August 2010

GUIDE TO

The Preparation of a Best Management Practices Plan for the Control of Fugitive Dust for the Ontario Mining Sector

Version 1.0

RANCHES
EXHIBIT
18

CEMI
Centre for Excellence
in Mining Innovation

Foreword

The contents of this document are based on current Ontario regulations and guidance materials published at the time this document was prepared. Since government regulations and guidelines are periodically updated, it is recommended that users of this material ensure that the current regulations and guidelines are being followed by the checking the Ontario Ministry of the Environment website at http://www.ene.gov.on.ca/.

This document was prepared for use by professionals in the mining industry and contains interpretations of Ontario regulations and guidance materials as well as recommendations that will not necessarily lead to Ministry acceptance.

Any use which a third party makes of this document, or any reliance on or decisions to be made based on it, are the responsibility of the third party.

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1.0 INTRODUCTION

The purpose of the document is to aid the Ontario mining community in the preparation of a Best Management Practices Plan for the Control of Fugitive Dust (BMPP or the Plan). This document is designed as a guide and step-by-step tool to document the decision making process through the development of the Plan.

1.1 Background

The requirement to prepare and maintain a plan for fugitive dust control is a common condition on Certificates of Approval (Air) (CofA) for mining operations. What the Plan shall include varies only slightly from site to site and it is listed explicitly on the CofA. The majority of CofAs require the following be included in the Plan:

- identification of the sources of fugitive dust emissions associated with the facility;
- review of the composition and size distribution of the fugitive dust particulate including an analysis of the metals composition of the road dust;
- description of how fugitive dust can be controlled from each significant source and description of the best management practices (BMPs) in place at the facility;
- a schedule by which the Plan will be implemented;
- description of how the Plan will be implemented, including the training of personnel;
- description of inspection and maintenance procedures;
- description of methods of monitoring and record-keeping to verify and document ongoing compliance with the Plan.

The Ontario Ministry of the Environment (MOE) published a technical bulletin [*Review of Approaches to Manage Industrial Fugitive Dust Sources* (January 2004)] to help with the development of a Plan. However, it is generic and not industry specific. Unlike the MOE technical bulletin, this document is tailored to the Ontario mining industry and should provide adequate guidance to aid in the development of a site specific Plan for your facility.

1.2 Literature Review of Current Fugitive Dust Control Practices within the Mining Industry

A literature review of the current recommended BMPs related to activities within the mining industry was conducted on behalf of the Centre for Excellence in Mining Innovation (CEMI) and can be found at http://www.miningexcellence.ca/knowledge/reports/. This report can be used as reference when developing a BMPP and contains comparative assessments of different control options for the various mining type fugitive dust sources.

1.3 How to Use this Guide

This document is to be used as a tool to guide you through the process to create your site specific Plan. Section 2.0 is an overview of the process and lists the tools and relative section of this document that can be used to get more information.

Section 3.0 will walk you through the process to create site specific best management practices. It also includes tools and information required to aid in the process.

Section 4.0 provides an outline of the sections of the Plan document and instructions to complete the Plan according to the general requirements of the CofA. An example BMPP for a fictious mining company and a

BMPP template Microsoft Word® document are available on the CEMI website (http://www.miningexcellence.ca/knowledge/reports/) and can be used to create your own site specific Plan once the BMPs have been developed.

1.4 Questions

Questions pertaining to the use of this document should be directed to:

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2.0 PRACTICE PLAN DEVELOPMENT PROCESS

The following chart illustrates the steps in the process to develop a Plan, the accompanying documents that have been included to aid in the completion of that step and the section of this Guide that can be referenced for more information.

Process Steps	Toolbox Documents	Reference Section in Guide
Source Identification	Typical Fugitive Dust Sources at Mining Facilities	Section 3.2 Appendix B
Source Risk Ranking	Fugitive Dust Risk Management Tool	Section 3.3
Control Technology Alternatives	Literature Review Typical Control Measures for Fugitive Dust Emission Sources at Mining Facilities	Section 3.4 Appendix C
Implementation of Control Technology and Documentation	Fugitive Dust Risk Management Tool	Section 3.5
Development of Site Specific Best Management Practices Plan	ACME Mining Inc. Example BMPP BMPP Template Word Document	Section 4.0

As you can see, there is much planning that needs to be completed prior to drafting a Plan. For some existing facilities, this planning process may already have been completed and only documentation of the steps needs to be further addressed. However for some newer facilities, all process steps will need to be fully carried out and the process may take more effort and a longer time. In both cases, the end result will be the same, a site specific Plan that is easy to comply with and maintain but above all else, adequately controls the fugitive dust associated with the facility.

3.0 ASSESSMENT OF SITE SPECIFIC BEST PRACTICES

This section will walk you through the process to assess the success of any site specific best practices for fugitive dust sources at your facility and identify areas that may require enhancements to existing BMPs or new BMPs.

You may already employ fugitive dust best practices at your facility and this assessment will allow you to have documented justification that your best practices are sufficient to address the risk associated with the sources that are present at your facility. This assessment, however, may identify areas that need enhanced best practices to manage the risk or areas that require new best practices. You may also come across best practices that may be going above and beyond for the risk level identified for a particular source and those practices can be minimized which could result in cost savings or funds available to manage a more higher risked source.

At the end of the process, you should come away with a listing of BMPs that are required for your facility in order to address the acceptable risk associated with each of your most risky fugitive dust sources.

3.1 Fugitive Dust Risk Management Tool

A Fugitive Dust Risk Management Tool (the Tool) has been created to aid in decision making regarding allocation of resources for the control of fugitive dust as part of the BMPs process. The Tool was developed in an Excel® workbook and is available on the CEMI website (http://www.miningexcellence.ca/knowledge/reports/). It was designed to provide the user with the following information:

1) Risk levels (scores) associated with the fugitive dust sources. This information is intended to aid the user in prioritizing the fugitive dust sources for evaluation of control options.

2) Risk reduction and cost effectiveness of control alternatives. This information is intended to aid the user in selecting the most appropriate control option for each fugitive dust source based on a cost benefit analysis, where the benefit is related to risk reduction.

The Tool was designed based on a top-down approach, assuming that the ultimate goal of managing fugitive dust is to minimize the chance that emissions from a given facility will impact human receptors outside the property boundary, which is defined as risk. Using an Analytic Hierarchy Process (AHP)[1], the factors that affect the risk associated with fugitive dust emissions were identified and organized in a decision hierarchy structure, as presented in Appendix A. A pair-wise comparison of relative importance of these risk factors regarding the goal of minimizing impacts to receptors was carried out following the AHP methodology, and allowed the attribution of weights for each of these factors, as well as relative importance of different levels of intensity within each factor.

The Tool is pre-loaded with weights assigned to selected risk factors and levels of intensity within these factors, as well as built in drop-down menus with intensity levels for each of the risk factors. Using the drop-down menus, the user can characterize each of the fugitive dust sources at the facility for each of the risk factors; the Tool then calculates the total risk score associated with each source.

This decision hierarchy used to define the weights of the risk factors and levels of intensity has been tested on a number of mining sites; however it may be necessary to adjust the weight according to site specific conditions.

The following sections will explain the steps in the BMP process as well as how to use the Tool.

[1] Saaty, T. L., 1990. How to make a decision: The Analytic Hierarchy Process. European Journal of Operational Research 48, 9 – 26.. Saaty, T. L., 2008. Decision making with the Analytic Hierarchy Process. Int. J. Services Sciences, Vol. 1, No. 1, 83 – 98.

3.2 Source Identification

The first step in developing site specific fugitive dust control best practices is identifying all the fugitive dust sources at your facility. Typically, the main fugitive dust sources associated with mining operations are:

- site preparation (land clearing);
- open pit drilling and blasting;
- material movement (conveyors, loading and unloading);
- crushing and screening;
- onsite roadways;
  - paved; and
  - unpaved.
- tailings areas and storage piles – wind erosion.

Appendix B contains this list of the possible sources for a mining operation along with the cause of emissions for each source and the factors that effect the emission from that source.

It is important to illustrate the sources that are present at your facility on a site plan that references the property boundary and also shows the locations of the nearest receptors. Knowing the meteorological conditions for the area in and around your facility can aid in this planning process. The dominant wind direction can be added to the fugitive dust sources site plan.

Step 1 of the Tool includes inputting the list of sources at your facility in Column C of the worksheet as shown in Figure 1. You will notice that one source (WCS) is already inputted in the table. This source represents the "Worst Case Scenario" and is used to normalize the remaining sources risk scores. Each source should be identified individually. Do not lump sources together. For example, stockpile A should be a separate source than stockpile B. It is important to separate long stretches of road into shorter segments with the same characteristics, approximately 25-50 metres in length where possible. You will notice that it is easier to assess smaller sources when responding to questions like "What is the distance to nearest receptor?" Also certain segments of a roadway may require more attention if that segment runs closer to a receptor.

In addition to the source description, the user must select the category of source from a drop-down menu in Column E. The source category is used for identification of the appropriate weights for each risk factor.

