Air Quality Monitoring
in
Buckland, AK
2003 –2012

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Air Quality Division

Air Monitoring
&
Quality Assurance
Program

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NW Arctic monitoring summary 2003-2005

In 2003 the Alaska Department of Environmental Conservation (ADEC) partnered with the Maniilaq Association to evaluate the level of fugitive dust emissions from unpaved roads in eight villages in Alaska's Northwest Arctic Borough. Field measurements were conducted during the summer seasons of 2003, 2004, and 2005. The villages of Selawik, Ambler, Kiana, Buckland, Kotzebue, Kivalina, Noatak, and Noorvik participated in the project with the initial intent of determining if a dust problem existed, and the extent of such a problem. The results of this sampling project were to be used to assess the amount of fugitive dust, to compare dust levels to the National Ambient Air Quality Standard (NAAQS), and to help develop a dust control strategy for rural Alaskan native villages.

Introduction and Research Approach

In 2003 the Maniilaq Association, Alaska Department of Transportation and Public Facilities (DOT&PF) and Department of Environmental Conservation (ADEC) started dust monitoring study in 8 native villages in Alaska's Northwest Arctic Borough. These villages are Selawik, Ambler, Kiana, Buckland, Kotzebue, Kivalina, Noatak, and Noorvik (see Figure 1). The initial phase of this effort began in February 2003 and ran during the summer seasons until September 2005. ADEC provided technical assistance to the Maniilaq Association in their effort to assess air quality and educate village residents on the potential health threat associated with the exposure to dust. Funding for the baseline assessment was provided through each village's Indian General Assistance Program (IGAP) and special grants from the Environmental Protection Agency (EPA) and the Bureau for Indian Affairs (BIA) to the Maniilaq Association. The day to day air monitoring was managed through the Maniilaq Association's environmental staff with project oversight from ADEC.

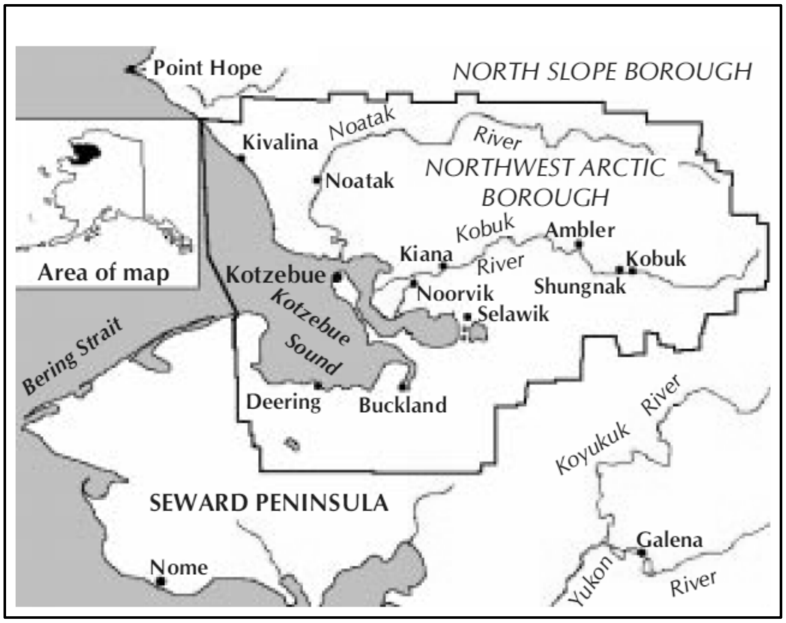

Figure 1: A map showing the eight Alaskan villages of the Northwest Arctic Borough that elected to participate in the road dust monitoring.

