Iowa Annual Data Review 2011 – Manganese

Ambient Air Monitoring Group
Iowa Department of Natural Resources

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Summary:

USA Today Story

In December of 2008, the newspaper **USA Today** published the story ***The Smokestack Effect – Toxic Air and America's Schools*** that ranked the air quality at 127,809 schools across the nation.[1] To obtain its rankings, USA today used publically available emissions estimates and an EPA model to estimate the relative risk posed by air contaminants at the schools. The report identified the pollutants predicted to cause the diminished air quality at the schools and nearby industries emitting those pollutants.

EPA's Follow up on the USA Today Story: The School Air Toxics Study

In the spring of 2009, EPA identified pollutants of interest based on the USA today study and developed screening levels and health limits for these pollutants.[2] They also established monitoring methods for the pollutants of interest that could be implemented with portable monitoring equipment.[3] Finally, they procured equipment, secured an analysis laboratory, and arranged for sample collection. The sampling plan was to gather 15 samples at a one in six sampling frequency over a ninety day period. The sampling period for each school was selected during a time of year when the winds at the school blew from the direction of the air pollution sources, so not all of the monitors began sampling at the same time. EPA initially selected 62 schools for ambient monitoring across the nation, and began sampling in April 2009. Final reports for EPA's school air toxics monitoring initiative are available online.[4] In sixteen of the fifty-eight final reports (28%) EPA recommended that additional monitoring be performed in the community or at the school where the sampling was performed.

EPA conducted sampling at one site in Iowa as part of the School Air Toxics Study, Roland-Story High School in Story City Iowa. This school was listed in the USA Today study in the top 1% of schools with the worst air quality in the nation. USA Today indicated that the toxics of concern at the school were diisocyanates, a group of chemicals used in the production of polyurethane from American Packaging Corporation in Story City. The final EPA report shows that data from sampling at the school showed no diisocyanates were detected by the monitoring equipment at the site and no further air sampling is planned at the school.[5]

DNR's follow up on the USA Today Story: Manganese Monitoring in Keokuk and Council Bluffs

The USA Today story identified Cardinal Stritch Jr. Sr. High School in Keokuk (currently Keokuk Catholic School), as a school in the top 1% "worst air" schools in the nation, with over 90 percent of the toxicity due to manganese emissions from Griffin Wheel Co. (Amsted Rail Co.). The DNR developed its own emissions estimates for Griffin Wheel. Un-captured emissions from the electric arc furnace dominated the emissions profile from the facility. These emissions estimates could not be verified with stack test data, because the emissions vented through a large number of roof vents that were not feasible for emissions testing. The DNR conducted air dispersion modeling for the Griffin Wheel Facility (Appendix A). The chronic risk threshold for manganese adopted by EPA in its School Air Toxics Study was 50 ng/m^3. Manganese has been demonstrated to be the causative agent in a syndrome of neurologic and psychiatric disorders that has been described in manganese miners. To establish a chronic risk threshold used for the School Air Toxics Study, EPA utilized the results of a health study on workers exposed over many years. The study showed a decrease in visual reaction times when workers were exposed to manganese at a level of 50 µg/m^3. EPA then applied a safety factor of 1,000 to determine the chronic risk threshold of 50 ng/m^3.[6]

The DNR's air dispersion modeling predicted an ambient concentration of manganese at Keokuk Catholic Schools of 36 ng/m^3. Owing to the uncertainty in the emissions estimates, and the public concern over the USA Today report, the DNR conducted one year of ambient monitoring on the school grounds in 2011. Samples were collected at a frequency of one sample every sixth day. Appendix E contains a comparison of the meteorological data from the Keokuk area to the manganese concentrations at Keokuk Catholic School. The average manganese level over the sampling period was 21 ± 4 ng/m^3, well under the threshold for the action level specified in the School Air Toxics Study. The DNR suspended

[1] http://content.usatoday.com/news/nation/environment/smokestack/index
[2] http://www.epa.gov/schoolair/pdfs/UsesOfHealthEffectsInfoinEvalSampleResults.pdf
[3] http://www.epa.gov/ttnamti1/files/ambient/airtox/2009sat/SATQAPP.pdf
[4] http://www.epa.gov/schoolair/schools.html
[5] http://www.epa.gov/schoolair/RolandStor.html
[6] See the discussion contained in: http://www.atsdr.cdc.gov/HAC/pha/AmstedRailCompany/AmstedRailCompanyLHC08032010.pdf

sampling at the Keokuk Catholic School site at the end of 2011.

In Council Bluffs, Edison Elementary School and Thomas Jefferson High School were identified as being in the top 1% of "worst-air" schools by USA Today, with over 90% of the toxicity attributed to manganese emissions from the Griffin Pipe Products facility. In November of 2009, the DNR established a lead monitoring site at a location near Griffin pipe. This monitor recorded levels over the National Ambient Air Quality Standard (NAAQS) for lead in 2010, and new baghouses were installed by Griffin Pipe in January 2011 that kept lead levels below the NAAQS during 2011. After analytical procedures to quantify manganese were developed by the State Hygienic Laboratory for DNR at the end of 2010, the DNR analyzed the filters from the lead site near Griffin pipe for manganese at a scheduled frequency of one sample every twelfth day during calendar year 2011. A comparison of manganese concentrations and meteorological data for Council Bluffs can be found in Appendix D. Dispersion modeling of DNR emissions estimates before and after installation of the baghouses at Griffin Pipe (Appendix B) predicts that the new baghouses should have reduced manganese levels near Griffin Pipe below the chronic risk threshold. However, the average manganese level at the site during 2011 was 104 ± 53 ng/m^3, well above the chronic risk threshold, but the uncertainty in this average was also high. The DNR increased the scheduled sampling frequency to one sample every 3 days for 2012; this should reduce the uncertainty in the average value in 2012. The DNR continues to work with Griffin Pipe to improve emissions estimates for the facility, including more accurate estimates of emissions from stacks, un- captured emissions (i.e. emissions that are released inside the building and vent through the roof) and fugitive emissions (emissions that arise from manganese containing dust that falls near the facility, but becomes airborne again in high winds). A better knowledge of the emissions will allow the DNR to work with Griffin Pipe to develop an effective mitigation strategy and reduce manganese levels in the area.[7]

Additional Information

Additional details on the manganese sampling conducted in Iowa during 2011 are indicated below.

Definitions

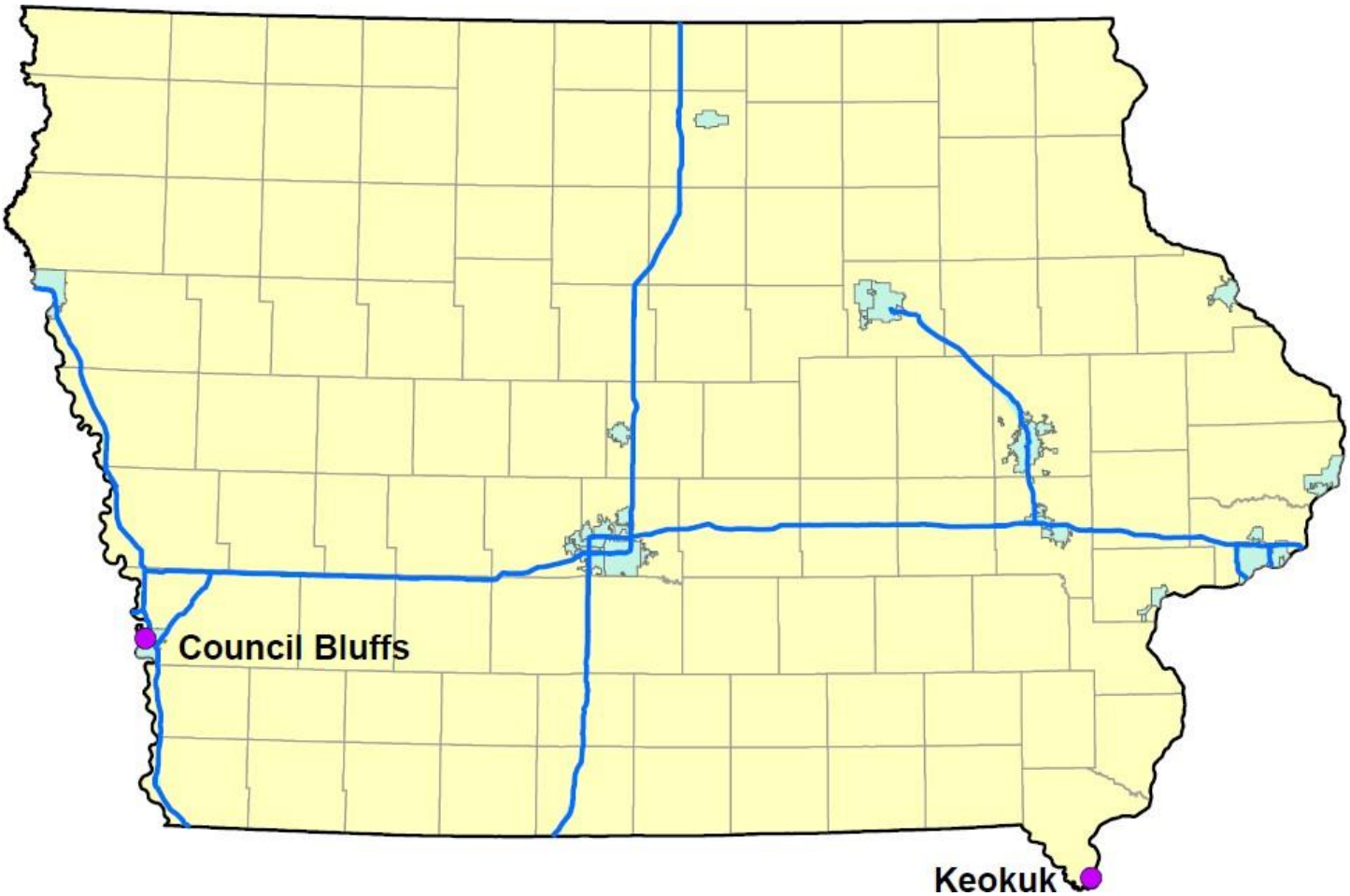
- Data Capture. The data capture rate is defined as the ratio of the number of samples taken (including scheduled and valid substitute samples) divided by the number of scheduled samples in each calendar quarter. EPA data analysis guidelines usually require 75% data completeness across each sampling quarter.
- Precision Data. Precision data are reported for the total number of collocated pairs of samples collected. Precision statistics shown in this report have been calculated according to 40 CFR Part 58, Appendix A (2006) using the methodology applicable to collocated fine particulate data pairs. (See Appendix C)