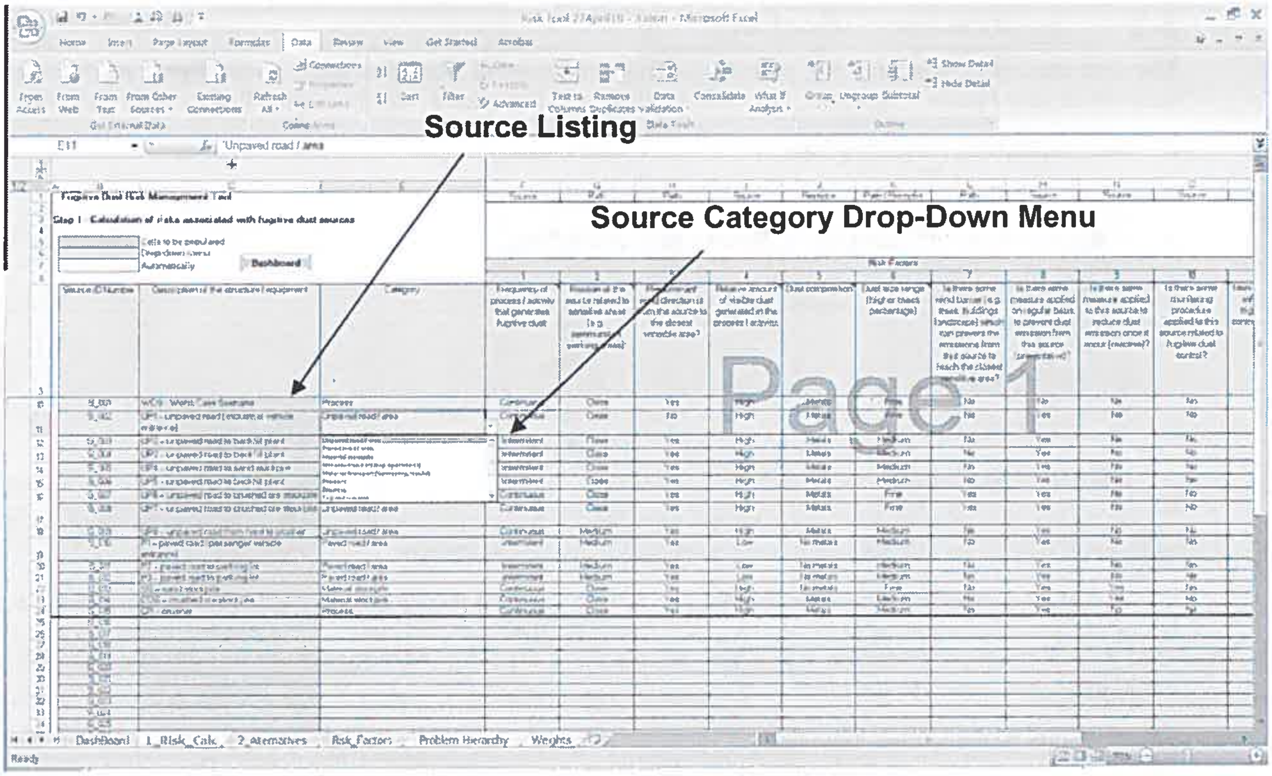


Figure 1: Source listing process

3.3 Source Risk Ranking

It is not always economical to create best practices for every fugitive dust source at your facility. Some sources are not large contributors to the site-wide fugitive dust emissions or are located far away from the property boundary and therefore are less likely to affect receptors.

The Tool can be used to rank the sources in order of risk. The sources that are determined to be high risk would require the most attention when developing the site specific best practices.

Criteria that contribute to a source's risk include:

- **Frequency of process/activity** – sources that are not operated or disturbed often are lower risk than sources that are operated or disturbed more often (higher frequency results in higher emissions, increasing the chance that emissions will impact a receptor).
- **Position of the source relative to sensitive areas** – sources that are located nearer to receptor are higher risk than sources that are located far away for receptors (smaller distances between source and receptor increase the chance that a given amount of emission will reach the receptor).
- **Predominant wind direction** – sources are considered higher risk if they are located upwind of the receptor in terms of the facility's predominant wind direction.
- **Relative amount of visible dust produced during the process/activity** – sources that do not produce large amounts of dust when in operation or are disturbed are lower risk than sources that produce large amounts of dust when in operation or are disturbed.

- **Dust composition** – sources that produce dust that does not contain metals are lower risk that sources that produce metal barring dust.
- **Dust size range** – sources that produce dust that is fine are higher risk as the dust can travel further distances and has more severe health implications.
- **Existence of wind barrier** – Is there some wind barrier which can prevent emissions from the source to the nearest receptor?
- **Existence of preventative measures** – Is there some preventative measure applied on a regular basis to prevent dust emissions?
- **Existence of reactive measures** – Is there some reactive measure applied to prevent dust emissions once it occurs?
- **Existence of monitoring procedures** – Is there some monitoring procedure for fugitive dust from this source?
- **Existence of triggered measures** – Does the monitoring data/information trigger some control measure?

From the factors affecting the risk associated with fugitive dust emissions indentified in the decision hierarchy, the 11 risk factors (criteria) listed above are used by the Tool to assess the risk associated with each source at your facility. The Tool provides options via a dropdown list for each of the risk factors for each of the sources that are identified for your site. If you place your cursor over the risk factor description, there are explanations for the dropdown options.

This risk factor determination process should be transparent and reproducible. It is recommended that a committee of knowledgeable site people come together to complete the risk factor assessment for each source.

Once the risk factors have been chosen for each source, the total risk score for each source is calculated and then normalized based on the score of the Worst Case Scenario. The normalized risk scores for each source are presented in Column AC. The user can select the risk values which are acceptable by inserting the values for "yellow" and "red" in the cells indicated in the Figure 2. Risk scores lower than the "yellow" value would be considered low risk and shown with green coloured cells in column AC; scores between the "yellow" and "red" values would be considered of medium risk and shown with yellow coloured cells in column AC; scores higher than the "red" value would be considered highest risk and shown with red coloured cells in the column AC. It is important to note that the risk scores are in a relative scale, normalized based on a worst case scenario and, therefore, the values will indicate how close the risk associated with each emission source is to a worst case scenario.

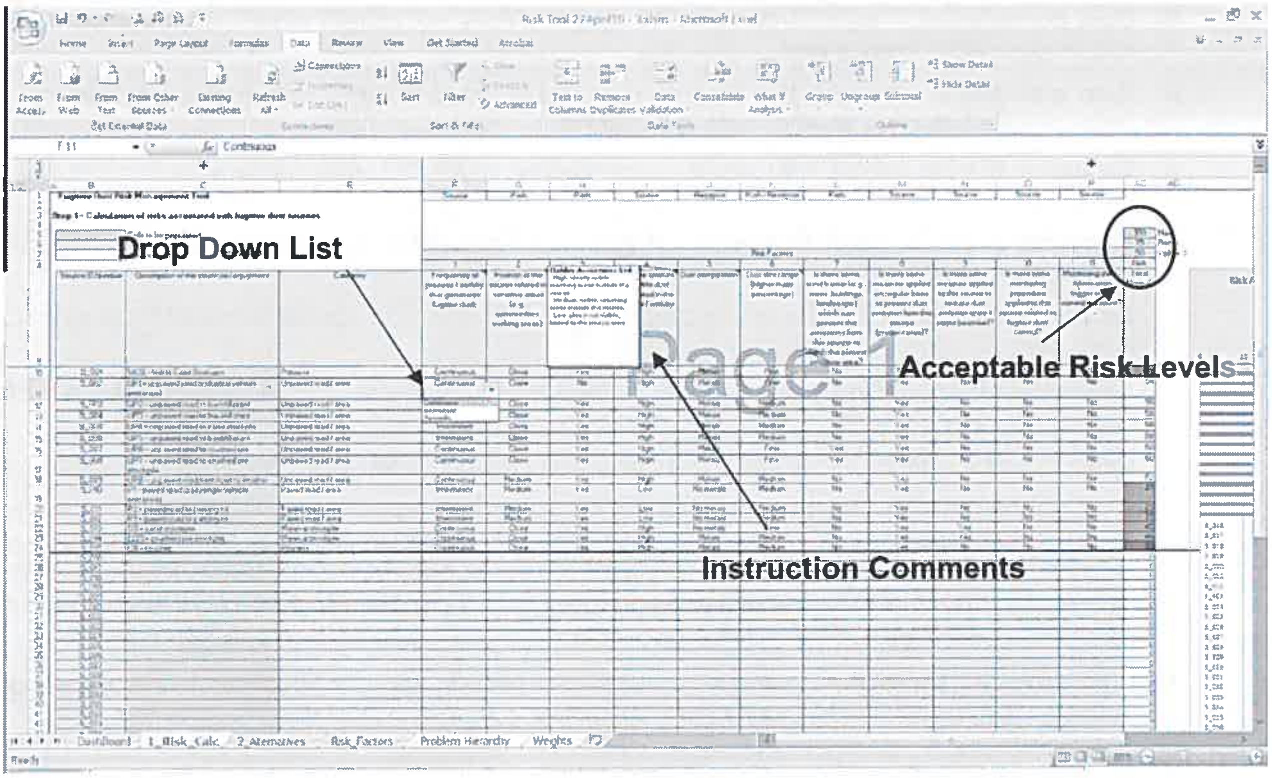


Figure 2: Risk factor assessment process

Once the assessment is complete and depending on the acceptable risk levels at your facility, you may notice that your current BMPs sufficiently manage the risk associated with each source and no BMPs need to be developed or enhanced. However, this process will identify which sources do require further control in order to manage the risk.

3.4 Control Technology Alternatives

Once it is determined that a source needs some type of fugitive dust control, an assessment of the control alternatives can be done using the Tool. The Alternatives worksheet allows for a comparison between the control alternatives by comparing the risk score reduction and the cost to implement the control. Like the source risk assessment, it is recommended that this assessment be completed by a committee of knowledgeable site people so that the results are transparent and reproducible.

The literature review of the current recommended dust control BMPs that is available on the CEMI website (http://www.miningexcellence.ca/knowledge/reports/) contains information on some of the control alternatives that are currently being used on mining and other industrial sites. It also contains some information on how to estimate cost associated with implementing some of these control alternatives. A summary of typical control measures for fugitive dust emission sources at mining facilities is included as Appendix C to this guide.

To use the Alternative worksheet as shown in Figure 3, the user must first select in Column B (cell B12) the fugitive dust source to be analysed. The risk factors and risk scores for this source are retrieved automatically from the risk calculation worksheet for reference. The user must then list in Column C the control alternatives to be assessed for this source and in Column E the respective estimated costs. It is recommended that the costs are presented in terms of present value and include capital, operation and maintenance costs for each alternative, assessed over the same time horizon, in order to produce comparable results.

The user must identify which risk factors would be affected by each of the alternatives, and select the appropriate intensity levels in the corresponding drop-down lists, completing the risk assessment for each of the alternatives. Each of the alternatives is expected to result in changes in one or more risk factors (e.g., reduce frequency of disturbance, change the position of the discharge relative to receptors, etc.), resulting in a normalized risk score that is expected to be lower than the original source (i.e., source without control options).

