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Project Summary

Fugitive Dust from Western Surface Coal Mines

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In this study, field measurements of fugitive dust levels were made 250 to 500 meters downwind of mining activities and areas at four surface coal mines in the Northern Great Plains during three different climatic conditions. Ambient dust levels were also monitored. Wide ranges of temperature, wind speed, wind direction, precipitation, soil moisture, and mining activity levels are represented in the field data.

Introduction

Some fundamental findings were: mine-to-mine differences in average total suspended particulates (TSP) levels were significant; the evidence for seasonal differences is weaker, but consistent with physical theory and prior judgements; and on the average, downwind TSP levels were 35 percent higher than ambient (upwind) levels.

Most strippable western coal is located in semi-arid, high plains areas characterized by sparse vegetation, erodable soils, and high winds. High ambient dust levels are a result of these factors. Disturbance of land by surface coal mining may worsen these dust conditions.

There exist theoretical models for use in estimating the dispersion patterns for particulate matter emanating from a point source, such as a power plant stack. Recently, attempts have been made to model emission, dispersion, and deposition of fugitive dust from point and non-point sources typical of those from western surface coal mines. To date, however, there have been few attempts to apply statistical techniques to determine empirical relationships between suspended particulate levels in mining areas and explanatory variables, such as mining activity levels and meteorological variables. This study employs such techniques to examine the effects of mine operations on air quality under various meteorological and operational conditions.

It is recommended that a large-scale, long-term experimental program be conducted to develop and validate empirical relationships between total suspended particulate levels in western surface coal mining areas and explanatory variables which measure the characteristics of the real dust sources found at such mines. Total suspended particulate levels should be measured at two or more mines over a period long enough to ensure that a wide range of mining and meteorological variables are observed. Empirical results should be systematically compared to those estimated using published emission factors and dispersion/deposition assumptions.

In brief, the data collection plan included three visits during different seasons to each of four surface mines. Four high volume air samplers were used to measure dust concentrations during these visits. Additional data were collected on soil moisture, weather conditions, and activity levels of various mining or mining-related operations. These data are candidate explanatory factors to describe the observed vari-

ability in dust concentrations.

Observations for this project were taken at several sites within four mines. Three visits were made to each mine to ensure that a wide variety of operating conditions were observed and, additionally, to study the effect of seasons of the year on particulate values.

Variables measured during the mine visits included dust concentrations, soil moisture, quantitative data on the pattern and intensity of mining activities, and meteorological variables such as wind speed and direction, temperature, and precipitation. Aerial photographs were taken from which maps were drawn.

Several factors must be considered in the design of a sampling plan for measuring the atmospheric concentration of particulates. Some of these are:

1. Emissions sources to be measured.
2. Direction of the air sampler from the source.
3. Distance of the air sampler from the source.
4. Duration of sampling interval.

The goal is to place the monitors in such a manner that a profile of the concentration of particulates can be obtained. Sampler locations and sampling intervals are such that sufficient amounts of particulates will be collected to give reliable estimates of the air concentration at the receptor point. We first considered sampling intervals.

Dust concentrations were measured with General Metal Works GMWL 2000 high volume air samplers. These draw in particulate matter and pass them through a graded series of paper filters. At the end of each observation period, the filters were removed and weighed, and the accumulated dust was converted to a concentration in units of micrograms per cubic meter.

Soil moisture as percent of total weight was recorded at locations designed to reflect diverse soil conditions: haul roads, the pit and bench, off-mine roads, topsoil or spoil piles, areas of contouring or reclamation, and the surrounding landscape.

Mining activities were recorded during shifts when dust sampling was active. Twelve potential dust-producing activities were observed: dragline operation, coal haulage, vehicular traffic on mine roads, vehicular traffic on nearby public roads (usually unpaved), water trucks, scraping, grading, coal loading, coal unloading, blasting, and drilling of overburden and coal.

The report summarizes the results of various statistical analyses of the data collected as part of this study. It judges differences in particulate values measured at various locations, mines, and seasons that can be held to be statistically significant. Estimates of main and interaction effects and complete components of variance analysis are furnished in the report. The report presents the findings of differences among samplers such as differences arising between the ambient sampler and those downwind of the mining operation. Shown also is the relationship between particulates and activity variables at the mining operations visited.

Reported, in particular, are the results of preliminary statistical analysis of the data and analysis of variance (ANOVA) on total particulates. The results of the analysis of variance support the contention that there were significant differences in readings among sampler locations.

Also discussed are some of the results of regression analysis to determine the relationship between observed TSP and activity levels for various mining operations.

The independent variables consisted of observations on some twelve activities at the mine operation, including dragline operation, coal haulage, drilling, blasting, loading, scraping, grading, etc. Additionally, wind speed and precipitation were employed in view of their observed or postulated relationships in previous analyses. The first observation of interest in examining the relationship between mine activity and resulting TSP values is the pattern of simple correlation coefficients. Two points are worthy of note: the exception of variable Q_3 (on-mine vehicles) TSP is positively correlated with each of the activity variables and the correlation coefficients are not great.

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The complete report, entitled "Fugitive Dust from Western Surface Coal Mines," (Order No. PB 80 221955; Cost: $15.00, subject to change) will be available from:
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