Monitoring Analysis
of Air Surrounding a Chippewa Falls, WI
Frac Sand Processing Plant

Brief Summary

Data from a monitoring project by Concerned Chippewa Citizens (CCC) shows strong evidence for detection of particulate matter emanating from the EOG Resources (NYSE: EOG) sand processing facility located in the Northeast corner of Chippewa Falls, WI.

Three questions are examined:

1. Is there reason to believe there are other sources of particulates that might affect either of the principal monitoring sites?

   Answer: NO

2. Is there reason to believe the EOG site is producing off site particulate pollution?

   Answer: YES

3. Is the particulate matter of sufficient quantity and/or quality to be a health hazard?

   Answer: Quite possibly. This monitoring effort can not answer this definitively. However, strong evidence of particulate matter from the EOG plant at locations over a mile from the facility call for a more intensive investigation by the Wisconsin DNR and Department of Health.

Summary

Concerned Chippewa Citizens (CCC) of Chippewa Falls, WI, now part of the Save the Hills Alliance (STHA), were concerned that the EOG RESOURCES sand processing plant located in Chippewa Falls would adversely affect air quality in the area. Particulate matter and respirable crystalline silica, a particulate produced when working sand, are known to have adverse health effects. An air monitoring system was set up using inexpensive monitors.

Two of the monitors, called “Jo” and “Up”, were positioned on opposite sides of the site such that the line between them would cross the EOG site. This would allow, under appropriate wind conditions, the best opportunity for “Jo”, for example, to measure particulate matter in the air downwind of the EOG site and for “Up” to measure particulate matter in the air immediately upwind of the site, and conversely. When the wind blew in the direction of the line between the two monitors, the difference in the amount of particulate matter measured by the one upwind when compared to the amount measured by the one downwind could be used to determine how much particulate matter was contributed by the plant. See pages 5-6 for an explanation and image of the monitor and site locations.

Three questions are explored and answered:

1. **Is there reason to believe there are other sources of particulates that might affect either of the Up or Jo sites more than the other?**

   If there were other large sources of particulates this could affect the analysis. Sites with such differing large sources of particulates would not be expected to change particulate concentrations in a corresponding manner and a regression of one such site on the other should show sizable error. Sites which are very large distances apart, and therefore without the same large associated sources of particulates, should not show high correlation. The correlation of Jo and Up with a distant site, Menomonie, are about 0.70; the correlation between the Jo and Up sites is about 0.94. Using regression and graphical data examination it is shown that there is much greater variability with the Menomonie site than between the Jo and Up sites. **The conclusion is that there is evidence that there are no other large sources of particulates affecting either Jo or Up and not the other.**

2. **Is there reason to believe the EOG site is producing off site particulate pollution?**

   Differences in particle counts between the two sites when the wind was blowing from one to the other, can be used to demonstrate whether it is likely there is particulate pollution emanating from the EOG plant. Comparing the measurements at the two sites when the wind was blowing from the Up site towards the Jo site, 97% of the data points indicate greater concentration of particulate matter at Jo than at Up. Conversely when the wind was blowing from Jo towards Up, 78% of the data points indicate greater concentration of particulate matter at Up than at Jo. **The conclusion is there is good reason to believe there is particulate pollution emanating from the EOG plant.**

3. **Is the particulate matter of sufficient quantity and/or quality to be a health hazard?**

In order to answer this question, the adjusted difference in small particle counts between the site at Up and the site at Jo for appropriate wind directions must be converted into a form comparable to standards, i.e. a concentration of weight per unit volume. This analysis brackets the concentration between an estimated minimal and maximal concentration.

Of 57 days with wind conditions and humidity appropriate, using the maximal concentration:

- **3.5% show possible exceedances of the EPA PM2.5 standard on a 24 hour basis**
- **37% show possible exceedances of this standard on an average hourly basis**
- **51% have at least one hour which possibly exceeds the standard.**

In addition each of the above exceedances would also, assuming a 10% silica content, exceed various state benchmark levels for silicosis. The data behind these numbers were from monitors about a mile from the facility. It is a safe assumption that as one gets closer to the facility the exceedances would increase.

A particulate monitor required by the Wisconsin Department of Natural Resources (WDNR) and operated by EOG is located onsite. However, it is a single PM10 monitor and the use of a single monitor is inadequate for the determination of concentrations of particulate matter emanating from a site and affecting nearby populations. For Analysis of Inadequacy of WDNR air monitoring requirements at sand mines and sand processing plants: **See APPENDIX A.**

The overall conclusion must be that the Wisconsin DNR has been negligent in regulating this site and its continued operation may be hazardous to the health of the surrounding community.

Preface

Sand mining in Buffalo County became an issue for me in December of 2011 when my wife and I received a notice from the Buffalo County Zoning Department informing us that there was an application for a Conditional Use Permit for a mining operation near where we own property. I attended the hearing and although that mine's application was withdrawn, another application for one a short distance away was approved.

A few days later while walking with our dog I noticed a digger high up on a sloping field about 20 feet away from our property line. The person supervising the dig was a geologist and indeed they were exploring for sand. He told me they didn't find anything close to the surface so mining wouldn't be worthwhile there.

A little research on why the sand was valuable and what it was destined to be used for convinced us that sand mining and processing had potential to damage the environment and health of people both local and distant. I came upon the website of the CCC/STHA and was impressed by the monitoring network that had been set up. I had learned enough to understand that the Wisconsin DNR would not take a pro-active role in particulate monitoring and that they would need to be cajoled by citizens to fulfill their mandate to be protective of public health and the environment.

I have a graduate degree in statistics from the University of Minnesota and experience with data analysis while working at the Red Wing Shoe Company and Gundersen-Lutheran Health Center, so I offered to analyze the data. Hank Boschen had set up and maintained the citizens' monitoring network. It is due to his efforts that this type of analysis can be completed. Hank accepted my offer and told me how to access the data. I have examined the short term data continuously for some of the sites and with small gaps for the rest from Jan. 5, 2012 to April 1, 2012.

As my knowledge of the actual site and activities on it is limited, I assume each day had the same potential for particulate release. The software used in the analysis was: MacAnova version 5.05, available from the Statistics Department at the University of Minnesota.

I would be glad to discuss this analysis. I can be contacted at:

Jeff Falk
Box 5
Fountain City, WI 54629
PHONE: 608-687-8486

Introduction

The monitors used at the sites are Dylos 1100 Air Quality Monitors. These are small units designed for indoor use to indicate counts of aerosols for people concerned with the level of dust in their homes, offices, etc. The Dylos Company website provides relevant user information. (http://www.dylosproducts.com/index.html)

Particles are drawn into a chamber by a small fan and a light beam is scattered off them and a sensor counts the number of hits by the scattered light. The monitors purchased have two channels for counts: one for particles greater than or equal to 2.5 microns, denoted 2.5μm, and the other for particles greater than or equal to 0.5 microns. (A micron is one one-millionth of a meter.) The count for the second channel will include the count for the first channel and therefore the difference between the two counts would yield counts for particles between 0.5μm and 2.5μm.

These smaller particles are the ones with the greatest potential to seriously affect health. They are called “respirable”. In particular, sand mining and/or processing will produce particulates from the sand and the associated engines and motors, including the particulates from diesel exhaust, and respirable silica, which is small enough to be inhaled and entrapped deep in lung tissue. All of these are thought to have many negative health effects. (See http://www.uwec.edu/CONHS/programs/enph/silica/HealthEffects.htm)

Standard monitors used for outdoor monitoring of particulate matter cost thousands of dollars. The Dylos monitors run $200-$300.