The resulting risk scores for each of the alternatives correspond to residual risks. In addition to this, the Tool calculates the risk reduction and the cost benefit, in dollars per risk reduction, for each alternative.

Figure 3 shows the steps in the control alternative assessment process.

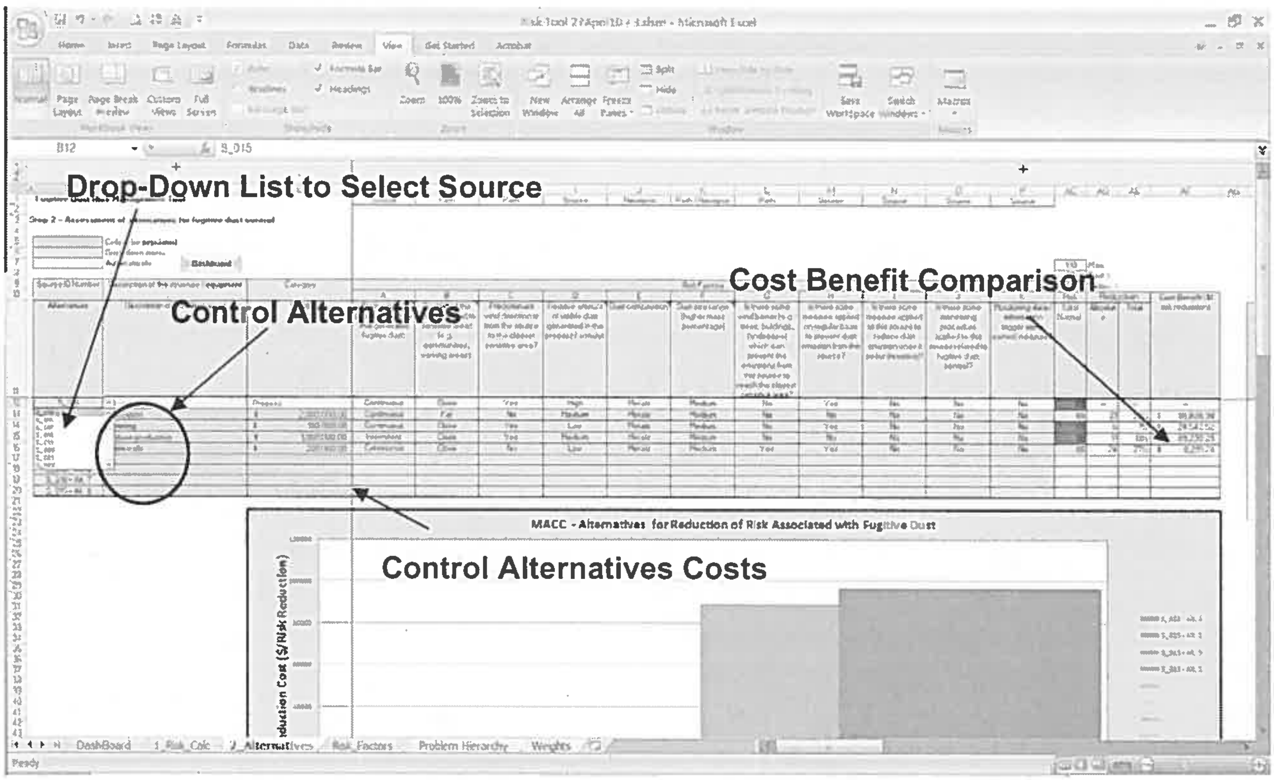


Figure 3: Control alternative assessment process

The costs and benefits results are also illustrated in a Marginal Abatement Cost Curve (MACC) chart. This chart presents the alternatives ranked based on cost benefit ratio ($/risk reduction) (Y axis), the total risk reduction resulting from each alternative (X axis) and the total cost of each alternative (area of each column in the chart) This allows the user to easily compare the alternatives in terms of cost benefit, total effectiveness and total cost.

This control alternative assessment can be completed for every source that has more than one control alternative. This approach provides a documented system for fugitive dust control alternative decision making.

3.5 Implementation of Control Technology

Once it has been determined which alternative control technology is going to put in place for every source that requires management, the controls need to be put in place. It is important to assess the sources again once the controls are put in place to ensure that they are sufficiently managing the fugitive dust as they were intended, in a process of continuous improvement. As you can see, this process can be iterative until the desired amount of risk reduction is achieved for every source.

3.6 Documentation

Once all the BMPs have been established for the fugitive dust sources at your facility, the last step is creating a BMPP that is consistent with the MOE requirements to document the BMPs that are in place and to explain how they will be implemented. The following section explains in detail what needs to be included in a BMPP.

4.0 DEVELOPMENT OF A SITE SPECIFIC BEST MANAGEMENT PRACTICES PLAN

Once site specific best practices have been created for your facility, they need to be documented in a Best Management Practices Plan (BMPP or the Plan) that does the following:

- identifies the sources of fugitive dust emissions associated with the facility;
- reviews the composition and size distribution of the fugitive dust particulate, including an analysis of the metals composition of the road dust;
- describes how fugitive dust can be controlled from each significant source and describes the BMPs in place at the facility;
- contains a schedule by which the Plan will be implemented;
- describes how the Plan will be implemented, including the training of personnel;
- describes inspection and maintenance procedures; and
- describes methods of monitoring and record-keeping to verify and document ongoing compliance with the Plan.

A template fugitive dust BMPP in Microsoft Word® and an example BMPP for a fictitious mining company, ACME Mining Inc., is available for use on the CEMI website (http://www.miningexcellence.ca/knowledge/reports/). The template contains all the necessary sections and some standard wording for a mining company BMPP with red text and blank tables which are to be filled in with site specific data.

The template and ACME example were prepared in accordance with the '*Procedure for Preparing an Emission Summary and Dispersion Modelling Report*' – Appendix E: Technical Bulletin - Review of Approaches to Manage Industrial Fugitive Dust Sources (January 2004) and meets the typical requirements of CofA issued to mining companies.

The following sections contain more detailed information and instruction to complete each of the sections of your BMPP and should be referenced when completing the template and referring to the ACME example.

Foreword and Version Control

Your BMPP is going to be a working document that will require updates from time to time. It is important to keep track of changes and updates. The Foreword outlines the document control structure and the Version Control table will show when and what updates were made.

Section 1.0 Introduction

The introduction section states the purpose of the Plan. It also references the facility and CofA section that requires that a BMPP be completed. **It is important to insert the exact wording from your specific CofA.** The purpose of the Plan should address all the requirements of the CofA.

This section also explains that the Plan is structured to follow the ISO Plan Do Check Act (PDCA) cycle and how each section of the Plan covers each of the steps in the cycle.

This section also references the location of any Ministry comments pertaining to the development and maintenance of the Plan.

Section 2.0 Facility Description

This section contains the facility information including the site address and a description of the operations that are present at the facility. All the main activities that are taking place at the facility should be referenced. The facility production limit(s), usually referenced in the CofA, should also be stated.

It is also important to reference the location of the nearest receptors for your facility. Mention what type of receptor it is (residential, school, etc.) and the distance and direction the receptor is with reference to the facility. Also the predominant wind direction for your area should be noted.

A figure, similar to Figure 1 in the ACME example, illustrating fugitive dust sources, receptor and predominant wind direction should also be included in this section. The tree line and natural berms or wind breaks can also be included on the figure.

Section 3.0 Responsibilities

The responsibilities section outlines what each employment level at the facility is responsible for with regards to the Plan. The headings for each employment level should be consistent with terminology used at your facility. It is more efficient to use job titles as opposed to employee names so that revisions are not necessary when employees change positions.

The amount of responsibility with regards to the Plan increases with increasing managerial level within the organization. **However, it should be noted that all employees have some responsibility in ensuring that the Plan and its BMPs are in place and are effective.**

Section 4.1 PLAN – Identification and Classification of Fugitive Dust Emission Sources

Identification

This section is where the fugitive dust sources at your facility are identified and classified as one of the following types of fugitive dust emission sources.

- paved roads;
- unpaved roads;
- drilling and/or blasting in open pits;
- material processing (crushing and screening);
- material handling (loaders, conveyors and transfer points); and
- material storage (stockpiles, tailings areas).

Only sources that are present at your facility should be included here. Table 2 of the BMPP should list the source types along with their location and potential cause for high emissions. Appendix B to this guidance document can be used as a reference when completing Table 2 of the BMPP.

Characterization

This section in the BMPP should describe the results of the analysis of the facility's fugitive dust sources, including material silt loading, moisture content and metals content, corresponding to the item (ii) of the Technical Bulletin - Review of Approaches to Manage Industrial Fugitive Dust Sources.

It is important to know the composition of the dust present at your facility. Sources emitting dust that contains a large fraction of silt and/or has high metals content should be managed accordingly. The following tables provide ranges for silt content and metals content taken from analytical results from over 100 roadway sample locations on mining sites in Ontario. It should be noted that the source sampling data has not been QA/QC'd for consistency in analytical methods and has been taken from sources with a variety of testing methods.

Appendix E of this document contains sampling protocol that should be followed when conducting onsite unpaved and paved road dust sampling. The results of the sampling campaign should be included as an Appendix to the BMPP.

Tables 3 and 4 of the BMPP compare your sites sampling results with the typical mining operations silt content and metals content given in the following tables.