Manganese Monitoring Network 2011

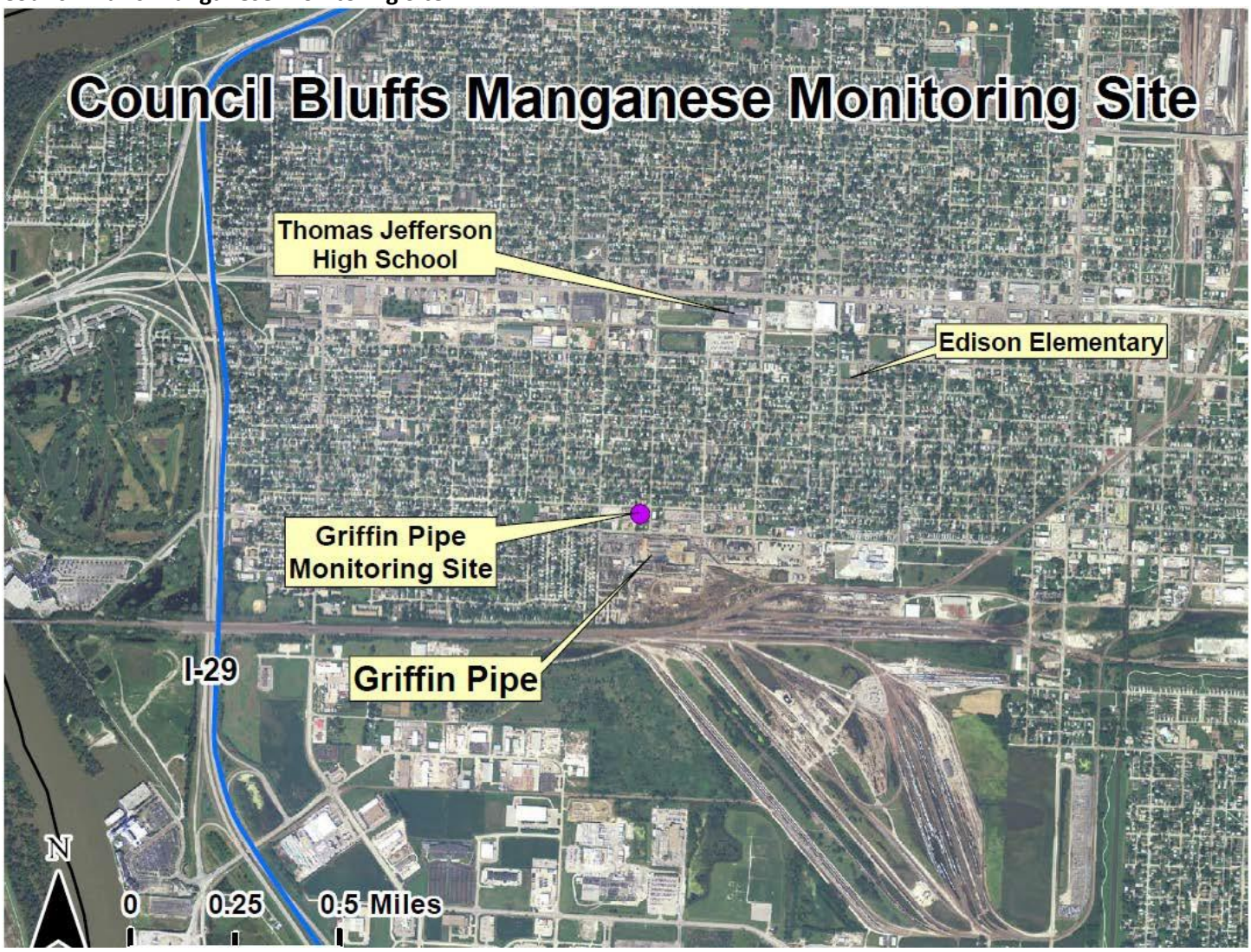
Site ID	Site Label	City	Address	County
191110009	Keokuk, Keokuk Catholic School	Keokuk	2981 Plank Road	Lee
191550011	Council Bluffs, Griffin Pipe	Council Bluffs	8th Avenue and 27th St	Pottawattamie

[7] Note: Preliminary 2012 data suggest that average manganese levels will exceed the chronic risk threshold during 2012 at the Griffin Pipe monitoring site, and that 2012 lead levels at the site will violate the lead NAAQS.

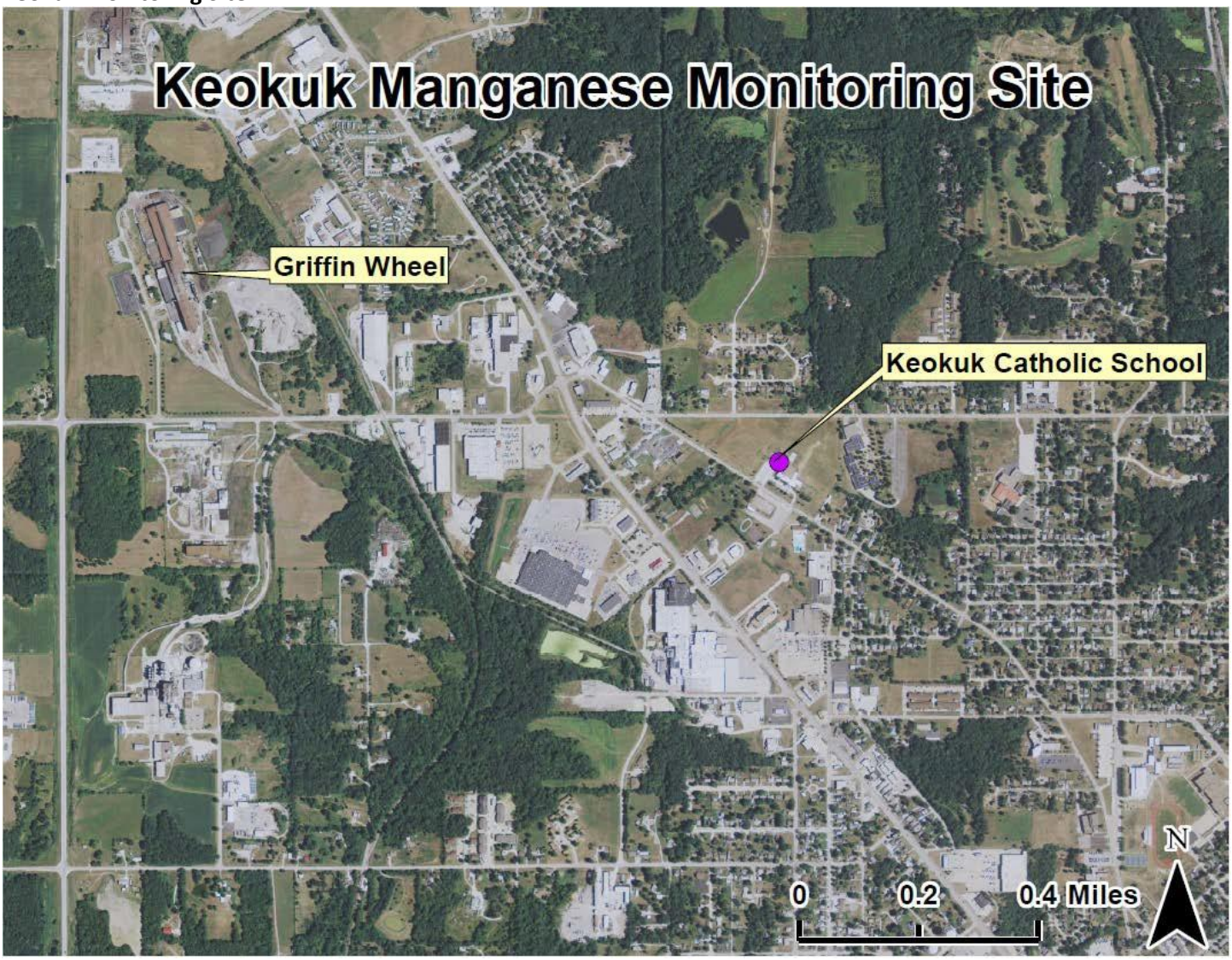
Iowa 2011 Manganese Monitoring Network



Council Bluffs Manganese Monitoring Site



Keokuk Monitoring Site

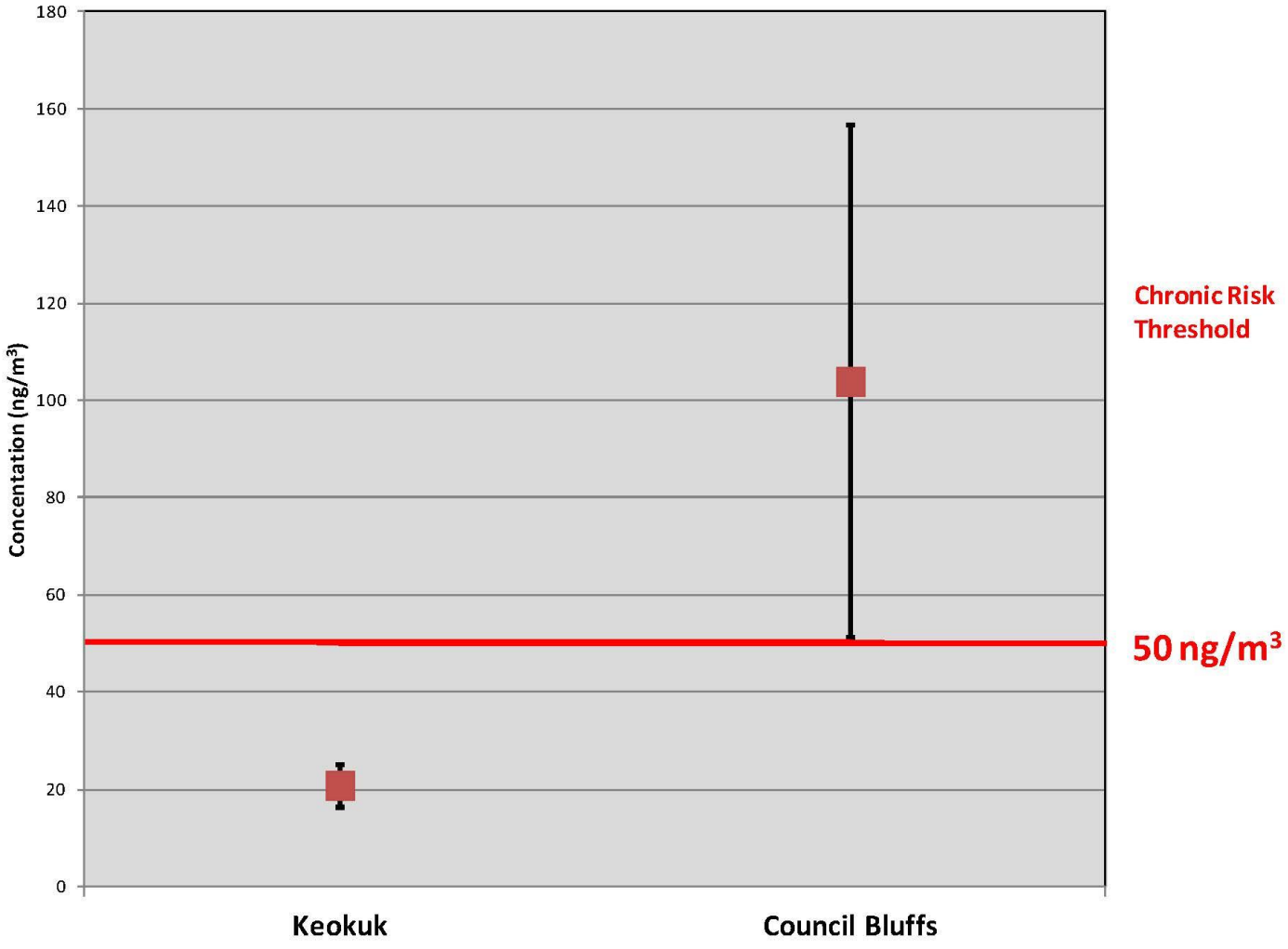


Concentration Summary (ng/m^3)

Site / Pollutant	Keokuk - Keokuk Catholic School	Council Bluffs - Griffin Pipe
Manganese	20.81 (±4.38)	103.93 (±52.71)

Values indicated are the average concentrations measured at each site in 2011 Values in parentheses represent the 95% Confidence Interval for the mean

