Air Quality Monitoring
at
Big Lake, Alaska
2000 – 2002

March 8, 2012

Air Quality Division

Air Monitoring
&
Quality Assurance
Program

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Introduction

EPA required in 1997 that all states establish airborne fine particulate ($PM_{2.5}$) monitoring networks. The Alaska Department of Environmental Conservation (ADEC) incorporated this requirement into its existing, statewide network of regulatory and special purpose monitoring sites. ADEC maintains regulatory $PM_{2.5}$ monitoring sites in Juneau, Anchorage, the Matanuska-Susitna Borough, and Fairbanks. ADEC set up a special-purpose monitoring site at Big Lake, located between the urbanized area of the Municipality of Anchorage (MOA) and Denali National Park and Preserve (Denali NPP), a mandatory Class I area[1] managed by the National Park Service (NPS).

Figure 1. Map of Matanuska-Susitna Valley, Alaska.

Methods

Big Lake, a community of approximately 3,500 people, is approximately 25 air miles north of the Municipality of Anchorage and lies within the Matanuska-Susitna Borough between Anchorage and Denali NPP, another 200 air miles further north (A on Figure 1). Big Lake lies near the base of the Susitna River valley that varies in width from one to eight miles and from 50 to 250 feet in relief. The retreating glaciers, which occupied the Susitna Valley, left a topography dominated by ridges, clusters of streamlined hills, sand and gravel beds, and glacial deposits. This valley is part of the most agriculturally developed and population dense region in the state.

ADEC installed two Rupprecht & Patashnik Co., Inc. (now Thermo Fisher Scientific) Partisol Federal Reference Method (FRM[2]) $PM_{2.5}$ samplers on the roof of the Big Lake Elementary School in 2000. Refer to Appendix A for photos and a diagram of the site. The Partisol 2000 FRM collects a sample by continuously pumping ambient air through a size selective inlet and a pre-weighed Teflon filter for 24 hours. Staff collects the filters, weighs them, and uses the difference between the filter weights along with flow rate, flow duration, ambient temperature, and ambient barometric pressure to calculate mass concentration. ADEC programmed each sampler to operate once every six days with schedules offset from each other by three days. This schedule allowed sampling according to the EPA national one-in-three schedule[3]. ADEC staff uploaded sampling data into the Air Quality System (AQS), EPA's ambient air quality database. ADEC used the sample results 1) to compare to the $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS) and 2) as indicators of

[1] Class I areas, as defined by the Clean Air Act, include national parks greater than 6,000 acres, wilderness areas, national memorial parks greater than 5,000 acres; and international parks that existed as of August 1977.

[2] A federally referenced monitor is one that EPA has accepted for use by for comparison to the National Ambient Air Quality Standards (NAAQS) by meeting certain design, precision, and bias (performance) specifications (40 CFR Part 58).

[3] EPA specifies days throughout each year on which all federally referenced monitoring must take place. There are schedules that allow sampling once every three, six, or twelve days as well as daily.

possible $PM_{2.5}$ pollutant transport from the Anchorage area to Denali NPP. Refer to Appendix B for sample data.

Results & Discussion

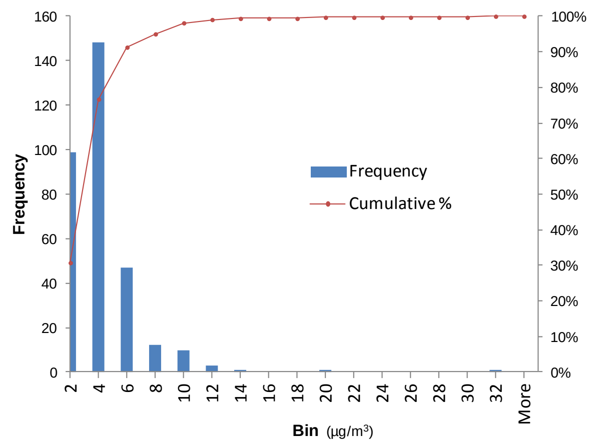

Figure 2. Frequency diagram showing distribution and cumulative frequencies of 24-hour average $PM_{2.5}$ data from ADEC sampler.