Table 1: Typical Silt Content Values for Roadways on Ontario Mining Sites[2]

Silt Content	Unpaved Roads			Paved Roads		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean
(%)	36.80	0.10	9.14	35.60	0.72	3.55
(g/m^2)	282.00	1.21	34.30	18.85	0.00	0.18

Table 2: Regulatory Levels for Metals Concentrations in Soils and Typical Metals Concentrations on Ontario Mining Sites

METAL	REGULATORY LIMITS		ONTARIO STUDIES			ONTARIO MINING SITES[2]					
	CCME (mg/kg)	Ontario (µg/g)	Sudbury Soils Study[3] (µg/g)		Ontario Typical Range[4] (µg/g)	Unpaved Roads (µg/g)			Paved Roads (µg/g)		
	Industrial	Table 1: Full Depth Back.	95^{th} perc	Maximum	98^{th} perc	Maximum	Minimum	Mean	Maximum	Minimum	Mean
Aluminum	—	—	18000	39000	30000	64000	179	10135	15900	718	4870
Antimony	40	1	—	—	0.43	210	0.5	4.95	88.7	0.41	8.45
Arsenic	12	17	61	620	17	34000	0.5	89.7	1140	2.8	64.05
Barium	2000	210	120	720	180	580	1.2	51.3	173	5.45	46.6
Beryllium	8	1.2	0.25	2	1.1	1	0.24	0.5	7.1	0.4	0.5
Bismuth	—	—	—	—	—	116	0.54	3	192	1.2	17.5
Boron	—	—	—	—	30	35.8	1	5.8	16	1	3.8
Cadmium	22	1	1.8	6.7	0.84	16.6	0.05	1.29	28.6	0.4	1.65
Calcium	—	—	11000	250000	58000	72000	100	9400	7240	513	3220
Cerium	—	—	—	—	—	153	0.81	24.65	52.7	5.32	22

[2] A summary of road dust sampling results from over 100 sampling locations at mining sites in Ontario. This data has not been validated for consistency in analytical methods.

[3] Sudbury Area Risk Assessment, Volume I – Chapter 7: The Soil Survey, January 2008.

[4] Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Moss Bags and Snow, Ontario Ministry of the Environment and Energy, December 1993.

METAL	REGULATORY LIMITS		ONTARIO STUDIES			ONTARIO MINING SITES[2]					
	CCME (mg/kg)	Ontario (µg/g)	Sudbury Soils Study[3] (µg/g)		Ontario Typical Range[4] (µg/g)	Unpaved Roads (µg/g)			Paved Roads (µg/g)		
	Industrial	Table 1: Full Depth Back.	95^{th} perc	Maximum	98^{th} perc	Maximum	Minimum	Mean	Maximum	Minimum	Mean
Cesium	—	—	—	—	—	1.5	0.49	0.74	0.78	0.43	0.57
Chromium	87	71	56	1100	62	410	1.5	90.2	418	11.7	81.5
Cobalt	300	21	42	190	17	4950	2.29	130	10400	35.6	382
Copper	91	85	1100	5600	65	50300	49.1	1570	174000	200	11700
Europium	—	—	—	—	—	1.9	0.49	0.64	0.55	0.49	0.55
Gallium	—	—	—	—	—	7.88	0.66	4.4	6.7	0.61	3.9
Iron	—	—	26000	110000	35000	143000	1140	63500	177000	13200	50100
Lanthanum	—	—	—	—	—	85.3	2.7	11.6	29.9	2.5	10
Lead	600	120	130	790	98	721	2.3	41.8	993	14.4	131
Lithium	—	—	—	—	—	45	4.2	12.5	13	5.9	7
Magnesium	—	—	5700	26000	20000	47000	125	7080	6940	502	4020
Manganese	—	—	360	3300	2200	2300	5.04	310	1180	36	195
Mercury	50	0.23	—	—	0.18	0.758	0.049	0.24	1.2	0.04	0.455
Molybdenum	40	2.5	1.8	21	1	25.2	0.55	4.45	72	0.69	8.34
Nickel	50	43	1100	3700	38	488000	14.5	1580	429000	133	10400
Niobium	—	—	—	—	—	—	—	—	4.4	0.72	2.56
Phosphorus	—	—	—	—	—	1000	92	360	833	68	340
Rubidium	—	—	—	—	—	37.4	1.2	10	18.5	0.99	6.4
Scandium	—	—	—	—	—	8.38	0.59	3.2	3.9	0.86	2.6
Selenium	2.9	1.9	5	49	1.3	89.9	0.5	7.7	154	1.2	25.55

METAL	REGULATORY LIMITS		ONTARIO STUDIES			ONTARIO MINING SITES[2]					
	CCME (mg/kg)	Ontario (µg/g)	Sudbury Soils Study[3] (µg/g)		Ontario Typical Range[4] (µg/g)	Unpaved Roads (µg/g)			Paved Roads (µg/g)		
	Industrial	Table 1: Full Depth Back.	95th perc	Maximum	98th perc	Maximum	Minimum	Mean	Maximum	Minimum	Mean
Silver	40	0.42	1	8.1	0.33	131	0.052	1.47	139	0.4	9.06
Strontium	—	—	53	340	78	184	2.6	55.2	79.5	4	23
Thallium	1	2.5	—	—	0.81	0.59	0.59	0.59	—	—	—
Thorium	—	—	—	—	—	22.4	1.4	7.4	21.3	1.7	5.02
Tin	300	—	—	—	—	230	0.5	7.72	327	1.6	26
Titanium	—	—	—	—	5200	3400	18.2	870	1180	124	708
Tungsten	—	—	—	—	—	12.5	0.57	3.2	104	0.49	12
Uranium	300	—	—	—	2.1	6.8	0.49	0.965	1.6	0.71	1.1
Vanadium	130	91	45	130	77	220	0.5	44.7	55	6.69	32.35
Yttrium	—	—	—	—	—	52.2	1.1	6.725	10	0.72	4.45
Zinc	360	160	110	340	140	4400	5	220	1250	39.1	282
Zirconium	—	—	—	—	—	16.5	0.58	4.9	15.6	1.3	4.45

Notes:
— no data

Best Management Practices

This section should describe the BMPs that are in place for each of the identified emission sources at the facility corresponding to the item (iii) of the Technical Bulletin - Review of Approaches to Manage Industrial Fugitive Dust Sources.

Some BMPs are implemented through the use of Standard Operating Procedures (SOPs) computer software systems that generate work orders and distribute them to the person responsible to carry out the task. A reference to these SOPs would be included in this section. There can be an additional column in Table 5 of the BMPP that provides the SOP reference number.

It is important to note that the technical and economic feasibility of some of the control measures for the potential causes listed in the Table 2 of your BMPP will depend on site specific conditions. For example, wetting can cause undesirable changes in properties of materials which will be processed later and in some cases can not be applied; schedule changes to avoid critical weather conditions (which maximize dust emission) might not be feasible for some operations due to technical and/or economical restrictions, etc. Therefore, some potential causes are presented in Table 2 of the ACME Example as control opportunities and the application of the measures will depend on other factors which have to be assessed on a site specific basis.

This section also describes how an internal site specific risk ranking was completed in order to focus the more comprehensive BMPs on higher risk sources. Section 3.0 of this document explains how to carry out a risk based ranking on your fugitive dust sources and provides a means for choosing between control alternatives. Once the BMP process is complete, the risk ranking table (see Table 6 of the BMPP) provides a great tool for demonstrating that the BMPs in place adequately manage the risk associated with each fugitive dust source at your facility.

It is important to provide a listing of the fugitive dust sources at your site as well as their corresponding risk score.

Section 4.2 DO – Implementation Schedule for the BMP Plan

This section outlines the schedule for the implementation of the BMPP for control of fugitive dust emissions at the facility, as well as description of how the plan will be implemented, corresponding to the items (iv) and (v) of the Technical Bulletin - Review of Approaches to Manage Industrial Fugitive Dust Sources.

It's important to explain which BMPs listed in the Plan are currently in place and which are scheduled to be implemented at a later date. A timeline showing the implementation schedule should also be included for BMPs that are not yet in place.

It is also important to make sure that new fugitive dust sources that may be brought to the site in the future are given the same consideration as sources that were assessed during the development of this plan. This section should detail how new sources will be brought into the Plan and the documents that will support this procedure. Table 7 of the BMPP lists the start-up checklists that will be used when a new source is put into operation at the site. Appendix D of the ACME Example shows what these start-up checklists can look like.

This section will also include employee and contractor BMP training procedures.

Section 4.3 CHECK – Inspection, Maintenance and Documentation

This section presents inspection and maintenance procedures, monitoring methods and record keeping initiatives to ensure effective implementation of the preventative and control measures described in the Sections

4.1 and 4.2, corresponding to the items (vi) and (vii) of the Technical Bulletin - Review of Approaches to Manage Industrial Fugitive Dust Sources.

Included in this section should be references to all the documents that your site uses to maintain and ensure compliance the BMPs in place and the Plan. Examples include:

- inspection forms;
- maintenance forms;
- dust control activity logs;
- non-conformance logs; and
- any others.

Documenting non-conformances are an important step in the BMP process. It is anticipated that there will still be some fugitive dust occurrences however a good BMPP will trace the steps taken by the company in dealing with the occurrence. One of the main purposes of the Plan is to illustrate the process to be followed when fugitive dust occurrences happen and demonstrate that steps are taken to rectify the conditions that caused the occurrence.

It is useful to summarize the documents are used at your site and reference their frequency. If any of the inspections are managed through SOPs, list the SOP reference as well. Also reference the length of time these records are to be kept and where they can be located. They should not be located in a locked office. These documents need to be made available should an MOE inspector want to review them and the person responsible is not on site at the time.

Examples of the forms and logs that can be used are included in Appendices E, F and G of the ACME Example.

Section 4.4 ACT – BMP Plan Review and Continuous Improvement

This section outlines the BMP review process, including pilot testing with performance measurement of new practices, in order to promote continuous improvement of the control practices.

5.0 REFERENCES

Golder Associates Ltd. 2010. Literature Review of the Current Fugitive Dust Control Practices within the Mining Industry. August 11, 2010.

Ontario Ministry of the Environment. 2004. Review of Approaches to Manage Industrial Fugitive Dust Sources. January 2004.