2011 Manganese Concentration Summary Chart



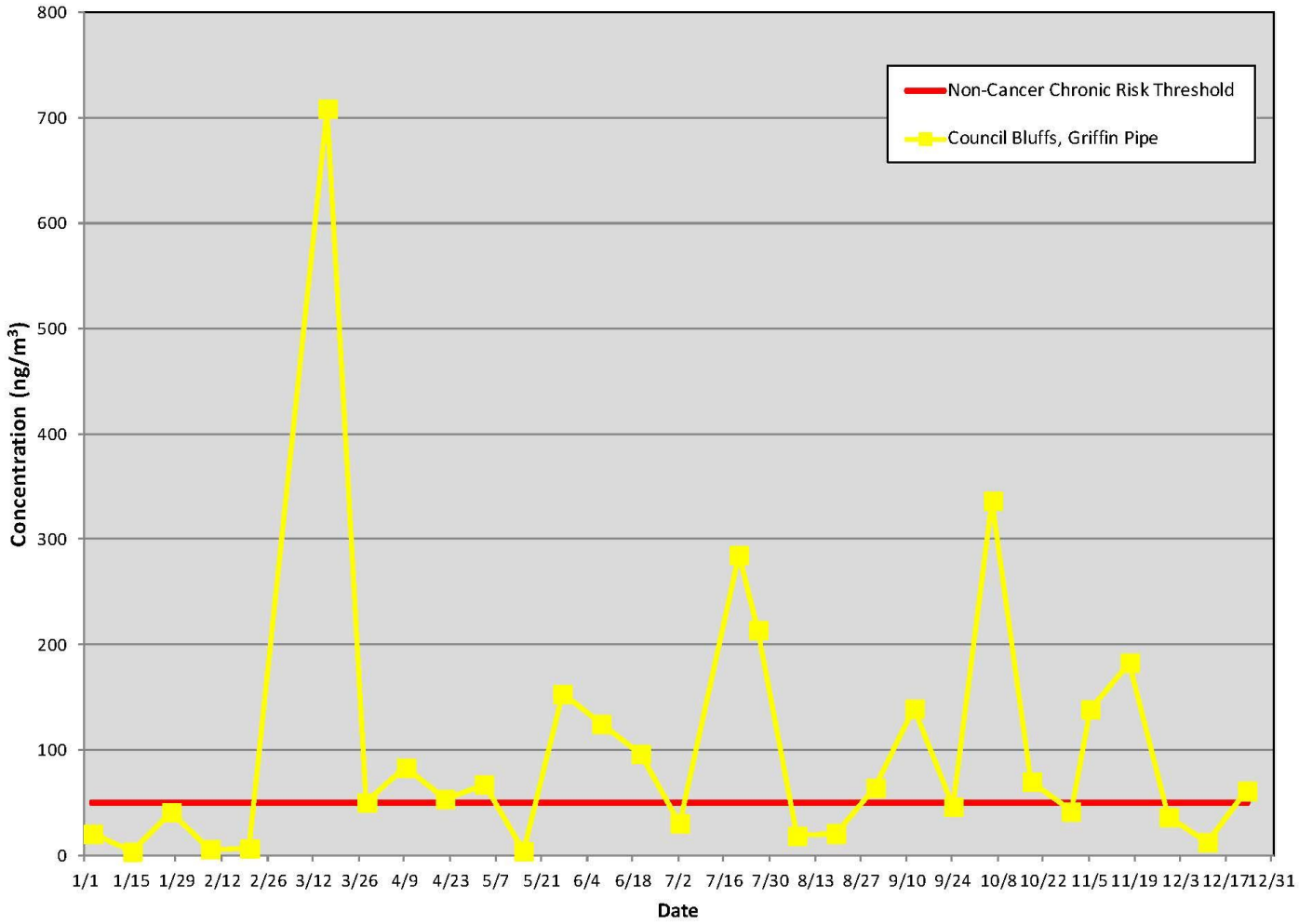
Percent Data Capture

Site / Pollutant	Keokuk - Keokuk Catholic School	Council Bluffs - Griffin Pipe
Manganese	98%	97%

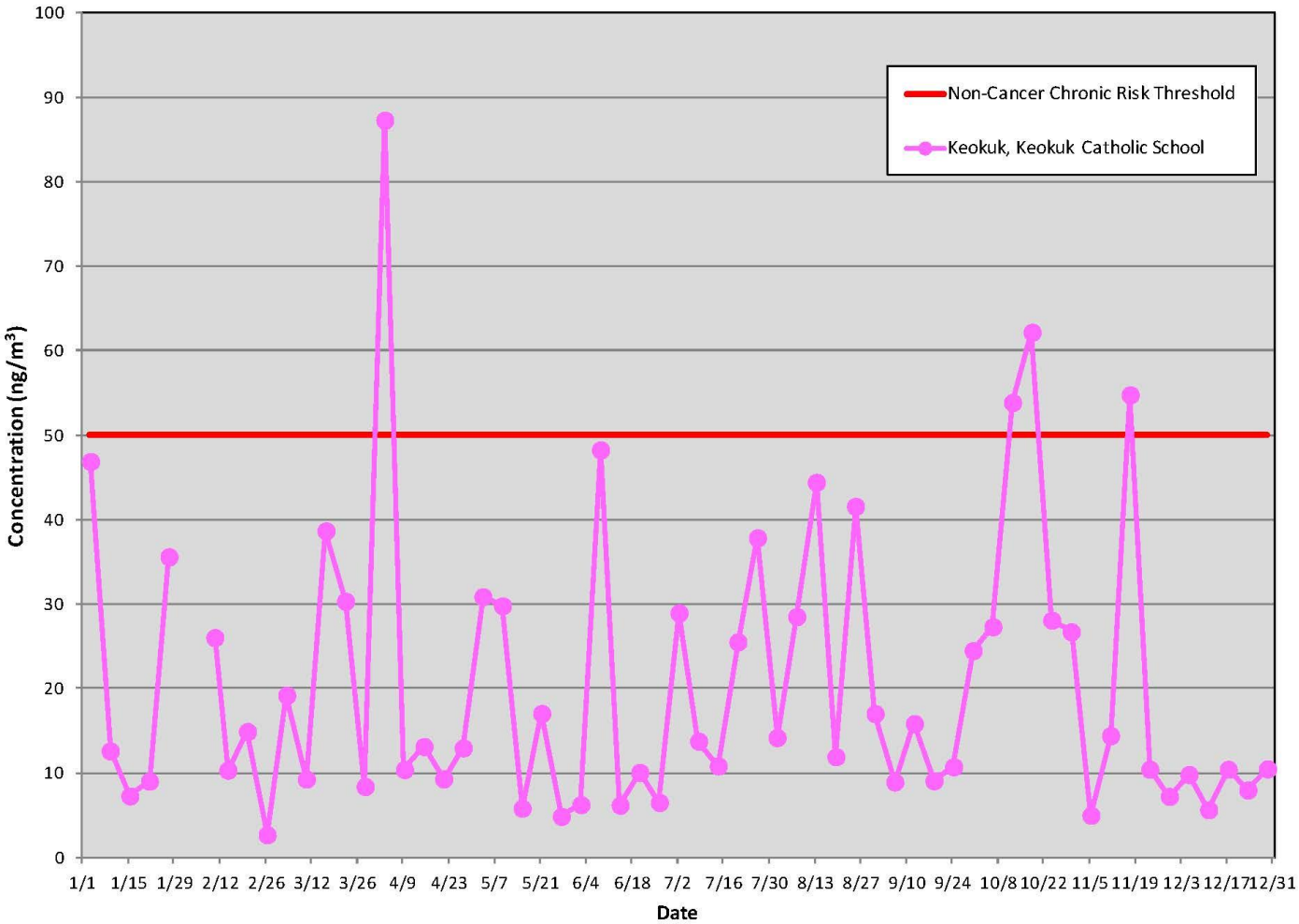
2011 Annual Manganese Precision Statistics

Statistic/ Pollutant	Number of Pairs	Coefficient of Variation	Lower 95% Confidence Limit	Upper 95% Confidence Limit
Manganese	30	14.7%	12.2%	18.7%

Manganese Raw Data and Chronic Risk Threshold 2011–Council Bluffs



Manganese Raw Data and Chronic Risk Threshold 2011-Keokuk



Raw Data – Manganese
(Concentration in ng/m^3)

Date	Keokuk, Keokuk Catholic School	Council Bluffs, Griffin Pipe
1/3/2011	46.9	20.63
1/9/2011	12.63	
1/15/2011	7.3	3.32
1/21/2011	9.05	
1/27/2011	35.61	41.14
2/2/2011		
2/8/2011		5.81
2/10/2011	26.05	
2/14/2011	10.35	
2/20/2011	14.92	6.65
2/26/2011	2.7	
3/4/2011	19.22	
3/10/2011	9.29	
3/16/2011	38.67	708.54
3/22/2011	30.34	

Date	Keokuk, Keokuk Catholic School	Council Bluffs, Griffin Pipe
3/28/2011	8.41	50.52
4/3/2011	87.3	
4/9/2011	10.42	83.51
4/15/2011	13.15	
4/21/2011	9.31	53.34
4/27/2011	12.99	
5/3/2011	30.88	67.32
5/9/2011	29.81	
5/15/2011	5.84	3.93
5/21/2011	17.06	
5/27/2011	4.88	153.12
6/2/2011	6.27	
6/8/2011	48.27	124.98
6/14/2011	6.2	
6/20/2011	10.08	96.4
6/26/2011	6.52	
7/2/2011	28.95	30.42
7/8/2011	13.79	
7/14/2011	10.85	
7/20/2011	25.54	284.98
7/26/2011	37.86	214.16
8/1/2011	14.21	
8/7/2011	28.53	18.57
8/13/2011	44.43	
8/19/2011	11.93	20.89
8/25/2011	41.58	
8/31/2011	17.04	64.19
9/6/2011	8.95	
9/12/2011	15.86	139.47
9/18/2011	9.1	
9/24/2011	10.75	46.21
9/30/2011	24.51	
10/6/2011	27.32	336.78
10/12/2011	53.87	
10/18/2011	62.19	70.07
10/24/2011	28.1	
10/30/2011	26.73	41.86
11/5/2011	5	138.56
11/11/2011	14.44	
11/17/2011	54.78	182.94
11/23/2011	10.45	
11/29/2011	7.24	36.2
12/5/2011	9.83	

Date	Keokuk, Keokuk Catholic School	Council Bluffs, Griffin Pipe
12/11/2011	5.66	12.33
12/17/2011	10.45	
12/23/2011	8	61.15
12/29/2011	10.5	

IOWA DEPARTMENT OF NATURAL RESOURCES

Environmental Services Division
Air Quality Bureau Modeling Group

MEMORANDUM

DATE: 12/04/09
TO: CATHARINE FITZSIMMONS, JASON MARCEL, BRIAN HUTCHINS
FROM: AMBER WOLF
RE: GRIFFIN WHEEL COMPANY, KEOKUK, PN 56-01-023, MANGANESE EMISSIONS MODELING
CC: LORI HANSON, PETE ZAYUDIS, KARRIE DARNELL, SEAN FITZSIMMONS, JIM MCGRAW, DAVE PHELPS

ANALYSIS SUMMARY

An air dispersion modeling analysis of actual manganese (Mn) emissions has been conducted at Griffin Wheel Company located in Keokuk. The facility-wide modeling analysis of the manganese emissions was conducted by the DNR to address concerns raised in recent USA Today articles regarding toxic air emissions and their impacts on nearby schools.

Two scenarios were modeled, differentiated only by the rate of the uncaptured electric arc furnace (EAF) emissions. Scenario 1 was conducted with actual uncaptured EAF emissions as calculated by the DNR; scenario 2 reflects the actual uncaptured EAF emissions as determined by the Griffin Wheel Company. This report provides an aerial view (Figures 1 and 2) of the facility with an overlay of concentration isopleths that allow for a visual representation of the maximum predicted concentrations of manganese for both scenarios. Also included in the aerial view is the location of Cardinal Stritch High School, one of the sensitive areas identified in the USA Today toxics study.

IMPACT COMPARISON VALUE

The comparison value of 0.05 µg/m^3 represents the threshold level for chronic exposure of manganese as determined by the Environmental Protection Agency (EPA). Chronic comparison values are meant to account for exposures greater than one year or a lifetime and were compared to the highest modeled annual impacts.

STACK PARAMETERS AND FACILITY OPERATING CONDITIONS

The emission units at the facility were evaluated using the parameters listed in Table 1. The modeled emission rates were verified by the emissions inventory and construction permitting staff. The facility was modeled as operating 24 hours/day, 8760 hours/year.

ANALYSIS RESULTS

According to the results from the AMS/EPA Regulatory Model (AERMOD, dated 09292), the manganese emissions from this facility will cause predicted concentrations that are <u>greater</u> than the chronic exposure threshold of 0.05 µg/m^3 for both scenarios 1 and 2. However, manganese emissions from this facility will cause predicted concentrations that are less than the chronic exposure threshold at Cardinal Stritch High School for both scenarios. The worst-case manganese modeling results and results at the school are listed in Table 2. A visual display of manganese concentration isopleths is provided for scenario 1 in Figure 1, and for scenario 2 in Figure 2.

Table 1. Modeled Emission Rates and Stack Parameters

Emission Points		Actual Mn Emission Rates (ton/yr)		Stack Parameters			
ID	Description	Scenario 1 (DNR)	Scenario 2 (Griffin Wheel)	Stack height (ft)	Stack gas exit temp (°F)	Stack gas flow rate (acfm)*	Stack tip diameter (ft)
EP1	Pouring emissions	0.0422	0.0422	75.00	Ambient	100	43.70

Emission Points		Actual Mn Emission Rates (ton/yr)		Stack Parameters			
ID	Description	Scenario 1 (DNR)	Scenario 2 (Griffin Wheel)	Stack height (ft)	Stack gas exit temp (°F)	Stack gas flow rate (acfm)*	Stack tip diameter (ft)
EP1A	Uncaptured EAF emissions	0.0913	0.0410	71.00	Ambient	67,000*	14.40
EP1B	Uncaptured EAF emissions	0.0913	0.0410	71.00	Ambient	67,000*	14.40
EP1C	Uncaptured EAF emissions	0.0913	0.0410	71.00	Ambient	67,000*	14.40
EP1D	Uncaptured EAF emissions	0.0913	0.0410	71.00	Ambient	67,000*	14.40
EP1E	Uncaptured EAF emissions	0.0913	0.0410	71.00	Ambient	67,000*	14.40
EP1F	Uncaptured EAF emissions	0.0913	0.0410	71.00	Ambient	67,000*	14.40
EP1G	Uncaptured EAF emissions	0.0913	0.0410	71.00	Ambient	67,000*	14.40
EP1H	Uncaptured EAF emissions	0.0913	0.0410	71.00	Ambient	67,000*	14.40
EP1I	Uncaptured EAF emissions	0.0913	0.0410	71.00	Ambient	67,000*	14.40
EP3	3 Electric Arc Furnaces	0.4540	0.4540	11.00	100.3	185,377*	5.59
EP4	Pressurized Pouring Emissions	0.0422	0.0422	59.00	200	205	0.30
EP5	Cooling emissions	0.0526	0.0526	64.00	Ambient	100	90.62

*Emission points with horizontal, downward, and obstructed exhaust are modeled with an exit velocity of 0.001 m/s.

