LD} = Average Light Duty Vehicle Weight (1.78848 tons)

R_{HD} = Average Heavy Duty Truck Weight (26.09135 tons)

R_{LD} = Light duty vehicle ratio

R_{HD} = Heavy duty truck ratio

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For test runs where the average vehicle weight is less than 23 tons, the resulting algorithm to estimate the ratio of heavy duty gas/diesel trucks in each test series is:

$$R_{HD} = (W_t - 1.78848) / (26.09135 - 1.78848)$$

For tests where the average vehicle weight is more than 23 tons, the resulting algorithm to estimate the ratio of heavy duty diesel trucks in each test series is:

$$R_{HD} = (W_t - 1.78848) / (35 - 1.78848)$$

Run specific emissions estimates for vehicle exhaust, brake wear and tire wear are estimated using the EPA Office of Transportation and Air Quality MOVES (MOtor Vehicle Emission Simulator) 2010 model[29]. For all tests with vehicle speed greater than 10 mph only emissions for freely moving traffic is calculated. Emissions for a representative mix of light duty vehicles and for a representative mix of heavy duty trucks are calculated. For each test series, information on the date of the test, the location of the test program, ambient temperature during the test, average vehicle speed, and other general information required to generate a valid PM_{10} emissions calculation with the MOVES model. While the MOVES model has the ability to generate start up emissions, all test conditions are assumed to include only vehicles which have achieved normal operating temperatures. For all test series with average vehicle speeds greater than 10 mph, the MOVES model calculated only running exhaust, tire wear and brake wear emissions. For heavy duty vehicles, the running emissions ranged from 0.645 g/VMT to 4.896 g/VMT. For light duty vehicles, the running emissions ranged from 0.0196 g/VMT to 0.1324 g/VMT. For test series with average vehicle speeds below 9.9 mph, in addition to running exhaust, tire wear and brake wear emissions; exhaust emissions during acceleration and idling are included. A separate MOVES model run estimated the average emissions for the non steady state emissions at 11.06 g/hour. The emissions factor for this driving condition was calculated by dividing the hourly emissions by the average vehicle speed. Summing the product of emissions factors from heavy duty trucks and light duty vehicles and the ratio of heavy duty vehicles and light duty vehicles provides an estimate of the total engine exhaust; tire wear and brake wear emissions for the test run.

The test run specific emissions factor estimate for engine exhaust, tire wear and brake wear is subtracted from the test run measured emissions factor to produce the test run specific emissions factor due to road surface material. To allow log transformation of the data, values of zero or less were set to 0.01 g/VMT. Table 4-17 presents the final dependent and independent variables for all of the useable test series that were assembled for developing the paved road emissions factor equation. There were 10 test runs of the 103 available data where downwind emissions were not measureable. Six of the data were associated with low speed traffic at corn refining facilities and four of the data were high or moderate speed urban traffic. None of these ten data were included in the data analyzed to estimate the predictive emissions factor equation. There were 3 out of the 103 available data sets where the estimated emissions from engine exhaust, tire wear and break wear were equal to or comparable to the measured emissions. Two of the three test runs were on roads where the average vehicle speed was 55 mph. Emissions of two additional test runs with vehicle speeds of 55 mph had engine exhaust, tire wear and break wear emissions greater than 160% of the road emissions. The silt level for one of the 55 mph test runs was greater than all

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other 55 mph data sets and was performed to characterize emissions from a road that had been sanded for traction control. For slightly slower moving traffic (40 – 45 mph), three of the five test runs had significant percentage of engine exhaust; tire wear and brake wear emissions. One of the remaining two runs had silt levels greater than 60% of the entire data set and the test was performed to characterize emissions from a road that had been sanded for traction control.

Graphical presentations of the final PM_{10} data base are shown in Figures 4-1 through 4-5. Because of the large range of silt loadings and estimated emissions factors, the data are plotted on a logarithmic scale for the first three figures. Figure 4-1 presents the data base by silt loading with five ranges of average vehicle weight depicted with different shape and color data points. The figure shows that with increasing silt loading there is an increase in the PM_{10} emissions factor. Figure 4-2 presents the data base by average vehicle weight with seven ranges of silt loading depicted with different shape and color data points. Although there is a significant overlap of the different vehicle weight data, there appears to be some relationship between average vehicle weight and the PM_{10} emissions factor. As with silt loading, it appears that the PM_{10} emissions factor increases with increasing vehicle weight. The wider spread of the data around the center line of the data makes the relationship more difficult to discern. Figure 4-3 presents the relationship between silt loading and average vehicle weight with eight ranges of emissions factors depicted with different shape and color data points. Although very poor, there appears to be a weak relationship between silt loading and vehicle weight. The cause of this relationship is probably due to the selection of the test location and parameters than any physical force that would cause this relationship. Figure 4-4 presents the relationship between average vehicle speed and the PM_{10} emissions factor. It appears that between 10 and 55 mph, the emissions factor decreases with increasing speed. Below 10 mph there does not appear to be a speed relationship. Figure 4-5 presents the relationship between silt loading and vehicle speed with five ranges of PM_{10} emissions factors. The silt loading appears to decrease with increasing speed above 10 mph. In addition, there seems to be a clear increase in PM_{10} emissions factor as silt loading increases and speed decreases. Figure 4-6 presents a three dimensional view of the silt loading, vehicle weight and PM_{10} emissions factors. One data point seems to be very uncharacteristic of the general trend of the data. Figure 4-7 provides a two dimensional view of the data with the data identifier in the label. For three data points, the PM_{10} emissions factor is also included in the label. The point which has the uncharacteristic emissions is point Z-3 with a PM_{10} emissions factor of 1819 g/VMT. While this value is the highest emissions factor of all of the 92 test data, both the vehicle weight and silt loading for this run are near other data which are under 100 g/VMT. As a result, this data was flagged as a potential outlier. This data was reassessed following log transformation and the variation was determined to be comparable with other data and was included in the final data set used to estimate the predictive equation. Figure 4-8 presents the three dimensional view of the test data with silt loading, vehicle weight and PM_{10} emissions factor with test run Z-3 removed. With point Z-3 removed, there appears to be two regimes of the data. Most of the data had silt loadings below 20 g/m^2 with few gaps down to 0.013 g/m^2. There are ten data with silt loadings spread out from 50 g/m^2 to almost 400 g/m^2 with no data between these two regimes. There appears to be one incline associated with the lower silt loading data and a significantly greater incline for the higher silt loading data. This greater incline is the result of a small number of data collected prior to 1983. These data have higher silt loadings that the default silt loading for the peak additive contribution value for roads with average daily traffic volume counts of less than 500. While there may be a very small number of streets that reach this silt loading level, these are believed to be unrepresentative of typical well managed urban or rural roads during any season. As a result, these data are flagged as extreme values and were not included in the final data set used to estimate the predictive equation.

Table 4-17. Final Paved Roads Emissions Factor Data Set

Reference	Run ID	Silt loading (g/m2)	Speed (mph)	Weight (tons)	Downwind Concentration mg/m^3	Measured PM_{10} Emission factor (g/VMT)	Estimated Fraction Heavy Duty Vehicles	Estimated Engine, brake, tire emission factor (g/VMT)	Estimated PM_{10} Road Dust Emission factor (g/VMT)
USX 5/1990	AUC3	0.42	27	5.5	0.011	2.25	0.153	0.3298	1.920
	AUC4	0.52	25	6	0.04	16.1	0.173	0.3537	15.746
	AUC5	0.23	29	3.9	0.07	15.3	0.087	0.1941	15.106
	AUC6	0.23	27	6.2	0.03	3.7	0.182	0.3961	3.304
	AUC7	0.26	27	3	0.01	0.402	0.050	0.1653	0.237
	AUC8	0.15	27	2	0.03	7.88	0.009	0.0936	7.786
	AUE1	4	15	12	0.01	3.22	0.420	0.9337	2.286
	AUE2	4	16	5.1	0.6	10.6	0.136	0.3709	10.229
	AUE3	2.2	15	2.6	0.08	16.1	0.033	0.1804	15.920
	AUE4	1.3	15	2.6	0.06	9.01	0.033	0.1804	8.830
EPA 7/1984	M-1	0.46	30	5.6	0.124	4.99	0.157	0.3610	4.629
	M-2	0.26	30	3.8	0.033	1.55	0.083	0.2486	1.301
	M-3	0.147	30	4.5	0.070	3.54	0.112	0.2845	3.256
	M-4	0.432	35	2.1	0.030	0.177	0.013	0.0927	0.084
	M-5	1.01	35	2.2	0.090	0.692	0.017	0.0749	0.617
	M-6	0.716	30	2.1	0.063	1.38	0.013	0.1043	1.276
	M-7	0.59	35	2.3	0.130	4.22	0.021	0.1146	4.105
	M-8	2.48	20	2.2	0.120	11.2	0.017	0.1063	11.094
	M-9	0.293	30	4.1	0.130	3.24	0.095	0.2190	3.021
	M-10	0.022	55	4.5	0.104	0.177	0.112	0.1798	0.010
	M-11	0.022	55	4.8	0.080	0.322	0.124	0.2009	0.121
	M-12	0.022	55	3.8	0.080	0.084	0.083	0.1403	0.010
	M-13	0.11	35	2.7	0.065	0.306	0.038	0.0988	0.207
	M-14	0.079	35	2.7	0.030	1.37	0.038	0.1044	1.266
	M-15	0.049	35	2.7	0.090	1.47	0.038	0.0886	1.381
	M-16	0.022	55	4.3	0.060	0.241	0.103	0.1581	0.083
	M-17	0.809	30	2	0.056	2.64	0.009	0.0501	2.590
	M-18	0.731	30	2	0.080	0.37	0.009	0.0501	0.320
	M-19	0.929	30	2.4	0.050	0.177	0.025	0.0791	0.098

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Table 4-17. (Continued)

Reference	Run ID	Silt loading (g/m2)	Speed (mph)	Weight (tons)	Downwind Concentration mg/m^3	Measured PM_{10} Emission factor (g/VMT)	Estimated Fraction Heavy Duty Vehicles	Estimated Engine, brake, tire emission factor (g/VMT)	Estimated PM_{10} Road Dust Emission factor (g/VMT)
EPA 1/1983	Y1	90.7	10	3.6		117	0.075	0.2274	116.773
	Y2	76.1	10	3.7		182	0.079	0.2359	181.764
	Y3	193	10	3.8		36.3	0.083	0.2443	36.056
	Y4	193	10	3.7		200	0.079	0.2359	199.764
	Z1	11.3	10	8		317	0.256	0.6096	316.390
	Z2	12.4	15	8		740	0.256	0.5697	739.430
	Z3	12.4	15	8		1820	0.256	0.5697	1819.430
	AC4	287	10	5.7		1750	0.161	0.4090	1749.591
	AC5	188	15	7		1420	0.214	0.4852	1419.515
	AC6	399	20	3.1		613	0.054	0.1466	612.853
	AD1	94.8	23	42		1480	1.000	1.8114	1478.189
	AD2	63.6	23	39		342	1.000	1.8114	340.189
	AD3	52.9	23	40		233	1.000	1.8114	231.189
EPA 8/1983	F34	2.78	NR	28	0.552	188	0.789	1.4388	186.561
	F35	2.03	NR	25	0.057	298	0.699	1.2790	296.721
	F36	0.201	NR	8.3	0.134	54.7	0.268	0.5320	54.168
	F37	0.417	NR	17	0.163	77.2	0.626	1.1617	76.038
	F38	0.218	NR	18	0.301	167	0.667	1.2339	165.766
	F39	0.441	NR	18	0.177	253	0.667	1.2339	251.766
	F27	14.8	NR	14	0.531	130	0.502	0.9292	129.071
	F32	0.117	NR	14	0.138	53.1	0.502	0.9292	52.171
	F61	17.9	NR	40	0.327	463	1.000	1.8261	461.174
	F45	5.11	NR	16	0.744	212	0.585	1.0896	210.910
	F62	14.4	NR	36	0.294	317	1.000	1.8226	315.177
	F74	5.59	NR	29	0.114	545	0.819	1.5012	543.499

Table 4-17. (Continued)

Reference	Run ID	Silt loading (g/m2)	Speed (mph)	Weight (tons)	Downwind Concentration mg/m^3	Measured PM_{10} Emission factor (g/VMT)	Estimated Fraction Heavy Duty Vehicles	Estimated Engine, brake, tire emission factor (g/VMT)	Estimated PM_{10} Road Dust Emission factor (g/VMT)
EPA 8/1983	B50	13.6	NR	9.4	0.225	82.1	0.313	0.5936	81.506
	B51	13.6	NR	11	0.410	140	0.379	0.7108	139.289
	B52	7.19	NR	12	0.102	35.4	0.420	0.7836	34.616
	B54	3.77	NR	10	0.187	93.3	0.338	0.6379	92.662
	B55	6.3	NR	11	0.295	183	0.379	0.7108	182.289
	B56	2.4	NR	9.2	0.229	126	0.305	0.5794	125.421
	B58	10.4	NR	18	0.190	368	0.667	1.2221	366.778
	B57	2.32	NR	12	0.358	195	0.420	0.7836	194.216
	B59	2.06	NR	11	0.149	348	0.379	0.7108	347.289
	B60	3.19	NR	12	0.339	439	0.420	0.7836	438.216
EPA 4/1997	BH1	0.184	55	2.2	0.233	1.08	0.017	0.0306	1.049
	BH2	0.0127	55	2.2	0.030	0.102	0.017	0.0306	0.071
	BH3	0.0127	55	2.2		0	0.017	0.0305	
	BH6	1.47	40	2.2	0.300	4.68	0.017	0.0343	4.646
	BJ6	0.06	45	2.2	0.045	0.301	0.017	0.0336	0.267
	BJ7	0.06	45	2.2	0.130	1.94	0.017	0.0336	1.906
	BJ9	0.06	45	2.2		0	0.017	0.0305	
	BJ10	0.06	45	2.2		0	0.017	0.0305	
	BJ11	0.06	45	2.2		0	0.017	0.0305	
	BK7	0.082	45	2.2	0.033	0.57	0.017	0.0336	0.536
	BK8	0.082	45	2.2	0.033	0.44	0.017	0.0336	0.406
CRA 5/2008	CE-1	1.16	1	36	0.050	27	1.000	11.06	15.940
	CE-2	0.86	1	36	0.075	64	1.000	11.06	52.940
	CE-11	1.34	5	12	0.200	154	0.420	2.212	151.788
	CE-3	0.86	1	39	0.070	45	1.000	11.06	33.940
	CE-15	1.91	5	40	0.065	63.5	1.000	2.212	61.288
	CE-16	1.41	5	40	0.050	77.1	1.000	2.212	74.888
	CE-17	2.93	5	40	0.040	41.3	1.000	2.212	39.088
	CE-19	0.76	5	38	0.040	18.6	1.000	2.212	16.388

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Table 4-17. (Continued)

Reference	Run ID	Silt loading (g/m2)	Speed (mph)	Weight (tons)	Downwind Concentration mg/m^3	Measured PM$_{10}$ Emission factor (g/VMT)	Estimated Fraction Heavy Duty Vehicles	Estimated Engine, brake, tire emission factor (g/VMT)	Estimated PM$_{10}$ Road Dust Emission factor (g/VMT)
CRA 5/2008	CE-12	1.34	5	13	0.085	23.1	0.461	2.212	20.888
	CF-1N	0.97	5	40	0.035	4.99	1.000	2.212	2.778
	CF-1/South	0.97	1	40	0.040	19.5	1.000	11.06	8.440
	CF-2N	0.81	5.3	41	0.044	16.3	1.000	2.0868	14.213
	CF-2/South	0.81	1	41	0.080	63.5	1.000	11.06	52.440
	CF-3N	0.63	5.1	41	0.015	1.09	1.000	2.1686	0.010
	CF-3/South	0.63	1	41	0.025	23.1	1.000	11.06	12.040
	CF-4N	1.1	4.7	41	0.019	3.08	1.000	2.3532	0.727
	CF-5	1.4	1	41	0.030	16.3	1.000	11.06	5.240
	CI-1	0.06	15.1	26		0	0.729	1.0008	
	CI-2	0.06	14.85	26		0	0.729	1.0008	
	CI-3	0.06	13.15	27		0	0.759	1.0410	
	CI-4	0.06	14.5	27		0	0.759	1.0410	
	CI-7	0.05	15.3	27	0.030	1.63	0.759	1.0409	0.589
	CI-8	0.05	15.3	27	0.030	2.99	0.759	1.0409	1.949
	CI-11	0.025	13.1	27		0	0.759	1.0410	
	CI-12	0.25	13.1	27		0	0.759	1.0410	
	CM-1	0.72	5	39.8	0.035	6.35	1.000	2.212	4.138
	CM-2	0.72	1	39.6	0.050	63.5	1.000	11.06	52.440
	CM-4	0.7	5	39.5	0.035	7.26	1.000	2.212	5.048

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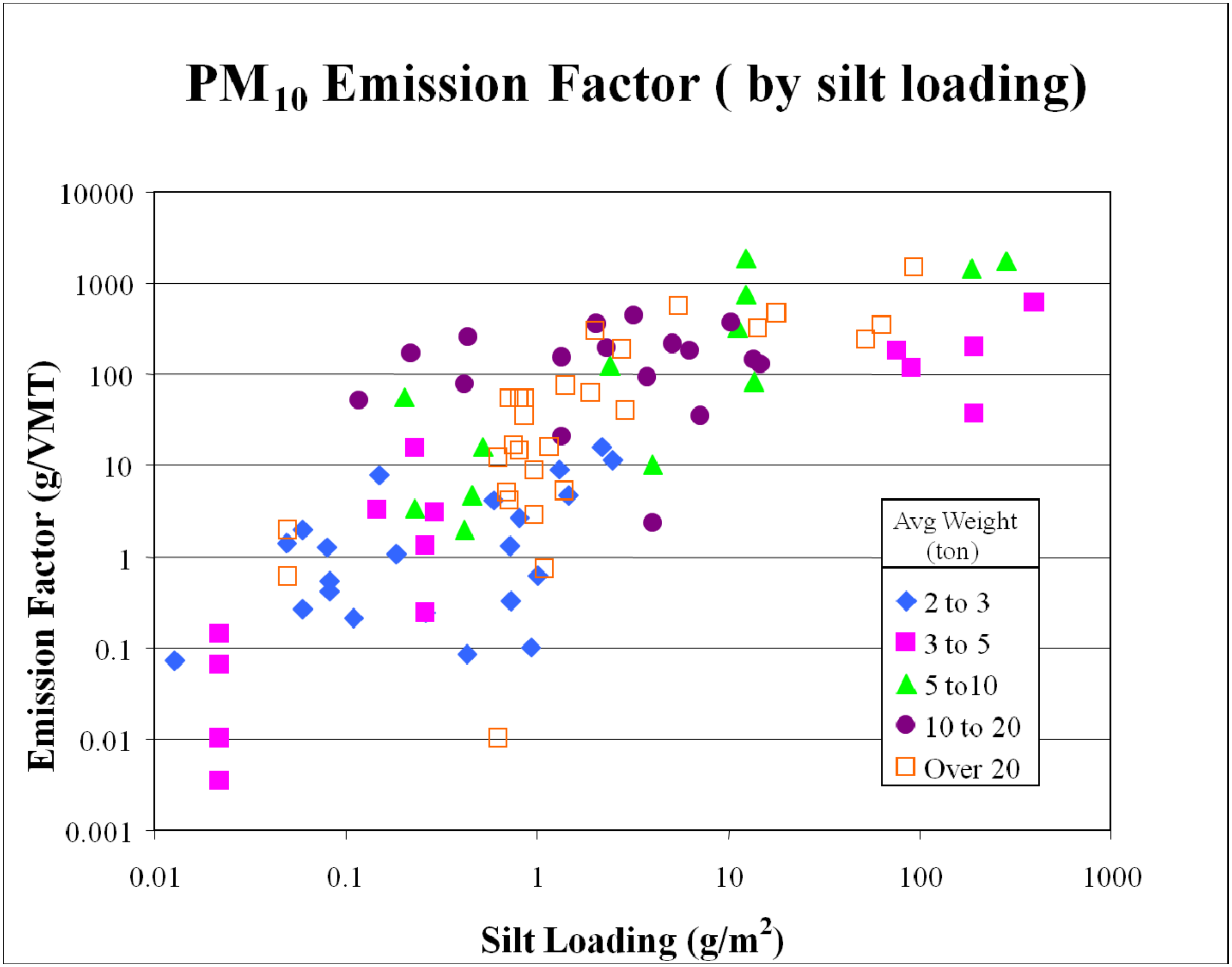

Figure 4-1. PM_{10} Emissions Factor Data Base by Silt Loading (93 test runs).

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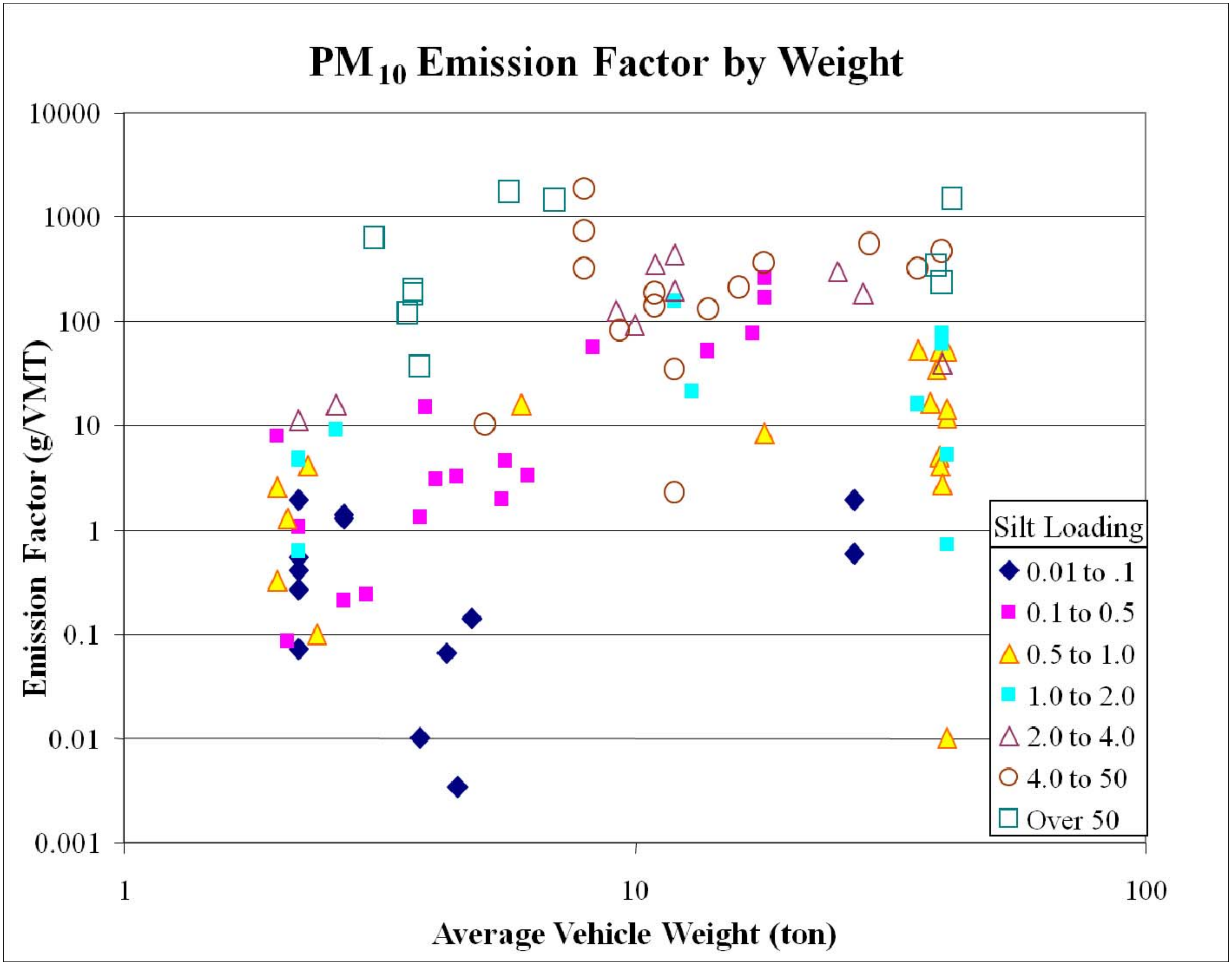

Figure 4-2. PM$_{10}$ Emissions Factor Data Base by Average Vehicle Weight (93 test runs).

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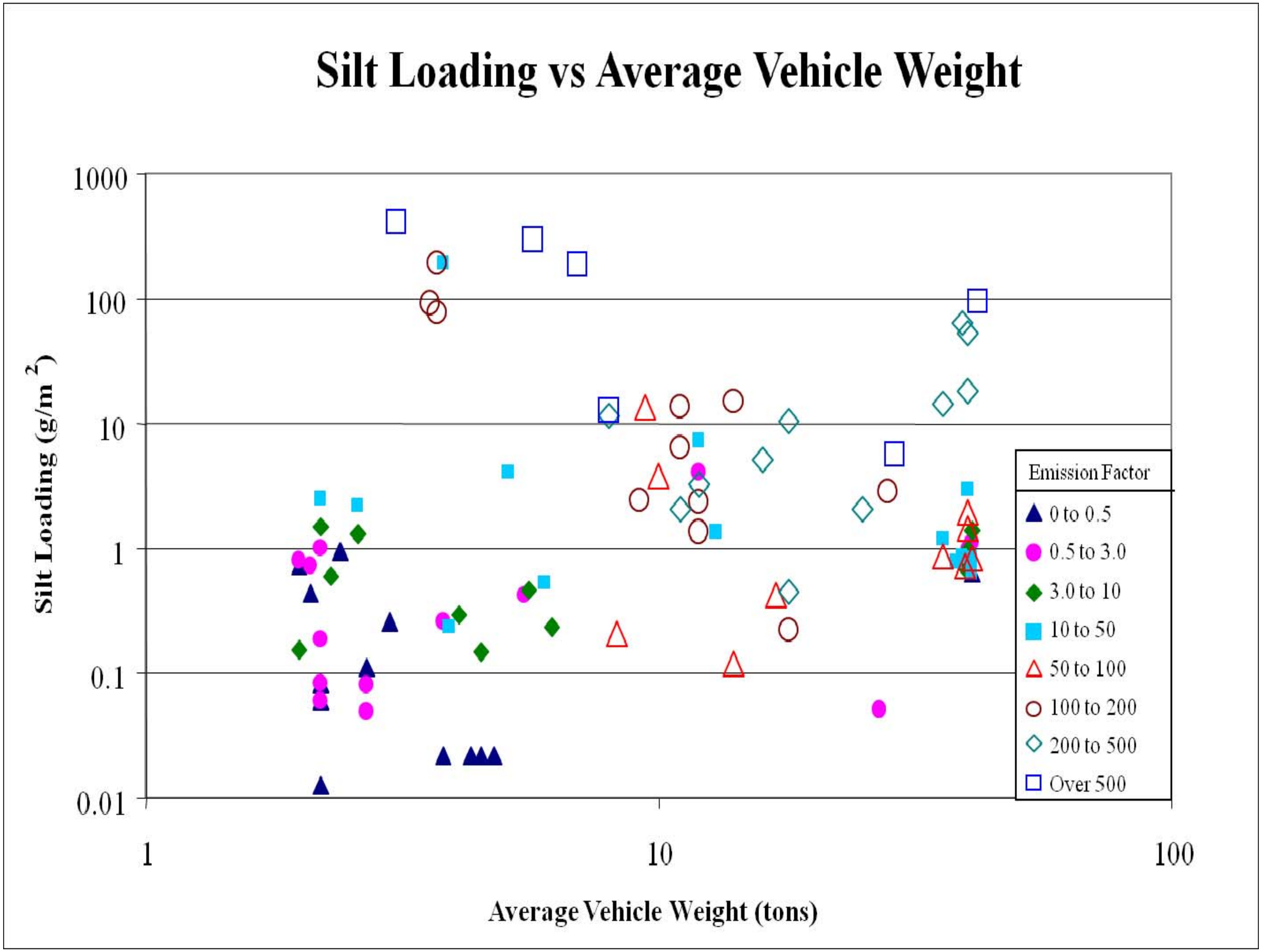

Figure 4-3. Silt Loading vs. Average Vehicle Weight (93 Test Runs).

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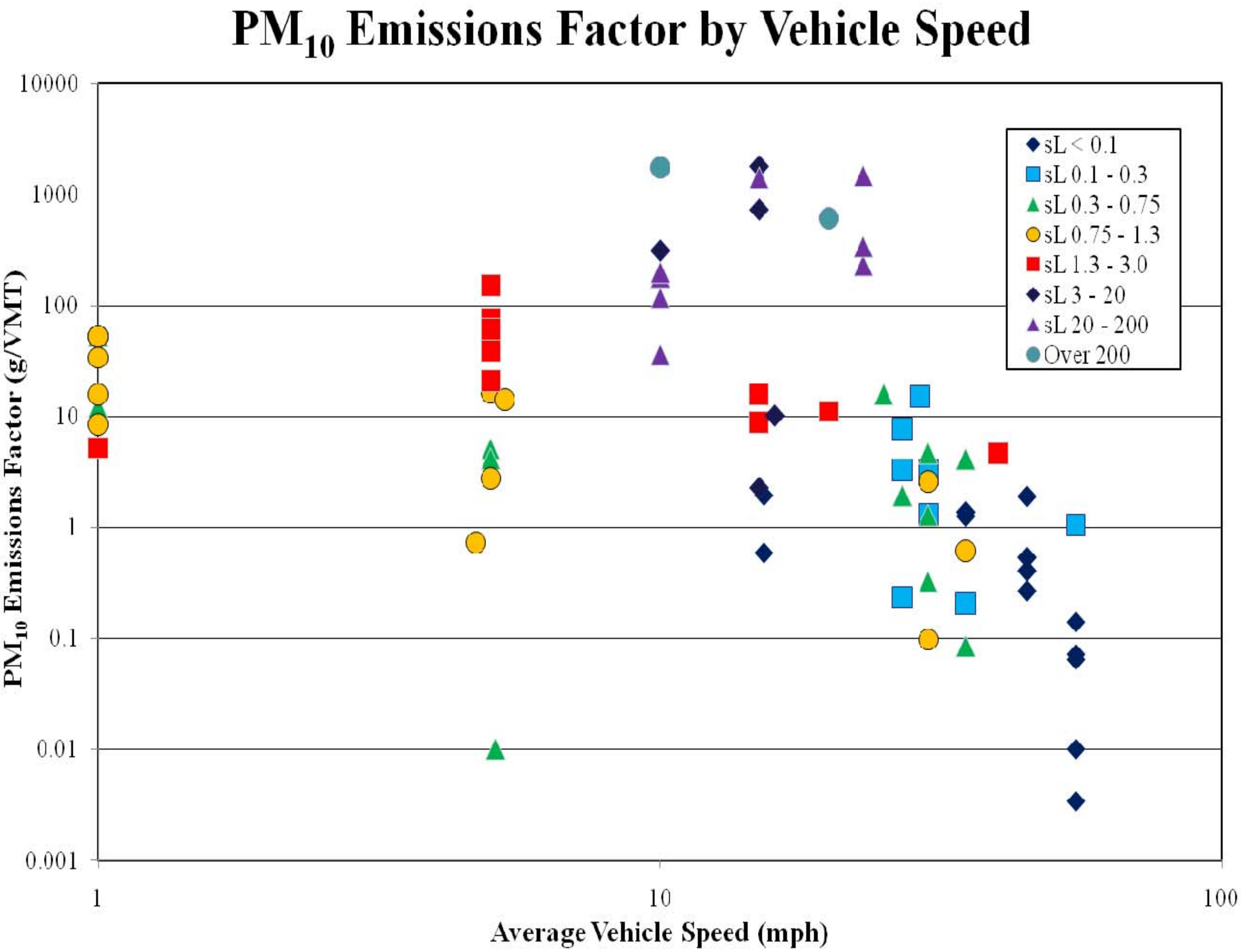

Figure 4-4. PM_{10} Emissions Factors by Vehicle Speed.

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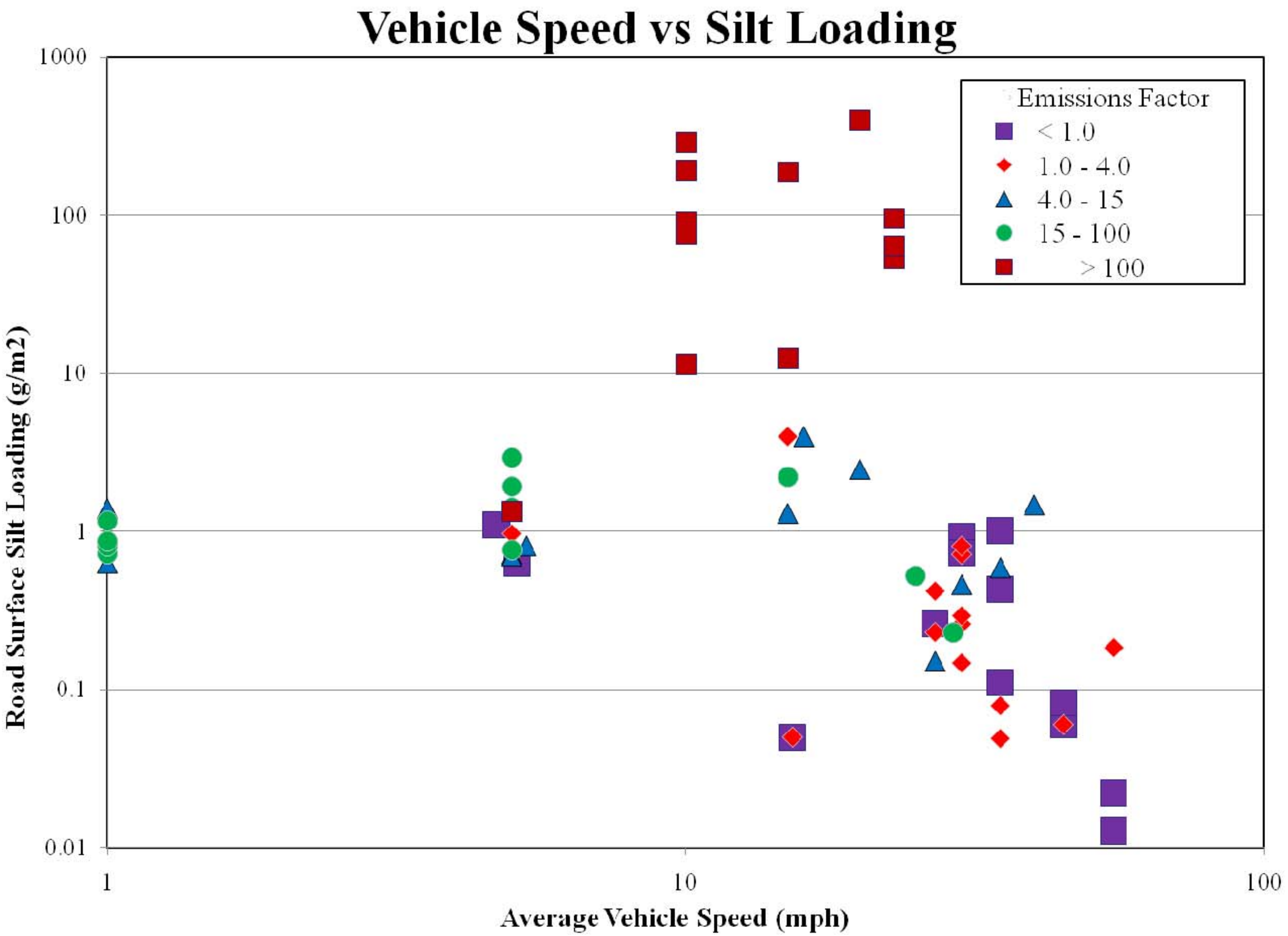

Figure 4-5. Vehicle Speed vs Silt Loading.

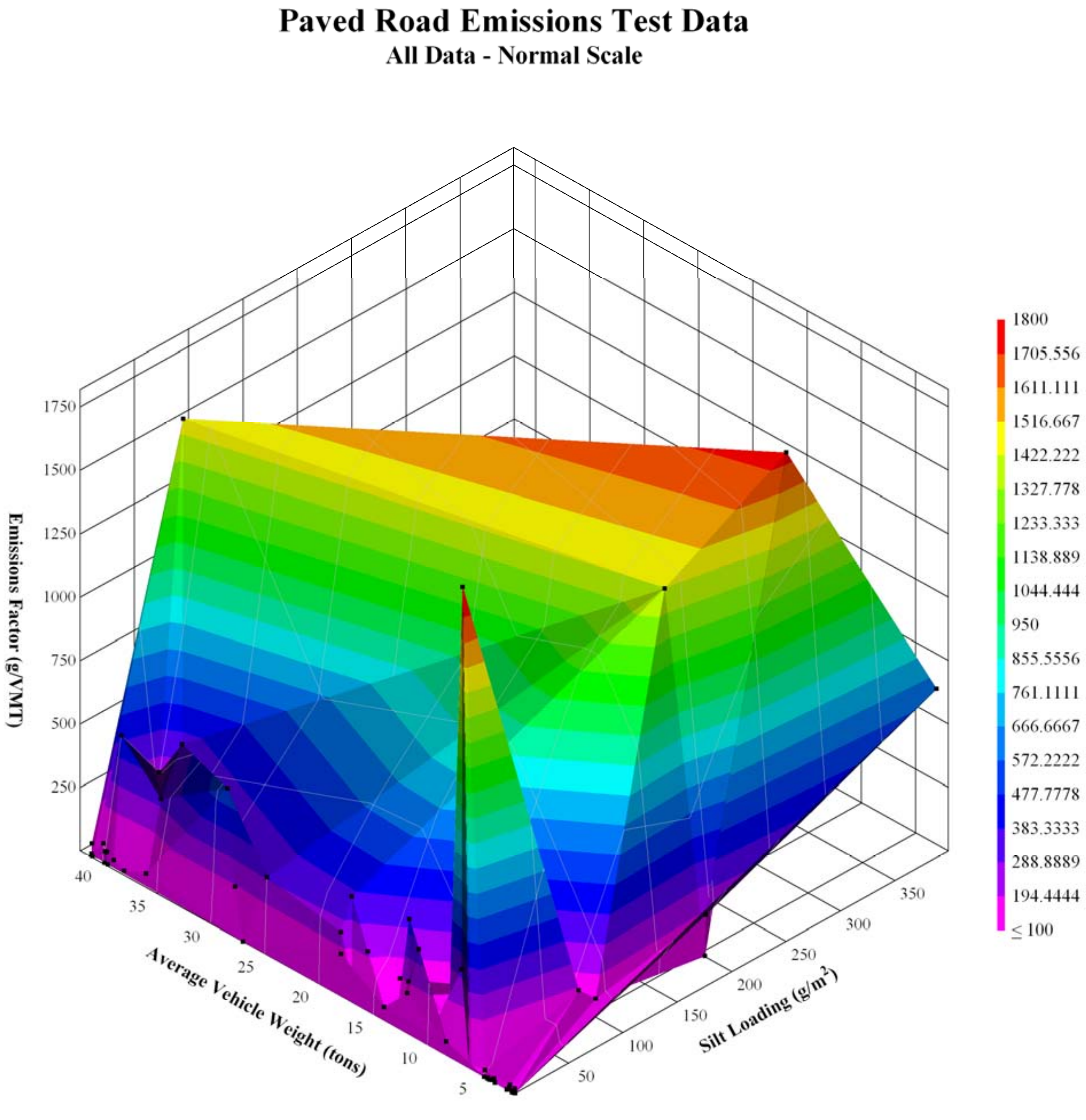

Figure 4-6. Paved Road Dust Emissions Factors, All Data.

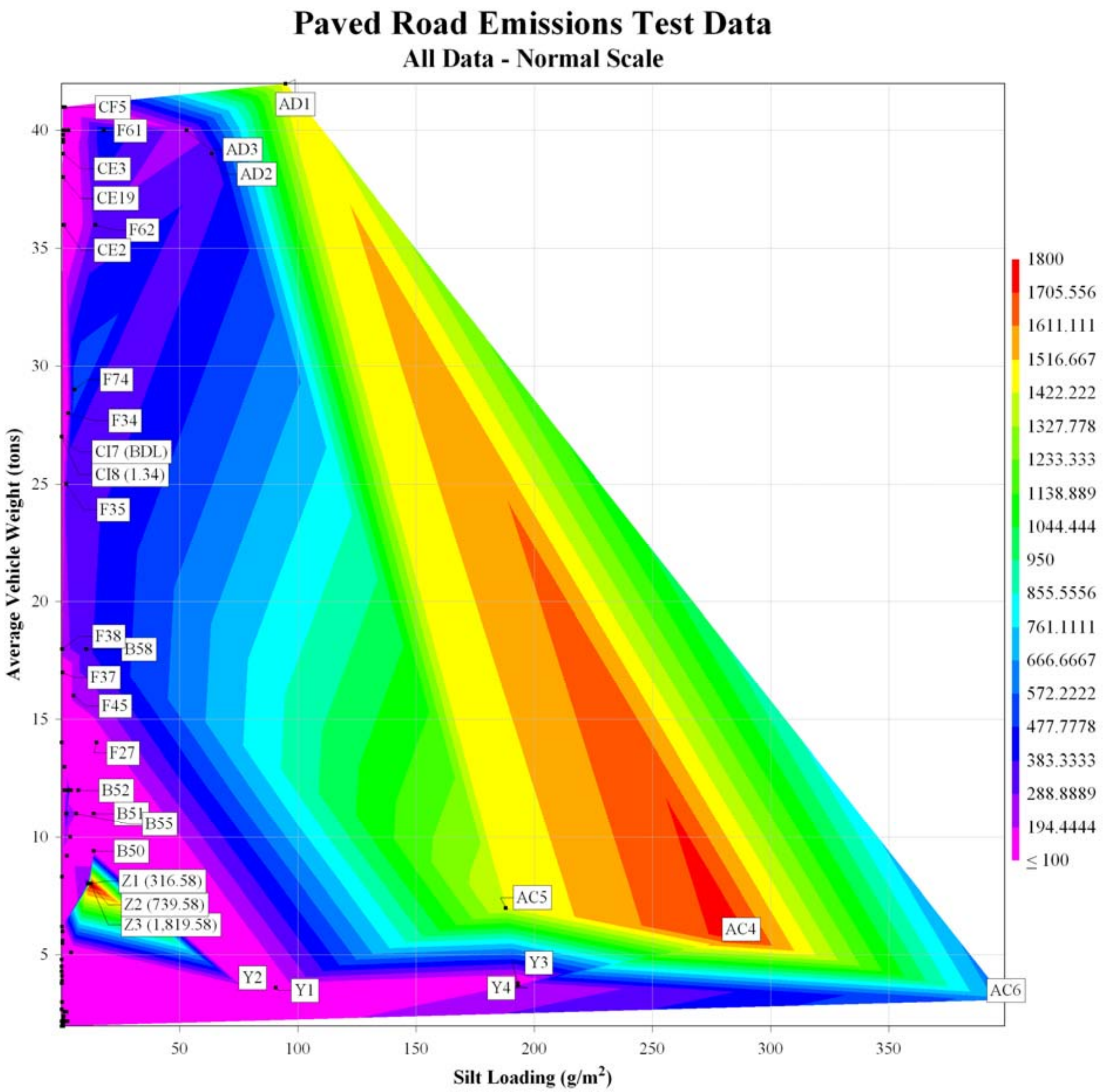

Figure 4-7. All Paved Road Data, Silt Loading by Vehicle Weight with EF.

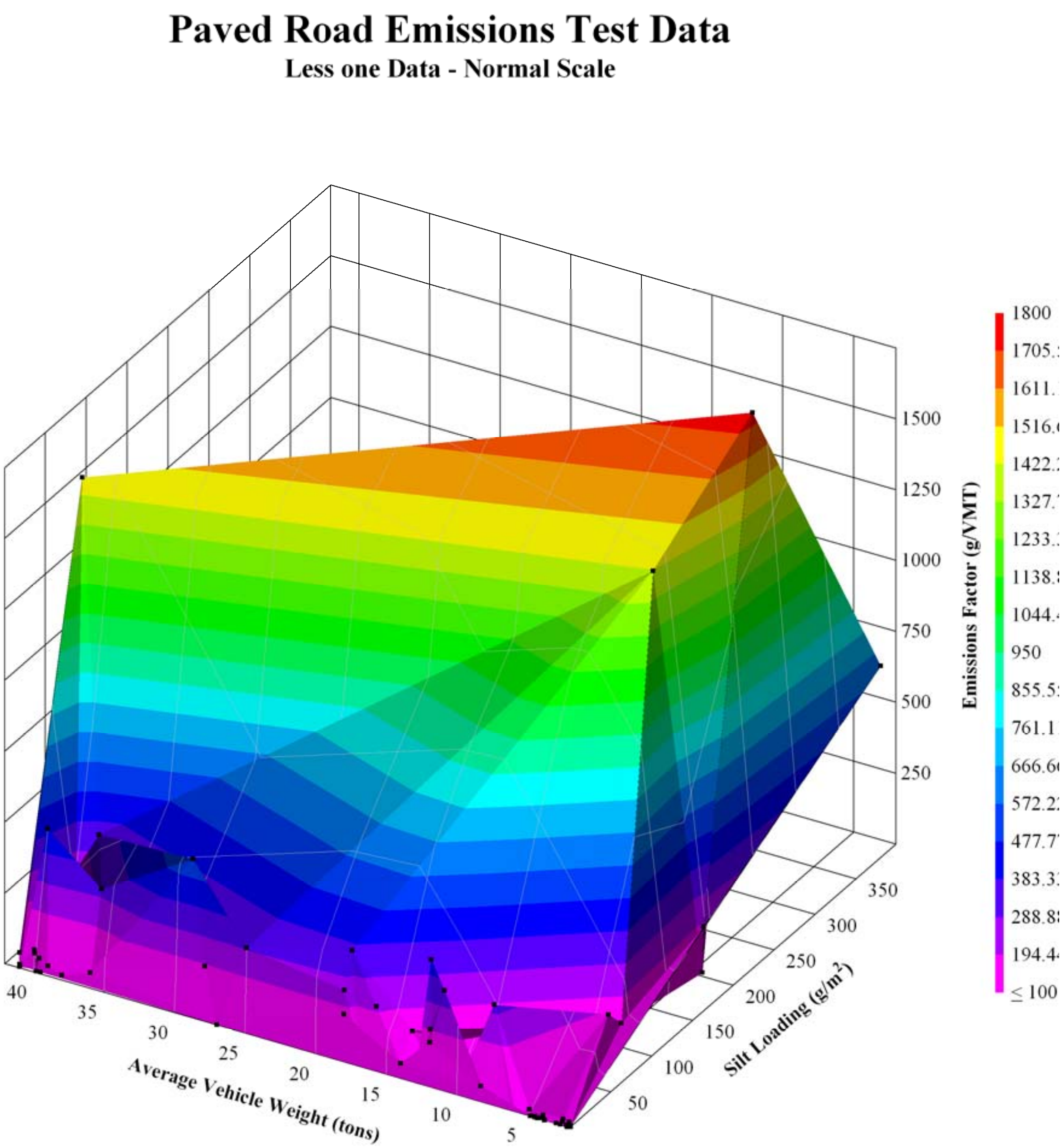

Figure 4-8. Paved Road Dust Emissions Factor Data Excluding Z-3.

4.2.2.2. Emission Factor Development.

Stepwise multiple linear regression was used to develop a predictive model with the final data set. The potential correction factors included:

- silt loading, sL
- mean vehicle weight, W
- mean vehicle speed, S

All variables were log-transformed in order to obtain a multiplicative model as in the past. Table 4-18 presents the correlation matrix of the log-transformed independent and dependent variables. The most notable feature of the correlation matrix is the high degree of correlation between silt loading and emissions factors. The correlation between emissions factor, weight and speed is much lower than with silt loading. The high correlation between weight and speed is believed to be the result of the large data collected by the corn refiners association to characterize emissions at terminals. This suggests that obtaining accurate silt loading information is the most important independent variable to obtain for accurately estimating emissions factors.

Table 4-18 Correlation Matrix for log-transformed PM_{10} data.

	PM_{10} Emission factor (g/VMT)	Silt loading (g/m^2)	Weight (tons)	Speed (mph)
PM_{10} Emission factor (g/VMT)	1			
Silt loading (g/m^2)	0.8010	1		
Weight (tons)	0.3280	-0.1841	1	
Speed (mph)	-0.4066	-0.2785	-0.7784	1

Initially several regression analysis were performed using the Data Analysis tools in MS Excel to evaluate a range of independent variables. The independent variables included silt loading, average vehicle weight, the product of silt loading and vehicle weight, the square of silt loading (after log transformation) and the square of the vehicle weight (after log transformation). In addition, the influence of including and excluding flagged test runs were explored. The primary criteria for selecting the most appropriate form and supporting data set was the predictive performance of the equation using the combination of the correlation coefficient, the P-value and the relative percent difference from the actual emissions factor for the test series with silt loadings and vehicle weights in the range of default values used in the national inventory. The stepwise regression was first performed using the “Regression” function in the “Analysis Tool” of Excel. It was determined that the use of the speed term either produced equations with P-values greater than 0.1 or produced equations with independent parameter relationships that were illogical (i.e. increased emissions with decreased weight). It was also determined that the inclusion of data with silt loadings greater than 20 g/m^2 produced equations which uniformly overestimated test data with lower silt loadings without a significant improvement in estimating the high silt loading data. Also, the exclusion of the ten data with high silt loadings did not significantly change the predictive accuracy of the equation for the ten high silt loading test runs. The 93 test data with positive measured emissions were provided to a statistician for subsequent analysis with SAS.

Several additional assessments were performed to determine an equation that provided a high correlation coefficient, a low average percent error for test series with targeted independent variables and which provided a reasonable level of predictive accuracy for test series where the independent variables were outside the targeted range. The equation which produced the highest correlation coefficient was one which forced the intercept to zero. This equation performed well and was consistent with engineering assessments of the physical influences on emissions. This equation used only silt loading and average vehicle weight as the independent variables. It was decided that the traditional scaling factors of 2 for silt loading and 3 for average vehicle weight were no longer required and resulted in simpler calculation of paved roads emissions factors. The resulting equation for PM_{10} is:

$$EF = 1.0\,(sL)^{0.912}(W)^{1.021}$$

Table 4-19 shows the statistical output. The predicted exponents for silt and weight are 0.912 and 1.021 respectively and have a coefficient of determination (R^2) of 0.72. The standard error associated with the silt and weight terms are 0.12 and 0.08 respectively. As a result, it is expected that 95% of future data would fall within equations with exponents of 0.677 and 1.14 for the silt term and 0.852 and 1.19 for the weight term.

The range of conditions which existed at the test sites used in developing the equation was as follows:

Silt loading:	0.03 - 400 g/m2 0.01 - 570 grains/square foot (ft2)
Mean vehicle weight:	1.8 - 38 megagrams (Mg) 2.0 - 42 tons
Mean vehicle speed:	1 - 88 kilometers per hour (kph) 1 - 55 miles per hour (mph)

Table 4-19. Regression Analysis using Silt Loading and Weight.

SUMMARY OUTPUT All positive test data, sL < 20 force 0, sL W

Regression Statistics	
Multiple R	0.848347765
R Square	0.71969393
Adjusted R Square	0.703887682
Standard Error	1.921751464
Observations	83

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	768.0593789	384.0296894	103.9849195	5.61978E-23
Residual	81	299.1434238	3.693128689		
Total	83	1067.202803			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A
Weight (tons)	1.0212836	0.084774552	12.04705393	9.58964E-20	0.852608836	1.189958364
Silt loading (g/m2)	0.911843675	0.117787966	7.741399277	2.42283E-11	0.677482574	1.146204776

An assessment of the performance of the predictive equation is difficult since the range of silt loadings and the associated emissions factors spans five orders of magnitude. This is further complicated by the focus of many of the field tests. Approximately half of the field test locations were selected either due to concerns that these sources were major contributors to air quality impacts, or were selected because of elevated road silt levels to allow the measurement of a difference from background concentrations of particulate matter. Another complication is that PM emissions of the vehicle exhaust were not measured during the tests and a modeled average emission factor or rate was subtracted to arrive at the road dust emissions.

One can assess the performance of the predictive equation by calculating the average predicted to actual ratio and producing the cumulative distribution of these ratios. For the two parameter equation, the average predicted to actual ratio is 49. This is significantly lower than the average predicted to actual ratio of 315 for the previous equation when applied to the existing data. When limited to silt loading levels of 20 g/m2, the new equation produces average predicted vs actual ration of 38 compared to the previous equations ration of 221. It should be noted that the previous equation subtracted 0.2119 g/VMT (the estimated national average engine exhaust, brake wear and tire wear emissions factor) from the previous equation which was based upon measured emissions. The new equation subtracts the estimated engine; brake wear and tire wear emissions estimated for each test run. These emissions average 1.565 g/VMT and range from 0.031 to 11.06 g/VMT depending on meteorological conditions, vehicle speed and vehicle weight determined during the test. Figure 4-9 depicts the cumulative distribution of the predicted to actual ratios for both the previous equation and the new equation. Figure 4-10 presents this same information but with ranges of silt loading depicted through the use of different shapes and colors for the markers of the data. Figure 4-11 is this same information but with ranges of vehicle weights depicted with different markers. It is difficult to discern any differences below the ratio of 1.0. Above the ratio of 1.0 the increased range of the predicted vs actual ratio of the older equation is evident. The new equation appears to demonstrate an improved performance compared to the previous equation.

Another means of assessing the performance of the regression equations is to compare the calculated results of the equations to the actual value measured. With a large range of measured emissions factors, comparing the relative percent difference between the results of the equation and the measured value places the differences in the smallest measured value and the largest measured value on comparable terms. Two comparisons were made to assess the relative predictive performance of the existing equation to the previous equation. As shown with the average percent error for the entire population in Table 4-23, the new equation provides an order of magnitude improvement in estimating the actual measured emissions over the previous equation. Associated with the reduction in the percent difference from actual emissions is a 47 percent reduction in the emissions factor. When the performance of the equation is evaluated within classes of the independent variables of silt loading, average vehicle weight and speed; the new equation shows comparable or improved performance in all groups of the variables except two.

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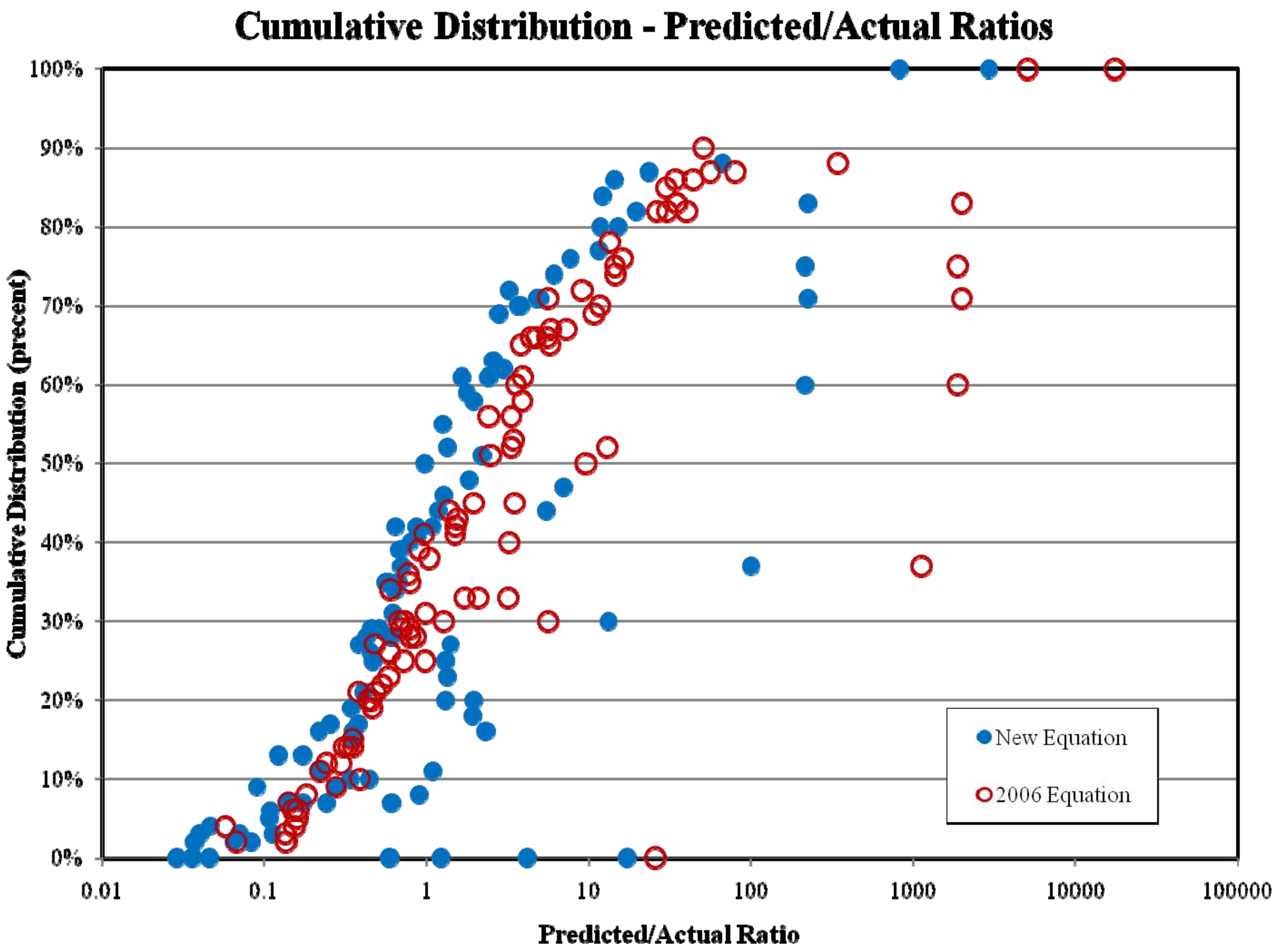

Figure 4-9. Cumulative Distribution of Predicted/Actual Ratios.

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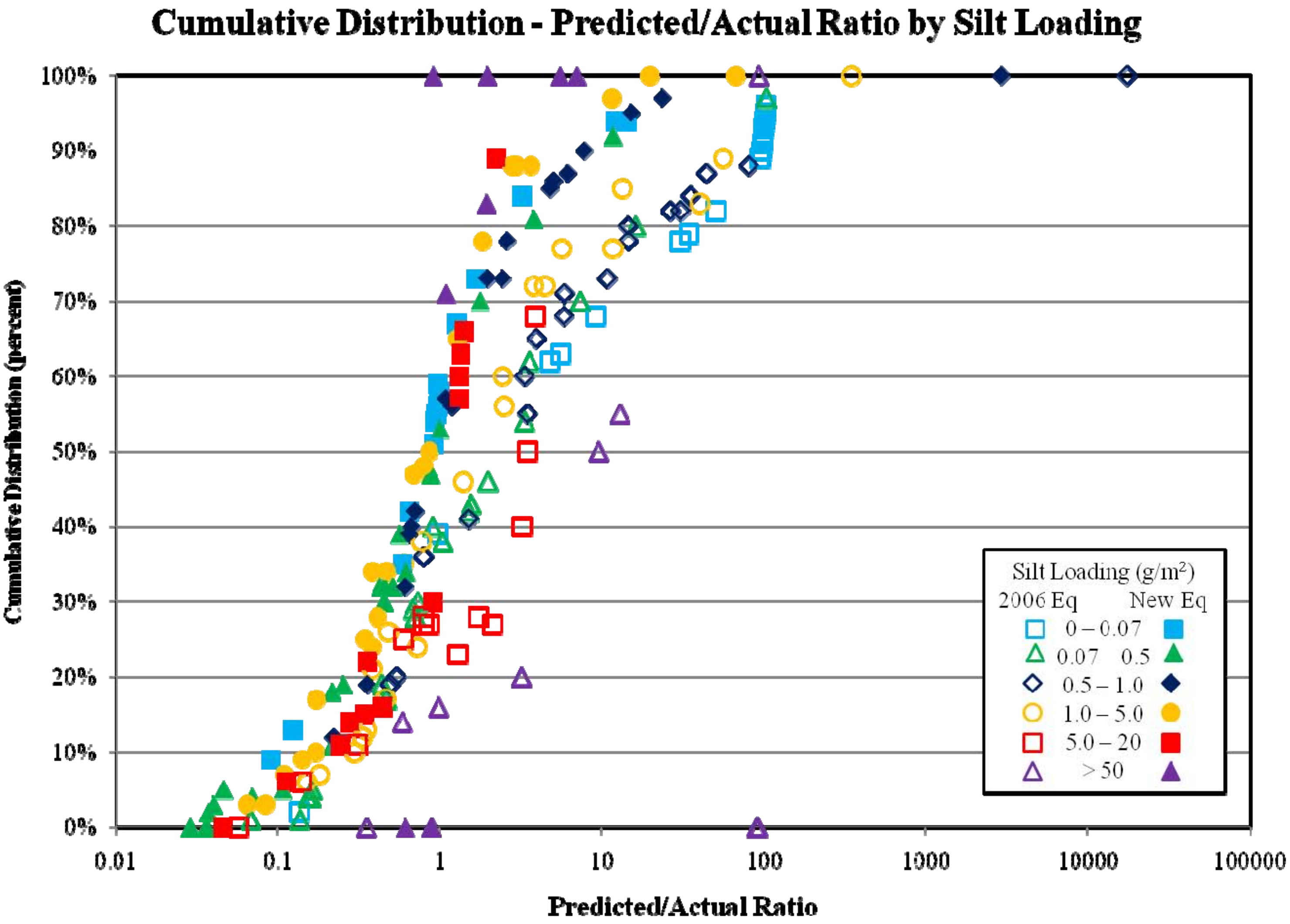

Figure 4-10. Cumulative Distribution – Predicted/Actual by Silt Loading.

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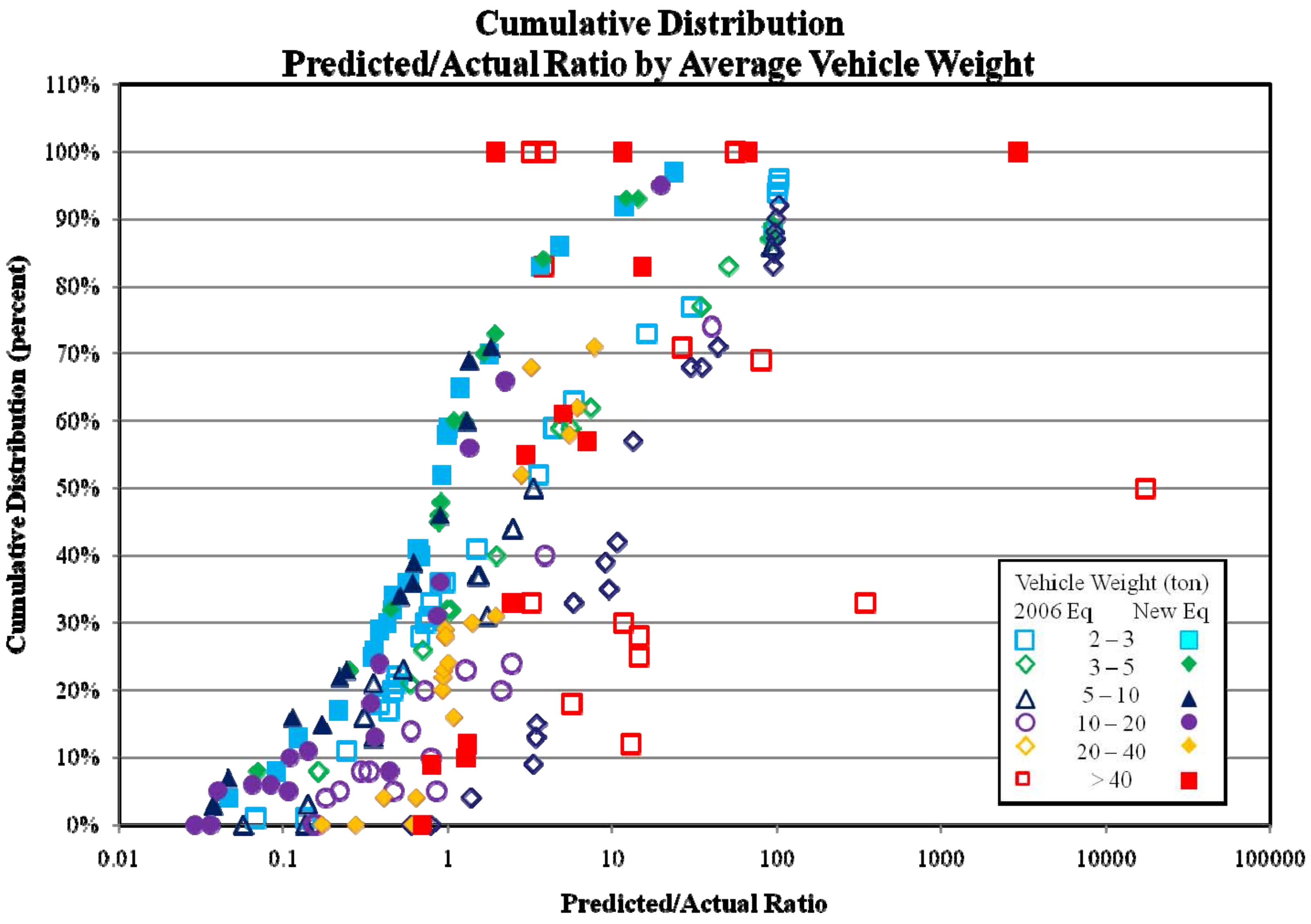

Figure 4-11. Cumulative Distribution – Predicted/Actual by Average Vehicle Weight.

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Figure 4-12 through Figure 4-9 provide graphical indications of the performance of the updated equation to estimate the actual emissions. The first figure shows the relationship of emissions to the road surface silt loading. Included in this figure is information on the average vehicle weight through the use of a different shape and color for different ranges of vehicle weight. While not shown, the previous equation had a greater spread than the new equations estimates. Figure 4-13 shows the influence of vehicle weight on the emissions factors. For all weight ranges, the spread of the data is much greater than is demonstrated in the figures with silt as the ordinate. Included in this figure is information on the silt loading associated with the test. One can see a general increase in emissions with silt loading. This is probably due to the greater correlation between silt loading and PM_{10} emissions factors than between average vehicle weight and PM_{10} emissions factors. Figure 4-9 shows the influence of speed on the emissions factors. As with vehicle weight, there is a greater spread of the emissions factor than when silt is the primary dependent variable graphed. One can also see a weak relationship between silt loading and average vehicle speed.

Table 4-20. Comparison of Previous and New Equations for Estimating Paved Road Dust Emissions.

	Predictive Performance of Paved Road Dust Emissions Equations					
	Average Relative Percent Difference [1]			Relative Standard Deviation		
	Old Equation vs Actual	New Equation vs Actual	Old Equation vs New Equation	Old Equation vs Actual	New Equation vs Actual	Old Equation vs New Equation
Population Average	31,378	3,142	-47	5.77	5.84	-1.2
By Classes of Silt Loading (g/m^2)						
≤ 0.2	33,601	3,858	-71	2.12	1.38	-0.62
0.2 – 0.75	102,647	17,049	-62	3.71	11.54	-0.35
0.75 – 1.5	3,236	669	-61	2.48	0.41	-0.46
1.5 – 50	221	47	-45	3.57	0.11	-0.46
≥ 50	248	253	73	1.81	0.27	1.20
By Classes of Average Weight (ton)						
2 - 3	467	333	40	2.09	0.43	-1.62
3 – 5	718	289	350	1.71	0.72	9.91
5 – 10	-2	-41	53	-394.3	0.37	-0.74
10 – 40	38,248	4,906	74,840	3.06	24.73	-0.18
≥ 40	128,217	21,549	68,550	4.27	112.84	-0.22
By Classes of Average Speed (mph)						
< 10	90,216	15,112	-79	4.30	20.67	-0.07
10 – 25	54,063	7,034	-6	2.17	4.94	-15.11
25 – 45	293	170	-41	2.41	0.139	-0.45
45	1,041	662	-34	1.28	0.198	-0.05
55	1,404	467	-114	1.57	0.114	-0.60

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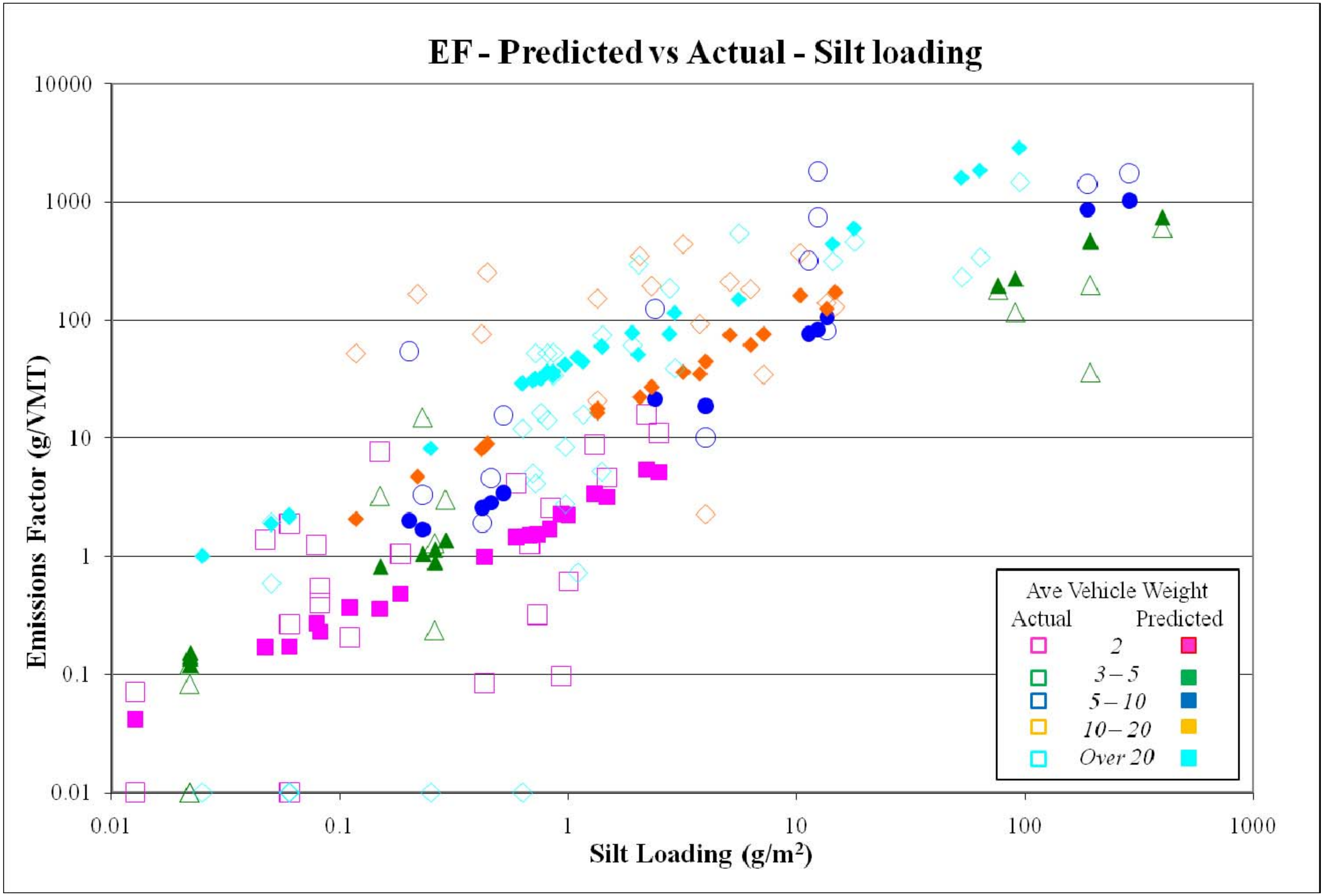

Figure 4-12. Predicted vs Actual PM_{10} Emissions Factor by Silt Loading.