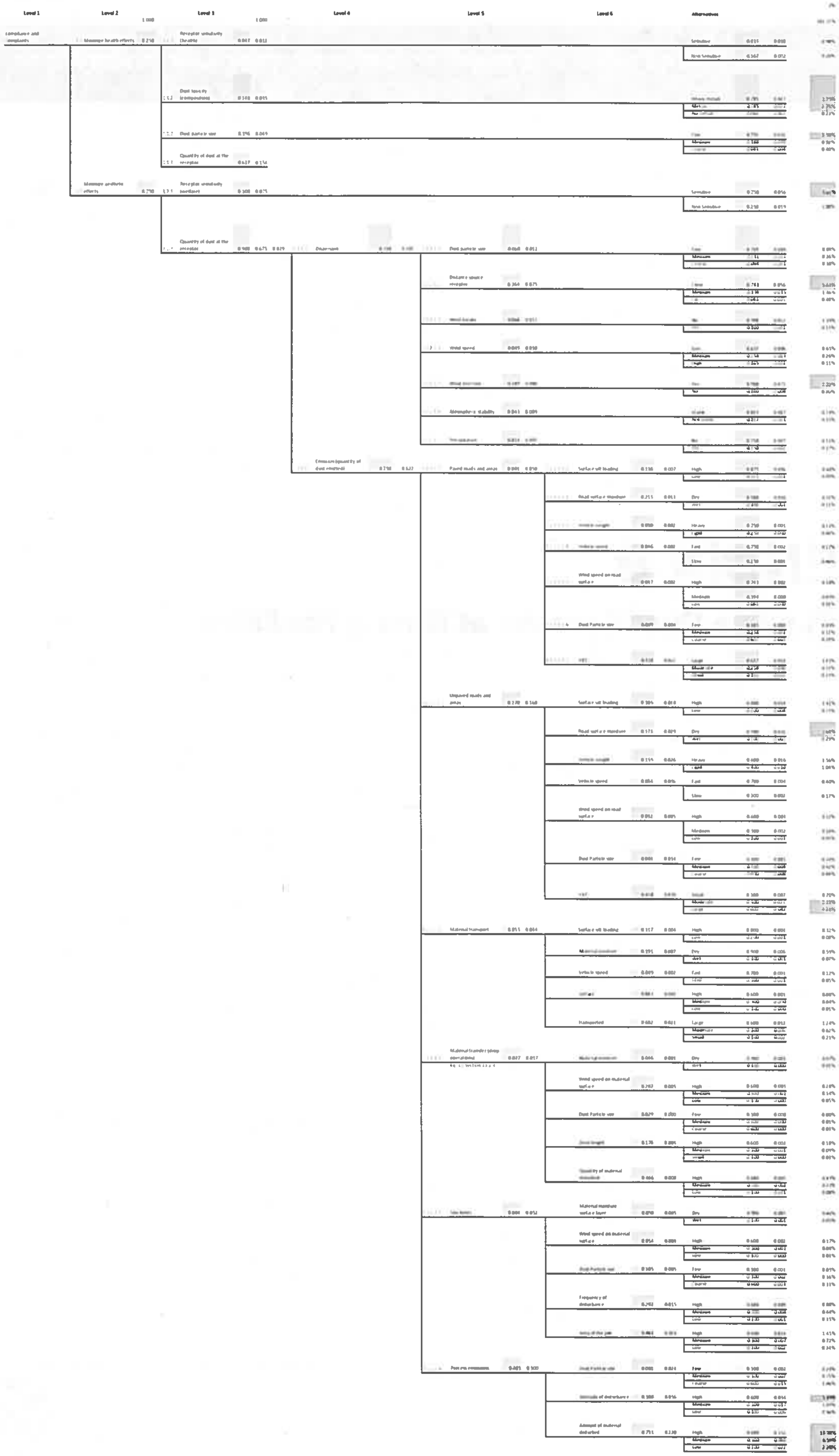
Ontario Ministry of the Environment. 2009. Procedure for Preparing an Emission Summary and Dispersion Modelling Report – Version 3.0. March 2009.

United States Environmental Protection Agency (USEPA). 1995. AP-42 – Compilation of Air Pollutant Emission Factors – Fifth Edition. January 1995

APPENDIX A

Source Risk Ranking Hierarchy

Dust Risk Hierarchy



APPENDIX B

Typical Fugitive Dust Sources at Mining Facilities

TYPICAL FUGITIVE DUST EMISSION SOURCES AT MINING FACILITIES

Process/Activity	Causes of Emission	Factors that Effect the Emission
Site Preparation (land clearing)	- Disturbance of materials being cleared caused by equipment - Wind erosion of exposed material	- Material silt content - Material moisture content - Wind conditions
Open Pit Drilling and Blasting	- Creation of dust during drilling - Wind blown drilled and blasted materials - Wind erosion of blasted material	- Size of area being blasted - Number of holes drilled - Material silt content - Material moisture content - Wind conditions

Material Movement (conveyors, material loading and unloading)	- Disturbance of materials being loaded/unloaded caused by equipment
	- Wind erosion of exposed material
	- Material un-intentionally falling off the conveyors/equipment
		- Material silt content
		- Material moisture content
		- Material density
		- Wind conditions
		- Material transfer rate
		- Equipment characteristics (vibration, etc.)
		- Loading/unloading conditions:
		  - Drop height
		  - Bucket load size (if load exceeds the bucket capacity, material can fall before being dumped into the vehicle)

Crushing and Screening	- Disturbance of materials being loaded/unloaded caused by equipment - Creation of dust during material processing	- Material silt content – initial and final - Material moisture content - Material density - Wind conditions - Material processing rate - Equipment characteristics (enclosures, spray bars, vibration, etc.) - Loading/unloading conditions: - Drop height

TYPICAL FUGITIVE DUST EMISSION SOURCES AT MINING FACILITIES

Process/Activity	Causes of Emission	Factors that Effect the Emission

Paved Roadways	- Disturbance of material on the road surface caused by vehicle traffic
	- Wind erosion on material being transported
	- Material non intentionally falling from trucks
	- Wind erosion from the road surface (independent of vehicle traffic)
		- Silt loading on the roadway surface
		- Road surface moisture content
		- Wind conditions
		- Vehicle speed (affects dust emission from the road; wind erosion on material being transported; and material falling from trucks)
		- Vehicle weight
		- The number of vehicles on the roadway
		- For vehicles transporting materials (e.g. trucks):
		  - Particle size distribution of material being transported
		  - Moisture content of material being transported
		  - Density of material being transported
		  - Distribution of material in the truck bed (if load exceeds the bucket capacity, material can fall during transport; low particle size distribution materials in the top layer increase the chance of wind erosion)

TYPICAL FUGITIVE DUST EMISSION SOURCES AT MINING FACILITIES

Process/Activity	Causes of Emission	Factors that Effect the Emission

Unpaved Roadways	- Disturbance of material on the road surface caused by vehicle traffic
	- Wind erosion on material being transported
	- Material non intentionally falling from trucks
	- Wind erosion from the road surface (independent of vehicle traffic)
		- Road surface material particle size distribution (silt content)
		- Road surface moisture content
		- Wind conditions
		- Vehicle speed (affects dust emission from the road; wind erosion on material being transported; and material falling from trucks)
		- Vehicle weight
		- The number of vehicles on the roadway
		- For vehicles transporting materials (e.g. trucks):
		  - Particle size distribution of material being transported
		  - Moisture content of material being transported
		  - Density of material being transported
		  - Distribution of material in the truck bed (if load exceeds the bucket capacity, material can fall during transport; low particle size distribution materials in the top layer increase the chance of wind erosion)

Tailings Areas and Storage Piles (wind erosion)	- Disturbance of materials caused by equipment loading/unloading
	- Wind erosion from exposed surfaces
		- Material silt content
		- Material moisture content
		- Material density
		- Wind conditions
		- Material placement conditions:
		  - Drop height
		  - Surface area (m^2) of material exposed to wind erosion

APPENDIX C

Typical Control Measures for Fugitive Dust Emission Sources at Mining Facilities

TYPICAL CONTROL MEASURES FOR FUGITIVE DUST EMISSION SOURCES AT MINING FACILITIES

Process/Activity	Factors Affected by Control Measures	Preventative Measures		Reactive Measures
		Design/Installation	Pre-operation/Operation	
Site Preparation	Material silt content			
	Material moisture content		- Wet material during dry conditions	
	Wind conditions		- Do not schedule activities for days when there are extremely high winds forecasted	- Stop activities in high wind conditions
Open Pit Drilling and Blasting	Size of area blasted / number of holes drilled	- Design for smaller blast areas	- Maintain drilling equipment to avoid excessive vibration	
	Material silt content			
	Material moisture content		- Wet material during dry conditions	
	Wind conditions		- Schedule drilling and blasting for days when there are low winds forecasted	- Stop drilling activities in high wind conditions
Material Movement (conveyors, material loading and unloading)	Material silt content			
	Material moisture content	- If possible, use spray bars when conveyors or drop points are not enclosed		
	Material density			

TYPICAL CONTROL MEASURES FOR FUGITIVE DUST EMISSION SOURCES AT MINING FACILITIES

Process/Activity	Factors Affected by Control Measures	Preventative Measures		Reactive Measures
		Design/Installation	Pre-operation/Operation	
	Wind conditions	- Consider historic data when choosing the equipment location to avoid areas with predominant wind from equipment towards sensitive areas - If possible, take advantage of natural wind breaks (trees, landscaping)	- Do not schedule activities for days when there are extremely high winds forecasted	- Stop activities in high wind conditions
	Material transfer rate		- Reduce material throughput	
	Equipment characteristics	- Avoid transfer points by using longer conveyors, if possible - Set up equipment with longer axis parallel with prevailing wind direction - Construct wind barriers - Fully enclose conveyors and transfer points - Implement dust collection equipment	- Maintain all equipment accordingly to reduce vibration - Maintain good housekeeping in areas around equipment to avoid track-out	
	Loading/unloading conditions (drop height, bucket load size, etc.)	- Minimize material drop heights	- Maintain minimum drop heights - Maintain appropriate load sizes to ensure material do not unintentionally fall	

