

EXCEPTIONAL EVENT REQUEST
FIREWORKS DISPLAY IMPACT
GRANITE CITY, ILLINOIS
Site 17-119-1007
July 5, 2008 PM_{2.5} Sample

submitted by

Illinois Environmental Protection Agency

March, 2009

Background

Some national and/or cultural traditions, such as July 4th Independence Day and the Chinese New Year, have long included fireworks displays as important elements of their observances. While this issue is not specifically covered in the Clean Air Act Section 319, the United States Environmental Protection Agency (US EPA) has stated that they believe Congress did not intend to require US EPA to consider air quality violations associated with such cultural traditions in regulatory determinations. In that regard, US EPA has adopted rules governing the review and handling of air quality measurements that have been unduly influenced by fireworks displays as exceptional events.

In the Code of Federal Regulations at 40 CFR Part 50.14(b)(2), it states that US EPA shall exclude data from use in determinations of exceedances and violation of a National Ambient Air Quality Standard (NAAQS) where a state demonstrates to US EPA's satisfaction that emissions from fireworks displays caused a specific air pollutant concentration to be in excess of one or more NAAQS at a particular monitoring location. Such data is to be treated as an exceptional event under the rule, provided that the state demonstrates that the violation would not have occurred "but for" the event, that is, absent the impact of fireworks display emissions, the critical value would have been below the NAAQS.

Exceptional Event - July 5, 2008

The Illinois EPA has determined that such an exceptional event did occur on July 5, 2008 at the Granite City (17-119-1007) monitoring site location. The site recorded a value of 41.8 micrograms per cubic meter (ug/m3) on July 5, 2008 that was significantly influenced by fireworks display emissions that lingered in the area after the events on the late evening of July 4th. The 41.8 ug/m3 measurement resulted in the site recording a 98th percentile value of 36.0 ug/m3 for 2008 and that in turn, provided an average 98 percentile value for 2006-2008 of 36.1 ug/m3, thus a violation of 35 ug/m3 daily PM_{2.5} NAAQS. Absent the 41.8 ug/m3 value, the Granite City results would provide a 98 percentile value of 31.9 ug/m3 in 2008 and an average 98 percentile value for 2006-2008 of 34.7 ug/m3, below the daily PM_{2.5} NAAQS. "But for" the July 5th measurement that was significantly impacted by fireworks displays emissions, the Granite City site would have complied with the PM_{2.5} daily NAAQS.

In order to substantiate the significance of the fireworks emissions impacts, Illinois EPA analyzed air quality, chemical speciation and meteorological data for July 5th. That analysis clearly shows that "but for" the contribution from fireworks emissions, the Granite City measurement would have been from 11.4 to 17 ug/m3 lower. This would have resulted in a daily value of only 25 to 30 ug/m3 and a value well below the PM_{2.5} NAAQS. The Illinois EPA data analysis was based upon:

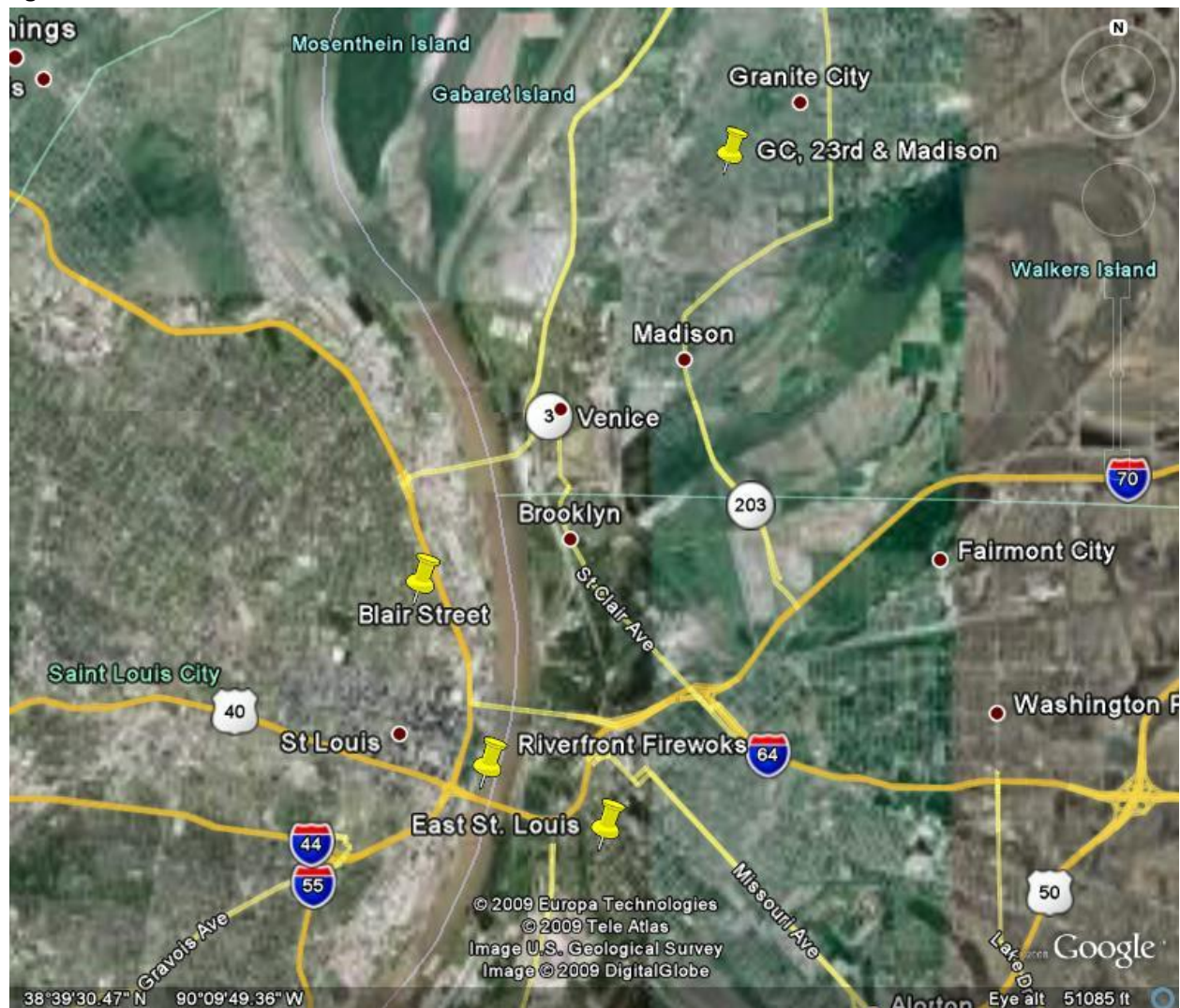
- 1) Real-time PM monitoring data. Histograms of hourly continuous data.
- 2) Chemical speciation data. Measured concentrations of metals associated with fireworks.
- 3) Meteorological observations. Illinois EPA and National Weather Service wind and visibility data.

The following sections provide discussion of these data and an interpretation of the results as they pertain to the significant influence of fireworks display emissions on July 4th and 5th.

Real-time Monitoring Results

As shown on the map displayed in Figure 1, there are three continuous PM monitoring stations in and around Granite City, a PM₁₀ monitor in Granite City (17-119-1007), a PM_{2.5} monitor at E. St. Louis (17-163-0010) located 4 miles South of Granite City, and a PM_{2.5} monitor at St. Louis- Blair St (25-510-0085) 4 miles Southwest of Granite City. The St. Louis Riverfront (Arch) July 4th fireworks display is a massive event and is the main event in the St. Louis area Independence Day celebration. The location of the fireworks discharge as shown on the map was along the riverfront just west of the E. St. Louis air monitoring site. All three monitoring sites were in close proximity to the fireworks display.

Figure 1



The hourly data from the three monitoring sites for the period of July 3rd through July 6th has been displayed in Figures 2-4. As can be seen from the graphs, beginning at 9:00 pm (2100) PM levels begin to spike dramatically. This coincides with the beginning of the fireworks displays and clearly shows their impact across the area. For the hours during with the fireworks display (July 4th 2100-2200), hourly PM_{2.5} concentrations reached 188 ug/m³ at St. Louis- Blair St. and 146 ug/m³ at E. St. Louis and 120