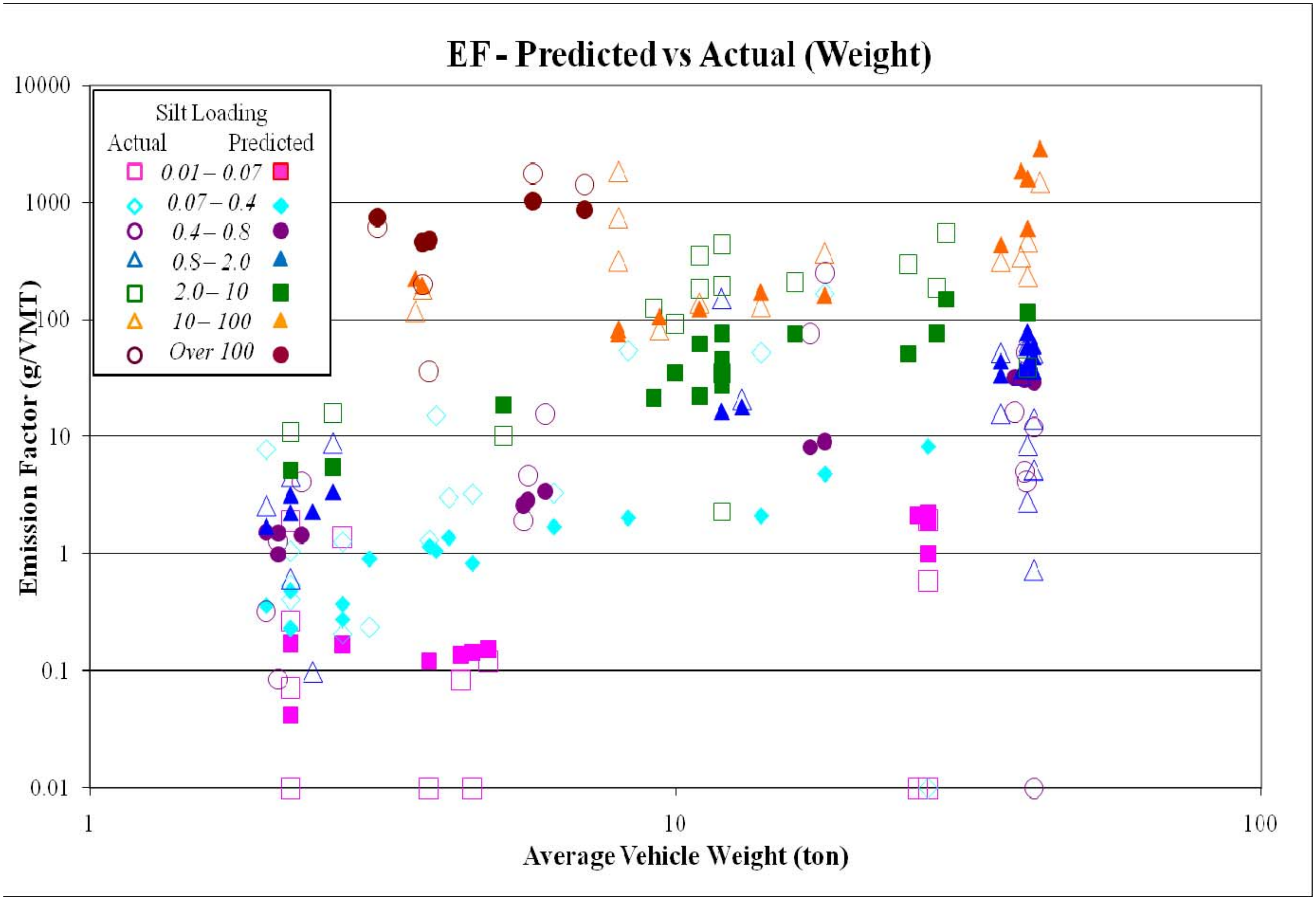

Figure 4-13. Predicted vs Actual PM_{10} Emissions Factor by Average Vehicle Weight.

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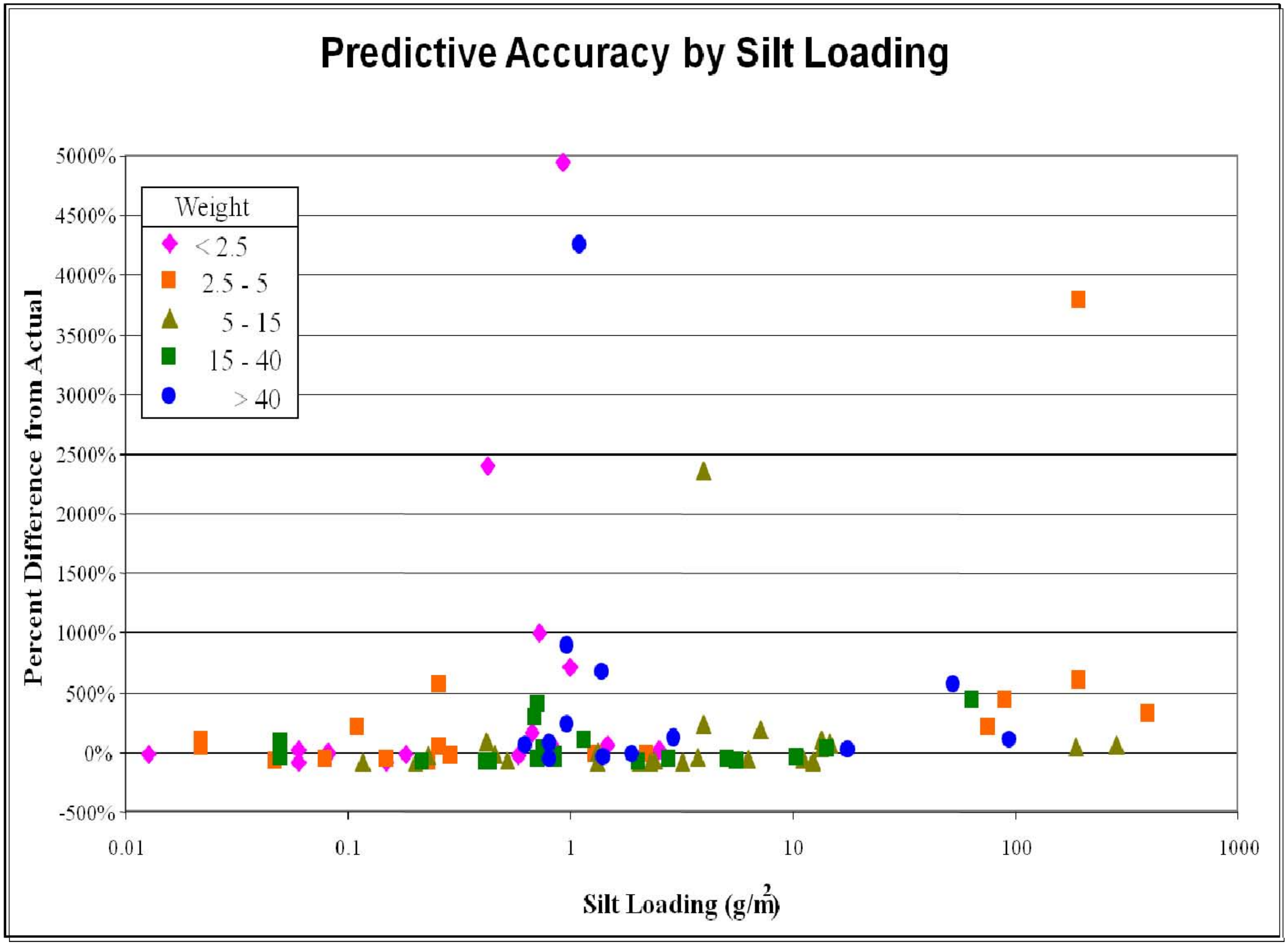

Figure 4-14. Predictive Accuracy by Silt Loading (unrestricted range).

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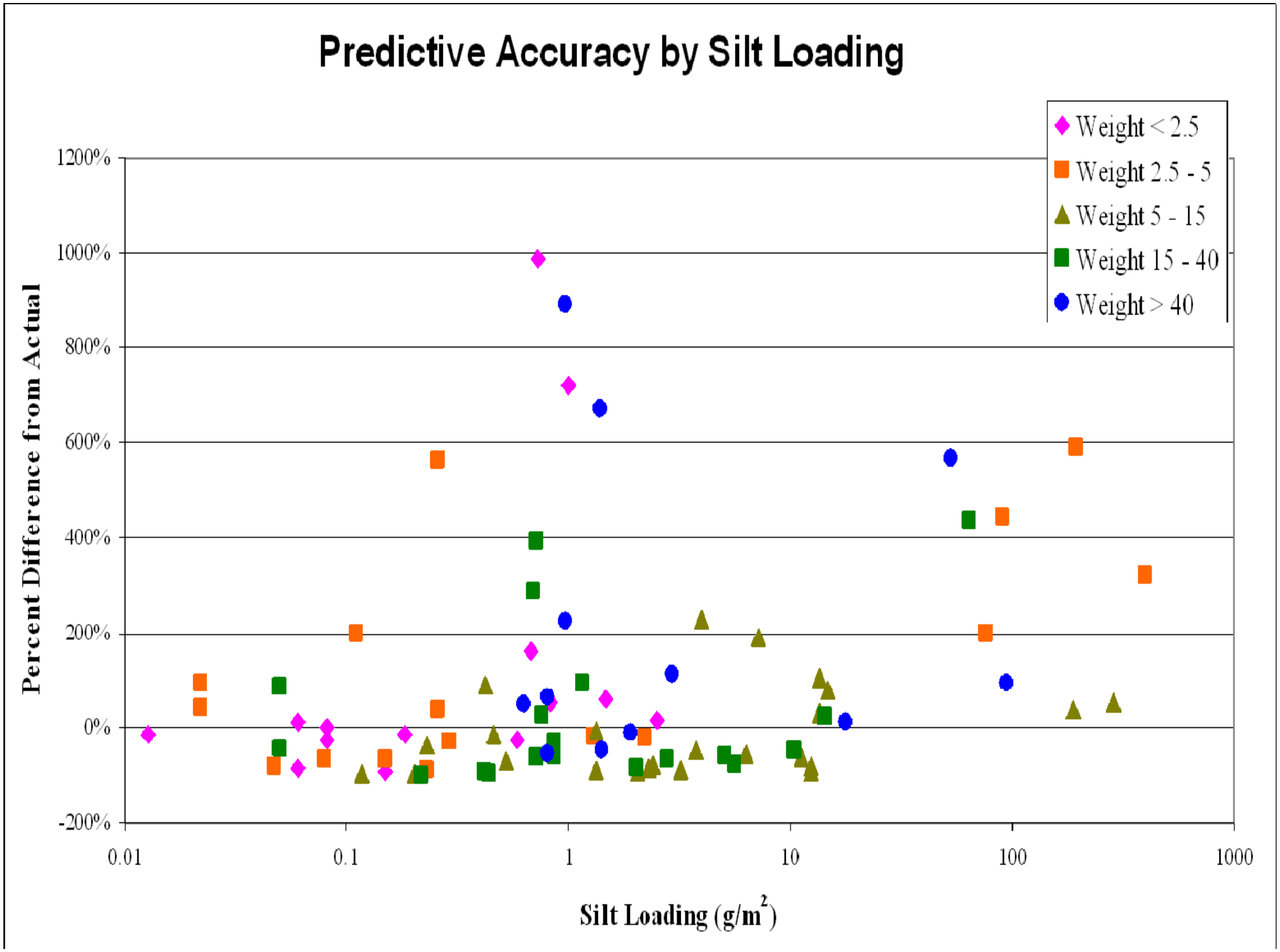

Figure 4-15. Predictive Accuracy by Silt Loading (restricted range).

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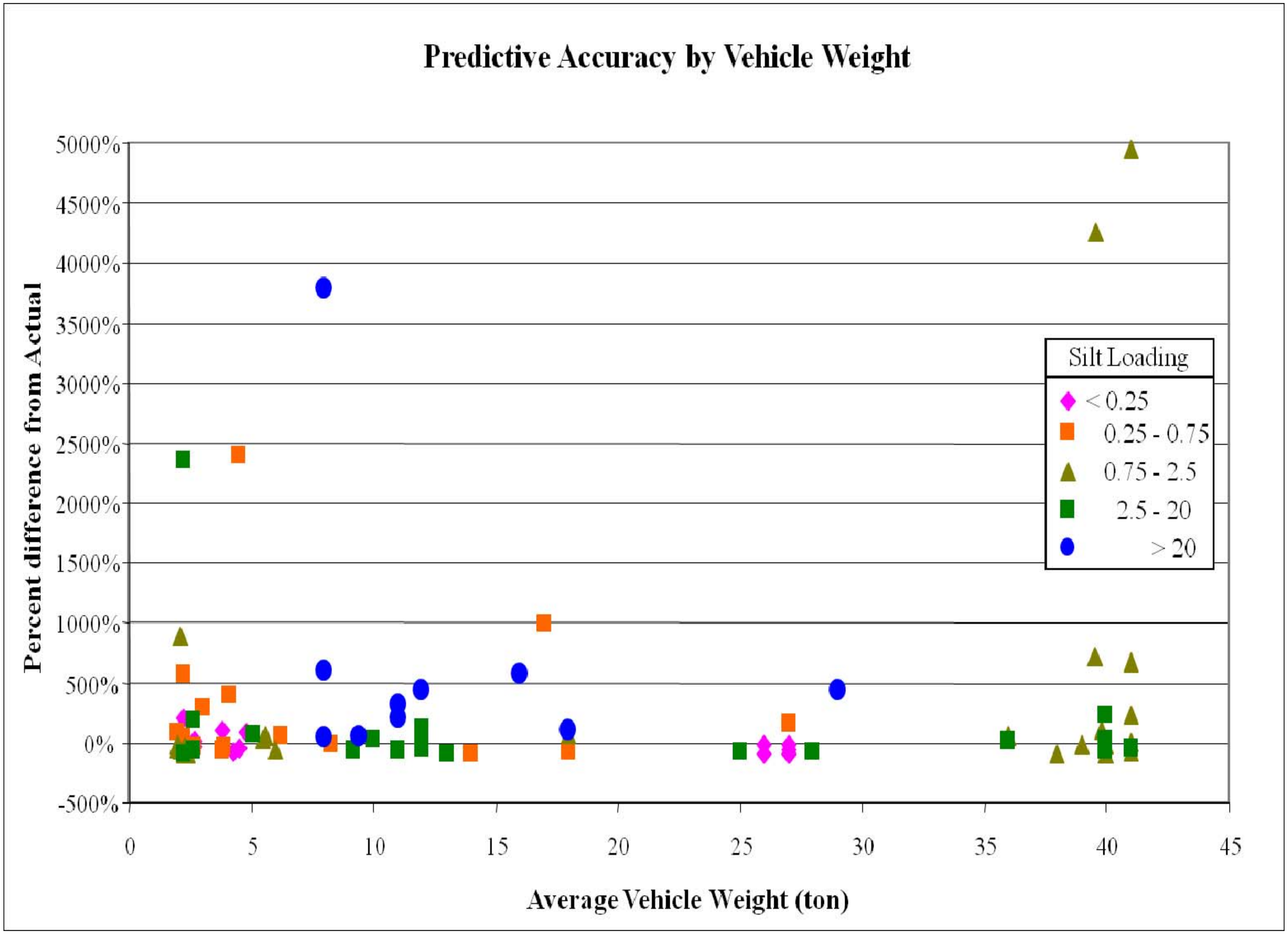

Figure 4-16. Predictive Accuracy by Average Vehicle Weight (unrestricted range).

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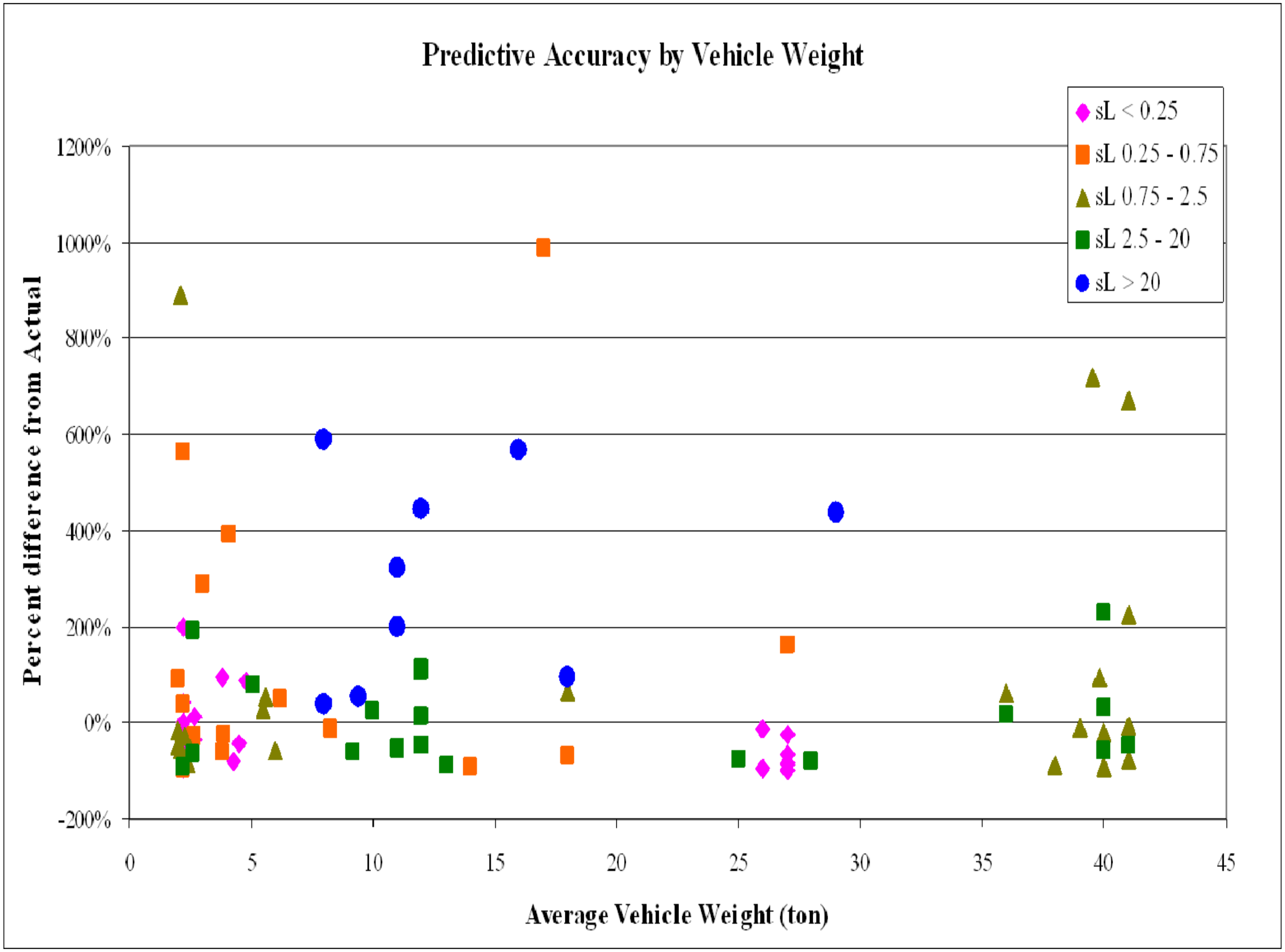

Figure 4-17. Predictive Accuracy by Average Vehicle Weight (restricted range).

4.2.2.3 Emissions Factor Quality Rating Assessment.

All of the source test data used to develop the emissions factor equation were rated A since the test procedures used were profiling tests and were all well documented. While only six reports are available that provide documentation of emissions factors for paved roads, these test reports contain the results of 17 different road conditions. The reports and the number of test conditions documented in the report are:

- USX 5/1990 - 2 tests (sL ~.3 & sL > 2),
- EPA 7/1984 - 2 tests (30 mph & 55 mph),
- EPA 1/1983 - 4 tests (<15 mph, >20 mph, W < 3 tons, W 5-8 tons, W > 30 tons),
- EPA 8/1983 - 2 tests for two parameter equation,
- EPA 4/97 - 3 tests (speed 55, 45), 3 locations, and
- CRA 5/2008 - 4 tests (4 locations, 2 speeds,)

However, since the EPA 8/1983 report does not contain information on the average speed of the vehicles in the study, none of the tests documented in that report is usable for further data set groupings. The remaining five reports contain the results of 15 different road conditions. While all of the tests were performed on paved roads, the ranges of conditions (silt loading, vehicle speed and vehicle weight) were diverse. An assessment of the variation associated with the data and the impact of that variation on a single value emissions factor. The average of all the adjusted emissions factors is 140 g/VMT and the standard deviation is 387. A relative standard deviation of 3 is greater than many other factors. As a result, the number of tests needed to achieve the predictive accuracy of the mean is greater. The availability of 15 A or B rated test reports would normally justify an initial assignment of a factor rating of B. However, the greater variability of the underlying data justifies a single value factor rating of C.

The stepwise regression of the available data indicated that a large portion of the variation of the emissions factor was due to the large range of the road silt loading that existed at the test locations. The preliminary regressions produced equations with varying constants and exponents with correlation coefficient below 60%. By excluding the high silt loading data and forcing a zero intercept, the correlation coefficient (R2) for the final equation is 72%. This indicates that approximately 72% of the variations in the emissions factors are due to the silt level and average vehicle weight. As a result of the improved ability of the equation to estimate the measured values over the single value emissions factor, a quality rating of B is assigned to the equation.

4.2.2.4 Assignment of equation parameters for PM_{30} and $PM_{2.5}$.

While several of the reports include measurements of $PM_{2.5}$, the WRAP studies suggest that many of these measurements are in error due to particle bounce issues with the impactor stages. The results of the WRAP study indicated that the $PM_{2.5}$ concentrations measured by the cyclone/impactor system were consistently biased by a factor of about 2 relative the $PM_{2.5}$ concentrations measured by the Partisol samplers. The second phase of the WRAP showed a tendency of the measured $PM_{2.5}$/ PM_{10} ratio to decrease with increasing

PM_{10} concentration. At PM_{10} concentrations above 1.0 mg/m3 the $PM_{2.5}$/ PM_{10} ratio was between 0.1 and 0.15. The $PM_{2.5}$/ PM_{10} ratio increased to about 0.35 as the PM_{10} concentration approached about 0.5 mg/m3. While some of the paved road test data encountered concentrations above 1.0 mg/m3 much of the test data consisted of measured concentrations below 0.5 mg/m3. The paved road emissions factor for $PM_{2.5}$ was revised to 15% of the calculated PM_{10} emissions factor in 2008. It is not clear whether the WRAP study assessed the PM_{10} concentrations measured during the paved roads testing prior to their recommendations for revising the $PM_{2.5}$ emissions factors. As shown in Table 4-17 the PM_{10} concentrations associated with 58 of the 71 test runs used to develop the three parameter emissions factor equation. Many of these test runs involve traffic volumes that would produce fairly constant particulate concentrations. Also, of these 58 test runs, only three runs were the highest PM_{10} concentrations greater than 0.5 mg/m3. An earlier report (Reference 5) measured $PM_{2.5}$/ PM_{10} ratios during field tests. The range of $PM_{2.5}$/ PM_{10} ratios was from 0.25 to 0.37. Since essentially all of the measured PM_{10} concentrations used for the stepwise regression were below 0.5 mg/m^3 and the ratios measured during field sampling of paved road emissions were between 0.25 and 0.37, the recommended $PM_{2.5}$ emissions factor is 25% of the PM_{10} emissions factor. Since there is little measured $PM_{2.5}$ data, an emissions factor quality rating of “D” is assigned.

While a stepwise regression could be performed to estimate the PM_{30} emissions factor equation, it is believed that the number of available data would be significantly less and a comparable confidence in the resulting equation could not be achieved. The ratio of PM_{30} to PM_{10} presented in the present AP-42 section is 5.2 and is proposed for the revised equation.

4.2.2.5. Assignment of a precipitation correction factor.

As is presented in Reference 38, a correction parameter for precipitation events was included in the revision of the AP-42 section in October 2002. As recommended in the Technical Memorandum to the files, the correction parameters are retained in this version of the AP-42 section.

4.3 DEVELOPMENT OF OTHER MATERIAL IN AP-42 SECTION

Concurrent with the development of the revised AP-42 section for paved roads, a separate effort was conducted to assemble a silt loading data base for nonindustrial roads. Over the past 10 years, numerous organizations have collected silt loading samples from public paved roads. Unfortunately, uniformity—in sampling and analysis methodology as well as roadway classification schemes—has been sorely lacking in these studies.

Silt loading data were compiled in the following manner. Persons knowledgeable about PM_{10} at each EPA regional office were asked to identify sL data for public roads. In many instances, the EPA representatives identified state/local air regulatory personnel who were then asked to supply the data. Given that the relative importance of PM_{10} emissions from public sources is greater in the western United States, it is not surprising that most of the data are from that area of the country. What is surprising, perhaps, is that Montana has collected roughly two- thirds of all data. Furthermore, only Montana had data collected from the same road over extended periods of time, thus permitting examination of temporal variation.

The assembled data set did not yield any readily identifiable, coherent relationship between silt loading and road class, average daily traffic (ADT), etc. Much of the difficulty is probably due to the fact that not all variables were reported by each organization. Further complicating the analysis is the fact that, in many parts of the country, paved road silt loading varies greatly over the course of the year. Recall that repeated sampling at Montana municipalities indicated a very noticeable annual cycle. Nevertheless, it is questionable whether the seasonal variation noted in the Montana data base could successfully predict variations for many other sites. While one could possibly expect similar variations for, say, Idaho or Wyoming roads, there is far less reason to suspect a similar cycle in, say, Maine or Michigan, in the absence of additional information.

Because no meaningful relationship could be established between sL and an independent variable, the decision was made to directly employ the nonindustrial data base in the AP-42 section. The draft AP-42 section presents the cumulative frequency distribution for the sL data base, with subdivisions into (a) low-ADT (< 5000 vehicles/day) and high-ADT roads and (b) first and second halves of the year. Suggested default values are based on the 50th and 90th percentile values.

The second use of the assembled data set recognizes that the end users of AP-42 are the most capable in identifying which roads in the data base are similar to roads of interest to them. The draft AP-42 section presents the paved road surface loading values together with the city, state, road name, collection date (samples collected from the same road during the same month are averaged), road ADT if reported, classification of the roadway, etc. Readers of AP-42 are invited to review the data base and to select values that they deem appropriate for the roads and seasons of interest.

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Appendix A

Response to Comments

Comments and responses on 2010 proposed revision of Section 13.2.1 Paved Roads.

Comments and Responses on June 2010 Draft Revision of AP-42 Section 13.2.1 for Paved Roads.

Chatten Cowherd of Midwest Research Institute on behalf of the Center for the Study of Open Source Emissions (CSOSE)

Comment: The general consensus among the Center for the Study of Open Source Emissions (CSOSE) participants who have worked in this field is that the proposed equation does not offer improved predictive capability but introduces additional data requirements to the paved road emission inventory process.

Response: We disagree that the proposed equation does not offer improved predictive capability. The predictive equation published in November 2006 produced negative PM_{10} emissions at very low silt loadings and negative $PM_{2.5}$ emissions estimates whenever a silt loading of less than 0.06 and average vehicle weight of 3.75 tons (or silt loading of 0.1 and vehicle weight of 3 tons). As presented in Table 4-23 of the draft background report, the 2006 equation had an average relative percent error of over 27,000 compared to the proposed equation with a relative percent error of 1,200. Part of the error imbedded in the 2006 equation is due to the use of the estimated 1980's fleet average vehicle emissions (average vehicle weight of 3.75 tons) for adjustment of the equation presented in the 2003 revision of the AP-42 section. This average underestimated the vehicle emissions of the fleets measured in almost 2/3 of the paved road emissions test (58 of the 93 tests had average vehicle weights over 5 tons). Since the proposed revision provided a correction to each test series based upon the average vehicle weight presented in the test report and the correction used in the final revision includes variations in speed, ambient temperature, year of vehicle fleet; this error has been reduced. Combining the reduction in error of the test data with the use of a more traditional revised stepwise regression of the paved road emissions data, we believe the revised equation will provide a superior basis than the 2006 equation.

Comment: There is also the broader issue of adopting mobile monitoring as the basis for more realistic emission inventorying of paved roads.

Response: EPA agrees that the adoption of mobile monitoring to estimate either the silt loading of the road system or the emissions factor provides a significant advance in characterizing the system wide emissions and the variation that exists with different roads. The use of mobile monitoring offers the ability to characterize road classes which have been problematic in the past due to resource constraints and safety issues. The ability of mobile monitoring to provide a temporally and spatially resolved emissions estimates and to characterize significantly more miles of roadways than were possible by the traditional vacuuming, screening and weighing techniques is a distinct advantage. In addition, the mobile monitoring method provides an excellent means for tracking system wide management controls instituted to provide emissions reductions from roadway emissions.

NMED EIB Rebuttal Exhibit 7

In the final version of the AP-42 section we describe the mobile monitoring technique along with a brief assessment that mobile monitoring provides significant improvements in the estimation of road dust emissions caused by vehicle traffic.

Comment: The proposed equation has a significant new data input requirement (vehicle speed) that increases the difficulty of generating paved road emission inventories.

Response: We disagree; access to the average vehicle speed of road segments is an existing requirement for the accurate estimation of vehicle exhaust emissions in the MOVES model. While the incorporation of the vehicle speed for every road segment may increase the complexity of emissions inventory development, for most road systems emissions estimates can be assembled by grouping of road segments into a limited number of groups.

The assessment of the influence of the speed term on the predictive accuracy of the resulting equation is a better criterion to determine whether this term should be used in the equation. Limited improvement (or degradation) in the predictive accuracy of the equation provides a more compelling rationale to exclude the speed term in the final equation than the alleged difficulty of generating the emissions inventory. The reassessment of the form of the emissions factor equation included the assessment of the influence of speed on the predictive accuracy of the equation, the improvement of the equation to address the variance which may be due to the independent parameters, and the statistical significance of each variable in predicting the dependent variable.

Comment: Based on our discussions of the proposed equation and the technical analyses presented by EPA, we find the scientific foundation for the revision unconvincing.

Response: The foundation upon which EPA proposed a revision of the paved road equation was a proposal by the Corn Refiners Association (CRA) to perform emissions tests to support the extension of the applicable source conditions. The Corn Refiners retained the services of Midwest Research Institute (MRI) in Kansas City to perform the emissions testing at lower average vehicle speeds to support the extension of the applicable source conditions. Twenty two usable profiling tests were performed. In addition to designing and conducting the emissions tests, MRI provided EPA with three options for incorporating the new data into the paved roads section. The Agency decided that returning to multiple estimation methods would recreate the problems that existed prior to 1995 when there was two AP-42 sections for paved roads and multiple methods within these two sections.

When MRI drafted the AP-42 section that included the CRA data, it was highlighted by the Office of Transportation and Air Quality (OTAQ) that the proposal and adoption of a revised equation had conformity implications that needed to be addressed. Several issues associated with conformity were raised. These included the situation that areas containing low volume rural roads were predicted to have greater emissions of PM_{10} than the previous equation predicted. Another situation was that the revised equation may result in greater predicted emissions of $PM_{2.5}$ under some conditions. The greater predicted emissions were the result of the existing equation generating negative emissions for high volume roads. In an assessment to understand the extent and significance of these issues, it was revealed that the vehicle exhaust, tire wear and break wear emissions components were not addressed properly. The estimates of vehicle exhaust, tire wear and break wear used in the 2003 revision did not account for the significant differences in these emissions during the available tests and in addition significantly mis characterized for the additional data provided by the corn refiners. For the historical data, the proposed revision incorporated test specific emissions estimates as calculated by MOBIL 6.2 and based upon the average vehicle weight reported for each test. For the CRA data, the proposed revision incorporated test specific emissions estimates as calculated by the MOVES model and based upon the average vehicle weight, vehicle speed and estimated acceleration rates. For consistency and for improved accuracy in predicting vehicle exhaust emissions, MOVES model estimates were calculated for the historical data. While the incorporation of the data provided by the Corn Refiners Association extended the capabilities of the equation to 1 mph, the Corn Refiners Association data highlighted the variable significance of exhaust emissions and the need to address these emission on a test by test basis. An additional advantage of determining road emissions prior to developing the road emissions equation is that the equation never predicted negative PM_{10} or $PM_{2.5}$ emissions.

Comment: Besides the problems stated above, we find difficulty in understanding the scientific basis for replacing the existing $PM_{2.5}/PM_{10}$ ratio published in 2006 with the ratio that was previously used by EPA. The ratio in the existing equation was accepted by EPA as an outcome of an experimental program supported by the Western Regional Air Partnership (WRAP).

Response: In evaluating the data underlying the equation proposed in this revision, all of the data were assessed to understand the basis and representativeness of the data. The WRAP laboratory study was evaluated and was found to focus primarily on categories of emissions that would generate very large concentrations of dust emissions and focused primarily on western sources of these emissions. These types of emissions sources have a high probability of overloading air sampling devices that depend on impaction to collect particles of differing sizes. These sources are also predominately dominated by sources where the emissions may have large variations over time depending on the repetition rate of the activity which generates the emissions. Paved roads, especially those with high traffic volumes and those that have neared their normal aged equilibrium state generate dust emissions of greater consistency in concentration and particle size characteristics. Not only are these emissions more consistent, the emissions concentrations are much lower except when the roads silt loading is very high. These high silt loadings are not typical of public roads except for periods where sand is applied as anti skid material, natural forces exacerbate the normal soil loading on the road or in areas where there is a large track out of dirt from an adjacent unpaved area.

The WRAP study included the collection of seven soil samples. The samples included sediment from Alaska, Alluvial Channel from Phoenix AZ, Agricultural Soil from Phoenix AZ, Road Dust from the Las Cruces Landfill in New Mexico, Grazing Soil from Radium Springs in New Mexico, Shoreline Soils from the Salton Sea in California and a Barrow Pit from Thunder Basin Mine in Wyoming. In addition, three additional samples which were used in the first Phase of the study were also used in the second Phase of the study. These three samples included a Standard fine Arizona Test dust, a Standard coarse Arizona Test dust and Lakebed Soil from Owens Dry Lake in California. For each of these samples, the WRAP study states that two five gallon containers of soil were collected. To collect this volume of sample from paved roads which are in equilibrium would require sweeping or vacuuming of multiple miles of roadway. Additionally, none of these samples are representative of aged material deposited on paved roads except for paved roads which have had anti-skid abrasives (such as sand) applied during winter or where significant windblown dust or track out dirt is deposited on paved roads.

Most of the laboratory tests performed to assess the revised $PM_{10}/PM_{2.5}$ ratio to assign to historical data was conducted at PM_{10} concentrations above 2.5 mg/m^3. The greatest downwind concentration measured in tests used to support the paved road equation development was 0.74 mg/m^3 in run ID F45. Of the tests conducted in the wind tunnel laboratory, only 15 percent of the samples were performed at concentrations below 0.74 mg/m^3. The lowest PM_{10} concentration measured during the laboratory study was 0.381 mg/m^3. Of the 80 profiling tests used to support the paved road emissions factor equation and where the downwind concentrations were available, only five had concentrations greater than 0.358 mg/m^3. In addition, over 80% of the profiling tests had downwind concentrations less than 0.2 mg/m^3 and 60% had downwind concentrations less than 0.1 mg/m^3. In the wind tunnel laboratory studies, the only particulate used to challenge the sampling devices was the material collected for the studies. The emissions measured during the paved road profiling tests was a combination of emissions from the road surface, engine exhaust, break wear and tire wear emissions. As presented in Table 4-17 of the draft background document, vehicle emissions can be a significant component of the emissions measured by the profiling samplers. In three cases, the estimated exhaust, break wear and tire wear emissions exceed the measured emissions and were assigned an emissions factor of 0.01 g/VMT (see test runs M10, M12 and CF-3N). In an additional 10% of the profiling tests, about half of the measured emissions were estimated to be exhaust break wear and tire wear emissions. And in approximately 35% of the profiling tests, the measured emissions were more than 10% exhaust; break wear and tire wear emissions.

Based upon a more careful and thorough examination of the experimental design of the WRAP study and the profile measurements conducted to characterize paved road emissions it is concluded that EPA mistakenly accepted the conclusion that the $PM_{2.5}$ to PM_{10} ratio for paved roads should be estimated at 15%. While the WRAP study provides a reasonable indicator that past measurements of the particle size distributions below 10 µm are unreliable due to particle bounce and re-entrainment associated with impactors, it does not discredit $PM_{2.5}$ to PM_{10} ratios established by field studies which used FRM or equivalent monitors for measuring $PM_{2.5}$ to PM_{10} concentrations. While there were only twelve test runs conducted during the profiling tests documented in the April 15, 1997 report by MRI for EPA, the $PM_{2.5}$ to PM_{10} ratios determined at these three locations provide a superior estimate of a national ratio for estimating $PM_{2.5}$ emissions than an extrapolation from the WRAP laboratory study.

Rebecca Kies and Courtney Bokenkroger Senior Statistician of Midwest Research Institute, Kansas City, MO.

Comment: The approach used by EPA to calculate the proposed paved road equation differs from standard least-squares regression procedures. MRI recommends that ordinary least squares regression procedures be used.

Response: EPA used the non standard approach in an attempt to provide an improved predictor of emissions than the exponential form traditionally used for this section. In the traditional form of regressing the equation, the log transformed data would be regressed and include an intercept. Then when returned to normal space, the inverse log of the intercept constant would be the multiplier for the silt and weight terms. The regression terms for silt and weight would then be the exponents for those terms in the final equation. More sophisticated statistical software and individuals with more thorough knowledge in the application of stepwise non linear regression were not available at the time but were used in the equation development for the published final section. EPA used SAS which is more robust statistical software than Excel for developing the equation used in the final AP-42 section. With guidance from the statistician, EPA used Excel to explore limited alternative forms of the equation that could potentially provide an equation with better predictive accuracy. EPA assessed the influence of test data that potentially would adversely influence the resulting equation and assessed the use of composite factors in an attempt to alleviate the additional problems identified by MRI's statisticians. These assessments led EPA to exclude ten test data where the silt loadings were greater than 20 g/m^2 and to exclude test data where field measurements could not quantify emissions due to traffic on the road. Additional regression methods available in

SAS were evaluated following the exploratory assessment within Excel. The equation which had the best predictive accuracy was based upon the traditional least squares regression of the log transformed data with the intercept forced to zero.

Comment: Additional concerns about gaps in the range of data surfaced during our statistical analysis. Notice the major holes highlighted by the circles in the speed-silt loading and speed-weight boxes. The dataset is missing low silt loading, low speed; low silt loading, high speed data; and low weight, low speed data. Ideally, the boxes relating silt loading, weight, and speed should be completely filled with data points in order to cover all ranges of possible occurrences and consider them to be independent factors in the model.

Response: It is recognized that there are gaps in the data. In most cases, the contractor performing the study (MRI in all cases) and the studies sponsor (EPA, industry) was interested only in un-managed road systems at the test location. In some of these instances, the condition highlighted would not be expected due to the physical forces influencing the independent variables. For example, low silt loading would not be a normal condition when the average vehicle speeds are low since the aerodynamic energy imparted on the road surface would not be great enough to move the silt to the road shoulder. This situation of low silt loading and low average speed may be a possibility should there be active management of the silt loading on the road. Either the active management of the road silt loading lacks the frequency to achieve lower silt loadings or there was not a need to achieve these lower silt loadings. In other cases, the data may be missing due to safety concerns associated with the collection of one or more pieces of information. For example, the collection of data at roads with high speed and low silt loading requires extensive time to collect sufficient material to quantify the low silt loading. Should resources become available in the future improving the emissions factor for paved roads, the collection of test data to fill in these data gaps will be suggested. In addition, mobile monitoring methods may be a viable alternative to the vacuuming of roads to estimate the silt loading of roads where there are safety concerns.

Comment: It is recommended that different modeling options be explored to find the best fit and set of predictors for the data provided. Two such options are:

- Look at low speed and high speed models separately, potentially excluding vehicle speeds under 5 mph from equation development.
- Use a composite factor of weight and speed together with either weight or speed as independent variables in the regression. This helps alleviate the problems due to multicollinearity between weight and speed seen in these data.

Response: EPA assessed different modeling options to find a best fit. A return to multiple sets of equations or values as predictors which introduce multiple results for similar independent variables has been shown to create confusion, "results in shopping for a fortuitous estimate" and adversarial debates. Any set of predictors should have nearly identical results for comparable independent parameters where there multiple predictors could be used.

EPA evaluated the exclusion of atypical independent parameter conditions such as the very low speed conditions. Other conditions that were evaluated were very high silt loading conditions. It was decided to exclude emissions tests with silt loading levels over 20 g/m^2 due to the potential complexity of an equation needed to incorporate the different characteristics that these few data present. While these high silt loadings may have been representative of conditions which would be tolerated by the sources (or regulatory authorities) in the mid to early 1980's, they are unusual conditions and may not be reasonable to use in developing or assessing the best predictor for the more representative and dominant situations. It is believed that management practices would be implemented by sources and regulatory authorities to address extended durations of high silt loading conditions. Additionally, an assessment of the final equations ability to estimate the emissions of the ten tests with high silt loading. While there were changes in the percent difference from actual emissions for individual test runs, the average percent difference from actual emissions was almost the same as the 2006 equation.

Greg Muleski of Midwest Research Institute

Comment: The measured emission factor for CM-2 should be "63.5" rather than "6.35" so the independent variable in Table 4-17 should have been about 52 g/vmt (rather than the default value of 0.02 g/vmt).

Response: The measured PM_{10} emissions factor in Table 4-15 was checked against the value reported in the test report. The value of 0.14 lb/VMT in the table was consistent with the value in the submitted test report. As indicated in the comment, there was an error in transcribing or units conversion to transfer the value from Table 4-15 to Table 4-17. The emissions factor for the Corn Refiners Association test numbered CM-2 was revised from 6.35 grams/VMT to 63.5 grams/VMT in Table 4-17. As a result, the subtraction of the estimated vehicle exhaust, tire wear and break wear resulted in Road Dust Emissions of 52.44 grams/VMT rather than 0.02 grams/VMT.

Comment: The two-step regression process described in Section 4.2.2.2 differs from standard stepwise multiple regression used in the past AP-42 updates. It is not clear how R-squared values at each step can be combined to obtain a meaningful value.

Response: As indicated by several comments from individuals at MRI, the multi-step regression used by EPA does not conform to traditional stepwise multiple regression techniques. More traditional techniques were used in the development of the equation used in the final section and SAS (which is more robust software for statistical analysis) was employed to assess the predictive accuracy of the final equation.

Comment: The high degree of correlation between speed and weight precludes both being included as independent terms in the emission factor equation.

Response: It was believed that the large number of tests where the road surface silt loading was artificially changed through either the addition of sand or through removal with mechanical means altered the normal correlation between the vehicle speed and the road silt loading. With the use of more robust statistical software, the presence of inter correlation between speed and silt loading was re assessed. In addition, the more robust software allows a better determination of the potential improvement of an equation which includes speed to predict road dust emissions. This assessment revealed that the use of the speed term was contraindicated and the final equation contains only silt loading and average vehicle weight as independent variables.

Comment: The goal should be to develop a predictive tool for situations without measured emissions rather than trying to get the best fit for the set of measured emissions.

Response: The use of Excel to generate the predictive equation made an evaluation of the capability for the equation to predict data that was not part of the existing data set difficult and labor intensive. The use of SAS allows for a more reliable assessment of the equations predictive capabilities.

Comment: The geometric mean is the better choice than the arithmetic average when working with the predicted/observed ratios.

Response: It is assumed that the use of the geometric mean is a metric to evaluate the predictive accuracy of the equation through the use of the average predicted to observed values. With the use of SAS, several indicators of the predictive capabilities of the resulting equation were evaluated.

Comment: The document would have benefitted from a thorough review/edit prior to being posted on the CHIEF web site.

Response: Prior to posting the final background report, the AP-42 Section and background report was reviewed and edited more thoroughly and the Table of contents was updated to provide an accurate indication of the contents of the chapters.

Comments and Responses on June 2010 Draft Revision of AP-42 Section 13.2.1 for Paved Roads.

Camille Sears for the Sierra Club

Comment: I have a few concerns regarding USEPA's proposed revision to AP-42 Section 13.2.1:

- USEPA's multiple regression analysis incorporating vehicle speed excludes a valuable data set for assessing paved road PM emissions from industrial facilities.
- USEPA's proposed revision to AP-42 Section 13.2.1 results in a very significant reduction in PM_{10} and $PM_{2.5}$ emission factors from paved roads in industrial settings.
- It is unclear whether USEPA's proposed revision to AP-42 Section 13.2.1 improves upon predictive performance of the existing 2006 emission factor.

Response: The performance of the multiple stepwise regression of the data recognized that incorporation of the speed term involved the exclusion of 22 test runs. EPA recognized that the exclusion of these data could affect the resulting equation and decided to include the speed term since the correlation coefficient showed a modest improvement. Another commenter indicated that there are better software and process available than were used by EPA to develop the equation. EPA employed software more suited for stepwise multiple nonlinear regression than Microsoft Excel in the final equation development. EPA used this improved software for a more rigorous assessment of the influence of incorporating the speed term in the equation in this reassessment. (In EPA's reassessment, it was revealed that the speed term provided no improvement in the predictive accuracy of the resulting equation. As a result, the equation published in the final AP-42 section includes only silt loading and average vehicle weight).

While EPA is cognizant of potential impact of any changes that may result in revising the emissions factors in AP-42, the primary goal of emissions factors development is to provide factors that provide as accurate of a prediction of the target population as possible. The underlying data has considerable variation even when several of the independent parameters are nearly identical. With the increased number of independent parameters, it is possible that some situations where emissions will be greater than the previous equation and some where emissions will be less.

While there may be some situations where the predictive performance of the proposed equation performed poorer at predicting the underlying data, there were others where the predictive performance was improved. Several measures were used to assess the predictive performance of the revised equation and the final equation performs better than the previous equation.

Comment: USEPA excluded 22 tests performed at two integrated iron and steel plants due to lack of vehicular speed data. These iron and steel plant source tests are crucial for calculating fugitive dust emissions from industrial facilities, and excluding these data has a very significant impact on predicted paved road emission rates. As discussed in the following section, USEPA's proposed revision to the paved road emission factor will reduce particulate emission calculations at typical industrial sites by roughly an order of magnitude. This large, and perhaps unrealistic, reduction in calculated industrial paved road emissions is an artifact of trying to develop an emission factor based on tests that must include vehicle speed data.

Response: The exclusion of the 22 tests performed at iron and steel facilities did not significantly bias the equation. An evaluation of the predictive precision of the equation in the November 2006 version of the AP-42 Section for Paved Roads reveals that on average the equation over predicted the 92 individual data by over 11,000%. While approximately 50% of the predicted estimates underestimated the measured emissions and 50% overestimated emissions, overestimates were significantly greater than the underestimates. The 25 percentile value underestimated actual emissions by 54% while the 75 percentile value overestimated actual emissions by 713%. The equation using only silt loading and average vehicle weight which was rejected for the equation that included speed overestimates actual emissions by 1,429%. The equation that was proposed and includes the speed term overestimates actual emissions by only 890%. For both the previously published equation and the proposed equation, the majority of the overestimation appears to be associated with the lowest speeds, silt loading in the middle third of the data and in the highest average vehicle weights. In these categories, it appears that the previously published equation overestimates emissions more than the proposed equation. With respect to roads with greater average vehicle weights such as may be present at industrial facilities, the equation in the November 2006 AP-42 section tended to overestimate emissions more than the proposed equation. Table 1 below presents the independent parameter variables, estimated measured emissions, predicted emissions by the 2006 AP-42 equation, the equation considered in the proposal that includes only silt loading and average vehicle weight and the equation proposed that includes silt loading, average vehicle weight and speed (with an average speed of 35 mph assigned for unrecorded speeds). For those test conditions where average vehicle weight was greater than 8 tons, the 2006 AP-42 equation tended to overestimate actual emissions factors by about 350%. The equation that considered only silt loading and average vehicle weight tended to overestimate actual emissions factors by about 3%. The equation that considered silt loading, average vehicle weight and speed tended to underestimate actual emissions factors by about 12%. A comparison between the equation proposed for use and the equation that was considered but did not include the speed term shows that the exclusion of the 22 test data that were missing the average speed did not adversely affect the average predictive capabilities of the equation. As stated elsewhere, a more rigorous and capable statistical software package was used to develop the final equation used in the AP-42 section.

For the equation published in the 2011 final AP-42 section, the predictive accuracy is slightly improved over the equation proposed in the draft AP-42 section. As presented in Table 2, the equation published in the final section provides a moderately better or worse predictor of actual emissions for a few tests, but does not provide a significantly different accuracy that the equation in the draft AP-42 section. While the equation presented in the AP-42 section published in 2006 overestimates actual emissions factors by 350%, the equation presented in the final 2011 section overestimates actual emissions by an average of 77%.

Comments and Responses on June 2010 Draft Revision of AP-42 Section 13.2.1 for Paved Roads.

Table 1. Performance of 2006 AP-42 equation and equations considered for 2010 draft section revision.

					Predicted Emissions (g/VMT)			Percent difference from Measured		
ID #	Silt Loading	Average Speed	Average Weight	Measured EF (g/VMT)	Old AP-42 (sL, W)	Rejected Proposal (sL, W)	Proposed (sL, W, s)	Old AP-42 (sL, W)	Rejected Proposal (sL, W)	Proposed (sL, W, s)
AD1	94.8	23	42	1478.189	4696.25	1575.71	1156.43	218%	7%	-22%
F61	17.9	NR	40	461.174	1476.91	325.20	235.28	220%	-29%	-49%
AD3	52.9	23	40	231.189	2987.29	881.27	636.21	1192%	281%	175%
AD2	63.6	23	39	340.807	3241.81	1020.25	751.93	853%	200%	121%
F62	14.4	NR	36	315.177	1094.65	241.87	179.78	247%	-23%	-43%
F74	5.59	NR	29	543.498	427.73	83.19	63.42	-21%	-85%	-88%
F34	2.78	NR	28	186.561	257.62	42.37	31.39	38%	-77%	-83%
CI-7	0.05	15.3	27	0.589	17.71	1.02	0.53	2907%	73%	-11%
CI-8	0.05	15.3	27	1.949	17.71	1.02	0.53	809%	-48%	-73%
F35	2.03	NR	25	296.721	177.11	28.62	21.73	-40%	-90%	-93%
F38	0.218	NR	18	165.766	25.19	2.73	2.05	-85%	-98%	-99%
F39	0.441	NR	18	251.766	39.95	5.21	4.09	-84%	-98%	-98%
B58	10.4	NR	18	366.778	313.08	95.42	90.51	-15%	-74%	-75%
F37	0.417	NR	17	76.038	35.33	4.70	3.76	-54%	-94%	-95%
F45	5.11	NR	16	210.911	165.22	44.58	42.38	-22%	-79%	-80%
F32	0.117	NR	14	52.170	11.42	1.22	0.98	-78%	-98%	-98%
F27	14.8	NR	14	129.070	270.08	105.02	111.94	109%	-19%	-13%
B57	2.32	NR	12	194.216	64.10	16.59	16.78	-67%	-91%	-91%
B60	3.19	NR	12	438.216	78.89	22.24	22.93	-82%	-95%	-95%
B52	7.19	NR	12	34.616	133.95	46.98	50.85	287%	36%	47%
AUE1	4	15	12	2.286	91.43	27.39	24.99	3900%	1098%	993%
B59	2.06	NR	11	347.289	52.04	13.74	14.26	-85%	-96%	-96%
B55	6.3	NR	11	182.289	107.84	38.43	42.66	-41%	-79%	-77%
B51	13.6	NR	11	139.289	177.97	78.02	90.68	28%	-44%	-35%
B54	3.77	NR	10	92.662	66.87	21.97	24.52	-28%	-76%	-74%
B50	13.6	NR	9.4	81.506	140.54	67.62	83.43	72%	-17%	2%
B56	2.4	NR	9.2	125.421	43.92	13.44	15.07	-65%	-89%	-88%
F36	0.201	NR	8.3	54.168	7.33	1.25	1.26	-86%	-98%	-98%
							Average	358%	3%	-12%

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Table 2. Performance of 2006 AP-42 equation, equation proposed in 2010 draft section and Final 2010 section.

					Predicted Emissions (g/VMT)			Percent difference from Measured		
ID #	Silt Loading	Average Speed	Average Weight	Measured EF (g/VMT)	Old AP-42 (sL, W)	Proposed (sL, W, s)	Final (sL, W)	Old AP-42 (sL, W)	Proposed (sL, W. s)	Final (sL, W)
AD1	94.8	23	42	1478.189	4696.25	1156.43	2886.277	218%	-22%	95%
F61	17.9	NR	40	461.174	1476.91	235.28	600.570	220%	-49%	30%
AD3	52.9	23	40	231.189	2987.29	636.21	1613.169	1192%	175%	598%
AD2	63.6	23	39	340.807	3241.81	751.93	1859.513	853%	121%	447%
F62	14.4	NR	36	315.177	1094.65	179.78	442.254	247%	-43%	40%
F74	5.59	NR	29	543.498	427.73	63.42	149.639	-21%	-88%	-72%
F34	2.78	NR	28	186.561	257.62	31.39	76.359	38%	-83%	-59%
CI-7	0.05	15.3	27	0.589	17.71	0.53	1.886	2907%	-11%	220%
CI-8	0.05	15.3	27	1.949	17.71	0.53	1.886	809%	-73%	-3%
F35	2.03	NR	25	296.721	177.11	21.73	51.060	-40%	-93%	-83%
F38	0.218	NR	18	165.766	25.19	2.05	4.773	-85%	-99%	-97%
F39	0.441	NR	18	251.766	39.95	4.09	9.073	-84%	-98%	-96%
B58	10.4	NR	18	366.778	313.08	90.51	161.994	-15%	-75%	-56%
F37	0.417	NR	17	76.038	35.33	3.76	8.133	-54%	-95%	-89%
F45	5.11	NR	16	210.911	165.22	42.38	75.113	-22%	-80%	-64%
F32	0.117	NR	14	52.170	11.42	0.98	2.093	-78%	-98%	-96%
F27	14.8	NR	14	129.070	270.08	111.94	172.829	109%	-13%	34%
B57	2.32	NR	12	194.216	64.10	16.78	27.253	-67%	-91%	-86%
B60	3.19	NR	12	438.216	78.89	22.93	36.436	-82%	-95%	-92%
B52	7.19	NR	12	34.616	133.95	50.85	76.446	287%	47%	121%
AUE1	4	15	12	2.286	91.43	24.99	44.785	3900%	993%	1859%
B59	2.06	NR	11	347.289	52.04	14.26	22.375	-85%	-96%	-94%
B55	6.3	NR	11	182.289	107.84	42.66	62.006	-41%	-77%	-66%
B51	13.6	NR	11	139.289	177.97	90.68	125.074	28%	-35%	-10%
B54	3.77	NR	10	92.662	66.87	24.52	35.222	-28%	-74%	-62%
B50	13.6	NR	9.4	81.506	140.54	83.43	106.525	72%	2%	31%
B56	2.4	NR	9.2	125.421	43.92	15.07	21.429	-65%	-88%	-83%
F36	0.201	NR	8.3	54.168	7.33	1.26	2.010	-86%	-98%	-96%
							Average	358%	-12%	77%

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Comment: USEPA prepared a consequence analysis of the National Emission Inventory ("NEI") resulting from their proposed revision.8 USEPA found that their revised paved road emission factor will significantly reduce PM_{10} emissions in the NEI (up to 200% reduction), while $PM_{2.5}$ emissions are only slightly affected (some NEI calculations increase, some decrease). USEPA, however, did not examine the affect of their draft revised paved road equation on fugitive dust emissions from industrial sources.

Response: The estimated impact on State Emissions Inventories and the NEI was performed as a tool for decisions which may need to be made to address conformity requirements. The Agency may provide States with extensions of times for adopting revised emissions estimates in their SIP and Transportation plans. These estimates were also produced to assist State and local agencies understand the potential impact that the revised emissions factors may have on their PM_{10} and $PM_{2.5}$ inventories which are being prepared to address non attainment conditions and required SIP plan development. The emissions inventory impact estimates were not produced as a decision criteria for revision of the emissions factor equation. The only criteria used in assessing the proper equation to publish are the representativeness of the underlying test data and the comparison of the equation to the actual measured emissions. Although not presented in the background report, the performance of the equation was made by ordering the available test data by silt loading, average vehicle weight and by speed to evaluate whether there was any systematic bias which was driven by one or more outlying data. Table 4-23 of the background report for the proposed revision did include the average percent error for the 2006 equation and the proposed equation. When arranged by weight, the 2006 equation produced errors of about 70,000 percent for vehicle weights of over 10 tons while the proposed equation produced errors of about 2,500 percent. The equation published in the final section produces errors of 5,000 percent for vehicle weights between 10 and 40 tons and errors of about 20,00 percent for vehicle weights over 40 tons. Although when limited to these high weight classes the performance appears to be worse, for lower weight classes the new equation demonstrates superior performance to both the previous published equation and the proposed equation.

David E. James, PhD PE; Associate Vice Provost for Academic Programs; UNLV, Las Vegas, NV.

Comment: In many parts of the country where there is significant rain or a rainy season, rain days may considerably effect estimated PM_{10} emissions in the inventory. However, for Las Vegas and other places like it in arid places, I tend to use a 'pessimistic' approach that doesn't include the rain days, since rain occurs sporadically, and what rain does fall is often very light. For the desert southwest, I think that it is best to look at the data without rain adjustments.

Response: It is recognized that the mitigation adjustment for rain events in AP-42 is imperfect. It is recognized that with very light rain events, the silt loading on paved roads may increase due to the removal of soil on the under carriage of vehicles. For most areas of the US, these very light rain events are offset with heavier rain events. Over a month to a year, these enrichment and mitigation events balance out. It should also be noted that the mitigation level is not based upon any measured data and is an "engineering or expert elicitation" estimate.

The emissions factors and the adjustment factors in AP-42 are educated estimates of the national average value and do not include variations that may occur due to local and regional influences. While some variation in the emissions factors for paved road has been reduced through the incorporation of the independent variables silt loading, vehicle weight and number of rain events, the remaining variation is still substantial. EPA does not prohibit the use of alternative emissions factors or adjustments when accompanied by a scientifically credible rationale and supporting data.

Comment: With locally derived data, we obtain results that are different from those that might be predicted using default silt loading data. The actual impact on total estimated PM_{10} emissions in an inventory or SIP would depend on how much VMT was assigned to each roadway category.

Response: It is recognized that the default silt loading information presented in AP-42 does not provide the precision and accuracy that may be needed to properly represent the influence of emissions from paved or unpaved roads. It is also recognized that the resources required collecting representative silt loadings for large numbers of roads is substantial. However, where roads are believed to be significant contributors to the levels of ambient air particulate matter, obtaining this information is valuable to accurately estimate emissions. To address the needs to obtain this information in a cost effective manner, we have included a discussion of the potential advantages of mobile monitoring to develop temporally and spatially resolved silt loading (or emissions) information.

Comment: I also ran a hypothetical sensitivity analysis comparing arbitrary combinations of vehicle weight and silt loading, to see what the impacts of the new PM_{10} equation might be.

Response: It is recognized that different road classes may have different silt loadings and the vehicles using these roads may have different average vehicle weights. These variables will have differing influences on the predicted emissions from these roads. As a result, the use of locally derived silt loading information is strongly encouraged.

Steve Zemba of Cambridge Environmental Inc for the National Asphalt Pavement Association.

Comment: The recommended default values for silt loading in draft Table 13.2.1-3, and particularly that for asphalt batching, may be too high for typical current applications. The recommended value is 120 g/m2, but, as you know, in EPA's 2000 Emission Assessment Report for Hot Mix Asphalt Plants, a silt-loading value 3 g/m2 is suggested for paved roads at typical hot-mix asphalt production facilities. Also, site-specific measurements at a hot mix asphalt facility in Alexandria, Virginia in 2005 (using the sampling and analytical methods described in AP42 Appendix C) found a silt loading level of 0.5 g/m2. This facility, which we analyzed in detail for the City of Alexandria, employs aggressive dust suppression techniques.

Response: Values presented in Table 13.2.1-3 are based upon road dust samples collected in the mid to late 1970's through the mid to late 1980's. It is unclear whether any management practices were used at these facilities to control the silt loading of the roads where these samples were collected. It is possible that current normal maintenance practices would achieve lower silt loadings than are presented in the table. Statements in the documentation included in the reports by the Corn Refiners Association and several other test programs used in the equation development indicate that there was active management of the road surface dust levels. As a result, the silt loading data collected during those test programs are lower than they would be otherwise. While there is no requirement to use the silt loading values provided in the tables of AP-42 updated silt loading data can be collected by any individual as long as they follow the procedures presented in the AP-42 appendices. It is recommended that in addition to documenting the sampling and analyses, the documentation include normal housekeeping practices and special monitoring and maintenance practices at the collection sites. While we cannot guarantee rapid incorporation of new silt loading data into the table, any reports submitted will be posted for use by subsequent users.

Catharine Fitzsimmons, Chief, Air Quality Bureau and Lori Hanson Iowa Department of Natural Resources.

> **Comment:** The DNR supports the revision of this section to incorporate new data from corn wet mills and to account for mean vehicle speeds below 10 miles per hour.
>
> **Response:** Thanks for your support.
>
> **Comment:** The proposed form of the equation requires that a mobile source emissions model be run in order to determine a paved road emission factor. Obtaining the emissions factor for vehicle emissions in this manner will be problematic as the DNR does not have the resources to generate specific emissions factors for vehicle emissions

by running MOVES20I0 for every construction permitting project that includes a paved haul road. The DNR suggests that either the empirical equation be developed to include vehicle emissions from engine exhaust, tire and brake wear, or that a table of default values be included in the section to account for vehicle emissions as an alternative to running a mobile source emission model.

Response: While vehicle exhaust emissions may have been relatively stable for the last twenty or thirty years, several regulatory programs which cover mobile source emissions are expected to produce decreasing exhaust emissions over the next five to ten years. In addition, engine exhaust like road dust emissions is highly dependent on the road characteristics, meteorological conditions, vehicle speed, vehicle class and other environmental conditions. As a result, a default engine exhaust equation will result in unknown errors and may lead to incorrect decisions on different programs. While decisions for many programs may not require the accuracy that would occur with individual selection of the requisite parameters needed for the most accurate emissions estimates, this would be a decision that should be made for each application. While State agencies (Department of Transportation or Air Quality) may not have the resources or time to generate a project specific emissions estimate for every project, individual States are in a better position to develop default parameters (engine exhaust, silt and average vehicle weight) which is appropriate for use for projects with different sensitivities.

Pat Davis of MARAMA for the States of New Jersey, Delaware, Maryland and Massachusetts.

Comment: We have been examining the ERTAC/PECHAN emission factors for Road Dust and Maryland noticed that the $PM_{2.5}$ emission factors were zeroed out for the following road types:

- Urban Collector
- Urban Minor Arterial
- Urban Other Principal Arterial
- Urban Other Freeways and Expressways
- Urban Interstate

Emission factors for PM_{10} were found and there was no mention in the documentation of why the $PM_{2.5}$ emission factors were zeroed out, so we are bit confused.

Response: As a result of a revision of the ratio of the $PM_{2.5}$ to PM_{10} recommended by the Western States Air Resources Council (WESTAR) from 25% to 15%, the multiplier k in the predictive equation for $PM_{2.5}$ was revised from 1.8 (for grams/VMT) to 1.1 (for grams/VMT) in the 2006 revision of the paved roads AP-42 Section. With a constant emissions factor of

0.1617 subtracted for the vehicle exhaust break wear and tire wear emissions, these emissions result in a negative calculated road dust emission when one enters an average vehicle weight of 4 tons or less and a silt loading of 0.2 grams/square meter or less. While the k value used in the previous version of the equation resulted in negative emissions whenever the silt loading was less than 0.03 grams/square meter, this affected only Freeways, Expressways and Interstates and was believed to be rational since roadways with average speeds of 55 mph (and the normal level of silt for that speed) had a high number of tests with low measured emissions and were considered to be composed primarily of exhaust emissions.

In the equation presented in the final version of this update, the estimated exhaust component was subtracted from each source test prior to the stepwise regressions of the test data to develop the predictive equation. As a result of the absence of vehicle exhaust, tire wear and break wear in the predictive equation, there are no conditions that will result in negative emissions for the road dust emissions.

Julie McDill (MARAMA), David Fees (Delaware), Julie Rand (New Jersey).

Comment: Here is Delaware's paved road dust spreadsheet for 2007, using the new equation. We got very detailed with this category; estimating emissions by month. Regarding the new equation, PM_{10} was reduced by 58% from the emissions submitted to MACTEC; while $PM_{2.5}$ increased by 48%. I believe the $PM_{2.5}$ increase is caused by two factors-first, the $PM_{2.5}$/ PM_{10} ratio was increased to 25% (previously 15%). The second reason is that under the old equation, one had to apply a correction factor, C, to remove the exhaust, brake, and tire wear from the front part of the equation. By subtracting C at the end of the equation, the resulting $PM_{2.5}$ value went negative for several roadway types. Of course we zeroed these out, but with the new method there is never a situation where the emission factor value can go negative. Having negative emission factors result from the use of the old equation was obviously a flaw in the method, so I expect the new equation is more accurate. I look forward to NJ's results when they apply the new equation, to see if they get changes similar to mine.

New Jersey has similar results, but even more drastic for $PM_{2.5}$. An increase in $PM_{2.5}$ of 350% and a decrease in PM_{10} of 46% I think one big cause is the difference in k factor, among other changes. The k factor for $PM_{2.5}$ went down from the 2003 AP-42 to the 2006 AP-42, and back up again in this new draft. We guessed at the new vehicle speed requirement, but a slight variation in speeds will not make that much of a difference.

Response: It is correct that the k value and the C value both influence the predictive value for the emissions factor. In addition, the exponents associated with the silt loading and the average vehicle weight also influence the emissions estimates. It is also correct that the updated equation will not generate a negative emissions factor since the vehicle emissions, tire wear and break wear will not be included in the equation development. Based upon an assessment of the predicted to actual emissions factor for each of the available emissions tests, the updated equation provides an improved estimate of the emissions compared to the previous equation. It is also believed that the return to the $PM_{2.5}$ to PM_{10} ratio of 25% is a better indicator of the $PM_{2.5}$ than the 15% ratio that was based upon laboratory assessment conducted for WESTAR.

Gary Garman of McVehil-Monnett.

Comment: It's good to see the paved road section is being revised. Thanks. It has been a challenge in the past explaining to industrial clients that paving a road would actually result in higher predicted emissions than if the road is left unpaved. I think we'll see more paving and actual emission reductions as a result of the new equation. A few editorial comments on the draft paved road section:

> Page 13.2.1-1, third paragraph, first sentence..change to "The particulate emission factors presented in a previous version.."
>
> Page 13.2.1-5, third paragraph, last sentence..change "Table 13.2.1-3" to "Table 13.2.1-2"
>
> Page 13.2.1-8, fifth paragraph, first sentence..change "Table 13.2.1-3" to "Table 13.2.1-2"
>
> Page 13.2.1-9, second paragraph, second sentence..remove hyphen between "not" and "suggest"
>
> Table 13.2.1-3...the page number this table is on should be changed to 13.2.1.10. Also, total loading range for iron and steel should be 0.006-4.77, not 43.0-64.0.
>
> Page 13.2.1-11, first paragraph, fourth sentence..remove hyphen between "any" and "of"

Thanks again. I look forward to this draft being finalized.

Response: An assessment of the paved verses unpaved road equation performance will be conducted. A statement will be added to the paved road section explaining that under some high silt loading conditions the equation may predict higher emissions than for an unpaved road and that for these conditions the unpaved road equation should be used. The typographical errors will be corrected in the final version.

Comments on Proposed Paved Road Equation

Cowherd, Chatten to: Ron Myers 08/31/2010 03:00 PM

Cc: "Kies, Rebecca", "Muleski, Greg"

History: This message has been forwarded.

Hello Ron,

Thank you for the opportunity to comment on the proposed revision to the paved road dust equation in AP-42 section 13.2.1. The attached letter presents comments developed on behalf of the Center for the Study of Open Source Emissions (CSOSE).

As you know, the revised equation (proposed by EPA as a replacement for the existing equation) and its technical foundation were topics of discussion during the August 18 teleconference hosted by the CSOSE. During this teleconference and in related information exchanges, the general consensus among CSOSE participants who have worked in this field is that the proposed equation does not offer improved predictive capability but introduces additional data requirements to the paved road emission inventory process.

There is also the broader issue of adopting mobile monitoring as the basis for more realistic emission inventorying of paved roads. In previous conversations, I believe that you have acknowledged the clear advantages of mobile monitoring over the traditional AP-42 method for determining paved road dust emissions with its reliance on limited and difficult measurements of silt loading.

We believe that the CSOSE constitutes a substantial resource in resolving these issues and in assisting EPA with the goal of developing improved emission factors such as those applicable to paved road dust emissions.

Please contact me with any questions or comments.