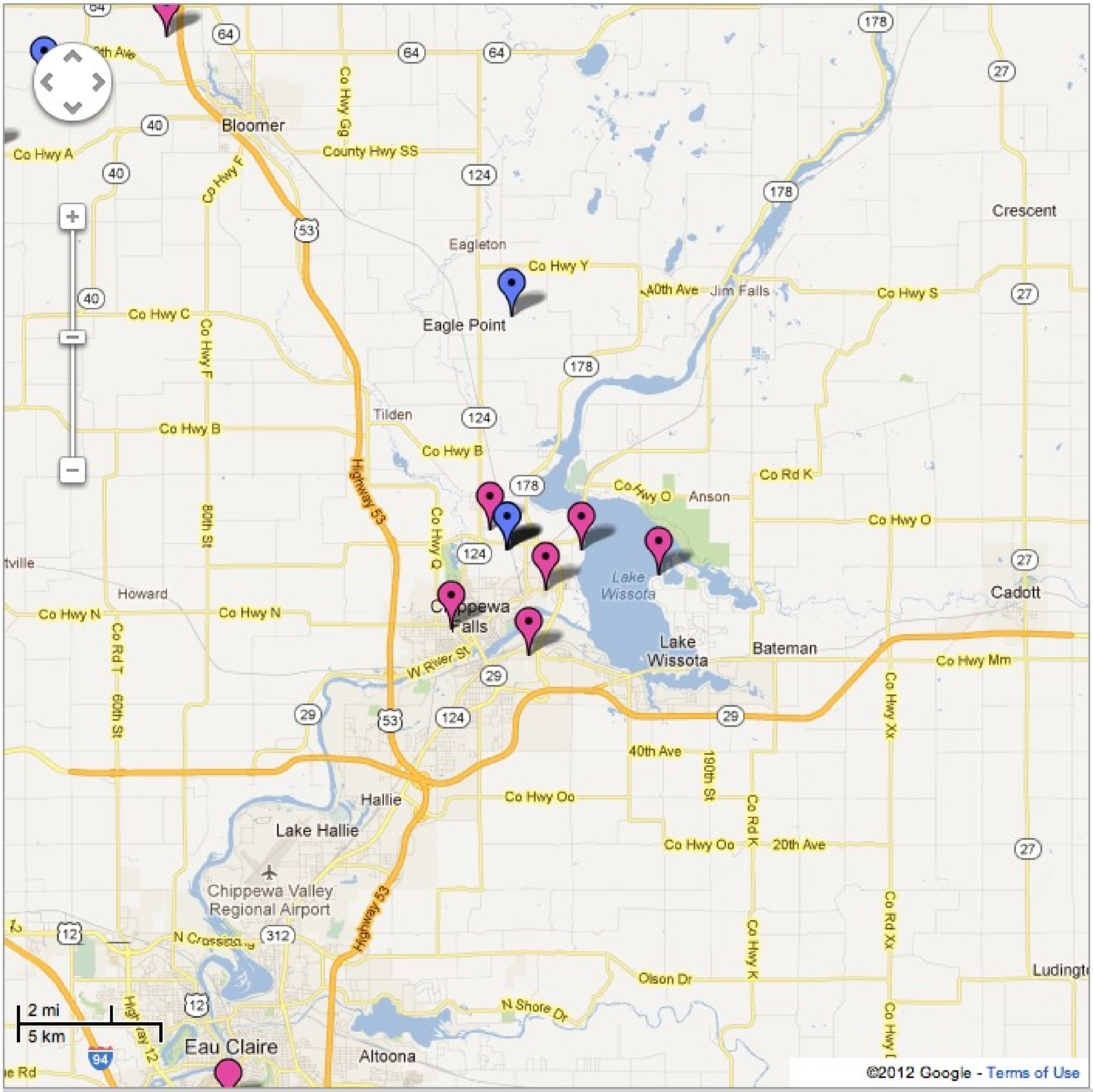
The EPA has established a National Ambient Air Quality Standard (NAAQS) for particles less than 10μm in size, PM10, and particles less than 2.5μm in size, PM2.5. The EPA standard for particles 2.5 microns and smaller is a 24 hour average of 35 micrograms per cubic meter. (A microgram is one one-millionth of a gram.) These standards were designed to be used with a monitor placed at a single location as information about the concentration exposure for the “general” population.

In addition, the National Institute of Occupational Safety and Health (NIOSH) has a recommended silica exposure level for an 8 hour occupational work shift of 50μg per cubic meter and the California Air Resources Board has established a chronic reference concentration in relation to silicosis of 3μg per cubic meter.

Citizens in Chippewa Falls were concerned with particulates that leave the EOG site. The concerned citizens were not able to encircle the site close to the perimeter and set up monitors where they could be used to estimate particulate concentrations around the area.

The following map shows the sites of monitor placement and the location of the EOG processing plant in the city of Chippewa Falls, Wisconsin.

This map came from the website of : Concerned Chippewa Citizens/ The Save the Hills Alliance. There is much useful information on this site.



Map indicates the sites of monitor placement as maroon markers and the EOG processing plant in the City of Chippewa Falls as the center blue marker.

The two sites used in this analysis are the one less than 1 mile northwest of the plant, named “Up”, and the one less than 1.5 miles southeast of the site, located near St. Joseph’s Hospital, and in this analysis named “Jo”. These two sites and the plant appear to lie almost on a straight line. It is assumed that the weather conditions as reported by the Eau Claire/ Chippewa Valley Regional Airport are applicable to both of them and it is shown that there is reason to believe there are no other large local sources of particulate matter that impinge on one site but not the other.

Therefore, when the wind is blowing from the NW to the SE, and the Jo site has a higher particle count than the Up site, we can reasonably maintain that the added particles are due to the processing plant. Similarly, when the wind blows from the SE to NW and the Up site has a higher particle count than the Jo site, we can again reasonably maintain that the added particles are due to the processing plant. We can also assume that particulate matter from the plant site will contain silica in the form of crystalline silica, a known health hazard.

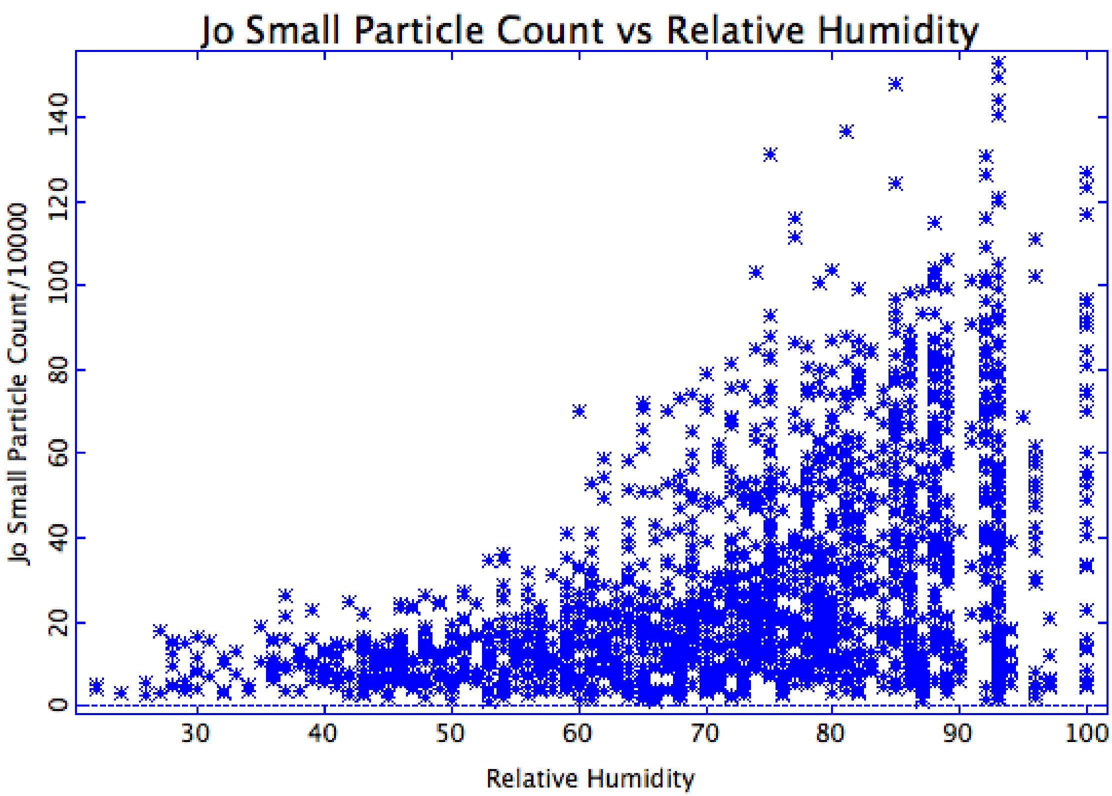
How to use the EPA standard in a fugitive dust monitoring analysis is not obvious. One simple idea is to use the EPA PM2.5 standard but look at exceedances per hour. Many hours showing exceedances could indicate a significant long term problem.