Sources of Dust in Rural Communities

The road systems in the villages are used by cars, trucks, motorcycles and four wheelers (ATVs) to transport residents within the community. Four wheelers are a main means of transportation within the village, and are also used as "recreation vehicles" throughout the day. Four wheelers have knobbier tires than cars and trucks, and thus pick up more dust than most other vehicles. Local dirt roads are constructed from local silt, gravel and sand. During the summer months when streets are dry and the winds are light, vehicle traffic can cause the silts and fine sands to become airborne. In addition, frequent and prolonged wind events also load the ambient air with coarse particulates, and thus affect air quality throughout the community, potentially creating an unhealthy environment for the residents. During windy episodes dirt roads can serve as sources for large dust columns, which cover the community. Average wind speeds during the summer are 4 mph, with gusts over 13mph, according to Kiana wind data provided by ADEC. To address the dust issue, some village governments water the streets during the summer months. Due to the silty makeup of the road surface and heat from the summer sun, watered streets can dry out within several hours; therefore road watering provides an effective but only short term limited relief from road dust.

Road dust remains an issue even in the fall after freeze up until there is sufficient snow on the ground to cover the road surface. During dry weather periods, the freeze-dried dust particulates are entrained by vehicle tires and the dust levels in the air can reach the same levels as during dry summer days.

The roads in the village are heavily used by pedestrians, and children frequently play in and around them. In the communities, the road is a means of vehicle transport, a walkway, and a recreational site for children. There are no sidewalks, and no front yards set back from the road—front doors face and are near to the road. The silty dust is easily blown in all directions, and can linger in the air for a while (see Figure 2). Because many community members spend a substantial amount of their time in and around the roads, the air quality samplers were set up alongside the road.

Figure 2: Kotzebue on a dusty summer day.

Public Health

Under the authority of the Clean Air Act, the United States Environmental Protection Agency (USEPA) has issued air quality standards for public exposure to safe levels of particulate matter suspended in the air. The focus of these standards is the protection of public health and welfare.

The term "particulate matter" (PM) includes both solid particles and liquid droplets found in air. Many man-made and natural sources emit PM directly or emit other pollutants that react in the atmosphere to form PM. Particles can range in size from large specks of soot to fine grains of dust with diameters about one-tenth the diameter of a strand of human hair. Fine particles ($PM_{2.5}$) result from fuel combustion in motor vehicles, power generation units, and industrial facilities, as well as from residential fireplaces and wood stoves. Coarse particles (PM_{10}) are generally emitted from crustal sources, such as dust generated by vehicles traveling on unpaved roads, material handling, crushing and grinding operations, as well as natural windblown dust from river gravel bars or other exposed areas.

The State and Federal air quality standards focus on “inhalable” size particulates, which are both fine and coarse. These materials can accumulate in the respiratory system and are associated with numerous health-related impacts. Exposure to coarse particles is primarily associated with the aggravation of respiratory conditions, such as asthma. Fine particles are more closely associated with increased hospital admissions and emergency room visits for heart and lung disease, increased respiratory symptoms and disease, decreased lung function, and even premature death. Sensitive groups that appear to be at greatest risk to such effects include the elderly, individuals affected by cardiopulmonary diseases such as asthma, and children. In addition to health problems, PM is a major cause of reduced visibility in many parts of the United States.

In order to maintain a healthy breathing environment, the National Ambient Air Quality Standard for PM_{10} is set as 150 $\mu g/m^3$ for a 24-hour average, (one microgram is one millionth of a gram) of particulate matter per cubic meter of air. If air monitoring results show that the concentration of PM_{10} is greater than this amount, the EPA may demand that action is taken to reduce airborne particulate to protect the health of residents. This monitoring project was conducted in the Northwest Arctic Borough to determine if local air quality meets the National Ambient Air Quality Standard for coarse particulate matter (dust).