Sincerely,

Chat Cowherd

Chatten Cowherd, Jr., Ph.D.
Midwest Research Institute
425 Volker Boulevard
Kansas City, MO 64110
(816) 753-7600 ext. 1586
(816) 360-5346 direct dial

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**Center for Study of
Open Source Emissions**

Chatten Cowherd, Jr., Ph.D.
Director
ccowherd@mriresearch.org
(816) 360-5346

August 31, 2010

Mr. Ron Myers
U.S. Environmental Protection Agency
Research Triangle Park NC 27711

RE: **Proposed Revision to AP-42 Emission Factor Equation for Paved Road Dust**

Dear Mr. Myers:

The **Center for Study of Open Source Emissions (CSOSE)** is pleased with the opportunity to submit comments in response to EPA's proposed revision of the emission factor equation in AP-42 Section 13.2.1. It should be noted that these comments were prepared by the undersigned as Director of CSOSE, taking into account verbal and written communications from interested members of the Center, including those provided during a presentation and discussion of this topic in the August 18 teleconference hosted by the Center. However, this letter was not circulated to CSOSE participants for review prior to submission.

One of the goals of CSOSE is to promote transparency and collaboration in the documentation of test results and in the use of those results to derive effective tools for compliance with air quality standards. We believe that this goal is consistent with EPA's stated goal ***to develop a self-sustaining emissions factors program that produces high quality, timely emissions factors, better indicates the precision and accuracy of emissions factors, encourages the appropriate use of emissions factors, and ultimately improves emissions quantification*** (see EPA's Advance Notice of Proposed Rulemaking on "Emission Factors Program Improvements," Oct. 14, 2009).

We acknowledge the concerns of various parties related to the scientific foundation for the proposed equation as well as the increased effort required in developing vehicle speed data to include in paved road emission inventories. CSOSE participants have presented analyses demonstrating that the proposed equation does not provide an improved predictive capability above that provided by the current equation. In addition the proposed equation has a significant new data input requirement (vehicle speed) that increases the difficulty of generating paved road emission inventories and that has possible implications on projected effectiveness of current SIP-mandated control strategies.

Based on our discussions of the proposed equation and the technical analyses presented by EPA, we find the scientific foundation for the revision unconvincing. This leads us to question the process used in advancing this proposed equation. Our understanding of the rationale for revision of the existing equation might be clarified if there were evidence of an internal review process within EPA that raised issues and resolved them appropriately.

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Besides the problems stated above, we find difficulty in understanding the scientific basis for replacing the existing PM-2.5/PM-10 ratio published in 2006 with the ratio that was previously used by EPA. The ratio in the existing equation was accepted by EPA as an outcome of an experimental program supported by the Western Regional Air Partnership (WRAP). That experimental program included regular progress updates in WRAP teleconferences with participation from EPA representatives. To our knowledge, WRAP was never directly informed in advance that the stated conclusions of their study are now being discounted.

We have encouraged others to present comments on the proposed equation that are supportive of the goal of providing improved emission factors. At the time of this writing, we are aware that separate comments are being submitted by Midwest Research Institute (Ms. Courtney Bokenkroger and Dr. Greg Muleski), by the Clark County Department of Air Quality and Environmental Management (Mr. Rodney Langston) and by the University of Nevada at Las Vegas (Dr. David James).

We trust that EPA will publish all comments as well as the responses to each comment. This will be of great assistance to all in moving toward the best possible use of the test data in supporting a meaningful and appropriate emission factor equation for entrained dust from paved roads.

In summary, we conclude that there is no compelling scientific justification for adopting the proposed emission factor equation as a replacement for the existing equation. This problem is compounded by the requirement for additional input data and the potential impact on current and future emission inventories as tools for compliance determination. We conclude that an internal EPA review may not have been performed prior to posting the proposed equation for public comment. Finally we emphasize the importance of publishing all comments submitted to EPA along with EPA's responses to each comment.

If you have questions about these comments submitted on behalf of CSOSE, please contact the undersigned by email (*ccowherd@mriresearch.org*) or by telephone (816) 360-5346. We look forward to your responses to these comments. We believe that CSOSE constitutes a substantial resource in resolving the above issues and in assisting EPA with the goal of developing improved emission factors for open sources. Thank you again for the opportunity to submit comments on the proposed revision to the current AP-42 equation for paved road dust emissions.

Sincerely yours,

CENTER FOR STUDY OF OPEN SOURCE EMISSIONS

Chatten Cowherd Jr.

Chatten Cowherd, Jr., Ph.D.
Director

From: "Kies
To: Ron Myers/RTP/USEPA/US@EPA

Date: Tuesday, August 31, 2010 11:17AM
Subject: Statistical Comments on Draft AP-42 Section 13.2.1
History: ➧ This message has been forwarded.

Ron,

Thank you for the opportunity to comment on the proposed AP-42 paved roads section 13.2.1. Attached to this email are MRI's comments resulting from statistical analysis of the proposed changes to the paved road equation by MRI Senior Statistician, Courtney Bokenkroger. These comments have been reviewed by myself, Chat Cowherd, and Greg Muleski.

Please feel free to respond with any questions or comments.

Sincerely,

Becky Kies

Rebecca Kies

Assistant Scientist

Midwest Research Institute

425 Volker Blvd. KCMO 64110

(816) 360-3825 (direct)

(816) 753-7600 x1818

rkies@mriresearch.org

Attachments:

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Comments in Response to EPA Proposed Section 13.2.1 Paved Road Equation.pdf

MIDWEST RESEARCH INSTITUTE
425 Volker Boulevard • Kansas City, Missouri 64110

Courtney Bokenkroger
Senior Statistician
816-360-5303

August 31, 2010

Mr. Ron Myers
U.S. Environmental Protection Agency
Research Triangle Park NC 27711

RE: **Draft AP-42 Section 13.2.1 Paved Roads**

Dear Mr. Myers:

Midwest Research Institute (MRI) is pleased with the opportunity to submit comments in response to EPA's proposed draft revisions to AP-42 Section 13.2.1 Paved Roads and corresponding background documents. We applaud EPA's effort to improve the quality of the emission factor model for paved roads and appreciate your consideration of external comments.

MRI has a productive history of work in air pollutant source testing, process characterization, and development of emission factors for EPA's Emission Factor Handbook (AP-42). Besides serving for more than 25 years as an EPA contractor in the testing of ducted sources and in associated methods development, we have made unique contributions to the development and application of test methods for open (non-ducted) sources. The open sources that we have tested over the past 35 years include agricultural operations, paved and unpaved roads, construction activities, surface mining activities, military training operations, and open area wind erosion. Because of the large natural variability of these sources, MRI pioneered the concept of predictive emission factor equations rather than relying on simple averaging of test results for fugitive dust sources. This approach reduced the uncertainty of emission factor estimates for unpaved roads--as the largest contributor to the national PM-10 emission total--by up to two orders of magnitude.

Our comments on the draft AP-42 Section 13.2.1 Paved Roads focus on a statistical analysis of the data set and procedure used to calculate the proposed new paved road emission factor equation and can be summarized as follows:

- The approach used by EPA to calculate the proposed paved road equation differs from standard least-squares regression procedures. MRI recommends that ordinary least-squares regression procedures be used.
- In using ordinary least squares regression to compare models for only the field measurements that included vehicle speed, we find that inclusion of speed in the model takes away from the explanation of variance of the model (R^2) and that vehicle speed does not have a statistically significant relation to emission factor.
- It is recommended that different modeling options be explored to find the best predictive equation from the data provided. Two such options are:
    - Look at low speed and high speed models separately, potentially excluding vehicle speeds under 5 mph from equation development.

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- Use a composite factor of weight and speed together with either weight or speed as independent variables in the regression. This helps alleviate the problem of the multicollinearity of weight and speed seen in these data.

Model Comparison

The data set used by EPA to develop the proposed paved road equation included emission factor, silt loading, weight, and speed. Out of 93 total observations, 71 included speed data. The 71 observations that included speed data were the ones used by MRI for model comparison.

It is not reasonable to compare the proposed model with other possible models for the data using the approach taken by EPA to calculate the proposed model. The double-regression approach used renders two different R-square values (one for each regression), neither of which accurately represent the proportion of variability explained by the final resulting model.

The resulting equations obtained from running least-squares regression on the log transformed, normalized values with and without inclusion of speed on the set of 71 data points appear below.

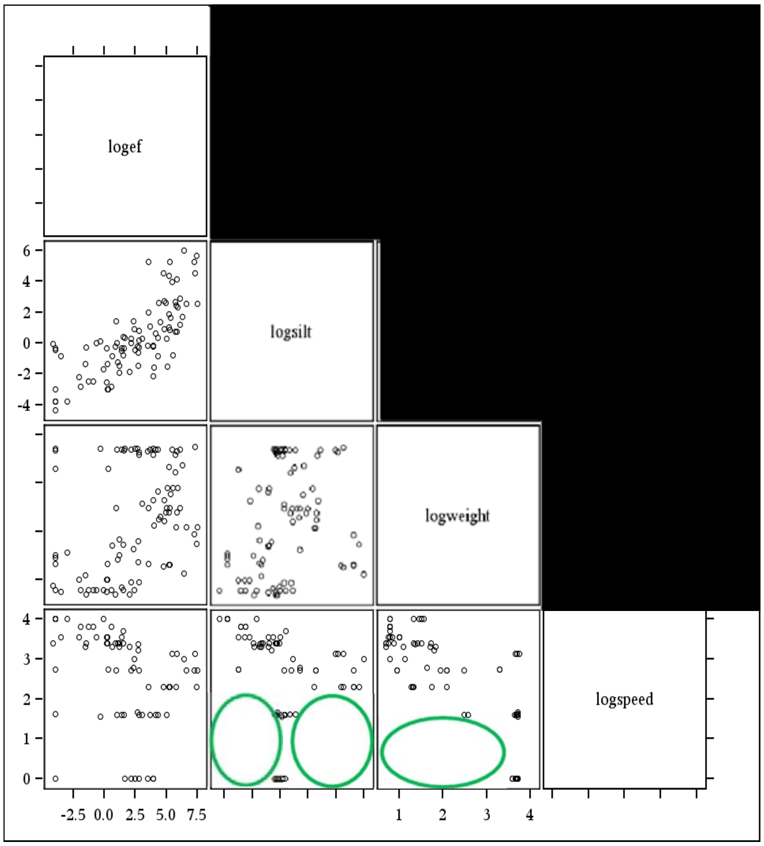
Regression without speed: $EF = 6.51 *(\text{silt loading}/2)^{0.97} * (\text{weight}/3)^{0.36}$
Regression including speed: $EF = 6.41 *(\text{silt loading}/2)^{0.97} * (\text{weight}/3)^{0.27} * (\text{speed}/30)^{-0.12}$

	Variance Explained by Model	Variable	p-value	"Proportion of Variance Explained"
Regression without speed	R^2= 0.6335	Silt loading	< 0.0001	0.62673
		Weight	0.0739	0.04621
Regression including speed	R^2= 0.6288	Silt loading	< 0.0001	0.62673
		Weight	0.3892	0.04621
		Speed	0.7140	0.00202

The R-square value from a standard least-squares regression represents the proportion of variability explained by the model. When speed is included in the regression, the R-square is slightly lower than when speed is not included. This means that the model explains less of the variance seen in emission factor when speed is included than when it is not.

The column labeled p-value represents the statistical significance of the factor in the prediction of the dependent variable (the lower the p-value, the greater the significance). In order to be considered statistically significant for inclusion in the model, generally p-values are less than or equal to 0.15. Note that the p-values for the equation that includes speed indicate that speed and weight are both statistically insignificant (this is because there is likely a relationship between weight and speed). When speed is not included, weight is statistically significant.

The column labeled "proportion of variance explained" is the proportion of R-square that is explained by each individual variable. Speed contributes almost no additional "explanation of variance" to the model (i.e. speed doesn't add much to the predictive power of the model).



Gaps in the Data

Additional concerns about gaps in the range of data surfaced during our statistical analysis. Notice the major holes highlighted by the circles in the speed-silt loading and speed-weight boxes. The dataset is missing low silt loading, low speed; low silt loading, high speed data; and low weight, low speed data. Ideally, the boxes relating silt loading, weight, and speed should be completely filled with data points in order to cover all ranges of possible occurrences and consider them to be independent factors in the model.

Conclusions and Recommendations

The proposed approach used by EPA to calculate the proposed paved road equation differs from standard regression procedures. The two-regression approach used results in two different R-square values, neither of which accurately represent the proportion of variability explained by the final resulting model. Additionally, different data sets were used to develop the two models.

In using ordinary least-squares regression to compare data models for the same data, inclusion of speed in the model does not significantly add to the explanation of variance in emission factor. Also, speed does not have a statistically significant relationship with emission factor.

The low-speed data (≤ 5 mph) have an un-proportionally large effect on the fit of the model. This is of concern because there are not enough low speed data to represent all ranges of weight and silt loading.

Because the correlation between the log-transformed, normalized weight and speed in the model is approximately -0.78, inclusion of both factors introduces issues related to multicollinearity. The problem with having highly correlated variables in a model is that the coefficients are easily influenced by the dataset used in estimation and may not be meaningfully interpreted because they are not independent.

It is recommended that different modeling options be explored to find the best fit and set of predictors for the data provided. Two such options are:

- Look at low speed and high speed models separately, potentially excluding vehicle speeds under 5 mph from equation development.
- Use a composite factor of weight and speed together with either weight or speed as independent variables in the regression. This helps alleviate the problems due to multicollinearity between weight and speed seen in these data.

If you have questions or comments about this evaluation of the proposed paved road equation in EPA AP-42 Section 13.2.1, please contact the undersigned by email (cbokenkroger@mriresearch.org) or telephone (816- 360-5303). We look forward to your response on this matter.

Sincerely yours,
MIDWEST RESEARCH INSTITUTE

Courtney Bokenkroger

Courtney Bokenkroger
Senior Statistician

NMED EIB Rebuttal Exhibit 7

Comments on Section 13.2.1 draft

Muleski, Greg to: Ron Myers 08/30/2010 02:58 PM

History: This message has been forwarded.

Ron

Thank you for the opportunity to comment on the draft paved road emission factor. Based on my analysis for the Corn Refiner Association member companies, I know that the revision moves the power on the "mean vehicle weight term" in the right direction.

My specific comments are as follows:

1. The measured emission factor for CM-2 should be "63.5" rather than "6.35" so the independent variable in Table 4-17 should have been about 52 g/vmt (rather than the default value of 0.02 g/vmt).

2. The two-step regression process described in Section 4.2.2.2 differs from standard stepwise multiple regression used in the past AP-42 updates. It is not clear how R-squared values at each step can be combined to obtain a meaningful value.

3. The high degree of correlation between speed and weight precludes both being included as independent terms in the emission factor equation. Furthermore, it is not clear what inclusion of speed does for the model. The goal should be to develop a predictive tool for situations without measured emissions rather than trying to get the best fit for the set of measured emissions.

4. The geometric mean is the better choice than the arithmetic average when working with the predicted/observed ratios.

5. The draft background document is in rough shape. It would have been better to have posted only Section 4 to avoid confusion arising from the table of contents, references, etc. The document would have benefitted from a thorough review/edit prior to being posted on the CHIEF web site.

Please feel free to contact me with any questions or comments.

Greg Muleski

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FW: Message from KMBT_421

Muleski, Greg to: Ron Myers 08/26/2010 09:52 AM

History: This message has been replied to and forwarded.

Ron

Sorry I missed your phone call. I've attached 2 annotated pages from your draft background document that show the problem.

-----Original Message-----
From: copier211h@mriresearch.org [mailto:copier211h@mriresearch.org]
Sent: Thursday, August 26, 2010 8:50 AM
To: Muleski, Greg
Subject: Message from KMBT_421

NMED EIB Rebuttal Exhibit 7

Table 1-14. Summary of Emissions Data from Cargill's Blair, Nebraska Facility (Test Report 3)

Run	Test condition	Traffic rate (veh/hr)	Traffic speed (mph)[a]	Mean vehicle weight, W (tons)	Surface silt loading, sL (g/m^2)[b]	Measured PM_{10} emission factor (lb/VMT)[c]
CI-1	Low Speed	45	13.4 / 16.8	26	0.06	-
CI-2	Low Speed	45	12.8 / 16.9	26	0.06	-
CI-3	Slowly moving	60[d]	13.6 / 12.7 13.5 / 15.5	27	0.06	-
CI-4	Low Speed	60[d]		27	0.06	-
CI-7	Slowly moving	47	15.2 / 16.2 13.6 / 16.1	27	0.05	0.0036
CI-8	Low Speed	47		27	0.05	0.0066
CI-11	Low Speed	56	13.5 / 12.7	27	0.025	-
CI-12	Low Speed	56		27	0.25	-

[a] Vehicle speed for inbound (loaded) /outbound (empty) trucks determined by accumulating time required to travel a measured distance.

[b] Surface silt loading sample information provided by Cargill.

[c] “-“ indicates that no net mass was attributed to the test road traffic.

[d] Twenty of 238 total passes were by “drone” trucks.

Table 4-15. Summary of Emissions Data from ADM's Marshall, Minnesota Facility (Test Report 4)

Run	Test Condition	Traffic rate (veh/hr)	Traffic speed (mph)[a]	Mean vehicle weight, W (tons)	Surface silt loading, sL (g/m^2)	Measured PM_{10} emission factor (lb/VMT)
CM-1	**Slowly moving**	**154**	**NA**	**40**	**0.72**	**0.014**
CM-2	**Stop-and-go**	**42**	**NA**	**40**	**0.72**	**0.14**
CM-4	**Slowly moving**	**156**	**5**	**40**	**0.70**	**0.016**

[a] Vehicles speeds maintained at plant limit of 5 mph. NA = not applicable.

Bold entries indicate that identical vertical sampling arrays were used to better isolate the source contribution.

①

This is OK; converts to 63.5 g/VMT

NOTE: I checked the value against Table 4-4 in our 12/5/03 report (next page)

Table 4-4. Measurement-Based PM-10 Emission Rates/Factors

Run	Traffic rate[a] (veh/hr)	Mean vehicle[a] weight (tons)	Silt loading (g/m^2)	Measured line source emission rate (g/mile-s)	Measured per vehicle emission factor (lb/vmt)	AP-42 predicted emission[a] factor (lb/vmt)
CM-1 (low speed)	154	39.8	0.72	0.27[b]	0.014	0.40
CM-2 (stop/go)	41.9	39.6	0.72	0.76[b]	0.14	0.40
CM-4 (low speed)	156	39.5	0.70	0.31[b]	0.016	0.39

[a] Vehicle weights based on the following values (lbs) in MCP's Title V application:

	Empty	Loaded
Straight Truck	10,000	26,000
Tandem	19,000	45,000
Semi	27,000	80,000

All trucks were inbound and full (including "drone" passes). AP-42 factor based on value of 40 tons.

[b] Based on 2 lines of queued traffic.

4.2 Discussion and Recommendation

The PM-10 emission factors developed in the 2003 testing program provide further evidence that Equation 1-1 produces highly overestimated predictions for PM-10 emissions from paved road traffic at the Marshall facility. At least two features of the AP-42 modeling approach fail to describe the emissions observed at Marshall.

First, re-entrained surface road dust is not nearly as dominant in the emissions measured at Marshall as compared to the AP-42 emission factor database. This was first noted in the 2001 test report [3]. The 2003 program provides no evidence that measured emissions exhibit a dependency on silt loading even remotely similar to that found in Equation 1-1.

Just as importantly, the 2003 test results point up a second shortcoming of AP-42 in modeling emissions at the Marshall plant. The predicted emission rate using AP-42 is found by multiplying Equation 1-1 by the traffic volume. In other words, the emission rate varies linearly with traffic rate. For example, if twice as many vehicles pass during one hour compared to the next, then the first hour's emission rate should be twice that of the second.

However, measured emission rates are remarkably constant over the range of traffic rates considered during the two test programs. Figure 4-1 presents the line source emission rate measured in both 2001 and 2003 for the inbound corn haul route. The emission rate is plotted against the traffic rate. Also included for comparison are the predicted values using AP-42. Measured emission rates show no significant relationship with traffic rate.

Emission Tests of Paved Road Traffic at ADM's Marshall, Minnesota Facility

Test Report

For
McVehil-Monnett Associates

MRI Project No. 310479.1.001

December 5, 2003

NMED EIB Rebuttal Exhibit 7

Reference	Run ID	Silt loading (g/m2)	Speed (mph)	Weight (tons)	Downwind Concentration mg/m^3	Measured PM-10 Emission factor (g/VMT)	Estimated Fraction Heavy Duty Vehicles	Estimated Engine, brake, tire emission factor (g/VMT)	Estimated PM-10 Road Dust Emission factor (g/VMT)
	CF-2/South	0.81	1	41	0.080	63.5	1.000	11.06	52.440
	CF-3N	0.63	5.1	41	0.015	1.09	1.000	2.1686	0.020
	CF-3/South	0.63	1	41	0.025	23.1	1.000	11.06	12.040
	CF-4N	1.1	4.7	41	0.019	3.08	1.000	2.3532	0.727
	CF-5	1.4	1	41	0.030	16.3	1.000	11.06	5.240
	CI-7	0.05	15.3	27	0.030	1.63	0.759	1.6434	0.020
	CI-8	0.05	15.3	27	0.030	2.99	0.759	1.6434	1.347
	CM-1	0.72	5	39.8	0.035	6.35	1.000	2.212	4.138
	CM-2	0.72	1	39.6	0.050	6.35	1.000	11.06	0.020
	CM-4	0.7	5	39.5	0.035	7.26	1.000	2.212	5.048

③

② should be
63.5

and this
should be
63.5 − 11.06

≈ 52 g/VMT

NMED EIB Rebuttal Exhibit 7

From: "Camille Sears" <camille.marie@sbcglobal.net>
To: Ron Myers/RTP/USEPA/US@EPA

Date: Monday, August 30, 2010 11:53PM
Subject: Re: AP-42 13.2.1
History: ➡ This message has been forwarded.

Hi Ron,

Attached are our comments. Please let me know if you have questions.

Your help is greatly appreciated!

Best wishes,
Camille

Attachments:
SC-13.2.1.comments.pdf

NMED EIB Rebuttal Exhibit 7

Camille Sears 502 W. Lomita Ave., Ojai, CA 93023

Tel: (805) 646-2588 e-mail: camille.marie@sbcglobal.net

August 30, 2010

Mr. Ron Myers
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711

Subject: Proposed Revision to AP-42 Section 13.2.1 – Paved Roads

Dear Mr. Myers,

Thank you for the opportunity to provide comments on the proposed revision to AP-42 Section 13.2.1. I have reviewed the proposed AP-42 revisions and associated reference documents and on behalf of Sierra Club offer the following brief comments.

1. Introduction

The existing USEPA air pollution emission factor for fugitive dust from vehicle traffic on paved roads is as follows:[1]

$$E = k(S_L/2)^{0.65} * (W/3)^{1.5} - C$$

Where: E = annual or other long-term average emission factor in the same units as k

k = particle size multiplier (from Table 13.2.1-1, k = 0.0024 lb/vehicle mile traveled (VMT) for $PM_{2.5}$ and 0.016 lb/VMT for PM_{10})

S_L = road surface silt loading (g/m^2)

W = average weight of vehicles (tons)

C = emission factor for 1980s vehicle fleet exhaust, brake wear, and tire wear (from Table 13.2.1-2, C = 0.00036 lb/VMT for $PM_{2.5}$ and 0.00047 lb/VMT for PM_{10})

The existing version of AP-42 Section 13.2.1 appears to be based on 64 source tests performed prior to 1995, the date when the paved road emission factor first takes its current form.

In July 2008, the Corn Refiners Association ("CRA") proposed a revision to AP-42 Section 13.2.1. CRA's proposed revision is based on 22 additional source tests performed at ethanol plants in 2001

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[1] USEPA, Office of Air Quality Planning and Standards, AP-42, Section 13.2.1, Paved Roads, November 2006, p. 13.2.1-4.

through 2003.[2] CRA recalculated a paved road emission factor including the 64 source tests used by USEPA as the bases for the existing emission factor, plus the 22 additional CRA source tests (for a total of 86 tests). Based on their regression analyses, CRA proposed a revised paved road emission factor with the following form:[3]

$$E = k(S_L/2)^{0.8} * (W/3)^{0.8} - C$$

CRA also proposed a revised particle size multiplier (k), where k = 0.0034 lb/VMT for $PM_{2.5}$ and 0.023 lb/VMT for PM_{10})

The additional 22 tests performed by the CRA include:

- Nine tests performed on roads at the Minnesota Corn Processors facility, Marshall, Minnesota, during April 2001;
- Eight tests performed on roads at the Minnesota Corn Processors facility, Columbus, Nebraska, during June 2001;
- Two tests performed on roads at the Cargill Sweeteners North America facility, Blair, Nebraska, during August 2002;
- Three tests performed on roads at ADM's facility, Marshall, Minnesota, during September 2003 (this is the same facility as the April 2001 tests).

In May 2010, USEPA developed and proposed a revision to AP-42 Section 13.2.1, "Paved Roads." From USEPA:

> This update recommends an updated equation for paved roads that is based upon additional test data that was conducted on roads with slow moving traffic and stop and go traffic. The emissions tests were performed for the Corn Refiners Association by Midwest Research Institute (MRI). The testing focused on PM10 emissions at four corn processing facilities.[4]

USEPA's update to AP-42 Section 13.2.1, however, incorporates other data than that collected by the Corn Refiners Association, and, more importantly, USEPA's update excludes important data that have been used in developing the existing paved road emission factor. In summary, USEPA's 2010 update to AP-42 Section 13.2.1 incorporates the following data base changes:

- Including the 22 CRA tests performed in 2001 through 2003;
- Including three tests performed on public roads in Denver, Colorado, during March 1996;

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[2] Corn Refiners Association, Paved Road Modifications at AP-42, Background Documentation, MRI Project No. 310842, July 18, 2008, p. 4.

[3] Id., p. 20.

[4] USEPA, Emission factor Documentation for AP-42, Section 13.2.1, Paved Roads, Draft, June 2010, p. 2-9.

- Including two tests performed on public roads in Raleigh, North Carolina, during April 1996;
- Including two tests performed on public roads in Reno, Nevada, during June 1996;
- Excluding 22 tests performed at two integrated iron and steel plants – one located in Houston, Texas, and the other in Middletown, Ohio (during 1980 and 1981).[5]

USEPA developed a proposed multiple regression equation based on paved road silt loading, mean vehicle weight, and vehicle speed. The existing version of AP-42 Section 13.2.1 is based on regression analyses of silt loading and mean vehicle weight. Since vehicle speed was not measured at the 22 tests from the two integrated iron and steel plants (Houston, Texas and Middletown, Ohio during 1980 and 1981), these tests were excluded from the data set.

USEPA's proposed revision to AP-42 Section 13.2.1, which is based on 71 individual source tests, takes the form:[6]

$$E = k(S_L/2)^{0.98} * (W/3)^{0.53} * (S/30)^{0.16}$$

Where: E = annual or other long-term average emission factor in the same units as k

k = particle size multiplier; k = 0.0037 lb/VMT for $PM_{2.5}$ and 0.015 lb/VMT for PM_{10}

S_L = road surface silt loading (g/m^2)

W = average weight of vehicles (tons)

S = average vehicle speed (miles per hour)

This equation does not incorporate emissions from engine exhaust and brake and tire wear, which will need to be estimated and added using USEPA's MOBILE6.2 or MOVES2010 models.

I have a few concerns regarding USEPA's proposed revision to AP-42 Section 13.2.1:

- USEPA's multiple regression analysis incorporating vehicle speed excludes a valuable data set for assessing paved road PM emissions from industrial facilities.
- USEPA's proposed revision to AP-42 Section 13.2.1 results in a very significant reduction in PM_{10} and $PM_{2.5}$ emission factors from paved roads in industrial settings.
- It is unclear whether USEPA's proposed revision to AP-42 Section 13.2.1 improves upon predictive performance of the existing 2006 emission factor.

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[5] Id., p. 4-18.

[6] USEPA, Office of Air Quality Planning and Standards, AP-42, Draft Section 13.2.1, Paved Roads, p. 13.2.1-4.

2. Key Industrial Source Tests are Excluded from USEPA's Revised Factor

USEPA's proposed revision to the paved road emission factor includes a third variable, mean vehicle speed. Vehicle speed, however, does not appear to be an important predictive aid to the overall emission factor equation. This is evidenced by vehicle speed having a small (0.16) exponential term in USEPA's proposed paved road emission factor. Furthermore, the CRA, in their analyses of the source test data, state:

> Taken together, these observations indicate that (a) silt loading and vehicle weight may be used as independent variables and that (b) inclusion of speed would add very little to the predictive capability of the model.[7]

I understand that USEPA has been asked to include vehicle speed in the revised paved road emission factor. Doing so, however, excludes valuable source tests that were performed without measuring vehicle speed. In particular, USEPA is excluding 22 tests performed at two integrated iron and steel plants due to lack of vehicular speed data. These iron and steel plant source tests are crucial for calculating fugitive dust emissions from industrial facilities, and excluding these data has a very significant impact on predicted paved road emission rates. As discussed in the following section, USEPA's proposed revision to the paved road emission factor will reduce particulate emission calculations at typical industrial sites by roughly an order of magnitude. This large, and perhaps unrealistic, reduction in calculated industrial paved road emissions is an artifact of trying to develop an emission factor based on tests that must include vehicle speed data.

3. USEPA's Proposed Update will Result in a Roughly Order of Magnitude Emission Reduction at Industrial Sites

In addition to developing an updated paved road emission factor, USEPA prepared a consequence analysis of the National Emission Inventory ("NEI") resulting from their proposed revision.[8] USEPA found that their revised paved road emission factor will significantly reduce PM_{10} emissions in the NEI (up to 200% reduction), while $PM_{2.5}$ emissions are only slightly affected (some NEI calculations increase, some decrease). USEPA, however, did not examine the affect of their draft revised paved road equation on fugitive dust emissions from industrial sources.

I prepared two tables that compare the existing paved road emission factor with USEPA's proposed revision – one for PM_{10} (Table 1A), and one for $PM_{2.5}$ (Table 1B). These tables include a range of silt loading, vehicle weight, and vehicle speed conditions. For each set of silt loading, weight, and speed, I calculated the emission factor using both the existing and proposed paved road emission factor. As can be seen, the reduction in calculated emissions for industrial sites using the revised factor is very large – about an order of magnitude lower for PM_{10} and somewhat less for $PM_{2.5}$.

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[7] Corn Refiners Association, Paved Road Modifications at AP-42, Background Documentation, MRI Project No. 310842, July 18, 2008, p. 15.

[8] See Excel spreadsheet: Impact_of_revised_paved_roads_pm_emission_factors_on_NEI.xls.

USEPA's choice to go ahead with their proposed paved road emission factor would have serious ramifications for NAAQS and PSD increment compliance. This is particularly true for proposed major sources of PM_{10} and $PM_{2.5}$ which have paved haul road emission sources. Using USEPA's proposed revision, sources that are currently being scrutinized for PM_{10} PSD increment and $PM_{2.5}$ NAAQS compliance would most likely be well below any regulatory design concentrations, even with significantly relaxed control measures. Again, USEPA's proposed revision is largely due to excluding a significant portion of the existing industrial source test data base, and is not due to any tests that contradict the excluded data. In effect, USEPA's revision would be "sweeping under the rug" what is perhaps the greatest impact caused by many industrial sources.

In terms of the modeling analyses for NAAQS and PSD increment compliance, the 24-hour PM_{10} PSD increment, which is 30 micrograms per cubic meter "$\mu g/m^3$," is almost always the most problematic regulatory design concentration. Proposed industrial sources, such as coal-fired power plants, pig iron facilities, coal-to-liquid operations, coal-to-synthetic gas plants, and lime production facilities, often cause air impacts that are quite close to exceeding the 24-hour PM_{10} PSD increment. It is common to see proposed PSD permit application modeled impacts consuming some 80 to 99% of the allowable 24-hour PM_{10} PSD increment. The majority of this modeled impact is caused by low-level open source fugitive emissions, including paved haul roads.

There is no basis to assume that the existing paved road emission factor overpredicts fugitive dust emissions from these major sources. And as we discussed earlier, it is common for major sources of emissions to be permitted without any PSD pre-construction or post-construction ambient air monitoring, even when such requirements are triggered by PM_{10} significant monitoring concentrations identified in 40 CFR 52.21(i). Thus, there is no current way to verify whether source PM_{10} impacts at the fenceline are realistically handled by the applied fugitive dust emission factor and subsequent air dispersion modeling.

I have also prepared two tables that compare the existing paved road emission factor with the CRA's proposed revision – one for PM_{10} (Table 2A), and one for $PM_{2.5}$ (Table 2B). While CRA's proposed revision results in lower industrial source PM_{10} and $PM_{2.5}$ emission factors, they are not nearly as severe as the changes proposed by USEPA.

The CRA source tests, however, include an apparent contradiction. CRA's source tests were designed for low vehicular speeds and stop-and-go conditions.[9] But CRA also acknowledges that "inclusion of speed would add very little to the predictive capability of the model."[10] So, the basis for including CRA's source tests in AP-42 Section 13.2.1 seems unnecessary.

Revising AP-42 Section 13.2.1, using either CRA's or USEPA's proposed revisions, will greatly reduce calculated fugitive dust emissions at most industrial facilities. This would make it easier for applicants to meet regulatory design concentration compliance, and to do so with fewer emission controls. These revisions, however, are based on data that are not representative of the majority of

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[9] Corn Refiners Association, Paved Road Modifications at AP-42, Background Documentation, MRI Project No. 310842, July 18, 2008, p. 4.
[10] Id., p. 15.

major emission sources. For example, the CRA source tests are for ethanol plants with low to very low silt loading levels. These conditions are not representative of the scores of proposed coal-fired power projects that have recently submitted permit applications to State agencies. And USEPA's modification of the source test data base, to add public road source tests and to eliminate the integrated steel plant tests, probably makes things even worse. The silt loading levels (and associated emission factors) measured at the integrated steel plant sites are representative of many industrial facilities.[11] Excluding these data will weigh the equation in a manner that reduces predictive performance for most industrial plants.

4. USEPA's Proposed Update may not Improve Predictive Performance

As part of the proposed revision to AP-42 Section 13.2.1, it would be helpful if USEPA presented performance analyses of both the existing and proposed paved road emission factors. Furthermore, it would be helpful if USEPA presented performance criteria for sub-categories of emission sources, such as public roads, industrial roads with low silt loading levels, and perhaps industrial roads with higher silt loading levels. From this analysis, USEPA and the reviewing public could get a better idea of whether the proposed changes will provide better predictive capability than does the existing method. And just as important, would be information on predictive performance for each sub-category of emission sources. In other words, we could tell whether improving performance for one source category, ethanol plants for example, would have a detrimental effect on emission prediction for other industrial sources with higher silt loadings.

Likewise, focusing on performance of public roads, with vehicle speed included, greatly affects industrial source emission rates. But what effect does it have on the predictive performance of industrial sources? As we discussed earlier, the coefficient of determination (r^2) is not particularly great for the proposed revision (all data sets included). It would be useful to examine the predictive performance on various subsets of the existing data base, with both the existing and proposed emission factors.

5. Other Factors Affecting USEPA's Paved Road Emission Factor

Following are a few observations that will affect the predictive emission factor equation when used on industrial sources. I believe USEPA should address these concerns prior to revising their existing paved road emission factor.

- The paved road emission factor should consider whether the road shoulder is paved and whether there is a source of dust fallout present. For example, facilities with dust-generating storage piles, and truck traffic moving between these piles, are likely to have high particulate emission rates. This is particularly true for facilities with unpaved road shoulders.

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[11] USEPA, Emission factor Documentation for AP-42, Section 13.2.1, Paved Roads, Draft, June 2010, pp. 4-42 to 4-45.

- Some vehicles have exhaust pipes pointing skyward, others are parallel to the ground, and still others pointing down to the ground. Downward-pointing exhaust can exacerbate resuspension of dust, as I have often observed with forklifts and delivery vehicles with such an exhaust configuration. It is unclear whether industrial vehicles with downward-pointing exhaust are accounted for in the paved road emission factor.
- In developing the revised emission factor, USEPA subtracted a "C" term from the CRA source tests. This results in very small or even negative emission rates for certain tests.[12] Given the plume rise of exhaust from the slow-moving CRA test vehicles, it is possible that most, if not all, of the exhaust plume passed above the downwind air samplers. In other words, the "C" term used by USEPA may be too large for the CRA (and other) source tests. USEPA should reevaluate to what extent, if any, exhaust, and brake and tire wear impact the downwind profile measurements.

6. Concluding Remarks

USEPA's proposed revision to AP-42 Section 13.2.1 excludes a valuable industrial source paved road data base simply because vehicle speed was not included in the study. USEPA's revised emission factor will result in a roughly order of magnitude emission reduction in industrial source paved road emissions. This very significant change may not be appropriate given that a key data set was excluded from the regression analyses.

USEPA may be trying to fit too many source categories into a one-size-fits-all emission factor. Under the umbrella of "paved roads" fits urban freeways, local street traffic, industrial sites with a wide-range of truck sizes and weights, parking lots, and all shapes and sizes of vehicles using these paved surfaces. I understand that USEPA has a very difficult task in developing a paved road emission factor that meets the needs of all affected sources. It is likely that "clean" roads are downward-biasing the emission factor for high-emitting facilities. And the opposite is also true – industrial roads with high silt loading are likely upward-biasing the emission factor for cleaner roads with lighter vehicles.

I offer the suggestion that USEPA should consider developing separate paved road emission factors for public and industrial roads. It may not be too far-fetched to examine separate emission factors for sub-categories of industrial source paved road emissions as well. Also, USEPA may want to focus on silt loading and vehicle weight, as variability in vehicle speed seems to have a less significant impact on predicted emission performance.

Until USEPA has addressed whether the severe reduction in industrial source paved road emission calculations is warranted, I believe that the existing AP-42 paved road emission factor should continue to be used.

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[12] Id.

I greatly appreciate your help in reviewing and commenting on the proposed revisions to AP-42 Section 13.2.1. Please contact me if you have any questions or require additional information.

Sincerely,

Camille Sears

Camille Sears

Table 1A
AP-42 Section 13.2.1: Paved Roads
Comparison of Existing and Draft Paved Road PM10 Emission Factors
(Silt loading resuspension only)

Setting	sL (g/m^2)	W (tons)	S (mph)	Draft E (lb/VMT)	Existing E (lb/VMT)	Draft E / Existing E
Public	0.2	3.75	25	0.0017	0.0045	0.38
Public	0.2	3.75	35	0.0018	0.0045	0.40
Public	0.2	3.75	45	0.0019	0.0045	0.42
Public	0.6	3.75	25	0.0050	0.0098	0.52
Public	0.6	3.75	35	0.0053	0.0098	0.55
Public	0.6	3.75	45	0.0055	0.0098	0.57
Industrial	0.6	10	5	0.0066	0.0441	0.15
Industrial	0.6	10	15	0.0078	0.0441	0.18
Industrial	0.6	10	25	0.0085	0.0441	0.19
Industrial	0.6	20	5	0.0095	0.1255	0.08
Industrial	0.6	20	15	0.0113	0.1255	0.09
Industrial	0.6	20	25	0.0122	0.1255	0.10
Industrial	0.6	30	5	0.0117	0.2309	0.05
Industrial	0.6	30	15	0.0140	0.2309	0.06
Industrial	0.6	30	25	0.0152	0.2309	0.07
Industrial	2.0	10	5	0.0213	0.0969	0.22
Industrial	2.0	10	15	0.0254	0.0969	0.26
Industrial	2.0	10	25	0.0276	0.0969	0.28
Industrial	2.0	20	5	0.0308	0.2749	0.11
Industrial	2.0	20	15	0.0367	0.2749	0.13
Industrial	2.0	20	25	0.0398	0.2749	0.14
Industrial	2.0	30	5	0.0382	0.5055	0.08
Industrial	2.0	30	15	0.0455	0.5055	0.09
Industrial	2.0	30	25	0.0494	0.5055	0.10
Industrial	5.0	10	5	0.0523	0.1762	0.30
Industrial	5.0	10	15	0.0624	0.1762	0.35
Industrial	5.0	10	25	0.0677	0.1762	0.38
Industrial	5.0	20	5	0.0756	0.4992	0.15
Industrial	5.0	20	15	0.0901	0.4992	0.18
Industrial	5.0	20	25	0.0977	0.4992	0.20
Industrial	5.0	30	5	0.0937	0.9174	0.10
Industrial	5.0	30	15	0.1117	0.9174	0.12
Industrial	5.0	30	25	0.1212	0.9174	0.13
Industrial	10.0	10	5	0.1032	0.2767	0.37
Industrial	10.0	10	15	0.1230	0.2767	0.44
Industrial	10.0	10	25	0.1335	0.2767	0.48
Industrial	10.0	20	5	0.1490	0.7835	0.19
Industrial	10.0	20	15	0.1777	0.7835	0.23
Industrial	10.0	20	25	0.1928	0.7835	0.25
Industrial	10.0	30	5	0.1847	1.4398	0.13
Industrial	10.0	30	15	0.2203	1.4398	0.15
Industrial	10.0	30	25	0.2390	1.4398	0.17

Notes:

E = resuspension emission factor; calculations exclude vehicle exhaust, brake wear, and tire wear emissions

sL = silt loading; W = mean vehicle weight; S = mean vehicle speed

For comparison purposes, no rain adjustments or control efficiencies applied

NMED EIB Rebuttal Exhibit 7

Table 1B
AP-42 Section 13.2.1: Paved Roads
Comparison of Existing and Draft Paved Road PM2.5 Emission Factors
(Silt loading resuspension only)

Setting	sL (g/m^2)	W (tons)	S (mph)	Draft E (lb/VMT)	Existing E (lb/VMT)	Draft E / Existing E
Public	0.2	3.75	25	0.0004	0.0004	1.08
Public	0.2	3.75	35	0.0004	0.0004	1.14
Public	0.2	3.75	45	0.0005	0.0004	1.19
Public	0.6	3.75	25	0.0012	0.0012	1.06
Public	0.6	3.75	35	0.0013	0.0012	1.12
Public	0.6	3.75	45	0.0014	0.0012	1.16
Industrial	0.6	10	5	0.0016	0.0063	0.26
Industrial	0.6	10	15	0.0019	0.0063	0.30
Industrial	0.6	10	25	0.0021	0.0063	0.33
Industrial	0.6	20	5	0.0023	0.0185	0.13
Industrial	0.6	20	15	0.0028	0.0185	0.15
Industrial	0.6	20	25	0.0030	0.0185	0.16
Industrial	0.6	30	5	0.0029	0.0343	0.08
Industrial	0.6	30	15	0.0034	0.0343	0.10
Industrial	0.6	30	25	0.0037	0.0343	0.11
Industrial	2.0	10	5	0.0053	0.0142	0.37
Industrial	2.0	10	15	0.0063	0.0142	0.44
Industrial	2.0	10	25	0.0068	0.0142	0.48
Industrial	2.0	20	5	0.0076	0.0410	0.19
Industrial	2.0	20	15	0.0091	0.0410	0.22
Industrial	2.0	20	25	0.0098	0.0410	0.24
Industrial	2.0	30	5	0.0094	0.0755	0.12
Industrial	2.0	30	15	0.0112	0.0755	0.15
Industrial	2.0	30	25	0.0122	0.0755	0.16
Industrial	5.0	10	5	0.0129	0.0261	0.49
Industrial	5.0	10	15	0.0154	0.0261	0.59
Industrial	5.0	10	25	0.0167	0.0261	0.64
Industrial	5.0	20	5	0.0186	0.0746	0.25
Industrial	5.0	20	15	0.0222	0.0746	0.30
Industrial	5.0	20	25	0.0241	0.0746	0.32
Industrial	5.0	30	5	0.0231	0.1373	0.17
Industrial	5.0	30	15	0.0275	0.1373	0.20
Industrial	5.0	30	25	0.0299	0.1373	0.22
Industrial	10.0	10	5	0.0255	0.0412	0.62
Industrial	10.0	10	15	0.0303	0.0412	0.74
Industrial	10.0	10	25	0.0329	0.0412	0.80
Industrial	10.0	20	5	0.0368	0.1172	0.31
Industrial	10.0	20	15	0.0438	0.1172	0.37
Industrial	10.0	20	25	0.0476	0.1172	0.41
Industrial	10.0	30	5	0.0456	0.2157	0.21
Industrial	10.0	30	15	0.0543	0.2157	0.25
Industrial	10.0	30	25	0.0590	0.2157	0.27

Notes:

E = resuspension emission factor; calculations exclude vehicle exhaust, brake wear, and tire wear emissions

sL = silt loading; W = mean vehicle weight; S = mean vehicle speed

For comparison purposes, no rain adjustments or control efficiencies applied

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Table 2A
AP-42 Section 13.2.1: Paved Roads
Comparison of Existing and CRA-Proposed Paved Road PM10 Emission Factors
(Silt loading resuspension only)

Setting	sL (g/m^2)	W (tons)	S (mph)	CRA E (lb/VMT)	Existing E (lb/VMT)	CRA E / Existing E
Public	0.2	3.75	25	0.0039	0.0045	0.86
Public	0.2	3.75	35	0.0039	0.0045	0.86
Public	0.2	3.75	45	0.0039	0.0045	0.86
Public	0.6	3.75	25	0.0100	0.0098	1.03
Public	0.6	3.75	35	0.0100	0.0098	1.03
Public	0.6	3.75	45	0.0100	0.0098	1.03
Industrial	0.6	10	5	0.0225	0.0441	0.51
Industrial	0.6	10	15	0.0225	0.0441	0.51
Industrial	0.6	10	25	0.0225	0.0441	0.51
Industrial	0.6	20	5	0.0396	0.1255	0.32
Industrial	0.6	20	15	0.0396	0.1255	0.32
Industrial	0.6	20	25	0.0396	0.1255	0.32
Industrial	0.6	30	5	0.0549	0.2309	0.24
Industrial	0.6	30	15	0.0549	0.2309	0.24
Industrial	0.6	30	25	0.0549	0.2309	0.24
Industrial	2.0	10	5	0.0598	0.0969	0.62
Industrial	2.0	10	15	0.0598	0.0969	0.62
Industrial	2.0	10	25	0.0598	0.0969	0.62
Industrial	2.0	20	5	0.1044	0.2749	0.38
Industrial	2.0	20	15	0.1044	0.2749	0.38
Industrial	2.0	20	25	0.1044	0.2749	0.38
Industrial	2.0	30	5	0.1447	0.5055	0.29
Industrial	2.0	30	15	0.1447	0.5055	0.29
Industrial	2.0	30	25	0.1447	0.5055	0.29
Industrial	5.0	10	5	0.1250	0.1762	0.71
Industrial	5.0	10	15	0.1250	0.1762	0.71
Industrial	5.0	10	25	0.1250	0.1762	0.71
Industrial	5.0	20	5	0.2179	0.4992	0.44
Industrial	5.0	20	15	0.2179	0.4992	0.44
Industrial	5.0	20	25	0.2179	0.4992	0.44
Industrial	5.0	30	5	0.3016	0.9174	0.33
Industrial	5.0	30	15	0.3016	0.9174	0.33
Industrial	5.0	30	25	0.3016	0.9174	0.33
Industrial	10.0	10	5	0.2179	0.2767	0.79
Industrial	10.0	10	15	0.2179	0.2767	0.79
Industrial	10.0	10	25	0.2179	0.2767	0.79
Industrial	10.0	20	5	0.3797	0.7835	0.48
Industrial	10.0	20	15	0.3797	0.7835	0.48
Industrial	10.0	20	25	0.3797	0.7835	0.48
Industrial	10.0	30	5	0.5254	1.4398	0.36
Industrial	10.0	30	15	0.5254	1.4398	0.36
Industrial	10.0	30	25	0.5254	1.4398	0.36

Notes:

E = resuspension emission factor; calculations exclude vehicle exhaust, brake wear, and tire wear emissions

sL = silt loading; W = mean vehicle weight; S = mean vehicle speed

CRA = Corn Refiners Association

For comparison purposes, no rain adjustments or control efficiencies applied

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Table 2B
AP-42 Section 13.2.1: Paved Roads
Comparison of Existing and CRA-Proposed Paved Road PM2.5 Emission Factors
(Silt loading resuspension only)

Setting	sL (g/m^2)	W (tons)	S (mph)	CRA E (lb/VMT)	Existing E (lb/VMT)	CRA E / Existing E
Public	0.2	3.75	25	0.0003	0.0004	0.73
Public	0.2	3.75	35	0.0003	0.0004	0.73
Public	0.2	3.75	45	0.0003	0.0004	0.73
Public	0.6	3.75	25	0.0012	0.0012	1.02
Public	0.6	3.75	35	0.0012	0.0012	1.02
Public	0.6	3.75	45	0.0012	0.0012	1.02
Industrial	0.6	10	5	0.0030	0.0063	0.48
Industrial	0.6	10	15	0.0030	0.0063	0.48
Industrial	0.6	10	25	0.0030	0.0063	0.48
Industrial	0.6	20	5	0.0056	0.0185	0.30
Industrial	0.6	20	15	0.0056	0.0185	0.30
Industrial	0.6	20	25	0.0056	0.0185	0.30
Industrial	0.6	30	5	0.0078	0.0343	0.23
Industrial	0.6	30	15	0.0078	0.0343	0.23
Industrial	0.6	30	25	0.0078	0.0343	0.23
Industrial	2.0	10	5	0.0085	0.0142	0.60
Industrial	2.0	10	15	0.0085	0.0142	0.60
Industrial	2.0	10	25	0.0085	0.0142	0.60
Industrial	2.0	20	5	0.0151	0.0410	0.37
Industrial	2.0	20	15	0.0151	0.0410	0.37
Industrial	2.0	20	25	0.0151	0.0410	0.37
Industrial	2.0	30	5	0.0211	0.0755	0.28
Industrial	2.0	30	15	0.0211	0.0755	0.28
Industrial	2.0	30	25	0.0211	0.0755	0.28
Industrial	5.0	10	5	0.0182	0.0261	0.70
Industrial	5.0	10	15	0.0182	0.0261	0.70
Industrial	5.0	10	25	0.0182	0.0261	0.70
Industrial	5.0	20	5	0.0319	0.0746	0.43
Industrial	5.0	20	15	0.0319	0.0746	0.43
Industrial	5.0	20	25	0.0319	0.0746	0.43
Industrial	5.0	30	5	0.0443	0.1373	0.32
Industrial	5.0	30	15	0.0443	0.1373	0.32
Industrial	5.0	30	25	0.0443	0.1373	0.32
Industrial	10.0	10	5	0.0319	0.0412	0.77
Industrial	10.0	10	15	0.0319	0.0412	0.77
Industrial	10.0	10	25	0.0319	0.0412	0.77
Industrial	10.0	20	5	0.0558	0.1172	0.48
Industrial	10.0	20	15	0.0558	0.1172	0.48
Industrial	10.0	20	25	0.0558	0.1172	0.48
Industrial	10.0	30	5	0.0774	0.2157	0.36
Industrial	10.0	30	15	0.0774	0.2157	0.36
Industrial	10.0	30	25	0.0774	0.2157	0.36

Notes:

E = resuspension emission factor; calculations exclude vehicle exhaust, brake wear, and tire wear emissions

sL = silt loading; W = mean vehicle weight; S = mean vehicle speed

CRA = Corn Refiners Association

For comparison purposes, no rain adjustments or control efficiencies applied

NMED EIB Rebuttal Exhibit 7

Fw: Dave's comments on the Excel workbook - do not need to be mentioned on the call

dave.james to: Ron Myers 08/18/2010 03:07 PM

Dear Ron,

Please find attached some comments on the proposed new AP42 paved road equation

A) I think that, on tab PM10 Paved Roads EF's, column Z, the
column labeled "Percent Total Emissions Factor Increase" uses the formula (column x - column s) / column x
to calculate percent changes. I think this should be, instead (column x - column s) / column s, so that the percent change is calculated relative to the 2006 emissions factor equation instead
of the proposed new 2010 emissions factor equation
Column AD is the recalculated percent reduction for the rain corrected EF's based on this suggested equation revision

B) For the desert southwest, I think that it is best to look at the data without rain adjustments

C) In my edited tab "PM10 Paved Roads EF's" I have added several columns, AB, AC, and AD
(1) Column AB is the calculated raw reduction of 2010 dry EF's compared to 2006 dry EF's. (column u - column o)
(2) Column AC is the calculated percent reduction of 2010 dry EF's compared to 2006 dry EF's using the equation (column u - column o)/column o

D) based on the 7,632 row data set in the tab PM10 Paved Roads EF's

(1) The new 2010 dry EF's are *much lower overal*l than the 2006 dry EF's. see the chart in the new tab labeled "compareNewOLDPM10EF's"

(2) The *reductions* of dry 2010 EF's compared to dry 2006 EF's linearly increase in magnitude with the magnitude of the original 2006 emissions factor (see the chart in the new tab labeled "reductions" - calculated in column AB)

(3) When I plot the *percentage changes* of the dry 2010 PM 10 EF's calculated) above against 2006 emissions factors, they are all around 70-80% (see the chart new tab labeled "percent reductions")

E) Athough national data might show reductions, since the new equation
1) raises the influence of silt loading (new exponent 0.98, old exponent 0.65)
2) lowers the influence of vehicle weight (new exponent 0.53, old exponent 1.5)
3) adds in an influence of vehicle speed,
4) eliminates the influence of the correction factor for exhaust brake and tire wear,
I would recommend that any assessment of the impact of the proposed new equation be based on locally sampled data and not use the national data.

Thank you for the opportunity to comment.

NMED EIB Rebuttal Exhibit 7

Sincerely,
Dave

David E. James, PhD PE
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Re: Fw: Dave's comments on the EPA Excel workbook - some additional follow up thoughts

dave.james to: Ron Myers 09/15/2010 02:44 PM
Cc: Rodney Langston, Russell Merle

Hi Ron,
Thank you for your good email below and for the additional information.
I apologize for taking so long to get back to you with my thoughts and responses. Here they are:

A) Understood about the zeros being problematic

B) In many parts of the country where there is significant rain or a rainy season, rain days may considerably effect estimated PM10 emissions in the inventory. However, for Las Vegas and other places like it in arid places,
I tend to use a 'pessimistic' approach that doesn't include the rain days, since rain occurs sporadically, and what rain does fall is often very light.

C) I'm glad that my extra columns in your Excel workbook are helpful

D) Yes, from the default data it looks like many of the estimated EF's would go down with the new proposed equation

E) Since we last corresponded,
1) I ran some calculations for Clark County's AP42 measured 2003-2006 silt loading data set using their locally derived fleet weights. Please see the attached file "comparison20062010_AP42 road dust EFs2003_2006.pdf"
If you examine the bottom-most table on the page, where percentage EF changes are computed, that the net impact of the new proposed equation on Clark County's estimated paved road dust PM-10 emissions would be to
a) increase estimated PM10 emissions as grams/VMT 23% on local roads,
b) decrease them by 3% on collector roads (probably not significant), and
c) increase them by 1% on minor arterials (also probably not significant).

With locally derived data, we obtain results that are different from those that might be predicted using default silt loading data. The actual impact on total estimated PM10 emissions in an inventory or SIP would depend on how much VMT was assigned to each roadway category.

2) I also ran a hypothetical sensitivity analysis comparing arbitrary combinations of vehicle weight and silt loading, to see what the impacts of the new PM10 equation might be. Please see the attached file "new2010EFsensitivityanalysis.pdf"
Table 1 shows the 2006 equation predicted PM10 emissions
Table 2 shows the proposed 2010 equation predicted PM10 emissions
Table 3 shows the changes in predicted emissions (2010 EF - 2006 EF)
and
Table 4 shows the Percentage changes, (2010 EF - 2006 EF)/2006 EF

Table 4 shows that the net effect of using the new proposed 2010 equation is that predicted

NMED EIB Rebuttal Exhibit 7

PM10 emissions
a) increase for lower silt loadings at all fleet average vehicle weights, and
b) decrease for higher silt loadings, espeically at lower fleet average vehicle weights

I hope that these preliminary calculations are helpful. I have also sent them as PDF and as the original Excel files to
my research sponsors, Clark County Dept of Air Quality and Environmental Management.

Sincerely,
Dave

David E. James, PhD PE
Associate Vice Provost for Academic Programs
Office of the Vice Provost for Academic Affairs
Box 451099
4505 South Maryland Parkway
Las Vegas, NV 89154-1099
Direct Line (702) 895-5804 Main Office (702) 895-1267
FAX (702) 895-3670 FDH 704 Mail Stop 1099
email: dave.james@unlv.edu
http://provost.unlv.edu/acadaffairs.html

From: Myers.Ron@epamail.epa.gov
To: dave.james@unlv.edu
Date: 08/18/2010 06:34 PM
Subject: Re: Fw: Dave's comments on the Excel workbook - do not need to be mentioned on the call

---

Dave:
Thanks for looking at the proposed revisions of the paved road equation.

First, I was trying to replicate the emissions estimates that are being made for the 2008 NEI, any rain adjustments or other mitigation that I included in the spreadsheet are the same as I estimated were used in the NEI emissions estimates. As with you I would not have included as much mitigation for rain and "Street Sweeping" and other silt management as there is is used in the NEI estimates.

A. You are correct. I should have divided by the estimated 2008 emissions as calculated with the existing AP-42. I think this was a hold over from when I was just looking at the road dust emissions estimates. When looking only at road dust emissions, all the zero emissions estimates is problematic since dividing by zero only generates errors in Excel. I added in the vehicle emissions when I saw how many 2008 NEI estimates were zero.

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B. I would tend to agree with you as there are not many rain days. As I stated above, I don't know what mitigation is included in the "adjusted" emissions data in the NEI. Frankly to documentation of the NEI emissions estimates doesn't help me much to recreate their emissions estimates (see paved_roads_2294000000_documentation.doc which is attached).

C. Thanks for the calculations. I did these calculation only because a few internal EPA people suggested that I provide State/local agencies with some information to provide an indication of how this change might affect their inventories.

D. My original assessment also showed that the revised equation generates much lower PM10 estimates than the previous equation. From a combined emisions inventory perspective and use in the modeling for SIP development this should get support from inventory developers, modelers and Air Quality Assessors as it has always been difficult to explain how fugitive dust emissions are the majority of the emissions in the inventory but comprise less than 10% of the emissions on PM monitors. This will not get the inventory there but it goes in the right direction. I agree that for best emissions estimates, locally derived silt loadings are needed. However, no one wants to develop these and would rather complain that EPA's default values aren't good enough and they want better defaults. There is so much variation in silt levels on roads no single number is good enough for every road.

Ron Myers
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Sector Policy and Programs Division
Monitoring Policy Group, D243-05
RTP NC 27711
Tel. 919.541.5407
Fax 919.541.1039
E-mail myers.ron@epa.gov

dave.james---08/18/2010 03:10:06 PM---Dear Ron, This is a resend, using a compressed version of the Excel file to reduce

From:

dave.james@unlv.edu

To:

Ron Myers/RTP/USEPA/US@EPA

Date:

08/18/2010 03:10 PM

Subject:

Fw: Dave's comments on the Excel workbook - do not need to be mentioned on the call

Dear Ron,

This is a resend, using a compressed version of the Excel file to reduce the file size,
in case my earlier send was rejected.

Please find attached some comments on the proposed new AP42 paved road equation

A) I think that, on tab PM10 Paved Roads EF's, column Z, the
column labeled "Percent Total Emissions Factor Increase" uses the formula
(column x - column s) / column x
to calculate percent changes. I think this should be, instead (column x - column s) / column s, so that
the percent change is calculated relative to the 2006 emissions factor equation instead
of the proposed new 2010 emissions factor equation
Column AD is the recalculated percent reduction for the rain corrected EF's based on this suggested equation revision

B) For the desert southwest, I think that it is best to look at the data without rain adjustments

C) In my edited tab "PM10 Paved Roads EF's" I have added several columns, AB, AC, and AD
(1) Column AB is the calculated raw reduction of 2010 dry EF's compared to 2006 dry EF's. (column u - column o)
(2) Column AC is the calculated percent reduction of 2010 dry EF's compared to 2006 dry EF's using
the equation (column u - column o)/column o

D) based on the 7,632 row data set in the tab PM10 Paved Roads EF's

(1) The new 2010 dry EF's are much lower overal l than the 2006 dry EF's. see the chart in the new tab labeled "compareNewOLDPM10EF's"

(2) The reductions of dry 2010 EF's compared to dry 2006 EF's linearly increase in magnitude with the magnitude of the original 2006 emissions factor (see the chart in the new tab labeled "reductions" - calculated in column AB)

(3) When I plot the percentage changes of the dry 2010 PM 10 EF's calculated) above against 2006 emissions factors, they are all around 70-80% (see the chart new tab labeled "percent reductions")

E) Athough national data might show reductions, since the new equation
1) raises the influence of silt loading (new exponent 0.98, old exponent 0.65)

2) lowers the influence of vehicle weight (new exponent 0.53, old exponent 1.5)
3) adds in an influence of vehicle speed,
4) eliminates the influence of the correction factor for exhaust brake and tire wear,
I would recommend that any assessment of the impact of the proposed new equation be
based on locally sampled data and not use the national data.

NMED EIB Rebuttal Exhibit 7

Thank you for the opportunity to comment.
Sincerely,
Dave

David E. James, PhD PE
Associate Vice Provost for Academic Programs
Office of the Vice Provost for Academic Affairs
Box 451099
4505 South Maryland Parkway
Las Vegas, NV 89154-1099
Direct Line (702) 895-5804 Main Office (702) 895-1267
FAX (702) 895-3670 FDH 704 Mail Stop 1099
email: dave.james@unlv.edu
http://provost.unlv.edu/acadaffairs.html

*********************** ATTACHMENT NOT DELIVERED *******************

This Email message contained an attachment named
djedit_Impact_of_revised_paved_roads_pm_emission_factors_on_NEI.xls.zip
which may be a computer program. This attached computer program could contain a computer virus which could cause harm to EPA's computers, network, and data. The attachment has been deleted.

This was done to limit the distribution of computer viruses introduced into the EPA network. EPA is deleting all computer program attachments sent from the Internet into the agency via Email.

If the message sender is known and the attachment was legitimate, you should contact the sender and request that they rename the file name extension and resend the Email with the renamed attachment. After receiving the revised Email, containing the renamed attachment, you can rename the file extension to its correct name.

For further information, please contact the EPA Call Center at
(866) 411-4EPA (4372). The TDD number is (866) 489-4900.

*********************** ATTACHMENT NOT DELIVERED
***********************[attachment "paved_roads_2294000000_documentation.doc" deleted by Dave James/UNLV]

From: Steve Zemba <zemba@cambridgeenvironmental.com>
To: Ron Myers/RTP/USEPA/US@EPA
cc: gfore@hotmix.org, Mike <ames@cambridgeenvironmental.com>, Laura Green <green@cambridgeenvironmental.com>, HMarks@hotmix.org

---

Date: Tuesday, August 31, 2010 02:32PM
Subject: Comment on AP42 Paved Roads Draft Section 13.2.1

History: This message has been replied to and forwarded.

Dear Ron,

I write to provide the attached comment on the draft AP42 section on Paved Road dust emissions. As described in the comment, NAPA (who sponsored the review) is potentially interested in collecting data to provide more representative parameters for applications to the asphalt pavement industry. We would appreciate your advice on how best to gather these data so that they could be submitted for consideration in the AP42 section.

Thanks for your help and consideration,

Steve

--
Stephen G. Zemba, Ph.D., P.E.
Senior Engineer

Cambridge Environmental Inc

58 Charles Street
Cambridge, MA 02141

Office: 617-225-0810 x34 M-W 518-306-4603 Th-F
Cell: 339-223-9328
Fax: 617-225-0813
http://www.CambridgeEnvironmental.com

- AP42PavedRoadsSectionComment083110.pdf	**Type:** application/pdf **Name:** AP42PavedRoadsSectionComment

NMED EIB Rebuttal Exhibit 7

Cambridge Environmental Inc

58 Charles Street Cambridge, Massachusetts 02141
617-225-0810 www.CambridgeEnvironmental.com

August 31, 2010

Ronald Myers
U.S. Environmental Protection Agency
109 T.W. Alexander Drive
Mail Code: D243-05
Research Triangle Park, NC 27709

Dear Ron,

It was a pleasure speaking with you again recently – thank you for the background information on the draft update to the AP42 section on Paved Road emissions (Section 13.2.1).

I have reviewed the draft update on behalf of the National Asphalt Pavement Association (NAPA), and write to comment on a specific aspect of interest. I believe that the recommended default values for silt-loading in draft Table 13.2.1-3, and particularly that for asphalt batching, may be too high for typical current applications. The recommended value is 120 g/m^2, but, as you know, in EPA's 2000 Emission Assessment Report for Hot Mix Asphalt Plants, a silt-loading value 3 g/m^2 is suggested for paved roads at typical hot-mix asphalt production facilities. Also, site-specific measurements at a hot mix asphalt facility in Alexandria, Virginia in 2005 (using the sampling and analytical methods described in AP42 Appendix C) found a silt loading level of 0.5 g/m^2. This facility, which we analyzed in detail for the City of Alexandria, employs aggressive dust suppression techniques.

More generally, as you know, best management practices (BMPs) such as water spraying and road sweeping can effectively control dust emissions; by the same token, the absence of these practices can indeed result in dusty roads. Perhaps the value of 120 g/m^2, which appears to be based on older data, derives from testing at one or more facilities that failed to employ BMPs. If so, then perhaps 120 g/m^2 could be considered to be a default value in the absence of BMPs, whereas the value of 3 g/m^2, as used in EPA's Emission Assessment Report, could be a default value in the presence of typical BMPs.

Of course, more data are always better. In that regard, we have spoken with representatives from NAPA , and they have expressed potential willingness to coordinate a study to provide updated values for silt loading and other emission factor parameters that reflect current practices in the hot-mix asphalt industry. At your convenience, might we schedule a call to discuss whether this would be of interest to you and your colleagues at the Agency?

Thank you for your consideration, and best regards.

Sincerely,

Stephen G. Zemba

Stephen G. Zemba, Ph.D., P.E.
Senior Engineer

NMED EIB Rebuttal Exhibit 7

IDNR comment on proposed AP 42 Section 13.2.1 Paved Roads

Hanson, Lori [DNR] to: Ron Myers 08/20/2010 10:45 AM
Cc: "McGraw, Jim [DNR]"

History: This message has been forwarded.

Mr. Myers,

I have attached the Iowa Department of Natural Resources comments on the proposed revision toAP42 section 13.2.1 on paved roads. Thank you for the opportunity to provide comments, Lori Hanson

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Fields of Opportunities

STATE OF IOWA

CHESTER J. CULVER, GOVERNOR
PATTY JUDGE, LT. GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
RICHARD A. LEOPOLD, DIRECTOR

August 20, 2010

U.S. Environmental Protection Agency (EPA)
Measurement Policy Group

Attn: Proposed Revisions to AP42 section13.2.1 Paved Roads

The Iowa Department of Natural Resources (IDNR) is providing comment on the proposed revision of AP-42 Section 13.2.1 for paved roads. The DNR supports the revision of this section to incorporate new data from corn wet mills and to account for mean vehicle speeds below 10 miles per hour.

The current AP-42 emission factor (November 2006) includes vehicle emissions (engine exhaust, tire wear and brake wear) in the empirical equation. Additionally there is a vehicle emission constant "C" that is subtracted from the equation. This "C" constant accounts for 1980's vehicle fleet exhaust, brake wear and tire wear and is subtracted from the equation to eliminate the possibility of double counting emissions and to account for the decrease in particulate emissions from improvements related to newer model trucks and cleaner fuels since the empirical equation was derived. A table of default values for "C" that varied with particle aerodynamic size range is included in the section.

The proposed empirical equation was developed by linear regression analysis after subtracting the engine, tire and brake wear estimated using EPA's MOBILE6.2 and MOVES2010 models from the measured impacts to estimate emissions solely from vehicle travel on the paved roads. To determine the total paved road emission factor, the emission factor from vehicle emissions generated by running either EPA's MOBILE6.2 or MOVES2010 models must be added to the emission factor from the empirical equation. This methodology requires that a mobile source emissions model be run in order to determine a paved road emission factor.

Obtaining the emissions factor for vehicle emissions in this manner will be problematic as the DNR does not have the resources to generate specific emissions factors for vehicle emissions by running MOVES2010 for every construction permitting project that includes a paved haul road. The DNR suggests that either the empirical equation be developed to include vehicle emissions from engine exhaust, tire and brake wear, or that a table of default values be included in the section to account for vehicle emissions as an alternative to running a mobile source emission model.

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Thank you for the opportunity to comment on the proposed revision of AP-42 Section 13.2.1 for paved roads.

Sincerely,

for

Catharine Fitzsimmons, Chief
Air Quality Bureau

NMED EIB Rebuttal Exhibit 7

RE: PECHAN/ERTAC Road Dust Emissions

Pat Davis to: Roy Huntley, Ron Myers 07/26/2010 01:22 PM

History: This message has been replied to.

Hi Ron,

Have you had a chance to look into this issue?

To refresh your memory we noticed that a number of the PM2.5 emission factors were zeroed out for a number of road types. Can you please tell us why the road types listed below were zeroed out?

Urban Collector
Urban Minor Arterial
Urban Other Principal Arterial
Urban Other Freeways and Expressways
Urban Interstate

Thanks,
Pat Davis

-----Original Message-----
From: Huntley.Roy@epamail.epa.gov [mailto:Huntley.Roy@epamail.epa.gov]
Sent: Tuesday, July 13, 2010 1:38 PM
To: Myers.Ron@epamail.epa.gov
Cc: Pat Davis
Subject: Fw: PECHAN/ERTAC Road Dust Emissions

Ron, could you answer Pat question?

Roy Huntley
Environmental Engineer
Emission Inventory and Analysis Group
Mail Drop (C339-02)
Environmental Protection Agency
RTP, NC 27711
Voice - 919 541-1060
Fax - 919 541-0684
Office C341H
----- Forwarded by Roy Huntley/RTP/USEPA/US on 07/13/2010 01:24 PM -----

```
|>
| From:      Pat Davis <pdavis@marama.org>
|
|>
| To:        Roy Huntley/RTP/USEPA/US@EPA
|
>
|>
| Cc:
Judy Rand <Judy.Rand@dep.state.nj.us>, Julie McDill <jmcdill@marama.org>,
Pat Davis <pdavis@marama.org>, "Fees David F. (DNREC)"<David.Fees@state.de.us>,|
"WRBARNARD@mactec.com" <WRBARNARD@mactec.com>, Walter Simms <wsimms@mde.state.md.us>,
"kenneth.santlal@state.ma.us"<kenneth.santlal@state.ma.us                            |
```

```
|------------>
| Date:      07/13/2010 12:02 PM
|
|
| Subject:   PECHAN/ERTAC Road Dust Emissions
|
```

>Hi Roy,

We have been examining the ERTAC/PECHAN emission factors for Road Dust and Maryland noticed that the PM2.5 emission factors were zeroed out for the following road types:

Urban Collector
Urban Minor Arterial
Urban Other Principal Arterial
Urban Other Freeways and Expressways
Urban Interstate

Emission factors for PM10 were found and there was no mention in the documentation of why the PM2.5 emission factors were zeroed out, so we are bit confused.

We were hoping that you might have answer for us, or be able to point us in the direction of someone who might know why the PM2.5 emission factors are zeroed out.