Figure 2
East St. Louis Continuous PM_{2.5}
July 3 - 6, 2008

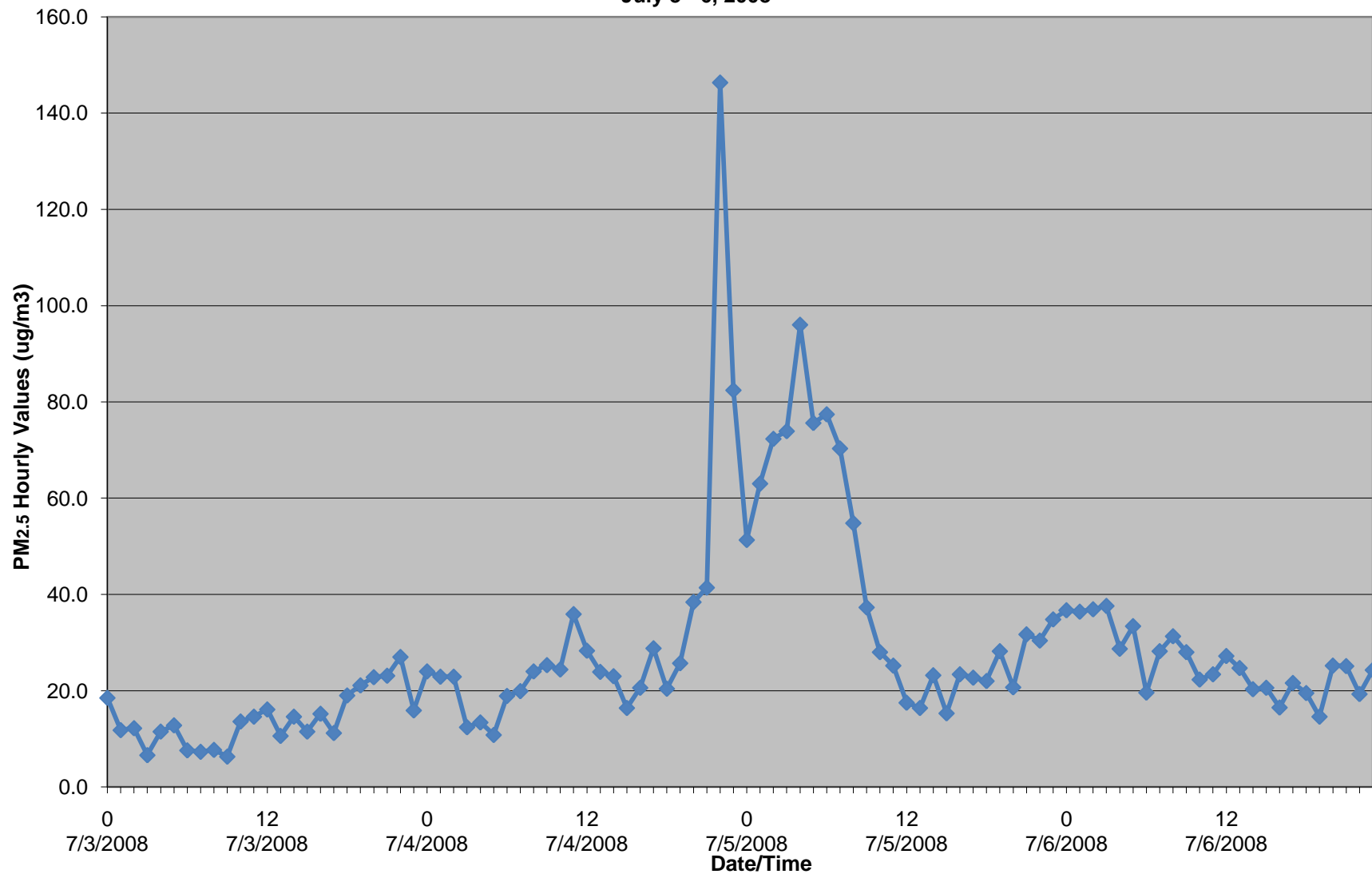