Monitoring Strategy

The equipment used in all communities to evaluate the concentration of airborne dust particles in ambient air was the Andersen High-Volume (Hi-Vol) PM_{10} sampler – an EPA designated Federal Reference Method (FRM) monitor. FRM sampling followed a 1 in 3 (1in 6 in 2011 -12) monitoring schedule for the majority of the time, meaning that a new sample filter was installed and the sampler operated every third day for 24 hours. Before being placed in the sampler, filters were pre-weighed on a high-precision scale in the laboratory to determine the weight of the filter without any dust deposit. The filter was then installed in the sampler, which used a mechanical timer to turn it on at midnight of the sample day and turn it off after it sampled for twenty-four hours. Ambient air was drawn in through the sampler head and filter media by a pump, similar to a vacuum cleaner motor so that airborne particulates were trapped on the filter. After sampling, the filter was returned to the laboratory and weighed again to determine how much dust was deposited on the filter. The difference between the two weights divided by the volume of air is the measurement that is used to determine 24-hour concentrations of PM_{10}. The samplers were set up alongside dirt roads in the communities, near a reliable power source, and near frequently-used routes where the most individuals were expected to be exposed.

The state and federal 24-hour health based standard for dust particulate size was set at 150$\mu g/m^3$ in 1987. During the sampling period between February 2003 and September 2005, 29 exceedances of the standard were reported using the Federal Reference Method Hi-Vol (High Volume) samplers. The maximum dust level reported was 608$\mu g/m^3$ (in Noorvik on July 23rd, 2004). The greatest number of exceedances was observed in Noatak (9 validated samples).

Kotzebue and Selawik both measured no exceedances, but Kotzebue had a higher average concentration of dust. For reference, the Federal Air Quality Standard for dust states that if a community has more than two exceedances of the standard in a year, averaged over a three-year period, the state and U.S. Environmental Protection Agency may declare the area non-attainment and require the community to take official steps to lower dust levels.

Buckland 2012 dust monitoring (before & after dust palliatives application)

Introduction

The purpose of 2012 monitoring in Buckland was to compare the road dust concentration levels after applying dust suppressants on selected roads (summer 2012) to the levels measured during the summers of 2003, 2004 prior to application. In 2003 we recorded one elevated value (164µg/m^3) of the National Ambient Air Quality Standard (NAAQS; 150µg/m^3) and in 2004 one elevated value (151µg/m^3). Buckland received three different dust suppressants and a trailer mounted palliative sprayer as part of the Alaska Department of Transportation and Public facilities (ADOT & PF) pilot study in 2010, but only two were applied in July 2012 in the location of our air quality monitors.

Buckland monitoring site specifics:

During the monitoring period in 2012 ADEC came across few challenges, related to road maintenance and its related air quality issues. Our air quality monitoring was part of the project focusing on the effectiveness of dust palliatives for reducing dust in rural villages caused by traffic.

In 2012 ADEC used the HiVol monitor (High Volume sampling method), and a continuous monitor Met One EBAM (Environmental Beta Attenuation Monitor), which was set to sample every hour. The EBAM recorded hourly PM_{10} levels as well as ambient temperature, barometric pressure, wind speed and wind direction from June through August 2012. The EBAM monitor was shut down in August because freezing temperatures can have a negative impact on the instrument performance. The Hi-Vol monitor operated on the EPA one in three day schedule prior to dust palliatives application and one in six days schedule after the application until the end of October 2012.

The EBAM monitor was co-located with the Hi-Vol monitor located next (approximately 3feet) to the road treated with dust palliatives. The EBAM was used to obtain continuous real time 1-hour average data accessible through internet/ Satellite connection any time.

ADEC compared the data collected by the continuous EBAM sampler and the HiVol. The HiVol sampler is federal reference Method (FRM) sampler and requires manual filter changes depending on sampling schedule (in this study 1 in 6 days). Both monitors are designed to sample PM10, but the HiVol air intake is greater (1000 l/min) than the EBAM (16.7 l/min). The HiVol sampling filters PM_{10} are weighted in the lab, and ADEC calculates particulate mass concentration. The EBAM calculates the particulate mass concentration at the end of every hour and averages these values for 24 hour period. The advantage of the EBAM is that the instrument is accessible any time through at the satellite modem connection, collects temperature, pressure, wind speed and direction while sampling, which helps to understand the characteristics of dust events at the site.