TYPICAL CONTROL MEASURES FOR FUGITIVE DUST EMISSION SOURCES AT MINING FACILITIES

Process/Activity	Factors Affected by Control Measures	Preventative Measures		Reactive Measures
		Design/Installation	Pre-operation/Operation	
Crushing and Screening	Material silt content (initial and final)	- Avoid over processing material, (i.e. only crush to largest size that is necessary)	- Only process enough material that will be used, avoid having to store finer materials in storage areas	
	Material moisture content	If possible, use spray bars when conveyors or drop points are not enclosed		
	Material density			
	Wind conditions	- Consider historic data when choosing the equipment location to avoid areas with predominant wind from equipment towards sensitive areas - If possible, take advantage of natural wind breaks (trees, landscaping)	- Do not schedule activities for days when there are extremely high winds forecasted	- Stop activities in high wind conditions
	Material processing rate		- Reduce material processing rate	
	Equipment characteristics (enclosures, spray bars, vibration, etc.)	- Set up equipment with longer axis parallel with predominant wind direction - Construct wind barriers - Fully enclose equipment - Implement dust collection equipment	- Maintain all equipment accordingly to reduce vibration - Maintain good housekeeping in areas around equipment to avoid track-out	

Process/Activity	Factors Affected by Control Measures	Preventative Measures		Reactive Measures
		Design/Installation	Pre-operation/Operation	
	Loading/unloading conditions (drop size, bucket load size)	- Minimize material drop heights	- Maintain minimum drop heights - Maintain appropriate load sizes to ensure material do not unintentionally fall	
Paved Roadways	Silt loading on the roadway surface		- Implement a vacuum truck	- Vacuum roads as needed
	Road surface moisture content		- Implement a water truck regularly	- Spray roads as needed
	Wind conditions	- Consider historic data when designing the road route to avoid high speed wind areas and areas with predominant wind from roadway towards sensitive areas - If possible, take advantage of natural wind breaks (trees, landscaping)		- Stop activities in high wind conditions
	Vehicle speed	- Specify and post speed limits	- Enforce posted speed limits	
	Vehicle weight		- Maintain appropriate load sizes so trucks are not over-loaded	
	Number of vehicles		- Maintain appropriate load sizes to reduce the number of truck trips	

TYPICAL CONTROL MEASURES FOR FUGITIVE DUST EMISSION SOURCES AT MINING FACILITIES

Process/Activity	Factors Affected by Control Measures	Preventative Measures		Reactive Measures
		Design/Installation	Pre-operation/Operation	
	Vehicle loads		- Maintain appropriate load sizes to ensure material do not unintentionally fall - Cover loads, if possible - Implement wheel washing stations and load wetting stations to avoid track-out	
Unpaved Roadways	Road surface silt content	- Resurface roadway with larger aggregate - Paved the roadway	- Apply dust suppression chemical regularly	- Apply additional suppression as needed
	Road surface moisture content		- Implement a water truck regularly	- Spray roads as needed
	Wind conditions	- Consider historic data when designing the road route to avoid high speed wind areas and areas with predominant wind from roadway towards sensitive areas - If possible, take advantage of natural wind breaks (trees, landscaping)		- Stop activities in high wind conditions
	Vehicle speed	- Specify and post speed limits	- Enforce posted speed limits	
	Vehicle weight		- Maintain appropriate load sizes so trucks are not over-loaded	

TYPICAL CONTROL MEASURES FOR FUGITIVE DUST EMISSION SOURCES AT MINING FACILITIES

Process/Activity	Factors Affected by Control Measures	Preventative Measures		Reactive Measures
		Design/Installation	Pre-operation/Operation	
	Number of vehicles		- Maintain appropriate load sizes to reduce the number of truck trips	
	Vehicle loads		- Maintain appropriate load sizes to ensure material do not unintentionally fall - Cover loads, if possible - Implement wheel washing stations and load wetting stations to avoid track-out	
Tailings Areas and Storage Piles (wind erosion)	Material silt content	- Cover/re-vegetate areas that are not longer in use	- If possible store coarser material on top of finer material - Apply chemical suppression regularly	- Apply additional suppression as needed
	Material moisture content	- Design for wet disposal of tailings if possible	- Maintain an appropriate moisture content of storage piles	- Spray storage areas/piles as needed
	Material density			

TYPICAL CONTROL MEASURES FOR FUGITIVE DUST EMISSION SOURCES AT MINING FACILITIES

Process/Activity	Factors Affected by Control Measures	Preventative Measures		Reactive Measures
		Design/Installation	Pre-operation/Operation	
	Wind conditions	- Consider historic data when designing the storage area to avoid high speed wind areas and areas with predominant wind from the storage area towards sensitive areas - If possible, take advantage of natural wind breaks (trees, landscaping)	- Do not schedule material placement for days when there are extremely high winds forecasted	- Stop activities in high wind conditions
	Material placement (drop height, exposed surface area)	- Minimize material drop heights - Design working areas to avoid disturbance of materials as much as possible (work from inside to outside, set up storage piles near the equipment which uses the material if possible, etc.) - If possible maintain one larger pile rather than many small piles to reduce exposed surface area - If possible build piles with long axis parallel with predominant wind direction - Construct wind barriers - Construct storage domes especially for finer materials	- Maintain minimum drop heights - Maintain good housekeeping in storage area to avoid track-out	

APPENDIX D

Road Dust Sampling Protocol

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APPENDIX C.1

PROCEDURES FOR SAMPLING SURFACE/BULK DUST LOADING

Appendix C.1

Procedures For Sampling Surface/Bulk Dust Loading

This appendix presents procedures recommended for the collection of material samples from paved and unpaved roads and from bulk storage piles. (AP-42, Appendix C.2, "Procedures For Laboratory Analysis Of Surface/Bulk Dust Loading Samples", presents analogous information for the analysis of the samples.) These recommended procedures are based on a review of American Society For Testing And Materials (ASTM) methods, such as C-136 (sieve analysis) and D-2216 (moisture content). The recommendations follow ASTM standards where practical, and where not, an effort has been made to develop procedures consistent with the intent of the pertinent ASTM standards.

This appendix emphasizes that, before starting any field sampling program, one must first define the study area of interest and then determine the number of samples that can be collected and analyzed within the constraints of time, labor, and money available. For example, the study area could be defined as an individual industrial plant with its network of paved/unpaved roadways and material piles. In that instance, it is advantageous to collect a separate sample for each major dust source in the plant. This level of resolution is useful in developing cost-effective emission reduction plans. On the other hand, if the area of interest is geographically large (say a city or county, with a network of public roads), collecting at least 1 sample from each source would be highly impractical. However, in such an area, it is important to obtain samples representative of different source types within the area.

C.1.1 Samples From Unpaved Roads

Objective -

The overall objective in an unpaved road sampling program is to inventory the mass of particulate matter (PM) emissions from the roads. This is typically done by:

1. Collecting "representative" samples of the loose surface material from the road;
2. Analyzing the samples to determine silt fractions; and
3. Using the results in the predictive emission factor model given in AP-42, Section 13.2.2, Unpaved Roads, together with traffic data (e. g., number of vehicles traveling the road each day).

Before any field sampling program, it is necessary to define the study area of interest and to determine the number of unpaved road samples that can be collected and analyzed within the constraints of time, labor, and money available. For example, the study area could be defined as a very specific industrial plant having a network of roadways. Here it is advantageous to collect a separate sample for each major unpaved road in the plant. This level of resolution is useful in developing cost-effective emission reduction plans involving dust suppressants or traffic rerouting. On the other hand, the area of interest may be geographically large, and well-defined traffic information may not be easily obtained. In this case, resolution of the PM emission inventory to specific road segments would not be feasible, and it would be more important to obtain representative road-type samples within the area by aggregating several sample increments.

Procedure -

For a network consisting of many relatively short roads contained in a *well-defined study area* (as would be the case at an industrial plant), it is recommended that one collect a sample for each 0.8 kilometers (km) (0.5 miles [mi]) length, or portion thereof, for each major road segment. Here, the term "road segment" refers to the length of road between intersections (the nodes of the network) with other paved or unpaved roads. Thus, for a major segment 1 km (0.6 mi) long, 2 samples are recommended.

For longer roads in *study areas that are spatially diverse*, it is recommended that one collect a sample for each 4.8 km (3 mi) length of the road. Composite a sample from a minimum of 3 incremental samples. Collect the first sample increment at a random location within the first 0.8 km (0.5 mi), with additional increments taken from each remaining 0.8 km (0.5 mi) of the road, up to a maximum length of 4.8 km (3 mi). For a road less than 1.5 mi in length, an acceptable method for selecting sites for the increments is based on drawing 3 random numbers (x1, x2, x3) between zero and the length. Random numbers may be obtained from tabulations in statistical reference books, or scientific calculators may be used to generate pseudorandom numbers. See Figure C.1-1.

The following steps describe the collection method for samples (increments).

1. Ensure that the site offers an unobstructed view of traffic and that sampling personnel are visible to drivers. If the road is heavily traveled, use 1 person to "spot" and route traffic safely around another person collecting the surface sample (increment).

2. Using string or other suitable markers, mark a 0.3 meters (m) (1 foot [ft]) wide portion across the road. (WARNING: *Do not mark the collection area with a chalk line or in any other method likely to introduce fine material into the sample.*)

3. With a whisk broom and dustpan, remove the loose surface material from the hard road base. Do not abrade the base during sweeping. Sweeping should be performed slowly so that fine surface material is not injected into the air. NOTE: *Collect material only from the portion of the road over which the wheels and carriages routinely travel* (i. e., not from berms or any "mounds" along the road centerline).

4. Periodically deposit the swept material into a clean, labeled container of suitable size, such as a metal or plastic 19 liter (L) (5 gallon [gal]) bucket, having a sealable polyethylene liner. Increments may be mixed within this container.

5. Record the required information on the sample collection sheet (Figure C.1-2).

Sample Specifications -

For uncontrolled unpaved road surfaces, a gross sample of 5 kilograms (kg) (10 pounds [lb]) to 23 kg (50 lb) is desired. Samples of this size will require splitting to a size amenable for analysis (see Appendix C.2). For unpaved roads having been treated with chemical dust suppressants (such as petroleum resins, asphalt emulsions, etc.), the above goal may not be practical in well-defined study areas because a very large area would need to be swept. In general, a minimum of 400 grams (g) (1 lb) is required for silt and moisture analysis. Additional increments should be taken from heavily controlled unpaved surfaces, until the minimum sample mass has been achieved.