Figure 3
Blair Street St. Louis, MO Continuous PM_{2.5}
July 3 - 6, 2008

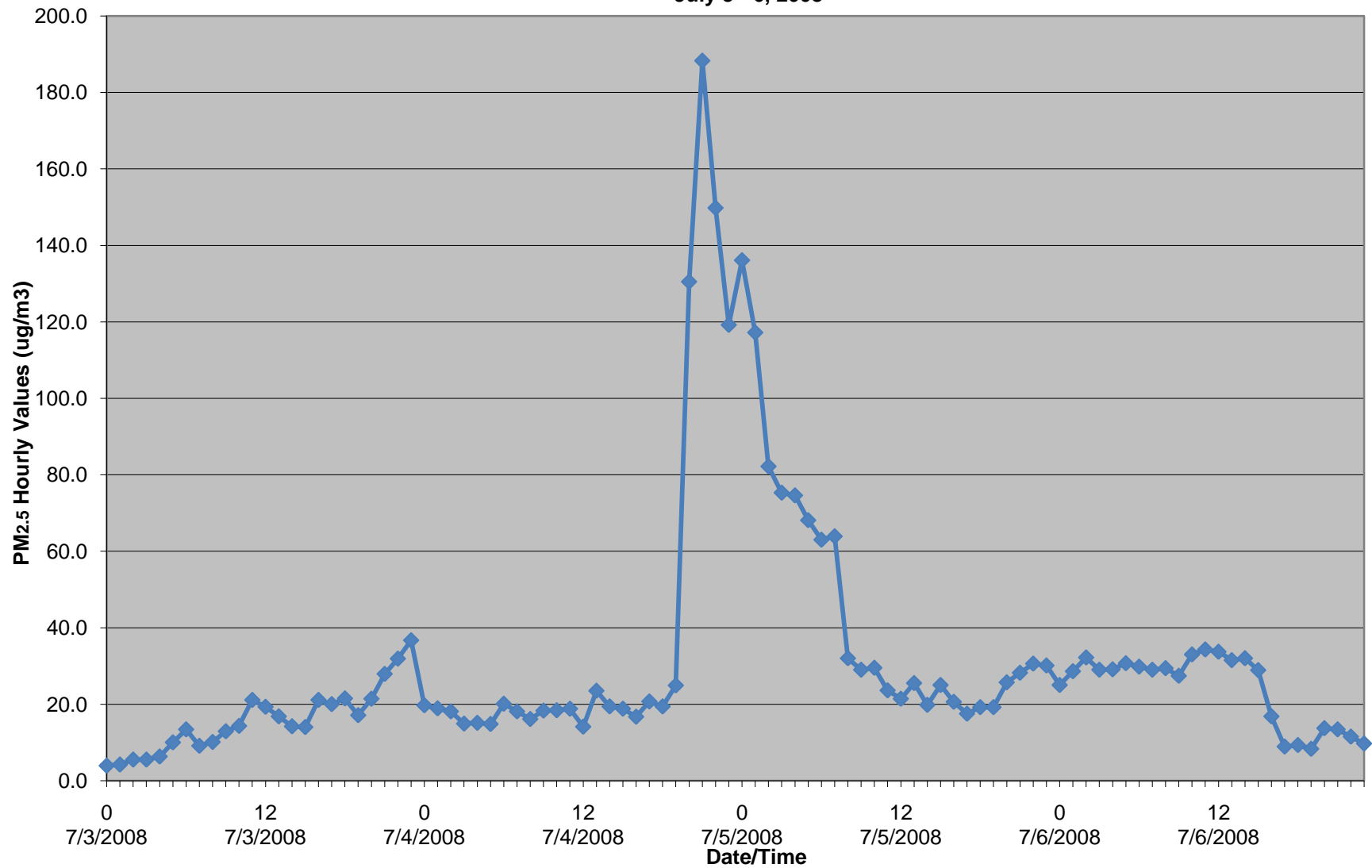
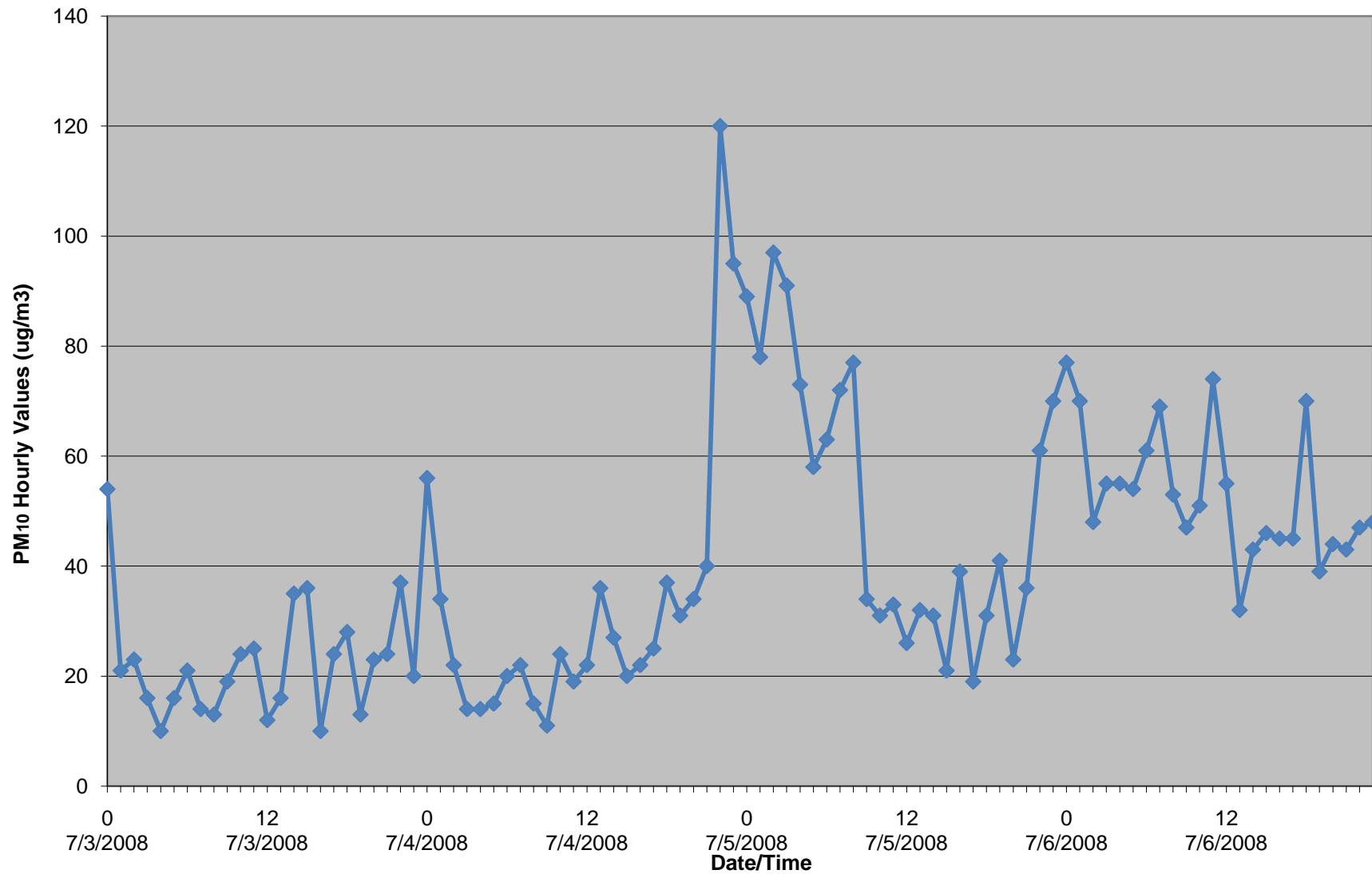