The Big Lake site operated from March 2000 through December 2002 (two years and 10 months), less than a full three years of operation, because budget cuts eliminated $PM_{2.5}$ monitoring sites that showed low $PM_{2.5}$ levels. The highest $PM_{2.5}$ sample value was 31.2 $\mu g/m^3$ on November 24, 2001and none of the data exceeded 65 $\mu g/m^3$, the $PM_{2.5}$ 24-hour NAAQS in effect at the time of the study or 35 $\mu g/m^3$, the $PM_{2.5}$ 24-hour NAAQS in effect since 2006. In general, the sample values at Big Lake are very low - 98% of the 24-hour average values are 10 $\mu g/m^3$ or less (Figure 2).

The data set as a whole does not show strong differences between seasons or between years (Figure 3, Table 1). Areas that are significantly impacted by forest fires in the summer season (June through August) and smoke from wood home heating in winter (November through March) typically do show higher $PM_{2.5}$ concentrations during those times.

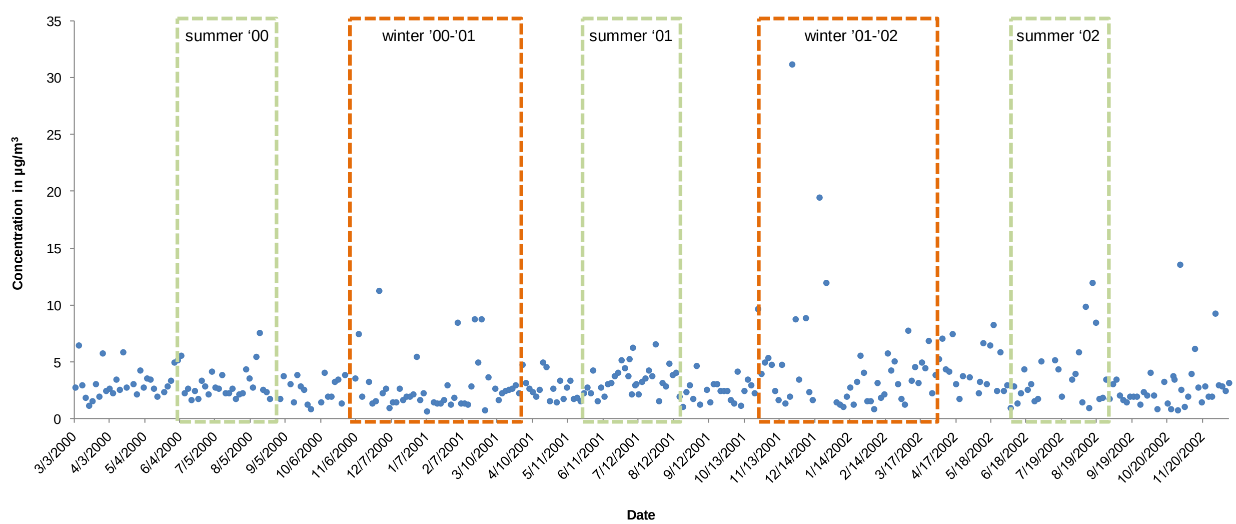

Figure 3. Scatterplot of 24-hour average $PM_{2.5}$ concentrations versus time at Big Lake School.

Table 1. Summary values of 24-hour $PM_{2.5}$ concentrations at Big Lake School.

Season	Seasonal average	Seasonal maximum	Year	Annual average	Annual maximum
Summer 2000	3.1	7.6	2000*	3.0	11.3
Winter 2000/2001	2.9	11.3	2001	3.6	31.2
Summer 2001	3.3	6.6	2002	3.6	13.6
Winter 2001/2002	4.6	31.2			
Summer 2002	3.7	12.0			
Winter 2002**	3.2	9.3			