Thanks, and I hope you are well!
Pat Davis

NMED EIB Rebuttal Exhibit 7

FW: [chief] Proposed revisions to AP 42 section 13.2.1 Paved Roads
Julie McDill to: Ron Myers 06/23/2010 03:29 PM
History: This message has been replied to.

Hello Ron,

I called and left a message about possibly getting on a call with the MARAMA states in the next couple of weeks to discuss proposed changes to the Paved Road PM emissions estimation method.

Please respond to let me know if and when that might be possible. I can set up a conference call and distribute a slide set. It would be best sometime between July 7 and 16th. What follows (and the attachment) are some emails that give you a flavor of the changes that states are finding as a result of the new calculations. As you probably know, the PM emission from paved roads has always posed problems in modeling. In general, modelers take our inventories and reduced the paved road emissions by about 90% before running the model.

Thanks for your help.

Julie McDill
MARAMA

From: Judy Rand [Judy.Rand@dep.state.nj.us]
Sent: Wednesday, June 16, 2010 4:43 PM
To: Julie McDill; Pat Davis; rthunell@mde.state.md.us; David.Fees@state.de.us
Cc: Nicholle Worland; WRBARNARD@mactec.com; kenneth.santlal@state.ma.us
Subject: RE: [chief] Proposed revisions to AP42 section 13.2.1 Paved Roads

Thanks Dave. We have come up with similar results, but even more drastic for PM2.5. An increase in PM2.5 of 350% and a decrease in PM10 of 46% I think one big cause is the difference in k factor, among other changes. The k factor for PM2.5 went down from the 2003 AP-42 to the 2006 AP-42, and back up again in this new draft. We guessed at the new vehicle speed requirement, but a slight variation in speeds will not make that much of a difference.

See NJ's attached calcs and compare spreadsheet. I won't be in til Monday. If you want to have a call either Nicholle can cover it tomorrow, or we are in on Monday.

Judy

>>> "Fees David F. (DNREC)" <David.Fees@state.de.us> 6/16/2010 2:02 PM >>>
Roger,
Here is Delaware's paved road dust spreadsheet for 2007, using the new equation. We got very detailed with this category; estimating emissions by month.
Regarding the new equation, PM10 was reduced by 58% from the emissions submitted to MACTEC; while PM2.5 increased by 48%. I believe the PM2.5 increase is caused by two factors-first, the PM2.5/PM10 ratio was increased to 25% (previously 15%). The second reason is that under the old equation, one had to apply a correction factor, C, to remove the exhaust, brake, and tire wear from the front part of the equation. By subtracting C at the end of the equation, the resulting PM2.5 value went negative for several roadway types. Of course we zeroed these out, but with the new method there is never a

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situation where the emission factor value can go negative. Having negative emission factors result from the use of the old equation was obviously a flaw in the method, so I expect the new equation is more accurate.
I look forward to NJ's results when they apply the new equation, to see if they get changes similar to mine.
If you have any questions about the calculations within the spreadsheet, just give a call.
Regards,
Dave
David F. Fees, P.E.
Managing Engineer
Emission Inventory Development Program
Air Quality Management Section, DNREC
tel. (302) 739-9402, fax (302) 739-3106
e-mail: david.fees@state.de.us<mailto:david.fees@state.de.us>

Blue Skies Delaware; Clean Air for Life

From: Roger Thunell [mailto:rthunell@mde.state.md.us]
Sent: Monday, June 14, 2010 3:00 PM
To: Judy Rand; Julie McDill; Pat Davis
Cc: WRBARNARD@mactec.com; Fees David F. (DNREC); kenneth.santlal@state.ma.us
Subject: RE: [chief] Proposed revisions to AP42 section 13.2.1 Paved Roads

Judy/Dave/Kenneth:
Could any of you send me a spreadsheet calculating emissions in this manner?
I am not sure if we are using the latest methods or not.

Thanks
Roger

>>> Pat Davis <pdavis@marama.org> 6/14/2010 12:54 PM >>>
Thanks a lot for sending this along, Judy. Please let us know what you find when you look at the changes in emissions.

Pat

-----Original Message-----
From: Judy Rand [mailto:Judy.Rand@dep.state.nj.us]
Sent: Monday, June 14, 2010 9:16 AM
To: Julie McDill; Pat Davis
Cc: WRBARNARD@mactec.com; rthunell@mde.state.md.us; David.Fees@state.de.us; kenneth.santlal@state.ma.us
Subject: Fwd: [chief] Proposed revisions to AP42 section 13.2.1 Paved Roads

Pat and Julie,
We are going to look at this to see how it affects emissions. In the past, each change to this category has changed emission calculations.
Thanks,
Judy

Judy Rand, PE
Environmental Engineer
NJDEP Air Quality Planning
(609) 984-1950
jrand@dep.state.nj.us

FW: Proposed revisions to AP 42 section 13.2.1 Paved Roads
Julie McDill to: Ron Myers 06/30/2010 04:25 PM

Hi Ron,
Here is the announcement for our call next week. Can you send me a slide set by noon next Tuesday and I will distribute it to the group and post it on our ftp.
Thanks,
Julie

From: Julie McDill
Sent: Tuesday, June 29, 2010 3:21 PM
To: Paul.Bodner@ct.gov; mark.prettyman@state.de.us; David.Fees@state.de.us; jessica.daniels@dc.gov; melanie.loyzim@maine.gov; rthunell@mde.state.md.us; kenneth.santlal@state.ma.us; david.healy@des.nh.gov; judy.rand@dep.state.nj.us; Nicholle.Worland@dep.state.nj.us; jdbarnes@gw.dec.state.ny.us; rwstanna@gw.dec.state.ny.us; sbogart@state.pa.us; karen.slattery@dem.ri.gov; jeff.merrell@state.vt.us; Thomas.Foster@deq.virginia.gov; laura.boothe@ncdenr.gov; Robert.J.Betterton@wv.gov; mcconnell.robert@epamail.epa.gov; Forde.Raymond@epamail.epa.gov; kremer.janet@epamail.epa.gov; huntley.roy@epa.gov; Susan Wierman
Cc: cooke.donald@epamail.epa.gov; burkhart.richard@epamail.epa.gov; Garcia.Ariel@epamail.epa.gov; Kelly.Bob@epamail.epa.gov; Salomone.Jenna@epamail.epa.gov; Wieber.Kirk@epamail.epa.gov; Moltzen.Michael@epamail.epa.gov; Laurita.Matthew@epamail.epa.gov; Feingersh.Henry@epamail.epa.gov; Kremer.Janet@epamail.epa.gov; Ellsworth.Todd@epamail.epa.gov; Leon-Guerrero.Tim@epamail.epa.gov; Cripps.Christopher@epamail.epa.gov; Rehn.Brian@epamail.epa.gov; Kotsch.Martin@epamail.epa.gov; Dolce.Gary@epamail.epa.gov; Kapichak.Rudolph@epamail.epa.gov; Houyoux.Marc@epamail.epa.gov; Timin.Brian@epamail.epa.gov; Stackhouse.Butch@epamail.epa.gov; Broadwell.Valerie@epamail.epa.gov; Ling.Michael@epamail.epa.gov; Fox.Tyler@epamail.epa.gov; Cook.Leila@epamail.epa.gov; Spink.Marcia@epamail.epa.gov; Wayland.Richard@epamail.epa.gov; Hemby.James@epamail.epa.gov; Wilkie.Walter@epamail.epa.gov; Fernandez.Cristina@epamail.epa.gov; Ruvo.Richard@epamail.epa.gov; Werner.Raymond@epamail.epa.gov; arnold.anne@epamail.epa.gov; Baker.William@epamail.epa.gov; Arnold.David@epamail.epa.gov; Conroy.Dave@epamail.epa.gov
Subject: FW: Proposed revisions to AP42 section 13.2.1 Paved Roads

Hello all,

This email is to announce a teleconference on July 7 at 2:30 PM Eastern concerning the proposed change to the equation used to estimate PM 10 and 2.5 emissions from paved roads. Ron Myers of OAQPS will provide a presentation on the development of the new equation and will answer your questions. Modellers and planners from MANE-VU state agencies along with some USEPA regional staff have been invited. Call in information is as follows:

Number: 866-202-1783
Code: *5743656* - Make sure you press * before and after the number.
Date: July 7
Time: 2:30 - 4:00 P.M. Eastern

BACKGROUND FOR THE CALL
This equation is used to calculate emissions for the area source modeling inventory. Delaware and New Jersey have already done some preliminary calculations and find the new equation results in very different values than the old equation. I attach their spreadsheets for your review. Toward the bottom of this email are texts of emails discussing the differences. In addition is the text distributed by NACAA which provides links to materials

NMED EIB Rebuttal Exhibit 7

for your formal comment to USEPA.

As you are no doubt aware, modellers have applied a transport fraction reduction to fugitive road dust emissions in the past to bring the calculated impact on ambient PM in line with measured concentrations. The new equation may require a revision to the transport fraction calculation. I have invited our NY modellers to join the call to hear the discussion so that they can consider any impact on the transport fraction calculation.

The new equation is proposed, so we can decide to use the old calculation method for our modeling inventory. That is what is in our current draft area source inventory files. However, States will then face a disconnect with the model for future emission calculations. At any rate, it seems to me that all states should use the same methodology so that the inventory is consistant accross our region.

Julie McDill
MARAMA

Relevant Email texts

From: Judy Rand [Judy.Rand@dep.state.nj.us]
Sent: Wednesday, June 16, 2010 4:43 PM

Thanks Dave. We have come up with similar results, but even more drastic for PM2.5. An increase in PM2.5 of 350% and a decrease in PM10 of 46% I think one big cause is the difference in k factor, among other changes. The k factor for PM2.5 went down from the 2003 AP-42 to the 2006 AP-42, and back up again in this new draft. We guessed at the new vehicle speed requirement, but a slight variation in speeds will not make that much of a difference.

See NJ's attached calcs and compare spreadsheet. I won't be in til Monday. If you want to have a call either Nicholle can cover it tomorrow, or we are in on Monday.

Judy

From: "Fees David F. (DNREC)" <David.Fees@state.de.us> 6/16/2010 2:02 PM

Roger,
Regarding the new equation, PM10 was reduced by 58% from the emissions submitted to MACTEC; while PM2.5 increased by 48%. I believe the PM2.5 increase is caused by two factors-first, the PM2.5/PM10 ratio was increased to 25% (previously 15%). The second reason is that under the old equation, one had to apply a correction factor, C, to remove the exhaust, brake, and tire wear from the front part of the equation. By subtracting C at the end of the equation, the resulting PM2.5 value went negative for several roadway types. Of course we zeroed these out, but with the new method there is never a situation where the emission factor value can go negative. Having negative emission factors result from the use of the old equation was obviously a flaw in the method, so I expect the new equation is more accurate.
I look forward to NJ's results when they apply the new equation, to see if they get changes similar to mine.
If you have any questions about the calculations within the spreadsheet, just give a call.
Regards,
Dave

TO: NACAA EMISSIONS & MODELING COMMITTEE
Please information below regarding a proposed revision of the AP-42 paved roads section. The proposed draft can be found here - http://www.epa.gov/ttn/chief/ap42/ch13/index.html; scroll down to section 13.2.1, paved roads. EPA will take comments on the draft until July 30, 2010. For more information, please contact Ron Myers at myers.ron@epa.gov.

Emissions Comparison

		2002	2007 (Existing)	2007(new)	% Change
Annual	**pm-10 tpy**	37,606.28	38,210.45	20,532.18	-46%
	pm-2.5 tpy	3,788.42	1,142.03	5,110.37	347%
Summer	**pm-10 tpd**	115.11	105.70	56.75	-46%
	pm-2.5 tpd	11.56	3.13	14.12	351%
Winter	**pm-10 tpd**	95.87	101.69	54.74	-46%
	pm-2.5 tpd	9.69	3.13	13.63	336%
Spring	**pm-10 tpd**	99.94	105.08	56.41	-46%
	pm-2.5 tpd	10.07	3.11	14.04	351%
Fall	**pm-10 tpd**	101.03	106.23	57.08	-46%
	pm-2.5 tpd	10.18	3.15	14.21	352%

AP-42 k factors (g/mile)

	2003	2006	2010
PM-10	7.3000	7.3000	6.79
PM-2.5	1.8000	1.1000	1.69

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2007 CAP Emissions Calculations

	PM10-FIL (TPY)			PM2.5-FIL (TPY)		
	Kent	New Castle	Sussex	Kent	New Castle	Sussex
Rural Oth. Princ. Art.						
January	3.0368	3.8504	5.6417	0.7558	0.9584	1.4042
February	2.8324	3.6256	5.2929	0.7050	0.9024	1.3174
March	3.3463	4.3680	6.3490	0.8329	1.0872	1.5802
April	3.4705	4.4744	6.6084	0.8638	1.1137	1.6448
May	4.3379	5.4584	8.1201	1.0797	1.3586	2.0210
June	4.4049	5.1675	8.5339	1.0964	1.2862	2.1240
July	5.1486	5.3205	10.4483	1.2815	1.3243	2.6005
August	4.8552	5.4994	10.3512	1.2084	1.3688	2.5764
September	4.2558	5.1069	7.7932	1.0592	1.2711	1.9397
October	3.6182	4.6311	6.9531	0.9006	1.1527	1.7306
November	3.2676	4.3388	6.2977	0.8133	1.0799	1.5675
December	2.9585	4.0132	5.7959	0.7364	0.9989	1.4426
	45.5327	**55.8543**	**88.1854**	**11.3329**	**13.9019**	**21.9489**
Rural Minor Arterial						
January	19.7917	0.9224	2.9397	4.9261	0.2296	0.7317
February	19.4746	0.9004	2.7698	4.8472	0.2241	0.6894
March	7.3003	1.0547	1.7424	1.8170	0.2625	0.4337
April	6.7427	1.0176	1.8092	1.6782	0.2533	0.4503
May	7.5361	1.1867	2.1881	1.8757	0.2954	0.5446
June	6.8577	1.0829	2.5017	1.7069	0.2695	0.6226
July	7.5020	1.1643	1.5249	1.8672	0.2898	0.3795
August	7.2545	1.1817	2.8365	1.8056	0.2941	0.7060
September	7.2050	1.1851	2.0514	1.7933	0.2950	0.5106
October	7.0923	1.1383	1.7639	1.7652	0.2833	0.4390
November	6.6536	1.0271	1.5527	1.6561	0.2556	0.3865
December	6.7191	0.9796	1.4285	1.6723	0.2438	0.3556
	110.1298	**12.8408**	**25.1086**	**27.4108**	**3.1960**	**6.2494**
Rural Major Collector						
January	17.4130	10.8453	81.4407	4.3340	2.6993	20.2702
February	15.2798	9.2386	74.5901	3.8031	2.2994	18.5651
March	6.6067	4.1449	31.0497	1.6444	1.0317	7.7281
April	6.3955	4.2942	30.7597	1.5918	1.0688	7.6560
May	8.4396	5.6208	36.4193	2.1006	1.3990	9.0646
June	8.9101	5.3072	11.1730	2.2177	1.3209	2.7809
July	8.7305	6.1122	13.2889	2.1730	1.5213	3.3075
August	7.9809	5.1746	12.3685	1.9864	1.2879	3.0785
September	9.0665	5.4730	33.1489	2.2566	1.3622	8.2506
October	8.0543	4.6414	30.6447	2.0047	1.1552	7.6273
November	6.8855	3.8170	28.0237	1.7138	0.9500	6.9750
December	5.8669	3.4370	27.2418	1.4602	0.8555	6.7804
	109.6292	**68.1062**	**410.1489**	**27.2862**	**16.9513**	**102.0842**
Rural Minor Collector						

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2007 CAP Emissions Calculations

	PM10-FIL (TPY)			PM2.5-FIL (TPY)		
	Kent	New Castle	Sussex	Kent	New Castle	Sussex
January	7.5825	3.1843	9.1770	1.8872	0.7926	2.2841
February	6.6536	2.7126	8.4051	1.6561	0.6751	2.0920
March	2.8769	1.2170	3.4988	0.7160	0.3029	0.8708
April	2.7849	1.2609	3.4661	0.6931	0.3138	0.8627
May	3.6750	1.6504	4.1039	0.9147	0.4108	1.0214
June	3.8799	1.5583	4.0969	0.9657	0.3878	1.0197
July	3.8017	1.7946	4.8727	0.9462	0.4467	1.2128
August	3.4753	1.5194	4.5352	0.8650	0.3782	1.1288
September	3.9480	1.6069	3.7353	0.9826	0.4000	0.9297
October	3.5072	1.3628	3.4532	0.8729	0.3392	0.8595
November	2.9983	1.1207	3.1578	0.7463	0.2789	0.7860
December	2.5547	1.0092	3.0697	0.6359	0.2512	0.7640
	47.7380	**19.9970**	**55.5718**	**11.8818**	**4.9772**	**13.8316**
Rural Local						
January	72.2816	14.2450	182.5225	17.9906	3.5455	45.4290
February	63.4268	13.0827	167.1691	15.7866	3.2562	41.6076
March	20.6871	5.3708	17.8860	5.1489	1.3368	4.4517
April	20.0256	4.9021	17.7190	4.9843	1.2201	4.4102
May	26.4262	6.0689	20.9791	6.5774	1.5105	5.2216
June	9.5065	4.9294	20.9434	2.3661	1.2269	5.2127
July	27.3372	5.0483	24.9096	6.8041	1.2565	6.1999
August	24.9900	5.2372	23.1843	6.2199	1.3035	5.7705
September	9.6733	6.0687	19.0953	2.4076	1.5105	4.7527
October	25.2198	5.8458	17.6527	6.2771	1.4550	4.3937
November	21.5599	5.2538	47.3761	5.3662	1.3077	11.7917
December	18.3704	5.0929	46.0544	4.5723	1.2676	11.4627
	339.5044	**81.1457**	**605.4913**	**84.5011**	**20.1968**	**150.7040**
Urban Interstate						
January	0.0000	11.7187	0.0000	0.0000	2.9167	0.0000
February	0.0000	12.5883	0.0000	0.0000	3.1332	0.0000
March	0.0000	13.3265	0.0000	0.0000	3.3169	0.0000
April	0.0000	14.0185	0.0000	0.0000	3.4891	0.0000
May	0.0000	15.5068	0.0000	0.0000	3.8596	0.0000
June	0.0000	14.5005	0.0000	0.0000	3.6091	0.0000
July	0.0000	15.7325	0.0000	0.0000	3.9158	0.0000
August	0.0000	16.9323	0.0000	0.0000	4.2144	0.0000
September	0.0000	14.9430	0.0000	0.0000	3.7192	0.0000
October	0.0000	13.8368	0.0000	0.0000	3.4439	0.0000
November	0.0000	13.6508	0.0000	0.0000	3.3976	0.0000
December	0.0000	12.6716	0.0000	0.0000	3.1539	0.0000
	0.0000	**169.4261**	**0.0000**	**0.0000**	**42.1694**	**0.0000**
Urban Oth. Freeway						
January	2.2724	2.2051	0.0000	0.5656	0.5488	0.0000

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2007 CAP Emissions Calculations

	PM10-FIL (TPY)			PM2.5-FIL (TPY)		
	Kent	New Castle	Sussex	Kent	New Castle	Sussex
February	2.1240	2.3687	0.0000	0.5287	0.5896	0.0000
March	2.6382	2.5076	0.0000	0.6566	0.6241	0.0000
April	2.6584	2.6378	0.0000	0.6617	0.6565	0.0000
May	3.3363	2.9179	0.0000	0.8304	0.7262	0.0000
June	3.5141	2.7285	0.0000	0.8747	0.6791	0.0000
July	4.2085	2.9604	0.0000	1.0475	0.7368	0.0000
August	4.1031	3.1861	0.0000	1.0213	0.7930	0.0000
September	3.2980	2.8118	0.0000	0.8209	0.6998	0.0000
October	2.6345	2.6036	0.0000	0.6557	0.6480	0.0000
November	2.3741	2.5686	0.0000	0.5909	0.6393	0.0000
December	2.1895	2.3844	0.0000	0.5450	0.5935	0.0000
	35.3512	**31.8807**	**0.0000**	**8.7988**	**7.9349**	**0.0000**
Urban Oth. Princ. Art.						
January	1.3373	13.5266	3.0648	0.3328	3.3667	0.7628
February	1.2472	13.0598	2.8754	0.3104	3.2505	0.7157
March	1.4735	14.9285	3.4491	0.3668	3.7156	0.8585
April	1.5282	14.5413	3.5900	0.3804	3.6193	0.8935
May	1.9102	16.7660	4.4112	0.4754	4.1730	1.0979
June	1.9397	15.0529	4.6360	0.4828	3.7466	1.1539
July	2.2672	15.1950	5.6760	0.5643	3.7820	1.4127
August	2.1380	15.2299	5.6233	0.5321	3.7906	1.3996
September	1.8740	15.1373	4.2336	0.4664	3.7676	1.0537
October	1.5933	14.6302	3.7772	0.3966	3.6414	0.9401
November	1.4389	13.7450	3.4212	0.3581	3.4211	0.8515
December	1.3028	13.7174	3.1486	0.3243	3.4142	0.7837
	20.0502	**175.5298**	**47.9065**	**4.9904**	**43.6886**	**11.9237**
Urban Minor Arterial						
January	4.3310	4.8764	2.4339	1.0780	1.2137	0.6058
February	4.2617	4.8104	2.2835	1.0607	1.1973	0.5683
March	4.6884	5.7734	1.3887	1.1669	1.4370	0.3456
April	4.3304	5.8589	0.7328	1.0778	1.4582	0.1824
May	4.8399	7.1419	0.9004	1.2046	1.7776	0.2241
June	4.4042	6.2220	0.9463	1.0962	1.5486	0.2355
July	4.8180	6.2667	1.1586	1.1992	1.5597	0.2884
August	4.6591	6.1525	1.1478	1.1596	1.5313	0.2857
September	4.6273	6.2988	0.8642	1.1517	1.5677	0.2151
October	4.5549	5.6747	0.7710	1.1337	1.4124	0.1919
November	4.2731	4.7114	0.6983	1.0636	1.1727	0.1738
December	4.3152	4.3381	1.2677	1.0740	1.0797	0.3155
	54.1031	**68.1252**	**14.5932**	**13.4660**	**16.9561**	**3.6322**
Urban Collector						
January	31.7118	16.1893	32.0745	7.8929	4.0294	7.9832
February	30.9520	0.0378	29.3765	7.7038	3.4325	7.3117

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2007 CAP Emissions Calculations

	PM10-FIL (TPY)			PM2.5-FIL (TPY)				
	Kent	New Castle	Sussex	Kent	New Castle	Sussex		
March	3.7702	9.2060	3.7580	0.9384	2.2913	0.9353		
April	3.4498	9.5377	3.7229	0.8586	2.3739	0.9266		
May	3.8650	12.4840	4.4079	0.9620	3.1072	1.0971		
June	3.5323	11.7876	4.4004	0.8792	2.9339	1.0952		
July	3.6517	13.5754	5.2337	0.9089	3.3789	1.3026		
August	11.2659	11.4931	4.8712	2.8040	2.8606	1.2124		
September	3.5772	12.1557	4.0121	0.8903	3.0255	0.9986		
October	3.5078	10.3087	3.7090	0.8731	2.5658	0.9231		
November	10.2321	8.4777	11.0368	2.5467	2.1101	2.7470		
December	10.0602	7.6337	10.7289	2.5039	1.9000	2.6704		
	119.5761	**122.8866**	**117.3317**	**29.7620**	**34.0090**	**29.2033**		
Urban Local								
January	43.1321	149.3299	23.6401	10.7354	37.1675	5.8839		
February	42.0987	137.1463	21.6515	10.4782	34.1351	5.3890		
March	16.6866	56.3019	9.0129	4.1532	14.0133	2.2433		
April	15.2685	51.3884	8.9287	3.8003	12.7903	2.2223		
May	17.1063	63.6201	10.5715	4.2577	15.8347	2.6312		
June	15.6337	51.6748	10.5535	3.8912	12.8616	2.6267		
July	16.1621	52.9218	12.5521	4.0227	13.1720	3.1242		
August	15.3230	54.9018	11.6827	3.8138	13.6648	2.9078		
September	15.8323	63.6183	9.6223	3.9406	15.8343	2.3949		
October	15.5252	61.2816	8.8953	3.8641	15.2527	2.2140		
November	13.9169	55.0759	8.1345	3.4639	13.7081	2.0246		
December	13.6832	53.3890	7.9076	3.4057	13.2883	1.9682		
	240.3684	**850.6498**	**143.1529**	**59.8266**	**211.7228**	**35.6301**		
							STATEWIDE	
All Roadway Types							**PM10-PRI**	**PM2.5-PRI**
January	202.8901	230.8934	342.9350	50.4984	57.4683	85.3550	776.7185	193.3217
February	188.3509	199.5712	314.4139	46.8797	53.0954	78.2562	702.3359	178.2313
March	70.0744	118.1994	78.1346	17.4412	29.4193	19.4473	266.4084	66.3078
April	66.6544	113.9317	77.3368	16.5900	28.3571	19.2488	257.9230	64.1958
May	81.4724	138.4216	92.1014	20.2781	34.4525	22.9236	311.9955	77.6543
June	62.5833	120.0116	67.7849	15.5767	29.8703	16.8714	250.3798	62.3184
July	83.6273	126.0918	79.6648	20.8145	31.3837	19.8282	289.3839	72.0263
August	86.0449	126.5080	76.6007	21.4162	31.4873	19.0656	289.1537	71.9690
September	63.3575	134.4055	84.5562	15.7694	33.4529	21.0457	282.3192	70.2680
October	75.3075	125.9550	77.6201	18.7437	31.3496	19.3193	278.8826	69.4126
November	73.6000	113.7869	109.6988	18.3187	28.3210	27.3035	297.0857	73.9433
December	68.0204	108.6660	106.6430	16.9300	27.0465	26.5430	283.3294	70.5194
	1121.9831	**1656.4422**	**1507.4902**	**279.2565**	**415.7040**	**375.2074**	**4285.9155**	**1070.1679**

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comments to draft AP-42 paved road section

Gary Garman to: Ron Myers 06/24/2010 12:58 PM

Please respond to ggarman

History: This message has been replied to and forwarded.

Ron,

It's good to see the paved road section is being revised. Thanks. It has been a challenge in the past explaining to industrial clients that paving a road would actually result in higher predicted emissions than if the road is left unpaved. I think we'll see more paving and actual emission reductions as a result of the new equation. A few editorial comments on the draft paved road section:

Page 13.2.1-1, third paragraph, first sentence..change to "The particulate emission factors presented in a previous version.."
Page 13.2.1-5, third paragraph, last sentence..change "Table 13.2.1-3" to "Table 13.2.1-2"
Page 13.2.1-8, fifth paragraph, first sentence..change "Table 13.2.1-3" to "Table 13.2.1-2"
Page 13.2.1-9, second paragraph, second sentence..remove hyphen between "not" and "suggest"
Table 13.2.1-3...the page number this table is on should be changed to 13.2.1.10. Also, total loading range for iron and steel should be 0.006-4.77, not 43.0-64.0.
Page 13.2.1-11, first paragraph, fourth sentence..remove hyphen between "any" and "of"

Thanks again. I look forward to this draft being finalized.

Gary
--
Gary Garman
Environmental Scientist

McVehil-Monnett Associates, Inc.
44 Inverness Drive East, Bldg C
Englewood, CO 80112

303-790-1332

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Emission Factor Documentation for AP-42 Section 13.2.2

Unpaved Roads

Final Report

For U. S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Emission Factor and Inventory Group

EPA Purchase Order 7D-1554-NALX

MRI Project No. 4864

September 1998

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Emission Factor Documentation for AP-42
Section 13.2.2

Unpaved Roads

Final Report

For U. S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Emission Factor and Inventory Group
Research Triangle Park, NC 27711

Attn: Mr. Ron Myers (MD-14)
Emission Factor and Inventory Group

EPA Purchase Order 7D-1554-NALX

MRI Project No. 4864

September 1998

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NOTICE

The information in this document has been funded wholly or in part by the United States Environmental Protection Agency under Contract No. 68-D2-0159 and Purchase Order No. 7D-1554-NALX to Midwest Research Institute. It has been reviewed by the Office of Air Quality Planning and Standards, U. S. Environmental Protection Agency, and has been approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

PREFACE

This report was prepared by Midwest Research Institute (MRI) for the Office of Air Quality Planning and Standards (OAQPS), U. S. Environmental Protection Agency (EPA), under Contract No. 68-D2-0159, Work Assignment No. 02 and Purchase Order No. 7D-1554-NALX. Mr. Ron Myers was the requester of the work.

Approved for:

MIDWEST RESEARCH INSTITUTE

Roy Neulicht
Program Manager
Environmental Engineering Department

Jeff Shular
Director, Environmental Engineering
Department

September 1998

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EMISSION FACTOR DOCUMENTATION FOR AP-42 SECTION 13.2.2
Unpaved Roads

1. INTRODUCTION

The U. S. Environmental Protection Agency (EPA) publishes the document *Compilation of Air Pollutant Emission Factors* (AP-42) as its primary compilation of emission factor information. Supplements to AP-42 have been routinely published to add new emission source categories and to update existing emission factors. AP-42 is routinely updated by EPA to respond to new emission factor needs of EPA, State and local air pollution control programs, and industry.

An emission factor is a value that attempts to relate the representative quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. Emission factors usually are expressed as the weight of pollutant divided by the unit weight, volume, distance, or duration of the activity that emits the pollutant. The emission factors presented in AP-42 may be appropriate to use in a number of situations, such as making source-specific emission estimates for area wide inventories for dispersion modeling, developing control strategies, screening sources for compliance purposes, establishing operating permit fees, and making permit applicability determinations. The purpose of this report is to provide background information from test reports and other information to support revisions to AP-42 Section 13.2.2, Unpaved Roads.

This background report consists of five sections. Section 1 includes the introduction to the report. Section 2 gives a characterization of unpaved road emission sources and a description of the technology used to control emissions resulting from unpaved roads. Section 3 is a review of emission data collection and emission measurement procedures. It describes the literature search, the screening of emission data reports, and the quality rating system for both emission data and emission equations and methods of emission factor determination. Section 4 details how the revised AP-42 section was developed. It includes the review of specific data sets, a description of how candidate the emission equation was developed, and a summary of changes to the AP-42 section. Section 5 presents the AP-42 Section 13.2.2, Unpaved Roads.

Throughout this report, the principal pollutant of interest is PM-10—particulate matter (PM) no greater than 10 μmA (microns in aerodynamic diameter). PM-10 forms the basis for the current National Ambient Air Quality Standards (NAAQS) for particulate matter. PM-10 thus represents the particle size range that is of the greatest regulatory interest. Because formal establishment of PM-10 as the standard basis for the NAAQS occurred in 1987, many earlier emission tests (and in fact the current version of the unpaved road emission factor) have been referenced to other particle size ranges, such as,

TSP	Total Suspended Particulate, as measured by the standard high-volume (hi-vol) air sampler. Total suspended particulate, which encompasses a relatively coarse size range, was the basis for the previous NAAQS for PM. Wind tunnel studies have shown that the particle mass capture efficiency curve for the hi-vol sampler is very broad, extending from 100 percent capture of particles smaller than 10 micrometers to a few percent capture of particles as large as 100 micrometers. Also, the capture efficiency curve varies with wind speed and wind direction, relative to roof ridge orientation. Thus, the hi-vol sampler does not provide definitive particle size information for emission factors. However, an effective cutpoint of 30 μm aerodynamic diameter is frequently assigned to the standard hi-vol sampler.

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SP Suspended Particulate, which is often used as a surrogate for TSP, is defined as PM with an aerodynamic diameter no greater than 30 μmA. SP may also be denoted as "PM-30."

PM-2.5 PM with an aerodynamic diameter no greater than 2.5 μmA.

The EPA promulgated new PM NAAQS based on PM-2.5, in July 1997.

Because of the open source nature of unpaved roads, ambient particulate matter samplers are usually most applicable to emission characterization of this source category. Nevertheless, one may adapt traditional stack source sampling methods to unpaved roads. In that case, "total PM" refers to the amount of PM collected in EPA Method 5 plus EPA Method 202 sampling trains. "Total filterable PM" denotes the filter catch in the Method 5 train. Similarly, "PM-10" refers to the sum of the catch in EPA Method 201A and Method 202 trains, while "filterable PM-10" corresponds to the filter catch in Method 201A.

2. SOURCE DESCRIPTION

2.1 SOURCE CHARACTERIZATION[1]

Particulate emissions occur whenever vehicles travel on unpaved roads. Dust plumes trailing behind vehicles on unpaved roads are a familiar sight in rural areas of the United States. Many industrial areas also have active unpaved roads. When a vehicle travels an unpaved road, the force of the wheels on the road surface causes pulverization of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed.

2.2 EMISSIONS[1,2]

The emission of concern from unpaved roads is particulate matter (PM) including PM less than 10 microns in aerodynamic diameter (PM-10) and PM less than 2.5 microns in aerodynamic diameter (PM-2.5). The quantity of dust emissions from a given segment of unpaved road varies linearly with the volume of traffic. Field investigations also have shown that emissions depend on correction parameters that characterize (a) the condition of a particular road and (b) the associated vehicle traffic. Parameters of interest in addition to the source activity (number of vehicle passes) include the vehicle characteristics (e.g., vehicle weight), the properties of the road surface material being disturbed (e.g. silt content, moisture content), and the climatic conditions (e.g., frequency and amounts of precipitation).

Dust emissions from unpaved roads have been found to vary directly with the fraction of silt in the road surface material. Silt consists of particles less than 75 μm in diameter, and silt content can be determined by measuring the proportion of loose dry surface dust that passes through a 200-mesh screen, using the ASTM-C-136 method.

2.3 HISTORY OF THE UNPAVED ROAD EMISSION FACTOR EQUATION IN AP-42

The current version of the AP-42 unpaved road emission factor equation for dry conditions has the following form:[1]

$$E = k\ 5.9 \left(\frac{s}{12}\right)\left(\frac{S}{30}\right)\left(\frac{W}{3}\right)^{0.7}\left(\frac{w}{4}\right)^{0.5} \tag{2-1}$$

where:

E = Emission factor, pounds per vehicle-mile-traveled, (lb/VMT)
k = Particle size multiplier (dimensionless)
s = Silt content of road surface material (%)
S = mean vehicle speed, miles per hour (mph)
W = mean vehicle weight, ton
w = mean number of wheels (dimensionless)

The AP-42 discusses how Equation 2-1 can be extrapolated to annual conditions through the simplifying assumption that emissions are present at the "dry" level on days without measurable precipitation and conversely, are absent on days with more than 0.01 in. (0.254 mm) of precipitation. Thus, the emission factor for annual conditions is:

$$E = k\ 5.9 \left(\frac{s}{12}\right)\left(\frac{S}{30}\right)\left(\frac{W}{3}\right)^{0.7}\left(\frac{w}{4}\right)^{0.5}\left(\frac{365-p}{365}\right) \qquad (2\text{-}1a)$$

where all quantities are as before and:

p = number of days with at least 0.254 mm (0.01 in.) of precipitation per year

The particle size multiplier "k" for different particulate size ranges is shown below.

Aerodynamic Particle Size Multiplier (k) for Equation 2-1					
≤30µm[a]	≤30µm	≤15µm	≤10µm	≤5µm	≤2.5µm
1.0	0.80	0.50	0.36	0.20	0.095

[a]Stoke's diameter

The earliest emission factor equation for unpaved roads first appeared in AP-42 in 1975. The current version of the emission factor equation appeared in 1983 as part of Supplement 14 to the third edition of AP-42.

The earliest version of the unpaved road emission factor equation included the first two correction terms shown in Equation 2-1 (i.e., silt content and mean vehicle speed). However, the data base for that version was limited to tests of publicly accessible unpaved roads travelled by light-duty vehicles and had a small range of average travel speeds (30 to 40 mph).[3] Subsequent emission testing (especially roads at iron and steel plants) expanded the ranges for both vehicle weight and vehicle speed. In 1978, a modified equation that included silt, speed, and weight was published in an EPA report.[4] In 1979, the current version (Equation 2-1) was first published;[5] it incorporated a slight reduction in the exponent for vehicle weight and added the wheel correction term.

Although the emission factor equation for unpaved roads has been modified over the past 20 years, all versions have important common features. All were developed using multiple linear regression of the suspended particulate emission factor against correction parameters that describe source conditions. The silt content has consistently been found to be of critical importance in the predictive equation. The first version of the predictive equation (and each subsequent refinement) included a roughly linear (power of 1) relationship between the emission factor and the road surface silt content.[a]

In addition to the unpaved road emission factor equation discussed above, other studies have been undertaken to model emissions from unpaved road vehicular traffic. For example, the 1983 background

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[a] Note that during the 1970's, the exponent for the silt content was rounded to unity because of the greater computational ease. Recall that this equation predated inexpensive calculators with "x to the y" capability.

document for this section of AP-42 lists three other candidate emission factor equations.[6] Equation 2-1 was recommended over the other candidates on the basis of its wider applicability.

Additional studies addressed emissions from restricted classes of unpaved roads. In particular, a 1981 report included separate emission factors for (a) light-to medium-duty traffic, and (b) haul trucks on unpaved roads for use at western surface coal mines.[7] Neither equation bore resemblance to the generic unpaved road emission factor (Equation 2-1). A 1991 study (described in Section 4 of this report) addressed emissions due to relatively high-speed traffic on publicly accessible roads in Arizona.[2] Furthermore, in response to Section 234 of the Clean Air Act Amendments, the western surface coal mining emission factors were reexamined.[8,9] Results from that study are also described in Section 4.

2.4 EMISSION CONTROL TECHNOLOGY[1,10,11]

Controls to reduce particulate emissions from unpaved roads fall into three general categories as follows: source extent reductions, surface improvements, and surface treatment. Each of the categories is discussed below.

Source extent reductions limit the amount of traffic to reduce particulate emissions. The emissions directly correlate to the vehicle miles traveled on the road. An example of limiting traffic is restricting road use to certain vehicle types. The iron and steel industry, for example, has instituted some employee busing programs to eliminate a large number of vehicle passes during shift changes.

Surface improvements offer a long term control technique. Paving is a surface improvement that is a highly effective control, but can be cost prohibitive especially on low volume roads. From past experience, paving has an estimated 99 percent control efficiency for PM-10. Control efficiencies achievable by paving can be estimated by comparing emission factors for unpaved and paved road conditions. The predictive emission factor equation for paved roads, given in AP-42 Section 13.2.1, requires estimation of the silt loading on the traveled portion of the paved surface, which in turn depends on (a) the intensities of deposition processes that add silt to the surface, and (b) whether the pavement is periodically cleaned.

Other surface improvements include covering the road surface with a new material of lower silt content. For example a dirt road could be covered with gravel or slag. Also, regular maintenance practices, such as grading of gravel roads, help to retain larger aggregate sizes on the traveled portion of the road and thus help reduce emissions. The amount of emissions reduction is tied directly to the reduction in surface silt content.

Surface treatments include control techniques that require reapplication such as watering and chemical stabilization. Watering increases the road surface moisture content, which conglomerates the silt particles and reduces their likelihood to become suspended when a vehicle passes over the road surface. The control efficiency of watering depends upon (a) the application rate of the water, (b) the time between applications, (c) traffic volume during the period, and (d) the meteorological conditions during the period.

Chemical stabilization suppresses emissions by changing the physical characteristics of the road surface. Many chemical unpaved road dust suppressants form a hardened surface that binds particles together. As a result of grinding against the improved surface, the silt content of loose material on a highly controlled surface may be substantially higher than when the surface was uncontrolled. Thus, the predictive emission factor equation for unpaved roads usually cannot be used to estimate emissions from chemically stabilized roads.

Although early studies of unpaved road dust control showed a strong correlation between efficiency and the silt content of the surface material, this correlation was based on the very high (e.g., >90 percent) control efficiencies and very low silt values typically found over the first few days after application. Because these conditions represent only a small, restricted portion of the range of possible conditions encountered during a control application cycle, the high degree of correlation was misleading.

Later study of long-term control indicated no significant correlation between silt content and control efficiency. In addition, fairly high (~50 percent) control efficiencies were found to occur with silt contents at or above the uncontrolled level. Because of these findings, attention turned to the use of the amount of silt per unit area (i.e., “silt loading”) as a performance indicator.

A long-term study of the performance of 4 chemical dust suppressants of interest to the iron and steel industry was conducted through EPA in 1985. This study found that although emission factors varied over an order of magnitude, the silt loading values varied over two orders of magnitude, and did not appear to follow a specific trend with time. Furthermore, the results for the different suppressants tended to be clustered together; this indicated that the various suppressant types did not affect silt loading in the same way.

The control effectiveness of chemical dust suppressants depends on the dilution rate, application rate, time between applications, and traffic volume between applications. Other factors that affect the performance of dust suppressants include the vehicle characteristics (e.g., average vehicle weight) and road characteristics (e.g., bearing strength). The variabilities in the above factors and in individual dust control products make the control efficiencies of chemical dust suppressants difficult to calculate. Past field testing of emissions from controlled unpaved roads has shown that chemical dust suppressants provide a PM-10 control efficiency of about 80 percent when applied at regular intervals.

Because no simple relationship of control efficiency with silt or silt loading could be found to successfully model chemical dust suppressant performance, other types of performance models were developed based on the amount of chemical applied to the road surface. Figure 2-1 presents control efficiency relationships for petroleum resins averaged over two common application intervals, 2 weeks and 1 month.[10]

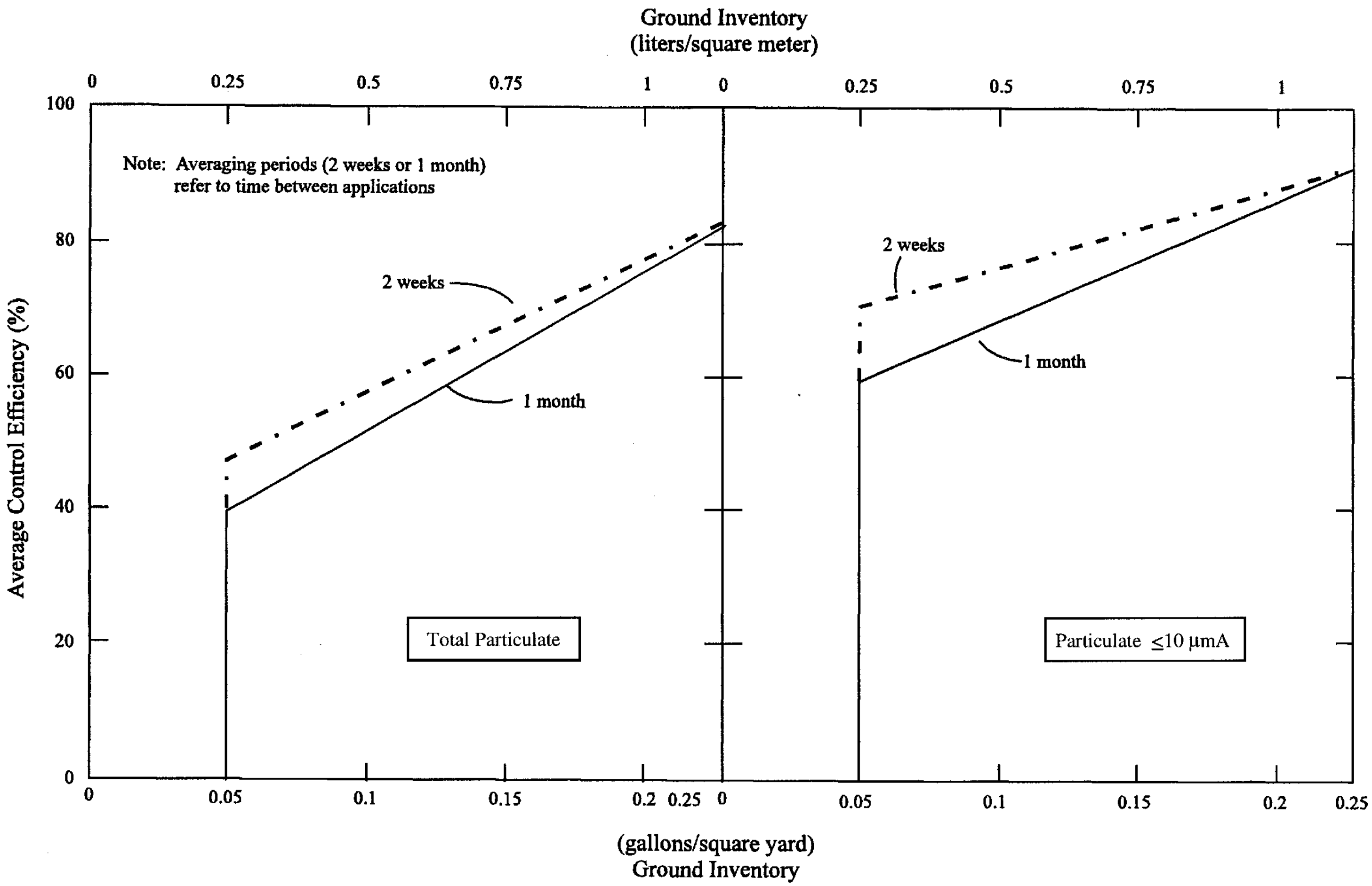

Figure 2-1. Average control efficiencies over common application intervals for chemical dust suppressants.

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3. GENERAL DATA REVIEW AND ANALYSIS PROCEDURES

3.1 LITERATURE SEARCH AND SCREENING

To reduce the amount of literature collected to a final group of references from which emission factors could be developed, the following general criteria were used.

1. Emissions data must be from a primary reference.

a. Source testing must be from a referenced study that does not reiterate information from previous studies.

b. The document must constitute the original source of test data. For example, a technical paper was not included if the original study was contained in the previous document. If the exact source of the data could not be determined, they were eliminated.

2. The referenced study must contain test results based on more than one test run.

3. The report must contain sufficient data to evaluate the testing procedures and source operating conditions.

A final set of reference materials was compiled after a thorough review of the pertinent reports, documents, and information according to these criteria.

3.2 METHODS OF EMISSION FACTOR DETERMINATION[2]

Fugitive dust emission rates and particle size distributions are difficult to quantify because of the diffuse and variable nature of such sources and the wide range of particle size involved including particles which deposit immediately adjacent to the source. Standard source testing methods, which are designed for application to confined flows under steady state, forced-flow conditions, are not suitable for measurement of fugitive emissions unless the plume can be drawn into a forced-flow system. The following presents a brief overview of applicable measurement techniques.

3.2.1 Mass Emission Measurements

Because it is usually impractical to enclose open dust sources or to capture the entire emissions plume, only the upwind-downwind and exposure profiling methods are suitable for measurement of particulate emissions from most open dust sources.[3] These two methods are discussed separately below.

The basic procedure of the upwind-downwind method involves the measurement of particulate concentrations both upwind and downwind of the pollutant source. The number of upwind sampling instruments depends on the degree of isolation of the source operation of concern (i.e., the absence of interference from other sources upwind). Increasing the number of downwind instruments improves the reliability in determining the emission rate by providing better plume definition. In order to reasonably define the plume emanating from a point source, instruments need to be located at two downwind distances and three crosswind distances, at a minimum. The same sampling requirements pertain to line sources except that measurement need not be made at multiple crosswind distances.

Net downwind (i.e., downwind minus upwind) concentrations are used as input to dispersion equations (normally of the Gaussian type) to back calculate the particulate emission rate (i.e., source strength) required to generate the pollutant concentration measured. Emission factors are obtained by dividing the calculated emission rate by a source activity rate (e.g., number of vehicles, or weight of material transferred per unit time). A number of meteorological parameters must be concurrently reported for input to the dispersion equations. The test report should describe what constitutes acceptable meteorological conditions.

At a minimum, the wind direction and speed must be recorded on-site and should remain within acceptable ranges. When the upwind/downwind technique is applied to unpaved roads, the test report must describe the mean angle of the wind relative to the road centerline.

As part of a sound test methodology, source activity parameters should be recorded, including the vehicle weights and vehicle speeds. The surface material at the test location (specifically, its silt and moisture contents) should also be characterized following guidance of AP-42 Appendicies C.1 and C.2.

While the upwind-downwind method is applicable to virtually all types of sources, it has significant limitations with regard to development of source-specific emission factors. The major limitations are as follows:

1. In attempting to quantify a large area source, overlapping of plumes from upwind (background) sources may preclude the determination of the specific contribution of the area source.

2. Because of the impracticality of adjusting the locations of the sampling array for shifts in wind direction during sampling, it cannot be assumed that plume position is fixed in the application of the dispersion model.

3. The usual assumption that an area source is uniformly emitting does not allow for realistic representation of spatial variation in source activity.

4. The typical use of uncalibrated atmospheric dispersion models introduces the possibility of substantial error (a factor of three according to Reference 4) in the calculated emission rate, even if the stringent requirement of unobstructed dispersion from a simplified (e.g., constant emission rate from a single point) source configuration is met.

On an even more fundamental level, typical traffic volumes on unpaved roads are far too low to represent the road as a steady, uniformly emitting line source for dispersion analysis purposes. A far better representation (but one which, unfortunately, is not available at this time) would view the unpaved road source as a series of discrete moving point sources.

Just as importantly, it is not clear that “cosine correction” used to account for the effect that an oblique wind direction has on line sources is applicable to the case of an unpaved road. As the plume is released, dispersion occurs in all three cartestian coordinate directions. Only dispersion in the direction parallel to the plume centerline would be negligible. Depending on the direction a vehicle is traveling, an oblique wind would appear to dilute or "concentrate" the plume mass seen by the samplers, as compared to the case of a perpendicular wind. Correction for each plume depends upon the magnitude and direction of the wind relative to vehicle velocity vector.

The other measurement technique, exposure profiling, offers some distinct advantages for source-specific quantification of fugitive emissions from open dust sources. The method uses the isokinetic profiling concept that is the basis for conventional (ducted) source testing. The passage of airborne pollutant immediately downwind of the source is measured directly by means of simultaneous multipoint sampling over the effective cross section of the fugitive emissions plume. This technique uses a mass-balance calculation scheme similar to EPA Method 5 stack testing rather than requiring indirect calculation through the application of a generalized atmospheric dispersion model. As with other testing methodologies, source activity must be recorded as part of a sound exposure profiling program.

For measurement of nonbuoyant fugitive emissions, profiling sampling heads are distributed over a vertical network positioned just downwind (usually 5 m) from the source. If total particulate emissions are to be measured, sampling intakes are pointed into the wind and sampling velocity is adjusted to match the local mean wind speed, as monitored by anemometers distributed over heights above ground level.

Note that, because the test method relies on ambient winds to carry emissions to the sampling array, acceptance criteria for wind speed/direction are necessarily based on antecedent monitoring. That is, the immediate past record is used to determine acceptability for the current or upcoming period of time. As a practical matter, this means that wind monitoring must be conducted immediately before starting an exposure profiling test. The test methodology must also present what guidelines govern stopping/suspending a test for unacceptable wind conditions. For example, testing should be suspended if the angle between the mean wind direction and the perpendicular to the road centerline exceeds 45° for two consecutive 3- to 10-min averaging period. Similarly, testing should be suspended if the mean wind speed falls below 4 mph or exceeds 20 mph for more than 20 percent of the test duration.

The size of a sampling grid needed to conduct exposure profiling tests of an unpaved road depends on several factors, including size/speed of the vehicles traveling the road; expected wind speed; width of the road; and the sampler separation distance from the road. Particulate sampling heads should be symmetrically distributed over the concentrated portion of the plume containing roughly 90 percent of the total mass flux (exposure). In general, the best way to judge the sampling height is to view the plumes being generated from vehicle passes over the road. Past field studies using exposure profiling also provide a good means to establish the necessary size for the sampling grid.

Grid size adjustments may be required based on the results of preliminary testing. To be reasonably certain that one is capturing the entire plume, one needs to demonstrate that the concentration (or, more to the point, the mass flux) decreases near the top of the sampling array. As a practical matter, this means that individual samplers be deployed so that results can be compared from one height to the next. Specifically, use of a manifold to (a) collect air samples at different heights but (b) to route the emissions to a common duct for measurement cannot provide direct evidence of the sufficient height of the sampling array.

Use of dispersion algorithms to determine sampling heights suffers from the same limitations as noted earlier in connection with the upwind/downwind method. That is, typical traffic volumes on unpaved roads are far too low to represent the road as a steady, uniformly emitting line source for dispersion purposes. Just as importantly, it is not clear that "cosine correction" used to account for the effect that an oblique wind direction has on line sources is applicable to the case of an unpaved road.

To calculate emission rates using the exposure profiling technique, a conservation of mass approach is used. The passage of airborne particulate (i.e., the quantity of emissions per unit of source activity) is obtained by spatial integration of distributed measurements of exposure (mass/area) over the effective cross section of the plume. The exposure is the point value of the flux (mass/area/time) of airborne particulate integrated over the time of measurement.

3.2.2 Emission Factor Derivation

Usually the final emission factor for a given fugitive source operation, as presented in a test report, is derived simply as the arithmetic mean of the individual emission factors calculated from each test of that source. Frequently, test reports present the range of individual emission factor values.

Although test reports often present an arithmetic mean emission factor for a single specific source, it is important to recognize that the population of all unpaved road emission factors is better characterized as log-normally than as (arithmetic) normally distributed. That is to say, the logarithms of the emission factor are themselves normally distributed. This can be seen in Figures 3-1 and 3-2, which present normal probability plots for both a set of PM-10 unpaved road emission factors and the logarithms of the factors. Note that the plot of the log-transformed data results in a straight line, which indicates normality. In Figures 3-1 and 3-2 the ordinate (y-axis) is sometimes termed the "z-score." The z-score is found by ranking the data in ascending order and dividing each value's rank by the total number N of data points:

Proportion = (RANK - 0.5)/N

The z-score represents the value of the standard normal distribution (i.e., mean equal to 0 and a standard deviation of 1) whose cumulative frequency equals the proportion found. In practical terms, a sample from a normally distributed population will exhibit a reasonably straight line in this type of plot.

To characterize emissions from unpaved roads, one could use the geometric mean emission factor (i.e., the arithmetic mean of the log-transformed data). However, attempting to characterize emissions from data spanning several orders of magnitude, from extremely large mine haul trucks to light-duty vehicles on county roads, with a single valued emission factor would be futile. Alternatively, one could construct a series of different single-valued mean emission factors, with each mean corresponding to a different category of unpaved roads. For example, one might derive a factor for use with passenger cars on rural roads, another factor for haul trucks, and a third for plant traffic at an industrial facilities. This "subcategory mean" approach, as applied to emissions from unpaved roads, has several drawbacks.

The approach ignores the similarities in the dust-emitting process between subcategories of unpaved road travel. Despite the contrast in scale between haul trucks and small vehicles, the general physical process is the same. The vehicle's tires interact with the surface material, directly injecting particles into the atmosphere while at the same time pulverizing the material. Furthermore, the passage of the vehicle results

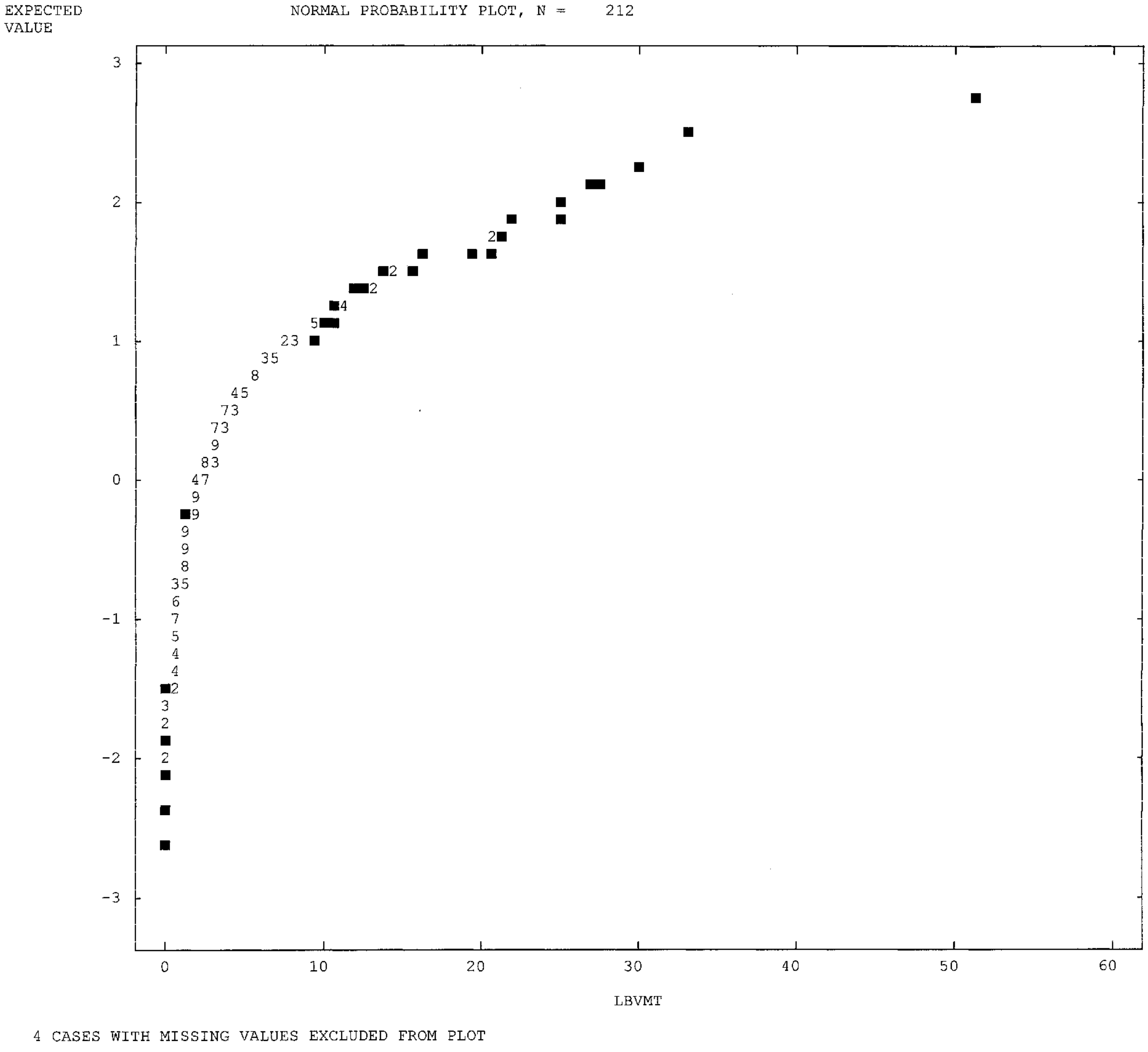
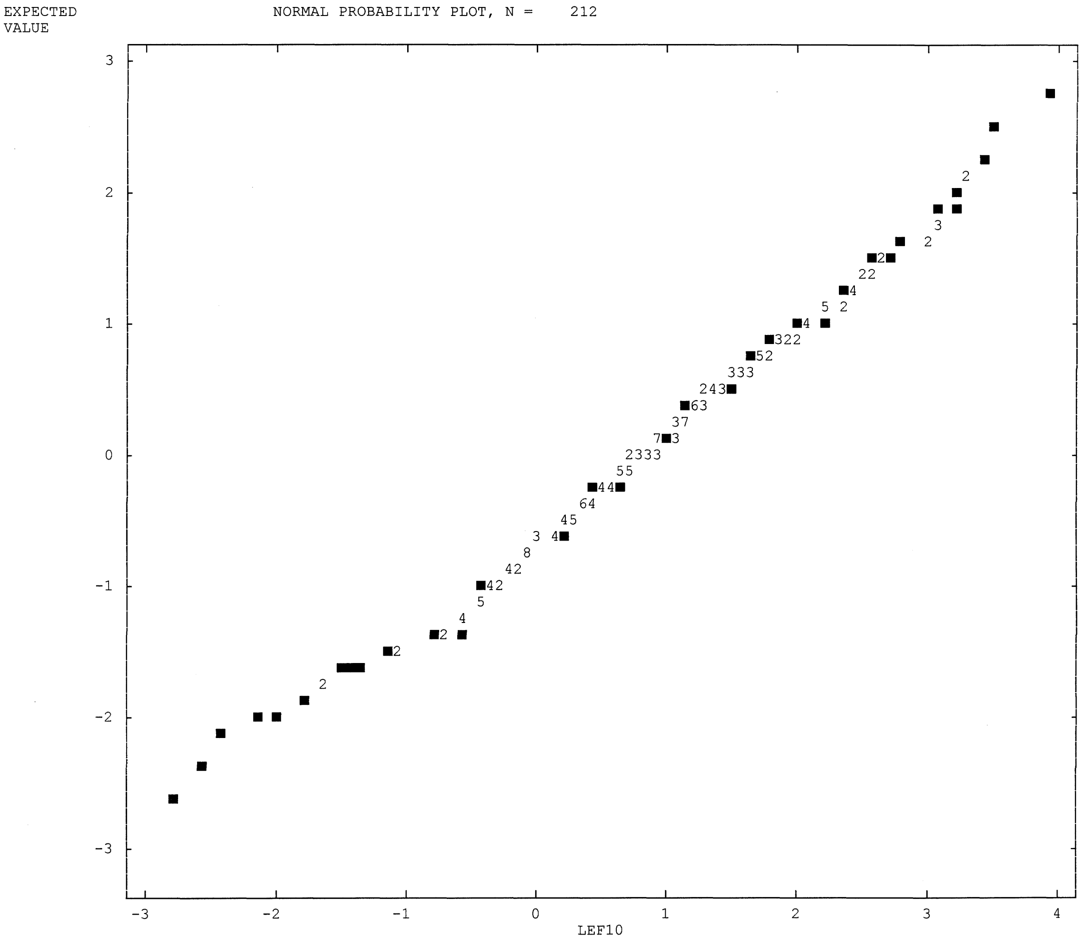


Figure 3-1. Normal probability plot for PM-10 unpaved road emission factors.



4 CASES WITH MISSING VALUES EXCLUDED FROM PLOT

Abscissa consists of natural logarithm of emission factor in lb/vmt.

Figure 3-2. Normal probability plot for logarithms of PM-10 unpaved road emission factors.

in a wake which also entrains particulate matter. Admittedly, the intensity of any process will depend on many factors, such as: vehicle weight, number of wheels, tread design, tire footprint pressure, clearance height, vehicle speed. The approach undertaken in this study (as described later in this section) attempts to capture the essential traffic differences in a few easily quantified vehicle parameters.

Beyond variations in vehicle scale, unless one devises many different classifications, the "subcategory mean" technique cannot capture important regional or other differences. For example, an emission factor applied throughout the United States for passenger cars on rural roads would necessarily smear any differences in emissions between arid western states and those in the wetter, eastern part of the country. Beside "east" and "west," one could also distinguish between: improved/unimproved and well/poorly maintained road surfaces. No matter how many classifications are chosen, partitioning emission test data into finely divided categories reduces the amount of data available to develop each factor. The practical result from this fine subdivision is to lower the confidence in any result obtained from the analysis.

As an alternative to a single valued mean, an emission factor may be presented in the form of a predictive equation derived by regression analysis of test data. The general method employed in regression anlaysis is to first examine the physical forces that affect the dependent variable, to construct an empirical model reflective of those forces, then to use regression to provide a best fit. Such an equation mathematically relates emissions to parameters which characterize those measurable physical parameters having the most affect on the emissions. Possible parameters considered may be grouped into three categories:

1. Measures of source activity or energy expended (e.g., the speed, number of wheels, and weight of vehicles traveling on an unpaved road). As a practical matter useful vehicle-related parameters should be observable at a distance under normal traffic conditions. Most secondary parameters such as tire size, pressure, etc., are correlated with gross vehicle characteristics such as vehicle weight as related to the type of vehicle (light duty automobile, tractor trailer, etc.).

2. Properties of the material being disturbed (e.g., the content of suspendable fines in the surface material on an unpaved road or the moisture content of the surface material).

3. Climatic parameters (e.g., number of precipitation-free days per year during which emissions tend to be at a maximum).

An emission factor equation is useful if it is successful in “explaining” much of the observed variance in emission factor values on the basis of corresponding variances in specific source parameters. This enables more reliable estimates of source emissions on a site-specific basis. In general, an equation’s success in explaining variance is gauged by the R-squared value. If an equation has an R-squared value of 0.47, then it is said to “explain” 47 percent of the variance in the set of emission factors.

It should be noted, however, that a high value of R^2 may sometimes prove misleading in developing an emission factor equation for a particular data set. For example, an equation may be “fine tuned” to the developmental data set by including an additional correction parameter, but in a manner that is contrary to the physical phenomena of the dust generation process. This was illustrated in a field study conducted for the Arizona Department of Environmental Quality (as described in Section 4) that found that inclusion of moisture and silt content as correction parameters would require that they enter into the equation in a manner opposite to common sense. That is to say, emissions would increase with increasing moisture content and would decrease with increasing silt content. In that instance, it is important to recognize that the goal of an emission factor equation is not to provide a near-perfect fit to the emission measurements in the developmental data base, but rather to provide reasonably reliable estimates of emissions for situations where no test data are available.

A generic emission factor equation is one that is developed for a source operation defined on the basis of a single dust generation mechanism that crosses industry lines. Clearly, vehicle travel over unpaved roads is not only a common operation in almost all industries but also represents a general, public source of particulate emissions.

Unpaved road source conditions encompass extreme variations. For example, average vehicle weights on unpaved roads (ranging from country roads to mining haul roads) easily span two orders of magnitude. Furthermore, there is also a wide range in surface material properties. Values for silt and moisture content from the available test data span one and two orders of magnitude, respectively. Not surprisingly, these correction parameters (like the emission factor values) are better characterized by a log-normal rather than (arithmetic) normal distribution.

Furthermore, normal and log-normal distributions appear to fit other vehicle-related variables (speed and number of wheels) equally well. Because standard tests of significance assume normal parent populations, regression of log-transformed data is far more appropriate than regression of untransformed values. The log-linear regression results in a multiplicative model.

To establish its applicability, a generic equation should be developed from test data obtained in different industries. As will be discussed in Section 4, the approach taken to develop a new unpaved road equation has been to combine (to the extent possible) all emission tests of vehicles traveling over an unpaved surface. The combination is made without regard to previous groupings in AP-42. In particular, tests at surface coal mines are combined with tests of unpaved roads within other industries and tests of publicly accessible unpaved roads.

3.3 EMISSION DATA AND EMISSION FACTOR QUALITY RATING SCHEME USED FOR THIS SOURCE CATEGORY[1,2,5]

As part of the analysis of the emission data, the quantity and quality of the information contained in the final set of reference documents were evaluated. The uncontrolled emission factor quality rating scheme used for this source category represents a refinement of the rating system developed by EPA for AP-42 emission factors. The scheme entails the rating of test data quality followed by the rating of the emission factor(s) developed from the test data, as described below.

In the past, test data that were developed from well documented, sound methodologies were viewed equally and assigned an A rating. Although side-by-side studies would better define the differences in precision between upwind/downwind and profiling methodologies, historical experience has granted a greater degree of confidence in the ability of profiling to characterize the full particulate emissions plume. In this document, test data using sound, well documented profiling methodologies were assigned an A rating. Test data using sound, well documented upwind/downwind methodologies were assigned a B rating.

In evaluating whether an upwind-downwind sampling strategy qualifies as a sound methodology, the following minimum test requirements are used. At least five particulate measuring devices must be operated during a test, with one device located upwind and the others located at two downwind and three crosswind distances. The requirement of measurements at crosswind distances is waived for the case of line sources. Also wind direction and speed must be monitored concurrently on-site.

For upwind/downwind testing, it is generally assumed wind speed and direction are constant. To maintain a likeness of constant conditions, the downwind sampler should be shut down when the wind speed drops below 75 percent or raises above 125 percent of the predetermined design speed for periods longer than 3 minutes. Once the wind speed has returned to the acceptble range of 90 percent to 110 percent for 2 minutes, the downwind sampler should be restarted. Samplers should also be shut down when the wind direction varies by 10° or more from the predetermined design direction for longer than 3 minutes. Once the wind direction has returned to the acceptable range for two minutes, the samplers should be restarted. General procedure includes shutting down the upwind sampler during the same periods the downwind samples are shut down.[5]

The minimum requirements for a sound exposure profiling program are the following. A one-dimensional, vertical grid of at least three samplers is sufficient for measurement of emissions from an unpaved road. At least one upwind sampler must be operated to measure background concentration, and wind speed must be measured on-site.

As an alternative to discrete downwind sampling units, a manifold system comprising several sampling points may be used. The mass collected at different heights is ducted to a common tube where stack sampling methods can be applied. A fundamental difference between the use of discrete samplers and a manifold is the need in the latter case to demonstrate plume capture. In other words, the discrete sampling approach directly demonstrates that concentration (or, more to the point, the mass flux) decreases near the top of the sampling array. Because the manifold approach, on the other hand, integrates samples collected at different heights, it cannot provide direct evidence of plume capture. Should the manifold approach be adopted, a minimum of 4 sampling heights should be used for unpaved road testing. In addition, the test report must address the issues related to capture of the entire plume. Furthermore, because wind speed increases with height, the test report must also discuss isues of how intake velocities at different points were selected and controlled to account for the variation in mass flux due simply to wind speed.

For a sound exposure profile operation, several test parameters must remain in predetermined ranges including wind direction, wind speed, precipitation, and source conditions. Mean wind direction during sampling should remain within 45° of perpendicular to the path of the moving point source for 90 percent of the 10 min averaging periods. The mean wind speed should not move outside of the 4 to 20 mph range more than 20 percent of the sampling period. Rainfall must not ensue during the equipment set-up or during sampling for uncontrolled conditions. The predetermined criteria for source conditons (e.g., uncontrolled surface conditions, change from normally maintained road, unusual traffic, truck spill) should be maintained.

Neither the upwind-downwind method nor the exposure profiling method can be expected to produce A-rated emissions data when applied to large, poorly defined area sources, or under very light and variable wind flow conditions. In these situations, data ratings based on degree of compliance with minimum test system requirements were reduced one letter.

It is critically important in either the upwind/downwind or exposure profiling method that the unpaved road is uniformly emitting along the length of the road. In practical terms, this generally requires that

* The road is straight or very gently curving over a distance that is much greater than the distance to the downwind samplers.

* Vehicles do not typically start or stop moving in the general vicinity of the sampling array.

* In the case of heavy-duty vehicles, there is no need to downshift or otherwise cause substantial diesel emissions near the test site.

It is also important to note that neither upwind-downwind nor exposure profiling interfere with plume development or dispersion by forcing or blocking the air flow. Instead, the PM travels "naturally due to vehicle wakes and ambient winds toward the sampling array

After the test data supporting a particular single-valued emission factor are evaluated, the criteria presented in Table 3-1 are used to assign a quality rating to the resulting emission factor. The collection and reporting of activity and process information such as road surface silt content, moisture content, and average vehicle weight are also considered in the evaluation. These criteria were developed to provide objective definition for (a) industry representativeness and (b) levels of variability within the data set for the source category. The rating system obviously does not include estimates of statistical confidence, nor does it reflect the expected accuracy of fugitive dust emission factors relative to conventional stack emission factors. It does, however, serve as a useful tool for evaluation of the quality of a given set of emission factors relative to the entire available fugitive dust emission factor data base.