Figure 4
Granite City - 23rd & Madison Continuous PM₁₀
July 3 - 6, 2008



ug/m³ of PM₁₀ measured at Granite City. As the fireworks associated emissions lingered in the area due to light winds, the PM_{2.5} levels remained elevated at all three sites until 0800 on July 5th. During the early morning hours on July 5th, the St. Louis- Blair St. recorded PM_{2.5} hourly values of 138 and 118 ug/m³ and E. St. Louis site recorded a PM_{2.5} hourly value of 96 ug/m³. As Figures 2-4 illustrate, the concentrations of PM dropped dramatically after 0800 on July 5th when area winds increased and PM levels dispersed. The daily (Midnight to Midnight) PM values measured at the three sites on July 5th were as follows:

E. St. Louis (17-163-0010) PM_{2.5} - 42.1 ug/m³

St. Louis Blair St. (25-510-0085) PM_{2.5} - 44.9 ug/m³

Granite City PM (17-119-1007) PM₁₀ - 51.0 ug/m³

These three values agree closely with the 41.8 ug/m³ value recorded on July 5th by the FRM sampler located at Granite City (17-119-1007) and the subject of this exceptional event request.

While the fireworks impacts are obvious from Figures 2-4, an analysis was conducted to estimate the contribution of the fireworks displays emissions to area PM_{2.5} levels. Both St. Louis- Blair St. and E. St. Louis monitors recorded levels at 25 ug/m³ for extended periods before and after the fireworks event. Using 25 ug/m³ as a baseline for July 5th, the mass concentrations of PM_{2.5} measured from hours 0000 through 0800 were adjusted by subtracting 25 ug/m³ and the remaining total mass totaled. This adjusted mass was then compared to the total mass for the day to estimate the per cent contribution of hours 0000-0800 (fireworks) to the July 5th measurements. The analysis results found St. Louis- Blair St. to have 44% and E. St. Louis to have 40.5% of their July 5th mass directly associated to the fireworks display emissions. Using the more conservative number of 40.5% to estimate the fireworks impact to the 41.8 ug/m³ FRM measurement at Granite City, an impact of 16.9 ug/m³ was projected. The analysis concludes that absent the fireworks display impact (16.9 ug/m³), the Granite City FRM value for July 5th would have been only 24.9 ug/m³ and provides supportive evidence that no violation would have occurred but for the fireworks event.

Those sites outside of the downtown E. St. Louis area were found to have recorded significantly lower PM_{2.5} values on July 5th. The Houston site located in a rural area south of the St. Louis area (Randolph County) recorded a value of only 18.8 ug/m³ and the Alton and Wood River sites located 10 miles north of Granite City recorded values of 25.5 and 24.0 ug/m³ respectively. These data indicate that the regional air mass (background) concentration on July 5th was well below the level of the NAAQS. A review of historical PM_{2.5} data for the Granite City (17-119-1007) site for the period of 2006 through 2008 found that the 41.8 ug/m³ value on July 5, 2008 was the highest of the 322 daily measurements reported. The second highest daily value was 40.0 ug/m³ reported on February 28, 2006. Clearly, as the 100 percentile value, the 41.8 ug/m³ value on July 5, 2008 would meet the criteria of being in excess of normal historical values. These results would serve to confirm an incrementally significant impact of fireworks emissions on July 5th.

Chemical Speciation Results

The Granite City (17-119-1024) site includes a special sampler to provide information on the chemical composition of collected PM_{2.5} mass. The site is one of US EPA's national trend sites for chemical speciation and samples collected from Granite City are submitted to US EPA's national contract laboratory for analysis and reporting. A valid sample was collected at Granite City on July 5, 2008 and the results were available for analysis to confirm impacts from fireworks displays emissions.

Previous requests to US EPA for the approval of a sample as an exceptional event impacted by fireworks emissions have included supporting chemical speciation data. Fireworks emissions are particularly rich in certain compounds and elements that are not normally found in high concentration in PM_{2.5} mass. The presence of these compounds/elements then serve as a tracer for fireworks emissions and can indicate a level at which a particular sample has been impacted. Fireworks tracers that have been identified are barium, copper, potassium, strontium, ammonium, nitrates, sulfates and organic carbon.

A review of the Granite City sample for July 5, 2008 revealed significantly high concentrations of all of these fireworks tracers. The following data tables summarize the July 5th results and provides the site average for each fireworks tracer compound/element .

As can be seen from Tables 1 and 2, significantly higher than normal levels of potassium, barium and strontium (which is almost never detected) were present in the July 5th sample. Sulfates, nitrates and organic carbon were also well above normal values. These results clearly substantiate a significant impact of fireworks emissions on the July 5th Granite City sample. By using the difference between the July 5th sample results and the average values recorded at the Granite City site over the previous year, an approximation of mass associated with the fireworks impact can be determined. The tables provide the these compound/element differences to total up to 11.4 ug/m3. While lower than the 16.9 ug/m3 impact projected from the real-time data, the 11.4 ug/m3 impact projected from the speciation data is significant. Subtracting that amount from the July 5th value of 41.8 ug/m3, a Granite City PM_{2.5} concentration of only 30.3 ug/m3 would have been projected.

Table 1.

Granite City Gateway Medical - Speciation Data (ug/m3)						
Period	Elements Total	Ammonium	Nitrate	Sulfate	Elemental Carbon	Organic Carbon
7/5/2008	2.7	2.4	2.0	8.0	0.8	5.6
Site Average	1.4	1.4	0.8*	3.1	0.6	2.8
Difference	1.3	1.0	1.2	4.9	0.2	2.8
Difference Sum	11.4					

*Nitrate uses May through October average.