Federal Reference Method HiVol Monitor

There were 25 possible sampling days during the summer 2012 sampling period when following the EPA sampling schedule requiring sampling every sixth of three day for 24 hours from midnight to midnight. Flow checks were performed periodically by DEC personnel once a month in July, August and October. The site operator (Shannon M. Melton) was the site operator in Buckland. ADEC received 18 exposed filters for the entire summer sampling period all following the EPA schedule. The data capture was 72% and 84% data was considered valid according to the EPA requirements. There no values above the NAAQS. The results from the sample analysis are summarized in the table below.

Table 2: Hi-Vol - summary of filter PM_{10} concentration for each 'run' date in summer 2012

(Invalid data bold and underscored)

Date	Concentration µg/m3	Filter #	Comments
6/20/2012	7	Q9504218	Elapsed timer not working
6/27/2012	89	Q9504217	Elapsed timer continually running
7/7/2012	60	Q9504216	Fixed monitor -calibration done 7/6/2012
7/11/2012	118	Q9504215	Didn't reset timer
7/15/2012	20	Q9510400	Rainy
7/21/2012	22	Q9510399	Rainy
7/25/2012	<u>**4**</u>	Q9510398	Run twice 7/25/2012 & 7/31/2012
7/31/2012	<u>**4**</u>	Q9510398	Concentration value divided by 2
8/17/2012	<u>**7**</u>	Q9510397	Run twice & stopped
8/24/2012	13	Q9510396	Rainy
9/4/2012	5	Q4016218	Rainy, El. problems so it run 09/04/2012
9/11/2012	5	Q4016219	
9/16/2012	<u>**3**</u>	Q4016220	Run twice / Shannon out of town
9/25/2012	4	Q4016221	
9/30/2012	4	Q4016222	
10/6/2012	5	Q4016223	Rainy & very windy
10/12/2012	25	Q4016224	Dusty & Dry roads
10/18/2012	34	Q4016225	Dry & Windy
10/23/2012	3	Q4016226	Dry & 1st snowfall

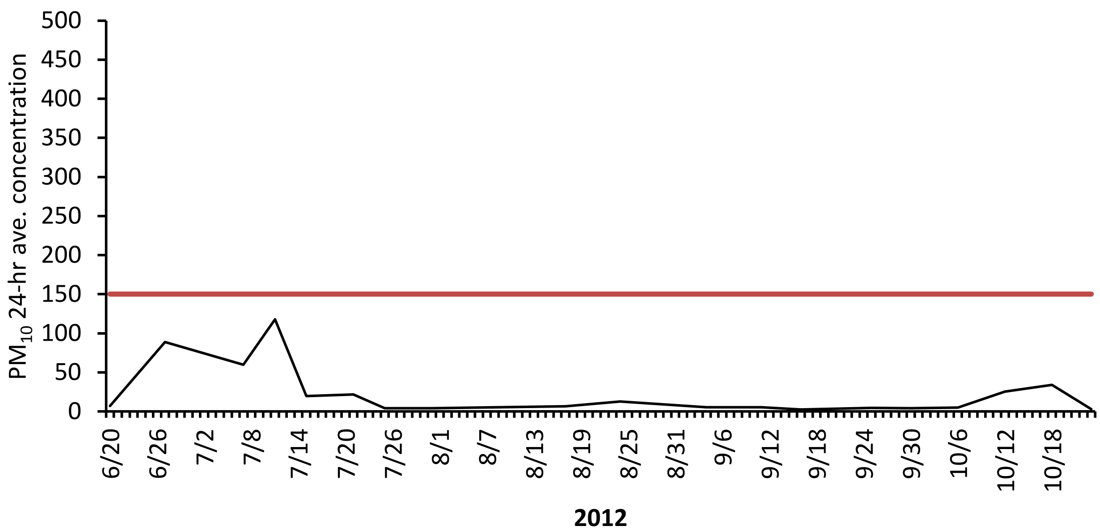

Figure 4: Summer 2012 Hi-Vol PM_{10} 24-hour average concentration compared to NAAQS (red line)