The EPA standards are in micrograms per cubic meter whereas the Dylos monitors give counts of particles of a certain size range in 0.01 cubic feet. To compare, it is necessary to convert from counts per cubic foot to micrograms per cubic meter. Usually it is assumed the particles are spherical in shape and given a radius, their volume can be calculated as the volume of a sphere. A density for the particles is also assumed, and then, the product of

1) particle counts per volume, 2) volume per particle, and 3) density in mass per volume

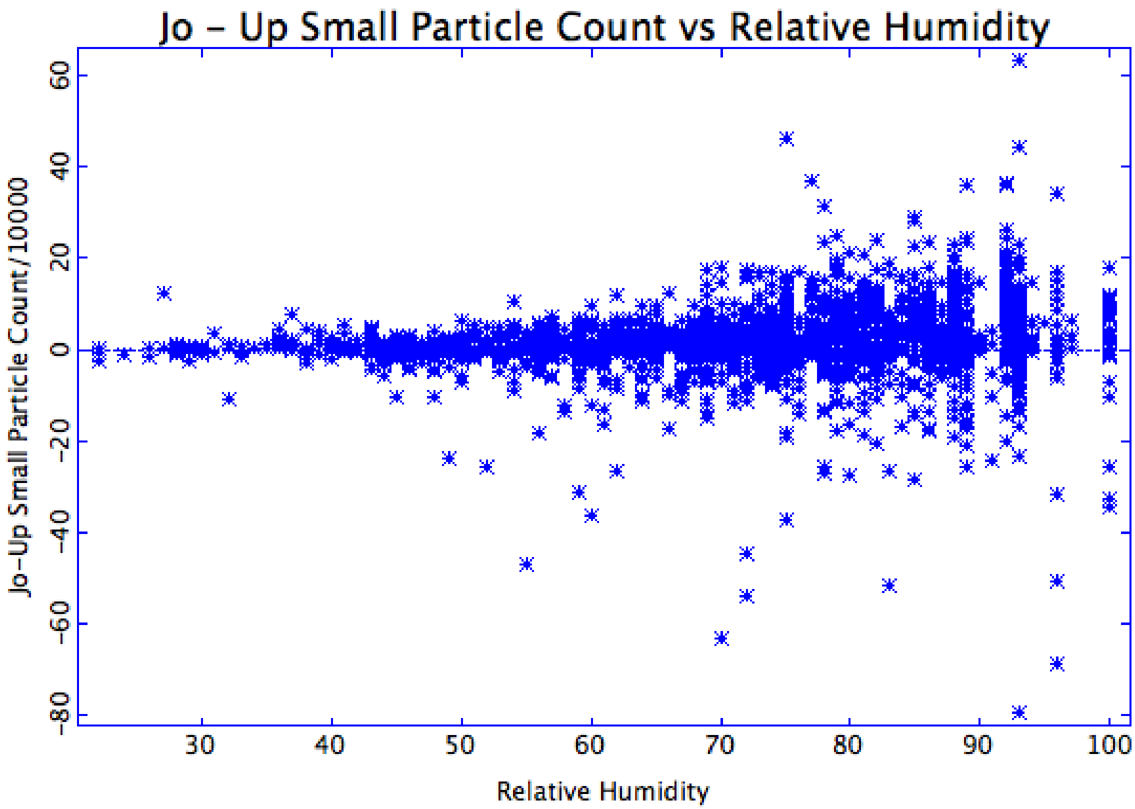
will yield a number of micrograms per cubic meter, <u>if the unit conversions are done appropriately</u>. Two quantities are assumed: a radius for a particle and a density for the particles.

There are complications involved with using any particle counter like the Dylos monitor that uses light scattered by particles. In situations of high humidity, fog or mist can scatter light and be counted as particles. The effect of this can be seen in **Figure 1**:



Variability increases as humidity increases; the upper limit increases. However, as Figure 2 shows this effect appears to influence the two sites equally as the count differences are centered close to the zero line.

Figure 2:



In addition some particles absorb light; when this happens light would not scatter and a particle would not be counted. Some particles are hygroscopic and in high humidity conditions can absorb water which would add to their mass and the assumption of a dry density would not be correct.

These are all weather related and our assumption of similar weather at both the Up and Jo site would tend to equalize these complications at both sites; under these assumptions, if the wind were right, a difference in counts could still be attributable to the EOG plant.

The analysis to follow is in three sections to answer the three questions examined in this paper.

1. Is there reason to believe there are no large sources of particulates that would affect one of the Up or Jo sites more than the other?
2. Is there reason to believe the EOG site is producing particulate pollution?
3. Is the particulate pollution of sufficient quantity and/or quality to be a health hazard?

Analysis of Data

Every ten minutes the Dylos monitors produce an average per minute count per 0.01 cubic feet for the past ten minutes. Multiplying each of these average counts within an hour by 10 (for each minute) and by 100 (to change to per cubic foot) and summing produces a total particulate count per 60 cubic feet for that hour. Dividing by 60 yields a total particulate count per cubic foot for that hour. This resulted in 2040 hourly data points for days 6 through 91, 1/6/2012 through and including 3/31/2012, or 86 days total for the Up and Jo sites. Other sites had fewer hourly data due to assorted problems.

In what follows, the Dylos large particle count - particles greater than 2.5µm - was subtracted from the smaller particle count - particles greater than 0.5µm. **The result is a count for particles between about 0.5 and 2.5 microns, called the “small particle count."** These are the particles most likely to have adverse health effects and are most likely to be wind-affected.

The maximum of the small particle counts is over 1,600,000, and the minimum is above 5,000. In order to make the graphs easier to read the counts are divided by 10,000. So, a count of 1,000,000 would read 100 and a count of 30,000 would read 3. This is always indicated in the axis labels of the graphs.

1. **Is there reason to believe there are no large sources of particulates that would affect either of the Up or Jo sites more than the other?**

If two sites were being largely affected by different sources of particulates, the types of changes of particulates at one should not follow the types of changes at the other, ie they should not have a high correlation. And one should not be able to predict with good precision, using a regression analysis, the counts at one knowing only the counts at the other. This is because the source largely affecting only one would not be taken into account in the regression. Conversely, if two sites were not being largely affected by different sources they should be highly correlated and more accurate prediction should be possible.

There is a monitor in Menomonie, WI, that has 1751 good hourly data values. Menomonie is about 28 miles from the monitors at Upwind and Jo. Given the large distance, there is no reason to believe one could accurately predict the Menomonie counts from the Chippewa Falls counts. This is illustrated by examining the correlation between sites, graphs, and the results of a regression analysis.

Correlation of Menomonie, Up, and Jo using Menomonie data hours:

	Menomonie	Up	Jo
Menomonie	1	0.702	0.705
Upwind	0.702	1	0.943
Jo	0.705	0.943	1

For the same hourly data the correlation between the Menomonie and Up site is about 0.70; the correlation between Menomonie and the Jo site is also about 0.70.

These are considerably lower than the correlation between the two Chippewa Falls sites, about 0.94. The higher the correlation between two sites the more closely the counts at each site follow each other. Using all the data (2040 hours) the correlation between the Up and Jo sites is also about 0.94.

Jo and Menomonie have a low correlation, indicating there may be different sources of particulates affecting each; whereas Jo and Up have a high correlation, confirmation of no large sources effecting Jo that do not also affect Up.