Table 2. Worst Case Modeling Results for Mn for the 2000 – 2004 Meteorological Data Set

Scenario	Averaging Period	Highest Predicted Concentration* ($\mu g/m^3$)	Cardinal Stritch High School ($\mu g/m^3$)	Chronic Inhalation Exposure Threshold ($\mu g/m^3$)
Scenario 1 (DNR)	Annual	0.35	0.036	0.05
Scenario 2 (Griffin Wheel)	Annual	0.31	0.028	0.05

* The annual concentrations are the highest predicted values. The locations of the highest predicted concentrations for Scenarios 1 and 2 are detailed in Figures 1 and 2.

Griffin Wheel
Manganese Maximum Annual Concentrations Scenario 1 - DNR Estimated Emission Rates

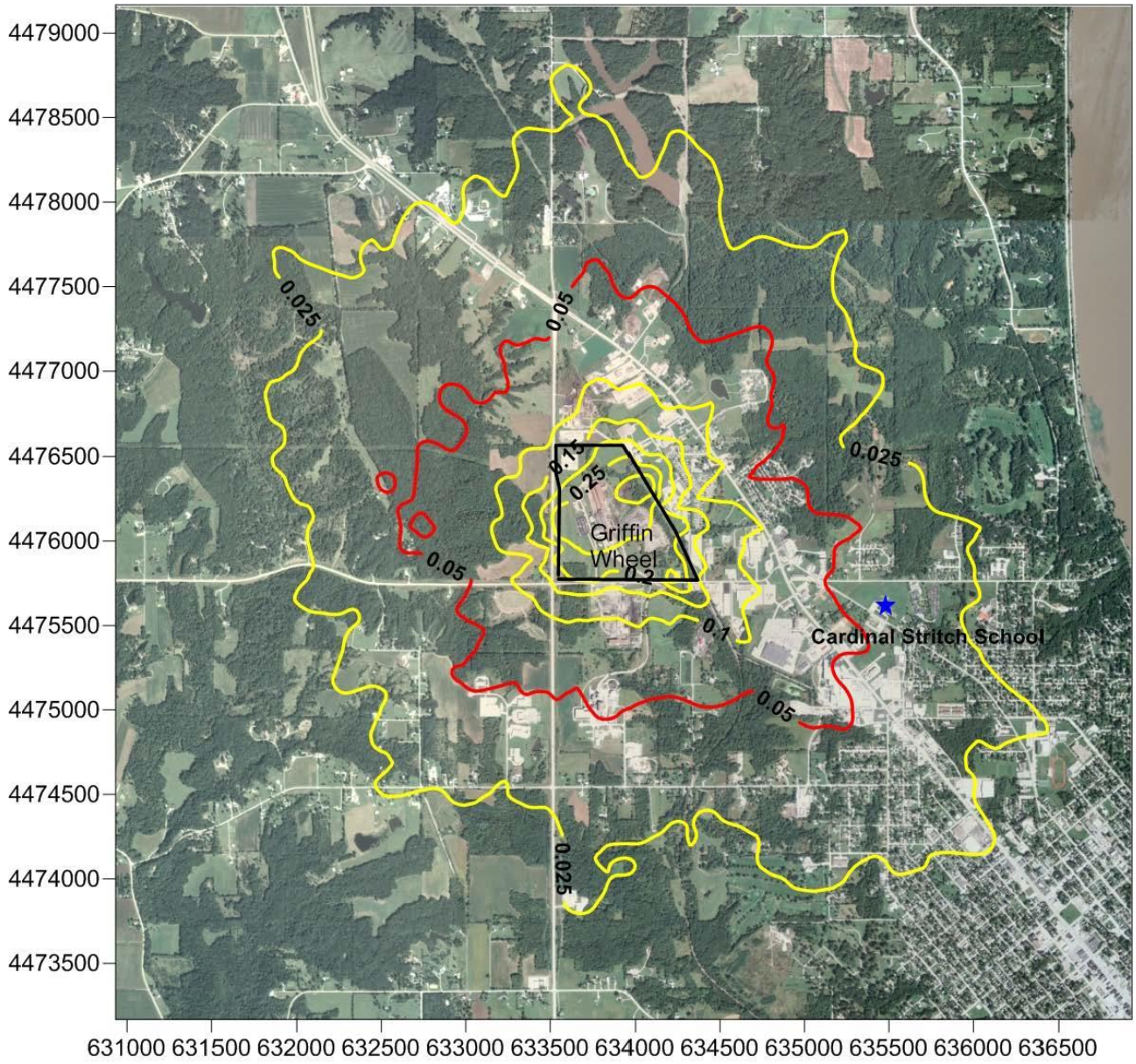


Figure 1: Modeled concentrations due to actual manganese emissions from Griffin Wheel. The location of the highest predicted concentration (0.35 µg/m3) is located at UTM coordinates 634075m (Northing), 4476325m (Easting), NAO 83. This is along the facility's northeast property boundary.

The chronic threshold level for manganese emissions as determined by the Iowa Department of Public Health is 0.05 µg/m3.

Griffin Wheel

Manganese Maximum Annual Concentrations Scenario 2 - Griffin Wheel Estimated Emission Rates

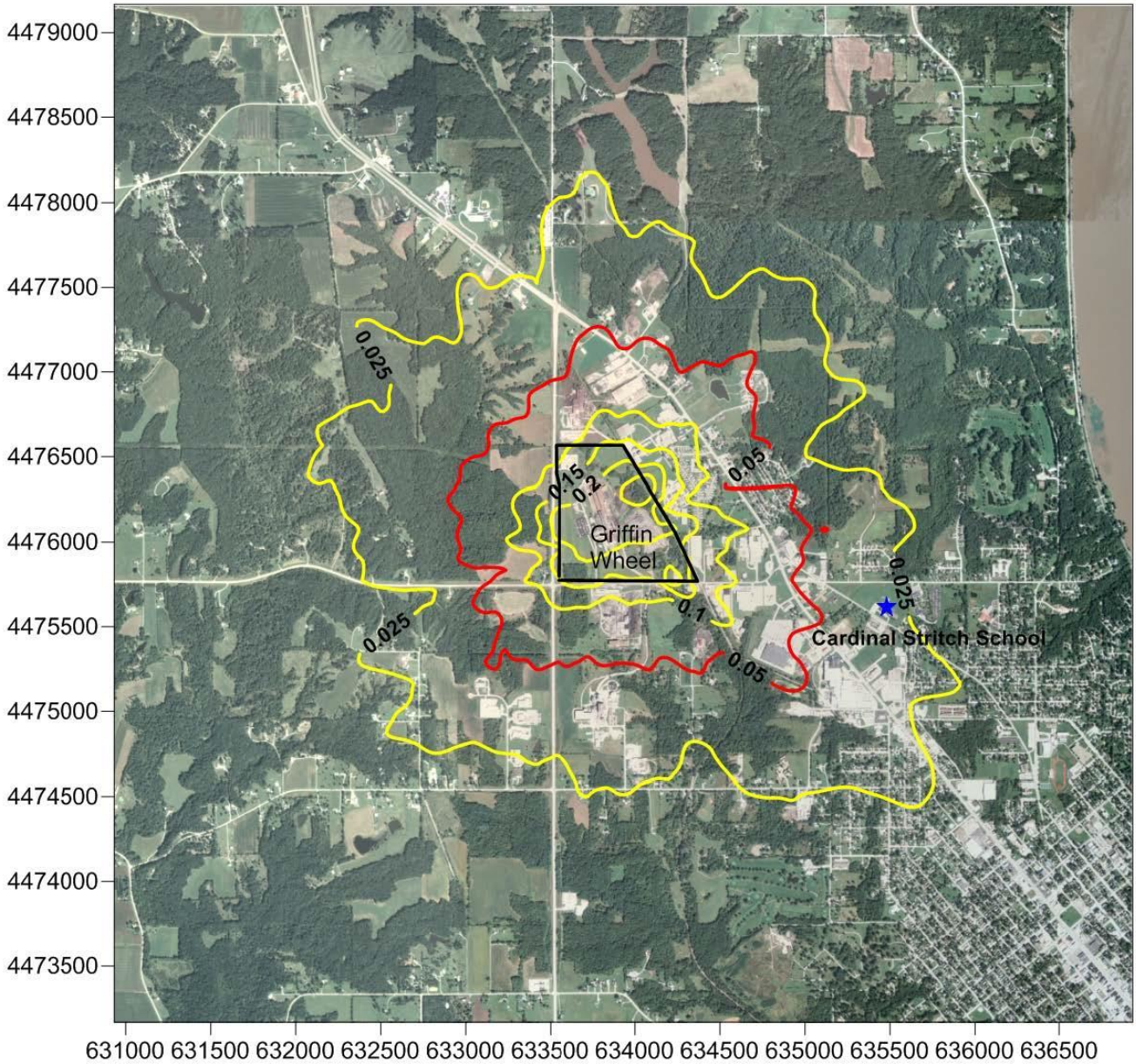


Figure 2: Modeled concentrations due to actual manganese emissions from Griffin Wheel. The location of the highest predicted concentration (0.31 µg/m3) is located at UTM coordinates 634075m (Northing), 4476325m (Easting), NAO 83. This is along the facility's northeast property boundary.

The chronic threshold level for manganese emissions as determined by the Iowa Department of Public Health is 0.05 µg/m3.

IOWA DEPARTMENT OF NATURAL RESOURCES

Environmental Services Division
Air Quality Bureau Modeling Group

MEMORANDUM

DATE: 10-1-2012
TO: SEAN FITZSIMMONS, BRIAN HUTCHINS
FROM: BRAD ASHTON
RE: GRIFFIN PIPE PRODUCTS COMPANY (78-01-012), MANGANESE EMISSIONS MODELING
CC: LORI HANSON, PETE ZAYUDIS, NICK PAGE, JIM MCGRAW, DAVE PHELPS

ANALYSIS SUMMARY

An air dispersion modeling analysis of actual manganese (Mn) emissions has been conducted at Griffin Pipe Products Company located in Council Bluffs. The modeling is being conducted in response to recent high monitored ambient concentrations. Previous lead modeling was used as a base on which to build the current analysis. The source and building locations were updated using a revised plot plan dated December 2011.

Griffin pipe recently added controls to the Cupola, desulfurization and magnesium inoculation processes at the facility and increased the stack height of the roof vents that exhaust the uncaptured magnesium inoculation and desulfurization process emissions. For this reason, both the pre-control and post-control emissions were evaluated. This report provides an aerial view (Figures 1 and 2) of the facility with an overlay of concentration isopleths that allow for a visual representation of the maximum predicted concentrations of manganese for both scenarios. Also included in the aerial view is the location of the existing ambient air monitor.

IMPACT COMPARISON VALUE

The comparison value of 0.05 $\mu g/m^3$ represents the threshold level for chronic exposure of manganese as determined by the Environmental Protection Agency (EPA). Chronic comparison values are meant to account for exposures greater than one year or a lifetime and were compared to the highest modeled annual impacts.

STACK PARAMETERS AND FACILITY OPERATING CONDITIONS

The emission units at the facility were evaluated using the pre-control and post-control emission rates and stack parameters listed in Tables 1a and 1b respectively. Sources were modeled using the most recent emission rates approved by the construction permit engineering staff. The facility was modeled as operating 24 hours/day, 8760 hours/year.

ANALYSIS RESULTS

According to the results from the AMS/EPA Regulatory Model (AERMOD, dated 12060), the pre-control manganese emissions from Griffin Pipe will cause predicted concentrations that are greater than the chronic exposure threshold of 0.05 $\mu g/m^3$. However, the post-control manganese emissions will cause predicted concentrations that are less than the chronic exposure threshold. The worst-case manganese modeling results are listed in Table 2. A visual display of manganese concentration isopleths is provided for pre-control emissions in Figure 1, and for post-control emissions in Figure 2.