TABLE 3-1. QUALITY RATING SCHEME FOR SINGLE-VALUED EMISSION FACTORS

Code	No. of test sites	No. of tests per site	Total No. of tests	Test data variability[a]	Adjustment for EF rating[b]
1	≥3	≥3	-	< F2	0
2	≥3	≥3	-	> F2	-1
3	2	≥2	≥5	< F2	-1
4	2	≥2	≥5	> F2	-2
5	-	-	≥3	< F2	-2
6	-	-	≥3	> F2	-3
7	1	2	2	> F2	-3
8	1	2	2	> F2	-4
9	1	1	1	-	-4

[a] Data spread in relation to central value. F2 denotes factor of two.

[b] Difference between emission factor rating and test data rating.

Minimum industry representativeness is defined in terms of number of test sites and number of tests per site. These criteria were derived from two principles:

1. Traditionally, three tests of a source represent the minimum requirement for reliable quantification.
2. More than two plant sites are needed to provide minimum industry representativeness.

The level of variability within an emission factor data set is defined in terms of the spread of the original emission factor data values about the mean or median single-valued factor for the source category. The fairly rigorous criterion that all data points must lie within a factor of two of the central value was adopted. It is recognized that this criterion is not insensitive to sample size in that for a sufficiently large test series, at least one value may be expected to fall outside the factor-of-two limits. However, this is not considered to be a problem because most of the current single-valued factors for fugitive dust sources are based on relatively small sample sizes.

Development of quality ratings for emission factor equations also requires consideration of data representativeness and variability, as in the case of single-value emission factors. However, the criteria used to assign ratings (Table 3-2) are different, reflecting the more sophisticated model being used to represent the test data. As a general principle, the quality rating for a given equation should lie between the test data rating and the rating that would be assigned to a single-valued factor based on the test data. The following criteria are used to determine whether an emission factor equation has the same rating as the supporting test data:

1. At least three test sites and three tests per site, plus an additional three tests for each independent parameter (P) in the equation.
2. Quantitative indication that a significant portion of the emission factor variation is attributable to the independent parameter(s) in the equation.

TABLE 3-2. QUALITY RATING SCHEME FOR EMISSION FACTOR EQUATIONS

Code	No. of test sites	No. of tests per site	Total No. of tests[a]	Adjustment for EF rating[b]
1	≥ 3	≥ 3	$\geq (9 + 3P)$	0
2	≥ 2	≥ 3	$\geq 3P$	-1
3	≥ 1	-	<3P	-1

[a] P denotes the number of correction parameters in the emission factor equation.
[b] Difference between emission factor rating and test data rating.

Loss of quality rating in the translation of these data to an emission factor equation occurs when these criteria are not met. In practice, the first criterion is far more influential than the second in rating an emission factor equation, because development of an equation implies that a substantial portion of the emission factor variation is attributable to the independent parameter(s). As indicated in Table 3-2, the rating is reduced by one level below the test data rating if the number of tests does not meet the first criterion, but is at least three times greater than the number of independent parameters in the equation. The rating is reduced two levels if this supplementary criterion is not met.

The rationale for the supplementary criterion follows from the fact that the likelihood of including false relationships between the dependent variable (emissions) and the independent parameters in the equation increases as the ratio of the number of independent parameters to sample size increases. For example, a four parameter equation based on five tests would exhibit perfect explanation ($R^2 = 1.0$) of the emission factor data, but the relationships expressed by such an equation cannot be expected to hold true in independent applications.

REFERENCES FOR SECTION 3

1. *Procedures for Preparing Emission Factor Documents*, EPA-454/R-95-015, Office of Air Quality Planning and Standards, U. S. Environmental Protection Agency, Research Triangle Park, NC, May 1997.

2. *Emission Factor Documentation for AP-42, Section 11.2.5 and 11.2.6, Paved Roads*, EPA-68-D0-0123, Assignment 44, Office of Air Quality Planning and Standards, U. S. Environmental Protection Agency, Research Triangle Park, NC, March 1993.

3. *Fugitive Dust Emissions Factor Update for AP-42*, EPA 68-02-3177, Assignment 25, U. S. Environmental Protection Agency, Research Triangle Park, NC, 1970.

4. *Workbook of Atmospheric Dispersion Estimates, AP-26*, U. S. Environmental Protection Agency, Research Triangle Park, NC, 1970.

5. *Protocol for the Measurement of Inhalable Particulate Fugitive Emissions from Stationary Industrial Sources*, EPA Contract 68-02-3115, Task 114, Process Measurements Branch, Industrial Environmental Research Laboratory, Environmental Protection Agency, Research Triangle Park, NC, March 1980.

4. REVIEW OF SPECIFIC TEST REPORTS

4.1 INTRODUCTION

A total of 12 field test reports were identified as sources of either potentially directly useful data on PM-10 emissions from unpaved roads or data that could be used to interpolate the necessary PM-10 information. These reports are described in Section 4.2.

4.2 REVIEW OF SPECIFIC DATA SETS

Profiling methodologies are generally used for these tests and include the following test parameters: (a) downwind test equipment should be located approximately 5 meters from the source, (b) background equipment should be placed approximately 15 meters upwind of the source, (c) wind direction should remain within 45° of perpendicular to the path of the moving point source for 90 percent of the 10 min averaging periods during testing, (d) mean wind speed should not move outside of the 4 to 20 mph range more than 20 percent of the sampling period, (e) and no wind flow disturbances should exist immediately upwind or downwind of the testing location. When following standard testing methodologies some vehicle heights may exceed the height of the sampling equipment typically about 7 m; however, the fact that the emissions originate at the road surface and the emission plume density can be characterized as decreasing with height indicates the total plume can be estimated. Vehicle heights are not generally reported in the source test reports. Analysis for silt content and moisture content of the road surface follow methodologies described in Appendix C.1 and Appendix C.2 of the AP-42. Variations from these generally accepted test parameters or any other nontraditional testing parameters are discussed within the individual test report reviews.

For this study, a well documented report not only discussed the test methodology but also included source condition and activity information. With each report description both a summary of all reported particulate sizes and individual PM-10 test data are presented. From these test reports, all uncontrolled tests and all water tests were included in the emission equation development unless noted otherwise. Chemical stabilizers were not included in the emission equation development discussed in Section 4-3.

4.2.1 Reference 1

Midwest Research Institute, "Letter Report of Field Tests, Road Sampling," for Washoe County District Health Department, Reno, NV, August 1996.

This letter report presents results of sampling of an unpaved road and a paved road in Washoe County, Nevada, in May and June of 1996. The study was undertaken to provide site-specific PM-10 test data to supplement a yearlong road surface sampling program. Also, the study supported ongoing EPA reviews of the PM-2.5 fraction of PM-10 emissions from paved and unpaved roads.

Exposure profiling was employed downwind to measure particulate emissions. For the unpaved road tests, three hi-vol samplers each fitted with a cyclone preseparator were located downwind of the test road at heights of 1, 3, and 5 m. Reference method PM-10 samplers were located upwind and downwind of the roadway as well. Road widths were not reported. Wind speed was also recorded at heights of 1, 3, and 5 m.

Four unpaved road tests and three paved road tests were completed. The unpaved road tests used only lightweight captive vehicles at low vehicle speeds. Although the testing methodology was sound, the conciseness of the letter report warranted a "B" rating of the test data. Table 4-1 presents summary test data and Table 4-2 presents detailed test information.

4.2.2 Reference 2

Midwest Research Institute, "Improvement of Specific Emission Factors (BACM Project No. 1)" for South Coast AQMD, California, March 1996.

This study developed improved particulate emission factors for construction activities and paved roads in western States. Sampling results for PM-10 are reported from testing in June and July, 1995, at three construction sites located in Nevada and California. Also, surface silt loading measurements were taken from paved roads in four separate areas in Nevada and California.

Exposure profiling was employed for the emission measurements. The downwind profiling arrays contained three high volume air samplers fitted with cyclone preseparators at heights of 1, 3, and 5 m. One high volume air sampler with a cyclone preseparator measured upwind concentrations at a 2 m height. Warm wire anemometers, located at heights of 1 and 5 m, measured wind speed. Road widths were not reported.

The unpaved road testing focused on particulate emissions from scraper travel and light-duty vehicles. Six uncontrolled scraper tests and three uncontrolled light duty vehicle tests were completed. In addition, watering was utilized as a control for two controlled scraper tests. The test data were assigned an "A" rating. Table 4-3 presents summary test data and Table 4-4 presents detailed test information.

4.2.3 Reference 3

Air Control Techniques, "PM10, PM2.5, and PM1 Emission Factors for Haul Roads at Two Stone Crushing Plants," for National Stone Association, Washington, D.C., November 1995.

This test program presents the results of sampling at two stone crushing plant quarries in August 1995. This study was undertaken to accurately measure PM-10, PM-2.5, and PM-1 emissions from a controlled haul road at a stone quarry. Testing occurred at Martin Marietta's Garner and Lemon Springs quarries in North Carolina.

The study used what was termed "an upwind-downwind profiling technique." The test approach relied on the use of a manifold to sample at several heights (up to 30 feet), which constitutes a profiling method. Downwind samples were drawn (approximately isokinetically) into 10 sample nozzles 8 to 10 inches in diameter that joined a single downcomer connected to an 18 in. horizontal duct. The vertical sampling occurred approximately 3 m downwind of the source. The system maintained a total gas flow rate of approximately 2,500 acfm. Sampling occurred along the 18 in. horizontal duct using EPA Method 201A for in-stack measurements of PM-10. Particle distribution measurements were collected with a cascade impactor and a nephelometer. Upwind measurements were made using a hi-vol sampler at a height of 15 ft, a cascade impactor, and a nephelometer placed only a few meters upwind. The roads were 30 ft wide at both test sites. Analysis included polarizing light microscopy (PLM) that measured particles of combustion products. Wind direction was required to be ±60° of perpendicular to the line source.

Three emission tests were completed at both Garner and Lemon Springs. All samples were considered controlled through water application during the test periods. Road watering occurred approximately every 2.5 to 3 hours. The amount of water applied per unit road surface area is not stated. Table 4-5 presents summary test data and Table 4-6 presents detailed test information. Emissions are presented in Table 4-5 as reported in the study; however, the emissions calculation in the study did not adjust for combustion product particles in the upwind measurements. For the development of the AP-42 emission equation, all particulate matter was factored into the emissions.

Although the sampling methodology varied from the more common exposure profiling methods, it was judged satisfactory to capture and measure a representative mass emission from the road. As a result, the Lemon Springs test was assigned an "A" rating. At the Garner test location, a large rock wall that stood immediately behind the downwind sampling site may have interrupted natural wind flows and/or created a local recirculation event. The potential wind obstruction accounted for a "B" rating of the test data at the Garner quarry.

4.2.4 Reference 4

Midwest Research Institute, "Surface Coal Mine Emission Factor Study," for U. S. EPA, January 1994.

This test report presents results of sampling during September and October 1992 at a surface coal mine near Gillette, Wyoming. This study was undertaken to address issues identified in the Clean Air Act Amendments of 1990 regarding the potential overestimation of the air quality impacts of western surface coal mining. The principal objective was to compare PM-10 field measurements against available emission factors for surface coal mines and revise the factors as necessary.

The study focused on characterizing particulate emissions from line sources such as haul roads and scrapers at a surface mining site. Four haul road sites (No. 1, 1B, 2, and 4) and one scraper site (No. 5) were characterized using downwind exposure profilers for PM-10 fitted with cyclone preseparators, a Wedding PM-10 sampler, and two hi-vol samplers for TSP. The exposure profiling arrays consisted of four samplers located from 1 m to 7 m in height. Upwind concentrations were monitored with a Wedding PM-10 sampler and one cyclone preseparator. Wind direction at one height (3 m) and wind speed at three heights (1 m, 3 m, and 5 m) were recorded at the downwind sites. Additional sampling studies included measuring the near-source particle size distributions using a combination cyclone preseparator and a cascade impactor.

At the five sites a total of 36 PM-10 emission tests were completed. A majority of the tests (34 PM-10 tests) were performed on haul roads. The road width was not reported. The haul road tests spanned a large range of wind speeds from 4.5 mph to 22 mph. Approximately half of these tests were controlled by use of water/surfactant. The water/surfactant provided a control efficiency from 40 to 70 percent for PM-10 and from 30 to 60 percent for TSP. A summary of emissions data is presented in Table 4-7 and detailed test information is presented in Table 4-8. The test data were assigned a rating of A. The report included adequte detail and the methodology meets the requirements for a sound exposure profiling system.

The study also presented an evaluation of the performance of emission factor models in predicting independent emission test data. An emission factor developed specifically for haul roads in the surface coal mining industry (see Equation 4-1) was compared against the "generic" AP-42 unpaved road emission factor (Equation 2-1). The Fourth Edition of AP-42 (September 1988) presented the following PM-30 emission factor for haul trucks in Section 8.24, "Western Surface Coal Mining:"

$$E30 = 0.0067\ (w)3.4\ (L)0.2 \tag{4-1}$$

where:

$E30 =$ TSP emission factor (lb/vmt)
$w =$ mean number of wheels
$L =$ road surface silt loading (g/m2)

In addition, the performance of an emission factor developed specifically for light-/medium-duty traffic at surface coal mines was also compared against that of the generic model. Section 8.24 in the Fourth Edition of AP-42 (September 1988) presented the following equation (Equation 4-2) for estimating PM-30 emission from light-/medium-duty traffic on unpaved roads at surface coal mines.

$$E30 = 5.79\ /\ (M)4.0 \tag{4-2}$$

where:
$E30 =$ TSP emission factor (lb/vmt)
$M =$ road surface moisture content (%)

It is important to note that, when Equation 2-1 was applied to independent emission test data, the generic emission factor performed as well as or better than emission factors developed specifically for the mining industry. For haul trucks, Equation 4-1 severely underpredicted the measured emission factors. On average, Equation 4-1 underpredicted the independent test data by a factor greater than 5. In contrast, Equation 2-1 tended to overpredict the independent test data, but by a factor of less than 2 on average.

Equation 2-1 also performed reasonably well (within 20 percent on average) when applied to independent tests of light-duty traffic emissions. Although the AP-42 light/medium duty factor provided reasonably accurate (within a factor of 2) estimates in two of three cases, the industry-specific factor overpredicted a third independent test result by a factor of 20. In summary, then, the generic AP-42 emission factor performed at least as well as the industry-specific factors on average and performed substantially better in terms of extreme over/underprediction. As will be discussed in Section 4.3, these findings led to combining emission tests collected over a broad range of source conditions into a single large data set for emission factor development.

4.2.5 Reference 5

Entropy, "PM10 Emission Factors for a Haul Road at a Granite Stone Crushing Plant," for National Stone Association, Washington, D.C., December 1994.

This test report presents test data from measurements at a granite quarry in Knightdale, North Carolina. The testing program occurred in October 1994 and focused on PM-10 emissions from an unpaved haul road.

The testing protocols followed what the report termed a "push-pull method." Four 36-inch diameter circulating fans were utilized on the upwind side of the road and large hoods were located downwind to capture particulate emissions. Two sets of two hoods stacked vertically were located side-by-side. A set of hoods consisted of two hoods each four ft high by seven ft wide with one located 2 ft and the other seven ft above the ground. The road width was 40 ft. Emissions captured in a set of hoods were drawn through a common 12 inch duct and sampled for PM-10 using EPA Method 201A. One hi-vol PM-10 ambient sampler was located upwind of the circulating fans. Wind speed and wind direction were also monitored.

Three controlled tests and four uncontrolled tests were performed. All seven tests utilized both sets of hoods and the results from both sets were averaged for the emission factor calculations. Testing was discontinued when wind speeds exceeded 3 mph. Controlled tests utilized water as the dust suppressant. For the controlled tests, watering occurred on average every 3.6 hr. The water application rate in terms of volume of water applied per unit road surface area was not reported. Table 4-9 presents summary test data and Table 4-10 presents detailed test information.

The push-pull method as described in Reference 5 does not correspond directly to any of the test methods presented in Section 3 of this report. Furthermore, the data reported provide strong evidence that some basic premises underlying unpaved road testing were not met. For example, in three of the seven tests, the concentrations measured by the side-by-side hood differed by a factor of 5 to 7, strongly suggesting either a lack of precision in the testing methodology or that the road under consideration could not be reasonably represented as a uniformly emitting line source.

There are additional concerns about operational features of the push-pull method. Reference 5 describes wind directions up to 80° from perpendicular as acceptable and testing was interrupted if the wind velocity exceeded 3 mph. Testing under low-speed winds or winds with very oblique directions promotes the passage of PM-10 over the short sampling array. In other words, the wind speed/direction acceptance criteria established for the push-pull method actually promote incomplete plume capture, thus resulting in a low bias in the reported emission factors.

Because of the deviations from established acceptable sample methodology and the lack of precision of the push-pull method, the quality highest rating the data could receive (following guidance given in EPA-454/R-95-015, Procedures for Preparing Emission Factor Documents) is "C." Nevertheless, because the operational parameters associated with the method would bias results low, a final quality rating of "D" was assigned.

4.2.6 Reference 6

Midwest Research Institute, "Unpaved Road Emission Impact,"for Arizona Department of Environmental Quality, March 1991.

This study performed field sampling on Arizona rural roads in Pima, Pinal, and Yuma counties. The study also recommended a mathematical model to estimate emissions from unpaved rural roads for arid and semiarid regions, based on a review of historical data as well as Arizona-specific field sampling results. Particle emission sizes of interest in this study were TSP and PM-10. Contrary to expectation, the examination of the historical data base did not find a systematic underprediction of emissions from unpaved roads in the arid portions of the Western United States.

Exposure profiling formed the basis of the measurement technique used at the Arizona sampling sites. For this study, two downwind arrays were deployed 5 m from the road. Each array had three sampling heads located at heights of 1, 3, and 5 m. One downwind unit was fitted with cyclone preseparators. The other downwind unit was equipped with cyclones for half the sampling periods and with standard high volume roofs for the other sampling periods. In addition, one pair each of high volume and dichotomous samplers were operated at a 100 ft downwind distance. No road widths were reported. Upwind measurements were obtained with a vertical array containing two sampling heads, a standard hi-vol sampler, and a dichotomous sampler. Wind speed was measured with warm wire anemometers at two heights (1 and 5 m), and wind direction was measured at a single height.

Vehicle passes were controlled during testing periods and three vehicle speeds were tested (35, 45, and 55 mph). The test data were assigned an "A" rating. Table 4-11 presents summary test data and Table 4-12 presents detailed test information. The report examined how well the data developed in the field tests agreed with the current version of the AP-42 emission factor.

Although the AP-42 equation provided reasonably accurate results when applied to the field tests conducted in this study, another emission factor model was developed. This was justified in the report by differences between typical traffic conditions in Arizona and the basis of the existing AP-42 emission factor. Common travel speeds on rural unpaved roads in Arizona generally fall outside the range of values in the AP-42 model's underlying data base. As a result of the numerous industrial road tests, the data base generally reflected heavier vehicles than are common on rural roads.

4.2.7 Reference 7

Midwest Research Institute, "Roadway Emissions Field Tests at US Steels Fairless Works," for U.S. Steel Corporation, May 1990.

This testing program focused on paved and unpaved road particulate emissions at an integrated iron and steel plant near Philadelphia, Pennsylvania, in November 1989. Exposure profiling was used to characterize one unpaved road (Site "X") located near the center of the facility and used principally as a "shortcut" by light-duty vehicles.

Two tests were conducted using a profiling array, with sample heights from 1.5 m to 6.0 m, that measures downwind mass flux. A high-volume, parallel-slot cascade impactor was employed to measure the downwind particle distribution and a hi-vol sampler was utilized to determine the downwind TSP mass fraction. Road width was not reported. The upwind particle size distribution was determined with a standard high-volume/impactor combination.

Unpaved roads at the plant had been treated with dust suppressant several years before the test program started. As a result, only controlled unpaved road emissions were tested. In other words, this test program did not produce data that could be used for an uncontrolled unpaved road emission equation. The control efficiencies for PM-10 were estimated to be 80 to 90 percent. Control efficiencies for TSP were estimated at 70 percent to 80 percent for the unpaved road chemical suppressants. Table 4-13 presents summary information and Table 4-14 presents detailed test information.

4.2.8 Reference 8

Midwest Research Institute, "Evaluation of the Effectiveness of Chemical Dust Suppressants on Unpaved Roads," for U. S. EPA, EPA-600/2-87-102, November 1987.

This study obtained data on the control effectiveness of common dust suppressants used in the iron and steel industry. Tests were conducted from May through November, 1985, at LTV's Indiana Harbor Works in East Chicago, Indiana, and at Armco's Kansas City Works in Missouri. The testing program measured control performance for five chemical dust suppressants including two petroleum resin products (Coherex® and Generic 2), a emulsified asphalt (Petro Tac), an acrylic cement (Soil Sement), and a calcium chloride solution.

The exposure profiling methodology was utilized for all testing. The downwind exposure profiler contained sampling heads at 1.5, 3.0, 4.5, and 6.0 m. Particle size distribution was determined both upwind and downwind with high volume cascade impactors. Wind speed was monitored at two heights and wind direction was monitored at a single height. Road width was not reported.

A total of 64 tests were completed with seven uncontrolled tests and 57 controlled tests. Suppressants tested at Indiana Harbor Works were initially applied as follows: Petro Tac at 0.44 gal/yd^2, Coherex® at 0.56 gal/yd^2, and calcium chloride at 0.25 gal/yd^2. All five suppressants were tested at the Kansas City Works facility and were initially applied at the following rates: Petro Tac at 0.21 gal/yd^2, Coherex® at 0.21 gal/yd^2, Soil Sement at 0.16 gal/yd^2, Generic at 0.14 gal/yd^2, and calcium chloride at 0.24 gal/yd^2. A rating of "A" was assigned to the data. Testing followed an acceptable methodology and the test report was reasonably well documented.

Total particulate, IP, PM-10, and PM-2.5 were measured during this study. A control efficiency of 50 percent or greater was measured for all chemicals tested. Reapplication of the suppressant resulted in a notably higher level of control. A cost-effectiveness comparison found little variation between suppressants under the test conditions with the exception of a nonfavorable comparison of calcium chloride. Table 4-15 presents summary test data and Table 4-16 presents detailed test information.

The report also discussed the development of models to estimate the control efficiency of different chemical dust suppressants. As was discussed at the end of Section 2, various suppressants do not appear to affect the road surface characteristics in the same way. As a result, this makes performance models based on surface physical parameters unfeasible.

4.2.9 Reference 9

Midwest Research Institute, "Fugitive Emission Measurement of Coal Yard Traffic at a Power Plant," for Confidential Client, December 1985.

This study included seven tests of controlled, unpaved surfaces and four tests of uncontrolled, unpaved surfaces at a power plant. Airborne particle size fractions of interest in this study are total particulate, TSP, IP, PM-10, and PM-2.5. A section of road within the facility's coal yard was tested in August 1985. The road was a permanent ramp up the main stockpile and is used by scrapers for both stockpiling and reclaiming operations.

Particulate emissions were characterized using three downwind exposure profilers, each consisting of four profiling heads at heights of 1.5, 3.0, 4.5 and 6.0 m. (The use of three profiling systems allowed continuous testing after water application by staggering the operation of the samplers.) Three high-volume, parallel-slot cascade impactors equipped with cyclone preseparators were used to characterize the downwind particle size distribution at a height of 2.2 m. One cyclone/impactor combination was used to characterize the upwind particle size distribution and total particulate concentration. Wind speed was measured with warm-wire anemometers at two heights (3 and 6 m) and wind direction was measured at a single height (4.5 m). Also, incoming solar radiation was measured with a mechanical pyranograph. Road width was not reported.

For the controlled tests, the road and surrounding areas were watered for approximately 30 minutes before the start of air sampling. Water was applied to the surface in two passes with a total mean of 0.46 gal/yd^2 (which is equivalent to approximately 0.08 in. of precipitation). The watering was found to provide effective control for 3 to 4 hours with 35 vehicle passes/hr. The control efficiency for TSP and PM-10 averaged 74 and 72 percent over 3 hours, respectively. The control efficiency closely correlated to the surface moisture content, with a higher moisture content increasing the control efficiency. A summary of the emissions data is presented in Table 4-17 and detailed test information is presented in Table 4-18. Because testing followed an accepted test methodology and the results were reasonably well documented, data were rated "A."

4.2.10 Reference 10

Midwest Research Institute, "Critical Review of Open Source Particulate Emission Measurements--Part II - Field Comparison," for Southern Research Institute, August 1984.

This report presents test results from a June, 1984, test at U.S. Steel's Gary Works in Gary, Indiana. The study was conducted to compare exposure profiling methodologies as used by five independent testing organizations to characterize fugitive emissions originating from vehicular traffic. The source tested was a paved road simulated as an unpaved road through the addition of exceptionally high road surface loading (600,000 lb/mile).

An exposure profiler with 5 sampling heads (located at heights of 1.5, 3.0, 4.5, 6.0, and 7.5 m) was used to characterize downwind emissions. Particle sizing was determined using cyclone/impactors located alongside the exposure profiler. Particle sizes of interest in this study included total particulate (TP), <30 μm, <15 μm, <10 μm , and <2.5μm in aerodynamic diameter. One cyclone/impactor and one cyclone were deployed upwind for background measurements. Warm wire anemometers measured wind speed at two heights (1.5 and 4.5 m). The road was reported to be 30 ft wide.

The material used to cover the road surface was a mixture of clay, iron ore and boiler ash. Reasonably good agreement was found between the AP-42 unpaved road model (Equation 2-1) and the emission data collected for the simulated unpaved road. However, the report noted that this was a surprising result for a number of reasons. First, the material (a mixture of clay, iron ore and boiler ash) used to simulate the surface is not typical of unpaved roads. There were also concerns about the homogeneity of the material spread over the five test sections. These problems were further complicated by the fact that the source conditions were not at a steady-state. Instead, the surface loading (mass of material per unit area) steadily decreased throughout the week of emission testing.

4.2.11 Reference 11

Midwest Research Institute "Size Specific Particulate Emission Factors for Uncontrolled Industrial and Rural Roads" for U. S. EPA, January 1983.

This study reports the results of testing conducted in 1981 and 1982 at industrial unpaved and paved roads and at rural unpaved roads. Unpaved industrial roads were tested at a stone crushing facility in Kansas, a sand and gravel processing facility in Kansas, and a copper smelting facility in Arizona. The rural unpaved road testing occurred in Colorado, Kansas, and Missouri. The study was conducted to increase the existing data base for size-specific particulate emissions. The following particle sizes were of specific interest for the study: IP, PM-10, and PM-2.5.

Exposure profiling was utilized to characterize particulate emissions. Five sampling heads, located at heights of up to 5 m, were deployed on the downwind profiler. A standard hi-vol sampler and a hi-vol sampler with a 15 μm size selective inlet (SSI) were also deployed downwind. In addition, two cyclone impactors were operated to measure particle size distribution. A hi-vol sampler, a hi-vol sampler with an SSI, and a cyclone impactor were utilized to characterize the upwind particulate concentrations. Wind speed was monitored with warm wire anemometers. No road width was reported.

A total of 18 paved road tests and 21 unpaved road tests were completed. The test data were assigned an "A" rating. Eleven industrial unpaved road tests were conducted as follows: five unpaved road tests at the stone crushing plant, three unpaved road tests at the sand and gravel processing plant, and three unpaved road tests at the copper smelting plant. For rural unpaved roads, six tests were conducted on roads with a crushed limestone surface in Kansas, four tests were conducted on dirt roads in Missouri, and two tests were conducted on gravel roads in Colorado. Rural road tests only measured emissions from light duty vehicles at speeds from 25 to 40 mph. The industrial road tests were conducted with medium duty vehicles at the stone crushing and copper smelting plants and heavy duty vehicles at the sand and gravel processing facility. Table 4-21 presents summary test data and Table 4-22 presents detailed test information.

4.2.12 Reference 12

Midwest Research Institute, "Iron and Steel Plant Open Source Fugitive Emission Control Evaluation," for U. S. EPA, August 1983.

This test report centered on the measurement of the effectiveness of different control techniques for particulate emissions from open dust sources in the iron and steel industry. The test program was performed at two integrated iron and steel plants, one located in Houston, Texas, and the other in Middletown, Ohio. Water and petroleum resin (Coherex®) were used to reduce emissions from traffic on unpaved roads. Control techniques to reduce emissions from paved roads and coal storage piles were also evaluated. Particle emission sizes of interest in this study were total particulate (TP), IP, and PM-2.5.

The exposure profiling method was used to measure unpaved road emissions at Armco's Middletown Iron and Steel plant. For this study, one downwind profiler with four or five heads located at heights of 1 to 5 m was deployed. Two high volume parallel slot cascade impactors samplers, one at 1m and the other at 3m, measured the downwind particle size distribution. A standard hi-vol sampler and an additional hi-vol sampler fitted with a size selective inlet (SSI) were located downwind at a height 2 m. One standard hi-vol sampler and two hi-vol samplers with SSIs were located upwind for background collections. The road width was not reported.

Nineteen unpaved road tests for controlled and uncontrolled emissions were performed. Testing included 10 runs of heavy-duty traffic (>30 tons) and 9 runs of light-duty traffic (<3 tons). Six heavy duty traffic tests were controlled and four were uncontrolled, whereas, the light-duty traffic had five controlled tests and four uncontrolled tests. The testing methodology was assigned an "A" rating, although a lack of reported moisture data downgraded the report to a "B" rating. Uncontrolled and watered tests were used in the exploratory development described in Section 4.3; however, due to the lack of reported moistures the data were not included in the final emission factor equation. Table 4-23 presents summary test data and Table 4-24 presents detailed test information.

For heavy-duty traffic, a 17 percent solution of Coherex® in water applied at a rate of 0.19 gal/yd^2, provided an average control efficiency of 95.7 percent for TP, 94.5 percent for IP, and 94.1 percent for PM-2.5 over a 48 hr period. Water was applied at a rate of 0.13 gal/yd^2 and, ½ hour after application, was found to decrease emissions by 95 percent for all particles. Control efficiencies 4.4 hours after the water applications were 55.0 percent for TP, 49.6 percent for IP, and 61.1 percent for PM-2.5.

A 17 percent solution of Coherex® in water was the only control applied during testing for the light-duty traffic. The Coherex® solution was applied at a rate of 0.19 gal/yd^2 and, 51 hr after application, provided a control efficiency of 93.7 percent for TP, 91.4 percent for IP, and 93.7 percent for PM-2.5.

4.2.13 Reference 13

Midwest Research Institute, "Extended Evaluation of Unpaved Road Dust Suppressants in the Iron and Steel Industry,"for U. S. EPA, October 1983.

This study centered on the reduction of particulate emissions for various dust suppressants used on unpaved roads in the iron and steel industry. Long-term control effectiveness of the dust suppressants was determined through testing at iron and steel plants located in East Chicago, Indiana and Kansas City, Missouri. Water, an emulsified asphalt, and a petroleum resin were the dust suppressants used. Particle emission sizes of interest in this study were TSP, IP, PM-10, and PM-2.5.

The exposure profiling method was used to measure unpaved road emissions at the Jones and Laughlin's (J&L's) Indiana Harbor Works and Armco's Kansas City Works. For this study, one downwind profiler, with four sampling heads at heights of 1.5 to 6 m, was deployed during all testing. High volume cascade impactors located at heights of 1.5 and 4.5m measured particle sizes. A high volume cascade impactor was also used to characterize the upwind particle distribution. Warm-wire anemometers at two heights monitored wind speed and a wind vane monitored horizontal wind direction. Road width was not reported.

Twenty-nine controlled and uncontrolled unpaved road tests were performed in this study. Three uncontrolled tests and eight controlled tests were conducted at J&L's Indiana Harbor Works; and three uncontrolled tests and 15 controlled tests were completed at Armco's Kansas City Works. All tests have been assigned an "A" rating. Only uncontrolled tests and controlled tests using water were utilized in the emission factor equation development. Table 4-25 presents summary test data and Table 4-26 presents detailed test information.

The three controlled conditions in this study included a 20 percent solution of emulsified asphalt (Petro Tac) applied at 0.7 gal/yd^2, water applied at 0.43 gal/yd^2, and a 20 percent solution of petroleum resin (Coherex®) applied at 0.83 gal/yd^2 followed by a repeat application of 12 percent solution 44 days later.

The control effectiveness was reported as the number of vehicle passes that occurred as the control efficiency decayed to zero. The initial asphalt emulsion application had an estimated lifetime of 91,000 vehicle passes for PM-10, the initial petroleum resin application had an estimated lifetime of 7,700 vehicle passes for PM-10, and the water application had an estimated lifetime of 560 vehicle passes for PM-10. Also, a reapplication of the petroleum resin had an estimated lifetime of 23,000 vehicle passes for PM-10.

4.2.14 Reference 14

Midwest Research Institute, "Improved Emission Factors for Fugitive Dust From Western Surface Coal Mining Sources" for U. S. Environmental Protection Agency, Cincinnati, OH, July 1981.

This study was conducted to develop emission factors for major surface coal mining activities occurring in the western United States. Results are reported of testing conducted in 1979 and 1980 at three surface coal mines located in Wyoming, North Dakota, and New Mexico. Sampling was conducted on the following mining operations: drilling, blasting, coal loading, bulldozing, dragline operations, haul trucks, light- and medium-duty trucks, scrapers, graders, and wind erosion of exposed areas. Particulate sizes measured include, TSP, IP, and PM-2.5.

Exposure profiling was used to measure emissions from line source activities such as vehicle traffic on unpaved roads and from scraping and grading. Comparisons of data from profiling and upwind-downwind methods were made for scrapers and haul roads. A modified exposure profiling methodology was utilized for blasting emission measurements, and a wind tunnel was used to measure wind erosion emissions. Area source emissions such as coal loading were tested with an upwind/downwind methodology.

The exposure profiling method used a downwind profiler with four sampling heads located at heights of 1.5 to 6.0 m. A standard hi-vol sampler (2.5 m), a hi-vol sampler fitted with a cascade impactor (2.5 m), and two dichotomous samplers (1.5 and 4.5 m) were located downwind. Dust fall buckets were placed upwind and downwind at a height of 0.75 m to measure the particle deposition. Upwind concentrations were measured with one dichotomous sampler and one standard hi-vol sampler, both located at a height of 2.5 m. Wind speed was measured with warm wire anemometers downwind at heights of 1.5 and 4.5 m. Road widths were not reported.

A total of 256 tests were performed in the study. Fifty-six of the tests were used in the development of the AP-42 emission factor equation. The source activity distribution for unpaved road tests was as follows: 20 uncontrolled haul road tests, 8 controlled haul road tests, 10 uncontrolled light- and medium-duty vehicle tests, 2 uncontrolled light- and medium-duty vehicle tests, and 15 uncontrolled scraper tests. Table 4-27 presents summary test data and Table 4-28 presents detailed test information.

4.2.15 Reference 15

Midwest Research Institute, "Fugitive Particulate Matter Emissions," for U.S. EPA, April, 1997.

This test report describes the results of field measurement and other data collection activities that were undertaken in late 1995 and early 1996. The study focused on the determination of PM-10 and PM-2.5 components of fugitive dust emissions from representative paved and unpaved roads at four geographic locations in the United States (Kansas City, MO; Reno, NV; Raleigh, NC; and Denver, CO.) Although, an emphasis was placed on the estimation of the PM-2.5 fraction of the emissions from unpaved and paved roads, this study only reports PM-10 emission factors and PM-2.5/PM-10 ratios.

Exposure profiling was employed to measure particulate emissions. As is general practice with profiling methods, the downwind sampling equipment was placed 5 m after the emission source and the upwind sampling equipment was placed 10 m before the source. For the unpaved road PM-10 tests, a high-volume air sampler equipped with a cyclone preseparator was utilized. A high-volume sampler equipped with cyclone preseparators and parallel-slot, five-stage cascade impactors collected particle sizing information. Also, dichotomous samplers were operated for particle sizing measurements. Wind speed was monitored by wind odometers at three heights and wind direction was recorded with a wind instrument.

State-of-the-art equipment was employed for particle sizing at two of the unpaved road locations; however, at the Raleigh, North Carolina location, an Amhurst Aerosizer Particle sizer failed because of a power supply problem. At the Kansas City, Missouri location, MRI personnel operated a DustTrak Aerosol Monitor light scattering instrument.

Thirteen uncontrolled unpaved road tests at three locations were completed as follows: five tests in Kansas City, four tests in Reno, and four tests in Raleigh. Testing was completed using lightweight captive vehicle traffic operated at a speed of 30 mph. This study recommends a PM-2.5/PM-10 particle size adjustment factor of 0.15 for unpaved roads. The test data were assigned an "A" rating and were used as part of the PM-10 validation study discussed in Section 4.3.1 of this report. Table 4-29 presents summary test data and Table 4-30 presents detailed test information.

4.2.16 References 16-19

Illinois State Water Survey--AWMA/APCA Publications, 1988-1989

Approximately 36 other unpaved road tests have been reported in a series of three APCA/AWMA papers. These tests employed a exposure profiling method to characterize emissions from captive traffic on several rural roads near Champaign, Illinois. A conversation[19] with the project manager confirmed that there is no test report that describes the methodology and results for the tests.

Twenty-one tests are reported in Reference 16, with the experimental methodology being described in an earlier APCA paper (Reference 18). The main interest in Reference 16 is the set of emission factors developed through exposure profiling. Sampling made use of three dichotomous samplers located at 1.55, 3.05, and 4.88 m. (Note that the sampling heights are different from those given in the paper [Reference 18] describing the methodology.) The stacked samplers were located at a distance of 20 m from the road. Reference 18 notes that wind speed and direction were continuously monitored, but no other details are available. No dates are given for the tests.

Captive traffic was used to generate emissions from unpaved, limestone roads. Single tests at each of three travel speeds (25, 35, and 45 mph) were conducted in each experiment. A total of 8 experiments (denoted as 7 and 9 through 14) are reported in Reference 16. Although the only two road identification codes are reported, it is not clear whether the tests were conducted at the same location and thus constitute replicate samples.

In each of the 21 cases analyzed, the emission factors were calculated by assuming a linear profile for exposure values. Thus, the maximum exposure 20 m downwind from the road distance is assumed to occur at ground level even though the wind speed (and thus exposure) vanishes at ground level. This leads to a systematic high bias in the emission factors reported.

Surface samples were collected “periodically” from the roads. All tests reported in a single experiment are associated with a single silt value. When samples were not available for the day that emission testing occurred, values are interpolated. Sample collection and analysis methods were not specified.

An additional fifteen tests were conducted in 1988 and are reported in Reference 17. In those tests, a fourth dichotomous sampler was included in the sampling array 20 m from the roadway. Sampling spanned 1.5 to 6.1 m, but individual sampling heights are not reported. Wind speed was monitored on-site at a 1.5 m height. Those measurements were combined with 10-m wind data from an off-site meteorological station to develop a logarithmic profile for calculation purposes.

A total of 4 experiments (15 through 18) are reported in Reference 17. With the exception of experiment 15, all consisted of an individual test at each of 4 captive vehicle speeds: 25, 35, 45 and 55 mph. Experiment 15 examined emissions at speeds of 25, 45 and 55 mph.

The 1988 tests were associated with a great deal of surface sampling. Three different samples were collected before and after every 100 vehicle passes. As opposed to Reference 16, separate silt values are reported with each test in an experiment.

Two sets of surface samples were considered. The first set was generally collected in the same manner as described in AP-42, Appendix C.1. Contrary to AP-42 Appendix C.2, however, these samples were not oven-dried prior to sieving. A second set of samples focused on the tracks and ruts formed by the captive traffic. The paper does not compare the results from the two different sets of samples.

Two roads were tested – one with limestone and the other with glacial gravel. Experiments 16 and 17 were conducted on the limestone road and on consecutive days; these constitute replicate measurements. Experiment 14 was conducted on the limestone road, but it is not know whether at the same location as experiments 16 and 17. Experiment 18 was conducted at the glacial road.

Although specific data reduction methods are not described, it is assumed that a linear profile was used to characterize exposure values. As noted earlier, this would lead to maximum exposure at ground level and to a systematic high bias in the emission factors reported.

Because supporting documentation could not be obtained, the data were not available for the development of an emission factor equation.

4.3 DEVELOPMENT OF CANDIDATE EMISSION FACTOR EQUATION

For unpaved roads, an emission factor equation has been found to be successful in predicting particulate emissions at different sites with varying source parameters. This section describes the development of the emission factor equation that will be proposed for the updated AP-42 Unpaved Road section.

Various road surface and vehicle characteristics are likely to have an impact on the particulate emissions from unpaved roads. Those parameters most likely to influence the particle emissions, while at the same time are able to be measured in a practical manner, are considered for the emission equation development. The possible parameters may be grouped into three categories: (a) measure of source activity (b) properties of the material being disturbed and (c) climatic parameters.

The measure of source activity includes the speed and weight of the vehicles traveling on the unpaved road. This category would also include the number of wheels of the vehicles in contact with the unpaved road. Subparameters that affect the particle emissions might also be considered; however, cost conscience efforts and clarity considerations for potential emission equation users have narrowed in-depth reviews of these subparameters. These subparameters may include the following: the turbulence created by the aerodynamics and clearance of the individual vehicle traveling on the unpaved road; the unique characterisics of the tire such as width, pressure, and tread design; angle of wheels compared to vehicle thrust; and wheel slippage over the unpaved road surface. Also, if extensive detailed traffic data were available for 15,000+ vehicle passes in the current data set, it would be possible to consider the relation of emissions of tangential wheel velocity compared to vehicle speed.

The properties of the material being disturbed includes moisture content and the content of the suspendable fines in the surface material. Although difficult to characterize within the magnitude of the available data, emissions could potentially be affected by interactions between dust particles of different physical characteristics. Conditions of the unpaved road may also be considered such as the characteristics of the road base (e.g., compacted, hardbase, washboard). Difficult to characterize variability in road conditions and resultant complexity of the emission equation were considered as basis for not including the road base characteristics in the emission factor equation.

Climatic characterization is generally reflected by the precipitation-free days per year on which emissions tend to be at a maximum. The radiant energy of the sun may be important when determining the control efficiency of watering, and in effect the average moisture content of the surface material. Direct moisture measurements are appropriate in this case.

The parameters readily measureable and applicable to a general unpaved road equation include surface silt content, surface moisture content, mean vehicle weight, mean vehicle speed, and mean number of wheels. Discussion of the analysis of these parameters continues later in this section.

The development of a revised unpaved road emission factor equation was built upon findings from the reviewed data sets. First, the decision was made to include all tests of vehicles traveling over unpaved surfaces. For example, tests of scrapers in the “travel mode” between cut and fill areas were included. Also, tests of very large off-road haul trucks used in the mining industry were also included in the developmental data set. On the other hand, graders blading an unpaved road were not included because of the low speed and the additional road surface disturbance involved. This decision had the effect of greatly expanding the historical data base. Not only are far more data available, but the data encompass a wider range of vehicle weights and travel speeds.

The decision to composite the data sets was based on findings from Reference 4, which dealt with the western surface coal mining industry. Remarks made in Section 4.2.4 bear mention here as well. Reference 4 found that the "generic" unpaved road emission factor model currently contained in AP-42 (Equation 2-1 in this document) performed at least as well in predicting emissions from both haul trucks and light-duty vehicles as did emission factors developed specifically for the industry under consideration.

Next, the decision was made to add tests of watered roads to tests of uncontrolled roads, because moisture content is also affected by natural mitigation resulting from climatic factors. Chemically controlled unpaved roads were not included because those treatments cause lasting physical changes to the road surface. A review of the measurable physical characteristics (silt content and moisture content) of chemically controlled unpaved roads found no identifiable trends. Reference 8 examined the historical data base and concluded that a general control estimation method based on surface characteristics was not feasible.

The inclusion of both uncontrolled and watered roads was based on findings in the Reference 4 study. That study and a later review included moisture as a potential correction parameter in developing a predictive equation for unpaved roads. It was found that both the old (Reference 14, circa 1980) and new (Reference 4, 1992) haul truck data could be successfully fitted with one equation that applied to both watered and uncontrolled surfaces. The decision was also supported by a similar approach taken in developing the current AP-42 paved road equation. In that case, controlled and uncontrolled tests were combined.

Inclusion of watered surfaces in the data base recognizes a fundamental difference in how the addition of water controls emissions (as opposed to the addition of other types of suppressants). First, the addition of water is a short-term control measure and is similar to the effect of rain. In addition, it causes no permanent change in the road surface characteristics. To an extent, one could argue that a road subject to frequent rain is no different than a road which is routinely watered.

Finally, the decision was made to focus on PM-10 emission tests. Because Equation 2-1 was developed earlier than the 1987 promulgation of the PM-10 NAAQSs, that factor did not focus on the particle size range of current regulatory interest. Combining data sets emphasizes the basic physical process of dust generation by vehicle traffic on unpaved roads. In keeping with that view, it is reasonable to expect that emission factors for different size fraction resemble one another. The approach requires that the models developed for different particle size ranges be "consistent," in the sense discussed below.

As a first step, the "developmental" data base was prepared from the test reports discussed in the previous section, with the following exceptions:

1. No test data were included from Reference 5. As noted earlier, these data were rated "D."

2. No data were included from Reference 7, because the unpaved road considered had been previously treated with a chemical dust suppressant. Also, individual tests of chemical dust suppressants in other references were not included.

Finally, some additional preparation of the data base was required. For example, References 12 and 14 did not present PM-10 emission factors; values were developed by log-normal interpolation of the PM-15 and PM-2.5 ratios to total particulate emissions. In addition, References 1, 12, and 13 did not report individual surface moisture contents. However, because silt content is determined after oven drying, the necessary information was readily available for Reference 1, which was being prepared at the same time that the current work was being undertaken. In Reference 13, some individual tests had moisture contents reported and a few additional tests were associated with moisture contents as well. Those tests for which moisture data were reported were included in the development data set. Furthermore, the data from Reference 3 had been corrected for "combustion particulate" content (although upwind concentrations had not). Using information contained in the report, "total" PM-10 emission factors (i.e., without regard to chemical composition) were calculated for inclusion in the developmental data set. (An ASCII data file containing the developmental data set is provided in the file D13502B.ZIP located on EPA's CHIEF web site under Draft AP-42 Sections.

Model development relied on the stepwise linear regression routine contained in the SYSTAT, Version 4 set of statistical routines. The default level of significance used by SYSTAT for a variable to "enter" the stepwise linear regression was 0.15 (15 percent). In this context, "level of significance" refers to the probability of making a so-called Type I error. The possibility of making this kind of error arises because we are dealing with samples drawn from a parent population. That is to say, under the default setting, samples drawn from two completely independent populations would be found to have a significant relation purely due to chance 15 times out of 100. The 15 percent level of significance was used for exploratory data analysis; refined analysis relied on specifying a 5 or 10 percent significance level.

Standard statistical tests of significance assume normal parent populations. Because unpaved road emission factors and key correction parameters are log-normally distributed, the regression analysis needs to rely on log-transformed data. This results in a multiplicative model, which is the form of the current AP-42 emission factor predictive equation.

Stepwise multiple linear regression was used to develop a predictive emission factor equation from the data set. Five potential correction parameters were included:

1. Surface silt content, s;
2. Surface moisture content, M;
3. Mean vehicle weight, W;
4. Mean vehicle speed, S; and
5. Mean number of wheels, w.

In addition to the emission factor and correction parameter values, the data base also contained codes indicating:

1. Whether the test was of an uncontrolled or a watered surface;
2. The type of road;
    a. publicly accessible unpaved road
    b. unpaved travel surface at an industrial facility
    c. “simulated” unpaved road
3. The predominant type of vehicle traveling the road;
    a. Light or medium-duty vehicles;
    b. Haul trucks;
    c. Scrapers in the travel mode; and
    d. Heavy-duty, over-the-road trucks.

For the initial analyses, the data base was sorted by whether the test represented uncontrolled or watered conditions and by the type of road (industrial vs. public unpaved road). There were two main objectives in this step. The first objective was to determine simply whether the different portions of the data base could be successfully combined. The second objective was to determine whether an emission factor model resulting from the large combined data would be consistent. The term “consistent” refers to (a) whether or not the same basic set of correction parameters could be used to estimate emission levels and (b) whether or not the relationships were similar between different subsets in the data base.

For example, suppose that stepwise regression of one portion (*I*) of the data base (e.g., uncontrolled industrial roads) showed that emissions were highly dependent on variable X but independent of variable Y. If stepwise regression of another portion (*II*) of the data base, on the other hand, indicated that emissions were very dependent upon Y but not on X, then the results for the two portions would not be viewed as consistent. The consistency in the relationships between independent and dependent variables is also important. To continue the example, suppose that regression of portions *I* and *II* both showed that the emission levels depend on variable X. If, however, for portion *I*, emissions depended on the 0.5 power of X while in portion *II*, emissions varied with the second power of X, then the relationships would again be viewed as "inconsistent."

Given that the individual sets within the data base do not necessarily contain many test results, evaluation of consistency cannot always follow hard and fast rules. For example, one would reasonably expect that the emissions from watered tests would depend on the surface material moisture content. The lack of a discernible relationship between moisture and emissions from the uncontrolled tests in the data base would not necessarily indicate inconsistency. Furthermore, determining how "close" two relationships are, requires considerable judgment as well. For example, both a power of 0.86 and power of 1.1 indicate a roughly linear relationship.

The analysis began by stepwise regression of only the 160 uncontrolled tests in the data base, using the potential correction parameters of silt, weight, speed and number of wheels. Note that moisture content was not included. In this case, mean vehicle weight entered the regression first, and surface silt content on the second step. This first regression was roughly equivalent to repeating how the current AP-42 unpaved road emission factor was derived. Unlike the past, however, the effort focused on PM-10. The resulting emission factor for PM-10 exhibited an almost linear (power of 1) relationship with silt content. Furthermore, emissions were shown to follow a "less-than-linear" relationship with vehicle weight, although the exponent was roughly half of that contained in the current AP-42 equation (Equation 2-1).

Next, uncontrolled and watered tests were considered separately, but this time with moisture content included as a potential correction parameter. For the 137 uncontrolled tests, weight and silt were again the first two variables to enter the regression. The exponents for both these variables were consistent with the values obtained for only the uncontrolled tests. However, two additional variables entered the stepwise regression in this case. Surface moisture content entered on the third step and mean vehicle speed on the fourth.

Inclusion of speed was somewhat tentative, in that its level of significance was just slightly greater than 10 percent. The default significance level for a variable to enter the regression was 15 percent. If the requirement for a variable to enter had been tightened to the 10 percent level of significance, speed would not have entered the relationship.

For the 43 watered tests, only two correction parameters entered the regression--silt and weight. The powers for silt and weight were reasonably consistent with the results obtained when the uncontrolled tests were considered separately. The reasonably consistent relationships for both silt and weight suggested that the two uncontrolled and watered portions of the data base could be successfully combined.[b]

When both uncontrolled and watered tests were considered as one data set, weight and silt again entered first and second, with moisture entering on the third step. Wheels would enter the equation if the level of significance were relaxed to 20 percent; however, for this analysis at the 10 percent level of significance wheels are not included. Speed entered on the fourth iteration. The resulting emission factor equation has the form

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[b] The relationships for both of these variables are also reasonably consistent with the relationships in the current AP-42 model (Equation 2-1).

$$E = k\ s^{0.85}\ W^{0.50}\ S^{0.32}\ /\ M^{0.29} \qquad (4\text{-}3)$$

where k is a constant of proportionality.[c] The R^2-value (0.354) for Equation 4-3 indicates that the model explains approximately 35 percent the variation in emission factors.

An alternative to Equation 4-3 results from tightening the significance requirement, from 10 percent to 5 percent, for a variable to enter the regression. In this case, speed does not enter the equation, and the equation has the form:

$$E = k\ s^{0.82}\ W^{0.46}\ /\ M^{0.28} \qquad (4\text{-}4)$$

This equation has a R^2-value of 0.345, which is only slightly less than Equation 4-3.

Equations 4-3 and 4-4 represent the two candidate PM-10 emission factor equations considered in this study. Initially, preference was given to Equation 4-3 because the inclusion of speed was viewed as providing additional predictive accuracy for instances involving very slow or very fast traffic. Equation 4-3 was initially chosen and validation of that model proceeded.

However, in the validation of Equation 4-3, it was found that almost no additional predictive accuracy was achieved and that the equation did not permit actual estimates of the effects of speed reduction. The inclusion of speed was highly dependent on the data set being used. For example, exclusion of only one or two low-speed tests from the data resulted in speed not entering the regression at even the 15 percent level of significance. On the other hand, dropping those tests had no effect on the other terms in the model. Thus, the four-parameter model (Equation 4-3) appeared to be relatively unstable.

Furthermore, past testing studies have found that, when all other road/traffic parameters are held constant, emissions depend on a higher power of mean vehicle speed than the 0.32 value given in Equation 4-3. In Reference 6 and other older studies designed to assess the influence of vehicle speed on PM emissions, powers between 1 and 2 have been found. Note, however, that those studies were able to separately consider different speeds by supplying “captive” traffic during testing. In other words, the testing organization supplied essentially all the vehicular traffic during the field exercise to tightly control source conditions. This is a "parametric approach" that is the only systematic way to isolate the effect of individual source parameter on emission levels. In practical terms, such an approach is restricted to roads that (a) have relatively little "natural" traffic and (b) are traveled by mostly light-duty vehicles.

The captive traffic approach to systematically examine the effect of vehicle speed is in pointed contrast to how most tests in the data base were conducted. Most tests were conducted on roads at which

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[c] Working versions of the emission factor equation are presented. In this context, the term “working” refers to factors that require that weight be expressed in tons, speed in mph, and silt and moisture contents in percent. Furthermore, the emission factor must be expressed in lb/VMT. In this case, the constant of proportionality has a complicated set of dimensions. The model recommended later in Equation 4-5 has been “normalized” by dividing, for example, weight by a default vehicle weight of 3 tons. In that case, the constant of proportionality has the same dimensions as the emission factor itself and can be readily converted from one set of units to another.

the traffic could not be tightly controlled by the testing organization. Because data from many studies have been assembled and because most tests do not rely on "captive" traffic, it is not possible to isolate the effect of speed on emissions. Without the benefit of captive traffic, it is not surprising that weight and speed are highly intercorrelated in the data set. Furthermore, speed and emissions are not significantly correlated in the developmental data set. In fact, there is a negative (although not significant) correlation between emission factor and speed.

It is crucially important to keep in mind that predictive accuracy is the goal of any emission factor equation. With this in mind, the predicted-to-actual ratios for Equation 4-3 were compared to those for Equation 4-4. The summary statistics follow:

	Equation 4-3 (with speed term)	Equation 4-4 (no speed term)
Minimum	0.104	0.100
Maximum	30.1	27.4
Geometric Mean	1.02	0.986
Geometric Std. Dev.	2.74	2.71

(Note that geometric rather than arithmetic statistics are used here. The reason for this choice is explained in Section 4.5.1). In comparing the two sets of statistics, it is clear that the inclusion of a speed term in Equation 4-3 lends almost no additional accuracy.

In summary, the following emission factor equation is recommended for estimating PM-10 emissions from vehicles traveling over unpaved surfaces:

$$E_{10} = 2.6\ (s/12)^{0.8}\ (W/3)^{0.4}/(M/0.2)^{0.3} \qquad (4\text{-}5)$$

where:

E_{10} = PM-10 emission factor (lb/VMT)
s = surface material silt content (%)
W = mean vehicle weight (tons)
M = surface material moisture content (%)

Note that the "normalizing factors" of 12 percent silt and 3 tons are the same as for the current AP-42 model. This allows one to compare the leading term of 2.6 lb/VMT in Equation 4-5 to the factor of 2.1 lb/VMT inherent in the current version of the unpaved road predictive model.[d] (The selection of 0.2 percent to normalize the moisture term follows from the specification of a default value. See Section 4.4).

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[d] That is, the leading value of 5.9 (in Equation 2-1) times the aerodynamic particle size multiplier of 0.36 for PM-10.

To the extent practical, the development of emission factor equations for other the PM size ranges followed that for PM-10. That is to say, the preferred approach was to develop a stepwise regression of the available test data. For PM-30 (used as a surrogate for TSP), stepwise regression of the 65 uncontrolled emission test data led to the following result:

$$E_{30} = k\ s^{0.97}\ W^{0.52} / M^{0.45} \tag{4-6}$$

where all variables are the same as before and E_{30} denotes the PM-30 emission factor in lb/vmt. The R^2-value for the above factor is 0.49 and the equation compares well with the intermediate and final results for PM-10. In contrast to PM-10, however, vehicle speed did not enter the stepwise regression for PM-30.

When both uncontrolled and watered PM-30 tests were considered, the same three variables--silt and moisture contents, and mean vehicle weight--again entered the stepwise regression of the 92 test date. With the inclusion of the tests of emissions from watered surfaces, the only noticeable change in exponents was a slight reduction in the power for silt content. Because of the consistency between the watered/ uncontrolled tests and between the PM-10/PM-30 results, the following emission factor equation is recommended for PM-30:

$$E_{30} = 10\ (s/12)^{0.8}\ (W/3)^{0.5} / (M/0.2)^{0.4} \tag{4-7}$$

The PM-30 emission factor is clearly consistent with the factor for PM-10 (Equation 4-5). Both factors involve the same three independent variables, each raised to essentially the same power. In contrast to PM-10, vehicle speed did not enter any of the stepwise regressions of PM-30 test data.

Model building efforts for PM-2.5 initially followed the same procedures as for PM-10 and PM-30. That is, stepwise linear regression of 77 uncontrolled PM-2.5 emission test data led resulted in three variables entering the equation

$$E_{30} = k\ s^{0.67}\ W^{0.21} / M^{0.17} \tag{4-8}$$

where all variables are the same as before and $E_{2.5}$ denotes the PM-2.5 emission factor in lb/vmt
Note that, again, the same three variables entered the stepwise regression: silt content, mean vehicle weight and moisture content. Although the power to which the silt term is raised is reasonably comparable to the exponents in the PM-10 and PM-30 factors, the two remaining exponents are only half those in the other emission factor equations. More troubling is the fact that a low R^2 value for the equation implies that only 8 percent of the variation in emission levels is explained by the equation. Furthermore, when the watered tests are added to PM-2.5 developmental data set, two more variables--mean vehicle speed and number of wheels--now enter the stepwise regression. The R^2 for the equation is again low at a value of 0.23. In other words, even with five variables, the regression-based PM-2.5 factor appears to be disappointingly poor in terms of predictive ability.

Because of the failure of stepwise regression to produce a suitable PM-2.5 emission factor equation, the significant difference from the PM-30 and PM-10 equations, the potential for the five variable PM-2.5 equation to result in a value exceeding the PM-10 equation under some circumstances, and the low R^2 for the three variable equation that is reasonably comparable to the PM-10 and PM-30 equation, an alternative approach was taken. In this case, a PM-2.5 factor was developed by scaling the PM-10 model (Equation 4-5) by the measured PM-2.5/PM-10 in the available data base:

	Geometric mean ratio of PM-2.5 / PM-10
Uncontrolled (n = 108)	0.140
Watered (n=20)	0.196
Overall (n=128)	0.148

No significant difference was found between the ratios for watered versus uncontrolled conditions, so the overall mean was applied. Furthermore, no significant correlation (at the 5 percent level) was found between PM-2.5/PM-10 ratio and emission factor, silt, moisture, weight, speed, or number of wheels.

In summary, for the three PM size fractions of greatest interest, the following emission factor equation is recommended for inclusion in AP-42:

$$E = k\,(s/12)^{a}\,(W/3)^{b}/(M/0.2)^{c} \tag{4-9}$$

where: k, a, b and c are empirical constants given below and

E = size-specific emission factor (lb/vmt)
s = surface material silt content (%)
W = mean vehicle weight (tons)
M = surface material moisture content (%)

The parameters for size-specific emission factors in Equation 4-9 are given below:

Empirical constant	PM-2.5	PM-10	PM-30
k	0.38	2.6	10
a	0.8	0.8	0.8
b	0.4	0.4	0.5
c	0.3	0.3	0.4

Based on the rating system given in Section 3.5, both the PM-10 and PM-30 emission factors would be rated “A” by strictly following the decision rules presented there. However, because the predictive equation was developed to span a very broad range of source conditions and has an R^2 of only 0.34, a lowering of the quality rating is appropriate. The PM-10 and PM-30 emission factors are rated "B." Because the factor is based on scaling the PM-10 factor, the PM-2.5 factor is downgraded 1 letter. Thus the PM-2.5 factor carries a quality rating of "C."

It is important to note that the overall performance of any emission factor improves when it is applied to a number of sources within a specific area. This is an important distinction between fugitive dust sources and the "stack" ("point") emission sources (such as utility boilers) commonly discussed by AP-42. That is to say, an area being inventoried typically contains no more than a handful of the stack-type sources which use a specific emission factor. Furthermore, stack sources are far better defined and steady in terms of operating conditions (feed rate, air flow, etc.). In contrast to a handful of stack sources, an inventoried area may contain dozens of unpaved travel surfaces, each with very different vehicle characteristics that change with hour of the day, seasonally, etc. In that case, the performance of an emission factor in accurately predicting emissions from a single, isolated source should not form a central focus. Instead, one should be most concerned about how well the factor performs in estimating the total (or average) emission from the entire set of sources over time periods of interest.

4.3.1 Validation Studies

A series of validation studies were undertaken to examine the predictive accuracy of the various emission factors recommended in the preceding section. Validation focused on the PM-10 model.

This section discusses the performance of the model primarily in terms of the predicted-to-measured ratio:

$$\frac{\text{emission factor predicted by model}}{\text{measured emission factor}}$$

As a practical matter, because of the log-linear regression used to develop the emission factor models, the log of the predicted-to-measured ratio is identical to the “residual” or error term:

residual = log(predicted) - log(measured) = log(predicted-to-measured)

Throughout this section, summary statistics are presented in terms of geometric mean and standard deviation. This follows directly from the use of log-linear regression. Furthermore, use of the geometric mean is clearly more appropriate to describe ratios than the arithmetic mean for the following reason. Unlike the arithmetic average, the geometric clearly represents the tendency of the ratio. To illustrate this point, consider the following 10 hypothetical ratios:

Case	Predicted-to-measured	Measured-to-Predicted
1	0.678	1.47
2	1.48	0.68
3	2.76	0.36
4	0.885	1.13
5	0.754	1.33
6	0.248	4.03
7	1.87	0.53
8	0.126	7.94
9	1.76	0.57
10	3.15	0.32
Arithmetic mean	1.37	1.84
Geometric mean	0.95	1.05

By using the arithmetic mean of the predicted-to-measured ratio of 1.37, one could argue that the predictions were about 37 percent higher than the measured. This leads to a natural suspicion that the measured values were roughly 37 percent lower than the predictions. However, it is seen that the arithmetic mean of the measured-to-predicted ratio is in fact 1.84 which is greater than 1.37. On the other hand, the geometric mean has the property that it is equal to the inverse of the mean for the inverse ratio.

In addition, because of the log-linear regression, the residuals are log-normally distributed. For this reason, logarithmic plots of the residuals are presented.

The first two PM-10 validations used the data base assembled for developing the model. The first made use of a cross-validation analysis of the PM-10 data set. In this approach, each data point is eliminated one at a time. The regression obtained from the “reduced” data base is used to estimate the missing data value. In this way, a set of “n” quasi-independent observations is obtained from the data set of “n” tests.

The PM-10 cross-validation (CV) shows that the model is fairly accurate for a very broad range of source conditions. Table 4-31 indicates that, although the model may slightly under- or overpredict individual emission factors in some specific subset of the data base, the general agreement is quite good. The CV analysis further found that, for the quasi-independent estimates of the measured emission factors:

1. 52 percent are within a factor of 2;
2. 73 percent are within a factor of 3;
3. 90 percent are within a factor of 5; and
4. 98 percent are within a factor of 10.

Again, recall that, because a facility typically contains numerous roadway segments, each with its own vehicle mix, one is most concerned about how well the factor performs in estimating the total (or average) emission. Thus, even though the above-cited statistics suggest that, for example, there is approximately a 30 percent probability of over- or underestimating emissions by a factor of 3 for an individual roadway segment, there is a substantially lower chance of making the same level of error for emissions from the totality of roadways under consideration at a facility. Computation of an exact probability would depend on: (a) the number of individual segments under consideration and (b) the relative contribution of each segment to the total PM emissions. Note that item (b) is a relatively complicated function of the emission factor, the vehicle traffic and the road segment length .

To illustrate the increased confidence, a series of simple random drawings of 5 tests from the developmental data set was made. Comparing the sum of the measured and the estimated emissions is analogous to a hypothetical situation in which plant contains 5 road segments, each with the same length and same number of vehicle passes. In 1000 repetitions of the random draw of 5 from the developmental data set, the following was found for the sum:

1. 73 percent were within a factor of 2;
2. 92 percent were within a factor of 3; and
3. 99.6 percent were within a factor 5.

In this illustration, one would have only and 8 percent chance of over- or underestimating total emissions by a factor of 3.

Plots of the residuals versus individual PM-10 emission factor, silt, moisture, weight, speed and wheels are presented in Figures 4-1 through 4-6, respectively. In examining the PM-10 residuals (i.e., the error between individual predicted and measured observed emission factors), it was found that Equation 4-9 tends to overpredict the lowest and underpredict the highest measured factors. In other words, the model appears to have a systematic bias at the extremes of the parent data base. This tendency is to be expected of any model developed from regression techniques.

The only other significant relationship found for the residuals in the PM-10 cross-validation involved the tendency of the equation to overpredict emissions for very slow speeds. The equation does not exhibit any bias for mean vehicle speeds 15 mph and higher. Figures 4-7 and 4-8 present separate residual plots for average vehicle speeds below and at 15 mph or higher, respectively. For the 19 tests conducted with an average speed less than 15 mph, Figure 4-7 suggests overprediction by approximately 80 percent. In contrast, at speeds higher than 15 mph (and especially for speeds 45 to 55 mph) the residuals are symetrically distributed about the line of perfect agreement.

The finding that the equation overpredicts for very slow speeds also influences how to account for the emission reduction due to speed control. This overprediction suggests that speed reduction has a near linear effect on emissions. That is to say, for an approximately 50 percent reduction (i.e., from 30 mph to less than 15 mph) in speed, the emission factor is roughly 50 percent lower than expected (i.e., overpredicted by about 80 percent). This is consistent with the linear reduction based on the current AP-42 factor (Equation 2-1). As discussed in Section 4.5, a linear effect for speed reduction is included in the revised AP-42 section.

A second validation of the PM-10 factor reserved approximately 20 to 25 percent of the data base for validation purposes. Test data were randomly selected for inclusion in either the “development” or the “validation” data set. Two separate random selections were performed. The development data set is used to develop the relationship which is used to estimate tests in the validation set. The first development set led to the following predictive equation for PM-10:

$$E = 2.8\ (s/12)^{0.78}\ (W/3)^{0.44}\ /\ (M/0.2)^{0.35} \qquad (4\text{-}10)$$

and Development Set 2 led to the following equation for PM-10:

$$E = 2.7\ (s/12)^{0.80}\ (W/3)^{0.43}\ /\ (M/0.2)^{0.26} \qquad (4\text{-}11)$$

Note that both development sets led to equations very similar to that in Equation 4-5. When the two models were used to predict data that had been withheld for validation, the following summary statistics resulted:

		Ratio of predicted to measured			
Validation set	No. of cases	Minimum	Maximum	Geo. mean	Geo. std.dev.
1	n = 41	0.123	29.3	0.926	2.92
2	n = 40	0.125	6.58	1.27	2.63

Unlike the quasi-independent estimates obtained in the cross-validation, the above truly represent independent applications of an emission factor model developed through stepwise regression technique. For that reason, this validation leads to a slight bias in the resulting estimates, underpredicting in the first set by 7 percent and overestimating by roughly 30 percent in the second. Nevertheless, the spread (variation) in the estimates is quite comparable to that found in the cross-validation and the estimates generally agree well with the measured values in the validation data set.

A final PM-10 validation study involved nine emission tests that had not been formally reported when the study began (Reference 15). Table 4-32 shows the results of the comparisons of predicted to measured PM-10 emission factors. Predictions based on both Equation 4-5 and the current AP-42 equation are considered. In general, agreement is quite good for the new unpaved road equation.

Validation of the PM-30 and PM-2.5 emission factors was also undertaken. For the PM-30, a cross-validation similar to that performed for PM-10 led to results very comparable to those found earlier. Figures 4-9 through 4-14 present the residuals from the PM-30 cross-validation. Interestingly, there was no significant relationship between the residuals and speed for the PM-30 equation. In other words, unlike the PM-10 equation, the PM-30 equation does not appear to systematically overpredict at very slow travel speeds.

In the PM-30 cross-validation, the following results were found comparing the predicted to measured values,

1. 50 percent were within a factor of 2;
2. 72 percent were within a factor of 3; and
3. 96 percent were within a factor of 5.

Remarks made earlier in connection with PM-10 bear repeating here. Recall that, in general, one is more interested in how well the factor performs in estimating the total (or average) emission from several roadway segments within a facility. In this way, there is considerably greater accuracy in the total emission estimate than might be inferred from the above statistics. As in the case of PM-10, consider the example of comparing the measured and predicted sums in random draws of five from the data set. In 100 realizations,

1. 83 percent were within a factor of 2;
2. 98 percent were within a factor of 3; and
3. All were within a factor of 5.

Note that the estimate for the total is substantially "tighter" than that for the individual road segment.

Because the result for PM-2.5 in Equation 4-9 was not developed by stepwise regression, a different type of validation was undertaken. In this case, the estimate based on Equation 4-9 was directly compared to the measured emission factor contained in the data. Because PM-2.5 data were not used directly to develop a regression-based model, the comparisons already represent essentially independent applications of Equation 4-9. That is to say, there was no need to eliminate tests on a point-by-point basis and repeatedly use stepwise regression to develop quasi-independent estimates.

In comparing the Equation 4-9 estimates to the measured emission factors in the PM-2.5 data set, it was found that, for individual test results,

1. 44 percent were within a factor of 2;
2. 68 percent were within a factor of 3; and
3. 78 percent were within a factor of 5.

Again, greater accuracy results when the predictive equation is applied to a set of roadway segments to estimate total emissions. As discussed in connection with the PM-10 and PM-30 validations, an illustration is provided by summing the emissions from five randomly selected tests from the data set. In 100 realizations of the random draw of five tests,

1. 62 percent were within a factor of 2;
2. 78 percent were within a factor of 3; and
3. 90 percent were within a factor of 5.