Further confirmation is shown below. Figure 3 is a plot of the Menomonie vs. Jo data with a regression line added. The regression had an R-squared value of 0.49 and a mean squared error of about 147.5. The R-squared value can be interpreted as implying that about 49% of the variability at the Menomonie site can be explained by the Jo data.

```
@x<- jomedif/10000;@y<- medif/10000;

regress("@y=@x",pval:T) Model used is @y=@x
```

	Coef	StdErr	t	P-Value
CONSTANT	10.50808802	0.4443297644	23.64930028	< 1e-08
x	0.4851259271	0.01173278586	41.34788896	< 1e-08

N: 1728, MSE: 146.3622841, DF: 1726, R^2: 0.4976202336
Regression F(1,1726): 1709.647921, P-value: < 1e-08, Durbin-Watson: 0.1842996141

Figure 3:

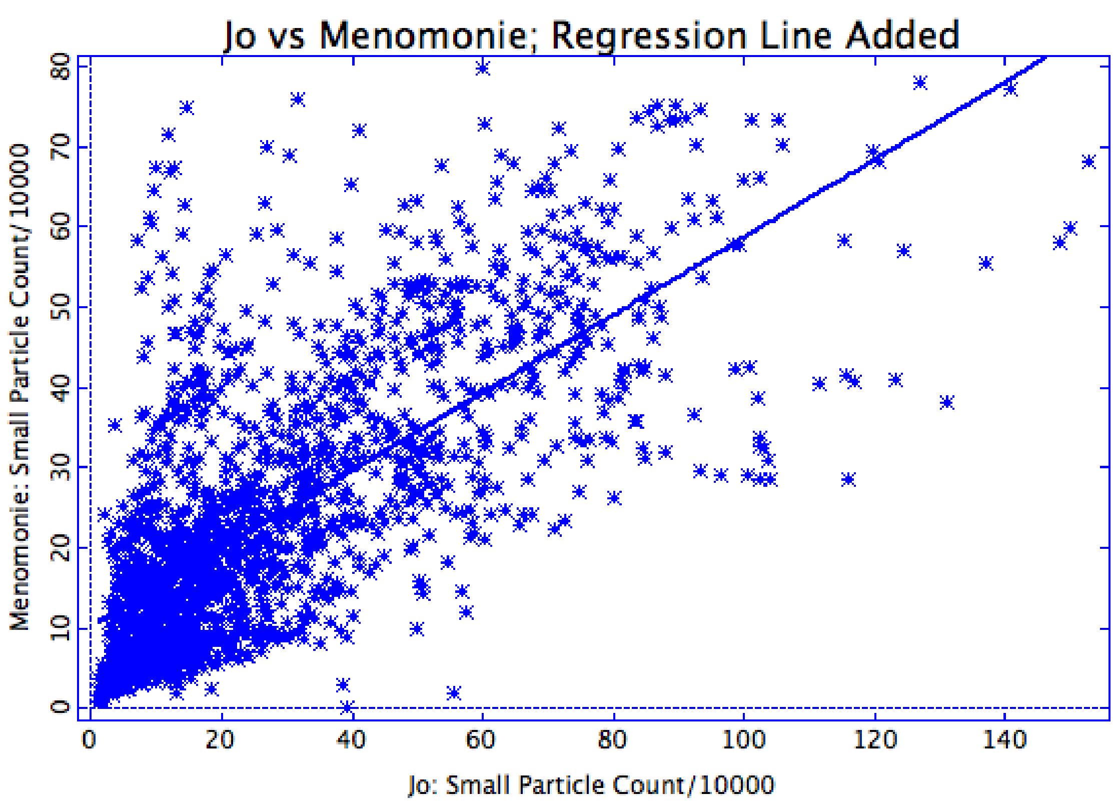


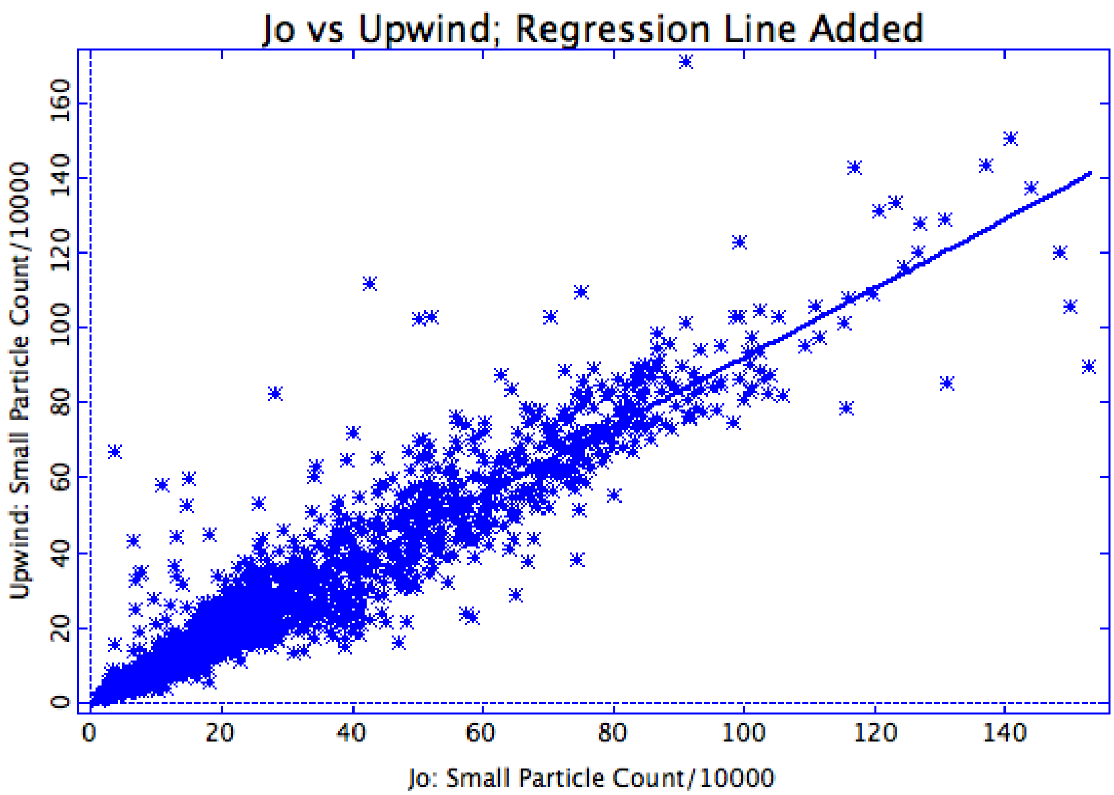
Figure 4 below is a plot of all the Jo vs. Up data with a regression line added. The regression had a R-squared value of 0.89 and a mean squared error of about 69.3. This is less than half of the mean squared error for the regression of Jo vs Menomonie. The R-squared value implies about 89% of the variability at the Up site can be explained by the Jo data, much greater than the 49% for Jo and Menomonie. This is again evidence for the similarity of sources affecting Jo and Up.

```
Cmd> @x<- jodif/10000;@y<- updif/10000;regress("@y=@x",pval:T)
Model used is @y=@x
```

	Coef	StdErr	t	P-Value
CONSTANT	0.4234885973	0.2699489396	1.568772961	0.1168560898
x	0.922623446	0.00693848926	132.9718057	0

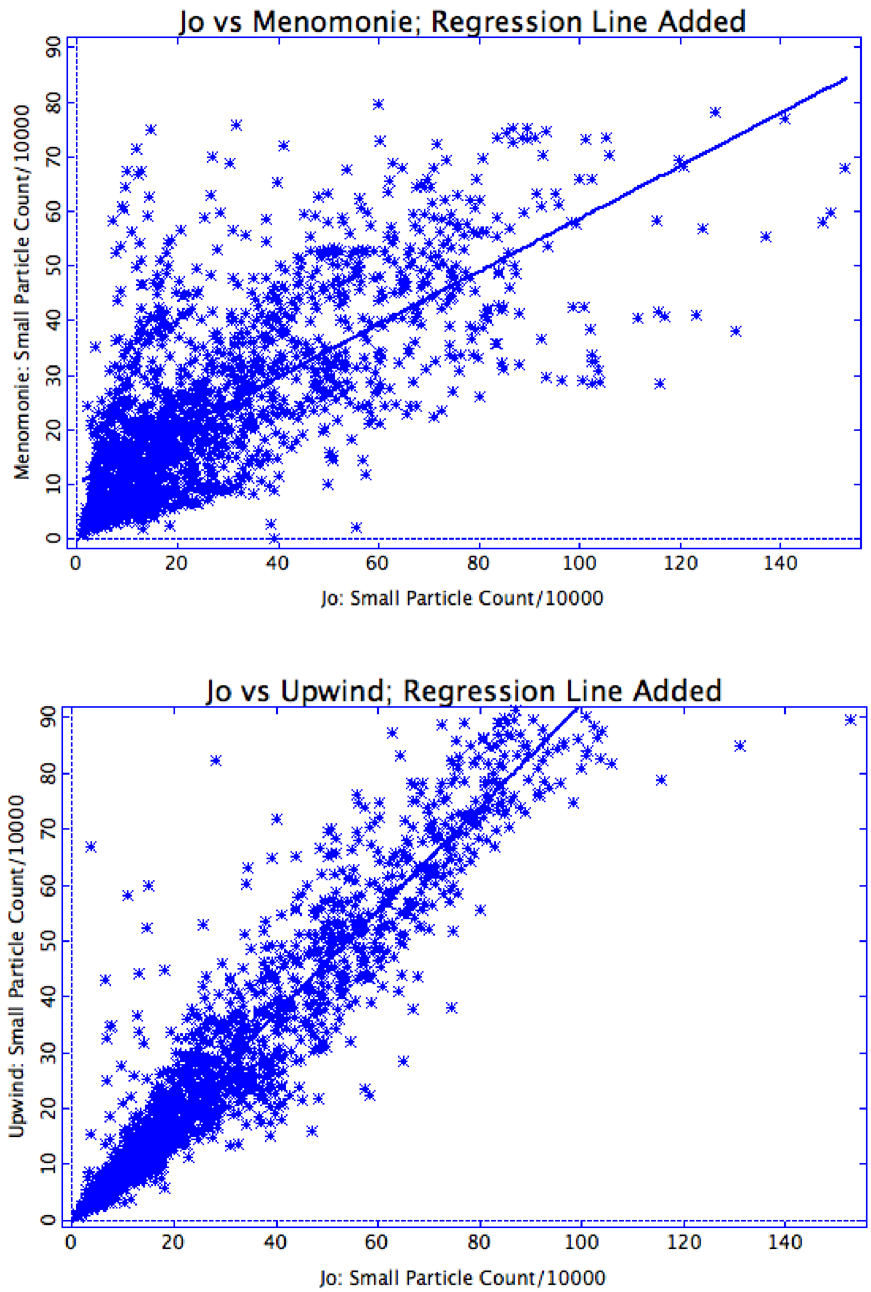
N: 2040, MSE: 64.84484871, DF: 2038, R^2: 0.8966505295
Regression F(1,2038): 17681.50112, P-value: 0, Durbin-Watson: 0.7010331387