*not a full year of data
**not a full season of data

EPA uses a probabilistic method to determine if an area's air quality meets the $PM_{2.5}$ NAAQS. This type of method allows for multiple exceedances as long as the distribution of sampled values is such that a set statistic is less than the NAAQS. It makes compliance with the NAAQS less sensitive to extreme conditions that may not be typical of the local area. At the time of this study, an area complied with the $PM_{2.5}$ 24-hour NAAQS if the average of the 98th percentile values for three consecutive years was less than 65 µg/m^3 and with the annual NAAQS if the 3-year average of weighted annual means was less than 15 µg/m^3. EPA refers to the statistic calculated from the sample data i.e., the three year averages described above, as the "design value." A design value can also be calculated using modeling results or a count of the number of exceedances of a NAAQS. Design values change from year to year depending on meteorological conditions, pollutant levels, and unusual events.[4]

Even though the first "year" of the study did not encompass the full calendar year, the 98th percentile values for individual monitoring years are useful for estimating design values and for tracking data trends. Table 2 lists yearly 98th percentile values along with the 24-hour and annual NAAQS values. The table lists both the 1997 NAAQS that was in effect at the time of the study and the current NAAQS in effect since 2006. The 24-hour average 98th percentile and the annual, weighted mean values for the sample period are well below both the 1997 and 2006 NAAQS.

Table 2. $PM_{2.5}$ 24-hour and annual design values at Big Lake, AK from 2000 through 2002. All concentrations are in µg/m³.

	24-hour			Annual		
	98th percentile	1997 NAAQS	2006 NAAQS	Weighted mean	1997 NAAQS	2006 NAAQS
2000	7.6*			3.0		
2001	12.0	65	35	3.6	15	15
2002	9.9			3.5		

*Not a full year of data

[4] Refer to 40CFR Part 50 for detailed methodology.

ADEC compared the Big Lake data with data from FRM samplers at both MOA and DENALI NPP.[5] ADEC used data subsets comprising data paired by sampling date and excluding values below 2 μg/m³, the lower detection level of the FRM.[6] Linear regressions of the Big Lake and MOA data subsets and the Big Lake and DENALI NPP data subsets yielded regression coefficients of 0.40 and 0.21 respectively (Figure 4a, b). The regressions indicate that $PM_{2.5}$ concentrations at the MOA site are not good predictors of $PM_{2.5}$ concentrations at the Big Lake site and, similarly, that $PM_{2.5}$ concentrations at the Big Lake site are not good predictors of $PM_{2.5}$ concentrations at the DENALI NPP site. If there was significant transport of $PM_{2.5}$ pollutant transport from MOA to Denali NPP via Big Lake, one would expect to see that reflected in high regression coefficients.

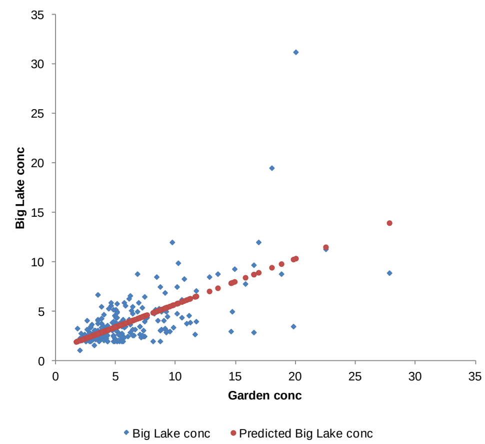

Figure 4a. Linear regression of Big Lake concentrations on MOA concentrations; N = 229, $r^2 = 0.40$.

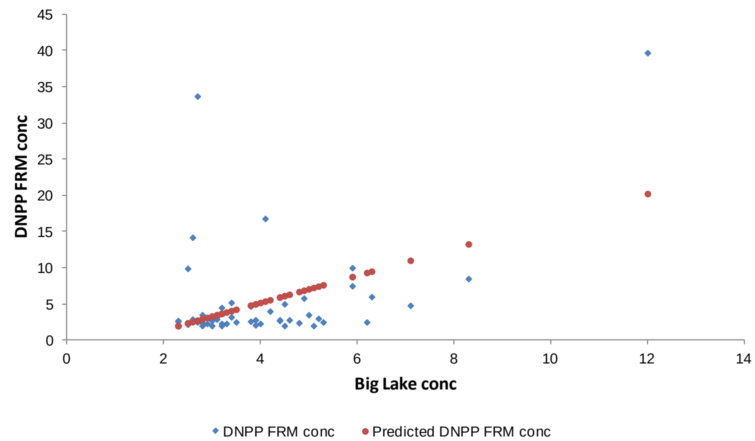

Figure 4b. Linear regression of DENALI NPP concentrations on Big Lake concentrations; N = 51, $r^2 = 0.21$.