In summary, then, the validation found that Equations 4-5, -7 and -9 provide reasonably accurate estimates of the PM-10, -30, and -2.5 emissions from an individual roadway. As noted throughout this section of the document, one has substantially greater confidence when the predictive models are applied to a set of roadways contained at a specific facility.

4.4 DEVELOPMENT OF DEFAULT VALUES FOR ROAD SURFACE MATERIAL PROPERTIES

As noted earlier, all previous versions of the AP-42 unpaved road emission factor have included the road surface silt content as an input variable. The predictive equations recommended in the last section are no exception. AP-42 Section 13.2 has always stressed the importance of using site-specific input parameters to develop emission estimates. Recognizing that not all users will have access to site-specific information, AP-42 has included methods to allow readers to determine default values appropriate to their situation.[e]

*	Table 13.2.2-1 currently in AP-42 contains default silt information for various applications. As part of this update, the table was modified to (a) include updated information on construction sites and log yards and (b) reformat the information for publicly accessible roads. Item (a) was a relatively straightforward process. On the other hand, item (b) required a thorough reexamination, as described below.

In order to develop default information for publicly accessible unpaved roads, a data set of available silt and moisture contents was assembled. The 78 data points were collected either as part of a field emission testing program or as input necessary to prepare emission inventories. Note that several of the

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[e] The inclusion of the surface moisture content as an input variable is not considered to represent an undue burden on the users of AP-42. In particular, the methods presented in AP-42 Appendix C.2 require oven drying before sieving. In other words, determination of the silt content of a road surface sample requires that the moisture content of the sample also be determined. Thus, users of AP-42 who have already determined site-specific values for road surface silt content should have corresponding moisture content information available as well.

inventory-type samples were aggregated from subsamples collected from different road segments within some portion of the study area.

Data are classified as being from either an "eastern" or a "western" location, based on the common distinction between "pedalfer" and "pedocal" soils. For pedalfer soils common in the eastern U.S., precipitation exceeds evaporation. Conversely, evaporation is greater than precipitation in the West and the soils are termed "pedocal." The 97th meridian is roughly coincident with the dividing line between pedalfer and pedocal soils.

Also, to the extent practical, data were classified as being from a "gravel" or "dirt" type of unpaved road surface. In this context, "dirt" refers to a road surface constructed from soils in the general vicinity of the site without a crushed aggregate (stone, slag, etc.) being incorporated. Similarly, "gravel" refers to surfaces in which aggregate material has been incorporated, regardless of whether the aggregate is crushed stone or some other material (such as slag or scoria).

Statistical analysis of the data set was undertaken to examine whether significant differences exist between the characteristics of eastern vs. western and gravel vs. dirt roads. Because the available data set had not been developed for this use, i.e., specifically to explore how unpaved road surface characteristics vary because of different road surface materials or different locations in the country, the data set contains unequal subsets of data. The 78 data points are distributed as shown below:

	Location	
Surface type	East	West
Dirt	10	14
Gravel	15	31
Unknown	0	8

The unequal sample sizes make it difficult to efficiently examine differences. First, the choice of statistical tests becomes limited. Generally, the most powerful methods to examine treatment and interaction effects rely on having equal number of observations per cell. On an even more fundamental basis, there is a question whether the available data represent a reasonably representative, random sample from the set of all publicly accessible unpaved roads. That assumption would underlies any statistical test undertaken.

Because of the data limitations, a series of pairwise comparisons such as,

1. Eastern gravel vs. eastern dirt roads;
2. Eastern vs. western roads; and
3. Gravel vs. dirt roads.

were undertaken to determine if there existed significant differences in either moisture or silt content. The small-sample comparison of means test was used with the level of significance set at 10 percent. When appropriate, a one-sided alternative hypothesis was used. For example, one could reasonably expect, on an a priori basis, that on average

1. Gravel roads have lower silt contents than dirt roads; and
2. Moisture contents are lower in the western U.S. than in the East

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When there was no a priori reason available, a two-sided alternative hypothesis was selected. For example, there was no reason to suspect that the set of eastern gravel roads would have higher silt contents than gravel roads in the west. In that case, the alternative hypothesis selected was that the mean silt contents for eastern vs. western gravel roads are not equal.

Given the limitations on the available data set, it is not particularly surprising that the pairwise comparisons led to somewhat contradictory findings. For example, although the data set indicated that eastern dirt roads had a higher average moisture content than eastern gravel roads, that result was not duplicated for western roads or for roads overall. Similarly, gravel surfaces were found to have a lower mean silt content than dirt when (a) only eastern roads and (b) all roads were compared. That is, no significant difference was found for silt contents between western gravel and dirt roads. Results from the pairwise comparisons are summarized below. In the table, “S” and “M” indicate that a significant different (10 percent level of significance) in the mean value of the silt and moisture content, respectively, was found in the comparison.

Comparison of gravel vs. dirt			Comparison of East vs. West		
East	S	M	Gravel	--	--
West		--	Dirt	--	M
Overall	S	--	Overall	--	--

In keeping with the findings summarized above, it was decided to provide separate default silt values for gravel and dirt roads, for use throughout the United States (i.e., no distinction between east and west).

	Mean Silt Content
Gravel Roads	6.4 percent
Dirt Roads	11 percent

Specification of an appropriate default moisture content for a dry road proved more problematic. The overall mean moisture content in publicly accessible road data set was found as 1.1 percent. Although this value potentially could have provided the default, it was believed that 1.1 percent did not adequately represent the extremes of the data set. The data base contained moisture contents approximately 0.1 to 0.3 percent for roads even in what are not considered "dry" parts of the nation. For example, four samples collected for an emission inventory of Grants Pass, Oregon, ranged from 0.14 to 0.38 percent in moisture content, with a mean value of 0.24 percent. The four Raleigh, North Carolina ("BJ") tests presented in Table 4-32 are associated with moisture contents between 0.07 and 0.1 percent. (In fact, the Raleigh test series provided the lowest moisture contents in the entire data set. By comparison, moisture contents for the desert [the Arizona, Palm Springs and Reno tests in References 6, 1 and 2, respectively] ranged from 0.17 to 0.48 percent.)

This situation is not surprising since the moisture content of the surface material of an unpaved road is very dynamic. The moisture content is affected by a number of meteorological and physical parameters that vary considerably with time and by location. For urban roads, rain is the primary meteorological event which adds moisture to the road surface. The frequency, duration, and quantity of rain are important aspects which determine the moisture content on any day and the long term average moisture content. The average annual number of rain days in the U.S. ranges from about 20 to over 200 with a variation in annual rainfall from less than 4 inches per year to over 100 inches per year. The primary meteorological parameters that affect the evaporation of moisture from the road surface include solar radiation, temperature, dew point, and wind speed. The Class A pan evaporation is a reasonable indicator of the evaporation potential. The variation in the annual Class A pan evaporation varies from about 25 inches per year to over 120 inches per year. Some physical parameters which affect the moisture content of the surface material include the amount and size distribution of the loose surface material and vehicle traffic on the road. The amount and size distribution of the loose surface material would affect the maximum amount of water that the surface material is capable of holding. Vehicle traffic enhances the evaporation of moisture from the road surface due to the increase in surface air movement. The presence of trees and other natural and man made formations may affect the moisture balance of the road surface material. As a result, the selection of any single default moisture content would introduce significant bias for all but a few locations in the U.S.

In the interest of encouraging AP-42 readers to collect site-specific data, a reasonably conservative (worst case) value of 0.2 percent was selected for the default dry condition moisture content. This moisture content value is higher than approximately 20 percent of all the publicly accessible uncontrolled road data set. It should be noted that this moisture value is not the average moisture content of the road surface material but is the minimum moisture content following an extended period without water additions to the road surface.

Even though the default moisture value may be viewed as conservative, the default should not generally lead to unacceptable emission estimates. This is due to the fact that moisture is raised to such a low power (0.3 and 0.4) in the predictive emission factors. When the 0.2 percent default is substituted for the site-specific moisture content for the 43 publicly accessible road tests in the PM-10 data set, all but four results are within a factor of 2 of the estimate based on the site-specific value. At most, use of a default value of 0.2 resulted in an estimate 2.5 times greater. Furthermore, on average, the increase in estimated emission factor was only 12 percent when the default was substituted for the site-specific moisture content.

4.5 SUMMARY OF CHANGES TO AP-42 SECTION

4.5.1 Section Narrative

The major revisions to AP-42 Section 13.2.2, Unpaved Roads, are as follows:

1. Text surrounding the emission factor equation was revised to reflect the new equation and provide more background information on how the equation was derived. Reference to the PM-15 size fraction has been removed.
2. The discussion on defaults and quality ratings was substantially expanded. In particular, there is a description of the model's performance when used to predict emissions from very slow-moving traffic and a presentation of a default value for moisture content.
3. The extrapolation to annual conditions (incorporating natural mitigation) has been revised to reflect the variables contained in the new equation. Readers who are interested in finer temporal and spatial resolution are directed to the background reports area of the CHIEF web site (http://www.epa.gov/ttn/chief/ap42back.html). An alternative procedure for estimating emissions on a monthly basis is available as a spreadsheet file. Information required to use this procedure includes hourly precipitation, humidity and snow cover data, and monthly Class A pan evaporation data.

It is emphasized that neither the simple assumption underlying the annual estimates or the more complex set of assumptions underlying the use of the alternative procedure have been verified in any rigorous manner.

4. Section 13.2.2.3, “Controls,” was re-organized and re-written. The section now begins with an overview of three basic control methods (vehicle restrictions, surface improvement, and surface treatment). Extensive new material was added to address the effect of speed reduction and watering on fugitive dust emissions from unpaved roads. A new method for “prospective” analysis based on the alternative procedure for estimating emissions using hourly precipitation data and Class A pan evaporation data was added. Slight revisions were made to the material presented for chemical unpaved road dust suppressants.

5. The revised Table 13.2.2-1 is as follows [bold indicates additions, strikeouts indicate deletions]:

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Table 13.2.2-1. TYPICAL SILT CONTENT VALUES OF SURFACE MATERIAL ON INDUSTRIAL AND RURAL UNPAVED ROADS[a]

Industry	Road Use Or Surface Material	Plant Sites	No. Of Samples	Silt Content (%)	
				Range	Mean
Copper smelting	Plant road	1	3	16 - 19	17
Iron and steel production	Plant road	19	135	0.2 - 19	6.0
Sand and gravel processing	Plant road	1	3	4.1 - 6.0	4.8
	Material storage area	**1**	**1**	**--**	**7.1**
Stone quarrying and processing	Plant road	2	10	2.4 - 16	10
	~~Haul road~~	~~1~~	~~10~~	~~5.0 - 15~~	~~9.6~~
	[Haul road to/from pit	**4**	**20**	**5.0-15**	**8.3]**
Taconite mining and processing	Service road	1	8	2.4 - 7.1	4.3
	Haul road [to/from pit]	1	12	3.9 - 9.7	5.8
Western surface coal mining	**Haul road [to/from pit]**	3	21	2.8 - 18	8.4
	[Plant] ~~Access~~ road	2	2	4.9 - 5.3	5.1
	Scraper route	3	10	7.2 - 25	17
	Haul road (freshly graded)	2	5	18 - 29	24
[Construction sites	**Scraper routes**	**7**	**20**	**0.56-23**	**8.5]**
[Lumber sawmills	**Log yards**	**2**	**2**	**4.8-12**	**8.4]**
~~Rural roads~~	~~Gravel/crushed limestone~~	~~3~~	~~9~~	~~5.0 - 13~~	~~8.9~~
	~~Dirt~~	~~7~~	~~32~~	~~1.6 - 68~~	~~12~~
~~Municipal roads~~	~~Unspecified~~	~~3~~	~~26~~	~~0.4 - 13~~	~~5.7~~
Municipal solid waste landfills	Disposal routes	4	20	2.2 - 21	6.4
[Publicly accessible roads	**Gravel/crushed limestone**	**9**	**46**	**0.10-15**	**6.4**
	Dirt (i.e., local material compacted, bladed, and crowned)	**8**	**24**	**0.83-68**	**11]**

[a] References 1,5-16.

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4.5.2 Emission Factors

Analysis of the test data exhibited an emission factor equation appropriate for average conditions. The equation no longer contains speed and mean number of wheels as parameters. The current data base shows a correlation of emissions to the surface moisture content, which was added as a parameter. The annual precipitation is now considered only when the emission factor equation is annualized for a particular source. As with the old equation, the new equation allows for the emission calculations of different particle sizes (PM-2.5, PM-10, and PM-30) with the use of appropriate constants. The old Section 13.2.2 Equation (1) is presented below (striked out) followed by the new Section 13.2.2 Equation (1).

Old Equation (1) ~~$e = k(5.9)\ (s/12)(S/30)(W/3)^{0.7}\ (w/4)^{0.5}(365\text{-}p/365)$~~

~~where:~~

~~e = emission factor (lb/vmt)~~

~~k = particle size multiplier (dimensionless)~~

~~s = silt content of road surface material (%)~~

~~S = mean vehicle speed, (miles per hour [mph])~~

~~W = mean vehicle weight, megagrams (Mg) (ton)~~

~~w = mean number of wheels~~

~~p = number of days with at least 0.01 in. of precipitation per year~~

~~Aerodynamic particle size multiplier~~

~~Constant~~	~~PM-2.5~~	~~PM-10~~	~~PM-15~~	~~PM-30~~
~~k (lb/VMT)~~	~~0.095~~	~~0.36~~	~~0.50~~	~~0.80~~

New Equation (1)

$$E = \frac{k(s/12)^a(W/3)^b}{(M/0.2^c)}$$

where k, a, b

and c are empirical constants given below

E = size-specific emission factor (lb/vmt)

s = surface material silt content (%)

W = mean vehicle weight (tons)

M = surface material moisture content (%)

Constants for Equation 1 based on the stated aerodynamic particle size:

Constant	PM-2.5	PM-10	PM-30
k (lb/VMT)	0.38	2.6	10
a	0.8	0.8	0.8
b	0.4	0.4	0.5
c	0.3	0.3	0.4
Quality rating	C	B	B

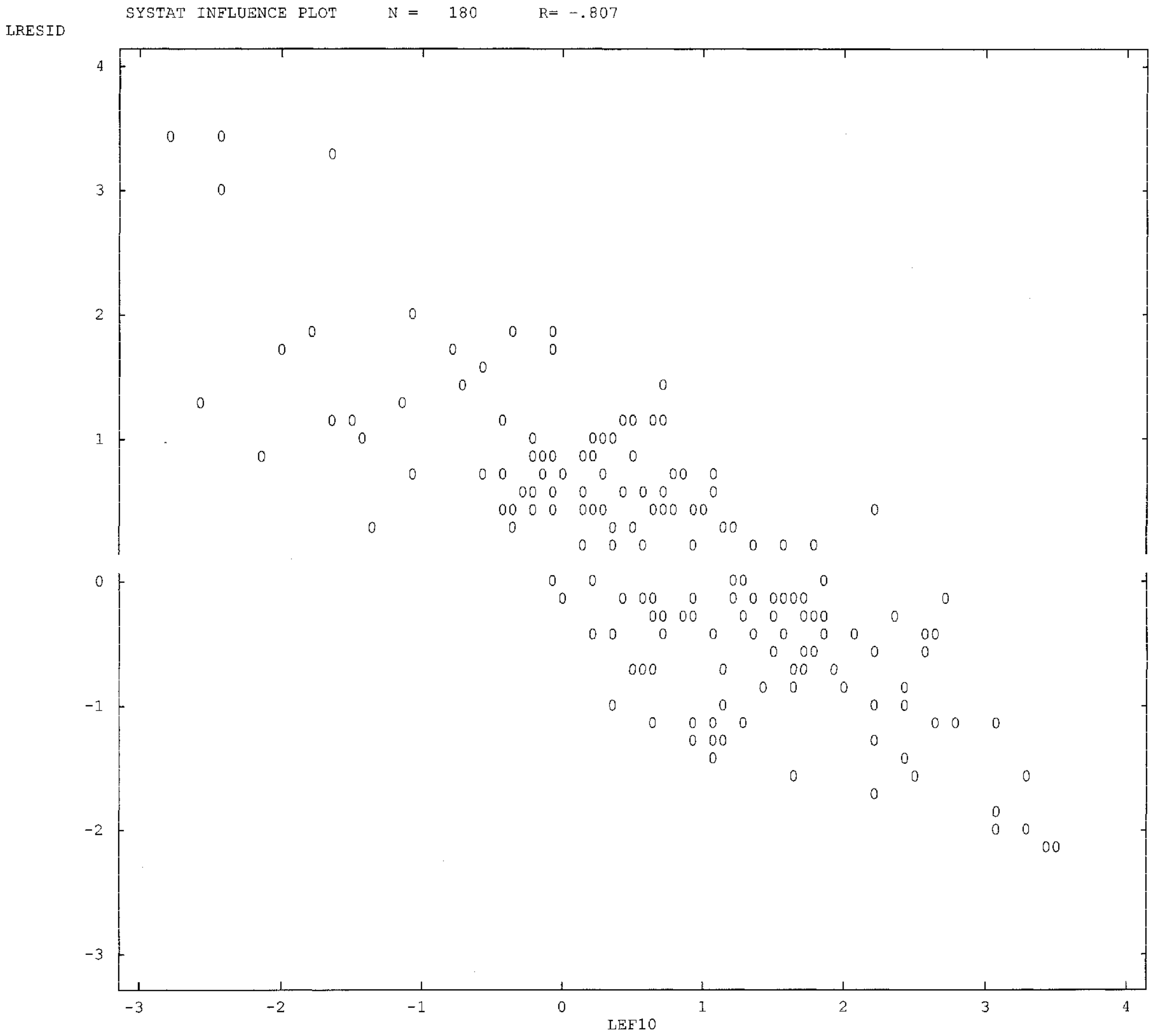

Figure 4-1. PM-10 residuals (log-scale) versus PM-10 emission factor (log-scale).

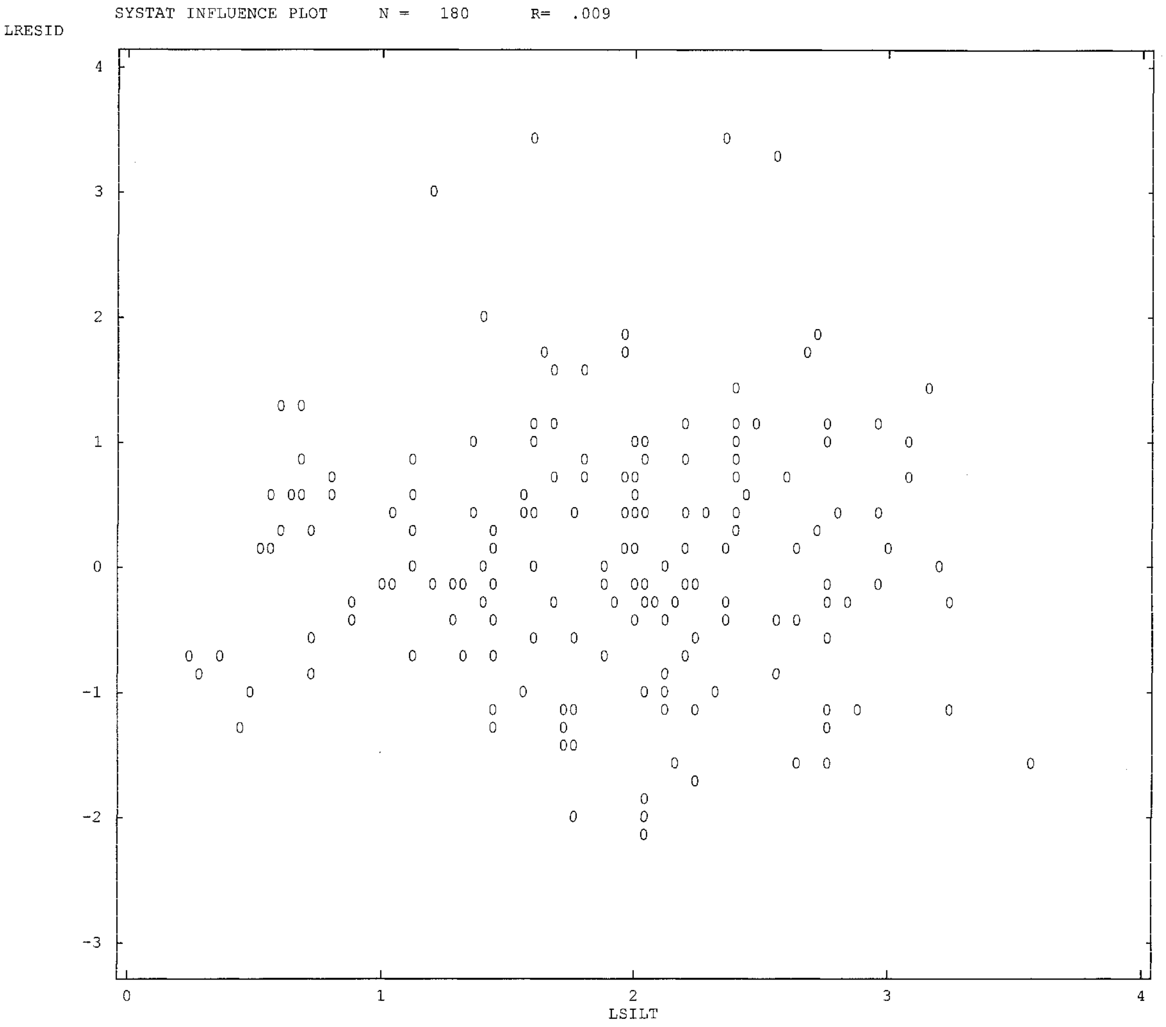

Figure 4-2. PM-10 residuals (log-scale) versus silt content (log-scale).

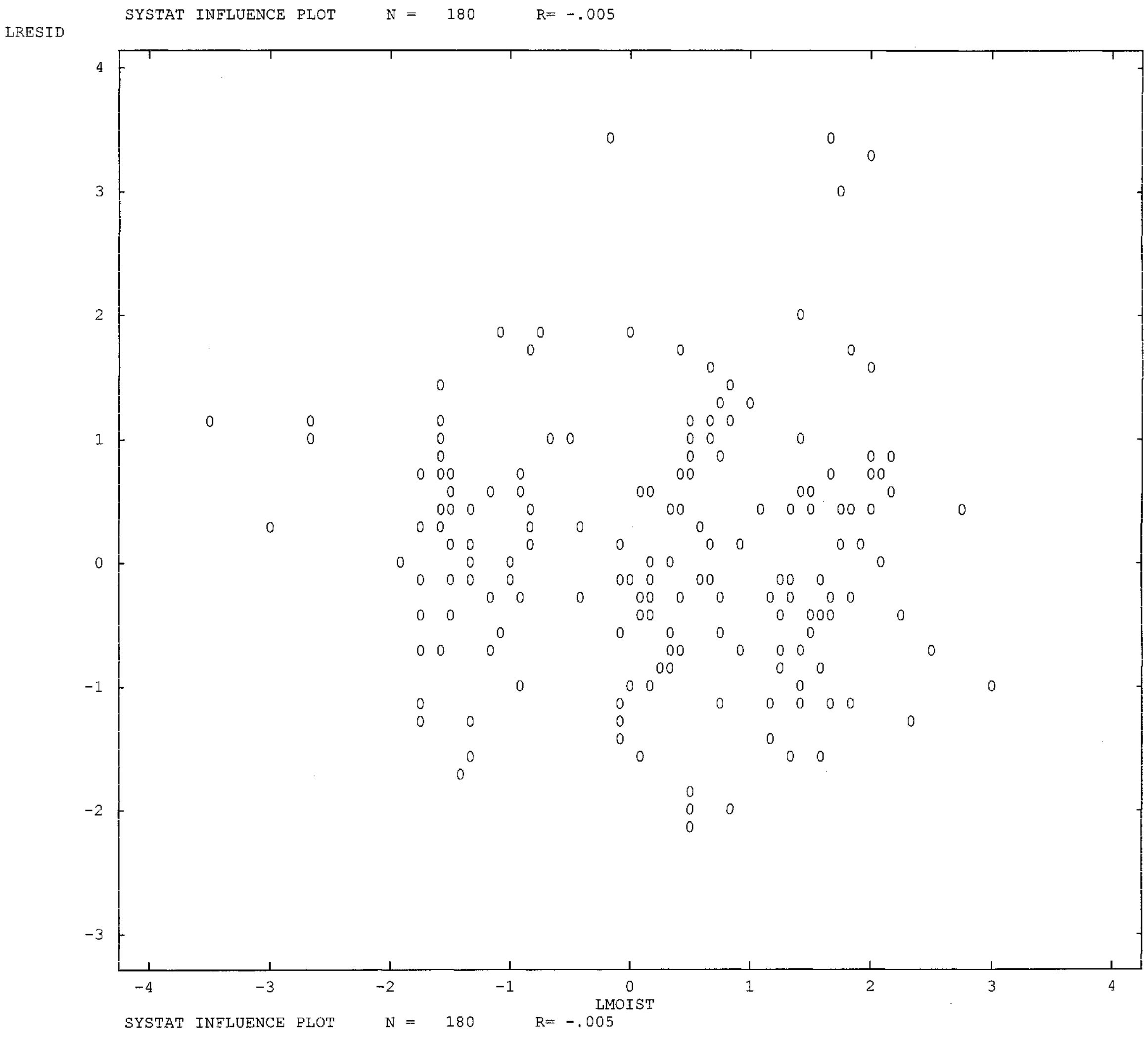

Figure 4-3. PM-10 residuals (log-scale) versus moisture content (log-scale).

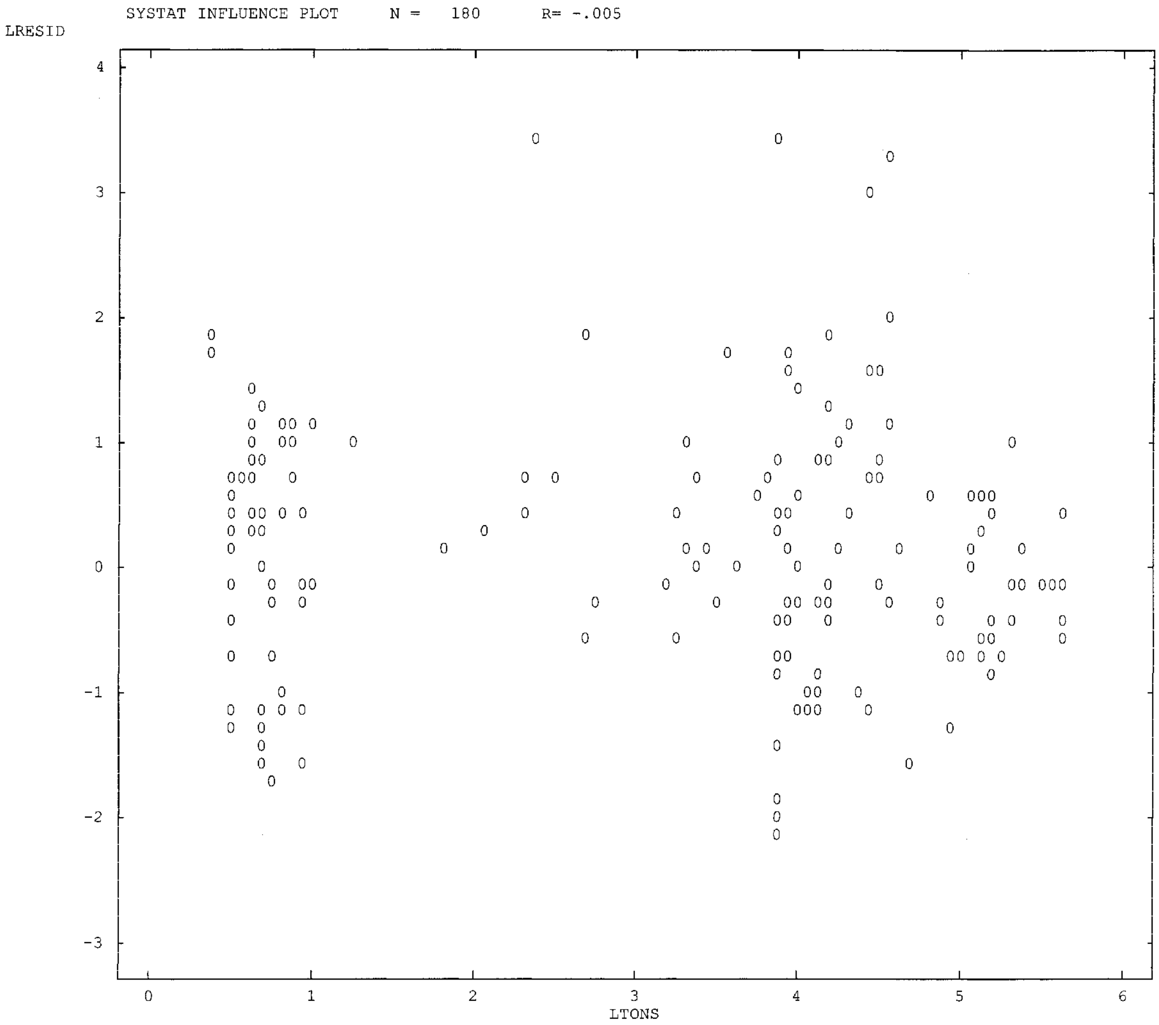

Figure 4-4. PM-10 residuals (log-scale) versus average vehicle weight (log-scale).

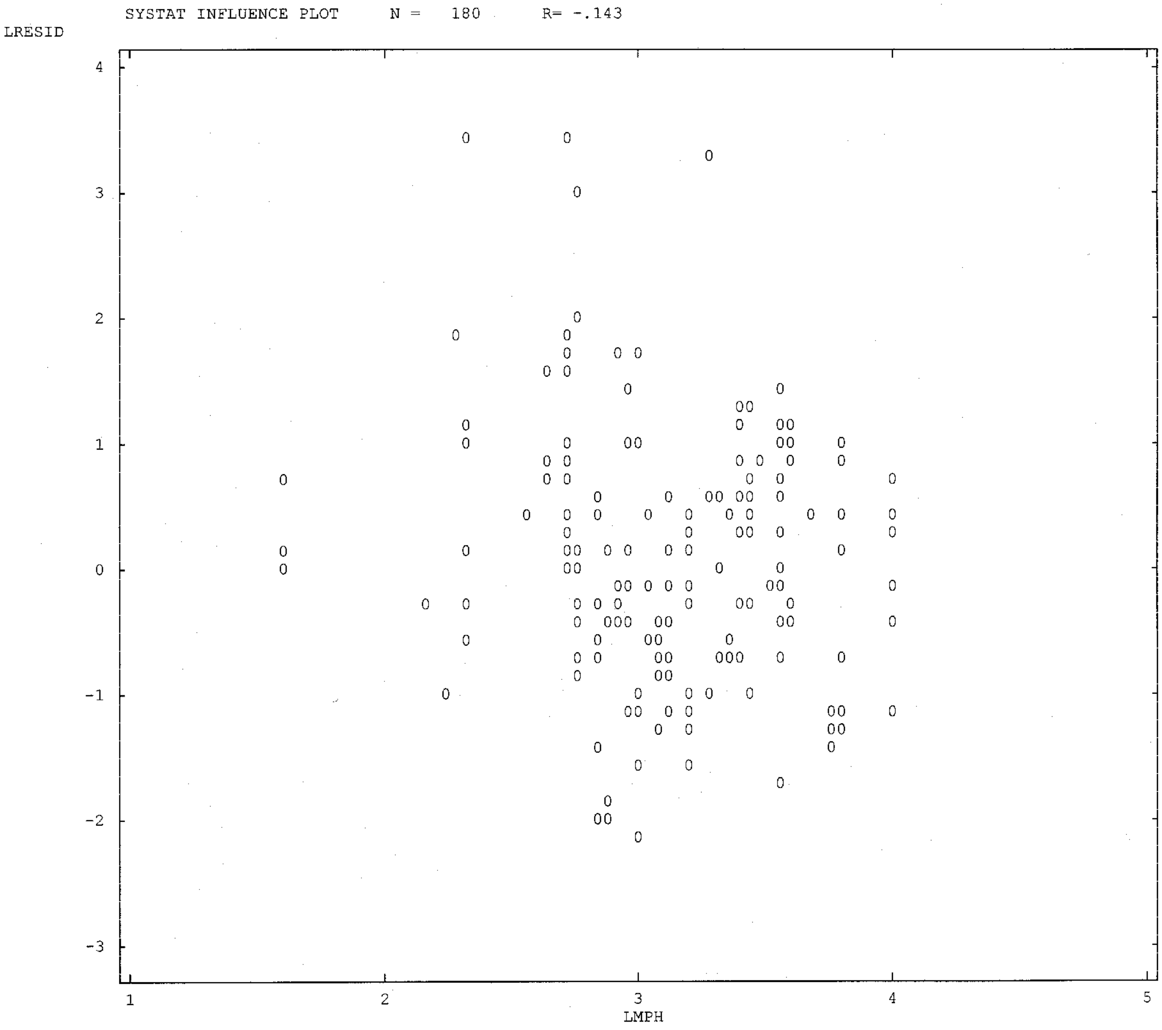

Figure 4-5. PM-10 residuals (log-scale) versus average vehicle speed (log-scale).

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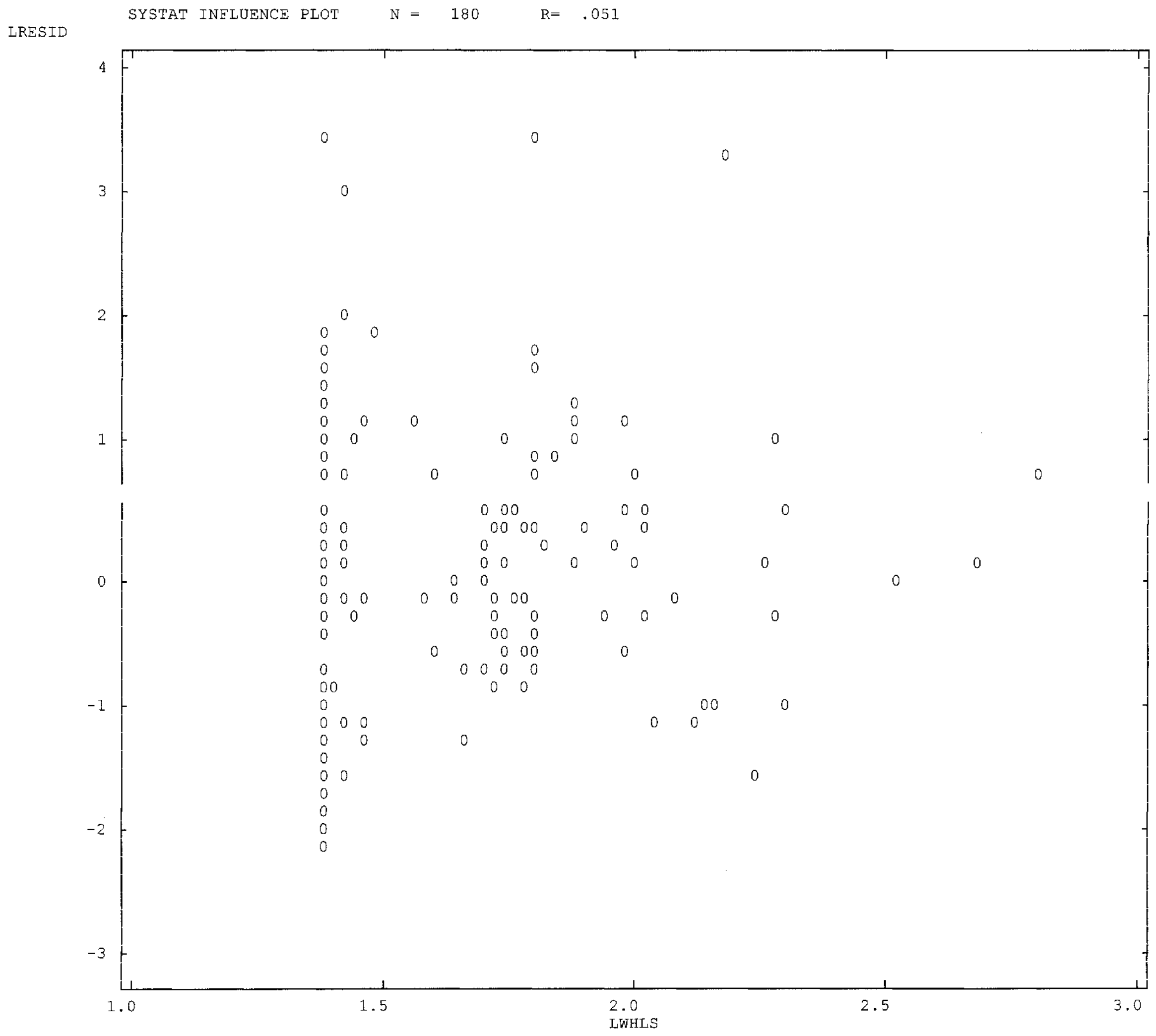

Figure 4-6. PM-10 residuals (log-scale) versus average number of wheels (log-scale).

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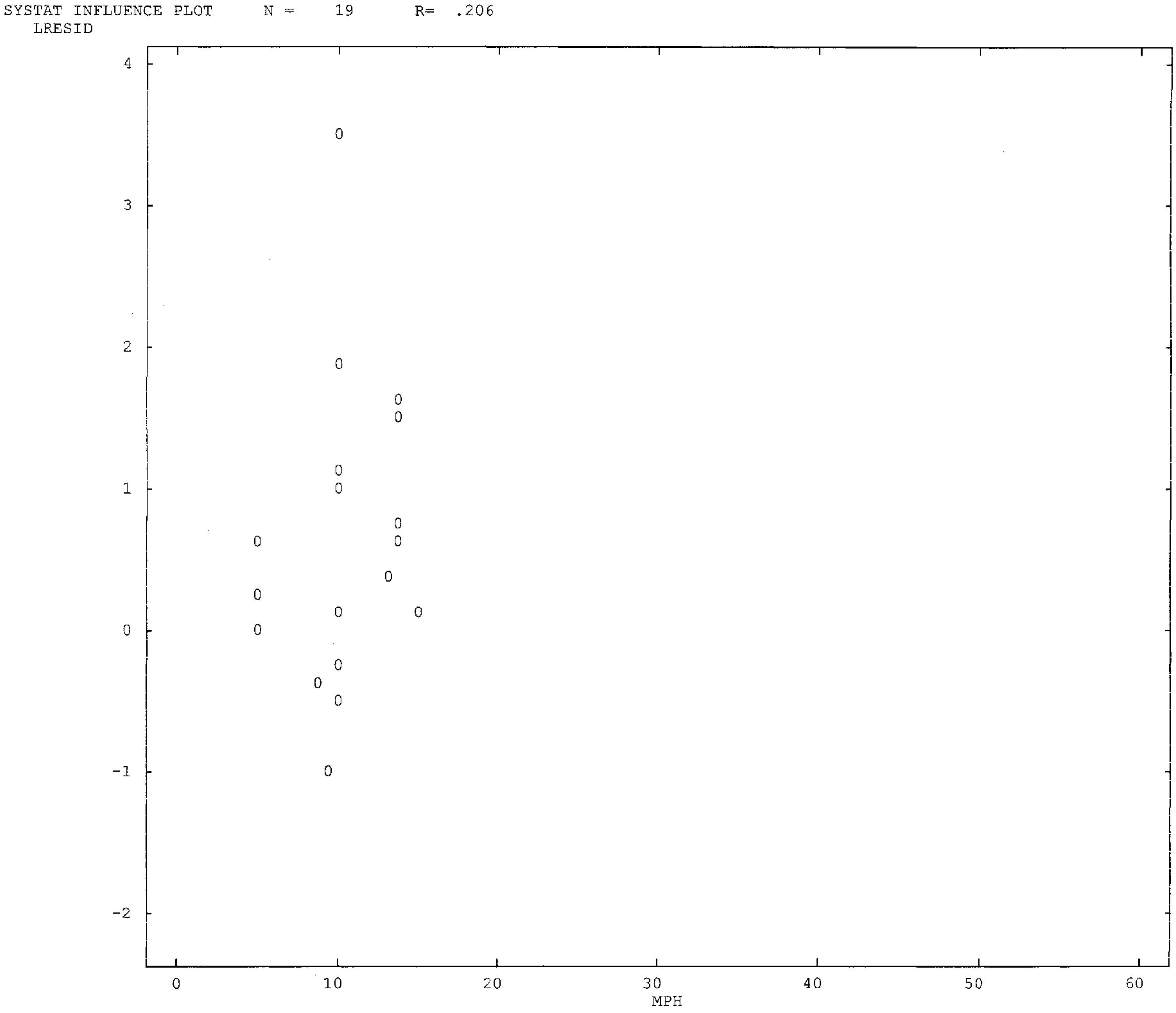

Figure 4-7. PM-10 residuals (log-scale) versus average vehicle speed <15 mph.

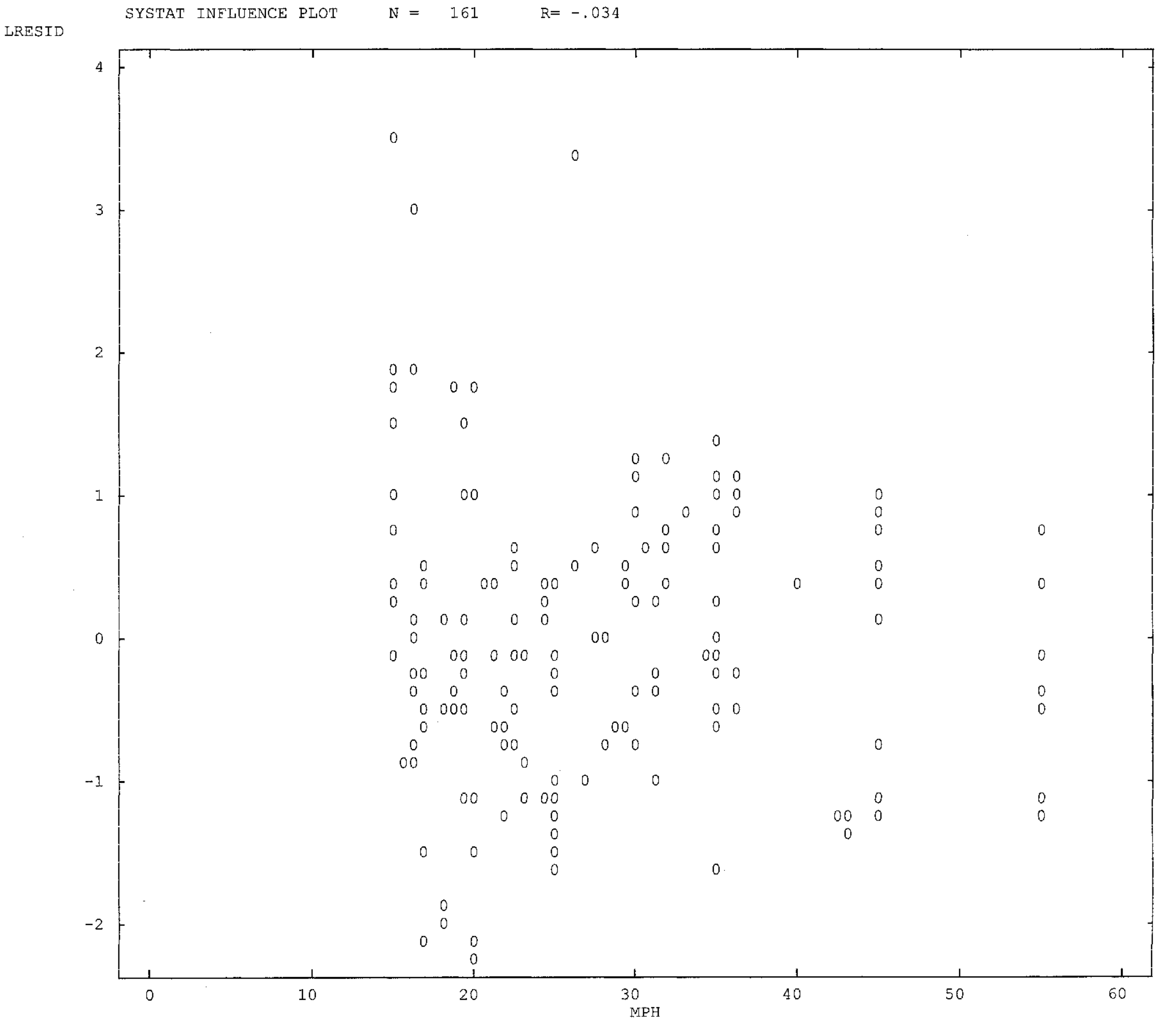

Figure 4-8. PM-10 residuals (log-scale) versus average vehicle speed >15 mph.

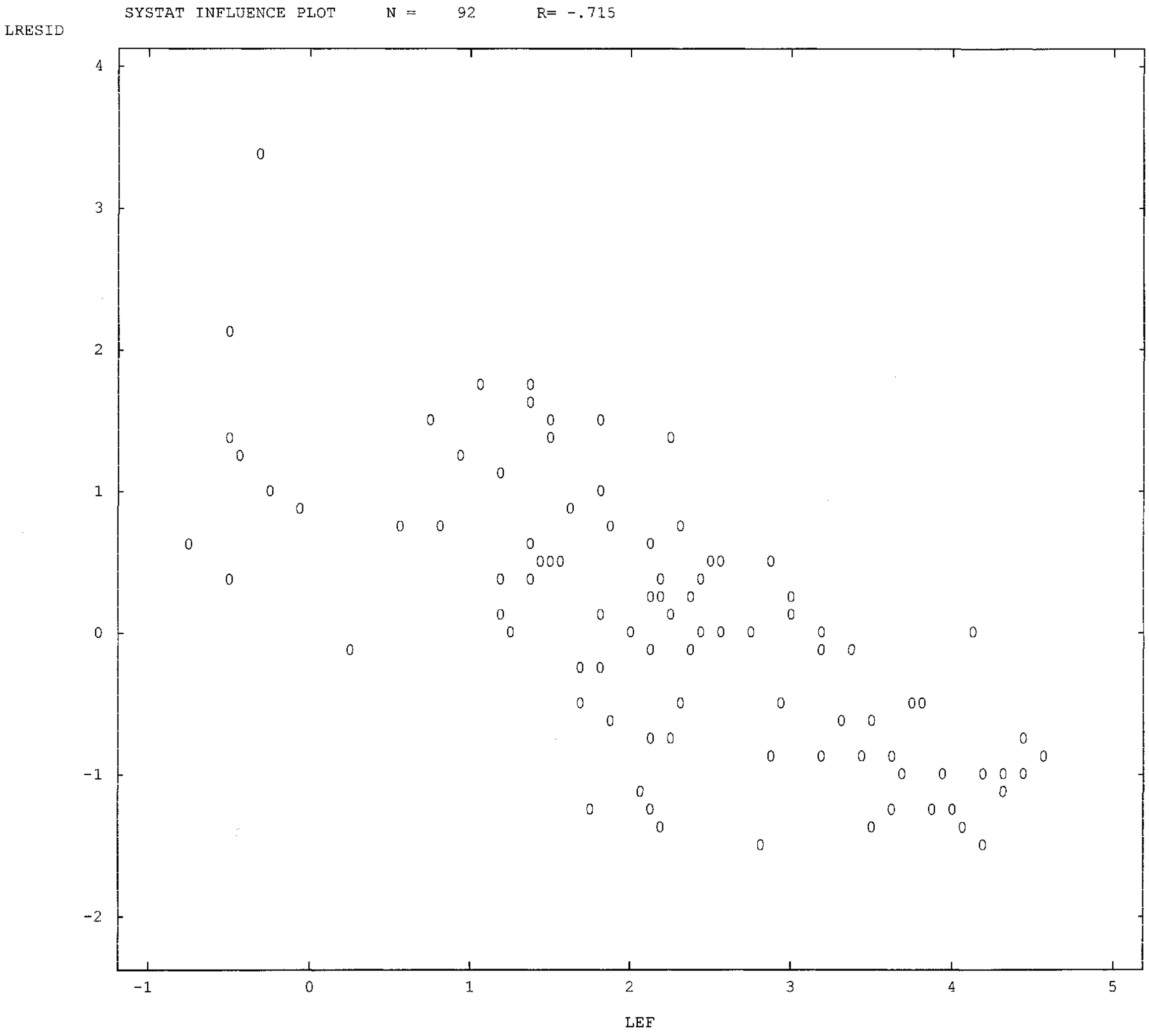

Figure 4-9. PM-30 residuals (log-scale) versus PM-30 emission factor (log-scale).

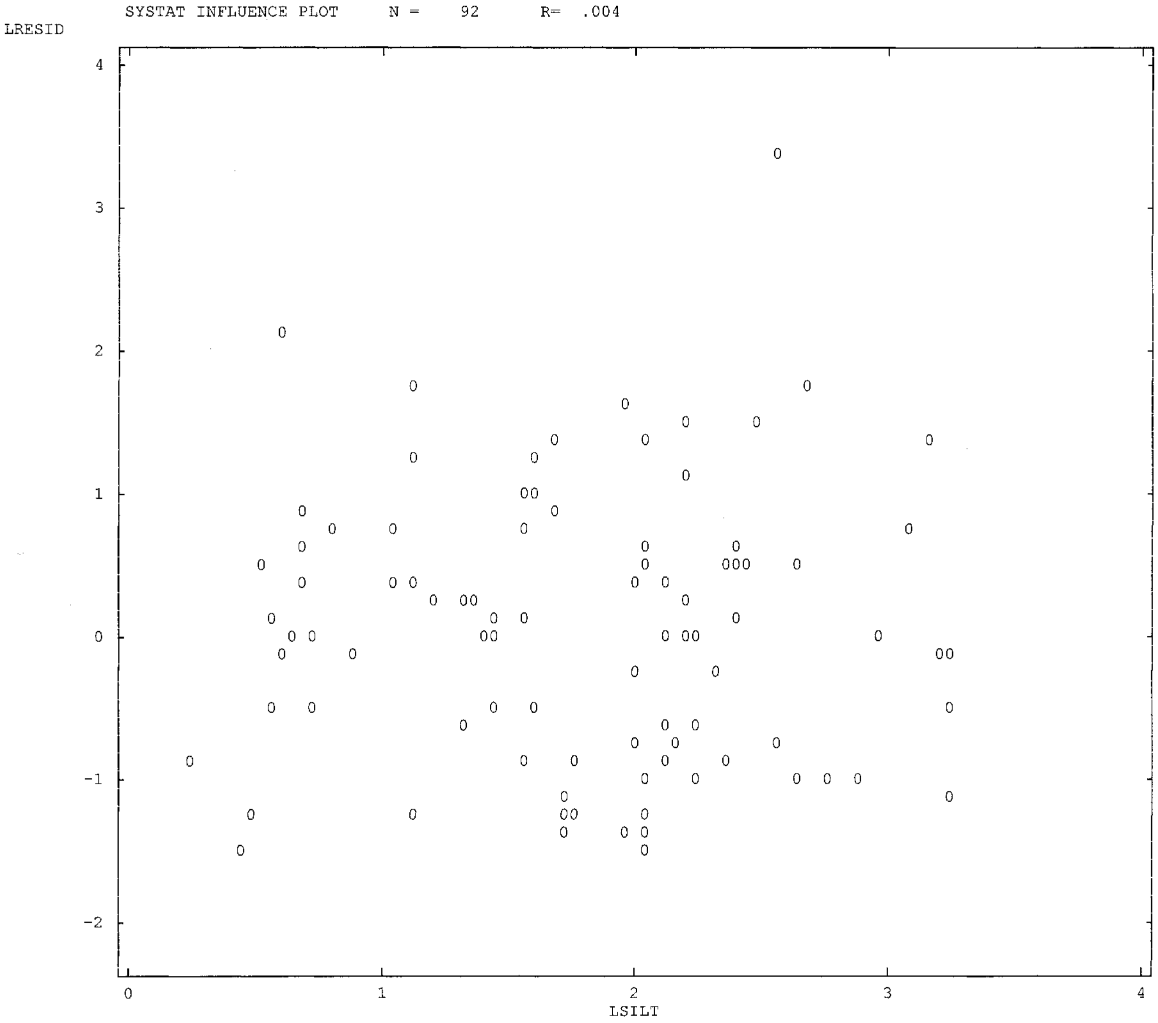

Figure 4-10. PM-30 residuals (log-scale) versus surface silt content (log-scale).

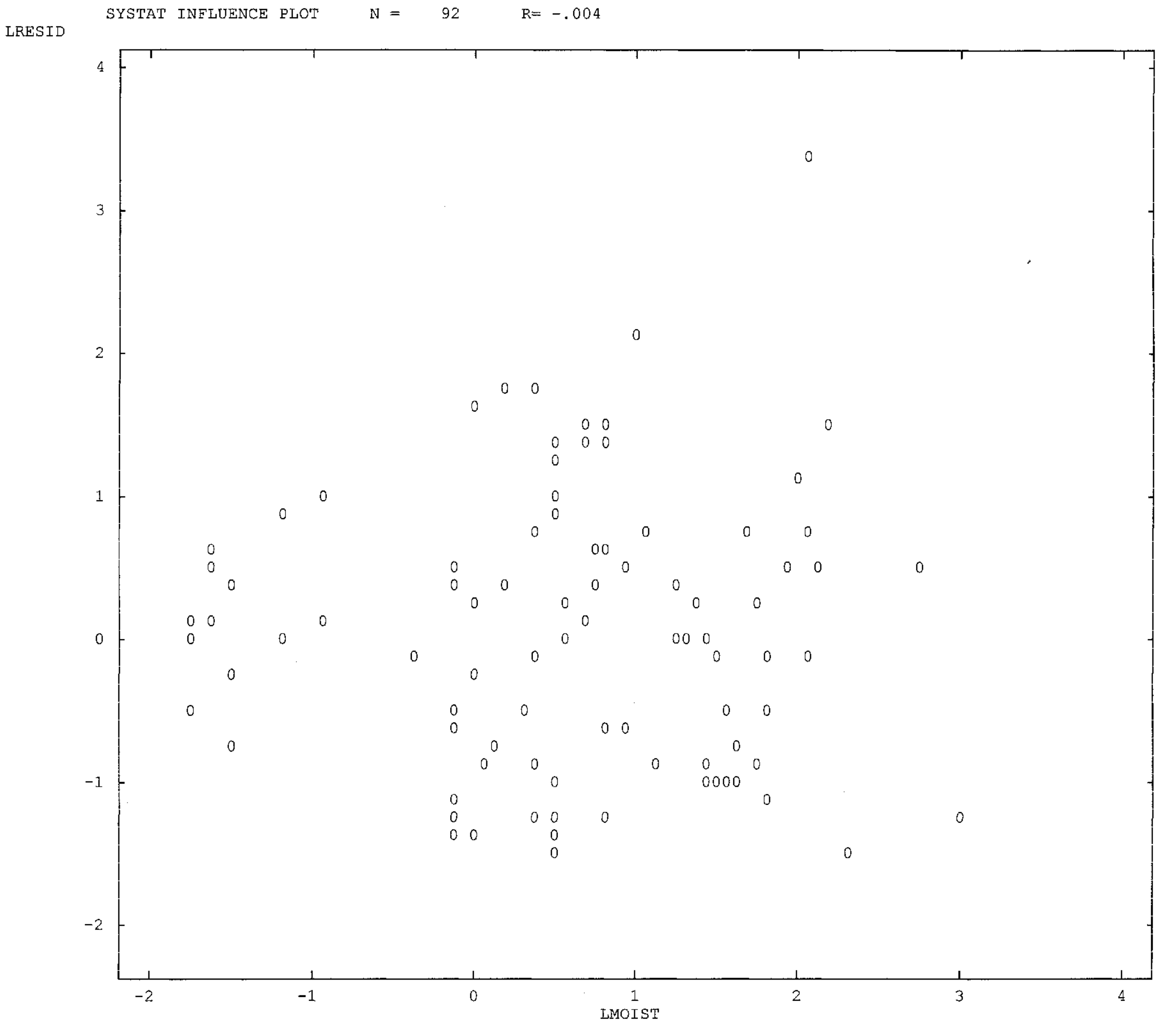

Figure 4-11. PM-30 residuals (log-scale) versus surface moisture content (log-scale).

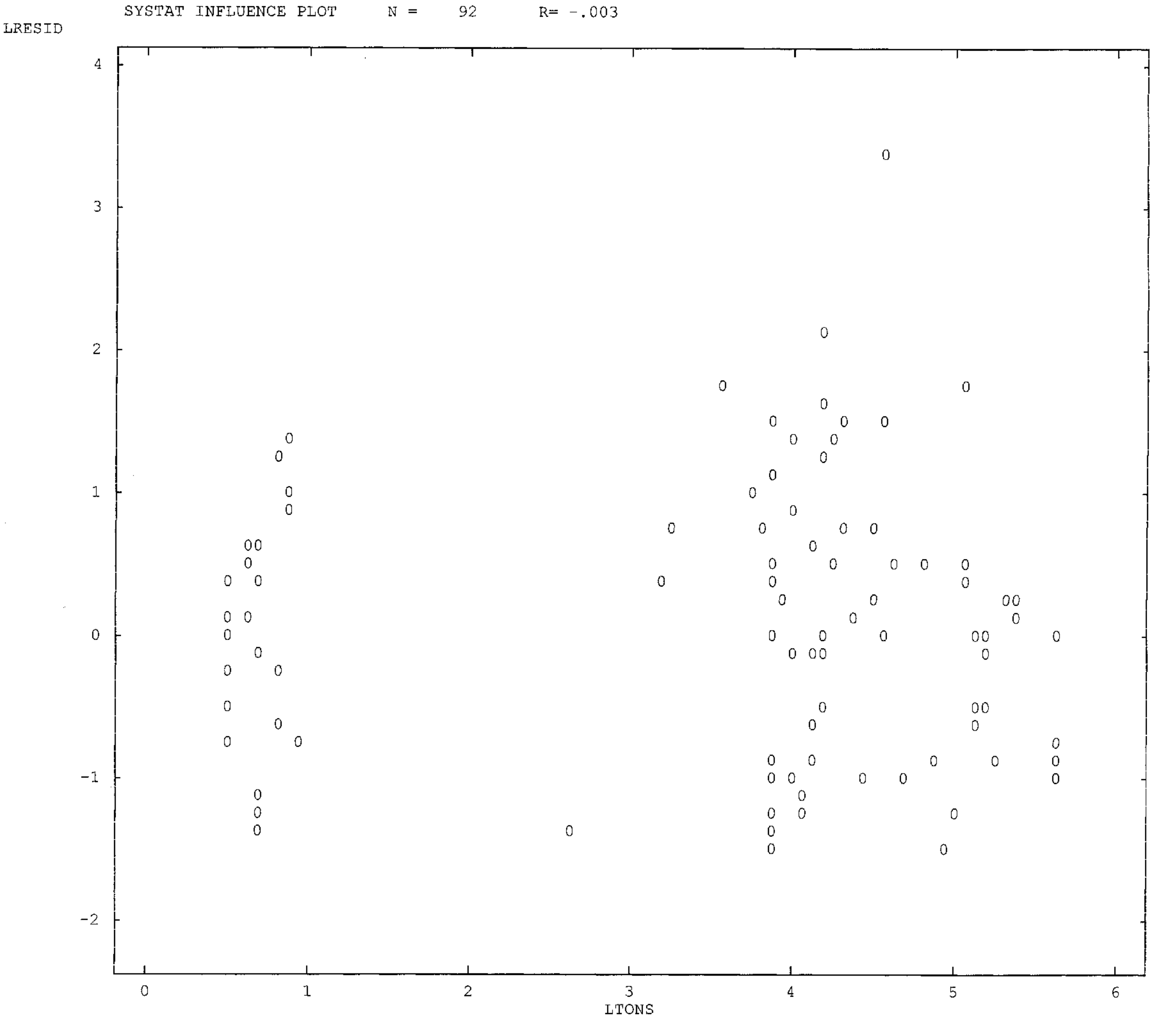

Figure 4-12. PM-30 residuals (log-scale) versus average vehicle weight (log-scale).

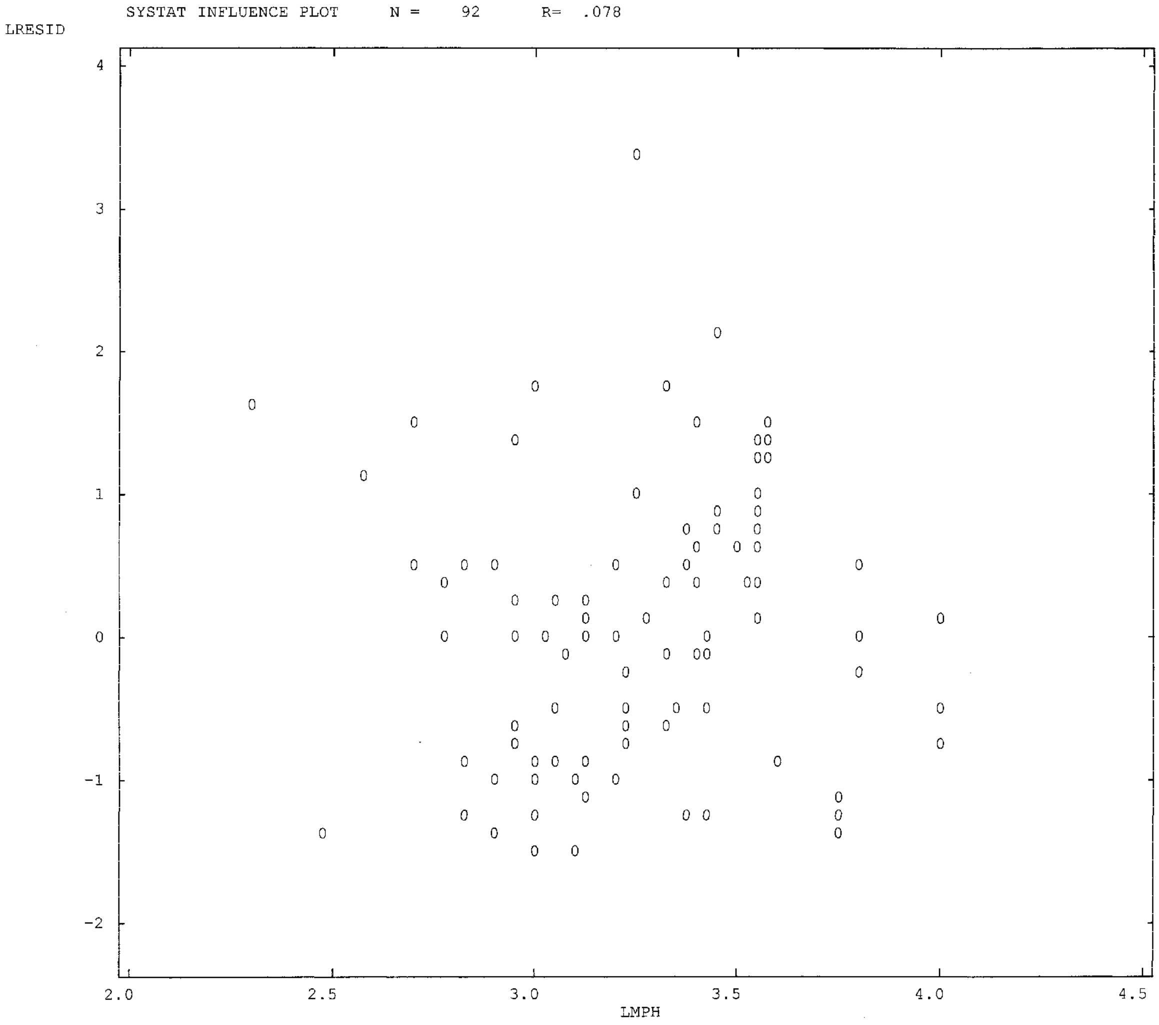

Figure 4-13. PM-10 residuals (log-scale) versus average vehicle speed (log-scale).

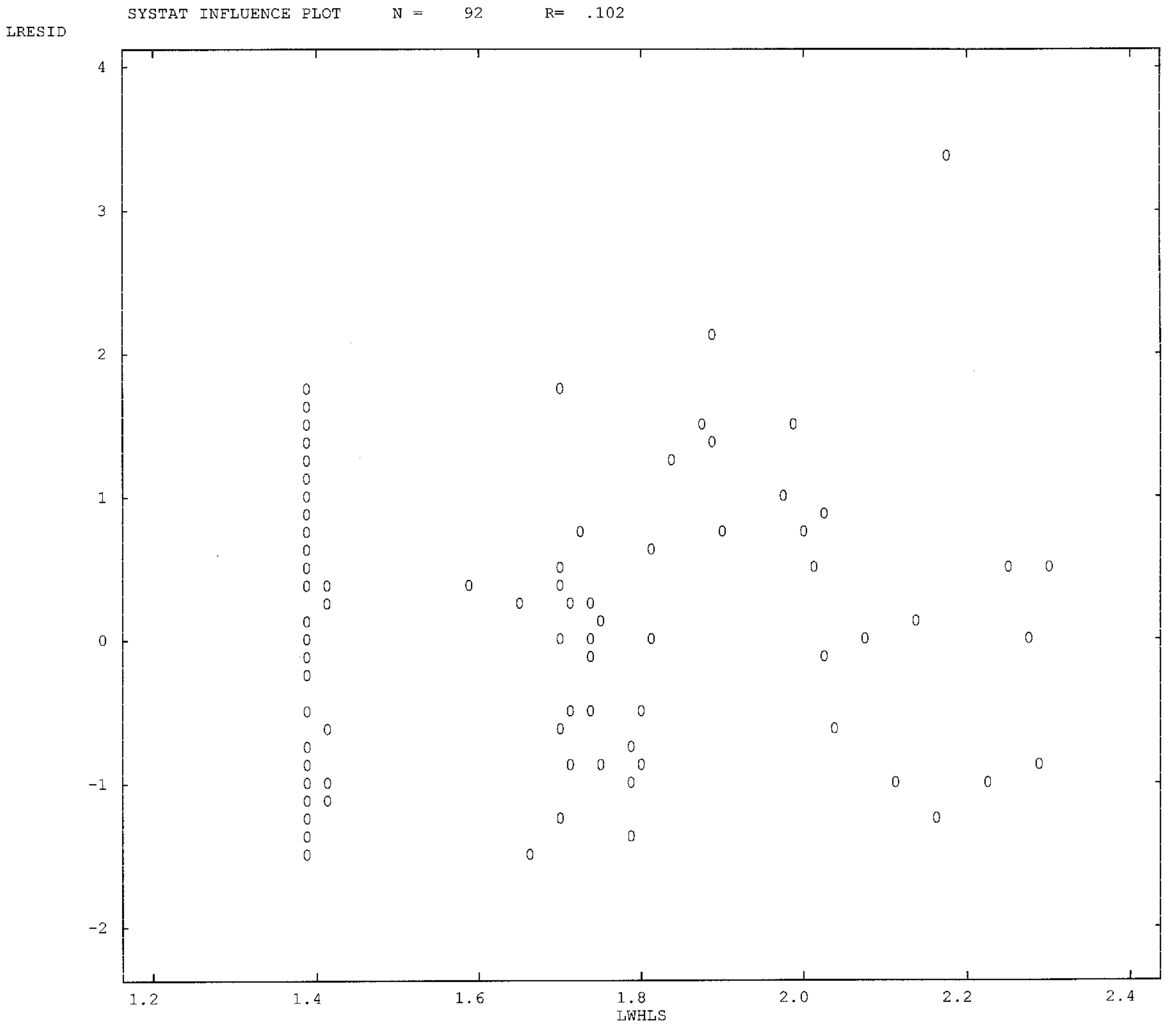

Figure 4-14. PM-10 residuals (log-scale) versus average number of wheels (log-scale).

TABLE 4-1. SUMMARY INFORMATION - REFERENCE 1

Operation	Control method	Test run	State	Test date	No. of tests	PM-10 emission factor, lb/VMT	
						Geom. mean	Range
Unpaved road	None	BK1-BK4	Nevada	5/96	4	0.820	0.309-2.65
Paved road	None	--	Nevada	5/96	3	0.0025	0.0022-0.0028

1 lb/VMT = 281.9 g/VKT

TABLE 4-2. DETAILED INFORMATION FOR UNPAVED ROAD TESTS - REFERENCE 1

Unpaved road test runs	PM-10 emission factor, lb/VMT	Duration, min.	Meteorology		Vehicle information			Mean vehicle speed, mph	Silt, %	Moisture %
			Temp., °F	Avg. wind, mph	No. of vehicle passes	Mean vehicle weight, ton	Mean No. of wheels			
BK-1	0.375	59	72	6.0	138	1.5	4	15	7.2	0.48
BK-2	0.309	29	70	6.5	150	1.5	4	15	5.2	0.44
BK-3	1.48	47	70	6.6	100	2.0	4	15	5.9	0.45
BK-4	2.65	27	71	6.6	80	2.0	4	15	6.6	0.38

TABLE 4-3. SUMMARY INFORMATION - REFERENCE 2

Operation	Control method	Unpaved road test runs	State	Test date	No. of tests	PM-10 emission factor, lb/VMT	
						Geom. mean	Range
Scraper	None	BA1-BA2	Nevada	6/95	2	8.19	6.05 -11.1
Scraper	None	BA3-BA6	California	6/95	4	0.838	0.550-1.32
Scraper	Watering	BA8-BA9	California	6/95	2	0.174	0.090-0.340
Light duty	None	BA10-BA12	California	7/95	3	7.24	3.33-12.5

TABLE 4-4. DETAILED INFORMATION FOR UNPAVED ROAD TESTS - REFERENCE 2

Unpaved road test runs	PM-10 emission factor, lb/VMT	Duration, min	Temp., °F	Vehicle information				Silt, %	Moisture, %
				No. of vehicle passes	Mean vehicle weight, ton	Mean No. of wheels	Mean vehicle speed, mph		
BA-1	6.05	43	91	19	54.8	4.2	8.8	7.69	1.16
BA-2	11.1	22	91	12	58.5	4.0	9.5	7.69	1.16
BA-3	1.32	40	74	17	86.5	4.0	14	6.04	7.41
BA-4	0.580	40	74	17	86.5	4.0	14	6.04	7.41
BA-5	1.17	56	74	14	77.0	4.0	14	6.04	7.41
BA-6	0.550	56	74	16	77.0	4.0	14	6.04	7.41
BA-8	0.340	13	70	42	86.7	4.1	16	4.11	4.14
BA-9	0.090	16	70	74	79.6	4.1	16	3.35	5.69
BA-10	3.33	29	105	32	2.8	4.3	25	15.5	0.27
BA-11	9.10	35	105	29	2.0	4.0	25	15.5	0.27
BA-12	12.5	28	105	31	2.0	4.1	25	15.5	0.27

TABLE 4-5. SUMMARY INFORMATION - REFERENCE 3[a]

Operation	Control method	Tests	State	Test date	No. of tests	PM-10 emission factor, lb/VMT		PM-2.5 emission factor, lb/VMT		PM-1 emission factor, lb/VMT	
						Geom. mean	Range	Geom. mean[b]	Range[b]	Geom. mean[b]	Range[b]
Stone quarry Haul truck	Watering	G-DW[b]	North Carolina	8/95	3	0.195	0.006-1.60	0.109	0.027-0.441	0.092	0.063 - 0.136
Stone quarry Haul truck	Watering	S-DW	North Carolina	8/95	3	1.37	0.490-2.99	0.353	0.137-1.32	0.059	0.015 - 0.360

1 lb/VMT = 281.9 g/VKT

[a] Emissions reported are said to include noncombustible particles only. Upwind measurements were not adjusted for noncombustible particles in report calculations.