Table 1a. Modeled Emission Rates and Stack Parameters – Pre-control

Emission Point	Mn (ton/yr)	Stack Height (ft)	Stack Gas Exit Temperature (°F)	Stack Tip Diameter (in)	Stack Gas Flow Rate (acfm)
EP2 (Cupola and Magnesium Inoculation)	1.18[A]	125.00	156	84.00	60,140
Fug-2a (Desulfurization Process)	0.077[A]	40.00	95	109.80	122,350
Fug-2b (Desulfurization Process)	0.026[A]	40.00	95	109.80	122,350

[A]The emission rate summarized here represents the actual emissions for this source from 2010.

Table 1b. Modeled Emission Rates and Stack Parameters – Post-control

Emission Point	Mn (ton/yr)	Stack Height (ft)	Stack Gas Exit Temperature (°F)	Stack Tip Diameter (in)	Stack Gas Flow Rate (acfm)
EP2A (Cupola)	0.147[A]	100.00	295	80.00	109,762
EP3 (Desulfurization Process and Magnesium Inoculation)	0.0007[A]	100.00	149	74.00	64,761
EP7A (Magnesium Inoculation - Uncaptured)	0.0022[A]	80.00	95	122.40	119,546
EP7B (Desulfurization Process - Uncaptured)	0.0022[A]	80.00	95	122.40	119,546

[A]The emission rate summarized here represents the actual emissions for this source from 2011.

Table 2. Worst Case Modeling Results

Scenario	Averaging Period	Highest Predicted Concentration ($\mu g/m^3$)	Chronic Inhalation Exposure Threshold ($\mu g/m^3$)
Pre-Control	Annual	0.073	0.05
Post-Control		0.002	

Figure 1. Maximum Annual Manganese Concentrations – Pre-Control

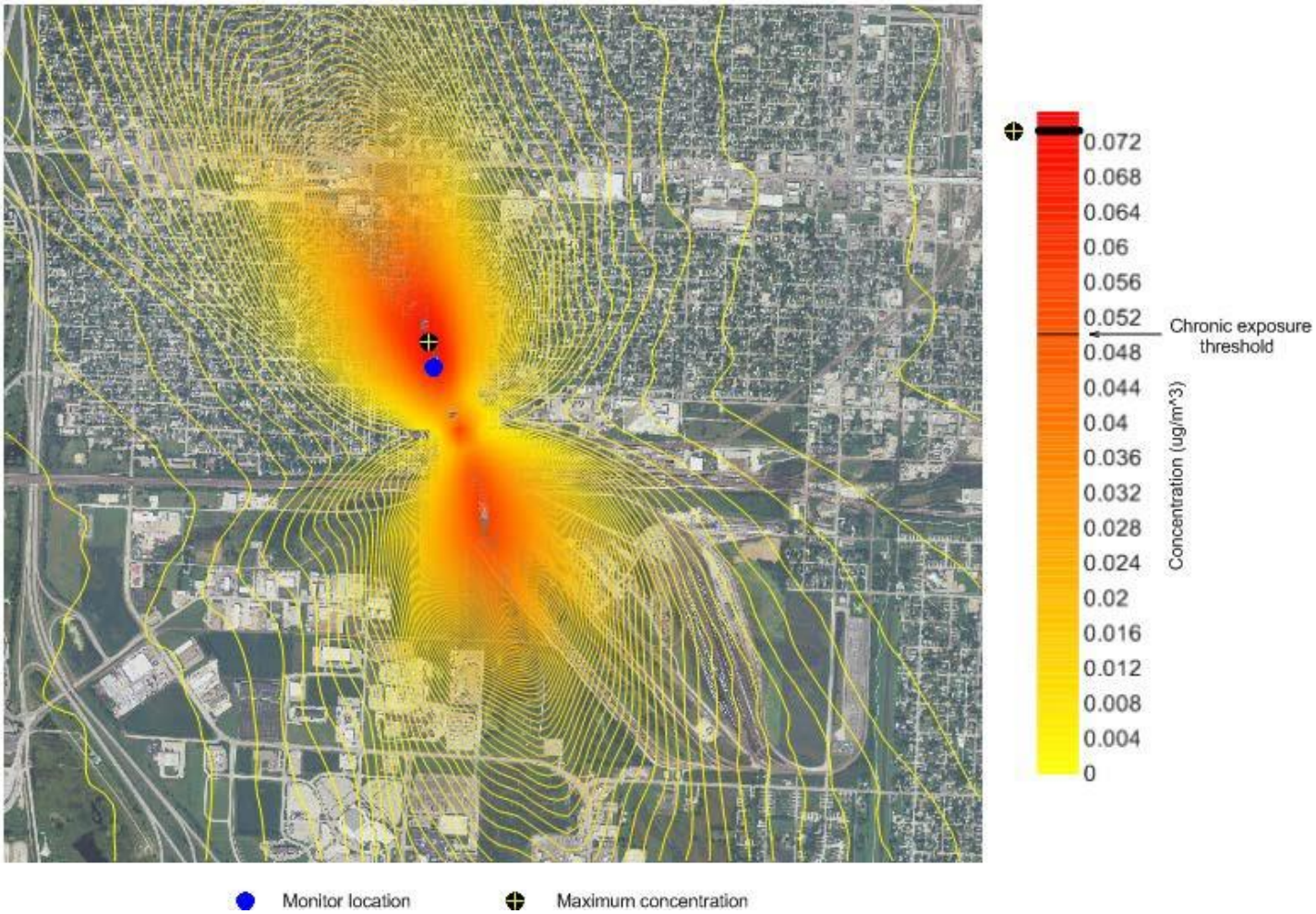
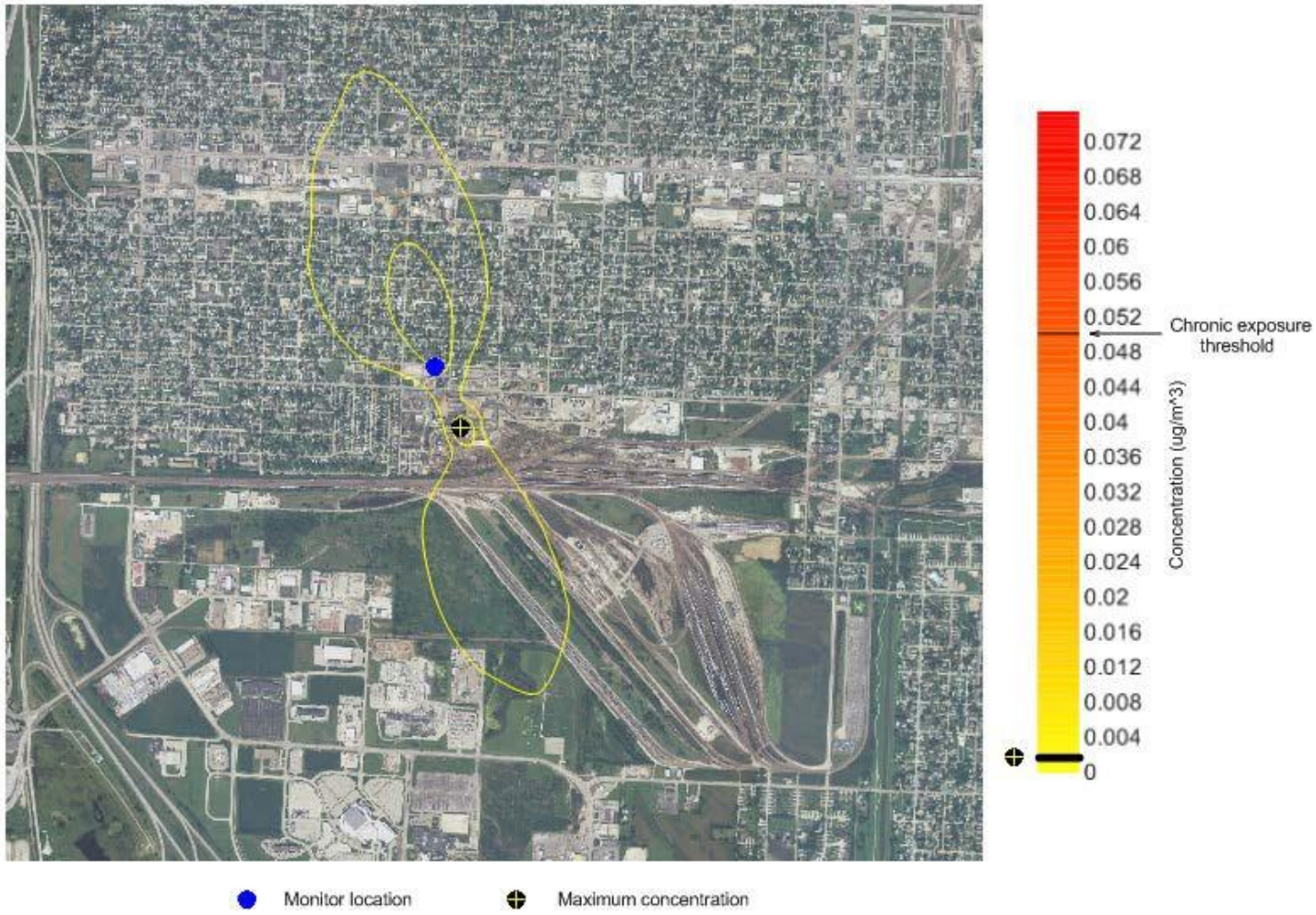


Figure 2. Maximum Annual Manganese Concentrations – Post-Control



Appendix C. Precision Calculations

Let c_i^1 and c_i^2 represent two concentrations from a particular monitoring location taken on the same day. If both are greater than the MDL, then they may be used to estimate the precision of the data at the sampling location as follows:

First compute the average:

$$\overline{c_i} = \frac{c_i^1 + c_i^2}{2}$$

And the mean difference:

$$d_i = \frac{c_i^1 - c_i^2}{c_i}$$

Define the coefficient of variation for the pair of samples as:

$$CV_i = \frac{d_i}{\sqrt{2}}$$

Compute the root mean square of the individual coefficients of variation to determine the coefficient of variation of the data at the site for the entire year:

$$CV = \sqrt{\frac{\sum_{i=1}^{n} CV_i^2}{n}}$$

Finally, compute confidence limits in the usual way:

$$Lower\ Confidence\ Limit = CV = \sqrt{\frac{n}{X_{(.05,n)}^{-1}}}$$

$$Upper\ Confidence\ Limit = CV = \sqrt{\frac{n}{X_{(.95,n)}^{-1}}}$$

Where X^{-1} represents the inverse of the chi-squared distribution.