C.1.2 Samples From Paved Roads

Objective -

The overall objective in a paved road sampling program is to inventory the mass of particulate emissions from the roads. This is typically done by:

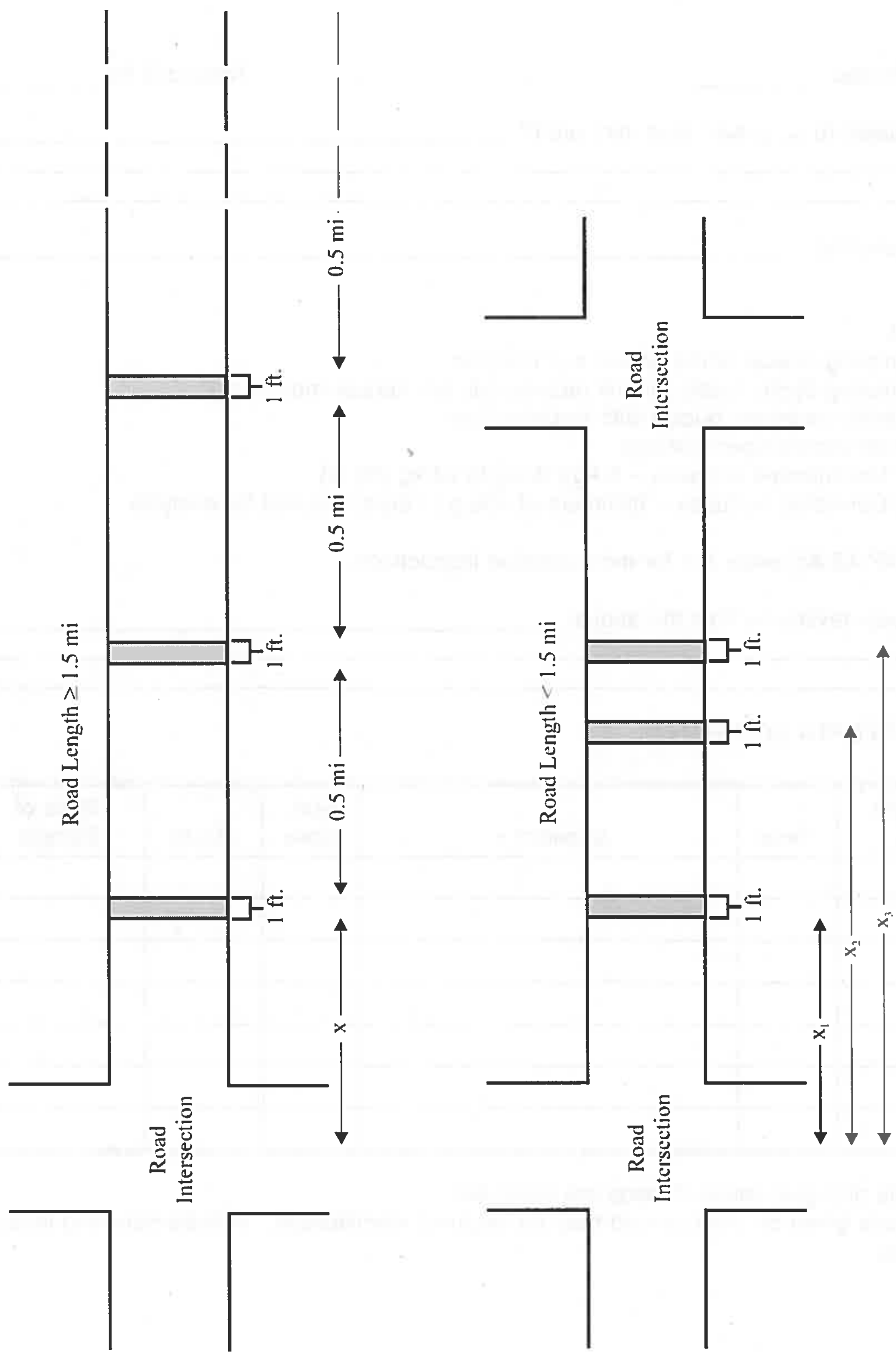

Figure C.1-1. Sampling locations for unpaved roads.

SAMPLING DATA FOR UNPAVED ROADS

Date Collected ___________ Recorded by ___________

Road Material (e.g., gravel, slag, dirt, etc.):* ____

____

____

Site of Sampling: ____

METHOD:

1. Sampling device: whisk broom and dustpan
2. Sampling depth: loose surface material (do not abrade road base)
3. Sample container: bucket with sealable liner
4. Gross sample specifications:
   a. Uncontrolled surfaces -- 5 kg (10 lb) to 23 kg (50 lb)
   b. Controlled surfaces -- minimum of 400 g (1 lb) is required for analysis

Refer to AP-42 Appendix B.1 for more detailed instructions.

Indicate any deviations from the above: ____

____

____

SAMPLING DATA COLLECTED:

Sample No.	Time	Location +	Surf. Area	Depth	Mass of Sample

* Indicate and give details if roads are controlled.

\+ Use code given on plant or road map for segment identification. Indicate sampling location on map.

Figure C.1-2. Example data form for unpaved road samples.

1. Collecting "representative" samples of the loose surface material from the road;
2. Analyzing the sample to determine the silt fraction; and
3. Combining the results with traffic data in a predictive emission factor model.

The remarks above about definition of the study area and the appropriate level of resolution for sampling unpaved roads are equally applicable to paved roads. Before a field sampling program, it is necessary first to define the study area of interest and then to determine the number of paved road samples that can be collected and analyzed. For example, in a well-defined study area (e. g., an industrial plant), it is advantageous to collect a separate sample for each major paved road, because the resolution can be useful in developing cost-effective emission reduction plans. Similarly, in geographically large study areas, it may be more important to obtain samples representative of road types within the area by aggregating several sample increments.

Compared to unpaved road sampling, planning for a paved road sample collection exercise necessarily involves greater consideration as to types of equipment to be used. Specifically, provisions must be made to accommodate the characteristics of the vacuum cleaner chosen. For example, paved road samples are collected by cleaning the surface with a vacuum cleaner with "tared" (i. e., weighed before use) filter bags. Upright "stick broom" vacuums use relatively small, lightweight filter bags, while bags for industrial-type vacuums are bulky and heavy. Because the mass collected is usually several times greater than the bag tare weight, uprights are thus well suited for collecting samples from lightly loaded road surfaces. On the other hand, on heavily loaded roads, the larger industrial-type vacuum bags are easier to use and can be more readily used to aggregate incremental samples from all road surfaces. These features are discussed further below.

Procedure -

For a network of many relatively short roads *contained in a well-defined study area* (as would be the case at an industrial plant), it is recommended that one collect a sample for each 0.8 km (0.5 mi) length, or portion thereof, for each major road segment. For a 1 km long (0.6 mi) segment, then, 2 samples are recommended. As mentioned, the term "road segment" refers to the length of road between intersections with other paved or unpaved roads (the nodes of the network).

For longer roads *in spatially heterogeneous study areas*, it is recommended that one collect a sample for each 4.8 km (3 mi) of sampled road length. Create a composite sample from a minimum of 3 incremental samples. Collect the first increment at a random location within the first 0.8 km (0.5 mi), with additional increments taken from each remaining 0.8 km (0.5 mi) of the road, up to a maximum length of 4.8 km (3 mi.) For a road less than 2.4 km (1.5 mi) long, an acceptable method for selecting sites for the increments is based on drawing 3 random numbers (x1, x2, x3) between zero and the length (See Figure C.1-3). Random numbers may be obtained from tabulations in statistical reference books, or scientific calculators may be used to generate pseudorandom numbers.

The following steps describe the collection method for samples (increments).

1. Ensure that the site offers an unobstructed view of traffic and that sampling personnel are visible to drivers. If the road is heavily traveled, use 1 crew member to "spot" and route traffic safely around another person collecting the surface sample (increment).

2. Using string or other suitable markers, mark the sampling portion across the road. (WARNING: *Do not mark the collection area with a chalk line or in any other method likely to introduce fine material into the sample.*) The widths may be varied between 0.3 m (1 ft) for visibly dirty roads and 3 m (10 ft) for clean roads. When an industrial-