[b] Negative emissions reported at Garner location are not included in range or geometric mean calculation.

TABLE 4-6. DETAILED INFORMATION FOR UNPAVED ROAD TESTS - REFERENCE 3

Unpaved road test runs	PM-10 emission factor, lb/VMT	Duration, min	Meteorology		Vehicle information				Silt, %	Moisture, %
			Temp., °F	Avg. wind, mph	No. of vehicle passes	Mean vehicle weight, ton	Mean No. of wheels	Average vehicle speed, mph		
G-DW-M201A-2	0.0061	356	88	4.66	204	NA[a]	NA[b]	18.55	7.22	5.96
G-DW-M201A-3	1.60	360	85	6.21	245	NA[a]	NA[b]	18.55	6.73	3.65
G-DW-M201A-4	0.76	360	86	6.35	200	NA[a]	NA[b]	18.55	8.23	9.68
S-DW-M201A-1	2.99	240	91	4.99	128	NA[a]	NA[b]	16.87	6.65	3.97
S-DW-M201A-2	0.49	300	90	3.69	250	NA[a]	NA[b]	16.87	9.81	6.44
S-DW-M201A-3	1.74	360	79	6.53	168	NA[a]	NA[b]	16.87	6.48	4.59

[a] Mean vehicle weight not available - Estimated = 52 tons for AP-42 development.

[b] Mean number of wheels not available - Estimated = 6 wheels for AP-42 development.

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TABLE 4-7. SUMMARY INFORMATION - REFERENCE 4

Operation	Location	State	Uncontrolled test runs	Test date	No. of tests	Uncontrolled TSP emission factor, lb/VMT		Uncontrolled PM-10 emission factor, lb/VMT		Controlled TSP emission factor, lb/VMT		Controlled PM-10 emission factor, lb/VMT	
						Geom. mean	Range	Geom. mean	Range	Geom. mean	Range	Geom. mean	Range
Haul road Summary	1, 1B, 2 and 4	Wyoming	BB2-16, BB29-34, BB36, BB44-48	9/92-10/92	42	31	0.49-95.1	5.5	0.08-15.6	15	4.64-84.2	2.6	0.83 - 13.0
Coal Haul Road	Site 1	Wyoming	BB2,3,10,11	9/92-10/92	6	42	20.2-95.1	6.1	2.86 -13.6	--	--	--	--
Coal Haul Road	Site 1B	Wyoming	BB6-8, BB12-16, BB45,BB48,	10/92	24	14	0.40 - 20.2	3.6	0.08-6.52	10	4.64-18.0	2.2	0.93 - 4.25
Coal Haul Road	Site 2	Wyoming	BB33,34	10/92	4	46	44.4-47.9	7.3	5.70-9.48	17	10.2-27.3	2.4	0.83 - 6.66
Overburden Haul Road	Site 4	Wyoming	BB29,31,36,44	10/92	8	72	1.27-84.2	13	0.25-15.6	57	38.4-84.2	5.8	2.61 - 13.0
Scrapper	Site 5	Wyoming	BB46,47	10/92	2	--	--	9.5	8.17-11.0	--	--	--	--

1 lb/VMT = 281.9 g/VKT

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TABLE 4-8. DETAILED INFORMATION FOR UNPAVED ROAD TESTS - REFERENCE 4

Site	Run	PM-10 emission factor, lb/VMT	Control measure	Duration, min.	Meteorology			Vehicle			Silt, %	Moisture, %
					Vehicle passes	°F	Wind speed mph	Mean vehicle weight, ton	Avg. No. of wheels	Mean vehicle speed, mph		
1	BB-2	10.8	None	30	35	61	14.43	131	5.54	36.4	10.7	1.08
1	BB-3	13.6	None	25	35	61	14.43	131	5.54	36.4	10.7	1.08
1B	BB-6	4.67	None	55	40	74	9.68	200	5.80	22.7	3.57	1.19
1B	BB-7	6.51	None	66	45	74	9.60	200	5.73	22.4	3.57	1.19
1B	BB-8	5.20	None	29	18	79	8.68	220	5.56	21.2	3.78	1.01
1	BB-10	3.26	None	88	57	80	18.06	160	5.47	27.5	3.08	1.17
1	BB-11	1.79	None	89	57	80	18.02	160	5.47	27.5	3.08	1.17
1B	BB-12	1.49	None	58	50	73	14.29	155	5.80	22.6	2.24	1.09
1B	BB-13	1.49	None	60	50	73	14.26	155	5.80	22.6	2.24	1.09
1B	BB-14	2.62	None	80	44	59	9.88	92.0	5.18	22.9	3.32	1.77
1B	BB-15	4.37	None	64	41	62	11.39	183	5.66	21.3	2.05	1.39
1B	BB-16	5.18	None	63	51	62	10.01	178	5.57	22.1	2.05	1.39
1B	BB-17	1.63	Watering	79	50	65	12.73	169	5.48	24.6	2.08	1.80
1B	BB-18	4.25	Watering	93	71	65	9.92	184	5.97	23.0	1.34	1.29
1B	BB-19	3.13	Watering	67	47	65	8.15	192	5.74	22.8	1.25	1.45
1B	BB-20	2.69	Watering	53	41	68	7.98	175	5.66	24.3	3.89	1.40
1B	BB-21	1.81	Watering	82	32	78	8.11	218	5.75	22.8	1.76	2.00
1B	BB-22	1.38	Watering	36	32	82	4.54	161	5.50	24.3	1.70	2.50
1B	BB-23	0.940	Watering	52	33	87	7.55	181	5.70	22.6	1.90	4.10
1B	BB-25	1.24	Watering	62	40	60	18.17	207	5.70	19.2	3.82	4.00
1B	BB-26	2.97	Watering	79	63	66	13.51	183	5.65	21.8	2.45	4.40
1B	BB-27	3.86	Watering	72	42	69	12.05	244	5.81	19.5	2.72	1.89
4	BB-29	15.6	None	37	21	65	5.86	283	5.90	18.8	19.2	3.78

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TABLE 4-8. (continued)

					Meteorology			Vehicle				
Site	Run	PM-10 emission factor, lb/VMT	Control measure	Duration, min.	Vehicle passes	°F	Wind speed mph	Mean vehicle weight, ton	Avg. No. of wheels	Mean vehicle speed, mph	Silt, %	Moisture, %
4	BB-31	9.34	None	37	22	65	5.18	271	6.09	20.8	19.2	3.78
2	BB-33	5.70	None	92	32	61	13.72	153	5.44	29.2	3.02	1.50
2	BB-34	9.45	None	72	36	63	12.24	170	6.06	28.6	4.88	0.91
2	BB-35	6.65	Watering	87	32	60	8.27	173	5.44	28.0	3.71	2.53
4	BB-36	14.2	None	44	21	69	4.63	286	6.00	19.3	12.9	5.00
1B	BB-38	3.22	Watering	50	43	53	22.71	141	5.26	22.0	1.57	10.3
1B	BB-39	1.70	Watering	45	40	53	22.52	137	5.25	21.8	1.44	12.3
4	BB-40	2.62	Watering	78	40	45	12.24	271	6.05	21.2	4.79	5.70
4	BB-41	5.66	Watering	97	51	45	11.88	267	5.92	22.3	6.48	5.03
4	BB-42	13.0	Watering	70	36	44	11.63	275	5.94	22.0	9.48	4.35
2	BB-43	0.810	Watering	48	25	62	14.11	164	5.52	30.4	1.78	4.65
4	BB-44	0.25	None	105	200	69	9.01	2.00	4.00	30.0	1.82	0.68
5	BB-46	11.0	None	89	32	80	10.13	63.0	4.06	15.5	12.7	4.88
5	BB-47	8.16	None	44	14	80	5.31	65.0	4.00	18.0	14.0	5.11
1B	BB-45	0.0782	None	75	322	53	9.93	2.00	4.00	30.0	1.95	2.10
1B	BB-48	0.120	None	50	381	53	7.71	2.00	4.00	30.0	1.95	2.10

TABLE 4-9. SUMMARY INFORMATION - REFERENCE 5

Operation	Control method	Tests	State	Test date	No. of tests	PM-10 emission factor, lb/VMT	
						Geom. mean	Range
Stone quarry haul truck	Watering	W-201A-1 to W-201A-3	North Carolina	8/95	3	0.112	0.0553-0.217
Stone quarry haul truck	None	D-201A-1 to D-201A-4	North Carolina	8/95	4	1.74	0.528-4.70

1 lb/VMT = 281.9 g/VKT

TABLE 4-10. DETAILED INFORMATION FOR UNPAVED ROAD TESTS - REFERENCE 5

Unpaved road test runs	PM-10 emission factor, lb/VMT[a]	Duration, min.	Meteorology		Vehicle information				Silt, %	Moisture, %
			Temp., °F	Avg. wind, mph	No. of vehicle passes	Mean vehicle weight, ton[b]	Mean No. of wheels[c]	Average vehicle speed, mph[b]		
W-201A-1	0.116	330	69	2.7	190	52.5	NA	16.94	5.86	5.59
W-201A-2	0.055	360	63	1.1	192	52.5	NA	16.94	7.35	6.31
W-201A-3	0.217	180	57	1.0	95	52.5	NA	16.94	7.19	5.87
D-201A-1	0.528	70	62	2.3	33	52.5	NA	16.94	8.54	2.22
D-201A-2	1.57	120	72	1.6	72	52.5	NA	16.94	7.34	1.19
D-201A-3	2.34	90	73	1.3	57	52.5	NA	16.94	9.25	1.31
D-201A-4	4.70	120	62	2.1	78	52.5	NA	16.94	11.03	0.83

[a] Emission Factors are average of left hood and right hood concentrations.

[b] Mean vehicle weight and average vehicle speed were a representative sample applied to entire testing period.

[c] Mean number of wheels not reported, estimated mean from truck description = 6.

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TABLE 4-11. SUMMARY INFORMATION - REFERENCE 6

Operation	Control method	Test run	State	Test date	TSP emission factor, lb/VMT			PM-10 emission factor, lb/VMT		
					No. of tests	Geom. mean	Range	No. of tests	Geom. mean	Range
35 mph rural road	None	AZ	Arizona	5/90	3	3.40	3.19 - 3.86	9	0.735	0.497 - 1.43
45 mph rural road	None	AZ	Arizona	5/90	3	4.59	3.56 - 5.94	9	1.26	0.777 - 2.97
55 mph rural road	None	AZ	Arizona	5/90	3	6.73	5.35 - 9.24	9	1.70	0.969 - 2.88

1 lb/VMT = 281.9 g/VKT

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TABLE 4-12. DETAILED INFORMATION FOR UNPAVED ROAD TESTS - REFERENCE 6

Unpaved road test runs[a]	PM-10 emission factor, lb/VMT	Duration, min.	Avg. wind, mph	Vehicle information				Silt, %	Moisture, %
				No. of vehicle passes	Mean vehicle weight, ton	Mean No. of wheels	Mean vehicle speed, mph		
AZ-01	0.780	21	4.9	53	1.9	4.0	45	11	0.2
AZ-02	--[b]	21	4.9	53	1.9	4.0	45	11	0.2
AZ-03	0.920	22	6.0	55	1.9	4.0	45	11	0.2
AZ-04	0.880	22	6.0	55	1.9	4.0	45	11	0.2
AZ-05	1.35	71	4.2	62	1.9	4.1	55	11	0.2
AZ-06	1.46	71	4.2	62	1.9	4.1	55	11	0.2
AZ-07	0.970	31	4.8	54	1.9	4.0	55	11	0.2
AZ-08	--[b]	31	4.8	54	1.9	4.0	55	11	0.2
AZ-09	0.500	97	5.9	172	1.9	4.0	35	11	0.2
AZ-10	--[b]	97	5.9	172	1.9	4.0	35	11	0.2
AZ-11	0.670	96	3.9	178	1.9	4.0	35	11	0.2
AZ-12	0.630	96	3.9	178	1.9	4.0	35	11	0.2
AZ-21	0.810	42	8.2	98	1.6	4.0	45	7.4	0.22
AZ-22	0.920	42	8.2	98	1.6	4.0	45	7.4	0.22
AZ-23	1.16	47	5.0	50	1.6	4.0	45	7.4	0.22
AZ-24	--[b]	47	5.0	50	1.6	4.0	45	7.4	0.22
AZ-25	1.55	27	5.4	51	1.6	4.0	55	7.4	0.22
AZ-26	--[b]	27	5.4	51	1.6	4.0	55	7.4	0.22
AZ-27	2.01	39	7.4	77	1.6	4.0	55	7.4	0.22
AZ-28	2.01	39	7.4	77	1.6	4.0	55	7.4	0.22
AZ-29	0.730	50	7.0	153	1.6	4.0	35	7.4	0.22
AZ-31	0.630	82	4.0	105	1.6	4.1	35	7.4	0.22
AZ-32	--[b]	82	4.0	105	1.6	4.1	35	7.4	0.22
AZ-33	0.650	46	6.4	134	1.8	4.0	35	7.4	0.22
AZ-41	1.03	96	3.8	155	1.6	4.1	35	4.3	0.17
AZ-42	0.680	96	3.8	155	1.6	4.1	35	4.3	0.17
AZ-43	1.43	76	3.7	107	1.6	4.0	35	4.3	0.17
AZ-44	--[b]	76	3.7	107	1.6	4.0	35	4.3	0.17
AZ-45	1.28	48	3.9	72	1.6	4.0	55	4.3	0.17

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TABLE 4-12. (continued)

Unpaved road test runs[a]	PM-10 emission factor, lb/VMT	Duration, min.	Avg. wind, mph	Vehicle information				Silt, %	Moisture, %
				No. of vehicle passes	Mean vehicle weight, ton	Mean No. of wheels	Mean vehicle speed, mph		
AZ-46	--[b]	48	3.9	72	1.6	4.0	55	4.3	0.17
AZ-47	2.88	97	3.0	35	1.6	4.0	55	4.3	0.17
AZ-48	2.62	97	3.0	35	1.6	4.0	55	4.3	0.17
AZ-49	2.97	72	5.2	36	1.6	4.3	45	4.3	0.17
AZ-50	2.57	72	5.2	36	1.6	4.3	45	4.3	0.17
AZ-51	1.91	115	5.0	45	1.6	4.0	45	4.3	0.17
AZ-52	--[b]	115	5.0	45	1.6	4.0	45	4.3	0.17

[a] Test runs include simultaneously collected samples (ex. AZ-01 and AZ-02). Tests AZ-1 through 12, AZ-21 through -33, and AZ-41 through -52 conducted in Pinal, Pima, and Yuma Counties, respectively.

[b] TSP emission factor.

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TABLE 4-13. SUMMARY INFORMATION - REFERENCE 7

					Controlled TSP emission factor, lb/VMT		Controlled PM-10 emission factor, lb/VMT	
Operation	Location	State	Test dates	No. of tests	Geom. mean	Range	Geom. mean	Range
Vehicle traffic	AU-X (Unpaved road)	PA	11/89	2	0.61	0.39-0.96	0.16	0.14-0.18
Vehicle traffic	Paved road	PA	11/89	6	0.033	0.012-0.12	0.0095	0.0009-0.036
Vehicle traffic	Paved road	PA	11/89	4	0.078	0.033-0.30	0.022	0.0071-0.036

1 lb/VMT = 281.9 g/VKT.

TABLE 4-14. DETAILED INFORMATION FOR UNPAVED ROAD TESTS - REFERENCE 7

				Meteorology		Vehicle information			
Unpaved road - test runs	PM-10 emission factor, lb/VMT	Control method	Duration, min.	Temp., °F	Wind, mph	No. of vehicle passes	Mean vehicle weight, ton	Mean vehicle speed, mph	Silt content, %
AU-X-1	0.14	Chemical suppressant	168	62	8.7	110	3.9	25	3.3
AU-X-2	0.18	Chemical suppressant	71	60	6.5	101	2.1	26	4.1

TABLE 4-15. SUMMARY INFORMATION - REFERENCE 8

Operation	Control method	Test runs	State	Test date	No. of tests	TSP emission factor, lb/VMT		IP emission factor, lb/VMT		PM-10 emission factor, lb/VMT		PM-2.5 emission factor, lb/VMT	
						Geom. mean	Range	Geom. mean	Range	Geom. mean	Range	Geom. mean	Range
Heavy-duty traffic	None (U)	AP	Indiana	5/85 & 8/85	4	10.3	2.20 - 37.6	1.21	0.064 - 7.91	2.55	0.575 - 6.42	0.408	0.156 - 0.791
Heavy-duty traffic	Calcium chloride (C)	AP	Indiana	5/85 & 8/85	1	1.26	1.26	--	--	--	--	--	--
Heavy-duty traffic	Petro Tac (P)	AP	Indiana	5/85 & 8/85	5	2.59	0.645-7.70	0.305	0.076-1.46	0.193	0.048-1.08	0.066	0.019-0.369
Heavy-duty traffic	Coherex (X)	AP	Indiana	5/85 & 8/85	5	4.68	0.653-21.3	0.776	0.108-4.26	0.564	0.078-3.20	0.079	0.011-0.766
Heavy-duty traffic	None (U)	AQ	Missouri	9/85, 10/85, & 11/86	2	6.67	5.68-7.84	1.47	1.25-1.72	1.00	0.851-1.18	0.180	0.153-0.212
Heavy-duty traffic	Calcium chloride (C)	AQ	Missouri	9/85, 10/85, & 11/86	6	2.09	0.211-17.5	0.279	0.032-3.87	0.144	0.008-2.98	0.418	0.102-0.922
Heavy-duty traffic	Generic (G)	AQ	Missouri	9/85, 10/85, & 11/86	11	3.05	1.27-14.5	0.728	0.397-2.46	0.546	0.279-2.03	0.118	0.029-0.724
Heavy-duty traffic	Petro Tac (P)	AQ	Missouri	9/85, 10/85, & 11/86	5	4.84	2.57-11.9	0.781	0.387-2.26	0.572	0.283-1.78	0.134	0.064-0.582
Heavy-duty traffic	Soil Sement (S)	AQ	Missouri	9/85, 10/85, & 11/86	11	1.63	0.200-6.78	0.265	0.050-1.08	0.176	0.014-0.816	0.053	0.009-0.148
Heavy-duty traffic	Coherex (X)	AQ	Missouri	9/85, 10/85, & 11/86	9	2.14	0.208-10.5	0.282	0.034-1.42	0.182	0.017-1.11	0.104	0.013-0.334

1 lb/VMT = 281.9 g/VKT.

TABLE 4-16. DETAILED INFORMATION FOR UNPAVED ROAD TESTS - REFERENCE 8

Unpaved road test runs	PM-10 emission factor, lb/VMT	Duration, min.	Meteorology		Vehicle information				Silt, %	Moisture, %
			Temp., °F	Avg. wind, mph	No. of vehicle passes	Mean vehicle weight, ton	Mean No. of wheels	Avg. vehicle speed, mph[a]		
AP2-P	0.0479	128	70	11	68	27	12.3	15	1.9	0.46
AP2-X	--	128	70	7.6	68	27	12.3	15	<0.05	0.50
AP2-C	--	128	70	4.2	65	28	11.8	15	2.7	1.2
AP2-U	6.42	127	70	4.2	8	33	7.0	15	8.1	0.64
AP3-P	0.124	119	70	11	50	29	7.08	15	2.6	0.36
AP3-X	0.0780	119	70	8.5	50	29	7.08	15	<0.05	1.4
AP3-C	--	119	70	8.5	50	29	7.08	15	4.3	1.4
AP3-U	4.47	119	70	6.2	10	37	5.2	15	8.3	1.1
AP5-P	1.08	84	73	2.6	34	28	13.9	15	6.1	0.12
AP5-X	3.20	82	73	3.9	34	28	13.9	15	11	0.14
AP6-P	0.178	59	75	2.0	51	26	17.4	15	6.8	0.13
AP6-X	1.38	56	75	3.7	51	26	17.4	15	10	0.08
AP6-U	--	46	75	3.7	51	26	17.4	15	7.3	0.10
AP7-P	0.231	104	72	0.92	87	26	13.5	15	11	--
AP7-X	0.293	109	72	1.6	90	26	13.4	15	12	--
AP7-U	0.575	87	72	1.6	85	25	13.4	15	6.0	--
AQ1-U	0.851	64	82	8.4	50	10	6.0	15	7.0	1.5
AQ1-G	0.887	66	82	8.4	50	10	6.0	15	7.6	1.5
AQ1-S	0.201	75	82	8.4	50	10	6.0	15	0.6	0.94
AQ1-X	0.809	75	82	8.4	50	10	6.0	15	15	1.2
AQ2-U	1.18	69	82	8.7	68	9.8	5.9	15	7.0	1.5
AQ2-G	1.04	82	82	8.7	68	9.8	5.9	15	7.6	1.5
AQ2-S	0.158	85	82	8.7	68	9.8	5.9	15	0.6	0.94
AQ2-X	0.504	82	82	8.7	68	9.8	5.9	15	15	1.2
AQ3-P	0.401	105	75	11	76	9.7	5.9	15	3.1	1.8
AQ3-G	0.329	52	75	9.0	19	9.3	5.8	15	6.8	1.5

TABLE 4-16. (continued)

Unpaved road test runs	PM-10 emission factor, lb/VMT	Duration, min.	Meteorology		Vehicle information				Silt, %	Moisture, %
			Temp., °F	Avg. wind, mph	No. of vehicle passes	Mean vehicle weight, ton	Mean No. of wheels	Avg. vehicle speed, mph[a]		
AQ3-S	0.135	50	75	9.0	19	9.6	5.9	15	1.5	1.1
AQ3-X	0.103	47	75	9.0	19	9.6	5.9	15	12	1.6
AQ4-G	2.03	22	75	11	50	24	6.0	15	6.8	1.5
AQ4-S	0.440	28	75	10	50	24	6.0	15	1.5	1.1
AQ4-X	0.585	22	75	12	50	24	6.0	15	12	1.6
AQ4-C	0.451	33	75	13	50	24	6.0	15	--	--
AQ5-P	1.78	21	63	5.9	34	24	5.9	15	5.0	1.1
AQ5-G	0.497	20	63	5.9	34	24	5.9	15	10	1.3
AQ5-S	0.816	29	63	5.9	34	24	5.9	15	4.4	0.99
AQ5-C	2.98	20	63	5.9	34	24	5.9	15	12	1.4
AQ6-P	0.568	18	75	5.0	44	24	6.0	15	5.0	1.1
AQ6-G	0.812	28	75	5.0	36	24	6.0	15	10	1.3
AQ6-S	0.646	23	75	5.0	36	24	6.0	15	4.4	0.99
AQ6-C	2.43	23	75	5.0	36	24	6.0	15	12	1.4
AQ7-P	0.283	30	64	6.5	50	24	6.0	15	3.6	1.2
AQ7-G	0.390	25	64	6.5	48	24	6.0	15	7.0	1.2
AQ7-S	0.284	28	64	6.5	50	24	6.0	15	2.9	0.95
AQ7-X	0.929	28	64	6.5	50	24	6.0	15	6.7	--
AQ8-P	0.536	22	70	5.0	36	24	6.0	15	3.6	1.2
AQ8-G	0.401	16	70	5.0	34	24	6.0	15	7.0	1.2
AQ8-S	0.422	17	70	5.0	34	24	6.0	15	2.9	0.95
AQ8-X	1.11	17	70	5.0	34	24	6.0	15	6.7	--
AQ9-G	0.282	110	64	6.5	125	10	6.0	15	.76	0.95
AQ9-S	0.0145	110	64	6.5	125	10	6.0	15	1.2	0.77
AQ9-X	0.0200	62	64	6.5	79	10	6.0	15	1.1	0.78
AQ9-C	0.0084	267	64	6.5	125	10	6.0	15	1.6	2.1

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TABLE 4-16. (continued)

Unpaved road test runs	PM-10 emission factor, lb/VMT	Duration, min.	Meteorology		Vehicle information				Silt, %	Moisture, %
			Temp., °F	Avg. wind, mph	No. of vehicle passes	Mean vehicle weight, ton	Mean No. of wheels	Avg. vehicle speed, mph[a]		
AQ10-G	0.279	138	61	6.6	200	7.6	5.3	15	2.9	1.3
AQ10-S	0.0340	134	61	6.6	200	7.6	5.3	15	--	--
AQ10-X	0.0168	129	61	6.6	200	7.6	5.3	15	--	--
AQ10-C	0.0204	133	61	6.6	200	7.6	5.3	15	--	--
AQ11-G	0.422	127	55	8.7	250	6.5	5.0	15	2.9	1.3
AQ11-S	0.0848	127	55	8.7	250	6.5	5.0	15	--	--
AQ11-X	0.0255	130	55	8.7	250	6.5	5.0	15	--	--
AQ11-C	0.0161	130	55	8.7	250	6.5	5.0	15	--	--

[a] Tests at AQ were conducted with captive traffic and vehicles were operated at 15 mph. For test runs, control methods were desacribed with the following codes: C = calcium chloride, G = Generic, P = Petro Tac, U = uncontrolled, S = Soil Sement, X = Coherex.

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TABLE 4-17. SUMMARY INFORMATION - REFERENCE 9

Operation	Test runs	State	Test date	No. of tests	TSP emission factor, lb/VMT		IP emission factor, lb/VMT		PM-10 emission factor, lb/VMT		PM-2.5 emission factor, lb/VMT	
					Geom. mean	Range	Geom. mean	Range	Geom. mean	Range	Geom. mean	Range
Uncontrolled tests - Scraper Travel	AN24-AN25	Michigan	8/85	4	51	41 - 64	34	28 - 43	26	22 - 33	7.7	6.3 - 10
Controlled Tests - Scraper Travel	AN21-AN23	Michigan	8/85	7	10	2.1 - 37	9.2	1.5 - 27	5.3	1.2 - 21	1.6	.47 - 7.2

1 lb/VMT = 281.9 g/VKT

TABLE 4-18. DETAILED INFORMATION FOR UNPAVED ROAD TESTS - REFERENCE 9

Unpaved road test runs	PM-10 emission factor, lb/VMT	Control method	Duration, min.	Meteorology		Vehicle information				Silt, %	Moisture, %
				Temp., °F	Avg. wind, mph	No. of vehicle passes	Mean vehicle weight, ton	Avg. No. of wheels	Mean vehicle speed, mph		
AN21U	1.90	Watering	46	84	3.8	75	49	4	13	8.9	7.3
AN21X	1.20	Watering	57	84	3.7	59	49	4	15	8.9	8.7
AN21Y	6.70	Watering	81	84	3.9	99	49	4	16	8.9	3.5
AN22U	21.0	Watering	56	81	4.1	49	49	4	17	5.9	2.3
AN22Y	11.0	Watering	61	79	3.7	45	49	4	17	5.9	3.1
AN23U	7.30	Watering	35	77	3.1	40	49	4	16	8.4	3.6
AN23Y	4.80	Watering	15	72	2.1	20	49	4	16	8.4	3.4
AN24U	27.0	None	23	82	7.1	20	49	4	18	7.7	1.7
AN24Y	22.0	None	23	82	7.1	20	49	4	18	7.7	1.7
AN25U	33.0	None	12	83	6.8	10	49	4	20	7.7	1.7
AN25Y	30.0	None	12	83	6.8	10	49	4	20	7.7	1.7

AN21U = Site “AN” test no. 21 at station “U.”

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TABLE 4-19. SUMMARY INFORMATION - REFERENCE 10

						TP emission factor, lb/VMT		TSP emission factor, lb/VMT		IP emission factor, lb/VMT		PM-10 emission factor, lb/VMT		PM-2.5 emission factor, lb/VMT	
Operation	Control method	Test run	State	Test date	No. of tests	Geom. Mean	Range	Geom. Mean	Range	Geom. Mean	Range	Geom. Mean	Range	Geom. Mean	Range
Heavy-duty traffic	None	AL 1, 3, 4, 7, 8, 9, 12	Indiana	6/84	6	10.4	7.16 - 15.9	4.66	3.69 - 7.13	3.20	2.65 - 4.82	2.46	2.02 - 3.75	0.781	0.618 - 1.23
Light/ Medium duty traffic	None	AL 2, 6, 10, 11	Indiana	6/84	4	4.61	2.54 - 6.88	2.13	1.75 - 2.88	1.39	1.12 - 2.02	1.09	0.860 - 1.58	0.377	0.274 - 0.524

1 lb/VMT = 281.9 g/VKT

TABLE 4-20. DETAILED INFORMATION FOR UNPAVED ROAD TESTS - REFERENCE 10

			Meteorology		Vehicle information				
Unpaved road test runs	PM-10 emission factor, lb/VMT	Duration, min	Temp., °F	Avg. wind, mph	No. of vehicle passes	Mean vehicle weight, ton	Mean No. of wheels	Mean vehicle speed, mph	Silt, %
AL-1	7.16	40	64	6.2	40	22	12	19	11.1
AL-2	3.05	55	64	6.3	31	7.7	5.2	20	11.1
AL-3	7.90	24	80	7.6	41	28	14	19	10.6
AL-4	13.3	24	80	9.2	41	27	13	20	10.6
AL-6	4.04	20	80	9.0	42	7.1	4.7	20	10.6
AL-7	9.36	29	73	5.4	42	28	14	17	11
AL-8	8.12	31	73	4.8	40	33	16	18	11
AL-9	3.65	44	59	11	67	31	15	25	6.9
AL-10	3.27	37	59	12	50	9.0	5.6	20	6.9
AL-11	5.60	30	59	14	50	11	6.3	20	6.9
AL-12	7.80	25	60	6.0	39	32	15	16	10.3

TABLE 4-21. SUMMARY INFORMATION - REFERENCE 11

Operation	Type	Control method	TP emission factor, lb/VMT		IP emission factor, lb/VMT		PM-10 emission factor, lb/VMT		PM-2.5 emission factor, lb/VMT	
			Geom. mean	Range	Geom. mean	Range	Geom. mean	Range	Geom. mean	Range
Rural roads	Crushed Limestone - Light duty	None	21.9	17.9-27.0	3.84	3.17-4.99	2.17	1.75-3.09	0.334	0.300-0.407
Rural roads	Dirt - Light duty	None	28.6	11.1-42.1	3.42	2.83-4.18	1.60	0.951-1.99	0.293	0.090-0.507
Rural roads	Gravel - Light duty	None	6.70	5.43-7.96	1.25	1.10-1.39	0.835	0.713-0.957	0.366	0.251-0.481
Copper smelter	Medium duty vehicle	None	8.99	7.62-10.0	2.57	2.21-2.97	1.67	1.46-1.91	0.317	0.283-0.370
Stone crushing	Medium duty vehicle	None	25.0	9.36-35.2	7.1	3.20-9.67	--	2.15-5.83	4.17	2.15-5.83
Sand and gravel	Heavy duty vehicle	None	11.1	8.28-15.3	3.92	3.35-4.44	2.73	2.34-3.26	0.742	0.620-0.982

1 lb/VMT = 281.9 g/VKT

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TABLE 4-22. DETAILED INFORMATION FOR UNPAVED ROAD TESTS - REFERENCE 11

Run No.	PM-10 emission factor, lb/VMT	Industrial category	Type of traffic	Avg. wind, mph	No. of vehicle passes	Mean vehicle weight, ton	Mean No. wheels	Mean vehicle speed, mph	Silt content, %	Moisture content, %
U-1	9.13	Rural roads crushed limestone	Light duty	8.28	125	1.9	4.0	35	9.5	0.25
U-2	3.09	Rural roads crushed limestone	Light duty	7.61	105	1.9	4.0	35	9.1	0.3
U-3	1.75	Rural roads crushed limestone	Light duty	2.46	101	1.9	4.0	35	7.7	0.27
U-4	1.87	Rural roads crushed limestone	Light duty	7.16	102	1.9	4.0	25	8.6	0.4
U-5	1.97	Rural roads crushed limestone	Light duty	11.6	107	2.3	4.0	25	9.2	0.37
U-6	--	Rural roads crushed limestone	Light duty	13.2	51	1.9	4.0	30	--	--
AB-1	12.1	Rural roads dirt	Light duty	13.2	94	2.3	4.0	25	35.1	3.9
AB-2	0.950	Rural roads dirt	Light duty	6.49	50	2.3	4.0	25	16.7	4.5
AB-3	1.99	Rural roads dirt	Light duty	8.50	50	2.3	4.0	25	16.8	3.2
AB-4	1.86	Rural roads dirt	Light duty	11.2	50	2.3	4.0	25	5.8	3.1
AE-1	0.710	Rural roads gravel	Light duty	9.62	46	2.1	4.0	40	5.0	0.26
AE-2	0.960	Rural roads gravel	Light duty	11.2	22	1.8	4.0	35	5.0	0.26
AA-1	2.15	Stone crushing	Med. duty	4.70	55	11	5.0	15	13.7	0.4
AA-2	0.940	Stone crushing	Med. duty	2.46	24	13	4.4	15	15.3	0.34
AA-3	0.090	Stone crushing	Med. duty	4.92	34	10	4.0	10	10.5	0.84
AA-4	4.52	Stone crushing	Med. duty	8.05	56	14	5.6	10	15.6	2.1
AA-5	5.83	Stone crushing	Med. duty	9.40	56	13	5.0	10	15.6	2.1
AC-1	1.63	Copper smelting	Light duty	4.25	51	2.2	4.8	10	19.1	0.07
AC-2	1.46	Copper smelting	Light duty	5.37	49	2.1	4.0	10	15.9	0.07
AC-3	1.91	Copper smelting	Light duty	6.93	51	2.4	4.3	10	16	0.03

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TABLE 4-23. SUMMARY INFORMATION - REFERENCE 12

						TP emission factor, lb/VMT		IP emission factor, lb/VMT		PM-2.5 emission factor, lb/VMT	
Operation	Control method	Location	State	Test date	No. of tests	Geom. mean	Range	Geom. mean	Range	Geom. mean	Range
Heavy-duty traffic	None	E	Ohio	11/80	3	132	129 - 133	30.5	25.9 - 33.5	8.35	7.74 - 8.84
Heavy-duty traffic	Coherex	C	Ohio	11/80	4	5.04	3.35 - 8.17	1.48	1.18 - 2.04	0.439	0.274 - 0.594
Heavy-duty traffic	Watering	E	Ohio	11/80	3	28.9	8.27 - 99.3	4.94	0.992 - 25.8	1.07	0.219 - 5.46
Light-duty traffic	None	B	Ohio	7/80	4	11.7	9.98 - 14.2	2.69	1.05 - 4.25	0.731	0.245 - 1.27
Light-duty traffic	Coherex	B	Ohio	10/80	5	0.636	0.089 - 1.23	0.226	0.061 - 0.384	0.0628	0.0318 - 0.0945

1 lb/VMT = 281.9 g/VKT

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TABLE 4-24. DETAILED INFORMATION FOR UNPAVED ROAD TESTS - REFERENCE 12

						Meteorology		Vehicle information				
Site	Unpaved road test runs	PM-10 emission factor, lb/VMT[a]	Type	Control	Duration, min.	Temp., °F	Avg. wind, mph	No. of vehicle passes	Mean vehicle weight, ton	Avg. No. of wheels	Mean vehicle speed, mph	Silt, %
E	F-68	25.1	Heavy-duty	None	17	50	7.4	21	22	5.9	20	14
E	F-69	20.6	Heavy-duty	None	13	50	7.9	14	53	10	20	--
E	F-70	25.3	Heavy-duty	None	13	50	8.2	10	53	10	20	16
E	F-65	0.70	Heavy-duty	Watering	57	60	6.4	64	53	10	20	4.5
E	F-66	3.53	Heavy-duty	Watering	20	60	5.5	41	54	9.0	25	--
E	F-67	19.4	Heavy-duty	Watering	17	55	9.5	30	54	9.8	25	5.1
C	F-59	--	Heavy-duty	Coherex	125	50	9.3	61	19	9.3	16	5.4
C	F-60	--	Heavy-duty	Coherex	123	50	8.2	84	46	9.2	22	5.4
C	F-63	--	Heavy-duty	Coherex	107	50	5.2	118	54	7.7	18	2.5
C	F-64	--	Heavy-duty	Coherex	121	50	6.5	136	54	7.8	15	--
B	F-28	0.750	Light-duty	None	45	78	1.6	101	3	4	15	--
B	F-29	3.34	Light-duty	None	34	79	6.2	50	3	4	15	--
B	F-30	2.40	Light-duty	None	17	79	6.2	50	3	4	15	--
B	F-31	3.10	Light-duty	None	40	80	3.5	33	3	4	15	--
B	F-40	--	Light-duty	Coherex	133	50	4.0	300	3	4	25	0.015
B	F-41	--	Light-duty	Coherex	100	50	5.1	255	3	4	25	0.075
B	F-42	--	Light-duty	Coherex	128	50	7.0	294	3	4	25	0.99
B	F-43	--	Light-duty	Coherex	120	50	8.5	300	3	4	25	--
B	F-44	--	Light-duty	Coherex	55	50	9.1	200	3	4	25	1.8

[a] PM-10 emission factor calculated from logarithmic interpolation of PM-15 and PM-2.5 data.

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TABLE 4-25. SUMMARY INFORMATION - REFERENCE 13

Operation	Control method	Test run	State	Test date	No. of tests	TSP emission factor, lb/VMT		IP emission factor, lb/VMT		PM-10 emission factor, lb/VMT		PM-2.5 emission factor, lb/VMT	
						Geom. Mean	Range	Geom. Mean	Range	Geom. Mean	Range	Geom. Mean	Range
Heavy-duty traffic	None	AG1-3	Indiana	6/82	3	18.1	12.0-23.4	3.80	1.38 - 7.47	3.05	1.34 - 5.55	0.384	0.117-0.994
Heavy-duty traffic	Petro Tac	AG4-11	Indiana	6/82	8	3.39	0.963-8.88	0.366	0.015-2.24	0.282	0.035-1.54	0.080[a]	0.0154 to 0.259
Heavy-duty traffic	None	AJ1-3	Missouri	9/82	3	16.4	13.8 - 21.4	3.79	2.94 - 5.15	2.86	2.14 - 4.17	0.694	0.498 - 0.915
Heavy-duty traffic	Watering	AJ4-6	Missouri	9/82	3	1.77	0.255-5.81	0.340	0.086-0.781	0.242	0.051-0.563	0.191	0.122-0.272
Heavy-duty traffic	Coherex	AJ7-18	Missouri	9/82	12	2.79	0.384-16.6	0.42	0.047-3.57	0.233	0.006-2.23	0.076[a]	0.0049 to 0.449

1 lb/VMT = 281.9 g/VKT

[a] Only included test runs with reported measurements.

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TABLE 4-26. DETAILED INFORMATION FOR UNPAVED ROAD TESTS - REFERENCE 13

Unpaved road test runs	PM-10 emission factor, lb/VMT	Duration, min.	Meteorology		Vehicle information				Silt, %	Moisture %
			Temp., °F	Avg. wind, mph	No. of vehicle passes	Mean vehicle weight, ton	Mean No. of wheels	Mean vehicle speed, mph		
AG-1	1.34	31	71	4.2	27	27	9.8	15	7.5	0.59
AG-2	5.55	106	69	7.4	30	25	7.3	17	5.8	0.33
AG-3	3.82	99	70	5.8	22	28	6.6	16	7.2	0.27
AG-4	0.097	107	52	2.7	79	23	9.2	15	0.28	--
AG-5	0.248	128	69	4.8	120	32	10	14	0.29	--
AG-6	0.035	166	87	6.6	160	30	13	15	5.0	--
AG-7	0.136	202	71	2.2	84	34	10	16	4.9	--
AG-8	0.610	100	70	3.2	93	31	9.1	14	5.3	--
AG-9	1.54	75	69	6.3	31	28	6.1	13	8.2	--
AG-10	1.11	76	65	3.4	49	31	8.1	13	8.5	--
AG-11	0.335	62	74	2.6	62	26	5.8	14	13	--
AJ-1	4.17	48	77	3.3	45	54	6.0	15	6.3	--
AJ-2	2.62	46	76	2.0	47	52	6.0	15	7.4	--
AJ-3	2.14	50	80	4.2	50	50	7.1	15	7.7	--
AJ-4	0.060	79	90	6.1	86	48	6.1	15	4.9	5.1
AJ-5	0.560	67	85	5.6	71	50	6.0	15	5.3	2.0
AJ-6	0.493	46	78	4.4	49	48	5.9	15	--	--
AJ-7	0.490	90	66	3.6	68	49	5.9	15	1.9	--
AJ-8	0.022	89	70	5.8	120	34	7.2	15	5.5	--
AJ-9	1.05	126	69	5.3	120	50	6.4	15	7.1	--
AJ-10	1.49	50	62	2.8	44	29	6.0	20	6.1	--
AJ-11	0.904	65	65	3.1	61	27	6.0	19	4.3	--
AJ-12	2.23	68	61	7.7	60	44	6.0	21	5.7	--
AJ-13	0.006	190	57	8.2	150	38	6.0	18	ND	--
AJ-14	0.183	240	42	12	250	56	6.0	22	0.034	--
AJ-15	0.313	131	49	8.8	107	54	6.0	17	1.6	--
AJ-16	0.098	140	55	4.9	140	32	6.0	23	2.1	--
AJ-17	0.066	125	65	7.9	120	34	6.0	20	1.5	--
AJ-18	0.373	119	43	5.0	115	31	6.0	22	1.7	--

TABLE 4-27. SUMMARY INFORMATION - REFERENCE 14

Operation	Control method	Test Run	State	Test date	No. of tests	TSP emission factor, lb/VMT		IP emission factor, lb/VMT		PM-2.5 emission factor, lb/VMT	
						Geom. mean	Range	Geom. mean	Range	Geom. mean	Range
Haul Truck	None	J9-J12,J20,J21, K1,K7,K9-K12, K26,L1,L3,L4, P1-3, P5	North Dakota, Wyoming, New Mexico	1979-80	20[a]	10.8	0.70 - 73	5.54	0.32 - 42	0.23	0.02 - 2.88
Haul Truck	Watering	K6,K8,K13,P4,P6-P9	Wyoming, New Mexico	1979-80	8[a]	2.97	0.60 - 8.4	1.51	0.40 - 4.1	0.09	0.05 - 0.16
Light/Medium Duty Truck	None	J13,J18,J19,K2, K3,K4,K5,P11,P12,P13	North Dakota, Wyoming, New Mexico	1979-80	10	2.94	0.60 - 9.0	1.79	0.33 - 6.6	0.119	0.03 - 1.5
Light/Medium Duty Truck	CaCl2	J7,J8	North Dakota	1979-80	2[b]	0.35	ND-0.35	0.34	ND-0.34	0.09	ND-0.09

1 lb/VMT = 281.9 g/VKT

[a] Haul Truck uncontrolled tests listed in report text = 19 and watered tests = 9, however data tables list 20 uncontrolled and 8 watered tests.

[b] Test Run J7 was reported as a nondetect (ND). Geometric Mean was calculated using only the detected test.

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TABLE 4-28. DETAILED INFORMATION FOR UNPAVED ROAD TESTS - REFERENCE 14

			Meteorology		Vehicle information					
Unpaved road test run	PM-10 emission factor lb/VMT[a]	Duration, min.	Temp., °F	Avg. wind, mph	No. of vehicle passes	Mean vehicle weight, tons	Mean No. of wheels	Mean vehicle speed, mph	Silt, %	Moisture, %
J-6	--	67	76.1	0.9	39	--	--	--	7.9	5.4
J-9	4.6	51	82.94	4.8	41	65	8	19.3	9.4	3.4
J-10	14.1	52	87.8	4.4	45	60	7.7	19.3	9.4	2.2
J-11	9.4	48	86.9	4.2	40	60	9.9	20	8.2	4.2
J-12	4.9	49	80.06	0.8	19	99	9.5	15	14.2	6.8
J-20	2.9	49	73.4	2.5	23	125	10	16.8	11.6	8.5
J-21	3.1	26	77	1.6	14	110	9.3	15	--	--
K-1	1.6	86	58.28	6.2	65	63	6.1	32.9	7.7	2.2
K-6	0.6	177	64.04	3.4	84	89	7.4	34.8	2.2	7.9
K-7	1.6	53	74.3	2.6	57	24	4.9	34.2	2.8	0.9
K-8	0.8	105	50.54	5.7	43	65	6.3	36	3.1	1.7
K-9	2	89	53.6	5	63	74	6.7	29.2	4.7	1.5
K-10	1.5	65	51.08	5	40	69	6.6	36	7.7	2
K-11	1.5	64	54.5	5.2	50	73	6.5	30	8.9	2
K-12	2	58	59.9	5.4	43	95	7.3	36	11.8	2.3
K-13	0.3	73	39.2	3.7	78	64	6.6	31.7	1.8	2.7
L-1	0.2	92	33.26	1.9	57	95	8.8	26.1	13	7.7
L-3	27.7	47	55.76	6.5	26	107	9.3	20	13.8	4.9
L-4	20.9	48	56.48	6.1	32	86	8.3	20	18	5.1
P-1	11.3	57	95	3.8	15	79	8.5	26.7	4.7	0.4
P-2	2	95	80.6	1.8	10	42	7.2	26.1	4.7	0.4
P-3	6.3	89	80.6	3.8	18	94	9.7	31.1	4.1	0.3
P-4	1.2	135	80.6	3.7	48	55	7.6	31.7	2	0.3
P-5	3.4	108	89.6	2.8	38	47	7.1	31.1	3.1	0
P-6	0.7	112	84.2	2.2	48	25	5.6	31.7	2.8	2.9
P-7	2.3	95	84.2	2.5	35	61	7.6	31.1	2.4	1.5

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TABLE 4-28. (continued)

Unpaved road test run	PM-10 emission factor lb/VMT[a]	Duration, min.	Meteorology		Vehicle information				Silt, %	Moisture, %
			Temp., °F	Avg. wind, mph	No. of vehicle passes	Mean vehicle weight, tons	Mean No. of wheels	Mean vehicle speed, mph		
P-8	1.2	103	84.2	3	49	47	7.5	29.2	7.7	15.3
P-9	1.4	142	80.6	3.7	48	58	8.7	31.1	1.6	20.1
J-1	2.48	87	73.94	2.8	63	50	4.1	19.3	8.9	5.7
J-2	2.09	34	77	1.4	33	53	4	19.3	23.4	2.3
J-3	16.3	51	84.92	1.3	35	54	4.1	24.2	15.8	4.1
J-4	0.963	52	68	1.1	30	36	4	20	14.6	1.5
J-5	5.8	60	85.1	1.4	14	70	4	18	10.6	0.9
K-15	4.54	13	41	3.9	6	46	4	28		
K-16	10.3	41	47.84	2.6	10	64	4	30	25.2	6
K-17	20.9	18	53.6	4	31	57	4.1	23	25.2	6
K-18	10.7	37	55.58	2.6	30	66	4	25	25.2	6
K-22	2.92	110	41	3	20	45	4	31.7	21.6	5.4
K-23	6.61	43	42.98	4.6	20	54	4	28	24.6	7.8
L-5	115	14	38.3	8.6	20	53	4	21.1	21	
L-6	51.3	22	39.56	9.4	15	50	4	20	21	
P-15	--	43	89.6	1.6	4	42	4	16.2	7.2	1
P-18	0.714	33	80.6	3.9	18	64	4	10	7.2	1
J-7	--	59	82.94	1.1	104	7	4.2	25	3	3.6
J-8	0.27	68	86	1.6	160	3	4	25	3	3.6
J-13	3.22	26	77.9	2.9	59	2.2	4	25	10.1	1
J-18	5.32	21	79.7	3.7	34	2.6	4	25	8.8	1.1
J-19	3.69	31	80.24	3.6	70	2.3	4.1	25	8.2	0.9
K-2	0.195	55	46.94	5.5	150	2.3	4	35	4.9	1.6
K-3	0.242	58	53.78	4.8	150	2.4	4	35	4.9	1.6
K-4	0.225	67	61.16	3.1	150	2.4	4	35	5.3	1.7
K-5	0.351	68	68.72	4.3	150	2.4	4	35.9	5.3	1.7

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TABLE 4-28. (continued)

Unpaved road test run	PM-10 emission factor lb/VMT[a]	Duration, min.	Meteorology		Vehicle information				Silt, %	Moisture, %
			Temp., °F	Avg. wind, mph	No. of vehicle passes	Mean vehicle weight, tons	Mean No. of wheels	Mean vehicle speed, mph		
P-11	2.56	73	95	5.8	100	2	4	42.5	5.5	0.9
P-12	2.94	60	95	5.2	125	2	4	43.1	5.5	0.9
P-13	2.52	55	84.2	4.2	100	2	4	43.1	5.5	0.9

[a] PM-10 emission factors were calculated from the PM-15 and PM-2.5 data using logarithmic interpolation.

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TABLE 4-29. SUMMARY INFORMATION - REFERENCE 15

Operation	Control method	Tests	State	Test date	No. of Tests	PM-10 (<10 μm) Emission Factor (lb/VMT)*	
						Geom. Mean	Range
Lightweight vehicle	None	BG	Missouri	11/95 to 12/95	5	0.352	0.0884-1.12
Lightweight vehicle	None	BJ	North Carolina	4/96	4	1.15	0.851-1.31
Lightweight vehicle	None	BK	Nevada	5/96	4	0.819	0.309-2.63

1 lb/VMT = 281.9 g/VKT

* Study reports a PM-2.5/PM-10 ratio of 0.15

TABLE 4-30. DETAILED INFORMATION FOR UNPAVED ROAD TESTS - REFERENCE 15

			Meteorology		Vehicle information					
Unpaved road test runs	PM-10 emission factor, lb/VMT	Duration, min	Temp., °F	Avg. wind, mph	No. of vehicle passes	Mean vehicle weight, ton	Mean No. of wheels	Average vehicle speed, mph	Silt. %	Moisture, %
BG-1	0.503	85	60	4.2	110	2	4	30	7.2	0.93
BG-2	0.925	125	60	11.6	330	2	4	30	6.22	0.65
BG-3	1.12	84	65	12.2	300	2	4	30	6.07	0.54
BG-4	0.118	102	57	6.0	306	2	4	30	7.56	1.38
BG-5	0.0884	88	62	4.0	320	2	4	30	7.97	1.12
BJ-1	1.24	92	84	10.2	257	2	4	30	4.01	0.1
BJ-2	1.28	115	84	10.5	261	2	4	30	2.9	0.1
BJ-3	0.851	115	84	14.6	247	2	4	30	4.26	0.07
BJ-4	1.31	82	84	16.4	251	2	4	30	3.70	0.09
BK-1	0.372	59	72	5.0	138	2	4	30	7.2	0.48
BK-2	0.309	29	70	5.6	150	2	4	30	5.24	0.44
BK-3	1.49	47	70	6.5	100	2	4	30	5.88	0.45
BK-4	2.63	27	71	6.5	80	2	4	30	6.55	0.38

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TABLE 4-31. RESULTS OF CROSS-VALIDATION

Type of vehicle/road	Uncontrolled/ watered	No. of cases	Ratio of quasi-independent estimate to measured emission factor	
			Geo. mean	Geo. std. dev.
Haul trucks	U	39	0.98	2.44
	W	34	1.10	2.49
	Overall	73	1.03	2.45
Light-medium duty/traffic on industrial roads	U	29	1.09	2.85
Light-medium duty/traffic on public roads	U	43	0.97	2.36
	Overall	72	1.02	2.54
Heavy duty/traffic on industrial roads	U	3	1.28	1.39
Scrapers in travel mode	U	23	0.82	3.62
	W	9	1.00	5.13
	Overall	32	0.87	3.93

TABLE 4-32. PREDICTED VS. MEASURED RATIOS FOR NEW UNPAVED ROAD EQUATION USING REFERENCE 15 TEST DATA

Run	Silt, %	Moisture, %	Weight, tons	Speed, mph	No. of wheels	Measured PM-10 emission factor, lb/VMT	Ratio of Predicted to measured	
							Equation 4-5	Current AP-42
BJ-1	4.01	0.10	2	30	4	1.23	0.88	0.43
BJ-2	2.90	0.10	2	30	4	1.29	0.65	0.30
BJ-3	4.26	0.07	2	30	4	0.840	1.51	0.67
BJ-4	3.70	0.09	2	30	4	1.32	0.80	0.37
BG-1	7.20	0.93	2	30	4	0.503	0.95	1.89
BG-2	6.22	0.65	2	30	4	0.925	0.95	0.89
BG-3	6.07	0.54	2	30	4	1.12	0.81	0.71
BG-4[a]	7.56	1.4	2	30	4	0.118	6.95	8.44
BG-5[a]	7.97	1.1	2	30	4	0.088	10.3	11.9

[a] These tests were conducted during misty conditions.

REFERENCES FOR SECTION 4

1. Muleski, G., Midwest Research Institute, *Letter Report of Field Tests, MRI Project No. 4470, "Road Sampling,"* for Washoe County District Health Department, Reno, Nevada, August 1996.

2. *Improvement of Specific Emission Factors (BACM Project 1)*, South Coast AQMD, South Coast AQMD Contract No. 95040, March 1996.

3. *PM-10, PM2.5, PM-1 Emission Factors for Haul Roads at Two Stone Crushing Plants*, National Stone Association, Washington, D.C., November 1995.

4. *Surface Coal Mine Emission Factor Study*, U. S. Environmental Protection Agency, EPA Contract No. 68-D2-0165, Assignment I-06, Research Triangle Park, NC, January 1994.

5. *PM-10 Emission Factors for a Haul Road at a Granite Stone Crushing Plant*, National Stone Association, Washington, D.C., December 1994.

6. *Unpaved Road Emission Impact*, Arizona Department of Environmental Quality, Phoenix, AZ, March 1991.

7. *Roadway Emissions Field Tests at US Steel's Fairless Works*, U.S. Steel Corporation, Fairless Hills, PA, USX Purchase Order No. 146-0001191-068, May 1990.

8. *Evaluation of the effectiveness of Chemical Dust Suppressants on Unpaved Roads*, funded by LTV Steel Company, Inc., prepared for U. S. Environmental Protection Agency, Office of Research and Development, Washington, D.C., EPA No. 600/2-87-102, November 1987.

9. *Fugitive Emission Measurement of Coal Yard Traffic at a Power Plant*, Midwest Research Institute for Confidential Client, December 1985.

10. *Critical Review of Open Source Particulate Emission Measurements - Part II - Field Comparison*, Southern Research Institute, Birmingham, AL, August, 1984.

11. *Size Specific Particulate Emission Factors for Uncontrolled Industrial and Rural Roads*, U. S. Environmental Protection Agency, Research Triangle Park, NC, EPA Contract No. 68-02-3158, Assignment 12, January 1983.

12. *Iron and Steel Plant Open Source Fugitive Emission Control Evaluation*, U. S. Environmental Protection Agency, Research Triangle Park, NC, EPA Contract No. 68-02-3177, Assignment 4, August 1983.

13. *Extended Evaluation of Unpaved Road Dust Suppressants in the Iron and Steel Industry*, U. S. Environmental Protection Agency, Research Triangle Park, NC, EPA Contract No. 68-02-3177, Assignment 14, October 1983.

14. *Improved Emission Factors for Fugitive Dust from Western Surface Coal Mining Sources*, U. S. Environmental Protection Agency, Research Triangle Park, NC, EPA Contract No. 68-03-2924, Assignment 1, July 1981.

15. *Fugitive Particulate Matter Emissions Final Draft Report*, U. S. Environmental Protection Agency, Research Triangle Park, NC, EPA Contrct No. 68-D2-0159, Assignment 4-06, January 1997.

16. A. L. Williams, G. J. Stensland, and D. F. Gatz, *Development of a PM10 Emission Factor from Unpaved Roads*, APCA Publication 88-71B.4, Presented at the 81st Annual Meeting of APCA, Dallas, TX, June 19-24, 1988.

17. A. L. Williams and G. J. Stensland, *Uncertainties in Emission Factor Estimates of Dust from Unpaved Roads,* AWMA Publication 89-24.6, Presented at the 82nd Annual Meeting & Exhibition, Anaheim, CA, June 25-30, 1989.

18. W. R. Barnard, G. J. Stensland, and D. F. Gatz, *Development of Emission Factors for Area and Line Source Fugitive Dust Emissions: Implications of the New PM-10 Regulations*, Transactions of PM-10 Implementation of Standards, ed. by C. V. Mathai and D. H. Stonefield, APCA publication TR-13, p 326, 1988.

19. Telephone communication between G. Stensland, Illinois State Water Survey, Champaign, Illinois, and G. Muleski, Midwest Research Institute, Kansas City, Missouri, July 11, 1997.

5. PROPOSED AP-42 SECTION

Summaries of comments on the proposed AP-42, Section 13.2.2 Unpaved Roads, and responses to these comments are presented on the following pages. The final AP-42 section is available as a seperate file.

IDAHO Department of Environmental Quality Memorandum dated December 31, 1997 from Val Bohdan of Idaho DEQ to Ron Myers of EPA (attached)	
3) The backup studies cited in this draft appear to have no representation from the cement/ concrete industry—a significant number of which exist in the State of Idaho. By contrast, much data backup originated as studies of the coal and steel industries—none existing in Idaho. This raises the question of eventual appropriateness of the proposed emissions formulas in terms of country regional fit.	MRI agrees that wider representation of different industries would be extremely beneficial in developing a truly generic equation applicable to all situations. Nevertheless, one must use the data available to develop emission factors. Unfortunately only limited data are available for cement/concrete industries. Please see also the response to the Portland Cement Association. Additionally, text has been added to the background document to more fully describe the approach taken here to capture the essential features of the emission process with a few readily obtained variables.
4) The issue of control efficiency factoring which can be afforded by vehicular speed reduction is very confusing and needs to be resolved more clearly. Logically, speed reduction, especially on the lower range, needs to be incorporated as an inducement for emissions reduction.	The linear reduction in emissions due to decrease in vehicle speed was not clearly expressed in the draft AP-42 section. This will be corrected in the final version.
5) We would like to suggest the use of clear statements in the writing of the whole Section 13.2.2. Instead of "should be," the direction needs to be "do this" or "use this" in order to give some assurance to the eventual user of this section.	Suggested wording changes will be considered in conjunction with suggestions made by other reviewers.
6) Notwithstanding the derivation process for the formulas, it seems logical that the formulas should be mathematically simplified for the eventual user. Use of negative exponentials can intimidate those not acquainted with higher math and thus should be avoided simply by placing the exponent as a positive number in the denominator. Moreover, combining of numerical constants should be carried out as far as possible, again to assist the eventual ease for the user.	These suggestions need to be considered in conjunction with comments made by other reviewing organizations.
7) Concerning the default moisture content value of 0.5%: For Southern Idaho, much of which is considered "high desert" area, the 0.5% default value is probably correct. We glean this value from the 1996-1997 "Pocatello Road Dust Study" of moisture content which was performed, however, on an unpaved MgCl treated local road. The lower end of this study indicated the moisture content value of 0.6%.	Note that the default value of 0.2% will be incorporated at the "normalizing" factor for moisture. This value was selected based upon the available moisture content data available from uncontrolled publicly accessable unpaved roads. The 20th percentile moisture content value was selected to represent a typical minimum value exclusve of natural mitigation. See also response to Minnesota Pollution Control Agency comment.
Specific Comments:	
Comments pertaining to the Section 13.2.2 Draft	
(a) Page 13.2.2-3: the first equation should be simplified to become $E = (k/7.03)\ (s)^{0.8}\ (W/3)^{b}\ (1/M^{c}) \qquad (1)$ Notice that "a" factor has been replaced by 0.8. This is proper since the value for "a" is the same for all the particulate sizes considered in this equation. Also notice that the	Wording/organization suggestions will be considered in conjunction with other comments and suggestions received. To avoid the use of a negative exponent, one could also write Equation 1 in the draft section as $E = (k/7.03)\ (s)^{0.8}\ (W/3)^{b}\ /\ (M/1)^{c} \qquad (1)$

value of superscript “c” is positive. Thus, Table 13.2.2-2 supporting Equation 1 needs also to be changed: eliminate row "a" (since the constant remains the same for all particulate sizes), and change the minus sign (-) for “c” factor to a plus sign (or better yet, no sign in front of it at all).	In response to the Minnesota Pollution Control Agency comments and evaluation of the moisture data from publicly accesable roads, the normalizing factor for moisture will be changed to 0.2%. See also the comments from the North Carolina DNR.
(b) Page 13.2.2-4: At the bottom of this page, the formula should be changed to read S/15 not (15-S/15) if you intend the factor to drop linearly from 15 to zero vehicular speed “S”. It needs to be stated more clearly that the emissions factor remains constant at speeds above 15 mph.	As noted above, the expression in the draft section was in error and will be corrected.
In Table 13.2.2-3, (Range of Source Conditions for Equation 1) on this page, we recommend that column headings also contain the appropriate letter symbols (s, W, S, and M—in that order) from Equation 1. This will aid all users, especially the infrequent users.	MRI agrees that change might be useful to infrequent readers of AP-42 and the change will be made in the final version.
(c) Page 13.2.2-5; The equation on this page should also be simplified to become $E = (k/7.03)\ (s)^{0.8}\ (W/3)^{b}\ (1/M_{dry}{}^{c})\ [(365-p)/365] \quad (2)$ The issues identified in Paragraph “a” (just above) also apply to this equation. Moreover, your use of the term M/1 appears overly simplistic and should be shortened to just M.	The "1" serves to non-dimensionalize the M term. The normalization allows one to more readily convert the emission factor expression from one set of units to another. This includes units for both the dependent (i.e., emission factor) and the independent variables. Please see the footnote "'c" in connection with Equation 4-1 of the background document.
Page 13.2.2-6; Insert the word “directly” at the sign of * in the third sentence from the bottom, which reads: “Although vehicle speed does not appear * as a parameter, it is obvious…”	This change will be made in the final versions of both the background document and the AP-42 section.
(d)Page 13.2.2-8; The second paragraph (control efficiency afforded by speed reduction) is very confusing and should be either clarified or deleted. The use of a power factor for vehicular speed “S” is very misleading and counters earlier statements. However, the power factor $S^{3/2}$ may best represent the emissions factor relationship for speeds below 15 MPH. If that is the case, then it should be so stated. A simple graph may be the best way to explain and clarify this point.	MRI agrees that the paragraph as presented can be confusing. The discussion about speed being raised to a power between 1 and 2 refers to tests conducted of captive traffic and will be removed and/or revised in order to improve clarity. At present, however, there is no good technical basis for the use of a 3/2 power relationship.

Attachment to Review and Comments on the Draft AP-42 Section 13.2.2, Unpaved Roads From the Idaho Division of Environmental Quality (IDEQ)

The following are the comments/suggestions compiled by the Technical Services Bureau, Air and Hazardous Waste Section, Idaho DEQ, in response to the invitation to comment on the Draft AP-42 Section 13.2.2. The cover letter addresses the AP-42 draft section whereas the following comments are more broad-based and address the background document and the overall methodology for the study.

General Comments:

	In making such sweeping changes to a set of equations which govern the emission estimation process from a major source category for the next decade(s), more testing and studies are warranted. The much touted ease of use is achieved by sacrificing the fine dependencies afforded by specific governing parameters, such as number of wheels and speed. The moisture term is a definite improvement but can be already enhanced in its application and by reference from other studies already performed. It is strongly recommended that this equation be implemented in a test-mode for one or two years before finalizing it. This would allow more time to analyze and study the effects of these proposed changes.	MRI agrees that more tests -- especially for the PM-2.5 size fraction -- would be extremely beneficial.
1.	What were the basic guidelines used to select studies used in the background document? The IDEQ is aware of two other studies, performed in Idaho with guidance from the Midwest Research Institute (MRI) that meets established screening criteria, which could have been used as background information for developing this emission factor. As those studies were conducted in Idaho, they would have provided some regional representation, a more extensive database, and made the factors more robust and applicable to regions like Idaho.	The two studies mentioned in the comment were directed to paved roads. The first was a surface sampling program and no emission test data were collected. The second study involved a yearlong road surface sample collection together with a one-time paved road emission testing program (April 1997). Only one unpaved surface was sampled and no unpaved road emission testing was performed. The background document under review considered only test reports with unpaved road emission test data.
2.	The studies chosen have no representation from the cement/concrete industry. Are the differences accounted by the silt content adequate to characterize emission factor dependence on significant parameters? The cement/concrete industry constitutes a significant number of sources in Idaho.	Clearly, one must rely on the available historical emission test data in order to develop the candidate emission factor expressions. MRI agrees that additional testing in many industries and parts of the country would be very beneficial.
3.	The document seems to primarily focus on PM-10. Is there a similar study planned for PM-2.5 to decipher the relationships between significant parameters that contribute to fine particle emissions? This is especially relevant in light of the fact that geologically derived material and agricultural impacts contribute to regional contributions of fine particles from studies in the west. This is also an issue of focus since the promulgation of the new PM-2.5 standards in mid-1997.	Once again, one must rely on the historical data available and most data referenced PM-10. MRI agrees that more testing focused on PM-2.5 is very much needed to improve the estimation methods for all fugitive emission sources.
4 .	There appears to be a preference to test unpaved roads in iron and steel industries in the east and coal industry in the west. Are these thought to be major contributors of emissions from this source category? Is there any test that was reviewed from unpaved roads in agricultural rural areas? IDEQ feels that such information is key to have in the database as most western states have agriculturally-dependent areas from which emissions have to be quantified, as accurately as possible, if any sort of control scenario is desired to be achieved.	The Arizona DEQ study considered three unpaved roads in rural portions of that state, and two sites were within the immediate vicinity of active agricultural lands. As noted above, although one must rely on the historical data base, collection of additional emission test data from many different situations would be very beneficial in later updates to this section of AP-42.

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5.	The IDEQ is aware of several studies to characterize emissions from paved and unpaved roads by the Washington State University in Pullman from 1994 to 1997 using tracers (The Measurement of Roadway PM-10 Emission Rates using Tracer Techniques, Washington State Department of Transportation, Technical Report # WAR 397.1). This study had important findings related to road emissions compared to relative humidity. There seems to be no mention of the same.	This report was issued to the Washington State DOT in March 1996 and the federal DOT forwarded it to EPA in November 1996. As a result, the test report was not available when the AP-42 update project began during the late summer of 1996. (It should be noted that there is no discernible trend in Table 4 of the WSU study between the 3 sets of paired unpaved road emission factors and relative humidity.)
6.	The Columbia Plateau PM-10 study reports a number of wind erosion studies, and techniques to address them. Specifically, the soil erosion factor, and the surface roughness factor, are mentioned as key parameters for wind erosion. Would this also not be a major factor in emissions from unpaved roads? (See related comment beginning of next section).	The emission factor developed and recommended for inclusion in AP-42 deals with traffic-generated PM, which is an ongoing emission source for active roads rather than the occasional wind erosion of the surface. Because traffic causes emissions even in the absence of wind, it is not intuitive that the parameters presented in the comment are applicable to the emission factor under consideration. See also the response to first comment under "Specific Comments," below.
7.	As there seem to be key omissions in the literature search conducted, to compile the database for the study, IDEQ is skeptical as to the comprehensiveness and soundness of the proposed equation to adequately provide an accurate emission factor for every region in the country.	Please see responses to comments 1 and 5.
8.	IDEQ is also concerned that the use of this forum is to review and provide comment is instituted at a stage later than at which key directional changes to the study can be implemented. What procedures are followed at each phase of the study to ensure participation and encourage input from state and local agencies, to make the study more robust and applicable to all regions? This process would also foster confidence in the final product.	