Figure 4



To make the comparison clearer, the next two graphs (Figure 5) are the same plots with equivalent scales.

Figure 5



It should be apparent that the points cluster tighter (variability is less) in the second plot than in the first.

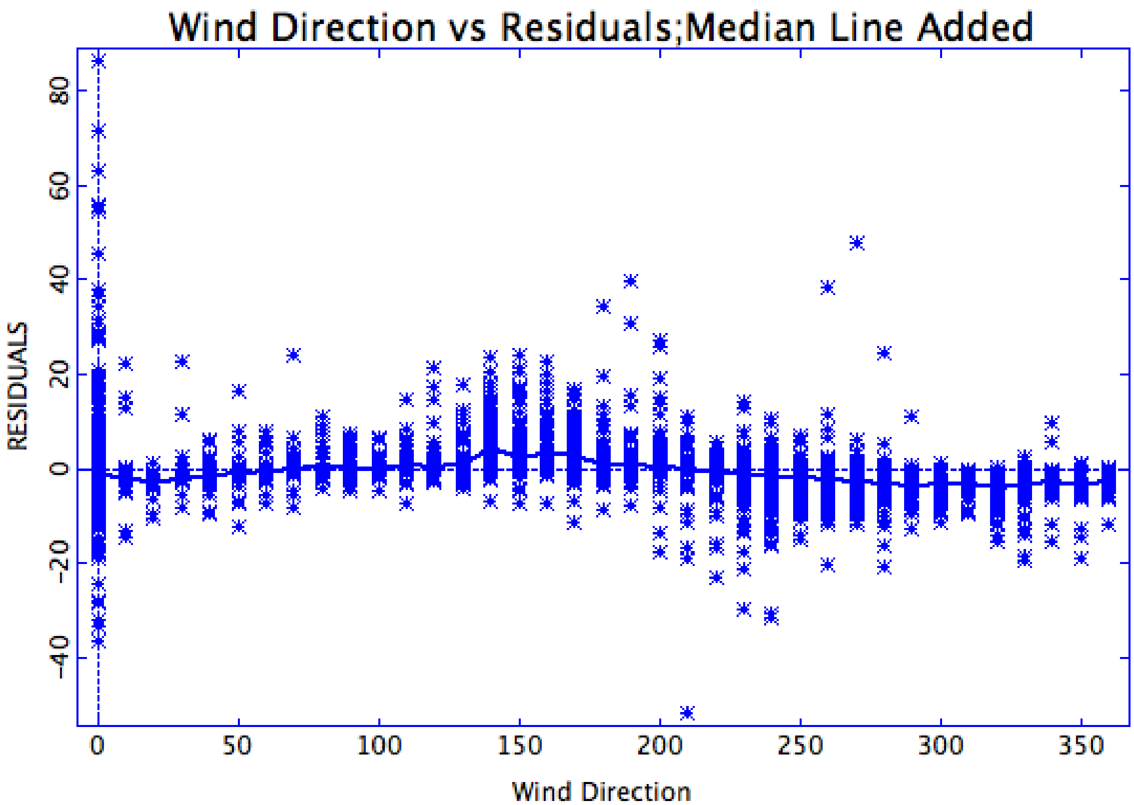
Because the Jo and Up counts are so highly associated, the conclusion is that by and large there is no indication of large sources of particulate matter that effect Up that do not also effect Jo and vice-versa.

But what about the EOG plant as a source of particulates?

2. Is there reason to believe the EOG site is producing particulate pollution?

Despite the strong association between the counts at Up and the counts at Jo, there may be counts at certain wind directions that are not, in general, associated or predicted well. A "residual" is the difference between an observed data point and the corresponding predicted value. Figure 6 is a plot of the residuals from the regression of Up on Jo with a line added of the medians of the residuals at each wind direction. The wind direction is from the hourly data of the Eau Claire/Chippewa Falls Regional Airport. The direction is given in 10 degree (10º) intervals and a direction of "0" indicates calm or no wind. A direction of 360º is a wind out of the North.

Figure 6



A positive residual indicates the expected value from the regression is too low. In other words there are more particles being counted than would be expected from the regression. The median line is positive from about 130º to about 180º. A negative residual indicates the expected value from the regression is too high. There are fewer particles than would be expected. The median line is negative from about 230º to about 360º.

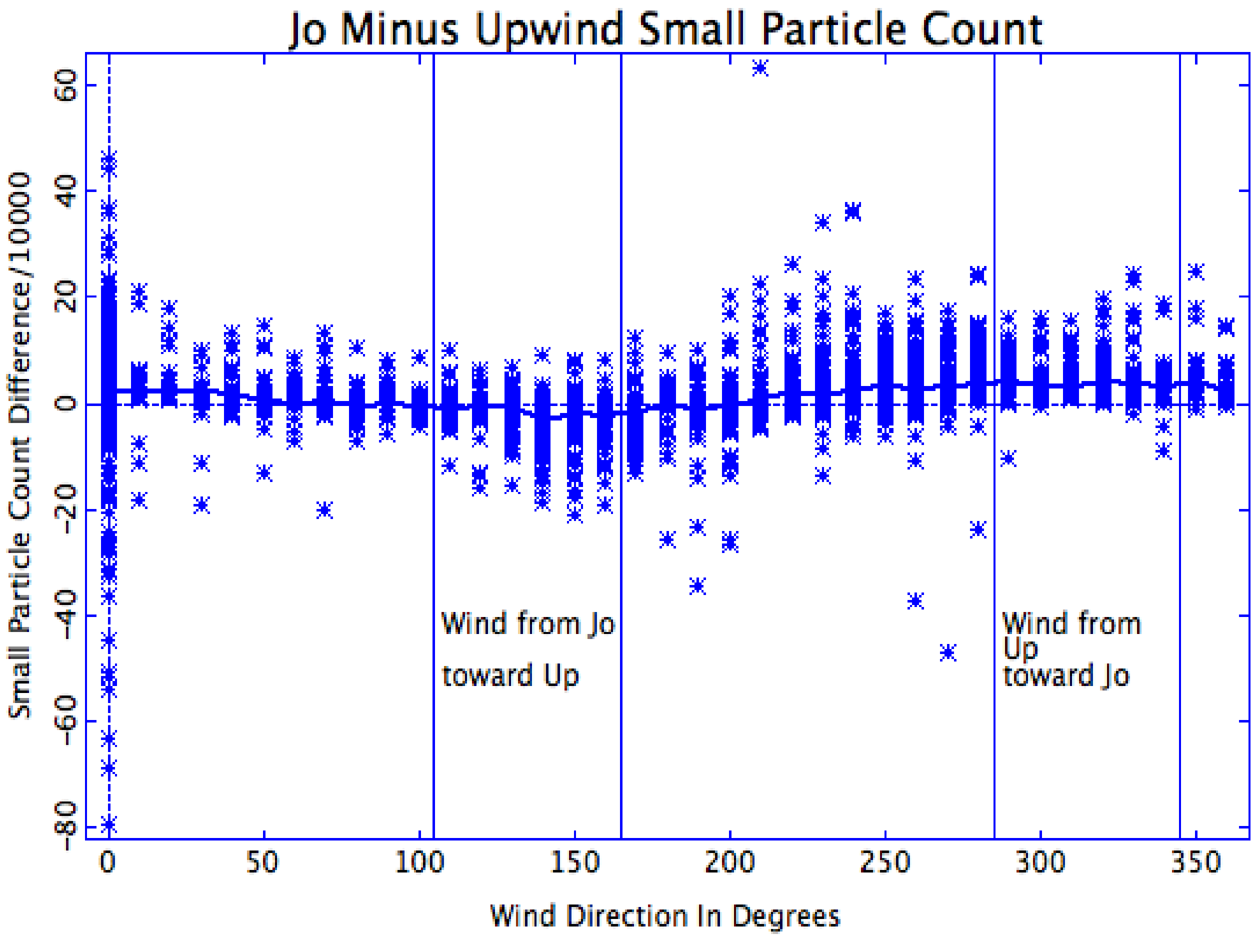
A wind from Jo to Up (around SE to around NW) would have a direction of about 135º and would blow across the EOG plant carrying any airborne particles from it toward the Up monitor; this would in general produce more particles at Up than expected. This is consistent with the median line being positive from about 130º to 180º as indicated in the last paragraph.