Appendix D. Council Bluffs Manganese (Concentration vs. Met Data)

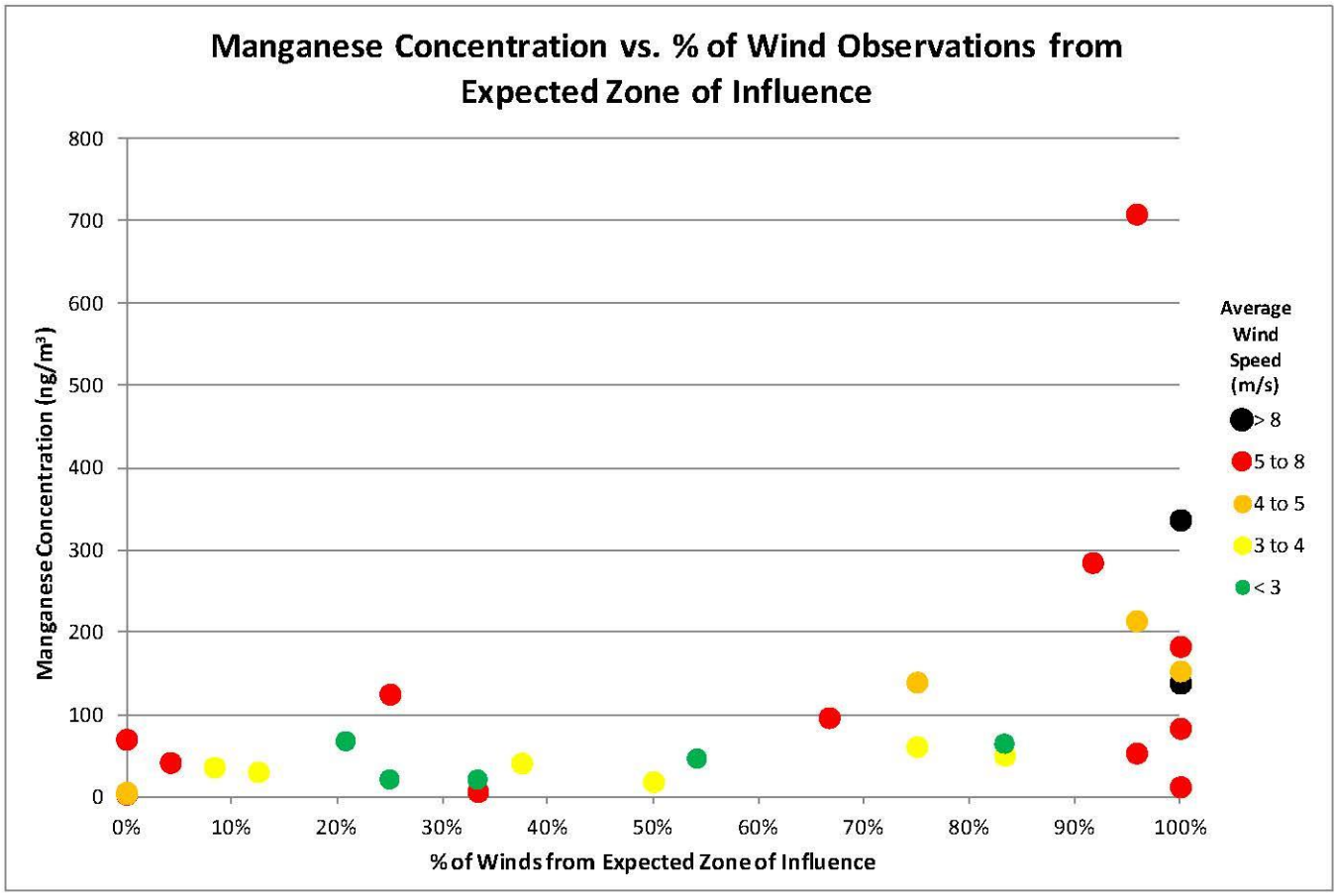
Meteorological data used for this report was collected at the Omaha Eppley Airport (KOMA) Automated Weather Observing System (AWOS) station. The airport is located approximately 3 miles NNW of the monitoring site. The data shows that winds measured over the sampling period as well as on sampling days were similar to winds observed in the area over larger timescales. The expected zone of influence is determined using the edges of the property of the nearby facility. The range of wind directions from approximately 90 to 250 degrees is considered the zone of influence (ZOI).

Parameter	Manganese (TSP)	% Hours w/ Wind Direction from Expected ZOI[a]	Wind Speed (avg. of hourly speeds)	Wind Direction (avg. of unitized vector)[b]	% of Hours with Speed below 1.5 mps
Units	ng/m^3	%	m/s	deg.	%
1/3/2011	20.63	33%	2.9	324	25%
1/15/2011	3.32	0%	5.8	345	0%
1/27/2011	41.14	38%	3.6	320	0%
2/8/2011	5.81	0%	4.9	342	0%
2/20/2011	6.65	33%	5.5	327	8%

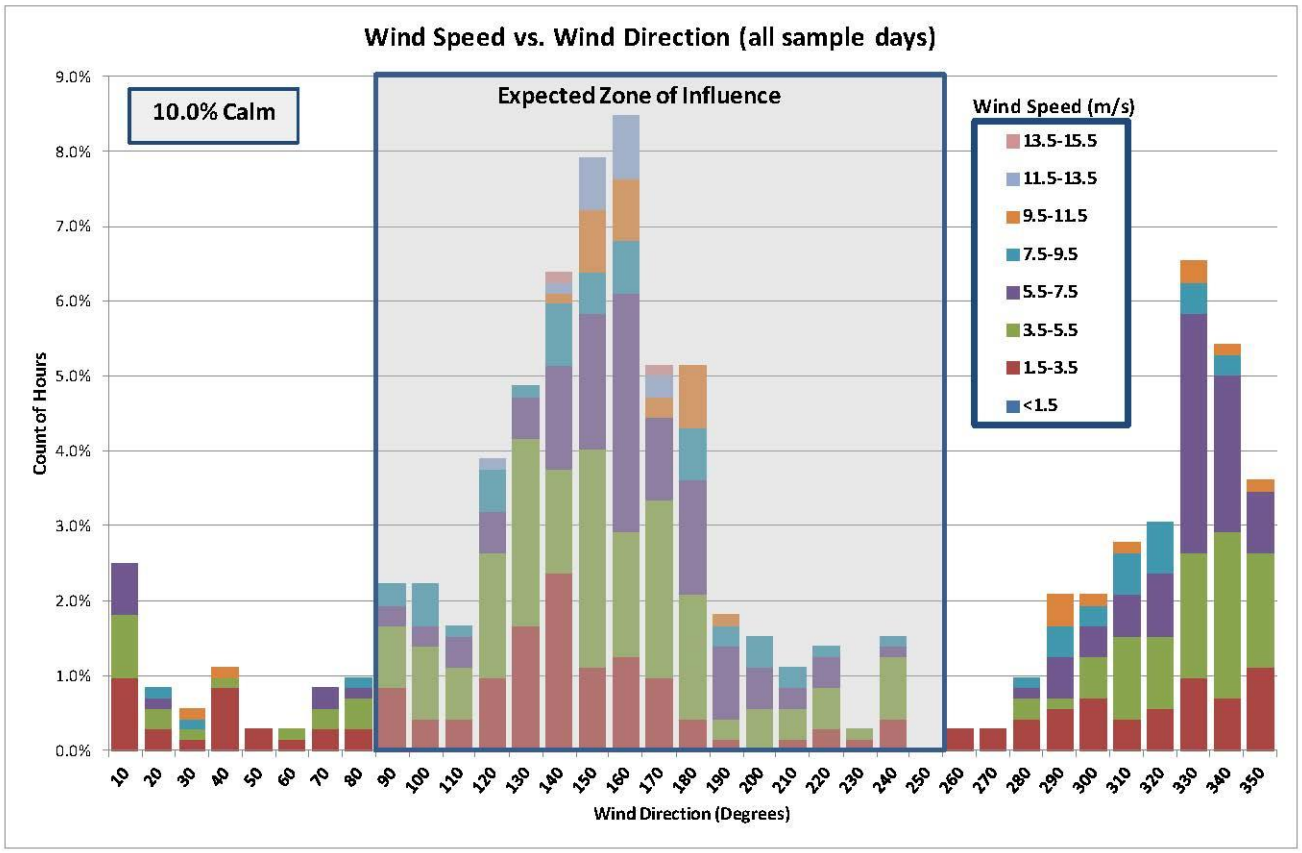
Parameter	Manganese (TSP)	% Hours w/ Wind Direction from Expected ZOI[a]	Wind Speed (avg. of hourly speeds)	Wind Direction (avg. of unitized vector)[b]	% of Hours with Speed below 1.5 mps
Units	ng/m^3	%	m/s	deg.	%
3/16/2011	708.54	96%	5.6	166	4%
3/28/2011	50.52	83%	3.9	119	13%
4/9/2011	83.51	100%	7.5	148	0%
4/21/2011	53.34	96%	5.9	119	4%
5/3/2011	67.32	21%	1.5	87	63%
5/15/2011	3.93	0%	4.9	354	0%
5/27/2011	153.12	100%	4.9	150	0%
6/8/2011	124.98	25%	6.1	340	0%
6/20/2011	96.4	67%	6.9	110	4%
7/2/2011	30.42	13%	3.5	27	4%
7/20/2011	284.98	92%	5.3	190	4%
7/26/2011	214.16	96%	4.5	151	4%
8/7/2011	18.57	50%	3.4	156	42%
8/19/2011	20.89	25%	2.6	30	17%
8/31/2011	64.19	83%	2.9	130	17%
9/12/2011	139.47	75%	4.6	185	8%
9/24/2011	46.21	54%	1.9	118	38%
10/6/2011	336.78	100%	8.4	153	0%
10/18/2011	70.07	0%	5.8	339	0%
10/30/2011	41.86	4%	5.9	312	0%
11/5/2011	138.56	100%	9.7	157	0%
11/17/2011	182.94	100%	5.2	189	0%
11/29/2011	36.2	8%	3.6	348	21%
12/11/2011	12.33	100%	5.4	170	0%
12/23/2011	61.15	75%	3.3	205	25%

[a]Based on count of hours for which vector wind direction is from expected zone of influence.
[b]Wind direction for each day is represented by values derived by scalar averaging of hourly estimates that were produced as unitized vectors.

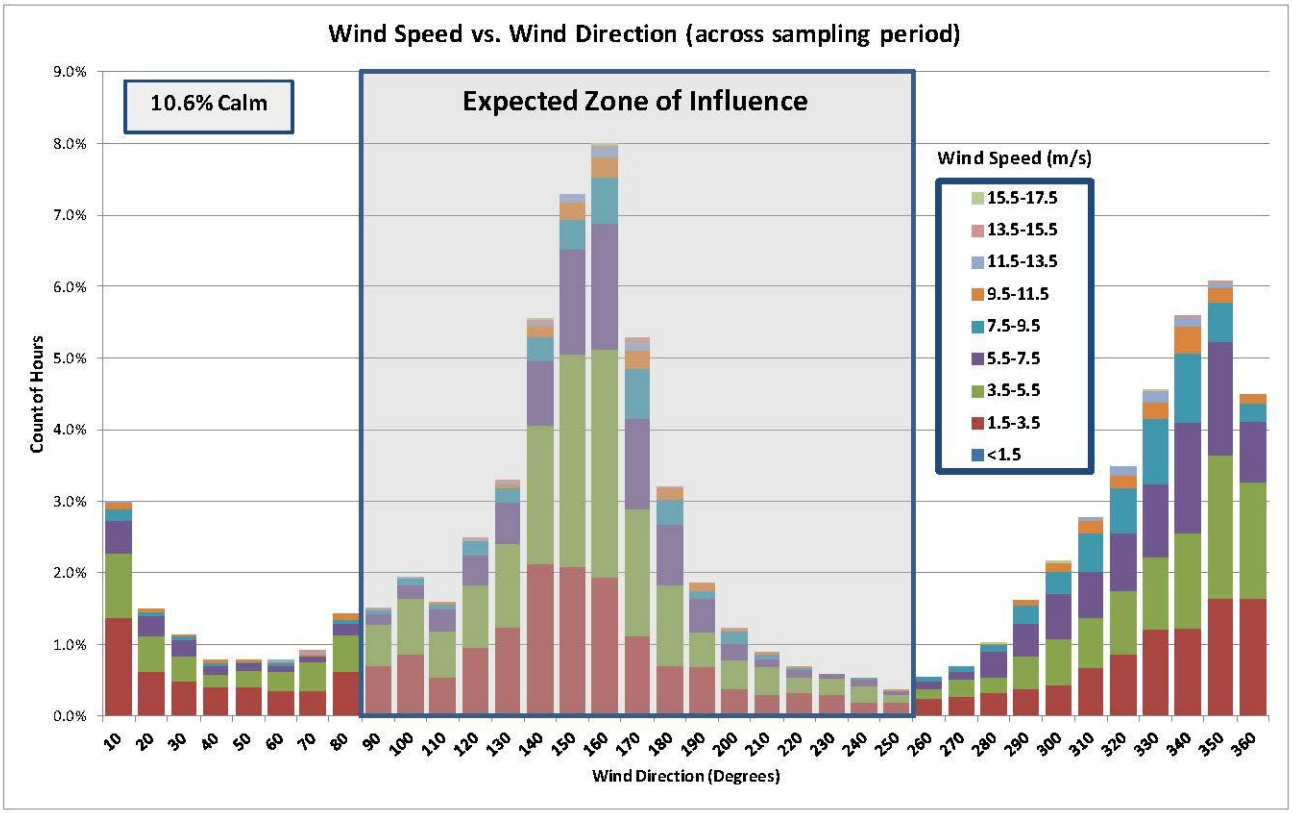
Council Bluffs Manganese Concentration and Wind Information