Table 2.

Element	Element Concentrations 7/5/2008	Site Average
Aluminum	0.06	0.03
Barium	0.08	0.01
Copper	0.04	0.01
Magnesium	0.13	0.02
Potassium	1.87	0.12
Strontium	0.03	0.00
Sum	2.21	0.19

As with the real-time monitoring data, the chemical speciation data for July 5th provides supportive evidence that no violation at Granite City would have occurred but for the fireworks event of July 4-5, 2008. The range of projected fireworks related mass contribution of 11.4 to 16.9 ug/m³, derived from chemical speciation and real-time monitoring data respectively, provides an estimated July 5th PM_{2.5} value of only 25 to 30 ug/m³. This analysis provides convincing evidence that no violation of the NAAQS would have occurred but for the July 5th fireworks event.

Meteorological Data and Observations

A detailed summary of the meteorological conditions present on July 4-5, 2008 was prepared and is presented in Attachment 1. The evening of July 4th experienced light, variable winds which dropped to calm at Midnight. The calm conditions persisted until 0900 on July 5th. In effect, these meteorological conditions hindered the dispersion of the fireworks emissions to the extent that smoke and haze blanketed the downtown riverfront area during the late hours of July 4th and into the morning hours of July 5th. These conditions are reflected in the National Weather Service (NWS) observations at St. Louis Airport (Lambert Field). Prior to the fireworks displays, the NWS reported visibility as 10 miles (best conditions for St. Louis) and no other special observations. The Midnight report indicated visibility at 10 miles dropping to 6 miles at 0300 and to 4 miles at 0600. Along with the dropping visibility, the NWS weather observers reported haze at the 0300 and 0600 hours. This reduced visibility and reported haze coincide with calm winds and the time period of recorded elevated PM_{2.5} concentrations at all three real-time monitoring stations.

The NWS data and observations provide additional corroboration of the earlier analysis findings that fireworks displays emissions lingered into the early morning hours of July 5th. These independent data and observations coincide with the time periods of elevated PM measurements reported by the area monitoring stations and further support the technical analysis findings.

Summary

The Illinois EPA has determined that on July 5, 2008 the Granite City (17-119-1007) monitoring site recorded a value of 41.8 micrograms per cubic meter (ug/m³) that was significantly influenced by fireworks display emissions that lingered in the area after the events on the late evening of July 4th. In order to substantiate the significance of the fireworks emissions impacts, Illinois EPA analyzed air quality, chemical speciation and meteorological data for July 5th. The analysis clearly showed that “but for” the contribution from fireworks emissions, the Granite City measurement would have been from 11.4 to 17 ug/m³ lower. Absent the contribution from the fireworks emissions, the July 5th PM_{2.5} measurement at Granite City would have been only 25 to 30 ug/m³ and a value well below the PM_{2.5} NAAQS.

As a result, the Granite City (17-119-1007) PM_{2.5} value of 41.8 ug/m³ reported for July 5, 2008 has been flagged as an exceptional event by the Illinois EPA. Concurrence of this event by US EPA is requested.

Attachment 1.

Meteorology on July 4th and 5th, 2008

On the morning of July 4th, 2008 areas of high pressure were located in the Lake Michigan vicinity. A 1021 mb high was centered of southern Wisconsin and a second 1021 mb high was centered over northern lower Michigan. An area of low pressure was located in southern Illinois along a stationary front that stretched from just off the New England coastline southwestward to the boot heel of Missouri and northwestward over the Eastern Rockies. Shower and thunderstorm activity was occurring along this boundary just south of the St. Louis, Missouri area. Winds were from the north and northeast at just under 10 mph through the mid afternoon time period. Reference to Figure 1 shows by 7 p.m. on July 4th high pressure had expanded over the entire Great Lakes region with a lightening surface wind pattern. The stationary front was still located from New England into the Missouri boot heel. Chart 1 shows wind speeds under 10 mph going calm just before midnight.

Figure 1.