A wind from Up to Jo (around NW to around SE) would have a direction of about 315º and would blow across the EOG plant carrying any airborne particles from it toward the Jo monitor; this would produce more monitored particles at Jo, in turn forcing the prediction at Up to be higher than that observed and therefore the residual to be negative. This is consistent with the median line being negative from about 230º to 360º as indicated above. This is shown even more clearly in the next section.

Wind Direction and Particulate Counts

Figure 7 plots the hourly wind direction on the x-axis and the **Jo minus Up** small particle count on the y-axis for the 2040 hourly segments. Also included is a median line. We hypothesize that the wind blowing from the Up, or NW site, toward the Jo, or SE site, will move across the EOG plant and pick up particulate matter. If this were true, the Jo minus Up small particle difference should be positive.

Figure 7:



In the graph the y-axis is the particle count difference divided by 10,000. So for example, y-axis: –40 indicates (-40)x(10,000) or –400,000. This is done so the numbers displayed on the y-axis are more manageable, eg 3 instead of 30,000.

Wind coming from the NW will have a 315 degree direction. If we allow 30 degrees on either side of NW, for we do not actually know whether the monitors are on a true NW-SE line nor how dust will be dispersed as it moves, and consider only those times with wind direction between 285 and 345 degrees, then as shown in Figure 7, there are 299 hourly points of which 290, or about 97% are positive. **This is consistent with the hypothesis of particles being added by the plant.**

Alternatively, we can hypothesize that the wind blowing from the Jo, or SE site, toward the Up, or NW site, will move across the EOG plant and pick up particulate matter. If this were true, the Jo minus Up small particle difference should be negative. Wind coming from the SE will have a 135 degree direction and if we allow 30 degrees on either side of SE as explained before, and consider only those times with wind direction between 105 and 165 degrees, as shown in Figure 7, there are 324 hourly points of which 254, or about 78% are negative. **This is also consistent with the hypothesis of particles being added by the plant.**

There are three more things to notice from Figure 7.

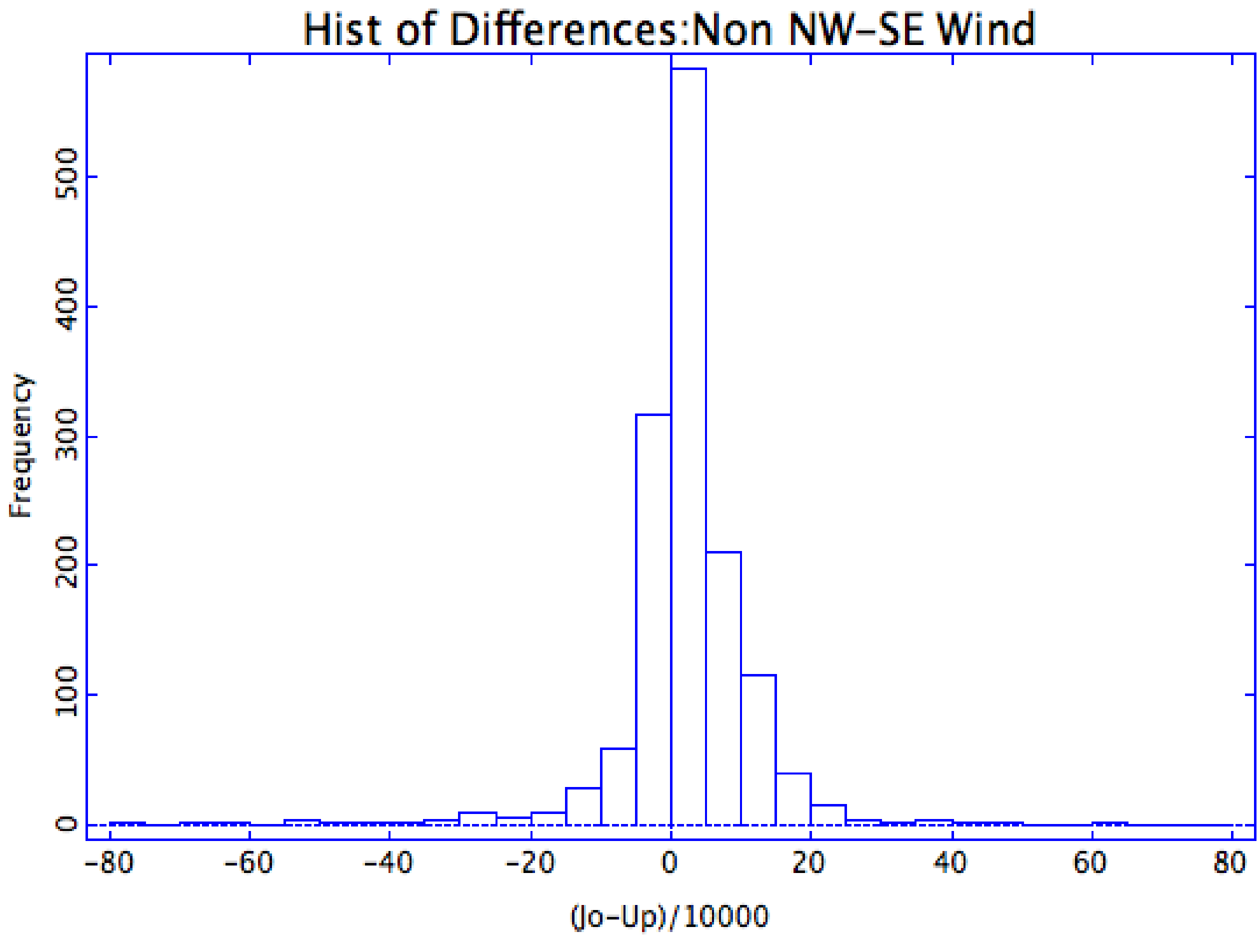
- First, there are only two wind orientations with a multitude of negative particle count differences: one is where the wind direction is along the line of Jo and Up, and the second is the wind direction of zero. However wind speeds of 0 are recorded as having a direction of 0; thus these are not counts for a wind direction on a N-S line. These are counts for little or no wind. For this reason these are not relevant here. **This multitude of negative particle counts with wind direction from Jo toward Up and across the EOG site is strong evidence that EOG is adding particulate matter.**

- Second, looking at Figure 7, it appears that the center of these negative values is more toward 150 degrees than 135. This would imply the line between Up and Jo might be more NNW and SSE than Northwest and Southeast.