EBAM sampler

The highest values recorded by the EBAM sampler occurred during June and July. The EBAM monitor operated continuously for 3 months starting on June 19, 2012, collecting hourly PM_{10} concentrations, ambient temperature, relative humidity, wind speed and direction. The meteorological parameters provided information about weather patterns associated to dust events at the site. The monitor is set to Greenwich Time (GMT)

Note: The EBAM sampler is not an EPA approved reference method and cannot be compared to the NAAQS. ADEC only used the EBAM for real time PM_{10} data access, as well as temperature, relative humidity and wind speed and direction. In addition the calculated 24-hour averages were used to assess the suitability of the EBAM for PM_{10} road dust measurements in remote locations. The correlation between the EBAM and the HiVol was unsatisfactory. During the time both samplers operated collocated, the EBAM on average only captured roughly 61% of the particulate mass concentration measured by the HiVol.

Table 3: PM_{10} 24-hour average values measured by continuous EBAM monitor

(24-hour average concentration over 150µg/m^3 bold; underscored and highlighted in red)

Buckland 2012	PM10 Values µg/m3		
Day	June	July	August
1		9.5	10.2
2		25.4	6.4
3		18.5	9.4
4		13.5	11.6
5		15.4	13.9
6		33.9	16.0
7		133.7	23.6
8		30.3	30.0
9		20.9	26.5
10		40.4	28.0
11		38.2	36.2
12		23.5	27.4
13		13.4	26.2
14		12.1	19.9
15		8.0	12.9
16		11.0	12.9
17		7.2	10.6
18		11.5	9.7
19		8.9	10.1
20	45.4	13.1	10.3
21	31.7	14.5	6.1
22	31.5	**181.6**	
23	45.3	20.3	
24	14.6	15.7	
25	9.9	13.8	
26	31.2	18.4	
27	31.3	15.2	
28	31.4	11.8	
29	36.3	14.6	
30	42.8	9.0	
31		10.2	

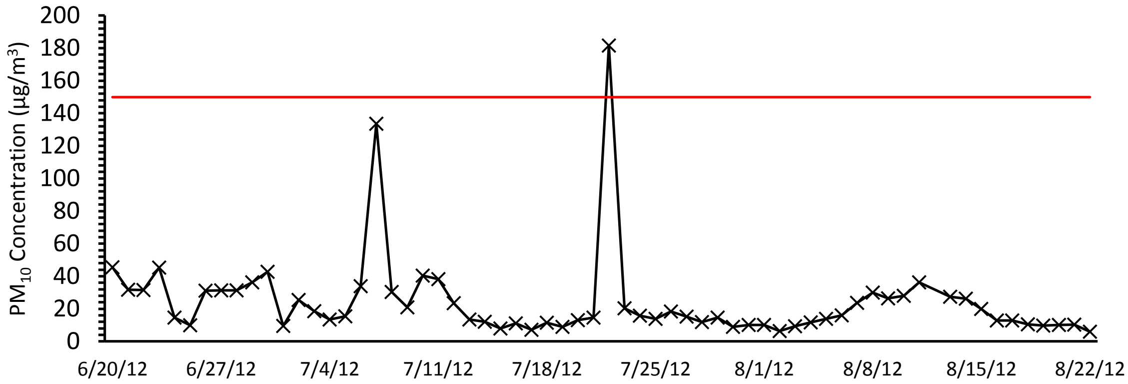

Figure 5: EBAM data summary summer 2012 compared to NAAQS (red line)

Discussion and Conclusion

The two different types of dust suppressants (EK-35 and Soil Sement) were applied on two sections of the main roads next to the sampler in Buckland in July in 2012 with the help of ADOT & PF. The precipitation levels were high during the monitoring season and the PM_{10} concentration levels did not exceed exceeded the NAAQS concentration measured by Hi – Vol monitor, but we could see a drop in PM_{10} levels after the dust palliatives application. The results clearly point at the fact that the dust palliatives do decreases PM_{10} levels. The roads should be treated on a regular basis to keep the dust level down. Success and longetivity of dust suppressant applications depend on many factors, a discussion of which is beyond the scope of this report.