[5] MOA sampler located at Garden site on E. 16th Ave.; DENALI NPP sampler located at Park Headquarters (ADEC, 2012).

[6] EPA estimated the lower detection limit of the mass concentration range for $PM_{2.5}$ to be 2 μg/m^3 based on mass changes in field blanks (40CFR50 Appendix L). ADEC incorporated this value into its Quality Assurance Project Plan (QAPP) for $PM_{2.5}$.

References Cited

Alaska Department of Environmental Conservation, 2012, “Air Quality Monitoring at Denali National Park & Preserve, Alaska: 2000-2003.”

Appendix A

Site Photos and Specifications

Figure 4. Big Lake Elementary School $PM_{2.5}$ Site-North View

Figure 5. Big Lake Elementary School $PM_{2.5}$ Site-East View

Figure 6. Big Lake Elementary School $PM_{2.5}$ Site-South View

Figure 7. Big Lake Elementary School $PM_{2.5}$ Site-West View

Big Lake Elementary School Roof Site Diagram

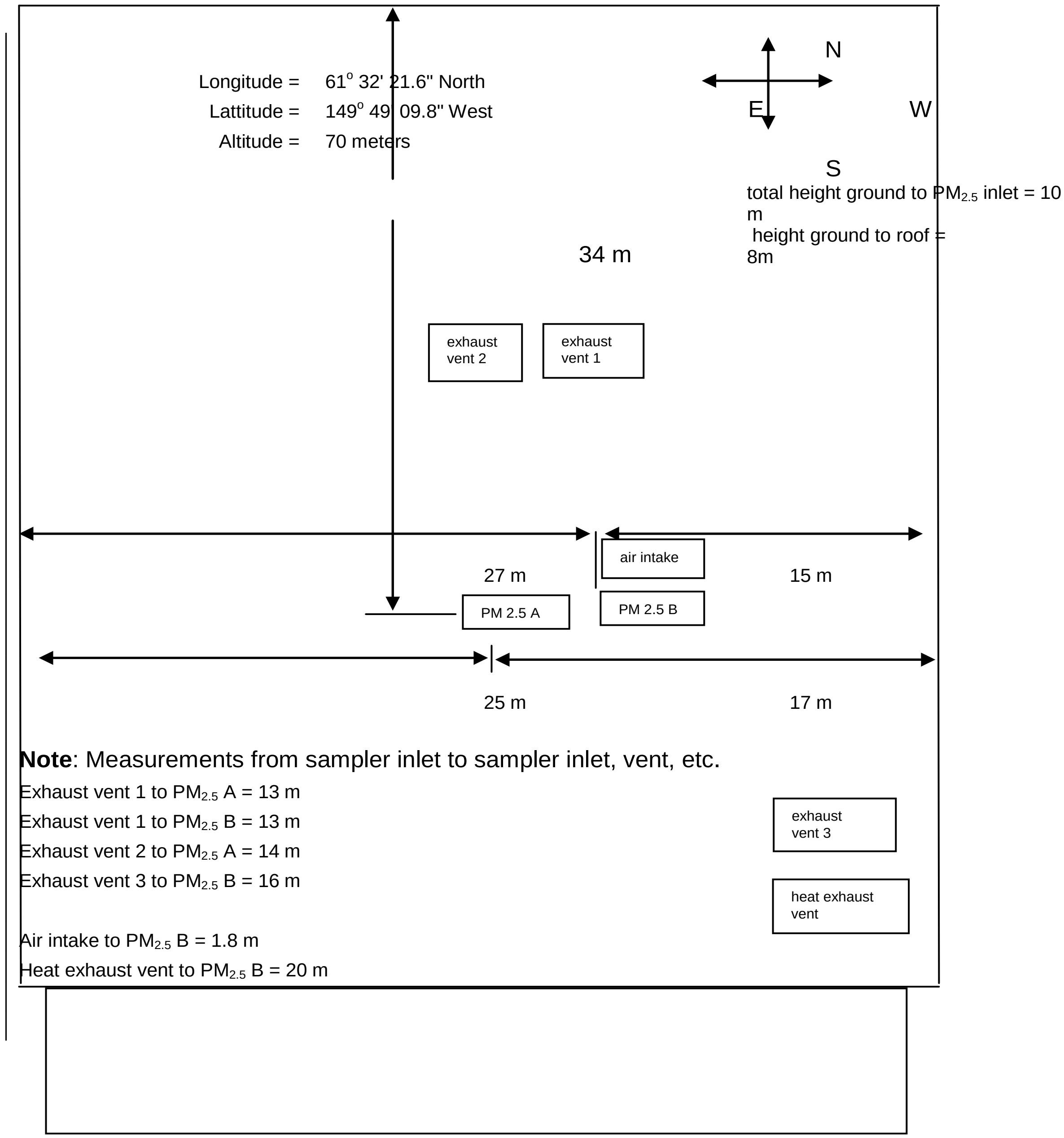

Figure 8. Big Lake Elementary School roof – site diagram.

Appendix B

$PM_{2.5}$ Data

BIG LAKE DATA

Date	Sample Value
20000304	2.8
20000307	6.5
20000310	3
20000313	1.9
20000316	1.2
20000319	1.6
20000322	3.1
20000325	2
20000328	5.8
20000331	2.5
20000403	2.7
20000406	2.3
20000409	3.5
20000412	2.6
20000415	5.9
20000418	2.8
20000424	3.1
20000427	2.2
20000430	4.3
20000503	2.8
20000506	3.6
20000509	3.5
20000512	2.7
20000515	2
20000521	2.4
20000524	2.9
20000527	3.4
20000530	5
20000602	5.2
20000605	5.6
20000608	2.3
20000611	2.7
20000614	1.7
20000617	2.5
20000620	1.8
20000623	3.4
20000626	2.9
20000629	2.2
20000702	4.2
20000705	2.8
20000708	2.7
20000711	3.9
20000714	2.3
20000717	2.3

20000720	2.7
20000723	1.8
20000726	2.2
20000729	2.3
20000801	4.4
20000804	3.6
20000807	2.8
20000810	5.5
20000813	7.6
20000816	2.6
20000819	2.4
20000822	1.8
20000831	1.8
20000903	3.8
20000909	3.1
20000912	1.5
20000915	3.9
20000918	2.9
20000921	2.6
20000924	1.3
20000927	0.9
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20001015	2
20001018	3.3
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20001024	1.4
20001027	3.9
20001105	3.6
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20001111	2
20001114	2.4
20001117	3.3
20001120	1.4
20001123	1.6