- Third, the multitude of positive differences over all other wind directions, indicating a larger small particle count at Jo than at Up, suggests the Jo area might be in general “dustier” than the Up area. This is consistent with the regression of small particle counts at Up on small particle counts at Jo. This gave a slope of 0.92, ie less than 1, indicating an expected smaller count at Up.

Though the conclusion was reinforced that there is no evidence of large sources of particulates affecting the Jo and Up sites differently, this last point needs more examination. Figure 8 is a histogram of Jo minus Up differences for wind directions other than NW or SE.

Figure 8:



The average difference (/10000) for wind direction other than on the NW to SE line is: about 2.25. This would indicate that the Jo site is actually "dustier" in general than the Up site. To adjust in what follows, this amount (22505.2) is subtracted from the particle count differences for wind directions over the EOG site.

The conclusion of the analysis in this section is that there is certainly reason to believe the EOG plant is producing particulate pollution.

3. **Is the particulate pollution of sufficient quantity and/or quality to be a health hazard?**

In order to answer this question, the adjusted difference in small particle counts between the site at Up and the site at Jo for appropriate wind directions must be converted into a form comparable to the standards which is always a concentration of mass of particulates per volume of air sampled.

To be conservative and decrease the potential for large humidity effects, all the following calculations only consider times when the relative humidity is below 80%. Also all hours when the wind is not from appropriate wind directions are taken to have a particle count of zero.

Conversion of Particle Counts to Micrograms per Cubic Meter to Compare to Exposure Standards

If we assume a spherical shape for the particles with a radius of “r”, in micrometers, a dust density of “d”, in grams per cubic centimeter, and a particle count of N per cubic foot then:

> (N) (r^3) (d) (0.00014792572) will produce a number in micrograms per cubic meter to compare to the exposure limits. Recall that the EPA standard for PM2.5 was an average of 35 micrograms per cubic meter over a 24 hour period.

The following values have been found for the density of dust and sand in grams per cubic centimeter (http://www.asiinstr.com/technical/Material_Bulk_Density_Chart_S.htm):

Quarry dust............1.65g/cc
Sand(dry)...............1.76g/cc
Sand(fine)...............2.0g/cc
Sand(moist)............2.08g/cc
Silica Sand.............1.30 g/cc
Crystalline Silica.... 2.648g/cc

For a given particulate count, a lower value for the density will produce a lower mass per cubic meter result. A smaller radius will produce a lower mass per cubic meter result. Similarly a higher value for density and/or radius will produce a higher value for the concentration.

The range of possible concentrations can be bracketed by two calculations. The minimal possible concentration calculations will assume all particles have the lowest density, 1.3g/cc, and smallest radius, 0.25µm. The maximum possible concentration calculations will assume all particles have the largest density, 2.648g/cc, and a radius of 1.25µm. This latter calculation assumes the counted particulates are of 100% crystalline silica density.

The maximum calculation is similar to the National Institute of Occupational Health (NIOSH) relationship to convert from a particle count to a weight for comparison to a silica standard which assumes a density of 2.5g/cc and a radius of about 0.65µm:

100µg/cubic meter=1,000,000 particles per cubic foot

See: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=DIRECTIVES&p_id=3790

Comparing to the Standards

In the following table:

Column 1: Date of counts

Column 2: Number of hours when wind was between 105º and 165º or between 285º and 345º and humidity was less than 80%

Column 3: Total small particle count difference for the hours in Column 2. This is the particulate count attributable to the EOG facility.

Column 4: Minimal mean concentration of particulates for the hours in column 3. No indication of exceeding exposure levels.

Column 5: Maximum mean concentration of particulates for the hours in column 3. 21 out of 57 days, about **37%,** exceed the EPA PM2.5 standard on an hourly basis (i.e. for the hours with appropriate wind direction). **Assuming a 10% silica amount by weight, each of these would also exceed on an hourly basis the California OEHHA respirable benchmark level for silicosis, the Texas Commission on Environmental Quality benchmark level for respirable crystalline silica to protect against silicosis, the New Jersey DEP 2009 PM10 silicosis benchmark level, and the US EPA silicosis benchmark level. (Benchmark levels from Table 2 of the Wisconsin DNR Silica Report, August 2011: http://dnr.wi.gov/air/pdf/finalsilicareport.pdf)**

Note: **Exceedances of reference levels are indicated by a yellow background.**

Column 6: Column 4 averaged over 24 hours. No standard exceeded.

Column 7: Column 5 averaged over 24 hours. 2 out of 57days, about **3.5%,** show exceedance of the EPA PM2.5 standard over a 24 hour period. **Assuming a 10% silica amount by weight, each of these would also exceed on an hourly basis the California OEHHA respirable benchmark level for silicosis, the Texas Commission on Environmental Quality benchmark level for respirable crystalline silica to protect against silicosis, the New Jersey DEP 2009 PM10 silicosis benchmark level, and the US EPA silicosis benchmark level. (Benchmark levels from Table 2 of the Wisconsin DNR Silica Report, August 2011: http://dnr.wi.gov/air/pdf/finalsilicareport.pdf)**

Column 8: maximum hourly minimal mass. No standards exceeded.

Column 9: maximum hourly maximum mass. 29 out of 57 days, about **51%,** show an hourly maximum that exceeds the EPA PM2.5 standard. **Assuming a 10% silica amount by weight, each of these would also exceed on an hourly basis the California OEHHA respirable benchmark level for silicosis, the Texas Commission on Environmental Quality benchmark level for respirable crystalline silica to protect against silicosis, the New Jersey DEP 2009 PM10 silicosis benchmark level, and the US EPA silicosis benchmark level. (Benchmark levels from Table 2 of the Wisconsin DNR Silica Report, August 2011: http://dnr.wi.gov/air/pdf/finalsilicareport.pdf)**

COMPARING TO THE STANDARDS

1	2	3	4	5	6	7	8	9
Day	Hours	Total Particles	min mean conc for hours in col 2	max mean conc for hours in col 2	24 hr min conc	24 hr max conc	max single hr min mass	max single hr max mass
11-Jan	5	407910	0.245133	62.41459	0.05107	13.003	0.3963	100.89
12-Jan	21	630648	0.090235	22.97519	0.07896	20.1033	0.1971	50.19
13-Jan	13	166326	0.038444	9.788307	0.02082	5.302	0.088	22.398
14-Jan	6	307243	0.153864	39.17625	0.03847	9.79406	0.3781	96.262
15-Jan	16	1312356	0.246456	62.75139	0.1643	41.8343	0.4011	102.12
16-Jan	4	349260	0.262359	66.80066	0.04373	11.1334	0.4182	106.49
17-Jan	10	204333	0.061397	15.6326	0.02558	6.51358	0.1083	27.565
18-Jan	3	164848	0.165108	42.03915	0.02064	5.25489	0.2445	62.247
19-Jan	10	252492	0.075867	19.31702	0.03161	8.04876	0.1668	42.464
20-Jan	2	46837.6	0.070367	17.91664	0.00586	1.49305	0.0792	20.161
21-Jan	11	665604	0.181815	46.29295	0.08333	21.2176	0.2965	75.496
22-Jan	9	695804	0.232301	59.14748	0.08711	22.1803	0.3076	78.325
23-Jan	3	223923	0.224277	57.10432	0.02803	7.13804	0.2861	72.836
24-Jan	1	77480.5	0.232809	59.27668	0.0097	2.46986	0.2328	59.277
25-Jan	5	803038	0.482584	122.8734	0.10054	25.5986	0.6478	164.95
26-Jan	4	145843	0.109555	27.8945	0.01826	4.64908	0.2669	67.949
27-Jan	1	21491.2	0.064575	16.44191	0.00269	0.68508	0.0646	16.442
29-Jan	2	92553.8	0.13905	35.40428	0.01159	2.95036	0.2229	56.747
30-Jan	14	1190544	0.25552	65.05924	0.14905	37.9512	0.4704	119.77
3-Feb	1	16050.6	0.048228	12.27958	0.00201	0.51165	0.0482	12.28
7-Feb	1	31477.6	0.094582	24.08204	0.00394	1.00342	0.0946	24.082
10-Feb	5	76565.7	0.046012	11.71537	0.00959	2.4407	0.1323	33.682
11-Feb	5	104390	0.062733	15.97281	0.01307	3.32767	0.0894	22.76
13-Feb	1	23775.4	0.071439	18.18946	0.00298	0.75789	0.0714	18.189
16-Feb	1	8067.6	0.024241	6.172145	0.00101	0.25717	0.0242	6.1721
17-Feb	6	526227	0.263529	67.09861	0.06588	16.7747	0.5257	133.85
18-Feb	6	101756	0.050958	12.97474	0.01274	3.24369	0.0759	19.334
20-Feb	14	701312	0.150519	38.32435	0.0878	22.3559	0.288	73.332
22-Feb	2	126673	0.190309	48.45562	0.01586	4.03797	0.2406	61.26
24-Feb	17	867506	0.153331	39.04048	0.10861	27.6537	0.3663	93.273
25-Feb	10	128589	0.038638	9.837769	0.0161	4.09907	0.088	22.417
26-Feb	13	348837	0.080628	20.52917	0.04367	11.12	0.1337	34.039
27-Feb	7	72981.4	0.031327	7.976381	0.00914	2.32644	0.0623	15.851
28-Feb	7	373496	0.160323	40.82067	0.04676	11.906	0.1843	46.933