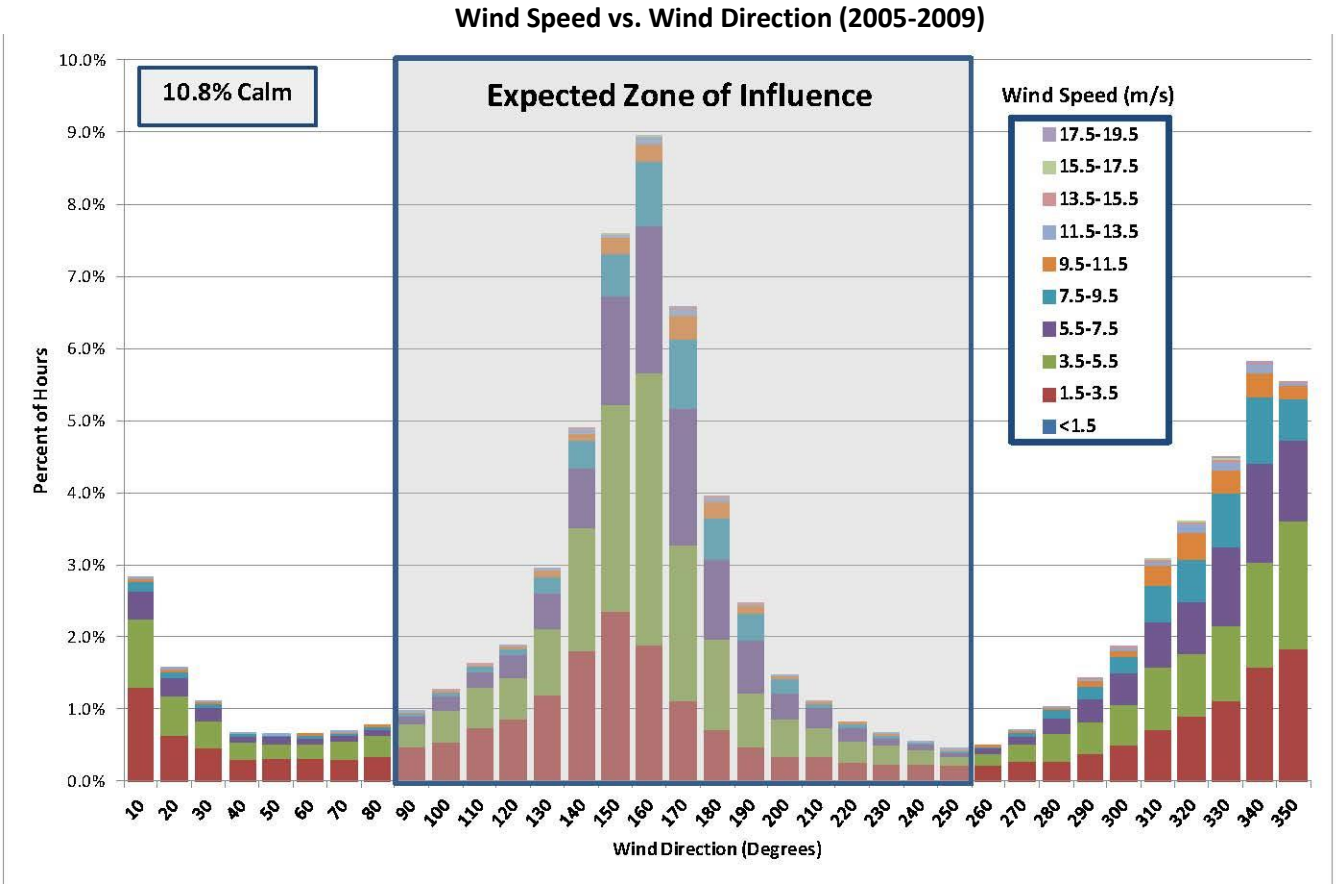
The chart above shows a marker for each sample whose position on the Y axis indicates the average manganese concentration for the 24-hour sample period. The X axis shows the percentage of hours when the wind blew from the expected zone of influence on the sample day. The color of the marker indicates the average wind speed on the sampling day.



The chart above was created from data from Omaha Eppley Airfield (KOMA) Automated Weather Observing Station (AWOS) using wind speed and direction data from all sample days in the sampling period.



The chart above shows wind data from the KOMA AWOS station throughout the entire period when sampling was conducted (1/3/2011-12/23/2011).

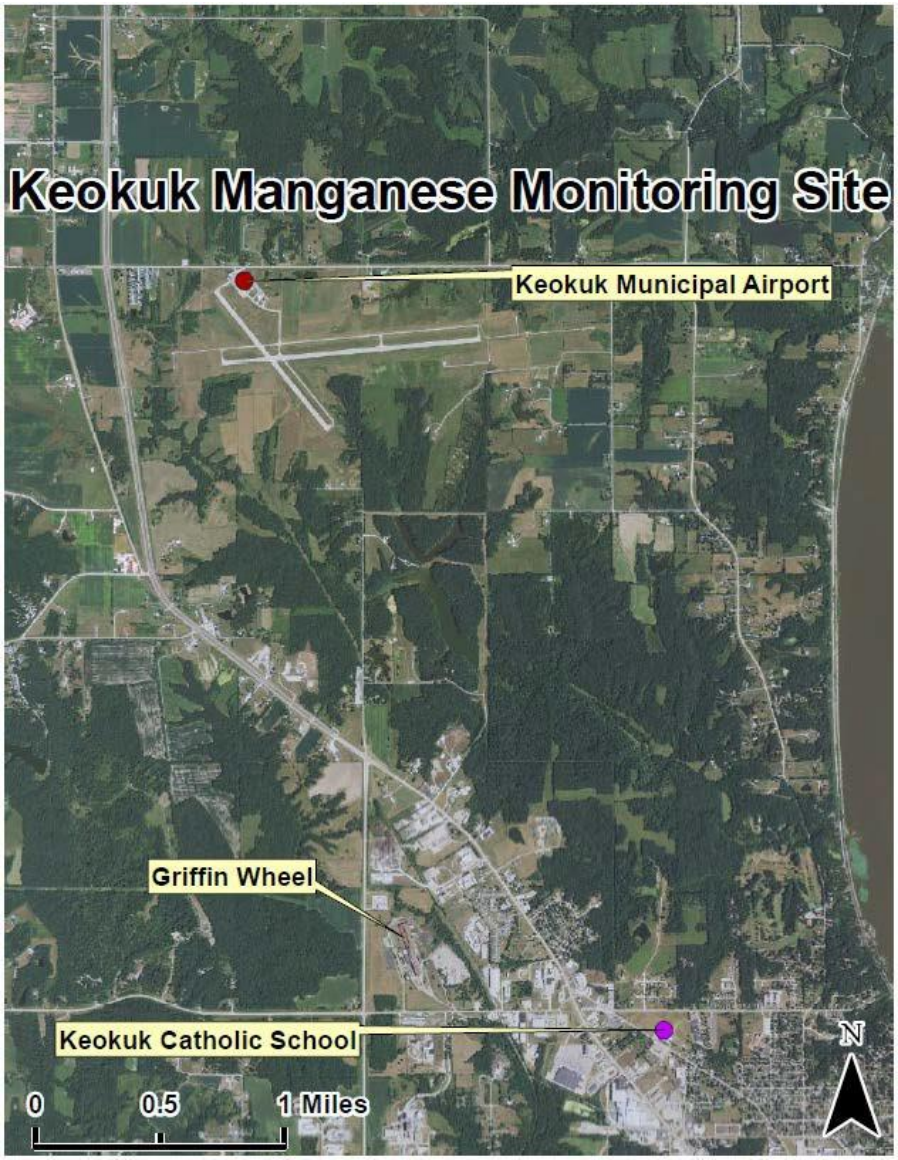


The chart above shows typical wind data from the KOMA AWOS station for the period 2005-2009.

Appendix E. Keokuk Manganese Concentration vs. Met Data

Keokuk Catholic School Manganese Concentrations and Meteorological Data

Meteorological data used for this report was collected at the Keokuk Municipal Airport (EOK) Automated Weather Observing System (AWOS) station. The airport is located approximately 3 miles NNW of the School. The data shows that winds measured over the sampling period as well as on sampling days were similar to winds observed in the area over larger timescales. The expected zone of influence is determined using the property boundaries of the nearby facility. The range of wind directions from approximately 270 to 310 degrees is considered the zone of influence (ZOI).

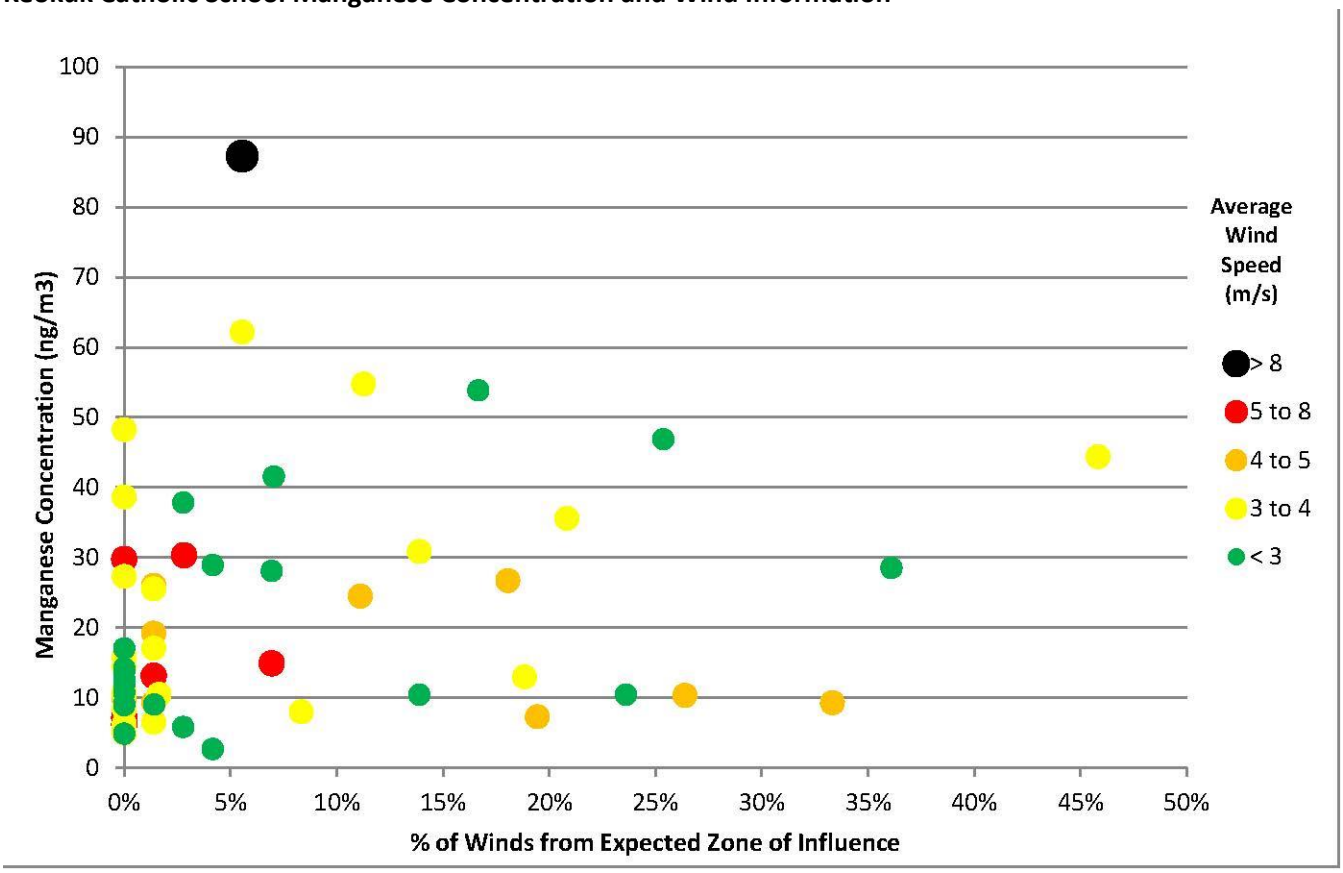


Parameter	Manganese (TSP)	% Hours w/ Wind Direction from Expected ZOI[a]	Wind Speed (avg. of hourly speeds)	Wind Direction (avg. of unitized vector)[b]	% of Hours with Speed below 1.5 mps
Units	ng/m^3	%	m/s	deg.	%
1/3/2011	46.9	25%	2.9	230	4%
1/9/2011	12.6	0%	2.2	88	32%
1/15/2011	7.3	19%	4.3	318	0%
1/21/2011	9.1	1%	1.6	121	45%
1/27/2011	35.6	21%	3.1	247	18%
2/10/2011	26.1	1%	4.0	222	19%
2/14/2011	10.4	26%	4.3	327	15%
2/20/2011	14.9	7%	5.3	164	0%
2/26/2011	2.7	4%	1.0	76	58%
3/4/2011	19.2	1%	4.3	253	0%
3/10/2011	9.3	33%	4.4	319	11%
3/16/2011	38.7	0%	3.6	210	0%
3/22/2011	30.3	3%	5.4	148	0%
3/28/2011	8.4	0%	3.7	74	0%
4/3/2011	87.3	6%	8.1	197	1%
4/9/2011	10.4	0%	3.8	135	8%
4/15/2011	13.2	1%	5.9	96	18%
4/21/2011	9.3	1%	4.0	99	22%
4/27/2011	13.0	19%	3.3	314	7%
5/3/2011	30.9	14%	3.2	343	10%
5/9/2011	29.8	0%	5.7	141	0%
5/15/2011	5.8	3%	2.8	358	17%
5/21/2011	17.1	1%	3.8	176	0%
5/27/2011	4.9	0%	2.9	119	11%
6/2/2011	6.3	0%	3.0	128	8%
6/8/2011	48.3	0%	3.9	196	6%
6/14/2011	6.2	0%	5.0	124	4%
6/20/2011	10.1	0%	4.0	127	5%
6/26/2011	6.5	1%	3.8	100	8%
7/2/2011	29.0	4%	2.2	301	17%
7/8/2011	13.8	0%	0.8	39	63%
7/14/2011	10.9	0%	3.2	105	3%
7/20/2011	25.5	1%	3.3	213	13%
7/26/2011	37.9	3%	1.6	171	38%
8/1/2011	14.2	0%	1.8	165	23%
8/7/2011	28.5	36%	2.4	278	31%
8/13/2011	44.4	46%	3.4	290	13%
8/19/2011	11.9	0%	1.1	73	60%
8/25/2011	41.6	7%	1.1	16	52%
8/31/2011	17.0	0%	1.3	181	48%