20001126	11.3
20001129	2.3
20001202	2.7
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20001214	2.7
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20001220	2
20001223	2
20001226	2.2

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20010107	0.7
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20010305	2.1
20010308	2.7
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20010314	2.3
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20010507	1.8
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20010513	3.4
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20010609	2.8
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20011212	1.7
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20020219	4.3
20020222	5.1
20020225	3.1
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20021210	2.5
20021213	3.2

MOA DATA GARDEN SITE

Date	Sample Value
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20000602	5
20000605	5.8
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20000611	3.3
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20000620	2.5
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20000708	4.1
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20000717	2.4
20000720	3.5
20000723	2.6
20000726	2.3
20000729	3.6
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20000804	4.3
20000807	3.5
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20011109	6
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20020210	5.3
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20020219	7.5
20020222	9.1
20020225	9.2
20020303	3.3
20020306	15.8

20020309	9.8
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20020315	8.8
20020318	14.7
20020321	9.3
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20020327	2
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20020426	5.5
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20020514	5
20020517	7.4
20020520	10.7
20020523	3.7
20020526	4.6
20020529	2.9
20020601	3.8
20020604	2
20020607	3.2
20020610	2.9
20020613	2.4
20020616	7.6
20020619	3.2
20020622	3.2
20020625	2.7
20020628	3.2
20020701	6.3
20020704	4.4
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