Specific Comments:

Chapter 2, Background Document:

1.	Is it not intuitive that over time, over a given surface area, that the suspendable particulate loading would decrease (by advection, carry-out, etc.), provided new material is not significantly added to the road surface (relates to erosion factors)? Is there, then, any decay factor, or parameter (added or planned) to be added to the equation as a correction for this effect? The effect of not having this correction would be an assumption that constant surface loading is available for re-suspension over an infinite amount of time resulting in gross overestimates–as compared to realistic measurements.	No, it does not seem intuitive that an actively used unpaved road will lose its dust emitting potential over time. Instead, the surface is continually ground by passing vehicles. Although there is only a limited amount of data available, emission tests conducted on the same uncontrolled road (References 8 and 13 in the background document) from one year to the next do not provide evidence of diminished emission potential (due to traffic over the roadway) .
•	How is the effect of relative humidity in the friction layer of the planetary boundary layer on characteristics of suspended particles accounted for? Although	The draft section does not include a direct treatment of relative humidity (RH). During the 1980s, attention was directed to use of a relative humidity term in road predictive emission factor equations. In one version of the unpaved model, RH was raised to a

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there may be no measurable precipitation on the ground surface, high relative humidity associated with high pressure events and associated interventions may result in decreased circulation events in the surface friction layer closest to the ground and cause suppression of dust, as in a fog with some precipitable water content.	positive power of about 4, whereas in another version the same organization found RH dependence at a power of -0.2. Furthermore, the WSU unpaved road results are inconclusive with respect to the relationship between unpaved road emissions and RH. Recall that the emission factor presented in the draft section references dry conditions. Clearly, misty conditions should result in lower observed emissions; nevertheless, there are insufficient data to determine the mathematical relationship. EPA has drafted additional guidance to better account for the effects of precipitation within the AP-42 section.
Chapter 3, Background Document:	
• In the last paragraph of page 3-7 the comments suggest, that tests from various sources have been combined to derive the new equation. This approach suggests that a large amount of testing was conducted to come up with gross average. As explained elsewhere in the document, a mathematical fit needs not always imply a reality fit. A log-normal distribution conveniently encompasses a wide range. This approach is good as screening criteria but not for further refined purposes as is applied from the AP-42 for permitting, PSD, and SIP purposes. For refined purposes, an industry-by-industry equation should be considered. Although the final equation may or may not differ much, the approach makes the study more robust and increases user confidence as the database would be broad. At the very least, a comparative study should be undertaken to establish the applicability and usefulness of industry specific equations.	As noted above, the development of an emission factor makes use of the data available. Under the ideal situation, one could have sufficient information to develop industry-specific factors for use in different regions of the country. MRI would welcome the opportunity to work with a broader data base that spans many more industries; however, these types of tests simply are not available. To the best of our knowledge, the only industry-specific unpaved road emission factors recommended in AP-42 pertain to western surface coal mining. As a result of this update of the unpaved road section, the emission factors in the western surface coal mining AP-42 section for haul trucks and for light duty trucks are being replaced with the equations developed during this effort. As part of Section 234 of the 1990 CAAA, a thorough comparison of the generic (i.e., Chapter 13) unpaved road expression with the industry-specific equations was undertaken. The background document summarizes the findings that, when applied to independent data (i.e., not used in the development of the models), the generic expression performed as well or better than the industry-specific factors.
Chapter 4, Background Document:	
• It is interesting to note that tests continue to be accepted as approved even as the emission factor values spread over 2-3 orders of magnitude without further investigation as to this extensive spread. The final calculations of emissions and the discretion, as to which order of magnitude to choose, is left to the field operator or engineer in the absence of any further supporting documentation on application of such ranges of values. In a practical regulatory sense this scenario leaves emissions from certain categories in"grey areas." **[underline added; see response]**	The intent of the comment is unclear to MRI. The 2 to 3 orders of magnitude spread in the overall data base is directly attributable to the wide range of underlying source conditions (e.g., vehicle weight, road surface texture, etc.). Should the comment refer to individual test reports, that type of spread might result if one were to compare controlled and uncontrolled test results. (In particular, the intent of the last 2 sentences (underlined) is especially unclear to MRI.) On the other hand, when one considers roads under comparable source conditions, there is considerably less spread.
• Please correct the table columns in Table 4-8.	Wind speed will be placed under the "meteorology" heading instead of "vehicle."
• The comment on page 4-20 that Equation 2-1 performed as well in estimating emissions as did factors for specific sources in the coal industry could also mean that the specific industry factors were somehow biased. It does not necessarily mean the general Equation 2-1 is adequate and correct. It seems a fundamentally gross over-generalization to then lump all the tests, in all studies reviewed, to	Please see response to Chapter 3 comment (above).

	come up with one large data set for the emission factor development. Is this the only specific industry factor test that provided the impetus to lump all the test data?	
•	It is not clear whether reference 12 was used in the final equation development as it did not have moisture content or PM-10 factors listed. What is the exact meaning of “data was used in the expanded data analysis, they were not included in equation development”?	MRI agrees that, as written, the background document is confusing on this point. That portion of the document will be rewritten to clearly explain that although Reference 12 was not used in development of the final emission factor equation, its data were used in those analysis that did not directly reference moisture content as a potential correction parameter (as in the second full paragraph on page 4-24 of the background document).
•	If as mentioned in page 4-26 the effect of speed could not be isolated due to unavailability of speed segregated data … (s)uch data should probably be obtained to study the effects of speed on emission factors. This leads to the conclusion that if a model does not simulate reality to some extent then, perhaps, the fundamental assumptions that went into creating the model are flawed, and are unable to be verified. It could lead to serious errors if the equation is used in this manner. The speed correction factor seems like an extreme ad hoc measure to solve this problem.	MRI agrees that collection of additional test data can only strengthen the validity of estimation methods. Nevertheless, as pointed out several times, one is forced to work with the data sets that are available.
•	Different size fractions may have different influences and effects, as related to the determined significant parameters, in that multiplication of PM-10 emission factors by appropriate size fraction would only be applicable as a rule-of-thumb calculation.	MRI agrees that there can be substantially different mechanisms involved in the reentrainment of particle sizes other than PM10. The reduced quality ratings for "scaled" emission factor equations reflect that concern. (See also responses to comments made by the Minnesota and North Carolina state agencies.)
•	It is interesting to note that a high measure of reliability is established using equation 4-5, as established by Table 4-32 without inclusion of speed in the equation! It is also particularly worrisome that the emissions increase with decreasing speed. **[underline added; see response]** This table also demonstrates the effect of high humidity (misty conditions) on the suppression of emissions.	Because all tests in Table 4-32 were conducted with a travel speed of 30 mph, it is unclear what is meant by the underlined portion of the comment.
	The attached graph demonstrates the effect that speed multiplier will have on the emission factor. The emission increases linearly with decreasing speed from 15 mph to 0 mph, and also causes an anomaly of having emissions from a stationary vehicle with a ‘B’ rating! The text implies the need for an inverse effect. So, the multiplier has to be inversed, as mentioned in the cover letter.	As noted elsewhere, this term will be corrected in the final version.
•	What is the rationale for using 12, 3, and 1 as the norms’ for silt content, mean vehicle weight, and moisture content, respectively?	The reference silt and weight values are the same as those used to normalize the old unpaved road factor. The moisture content of 1% was selected because it corresponds approximately to the geometric mean value for uncontrolled tests in the data set. However, MRI expects to revise the final equation with a normalizing value of 0.2% which is the same as the default value. This change should help ensure that water addition is not "double counted." (See also the response to a Minnesota Pollution Control Agency comment.)

Chapter 5, Proposed AP-42 Section:

• It is possible for the end-user of the equation to obtain daily precipitation totals and relative humidity readings from the National Weather Service (NWS), Local Climatological Data (LCDs). It should be made feasible to incorporate short-term relative humidity and precipitation data into daily or hourly estimates for emissions. Annual data can then be very accurately totaled from this equation. This approach is preferred to the national precipitation data map provided.	As mentioned elsewhere, EPA has indicated its plans to include additional discussion in the final version of the AP-42 section on how to incorporate more finely resolved precipitation data in emission estimates for public roads. Two methods are provided to accomodate local climatological information. One method provides a very simplistic but directionally correct method that has been used for many years to accomodate long term differences in the average moisture content of the road surface material. Another method accomodates more variables that are believed to result in changes in the road surface moisture content. This additional method requires hourly data on the quantity of precipitation, humidity and snow cover as well as monthly data on the evaporation potential (Class A pan evaporation and average traffic volume).
• The number of samples in determining silt content values in the table should be at least 10 or more to provide an adequate level of confidence in the data.	MRI agrees that more confidence should be placed on values based on more samples, but believes that it is important to provide the sparse industry-specific information that is available. State agencies should encourage site specific collection and analysis of road surface material to better characterize the silt and moisture content of roads. If state agencies have more surface material data, they are encouraged to forward that information to EPA for inclusion in Table.13.2.2-1

MINNESOTA POLLUTION CONTROL AGENCY

Letter dated October 29, 1997 from Michael J. Sandusky of Minnesota Pollution Control Agency to Ronald E. Myers of EPA. (attached)

Table 1 summarizes the findings of the MPCA staff in a thorough review on statistical analysis of the emission data provided by the EPA. **(see table in attached comments for footnotes, etc.)**

Table 1. Empirical Constants from Statistical Analysis of Uncontrolled Particulate Emission Factors

	PM-2.5		PM-10		PM-15		PM-30	
Constant	Draft	MPCA	Draft	MPCA	Draft	MPCA	Draft	MPCA
k, lb/VMT	0.24	3.57	1.6	1.72	2.4	3.41	5.3	6.08
a	0.8	0.67	0.8	0.77	0.8	0.72	0.8	0.97
b	0.4	0.24	0.4	0.43	0.4	0.29	0.5	0.52
c	-0.3	-0.55	-0.3	-0.24	-0.3	-0.06	-0.4	-0.45
Cases	?	77	180	141	?	77	92	65
R-squared	?	0.125	0.345	0.384	?	0.255	?	0.512
Adj. R-sq	?	0.089	?	0.371	?	0.224	?	0.488
Q. Rating	B	?	A	?	B	?	A	?
Regression	?	Forced	Stepwise	Stepwise	?	Forced	Stepwise	Stepwise

The fitting constants' quality ratings, the potential dual role of road surface moisture content, the annual adjustment for precipitation, and the disappearance of vehicle speed are major concerns to the MPCA. We believe, however, that the PM10 emission factor equation (lb/VMT) with the fitting constants is acceptable from the statistical standpoint.

Quality Rating Scheme

Emission Factor Documentation for AP-42 Section 13.2.2 (Draft Report) describes in Section 3.3 emission data and emission factor quality rating scheme used for unpaved roads source category. It states, “(t)he uncontrolled emission factor quality rating scheme used for this source category represents a refinement of the rating system developed by EPA for AP-42 emission factor. The scheme entails the rating of test data quality followed by the rating of the emission factor(s) developed from the test data….”

The quality control and quality assurance efforts in the development of emission factors for this source category are important. However, we believe that the final quality rating, as seen in Table 1 for PM-10, should also be more related to the goodness of fit of the regression model. In plain words, we think the ratings of A and B in Table 1, should be lower, e.g., C and D.

To further explain our concern with factor ratings, let’s look at another rating and the

The MPCA re-evaluated the different emission factors presented in Equation 1 and Table 13.2.1 of the draft AP-42 section. Several items should be noted:

1. The expressions for PM-30 do not agree because MPCA regressed only the 65 uncontrolled emission tests whereas the expression recommended for inclusion in AP-42 is based on both the 65 uncontrolled as well as the 27 watered tests. Note, however, that the two expressions in MPCA's Table 1 are essentially identical in terms of the "fitting constants." Thus, had only uncontrolled tests be considered in the development, the resulting PM-30 expression would not be substantively different from the recommended equation.

2. Similarly, the MPCA's PM-10 expression also is based on some subset of the total data sets used by MRI. Although it could not be confirmed from the information presented, it appears that the MPCA expression is again based on the uncontrolled test data. As was the case with the PM-30 factors, the MPCA's results indicate that no substantive difference in the form of the PM-10 would be expected if MRI had considered only uncontrolled tests in the AP-42 update.

3. The differences between the MPCA and MRI expressions for PM-2.5 and PM-15 stem the fact that MPCA developed their expression from a regression analysis while the background document describes how the draft versions were scaled against the PM-10 expression. Page 4-28 of the background document discusses MRI's stepwise regressions of PM-15 and -2.5 data and the decision to scale emission factors against the result for PM-10.

MRI agrees that the quality ratings should be dropped one letter when the emission factor is applied to a specific test road. The background document and draft AP-42 section will be revised to reflect this decision. (See also the response to comments from the North Carolina DNR.) The revisions will also discuss how the overall performance of the emission factor improves when it is applied to a number of roads within a specific area. This is an important distinction between fugitive dust sources and the type of combustion emission source mentioned in the comment. That is to say,

assumptions we make about it. An emission factor rating of A is given to the SO_2 emission factor for No. 6 oil fired, normal firing utility boilers in the current AP-42 Table 1.3-1. People in the regulatory and regulated communities are very confident in using such an emission factor. Now, when an emission factor rating of A is given to the uncontrolled PM-10 emission fitting constants, it has some profound implications. First, it implies that the predicted uncontrolled PM-=10 emission for unpaved roads from the regression model is the best (true), however, it also implies it is directly comparable to that of the SO_2 emission factor for No. 6 oil fired, normal firing utility boilers in the current AP-42 Table 1.3-1 (not true). People using these factors, who tend to take a number out of a table without carefully reading the context, will assume these factors are of equally high quality. Second, when people realize that less than 40 percent of the total variance in the emission data is explained by the regression model (see PM-10 column in Table 1) and rating A still is given to the regression model, they are going to seriously doubt the reliability of all the emission factors from AP-42—stack emissions and fugitive emissions.	a facility being inventoried typically contains no more than a handful of the stack-type source mentioned. Furthermore, the stack sources are far better defined and steady in terms of operating conditions. On the other hand, a facility may contain dozens of unpaved travel surfaces, each with very different vehicle characteristics that change with hour of the day, seasonally, etc. In that case, the performance of an emission factor in accurately predicting emissions from a single source is not necessarily the central issue. Instead, one is interested in how well the factor performs in estimating the total (or average) emission from the entire set of sources over time periods of interest. It should be noted that for many sources of particulate matter, the performance of AP-42 emission factors applied to individual source is not significantly different than the predictive capability of the unpaved road equation. The emission factor ratings are more a function of the number of emission tests supporting the emission factor than on the inherent variability of the emissions from the source being characterized.
We believe that people can be satisfied with the notion that, because of inherent variability, fugitive emission factors can never achieve the same level of quality rating. Therefore, we would urge you to lower the factor ratings associated with the proposed AP-42 for unpaved roads.	MRI agrees. Please also see the response to the first "General Observation" made in the North Carolina comments

Road Surface Material Moisture Content

The efficiency of water application to control particulate emissions is not analyzed statistically in this study, although equation (3) is presented in the Draft AP-42 for estimating control efficiency for water applications. Input parameters for this equation include water application parameters and pan evaporation rate, all of which to a great extent determine road surface material moisture content.	EPA has drafted additional guidance to better account for the effects of precipitation within the AP-42 section. This material -- which provides a means of using the hourly precipitation values that are readily available -- will be included in the final versions of both the background document and the AP-42 section.
There is a potential for double-counting the road surface material moisture content and watering control efficiency. If road surface material moisture content resulted from a control technology application, the road surface material moisture content before the application should be used to establish the regression equation with fitting constants shown in Table 1. We would like confirmation from the EPA that this was done correctly.	As noted in response to one of the Idaho DEQ's comments, the normalizing factor for moisture will be changed to 0.2% (i.e., the default value) and the definition of M_{dry} in Equation 2 will be expanded to ensure that this references uncontrolled conditions.
The inclusion of road surface material moisture content makes sense in reflecting the reality, if data collection to establish the equation in Table 1 was done correctly. However, users of the equation still may double count the moisture contribution by using post-application moisture value in the equation to predict uncontrolled emissions and adding control efficiency due to water application to get the "controlled" fugitive emissions. Of course, we realize that each regulatory agency just needs to guard against dual use of moisture.	The moisture contents for the 137 "uncontrolled" tests in the development data set all reference dry conditions (i.e., without any artificial watering or rainfall for a minimum of 24 hours). For the "watered" tests, the moisture content reported represents a time-averaged value of moisture <u>during the test period</u>. Thus, the appropriate value to substitute (for inventorying purposes) in Equation 1 would be the average moisture content during the watering cycle. If Equation 2 were used, then the appropriate value for M_{dry} would be the uncontrolled moisture content.
Table 2 presents moisture content data associated with PM-10 emissions, uncontrolled, watered, and the combined data set. There is a significant overlap between the	Note that Table 2 in the MPCA comments averages over a variety of different industries, road surface types, etc. More meaningful comparisons would result by

uncontrolled data and the watered data, suggesting the difficulty in preventing dual usage of moisture from happening.

Table 2. Road Surface Material Moisture Content for PM10 Emission Data

Description		Uncontrolled	Watered
Combined Data Set			
Number of valid observations	145	37	182
Missing observations	27	4	31
Mean	1.611	4.751	2.249
Standard deviation	2.049	4.099	2.879
Skewness	1.786	2.17	2.621
Range	8.5	19.8	20.1
Minimum	0	0.3	0
Maximum	8.5	20.1	20.1

matching uncontrolled and watered tests from in Tables 4-5 through 4-28 in the background document. However, MRI shares MPCA's concern that the effect of moisture might be "double-counted " and, as noted in a previous response, will expand the discussion of Equation 2 in Section 13.2.2 to ensure that M_{dry} clearly references uncontrolled conditions.

Annual Adjustments for Precipitation

Section 2.4 of the Draft Report (page 2-4) indicates the control efficiency of watering depends upon (a) the application rate of the water, (b) the time between applications, (c) traffic volume during the period, and (d) the meteorological conditions during the period. This suggests the annual simplifying assumption (365-p)/365, which reflects only first term, is an over simplification on the effects of natural precipitation, which is equation (2) in the draft AP-42 Section 13.2.2.

As noted elsewhere in the comment log, EPA plans to incorporate additional guidance in the use of more finely time resolved precipitation data.

In our experience with mining operations, 0.01 inches of precipitation in a 24-hour period cannot achieve 100 percent control of particulate emissions from unpaved roads. A multi-tier approach would be better such as minimal control for 0.01 inches, moderate control for 0.10 inches, near-maximum control for 0.50 inches, and maximum control for 1.00 inches or more. This could be done by developing four maps similar to Figure 13.2.2-1 using current monthly climatological data such as that in the enclosed Climatological Data, Minnesota, February 1997.

Material drafted by EPA includes use of both current hourly rainfall totals as well as antecedent precipitation.

Vehicle Speed

Section 4.3 of the Draft Report (page 4-27) states, “it is obvious to any one who has driven on an unpaved road that vehicle speed affects emissions, with faster vehicles generating more dust than slower ones. For this reason, it was decided to incorporate the findings of the captive traffic studies into the AP-42, independent of the emission factor equation.” Unfortunately, the corresponding section of the draft AP-42 Section 13.2.2 (page 13.2.2-8) is unclear on how this should be calculated.

This portion of the AP-42 will be revised to more clearly define the linear decrease in emissions with a decrease in travel speed. As noted elsewhere in the comment response log, the linear reduction in emissions was mistakenly expressed in the draft AP-42 section and will be corrected in the final version.

The MPCA staff did confirm the apparent difficulty with vehicle speed in our statistical analysis of the data file, unpaved.dat (July 31, 1997). We are unable at this point of time to propose any better way of dealing with this variable in a statistically acceptable manner. As for the emission factor adjustment for vehicle speed reduction

The 50 mph value was used solely for illustration purposes. The numerical example will be expanded to more fully describe the estimation process.

in the draft AP-42 Section 13.2.2, we strongly suggest that some examples be provided to clarify how this adjustment should be calculated for regulatory purposes. The text on page 13.2.2-8 alludes to a 30 percent reduction in emissions for a vehicle speed reduction from 50 mph to 35 mph; however, it is unclear why 50 mph is the appropriate reference vehicle speed when (1) the proposed emission factor equation lacks any reference vehicle speed, and (2) the SYSTAT regressions indicate vehicle speed adds little to the R^2-values.

NATIONAL STONE ASSOCIATION
Techncial Comments Concerning Sections 4.2.3 and 4.2.5 of the Report Entitled,
"Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads (Draft)"
(attached)

3. COMMENTS CONCERNING SECTION 4.2.3

3.1 Adequacy of the Testing Methodology

The first sentence of paragraph 2 of Section 4.2.3 makes an implied statement that the methodology was not adequate.	As a basis for this response, recall that emission source testing requires one to first isolate and then quantify the PM contribution from the source. This is spelled out more completely in the following responses.
"The study used an upwind-downwind profiling technique that varied from the more commonly used exposure profiling method."	
A similar statement was included in the fourth paragraph of Section 4.2.3. This statement goes on to declare that a large rock well created unrepresentative testing conditions.	Issues of pit trapping notwithstanding, the source testing procedure chosen by NSA and its contractors would require them, at a minimum, to
"At the Garner test location, a large rock wall that stood immediately behind the downwind sampling site may have interrupted natural wind flows and/or created a local recirculation event. The potential wind obstruction and the variation in methodology from common exposure profiling methods accounted for a "B" rating of the test data at the Garner quarry. The Lemon Springs test was assigned an "A" rating."	a) determine what portion of the downwind particulate is due to the source and what is due to "background" b) ensure that the source contribution is not sampled more than once c) demonstrate that the entire plume is accounted for in a calculation scheme to determine net mass passing through the measurement plane d) relate the net mass passage to some meaningful measure of source activity to obtain an emission factor
It is apparent that MRI has assigned a "B" rating to this test report due to the presence of the "large rock wall" and due to the testing methodology. NSA objects to these statements and to the "B" rating.	
The clearly expressed intent of the NSA sponsored studies was to evaluate fugitive particulate emissions from quarry haul roads. A major fraction of a quarry haul road at stone crushing plants is in the quarry pit that varies in depth from 50 feet to more than 300 feet.	
One of the testing locations selected for this test program was a portion of the haul road at the Garner, NC quarry of Martin Marietta. As shown in the photographs included with the test report, this location was approximately 100 feet below the top of the quarry and next to a "large rock wall." The Garner site is highly representative of quarry haul roads in the stone crushing industry. The other test location selected for this test program was at the top of the Lemon Springs, NC quarry of Martin Marietta. This site is representative of the portion of the quarry haul road outside of the quarry pit. NSA believes that the selection of these two sites was technically correct and justifiable.	The tested road may indeed be representative of roads at stone crushing plants, but the test site must allow one to isolate the source contribution in order to characterize emissions. These are separate issues.

There is, in fact, air recirculation due to the close proximity of the face of the quarry wall to the downwind side of the quarry haul road. This is the natural wind flow condition that exists in a deep quarry pit, and it must be taken into account during emission factor testing. This recirculation condition makes the emission profiling technique referred to by MRI difficult to apply for the following reasons. • The haul road and its "shoulder" are not sufficiently wide for the fifteen meter upwind and five meter downwind spacing of the monitoring instruments.	Given the recirculation, any number of things can occur that prevent one from isolating and quantifying the source contribution. For example, the upwind samplers may be impacted by the plume, resulting in too high a background concentration being subtracted out and biasing the calculated emissions low. On the other hand, if the plume circulates in the general vicinity of the samplers, the downwind samplers may repeatedly collect PM from the same vehicle pass, thus biasing the results high. The best one could hope for would be that the recirculation equally impacts both the upwind and downwind samplers to the same extent. Even in that case, however, it is problematic as to how one would attribute the net mass to a suitable measure of source activity if the PM from one vehicle pass is sampled repeatedly.
• The downwind particulate matter concentration does not necessarily approach ambient levels at the 21 foot elevation. Accordingly, there is no clear limit to the concentration profile integration.	At the upper boundary of the plume, the concentration should approach not necessarily an "ambient" level, but the background concentration. Also, if there is "no clear limit," then substantial plume mass would pass over the top sampler. The calculation scheme based on a fixed height (of 28.5 ft) may or may not account for the additional emissions. (See also the comment below on meaning of "ambient.")
Due to the proper selection of the test sites at the Garner and Lemon Springs quarries, the emission factor data are highly representative of stone crushing plant haul roads. The "B" rating is entirely inappropriate for the Garner tests. Exclusive use of the "commonly used emission profiling technique" outside of the quarry, where there was sufficient room for the monitoring towers would have clearly been non-representative of quarry pit haul roads.	The "representativeness" is based on grade, physical setting and other geometrical/location criteria . Nevertheless, for testing purposes, the basic issue of source isolation must be addressed independently.

3.2 Adherence to the Test Program Protocol

NSA and its contractor, Air Control Techniques, P.C., fully adhered to the test protocol. The first version of this protocol was submitted by NSA to EPA on May 8, 1995. Based on EPA comments, the protocol was revised and resubmitted by NSA on July 20, 1995. Both of these versions included the following statement.	
"Due to the short distances between the downwind side of the haul road and the edge of the quarry cliff, the ambient PM-10 monitors may be influenced by PM-10 emissions from the quarry itself or PM-10 particles formed due to the turbulent eddies that exist at the edge of the cliff."	How are PM-10 particles formed due to the eddies? In the quoted section, does "ambient " refer to background samplers? If so, how would particles formed downwind (i.e., due to eddies) influence the background sampler? Does the protocol address how to deal with these influences?
This comment was included in a section of the protocol explaining why the *"commonly used emission profiling technique"* was not applicable. NSA believes that this statement also clearly indicates our intent to test in the quarry pit itself, not just on the upper portion of the quarry haul road. During an extended negotiation in the three month period prior to the beginning of these tests in late August 1995, EPA personnel, at no time, indicated that the proposed test location in the quarry pit or the testing methodology described in the July 20, 1995 version of the protocol was inadequate. The tests were conducted under the belief that EPA personnel had every opportunity to review the testing approach and that all EPA concerns had been fully satisfied. Accordingly, NSA is surprised that MRI has taken the position on behalf of EPA that	MRI functions as an independent contractor and certainly does not purport to speak directly for EPA. MRI's comments on the test method and the sites chosen are based on a review of the test report and results presented therein. (Note that the test report does not include the protocol in the list of references and -- to the best of MRI's knowledge -- the protocol is not mentioned in the test report.) MRI neither received nor was ever asked to review a copy of the test protocol. Had we reviewed the protocol, at a minimum, questions would have arisen about effects mentioned in the quotation.

the Garner tests should be rated “B” due to the test location and the test methodology. NSA have done everything in our power to work in a fully cooperative manner with EPA. Furthermore, we have conducted these tests in complete adherence to the test protocols. The rating of “B” for the Garner test is completely inappropriate.

3.3 Water Application Rates

The second sentence of paragraph 3 of Section 4.3.2 of the MRI report states the following:

> *“Specific water application rates were not reported, although the watering is said to have occurred approximately every 2.5 to 3 hours.”*

Appendix D of the emission test report for Garner and Lemon Springs (pages 100 through 124) specifically lists the exact time that every haul truck, water truck, pickup truck, tractor, car, and van passed the sampling assembly. This MRI comment seems to imply that Air Control Techniques omitted an important variable and was careless in test documentation. This is not correct.

The term "rate" is used to refer not only to the time between watering but also to the amount (volume) of water applied per unit area. The statement that rates were not reported is simply a remark based on the completeness of the report.

NSA and Air Control Techniques, P.C. have fully reviewed the May 8, 1995 and July 20, 1995 test protocols submitted to EPA prior to the tests. It is clear in these protocols that we did not intend to record the water application rates. Furthermore, it was not our intent to analyze the data in any manner that might involve EPA’s wet suppression efficiency equation. To our knowledge, this is the only equation that uses the water application rates as an independent variable. Accordingly, we are surprised that MRI has taken the position that we failed to include these data. This MRI criticism is even more surprising considering that MRI and EPA have not included water application rate data in the revised haul road equations. If the water application rate data had been present, it is clear that it would have been ignored by MRI and EPA. This MRI criticism is clearly unnecessary.

Had MRI reviewed the protocol, another item that would have been raised is measurement of "rates" (in both the time and volume senses).

NSA would like to emphasize that we adhered fully to the revised test protocol that we submitted to EPA more than a month before the tests began. At no time during the pretest negotiations did EPA personnel request these data. NSA requests that MRI’s criticism regarding the water application rate data be removed from their document.

MRI will revise the background document to clearly state that the volume of water applied per unit road area was not reported.

4. COMMENTS CONCERING SECTION 4.2.5

4.1 The Use of Colocated Push-Pull Hoods

Paragraph five of Section 4.2.5 states the following:

> “The ‘push-pull’ method used for this study is not considered an accepted methodology for measuring open source particulate emissions.”

Paragraph 4 of Section 4.2.5 states the following:

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> “The low sampling height at relatively low wind conditions used for this test program potentially allows the particulate plume to pass over the sampling device without capture.”

After reviewing the Entropy emission test report (Reference 5), NSA and Air Control Techniques, P.C. believe that the emission factor calculation procedures have not been clearly described, and we understand how MRI could have misinterpreted these results. Actually, the “push-pull” method described in the Entropy emission test report is a straight-forward adaptation of the upwind-downwind concentration monitoring often used for measurement of fugitive dust emissions. Entropy did not calculate the emissions based solely on the quantity of air captured by the hoods. It was also not necessary for the hoods to capture 100% of the haul road emissions in order to facilitate an accurate measurement of the downwind concentration. It is clear from the sample emission factor calculation shown on page 12 of the Entropy report that the average wind velocity (not the hood capture velocity) through the entire testing zone was used to calculate the emission factor. Accordingly, this test used a conventional upwind/downwind concentration measurement technique.	As applied since at least 1972, the "conventional" upwind/downwind (UW/DW) technique utilizes atmospheric dispersion models along with measured net concentrations at a single height to back-calculate an emission rate. In conventional UW/DW sampling, the plume is intended to pass over the sampling device and so complete capture is not an issue. Terms such as "capturing the fugitive emissions" and "capture hoods" are used throughout the Entropy report. On the other hand, we could find no reference to any dispersion [diffusion] model that would be a core feature of "conventional" UW/DW. The calculation scheme described on pages 11 and 12 of the test report relies on the "area of the sampling array." The scheme described here is very reminiscent of the roof monitor and quasi-stack measurement approaches to fugitive emissions. There is no resemblance to "conventional" UW/DW method.
Entropy used the hoods simply to gather a sufficient gas stream sample to measure the downwind concentration. As shown in Figure 2-3 of the Entropy report, the hoods were located approximately 1 meter from the side of the haul road. This is considerably closer than the 5 meter position used in MRI tests. Accordingly, there is considerably less vertical dispersion from the point of dust release next to the haul road surface to the monitoring site in the Entropy tests as compared to MRI tests. Due to the extremely close position of the Entropy hoods, a representative sample of the downwind concentration was obtained. **(underline added; see response)**	The intent of the underlined portion of the comment and the meaning of "representative sample" are unclear to MRI. If the intention is to demonstrate reasonably complete capture, the comment immediately preceding this one is contradictory by stating 100% capture was not necessary. On the other hand, if vertical dispersion is "considerably less," how would that situation affect emission factors back-calculated in a conventional UW/DW method?
NSA and Air Control Techniques, P.C. do not believe that significant quantities of dust escaped over the top of the hoods. Almost all of the particulate matter is emitted close to the road surface. This belief is consistent with the particulate matter emission mechanism described in draft Section 13.2.2.1 of AP-42, *“Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface.”* The hoods used at Knightdale extended up to ten feet above the road surface, and smoke tracer tests confirmed that during truck passage, the large majority of the emissions remained at less than the 10 foot elevation and were sampled by the hoods. It should also be noted that hoods were located immediately adjacent to a 60 foot cliff that was part of the quarry pit wall. The 60 foot cliff less than 4 meters from the edge of the haul road also precluded the use of an emission profiling tower located 5 meters from the haul road.	Although "tests utilizing smoke" are mentioned on page 4 of the test report, there is no discussion of how or what type of tests were conducted. Where was smoke released -- at the height of the rolling wheels, top of truck, or at the surface? Was the smoke mixed with the dust plume as the particles are dispersed in the wake of the vehicle? What is meant by "immediately adjacent?" The cliff is not evident to MRI in Figure 2-3? What is the orientation of the 60 ft cliff with respect to the hoods? In any event, does the presence of the cliff aid in the capture or is recirculation likely?
It should also be noted that the fans on the upwind side of the haul road were used to enhance particle capture and reduced vertical dispersion of the plumes from the wakes of the haul road trucks. These fans increased the average wind speed across the road surface and drove the particulate toward the hoods.	

4.2 Adherence to the Emission Test Protocol

The “push-pull” upwind-downwind concentration test procedure used at the Knightdale quarry was first proposed in a series of meetings attended by EPA personnel and NSA personnel in the fall of 1993. It was described in an emission testing protocol dated December 3, 1993 and submitted to the Emission Measurement Branch by NSA. EPA personnel did not raise any objections to this test procedure over the ten month period preceding the test program. The only comments received was a telephone call from Dr. Chatten Cowherd or MRI on the first day of testing. NSA and Air Control Techniques believe that more than an adequate opportunity was provided to EPA and MRI to review the test procedure and raise any issues necessary. It was clearly unreasonable to delay the comments for over ten months and then raise issues after the equipment was set-up and testing was underway. It is also unreasonable to declare that the testing procedure is not an accepted methodology.

4.3 Co-located Hoods

Paragraph 4 of Section 4.2.5 states the following:

> *“The co-located hoods showed an order of magnitude difference between the left and right hoods in the concentrations sampled in three out of seven tests.”*

It is important to note that the side-by-side hoods were not used in a co-located manner. The emissions data from the two sets of hoods were combined. This is entirely different than the procedures used for co-located ambient monitors. The term “co-located” was not used in the Entropy report.

The term “order of magnitude” means a factor of 10. A review of the left and right hood concentrations at Knightdale indicates that MRI is exaggerating with respect to these differences. The data shown in the table [below have been taken from Entropy Table 3-3. One of the tests (Uncontrolled Run 4) was factor of seven different, and two of the tests (Controlled Runs 1 and 2) were approximately a factor of five different.

Test Left/Right	Left Hood Concentration grains/DSCF	Right Hood Concentration grains/DSCF	Difference
Controlled Run 1	1.05 E-04	2.06 E-05	5.1
Controlled Run 2	1.35 E-04	2.83 E-05	4.7
Controlled Run 3	2.99 E-04	1.85 E-04	1.6
Uncontrolled Run 1	5.94 E-04	2.83 E-04	2.1
Uncontrolled Run 2	1.29 E-03	1.37 E-03	0.94
Uncontrolled Run 3	2.18 E-03	2.53 E-03	0.86
Uncontrolled Run 4	7.38 E-04	5.18 E-03	0.14

NSA and Air Control Techniques, P.C. have reviewed the Entropy data and believe that the difference is caused primarily by the location of the left hood relative to an intersection of two haul roads and the quarry pit haul road near the test site. It was sometimes necessary for haul road trucks to stop and idle while another vehicle passed

As mentioned earlier, MRI functions as an independent contractor. MRI's comments on the test method and the sites chosen are based solely on review of the test report and results presented therein. The phone call mentioned in the comment was placed at the request of EPA, who asked MRI to provide a "courtesy" review of the overall approach on short (i.e., <24 hr) notice. To the best of our knowledge, MRI never received a full copy of the protocol. In any event, MRI was never asked to provide formal written comments.

MRI used the term "co-located" to indicate that the two set of hoods were in very close proximity and Entropy never employed the term in their report. The point being made in the background document was that the test data indicate a non-uniformly emitting source. The importance of a uniformly emitting source would be even more important for a conventional upwind/downwind sampling approach because of the need to apply a dispersion model to the source.

The data are taken from Entropy Tables 3-4 and 3-5 rather than 3-3. MRI used "order of magnitude" in the sense of "how many places left of the decimal point." Admittedly, this may be less than technically precise and more of "colloquial" use of the term. In any case, factors of 5 to 7 are still surprising high and indicative of a non-uniformly emitting source.

This emphasizes the importance of being able to isolate the source under consideration from the influence of other nearby (upwind) PM sources. Would idling emissions be collected by the upwind samplers? Were diesel emissions from the vehicles <u>passing</u> the array sampled or did these emissions pass above the 10 ft high array at a distance of

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through the intersection. The stopping point for vehicles exiting the pit and approaching the primary crushers was close to the left hood. Air Control Techniques, P.C. believes that the high concentrations observed in the left hoods during the first two runs were due to the capture of these idling emissions.

NSA and Air Control Techniques can not find any indications of the possible cause for the difference in the Left and Right Hood during Uncontrolled Run 4. However, we do not believe that Uncontrolled Run 4 should be treated as an outlier and discarded. Also, it should be noted that more than a factor of seven variability was described in many of the references used by MRI in developing the proposed unpaved road equation. The following examples illustrate the extent of differences in these other tests.

Variability of Particulate Emission Factor Data

(MRI Conducted Emission Factor Tests)

MRI Reference	Run #	Lbs/VMT	Difference	Silt, %	Moisture, %
2	BA-9	0.09		3.35	5.69
	BA-3	1.32	14.6	3.04	7.41
4	BB-47	78.2		14.0	5.11
	BB-46	8.14	9.6	12.7	4.88
8	AQ7-G	0.39		7	1.2
	AQ6-C	2.43	6.23	12	1.4

All three studies were conducted by MRI, and all three sets of runs were conducted at similar moisture and silt levels as indicated in the table above. MRI chose not to discuss the factor of 6 to 14 variability in their test runs but was highly critical of the factor of five to seven variability in the Entropy data. In fact, variability is a common problem in the large majority of fugitive emission testing projects.

4.4 Recirculation Air Flow

The fourth paragraph of Section 4.3.5 states the following.

> *"Strong evidence of recirculation of emissions to the upwind sampler is provided by the fact that the upwind concentrations increased by roughly an order of magnitude from the controlled to the uncontrolled tests."*

There is no technical basis for the criticism. The upwind concentrations increased *"…roughly an order of magnitude…"* because the upwind ambient air sampler had to be located close to a portion of the unpaved quarry haul road (see Figure 1). During the uncontrolled tests, this section of the road was not watered.

1m away from the road? Are there additional PM or source activity components not included in the emission factors reported? If additional PM emissions were sampled and not subtracted out as background, then one would expect (all other things being equal) that the factors would be biased high. However, controlled runs 1 and 2 have the two lowest factors reported of the 3 controlled tests considered at Knightdale.

MRI's original remark had nothing to do with the emission factors reported. Even so, we cannot let this comment pass without noting that in NSA's table :

- Runs BA-9 and BA-3 should not be compared because, although both are tests of scrapers in transit,

    1. the two tests were conducted at different sites;
    2. more importantly, one was a test of controlled emissions while the other was a test of uncontrolled emissions.

- Runs AQ7-G and AQ6-C are not comparable because they were conducted on surfaces treated with different chemical dust suppressants.

- Table 4-8 of the AP-42 background document contains a mistakenly converted emission factor for run BB-47. In the original test report, the emission factors for runs BB-46 and BB-47 are given as 3100 and 2304 g/VKT [11.0 and 8.1 lb/VMT], respectively. Entries in Table 4-8 in the background document will be corrected. (The correct values were included in the developmental data base.)

In the interest of isolating the source contribution, why wasn't the upwind section watered?

Air Control Techniques has recalculated the uncontrolled emission factors by ignoring the contribution of the upwind dust concentrations to the measured downwind concentrations. By taking this approach, the data are biased to higher-than-true levels. It is apparent that the revised emission factors (ignoring upwind dust concentrations) are only slightly higher than the emission factors reported in the test report. <u>The order of magnitude increase in the ambient air concentrations upwind of the test location did not have a significant impact on the reported uncontrolled emission factors as indicated in the table below</u>.

Recalculated Emission Factors Based on Zero Upwind Dust Concentration

	Upwind Concentration	Original PM10 Emission Factor	Revised PM10 Emission Factor	% Difference in Emission Factors, Revised /Original
Uncontrolled 1	2.28 E-04	0.528	1.10	2.08
Uncontrolled 2	2.28 E-04	1.57	1.89	1.20
Uncontrolled 3	2.28 E-04	2.34	2.59	1.11
Uncontrolled 4	1.75E-04	4.70	5.01	1.07

Except for one of the four runs, ignoring the contribution of the upwind air concentration entirely results in an increase of only 7% to 20% in the calculated emission factor.

It is important to note that a quarry haul road has an entirely different configuration than a public unpaved road and haul roads at iron and steel plants. The quarry haul road inherently has a swirl pattern necessary to allow heavy duty trucks to descend several hundred feet into the pit. Furthermore, there must be one or more approach roads to allow the heavy duty trucks, graders, and water trucks to reach the swirling quarry pit road. In most quarries, an ideal upwind ambient air monitoring site is hard to find due to the complex road pattern in a compact industrial site. Air Control Techniques believes that Entropy properly selected a monitoring site and accurately measured the actual upwind dust concentration approaching the portion of the haul road tested. There is no basis for the *"…recirculation"* criticism expressed by MRI.

4.5 Testing Was Discontinued During Certain Wind Conditions

The third sentence of the third paragraph of MRI Section 4.2.5 states the following.

> *"Testing was discontinued when speeds exceeded 3 miles per hour."*

This statement is a misinterpretation of the comments and data provided in the Entropy report. As stated in the Entropy report: *"Furthermore, the test was delayed if winds in excess of 3 miles per hour shifted and came from the North or East."* As indicated in Figure 1, the hoods were located directly west of the portion of quarry pit

What reason is there that the emission factors monotonically increased over the four uncontrolled test runs? (There is only a 6% probability of this occurring by chance alone.) How long had watering been suspended?

Note that the last column represents a ratio, rather than the percent difference shown in the column heading.

Note that the revised factors again increase monotonically. Again, how long had the watering been suspended?

As before, the issues of "representativeness" are based on geometry and physical setting criteria. As mentioned throughout, isolation of the source contribution is critical to successful source testing.

Testing under higher winds in the "proper" direction would help ensure more complete capture by the hoods, while testing under low-speed winds or winds with very oblique directions (up to 80 degrees off perpendicular, according to page 8 in the test report) would encourage material to pass over/around the hoods. <u>What is the reason that</u>

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haul road tested. The testing was conducted whenever the winds were from the west or northwest. Furthermore, testing was conducted during all low wind speed conditions (<3 m) because the upwind side fans generated a west-to-east air flow of approximately 3 mph. Accordingly, the testing contributed during all conditions when the air was flowing in the proper direction. The testing was interrupted whenever there were strong winds that were not in the proper direction. The testing was restarted when the winds shifted back to the acceptable direction. Winds from the north or east that exceeded 3 mph would have caused a bias to lower-than-true emissions because the hoods were not in a proper downwind orientation during these time periods. The procedures used by Entropy were correct. Furthermore, these procedures are entirely consistent with those used by MRI in tests of unpaved roads. **[underline added; see response]**	testing would be delayed under the very conditions that enhance complete capture? Also, what is the basis for the very broad acceptance criterion for wind direction? Again, this allows testing under the conditions of very poor capture. Where was the Weather Wizard unit deployed? What height was the monitoring unit? The last sentence (underlined) in the comment is entirely mistaken. MRI's acceptance criteria is not at all similar to that used in the Entropy study. Had criteria "consistent" with MRI's ranges been used, the underlined question in the above response would not have been asked.

PORTLAND CEMENT ASSOCIATION

Letter of November 14, 1997 from Garth J. Hawkins to Ronald E. Myers, USEPA (attached)

The Portland Cement Association (PCA) has the following comments on the September 1997 draft version of the following U.S. Environmental Protection Agency (EPA) report:

> *Emission Factor Documentation for AP-42, Section 13.2.2 Unpaved Roads (the "AP-42 Unpaved Road Document"),*

PCA appreciates the opportunity to review this document.

All portland cement manufacturing facilities require large amounts of limestone and other naturally occurring materials such as slate, shale, etc. Because of this fact, each cement plant operates quarries and crushing operations to provide these materials to the manufacturing facility, and therefore, constructs and maintains unpaved haul roads for the transportation of these materials.

The quarries are developed so that the most efficient transportation as possible of raw materials from the source to the cement plant can be accomplished. To move the volume of limestone and other materials required by the manufacturing facility, only large dump trucks or similar vehicles are used, and the trucks are operated at fairly consistent speeds from the quarry operation to the crushing and screening machinery. Smaller vehicles, such as pickup trucks or cars, are a limited percentage of the vehicles traveling the unpaved roads within the facility.

Due to the availability of limestone and similar materials, the unpaved roads at the quarry and manufacturing facility are constantly constructed and maintained with the raw materials being extracted. Overall, cement plants are very similar to limestone quarries that provide crushed stone to the road-building and construction industries.

Although several studies of unpaved roads related to the stone industry are included in the *AP-42 Unpaved Road Document*, some very dissimilar industries are also included in the development of the emission factor equations. Industries such as coal mining, copper smelting, and the iron and steel industry may required different types of vehicles, have variations in the traffic patterns, and use other materials in the construction of their unpaved haul roads. For example, multiple types of aggregate may be used at the above industries due to the lack of the availability of road-building materials.

The emission factor equations in the *AP-42 Unpaved Road Document* are also dependent on data collected from unpaved roads used by pickup trucks and cars. The use of these vehicles results in great variations in possible dust generation due to the differences in tires, vehicle speeds, and vehicle aerodynamic effects.

Therefore, PCA requests that the EPA consider including the emission factor equations developed by the National Stone Association (NSA) in the *AP-42 Unpaved Road Document*. PCA believes that the NSA equations are more representative of the unpaved roads found at a cement facility. The inclusion of the NSA equations will allow a cement manufacturing facility to select the equation that best represents the possible emissions form the haul roads related to its operations. For your reference, a copy of the cover page of the report summarizing the NSA findings is attached.

The National Stone Association (NSA) emission factors utilize the mathematical form of a predictive equation developed from tests of very large haul trucks at western surface coal mines. That is to say, the factors that PCA requests be considered are in fact based on source relationships that the PCA describe as "dissimilar" to portland cement industry. (See also the discussion of the NSA equation in the responses to Air Control Techniques, P.C. comments below.)

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AIR CONTROL TECNIQUES, P.C.
Letter of November 24, 1997 John Richards and Todd Brozell to Ron Myers of US EPA (attached)

1. Applicability of the Draft Unpaved Road Equation to Stone Crushing Plants

We believe that the predictive equation developed based strictly on emission factor tests at stone crushing plants is a better predictor of PM-10 and PM-2.5 emissions than the general emission factor equation for all types of unpaved roads. This position is consistent with the following statement included on page 3 of the Fifth Edition of AP-42.

> "If representative source-specific data cannot be obtained, emissions information from …actual test data from similar equipment, is a better source of information for permitting decisions than an AP-42 emission factor. When such information is not available, use of emissions factors may be necessary as a last resort."

The predictive equations developed based on NSA sponsored tests at stone crushing plants located at Knightdale, Garner, and Lemon Springs, NC are shown below as Equation 1 and 2.

$$E_{PM\text{-}10} = (s/3)^{0.8}(M/2)^{-0.9} \qquad \text{Equation 1}$$

$$E_{PM\text{-}2.5} = 0.25(s/3)^{0.8}(M/2)^{-0.9} \qquad \text{Equation 2}$$

Where:

$E_{PM\text{-}10}$ = PM-10 Emissions, Lb./VMT
$E_{PM\text{-}2.5}$ = PM-2.5 Emissions, Lb./VMT
s = Silt content, %
M = Moisture content, %

The use of the precipitation factor from Section 13.2.2 can be used to adapt this equation for predicting annual emissions. This results in Equations 3 and 4.

$$E_{PM\text{-}10} = (s/3)^{0.8}(M/2)^{-0.9}[(365-p)/365] \qquad \text{Equation 3}$$

$$E_{PM\text{-}2.5} = 0.25(s/3)^{0.8}(M/2)^{-0.9}[(365-p)/365] \qquad \text{Equation 4}$$

We believe that these equations are more representative of the PM-10 and PM-2.5 emissions from stone crushing plant haul roads for the following reasons:

- All tests were conducted on quarry haul roads representative of the stone crushing industry.
- One of the three tests was conducted in the quarry pit.
- The vehicle weights and speeds during the test program were representative of the

The quote from AP-42 applies to situations in which an emission test result is to applied to a different source at the same facility.

Even though Equations 1 through 4 in the comment reference stone crushing plant roads, several points should be noted about those factors and how they were developed. Those points are raised in the following paragraphs.

Equation 1 is presented as Equation 16 in a May 1996 report prepared for the National Stone Association (NSA) entitled "Review of the EPA Unpaved Road Equation and its Applicability to Haul Roads at Stone Crushing Plants." Because that report contains the recurring theme that the AP-42 unpaved road emission factor lacks a firm technical basis for application to pit roads, the report presents no discussion of the technical basis for the recommended Equation 1. The report only states that "*it was necessary to change the exponents concerning the moisture content and to adjust one of the constants"* in an equation developed for western surface coal mines. Just <u>how</u> that change and adjustment were made is never discussed. A preliminary analysis of the13 reported Knightdale, Garner and Lemon Springs tests (using the emission factors, moisture and silt contents reported) clearly shows that neither simple nor multiple linear least-squares regression was used. Just what is the technical basis for the "modification?"

Other points to note about Equations 1 through 4 in the comment:

- Combining the Knightdale and the Garner/Lemon Springs data sets mixes two types of data. The May 1996 report explains that that Garner/Lemon Springs emission factors have "subtract[ed] out the combustible particulate and organic particulate that were obviously not emitted from the road." (The test report, however, describes a correction only for "combustion particles resulting from diesel exhaust" and implies in the example calculation that organic material is included.) In any event, the Knightdale factors did not undergo this correction and, just as importantly, the corrections were not made in the <u>upwind</u> concentration measurements. (Recall from the background document that this

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stone crushing industry. • The silt and moisture contents of the road surfaces were representative of the stone crushing industry. • The surface characteristics of stone crushing plant haul roads are different from other types of unpaved roads due to the frequent watering, the compaction caused by the heavy duty trucks, and the high degree of road maintenance provided by plant operators.	omission leads to a systematic low bias in the emission factors.) • It is unknown what, if any, other culling/clean-up of the data sets may have been performed. For example, of the three Garner tests, one test has negative emission factors reported for both PM-2.5 and PM-1 and another test has $E_{PM-1} > E_{PM-2.5} > E_{PM-10}$. • Despite questions about the origin of Equation 1, it does reference back to the May 1996 report to NSA. There is, however, no indication as to how Equation 2 came to be. Presumably, it was scaled from Equation 1 using the PM-2.5/PM-10 data from the tests conducted for NSA. Because the Entropy test program (reference 5 in the background document) reports only PM-10 factors, we assume that only the six Garner and Lemon Springs tests were used to scale Equation 1 to PM-2.5. However, one of those tests resulted in a negative PM-2.5 emission and another implied a PM-2.5-to-PM-10 ratio of more than 100%. Assuming those test results were not used, the remaining ratios (58% at Garner and 8.2%, 28%, and 76% at Lemon Springs) do not yield the value of 0.25 implicit between Equations 1 and 2.
A comparison of Equation 1 with the measured PM-10 emission factors at the three stone crushing plants is shown in Figure 1. **[See figure in attached comments.]** The R^2 correlation coefficient for this equation is approximately 59%. A comparison of the measured PM-10 emission factors with the draft unpaved road equation is shown in Figure 2. **[See figure in attached comments.]** The R^2 correlation coefficient is 54%, slightly lower than for NSA's Equation 1. This means that the NSA equation explains the variability of the data slightly better than the EPA equation.	The figures are misleading in several ways. For example, the R^2 value shown in Figure 2 pertains to the least-squares best fit line between a subset of the measured and predicted emission factors. Also, because of the multiplicative form of both the AP-42 and NSA equations, the more appropriate plot (and correlation) for each figure would be log-log in nature. The R^2 shown is not the same as a multiple R-squared value for a regression-based predictive equation of a multiplicative form. Even more importantly, direct comparisons of R-squared values is misleading unless one also considers the number of "degrees of freedom." In addition to the R-squared value, the number of observations and the number of independent variables determine the "level of significance" for a predictive model. Because it is unclear how the NSA factor was derived, it was not possible to assign a meaningful level of significance for the NSA expressions. It also appears that values plotted in Figure 1 only ~70% of what is directly calculated using Equation 1. Consider, for example, the fourth uncontrolled test at Knightdale (the far right-hand data point in Figures 1 and 2). From Table 3-6D in the Entropy test report, the silt is 11.03% and the moisture content is 0.83%. In that case, Equation 1 leads to an estimated value over 6 lb/vmt which is 50% higher than the value shown on Figure 1. What are the predicted values and what silt and moisture contents were used?
The EPA unpaved road equation appears to have a significant bias to higher-than-observed PM-10 emissions for stone crushing plants having high haul road moisture levels. This bias is indicated by the intercept of the linear regression line with the y-axis at a value of approximately 2.0 lbs/VMT. We believe that this bias is due to the fact that the material present in the silt and stone crushing plants is inherently more wettable than the silt present on rural unpaved roads (e.g., clay), western surface coal mines (e.g., coal dust and clay), and iron and steel plants (e.g., slag). Use of the new	Some bias results simply because the Garner and Lemon Springs tests have undergone "correction for combustibles and organic material." In that case, a higher value from the draft AP-42 equation (which includes exhaust and other components found downwind of the roadway) is certainly to be expected. Also, recall that although downwind samples were adjusted, no corresponding adjustment was made to the upwind samples. That omission results in a systematic low bias in the resulting emission factors.

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unpaved road equation may penalize the operators of stone crushing plants that are the most conscientious in maintaining high moisture levels on their haul roads.	
The emission factor data obtained in the NSA sponsored tests appear to be more representative of PM-10 and PM-2.5 emissions from stone crushing industries. This is indicated by the more reasonable form of the relationship shown between the predicted and observed emission factor data shown in Figure 1.	Although one may argue about the form of and procedure used to develop the revised AP-42 unpaved road equation, the background document describes <u>how</u> the predictive model was developed. In this way, arguments and discussion can proceed with all parties on equal footing. On the other hand, the procedures and data that result in Equations 1 through 4 have not clearly been presented. Even ignoring issues of negative emission factors and mixed types of data, it is still not possible to recreate the results reported. In fact, simply calculating the values in Figure 1 using Equation 1 was unsuccessful. Given the undocumented procedure used to develop the predictive models, unilateral claims about the reasonableness of the method are simply not supported.

2. General Comments

Road Surface Moisture Levels

We believe that the EPA draft equation in its present form underestimates the benefits of moisture. Extrapolation of the curve defined by the equation to the 20% moisture level yields predicted PM-10 emission factors in the range of 1.0 lbs/VMT as shown in Figure 3. **[See figure in attached comments.]** Air Control Techniques, P.C. believe that the new equation overpredicts PM-10 emissions at high moisture levels.	MRI agrees that 15% represents a reasonable estimate of surface moisture content above which essentially no road dust is emitted. On the other hand, extensive watering should have no effect on emissions due to exhaust or any material entrained from the truck's load, undercarriage, etc.
The curve generated by the equation should approach very low emission factor values at 20 percent moisture levels. The particulate emissions from essentially all unpaved road surfaces should be very low at this very high moisture level. The mathematical form of the equation should be reviewed to determine if there is a more appropriate exponent for moisture that provides a better representation of emissions from highly moist unpaved road surfaces.	Recall that the Garner and Lemon Springs data have had at least diesel exhaust removed from the reported emission factors. Furthermore, the adjustment systematically biased emission factors low by not correcting the upwind background samples.
Despite the apparent deficiencies at high moisture levels, the equation appears to have the proper form for low moisture levels. As indicated in Figure 3, the predicted emissions have an asymptotic relationship with moisture at levels below approximately 0.3%. We have observed the same relationship in tests conducted for the National Stone Association.	Emissions should increase as the surface moisture content decreases, but it is also reasonable that each road has some "effective lower limit" for its surface moisture content. In that case, the asymptotic behavior in Figure 3 would not be observed, but instead emissions would follow a flatter portion. In other words, once a road is "dry," becoming "bone dry" would not greatly increase emission levels.

Precipitation Factor

We agree with the inclusion of the precipitation factor, [(365-p)/365] in Equation 2 of Draft Section 13.2.2, and with the statement that, "…all roads are subject to some natural mitigation because of rainfall and other precipitation." However, it would be helpful to add a statement that the precipitation days should include all days that the road surface is covered by snow or ice, irregardless of the amount of precipitation occurring on each specific day.	As mentioned elsewhere in the response log, EPA has drafted additional guidance to better account for the effects of precipitation within the AP-42 section.

Vehicle Speed and Other Factors

It is apparent in the Emission Factor Documentation report and in the draft Section 13.2.2 that the EPA and MRI authors are not entirely confident in the form of the new unpaved road equation. For example, the following statement is included in Section 1.2.2.3. “Although vehicle speed does not appear as a correction parameter, it is obvious to anyone who has driven on an unpaved road that (visible) emissions increase with vehicle speed.”	The statement pertains to dust generated by individual vehicle passes over a road while the recommended emission factor equation references emissions due "fleet average" conditions over a road. MRI believes that the statement does not connote a lack of confidence in the equation but rather implies that a) that every road probably has a fairly narrow range of "natural" average speeds and b) there are insufficient test data available to fully define the influence of average speed on emissions.
Air Control Techniques, P.C. agrees with this comment regarding the importance of the speed factor. Furthermore, we believe that there are a number of other important factors that have a direct and significant impact on PM-10 and PM-2.5 emissions. A partial list of these factors include the following. • Vehicle road clearance and the associated magnitude of the turbulent wake as a function of the vehicle speed • The tire tread characteristics with respect to the tendency to pick-up and entrain particles into the turbulent wake of the vehicle • The tire tangential velocity with respect to the tendency to release particles from the tire into the turbulent wake of the vehicle • The actual pressure exerted by the vehicle tire on the road surface that causes pulverization of silt particles to form PM-10 and PM-2.5 particles • The grindability of the silt particles • The extent of compaction of the road surface under various wet suppression and/or natural precipitation conditions • The extent to which tailpipe exhaust contributes to particle entrainment into the turbulent wake of the vehicle	MRI agrees that there are many factors that can influence emission levels from vehicle travel over unpaved surfaces. However, two points must be reiterated: 1. Many of the factors listed (and, for that matter, other potentially important variables) are highly intercorrelated. For example, speed is inversely correlated with weight; and tire tangential velocity, tread design, and footprint pressure are all interrelated. In developing a phenomenological model from available empirical data, inclusion of highly intercorrelated independent variables is usually not appropriate. 2. Related to the previous item, it would be necessary to obtain emission data under tightly controlled conditions to fully address factors of the type listed. In the case of tread design, for example, one would ideally want at least duplicate tests of 2 or 3 different tread designs on the same trucks driven by the same operators at the same speed over the same road. Even so, because tread design potentially affects the "steady-state" road surface properties, one would also need to allow the road to "condition" itself to each design over a period of at least several days or weeks. Even assuming one could achieve extensive experimental control over a "real-world" source, one would still need to contend with test conditions beyond control, such as antecedent meteorology.
Obviously, neither EPA nor NSA has the budget necessary to accurately analyze the possible impact of all of these important variables. Accordingly, Air Control Techniques, P.C. recommends that EPA conduct a fundamental particle formation and emission study using modern computational fluid dynamic modeling (CFD) techniques. These are “First Principle” models that are being actively used in a wide variety of aerospace design projects, automotive design projects, process equipment design projects, and air pollution control equipment optimization projects. We have had the opportunity to work on a number of projects involving CFD, and we are very impressed with the capability and accuracy of this technology. CFD would provide an economical way to provide a sound technical basis to the unpaved road equation. For too long, this equation has been based simply on layer after layer of empirical studies concerning only a few of the important variables affecting emissions. There is now a readily available technology to provide improved emission factor equations.	The comments regarding CFD are interesting, but it is not clear how such an approach could be "operationalized." For example, one could use CFD to determine the near-source air flow field for analysis of the trajectory of an individual particle released tangentially from a tire. Similarly, one might simulate air flow due to the turbulent wake that mixes entrained particles. However, the feasibility of CFD would depend on the analyst's ability to specify initial and boundary conditions that would be used relative to the entrainment of particles? From what point along the tire is the particle released? How would that change with size of a particle? A much more thorough prospectus of how CFD could be used is necessary before one can reach the conclusion of the last sentence in the comment.

NORTH CAROLINA DEPARMENT OF ENVIRONMENT AND NATURAL RESOURCES
Letter dated October 22, 1997 from Jim Southerland to Ronald E. Myers (with attached marked-up copies of background document and draft AP-42 section)

Table 13.2.2-1 could use some additional clarity. For example, "yard area" should clearly state that this is the storage area. "Haul" and "Access" should clearly indicate that these are to the pit or wherever. Is "mean" in the header an arithmetic or geometric variety? Can more definition be given to the road surface "dirt?" Again, additional explanation of what the new information in the table are as opposed to old, etc., should be added to provide clarity to the user who might be familiar with using the old tables in separate sections.**[underline added; see response]**	In general, the suggested wording changes will be incorporated into the draft section. As pertains to the underlined portion of the comment, note that only the western surface coal mining section would be affected -- in fact, the appropriate change has drafted and sent to the EPA work assignment manager. Also note that the current version of Table 13.2.2-1 already includes road material information for surface mining.
Page 3: The first paragraph does not seem to describe satisfactorily what was done. Additional detail and clarity with a reference to the further discussions in the background report might be helpful. Also on same page, I suggest writing out each equation (PM-30, PM-10, PM-2.5) separately for clarity. Footnote meaning or equivalence of PM-30, and drop PM-15 as it has little relevance/meaning. I do not believe these resulting equations technically merit the "A" and "B" ratings and should be downgraded at least a letter due to the statistics in the background report and personal judgment.	Reference to the background document will be added on page 13.2.2-3. Quality ratings will be re-evaluated in conjunction with suggestions made by other reviewers (most notably Minnesota Pollution Control Agency).
Page 5: The discussion talks about defaults but stops short of a "presumptive default" equation or expression for crude approximation. Since this is likely to be done anyway, I suggest providing such an equation with calculated extremes that can occur if applied without regard to real input data.	As mentioned elsewhere in the response log, the predictive equation will re-written with a normalizing value of 0.2% for moisture and text will be added to clearly indicate that 0.2% is the default value.
Page 8: The first full paragraph discusses collecting new road samples after 6 months of use. I sincerely doubt that anyone will likely do this. It is difficult to even get a facility to take samples at all to estimate emissions.	The recommendation concerns speed controls. Although it may be difficult to convince a facility to collect any samples, this seems to be a reasonable request if a facility claims control credit for speed reduction.
Page 10: The section does not explain "Class A pan evaporation," and it should. Some other word changes recommended on enclosed copies.	Text will be added to better explain Class A pan evaporation and its use in the prospective analysis.
Page 12: How does one determine "ground inventory?" is there a rule of thumb for default?	Additional text will be added the example in Table 13.2.2-4 to supplement the explanation of ground inventory given in item 1 on page 13.2.2-12. Because Figure 13.2.2-2 is used either to estimate the effectiveness of an existing control application plan or for planning a program to meet a certain efficiency level, it does not seem that a default value is necessary.

Background Report

Page 1-1: The Second Edition of AP-42 was published in 1972. The earlier "Duprey" edition was in 1968 or 1969. Earlier versions of similar documents were issued in 1965 or so. However, I don't believe fugitive dusts were addressed until the Third Edition, or perhaps a supplement to the Second or Third Edition.	The statement is based on page 1-1 of EPA-454/R-95-015, Procedures for Preparing Emission Factor Documents. The paragraph will be rewritten to remove the date reference.

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In the definitions section, “filterable particulate” should be included for completeness. I would suggest dropping the IP or PM-15 as it is not now used and could be confusing.	Filterable particulate will be added. In addition, the material will be rewritten to follow a "PM-x" format.
In Section 3, measurement methods are discussed. However, the “stone association” method seems avoided somewhat. Since it has been used and the data evaluated, it should be included in the descriptions. Here and in Section 4, the evaluations seem a bit biased against data not collected by MRI. Their data may be better or not, but “outside” tests seem more rigorously critiqued than the other tests. Comments may be valid, but need to be equal and balanced in presentation so as to not give this impression. For example, “unacceptable” is a judgment given without any documentation or reasons. Also, it is not reasonable that road widths and such basic information not included in test reports, even by the same contractor, are not recoverable in some fashion.	MRI will expand Section 3 to indicate that both the upwind-downwind and exposure profiling methods doe not interfere with plume development/dispersion by forcing or blocking the flow. Furthermore, as evidenced in the National Stone Association comments, the Knightdale test report did not clearly establish how emission factors were developed. However, MRI believes that the background document was lenient in the assignment of quality ratings to the Garner and Lemon Springs test data. For example, consider that • It is unclear what run the example calculation on page 17 refers to. The example states "Run Number G-UW-M201A-3 8/15/95." However, the end result of the example is an emission factor that corresponds to the reported value for run "G-U-AMB-2 / G-DW-M201A-2" in Table 3-12. • The example calculation also based the emission factor on 204 vehicle passes, but does not imply where that information is to be found. Table 3-7 gives 95 and 122 <u>loaded</u> truck passes during Runs G-UW-AMB-2 and G-UW-AMB-3, respectively. (Apparently, the traffic counts given in Appendix D are used.) • It remains unclear why, if one were to correct the downwind concentration for mineral content, etc., one would not also make the same correction for the background concentration. To not do so creates an "apples and oranges" situation, systematically biasing the results to lower than actual emission levels of mineral and organic particulate. • Issues of upwind composition notwithstanding, there are also questions about how the size distributions were used to correct for combustion particulate vs. stone dust. The data used in the correction are based on microscopy, but no mention is made of translating the number-based distribution to a mass-based distribution that would be needed to made the correction. • Surprisingly little discussion is offered for some unusual results reported. For example, in the three tests conducted at the Garner site, there is a ratio of 300 between the highest to lowest emission factors. Nothing is said about this. Assuming that the same types of trucks traveled at roughly the same speed over the same road during the 3 tests would lead one to the conclusion that the reproducibility of the measurements is not very good. Also, no discussion is offered for findings of negative PM2.5/PM1 emission factors nor of a PM1 emission factor being greater than a PM2.5 factor, which in turn is greater than the PM10 factor. In spite of the above, the Garner and Lemon Springs testing programs were still assigned B and A ratings. Given the issues raised about recirculation and source isolation in response to NSA's comments, it appears that the quality rating for Garner was even more lenient than originally believed.

Page 4-29 and thereabouts: Would it not make sense to view the data bases for PM-30, PM-10 and PM-2.5 separately and independently? There may likely be forces (e.g., static) acting upon the different sized particles that would best be represented by this treatment. With the statistics presented on page 4-30 and 31, the “A” rating on page 4-29 does not seem warranted. **[underline added; see response]**	The background document notes that all the PM data sets were originally analyzed separately and independently. The problem arose in that the resulting factor for PM-2.5 was not consistent with the result for PM-10/PM-30 and had only limited predictive accuracy. Also, note that the statistics for the underlined portion of the comment deal only with hypothetical data and not with any emission factor developed in the background document. Rather, these are only hypothetical data that serve illustrate why a geometric mean is more appropriate for the ratio-based statistics.
Mid-page 4-37: “0.5 percent” seems to materialize out of the air. Explain “pan evaporation” and its relevance on the next page.	Following a reevaluation of the public road data base the default surface moisture content and thus the moisture normilization parameter was revised to 0.2%. The background document will be modified to more fully explain why a value of 0.2% is recommended. As noted above and elsewhere in the response log, the moisture normalization in Equation 1 of Section 13.2.2 also will be changed to 0.2% with an explanation that it is a default value.

General Observations

There continues to be a generally insufficient level of information and detail for confidently estimating emissions from fugitive dust sources of all types. This includes information which would assist in relating sources more closely with their ambient impact. The parameters upon which the emissions should be based are fairly intuitive and the existing equations seem to address those. However, there is a gap of acceptance of these emissions as being part of the “real world” of sources which are emitting into the ambient air and for which we are comfortable with emissions being well correlated with their ambient impact. The complexity of resulting equations generally precludes a majority of facilities from estimating their emissions in this manner. The availability of a simple, stable, defensible and usable (user friendly) computerized model to accomplish this would be of assistance, but perhaps be only a partial solution. It might be helpful to develop several (based on aridity, soil characteristics, etc.) models which could represent different parts of the country and types of facilities and make the calculations simpler, although somewhat more crude. Facilities and agencies are somewhat geared to permit conditions, so this might provide a means to categorize further the estimation of emissions, application of controls and operations.	MRI agrees that fugitive sources are indeed a unique class of emissions unto themselves. In essence, this type of source is defined by what it is not (i.e., not directly through a stack or vent). Nevertheless, fugitive sources are pervasive throughout industry. Admittedly, in an ideal situation, one would have sufficient information to develop industry-specific factors for use in different regions of the country. However, one is always forced to work with the data that are available. Over the past 20 years, emission estimation methods have relied on similarities in the basic emission process over the broad range of source conditions throughout different industries.
Reading the section, I could not help but wonder if some future reviews and updates should not address this problem a little differently. For example, would an approach to separate the mechanical lifting forces and the air turbulent forces in the analysis be productive? Also, for PM-10 and PM-2.5, I doubt if it is still appropriate to look at just silt analysis. I am sure silt is still a crude and somewhat commonly available indicator, but the size particles being simulated are so much smaller than silt that one can not help but wonder if there is not a finer delineation within “silt” that is necessary before a determination of this sector can be appropriately made.	Again, in an ideal situation, one would have access to data that clearly delineate emissions from wakes, tire/road interactions, etc. Nevertheless, the practical constraints on developing this type of information are overwhelming, as discussed in response to an Air Control Techniques comment.

This report on fugitives from unpaved roads does not sufficiently show the comparison of old parameters and results with the newer ones. I recommend that each estimation process, including those for aggregate operations, coal mines, paved roads, etc., be examined in a case study comparison approach so the reader can view them side by side and evaluate the impacts of the revisions. One is understandably reluctant to adapt and apply a new set of numbers without having some concern about and evaluation for what this will do to the existing data structure and integrity built up over the previous years of application. A clear concise comparison detailed in the background report and summarized in the sections themselves would facilitate this level of confidence. A cross reference to any applicable (EIIP) estimation methods would be helpful.	MRI agrees that such a side-by-side comparison would be useful. Nevertheless, MRI believes that regular AP-42 users are in the best position to conduct such a study in order to provide information most applicable to their particular situation.

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DEPARTMENT ACCEPTED VALUES FOR: AGGREGATE HANDLING, STORAGE PILE, and HAUL ROAD EMISSIONS

TO: Applicants and Air Quality Bureau Permitting Staff

SUBJECT: Department accepted default values for percent silt, wind speed, moisture content, and control efficiencies for haul road control measures

This guidance document provides the Department accepted default values for correction parameters in the emission calculation equations for aggregate handling and storage piles emissions in construction permit applications and notices of intent submitted under 20.2.72 and 20.2.73 NMAC; and the Department accepted control efficiencies for haul road control measures for applications submitted under 20.2.72 NMAC.

Aggregate Handling and Storage Pile Emission Calculations

Applicants should calculate the particulate matter emissions from aggregate handling and storage piles using the EPA's AP-42 Chapter 13.2.4.
http://www3.epa.gov/ttn/chief/ap42/ch13/final/c13s0204.pdf

Equation 1 from Chapter 13.2.4 requires users to input values for two correction parameters, U and M, where U = mean wind speed and M = material moisture content. Below are the accepted values for U and M:

Default Values for Chapter 13.2.4, Equation 1:

Parameter	Default Value
U = Mean wind speed (miles per hour)	11 mph
M = Material moisture content (% water)	2%

Applicants must receive preapproval from the Department if they wish to assume a higher moisture content and/or a lower wind speed in these calculations. Higher moisture contents may require site specific testing either as a permit condition or submitted with the application. Applicants may assume higher wind speeds and lower percent moisture content in their calculations without prior approval from the Department.

Haul Road Emissions and Control Measure Efficiencies

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Applicants should calculate the particulate matter emissions from unpaved haul roads using the EPA's AP-42 Chapter 13.2.2. http://www3.epa.gov/ttn/chief/ap42/ch13/final/c13s0202.pdf

Equation 1(a) from Chapter 13.2.2 requires users to input values for two correction parameters, s and W, where s = surface material silt content (%) and W = mean vehicle weight (tons). The applicant should calculate the mean vehicle weight in accordance with the chapter's instructions. Below is the accepted value for the parameter s:

Default Values for Chapter 13.2.2, Equation 1(a):

Parameter	Default Value
s = surface material silt content (%)	4.8%

Applicants may use a higher silt content without prior approval from the Department. Use of a lower silt content requires prior approval from the Department and may require site specific testing in support of the request.

Equation 2 from Chapter 13.2.2 allows users to take credit for the number of days that receive precipitation in excess of 0.01 inches, in the annual emissions calculation, where P = number of days in a year with at least 0.01 inches of precipitation.

Default Values for Chapter 13.2.2, Equation 2:

Parameter	Default Value
P = number of days in a year with at least 0.01 inches of precipitation	70 days

Applications submitted under Part 72 may request to apply control measures to reduce the particulate matter emissions from facility haul roads. Applications submitted under Part 73 may not consider any emission reduction from control measures in the potential emission rate calculation, as registrations issued under Part 73 are not federally enforceable under the Clean Air Act or the New Mexico Air Quality Control Act. In order for those control measures to be federally enforceable, the controls must be a requirement in an air quality permit.

Below are the Department accepted control efficiencies for various haul road control measures:

Haul Road Control Measures and Control Efficiency:

Control Measure	Control Efficiency
None	0%
Base course **or** watering	60%
Base course **and** watering	80%
Base course **and** surfactant	90%
Paved **and** Swept	95%

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