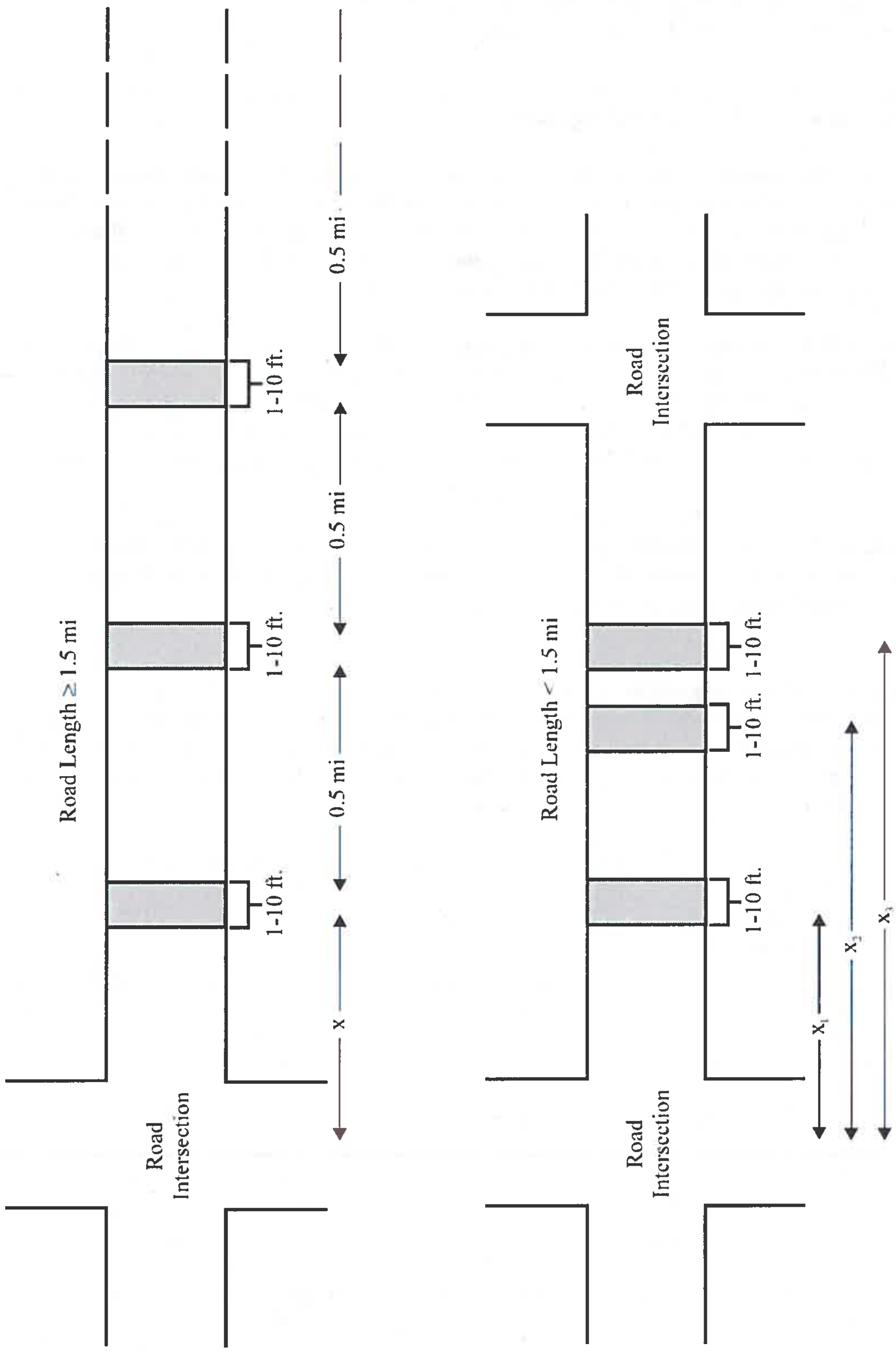

Figure C.1-3. Sampling locations for paved roads.

type vacuum is used to sample lightly loaded roads, a width greater than 3 m (10 ft) may be necessary to meet sample specifications, unless increments are being combined.

3. If large, loose material is present on the surface, it should be collected with a whisk broom and dustpan. NOTE: *Collect material only from the portion of the road over which the wheels and carriages routinely travel* (i. e., not from berms or any "mounds" along the road centerline). On roads with painted side markings, collect material "from white line to white line" (but avoid centerline mounds). Store the swept material in a clean, labeled container of suitable size, such as a metal or plastic 19 L (5 gal) bucket, with a sealable polyethylene liner. Increments for the same sample may be mixed within the container.

4. Vacuum the collection area using a portable vacuum cleaner fitted with an empty tared (preweighed) filter bag. NOTE: *Collect material only from the portion of the road over which the wheels and carriages routinely travel* (i. e., not from berms or any "mounds" along the road centerline). On roads with painted side markings, collect material "from white line to white line" (but avoid centerline mounds). The same filter bag may be used for different increments for 1 sample. For heavily loaded roads, more than 1 filter bag may be needed for a sample (increment).

5. Carefully remove the bag from the vacuum sweeper and check for tears or leaks. If necessary, reduce samples (using the procedure in Appendix C.2) from broom sweeping to a size amenable to analysis. Seal broom-swept material in a clean, labeled plastic jar for transport (alternatively, the swept material may be placed in the vacuum filter bag). Fold the unused portion of the filter bag, wrap a rubber band around the folded bag, and store the bag for transport.

6. Record the required information on the sample collection sheet (Figure C.1-4).

Sample Specifications -

When broom swept samples are collected, they should be at least 400 g (1 lb) for silt and moisture analysis. Vacuum swept samples should be at least 200 g (0.5 lb). Also, the weight of an "exposed" filter bag should be at least 3 to 5 times greater than when empty. Additional increments should be taken until these sample mass goals have been attained.

C.1.3 Samples From Storage Piles

Objective -

The overall objective of a storage pile sampling and analysis program is to inventory particulate matter emissions from the storage and handling of materials. This is done typically by:

1. Collecting "representative" samples of the material;
2. Analyzing the samples to determine moisture and silt contents; and
3. Combining analytical results with material throughput and meteorological information in an emission factor model.

As initial steps in storage pile sampling, it is necessary to decide (a) what emission mechanisms - material load-in to and load-out from the pile, wind erosion of the piles - are of interest, and (b) how many samples can be collected and analyzed, given time and monetary constraints. (In general, annual average PM emissions from material handling can be expected to be

SAMPLING DATA FOR PAVED ROADS

Date Collected __________ Recorded by __________

Sampling location* ______________________________ No. of Lanes __________

Surface type (e.g., asphalt, concrete, etc.)_______________________________________

Surface condition (e.g., good, rutted, etc.) _______________________________________

* Use code given on plant or road map for segment identification. Indication sampling location on map.

METHOD:

1. Sampling device: portable vacuum cleaner (whisk broom and dustpan if heavy loading present)
2. Sampling depth: loose surface material (do not sample curb areas or other untravelled portions of the road)
3. Sample container: tared and numbered vacuum cleaner bags (bucket with sealable liner if heavy loading present)
4. Gross sample specifications: Vacuum swept samples should be at least 200 g (0.5 lb), with the exposed filter bag weight should be at least 3 to 5 times greater than the empty bag tare weight.

Refer to AP-42 Appendix C.1 for more detailed instructions.

Indicate any deviations from the above: ____

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SAMPLING DATA COLLECTED:

Sample No.	Vacuum Bag ID	Vacuum Bag Tare Wgt (g)	Sampling Surface Dimensions (l x w)	Time	Mass of Broom-Swept Sample +

\+ Enter "0" if no broom sweeping is performed.

Figure C.1-4. Example data form for paved roads.

much greater than those from wind erosion.) For an industrial plant, it is recommended that at least 1 sample be collected for each major type of material handled within the facility.

In a program to characterize load-in emissions, representative samples should be collected from material recently loaded into the pile. Similarly, representative samples for load-out emissions should be collected from areas that are worked by load-out equipment such as front end loaders or clamshells. For most "active" piles (i. e., those with frequent load-in and load-out operations), 1 sample may be considered representative of both loaded-in and loaded-out materials. Wind erosion material samples should be representative of the surfaces exposed to the wind.

In general, samples should consist of increments taken from all exposed areas of the pile (i. e., top, middle, and bottom). If the same material is stored in several piles, it is recommended that piles with at least 25 percent of the amount in storage be sampled. For large piles that are common in industrial settings (e. g., quarries, iron and steel plants), access to some portions may be impossible for the person collecting the sample. In that case, increments should be taken no higher than it is practical for a person to climb carrying a shovel and a pail.

Procedure -

The following steps describe the method for collecting samples from storage piles:

1. Sketch plan and elevation views of the pile. Indicate if any portion is not accessible. Use the sketch to plan where the N increments will be taken by dividing the perimeter into N-1 roughly equivalent segments.

    a. For a large pile, collect a minimum of 10 increments, as near to mid-height of the pile as practical.

    b. For a small pile, a sample should be a minimum of 6 increments, evenly distributed among the top, middle, and bottom.

    "Small" or "large" piles, for practical purposes, may be defined as those piles which can or cannot, respectively, be scaled by a person carrying a shovel and pail.

2. Collect material with a straight-point shovel or a small garden spade, and store the increments in a clean, labeled container of suitable size (such as a metal or plastic 19 L [5 gal] bucket) with a sealable polyethylene liner. Depending upon the ultimate goals of the sampling program, choose 1 of the following procedures:

    a. To characterize emissions from *material handling operations at an active pile*, take increments from the portions of the pile which most recently had material added and removed. Collect the material with a shovel to a depth of 10 to 15 centimeters (cm) (4 to 6 inches [in]). Do not deliberately avoid larger pieces of aggregate present on the surface.

    b. To characterize *handling emissions from an inactive pile*, obtain increments of the core material from a 1 m (3 ft) depth in the pile. A sampling tube 2 m (6 ft) long, with a diameter at least 10 times the diameter of the largest particle being sampled, is recommended for these samples. Note that, for piles containing large particles, the diameter recommendation may be impractical.

c. If characterization of *wind erosion*, rather than material handling is the goal of the sampling program, collect the increments by skimming the surface in an upwards direction. The depth of the sample should be 2.5 cm (1 in), or the diameter of the largest particle, whichever is less. Do not deliberately avoid collecting larger pieces of aggregate present on the surface.

In most instances, collection method "a" should be selected.

3. Record the required information on the sample collection sheet (Figure C.1-5). Note the space for deviations from the summarized method.

Sample Specifications -

For any of the procedures, the sample mass collected should be at least 5 kg (10 lb). When most materials are sampled with procedures 2a or 2b, 10 increments will normally result in a sample of at least 23 kg (50 lb). Note that storage pile samples usually require splitting to a size more amenable to laboratory analysis.

SAMPLING DATA FOR STORAGE PILES

Date Collected __________ Recorded by __________

Type of material sampled ______________________________

Sampling location* ______________________________

METHOD:

1. Sampling device: pointed shovel (hollow sampling tube if inactive pile is to be sampled)
2. Sampling depth:
   For material handling of active piles: 10-15 cm (4-6 in.)
   For material handling of inactive piles: 1 m (3 ft)
   For wind erosion samples: 2.5 cm (1 in.) or depth of the largest particle (whichever is less)
3. Sample container: bucket with sealable liner
4. Gross sample specifications:
   For material handling of active or inactive piles: minimum of 6 increments with total sample weight of 5 kg (10 lb) [10 increments totalling 23 kg (50 lb) are recommended]
   For wind erosion samples: minimum of 6 increments with total sample weight of 5 kg (10 lb)

Refer to AP-42 Appendix C.1 for more detailed instructions.

Indicate any deviations from the above: ______________________________

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SAMPLING DATA COLLECTED:

Sample No.	Time	Location* of Sample Collection	Device Used S/T **	Depth	Mass of Sample

* Use code given of plant or area map for pile/sample identification. Indicate each sampling location on map.

** Indicate whether shovel or tube.

Figure C.1-5. Example data form for storage piles.