1-Mar	1	30071.9	0.090358	23.00663	0.00376	0.95861	0.0904	23.007
3-Mar	1	45303.6	0.136126	34.65967	0.00567	1.44415	0.1361	34.66
4-Mar	3	74747	0.074865	19.06181	0.00936	2.38273	0.1231	31.335
5-Mar	3	265257	0.265677	67.64534	0.03321	8.45567	0.3302	84.081
6-Mar	8	628098	0.235909	60.06601	0.07864	20.022	0.4415	112.41
7-Mar	2	54835.4	0.082383	20.97599	0.00687	1.748	0.0889	22.646
8-Mar	9	346076	0.115541	29.41855	0.04333	11.032	0.2092	53.275
9-Mar	16	437684	0.082196	20.92825	0.0548	13.9522	0.1473	37.507
10-Mar	5	177769	0.10683	27.20053	0.02226	5.66678	0.1228	31.271
13-Mar	3	36751.2	0.036809	9.372205	0.0046	1.17153	0.0566	14.403
15-Mar	1	16739.9	0.050299	12.80694	0.0021	0.53362	0.0503	12.807
16-Mar	6	229875	0.115119	29.31113	0.02878	7.32778	0.1337	34.03
17-Mar	4	99628.4	0.074839	19.05527	0.01247	3.17588	0.0939	23.913
18-Mar	7	180933	0.077665	19.77479	0.02265	5.76765	0.1203	30.641
19-Mar	12	482454	0.120804	30.75859	0.0604	15.3793	0.1495	38.07
20-Mar	1	24618.1	0.073971	18.83413	0.00308	0.78476	0.074	18.834
21-Mar	2	38534.5	0.057893	14.74049	0.00482	1.22837	0.0715	18.209
24-Mar	1	48468.6	0.145636	37.08106	0.00607	1.54504	0.1456	37.081
26-Mar	13	321694	0.074354	18.93177	0.04028	10.2547	0.0913	23.247
27-Mar	9	300922	0.100466	25.58019	0.03767	9.59257	0.1395	35.512
29-Mar	10	252426	0.075847	19.31192	0.0316	8.04664	0.0911	23.196
30-Mar	5	185488	0.111468	28.38159	0.02322	5.91283	0.1436	36.569
31-Mar	4	523040	0.3929	100.0384	0.06548	16.6731	0.4864	123.85

Conclusion

Of 57 days with wind conditions and humidity appropriate, 3.5% show possible exceedances of the EPA PM2.5 standard on a 24 hour basis, 37% show possible exceedances of this standard on an average hourly basis, and 51% have at least one hour which possibly exceeds the standard. In addition each of the above exceedances would also, assuming a 10% silica content, exceed various state benchmark levels for silicosis.

There is no doubt that there are limitations and complications with use of the Dylos monitors. Yet this citizen monitoring effort has shown that circumstantially these standards could have been exceeded multiple times on a daily basis with particulates emanating from the EOG site. These particulates are likely to contain crystalline silica.

\

APPENDIX A
Analysis of Inadequacy of Wisconsin DNR Air Quality Monitoring

The following are quotations from the Wisconsin DNR "*Report to the Natural Resources Board: Silica Study*", dated August 30, 2011, with added commentary. What is stated in reference to exposure to respirable crystalline silica emissions would apply in general to PM2.5:

"The California monitoring data (California OEHHA 2005; Richards et al. 2009) and US EPA (1996) and Environment Canada (2011) reports generally do not indicate the existence of any wide-spread significant concern about airborne crystalline silica exposures to the general public. (Note: “general public”, as the term is used here, means individuals not living near an identified source of crystalline silica emissions.) However, US EPA (1996) stated that “some potential exists for environmental silicosis to human populations”. Exposures of potential concern may be more likely if populations are close to large sources of uncontrolled emissions. Data from other air pollution control agencies shows that some emissions from industrial facilities could result in air concentrations above a level of concern for people living near these sources. However, it is currently unknown whether emissions from large sources in Wisconsin are high enough and people are close enough to have significant exposures." (Page 16)

> **Comment:** Throughout this report the DNR references exposure to the general public while noting that they DO NOT KNOW exposure levels close to the sites. Exposure for those living (or working or going to school) near the sites is "currently unknown."

“Individual situations should be evaluated because process-stream activities and natural conditions may lead to locally higher concentrations”. The best way to determine what crystalline silica impacts are near a source is to conduct monitoring, which as stated earlier, is very difficult to conduct and the methodology for the test methods are not standard. While the state of knowledge specific to crystalline silica is limited, most significant industrial or commercial sources of emissions are regulated for particulate matter in a manner that could also reduce silica emissions." (Page 17)

Comment:

- Note WDNR's acknowledgement that mining and processing activities "**may lead to locally higher concentrations**."
- Note that the "best way" to determine impacts close to sites (monitoring) is not what WDNR requires.
- As stated, they regulate "...in a manner that could also reduce silica emissions."

  Yes it COULD, but WDNR has no evidence that it actually DOES reduce silica emissions to levels deemed safe. Monitoring is difficult but not impossible and for health and safety concerns it should be instituted in a manner sufficient to answer relevant questions even if using non standard methods. All methods are non-standard until a standard method is accepted.

"Rather than focusing only on general exposures in cities, early 1990s sampling data from California suggested that monitoring near silica sources may also be important because exposures near sources could exceed 10% of the total PM10 levels. Thus, there may be exposures near facilities that could exceed the California health benchmark of 3 micrograms per cubic meter (ug/m3)." (Page 30)

> **Comment**: WDNR's uncertainty about the levels of crystalline silica to which the public living or working near sand mining facilities are exposed is repeated yet again:
>
> "...there may be exposures near facilities that could exceed the California health benchmark..."
>
> **There may be such exposures near facilities but the Wisconsin DNR will never know because their monitoring effort is so inadequate.**

APPENDIX B

Another way to examine the EOG additions to particulate matter is to use a regression of Up on Jo with categorical variables for wind direction from Jo toward Up and from Up toward Jo. This will also give some indication of variability in width of the confidence intervals.

In the output below, the independent variable,"x", is the small particle count at Jo. The dependent variable, "y", is the small particle count at Up. "joup" is a categorical variable indicating wind direction from Jo toward Up. "upjo" is a categorical variable indicating wind direction from Up toward Jo.

Model used is @y=@x+@joup+@upjo

	Coef	StdErr	t	P-Value
CONSTANT	8402.799583	2966.968928	2.832115801	0.004697351962
x	0.9143923968	0.009731328572	93.96377792	0
joup	36686.76139	4628.326926	7.926570871	< 1e-08
upjo	-33908.5157	4537.423205	-7.473077596	< 1e-08

N: 1270, MSE: 3693345437, DF: 1266, R^2: 0.8812181982

If the wind blows from Jo towards Up, particulates should be added to Up. This is confirmed with a positive coefficient of about 36687, which converts to adding about 28.1µg/m^3 to Up per hour, 95% confidence interval (21.1,35.0). This includes the 35µg/m^3 EPA24 hour PM2.5 standard considered hourly.

If the wind blows from Up towards Jo, particulates should be subtracted from Up and added to Jo. This is confirmed with a negative coefficient of about –33908, which converts to adding about 25.9µg/m^3 to Jo per hour, 95% confidence interval (19.1, 32.8). The upper limit of the confidence interval is just below the EPA 24 hour PM2.5 standard considered hourly.