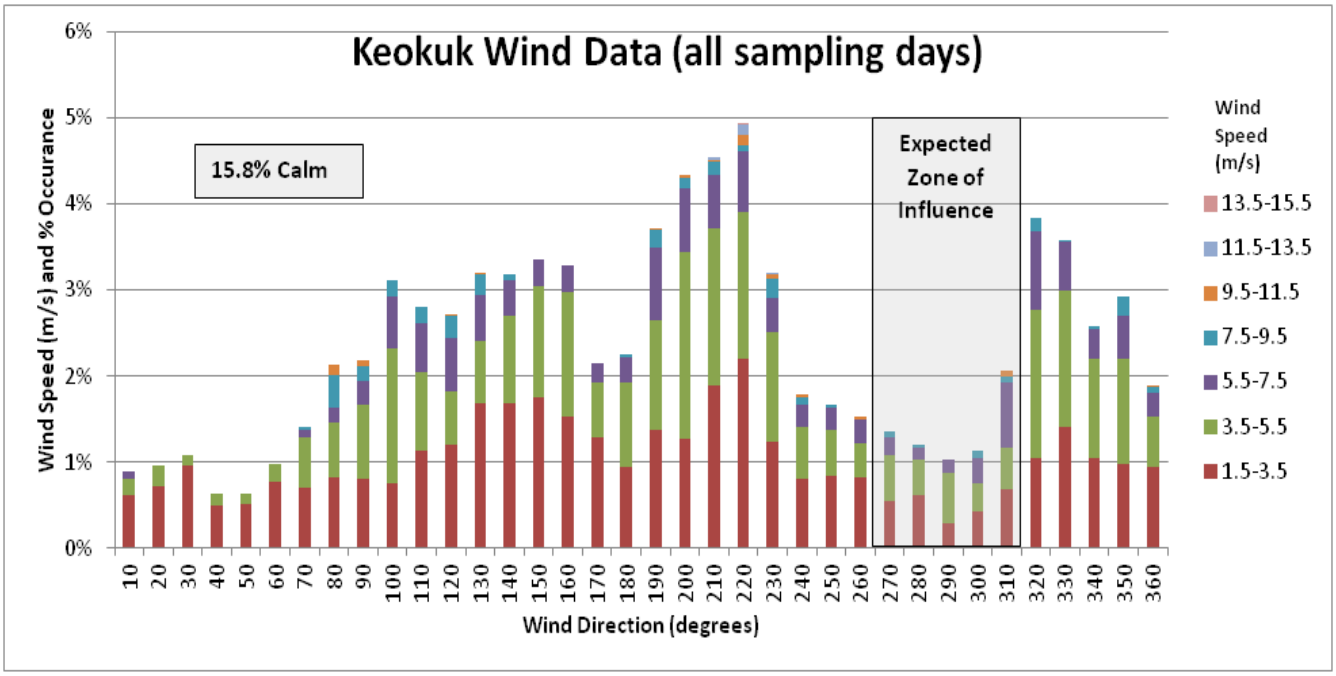
Parameter	Manganese (TSP)	% Hours w/ Wind Direction from Expected ZOI[a]	Wind Speed (avg. of hourly speeds)	Wind Direction (avg. of unitized vector)[b]	% of Hours with Speed below 1.5 mps
Units	ng/m^3	%	m/s	deg.	%
9/6/2011	9.0	0%	2.5	28	7%
9/12/2011	15.9	0%	3.7	221	0%
9/18/2011	9.1	0%	1.7	139	38%
9/24/2011	10.8	0%	1.4	31	44%
9/30/2011	24.5	11%	4.3	336	8%
10/6/2011	27.3	0%	3.3	147	6%
10/12/2011	53.9	17%	1.9	198	33%
10/18/2011	62.2	6%	3.0	332	28%
10/24/2011	28.1	7%	2.4	192	18%
10/30/2011	26.7	18%	4.4	221	4%
11/5/2011	5.0	0%	3.9	155	1%
11/11/2011	14.4	0%	3.4	202	10%
11/17/2011	54.8	11%	3.8	239	6%
11/23/2011	10.5	14%	2.1	224	28%
11/29/2011	7.2	0%	5.2	342	0%
12/5/2011	9.8	0%	4.2	342	0%
12/11/2011	5.7	0%	3.4	190	4%
12/17/2011	10.5	24%	2.9	243	7%
12/23/2011	8.0	8%	3.4	245	8%
12/29/2011	10.5	2%	3.9	223	3%

[a]Based on count of hours for which vector wind direction is from expected zone of influence.
[b]Wind direction for each day is represented by values derived by scalar averaging of hourly estimates that were produced as unitized vectors.

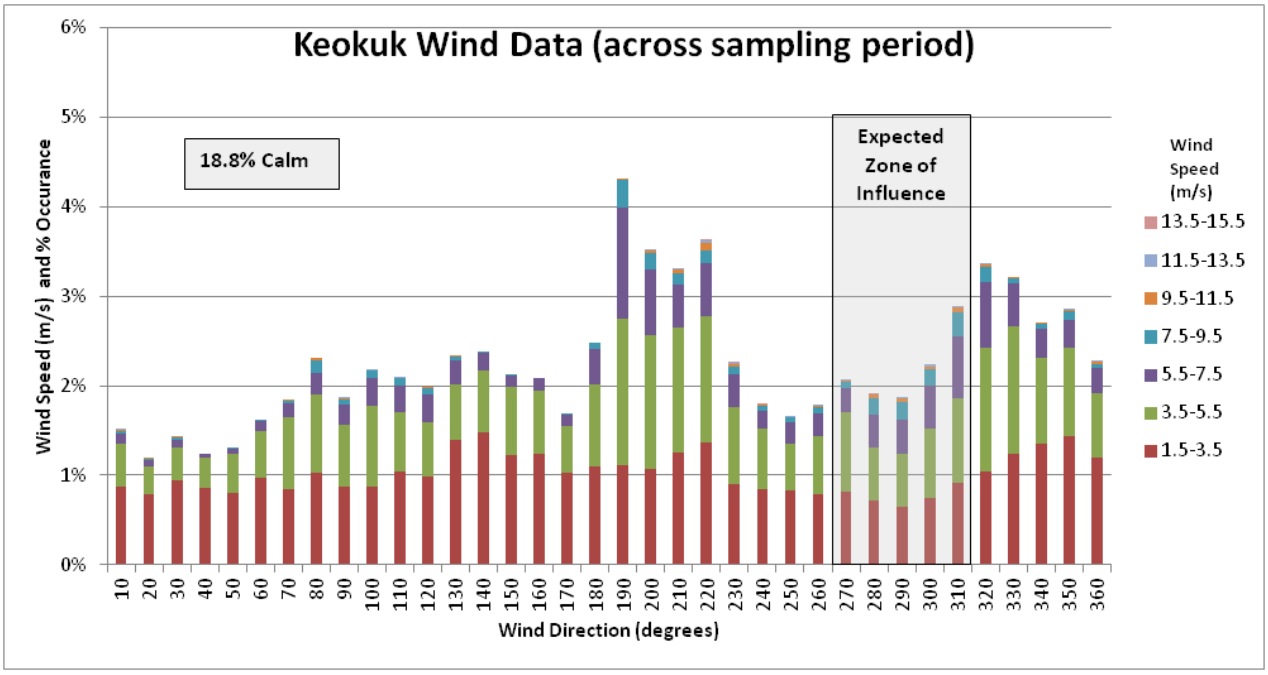
Keokuk Catholic School Manganese Concentration and Wind Information



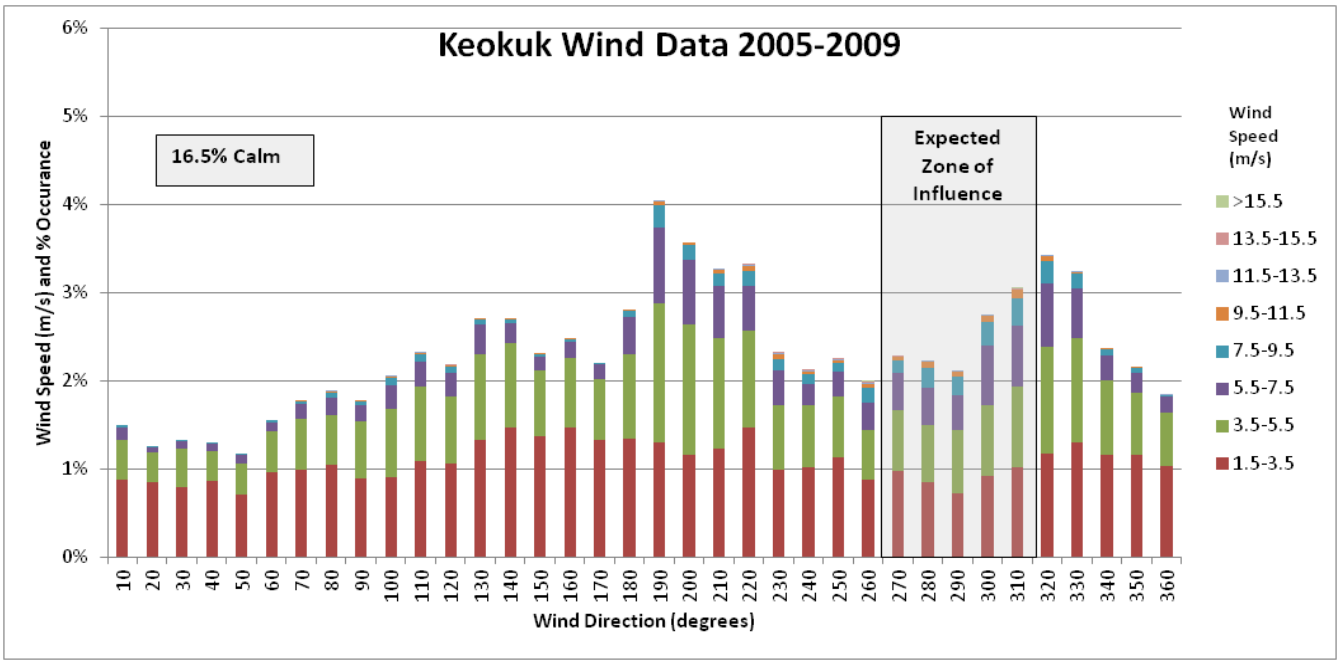
The chart above shows a marker for each sample whose position on the Y axis indicates the average manganese concentration for the 24-hour sample period. The X axis shows the percentage of hours when the wind blew from the expected zone of influence on the sample day. The color of the marker indicates the average wind speed on the sampling day.



The chart above was created from data from Keokuk Municipal Airport (EOK) Automated Weather Observing Station (AWOS) using wind speed and direction data from all sample days in the sampling period.



The chart above shows wind data from the EOK AWOS station throughout the entire period when sampling was conducted (1/3/2011-12/29/2011).



The chart above shows typical wind data from the EOK AWOS station for the period 2005-2009.