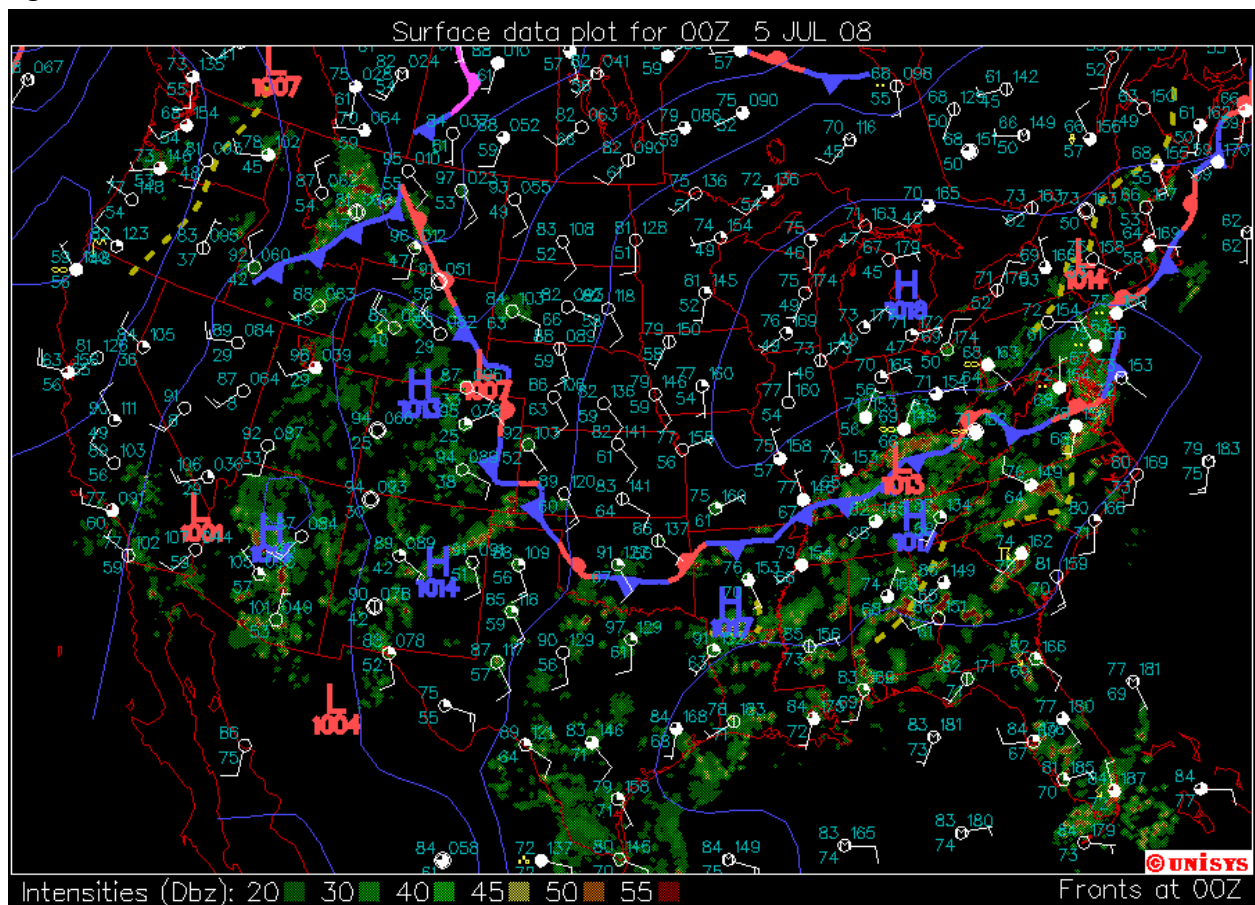


Chart 1.

NWS Monitoring Site: St. Louis, MO					
Date	Hour Ending	Visibiltiy (Miles)	Wind Direction (deg)	Wind Speed (mph)	Weather Remarks
7/4/08	03:00	9.00	50	7.0	
	06:00	10.00	30	9.0	
	09:00	10.00	350	8.0	
	12:00	10.00	340	8.0	
	15:00	10.00	320	7.0	
	18:00	10.00	350	7.0	
	21:00	10.00	320	7.0	
	24:00	10.00	0	0.0	

During the morning hours of July 5th, 2008 the stationary front was still located near southern Missouri with light winds throughout the area. Figure 2 shows the surface set-up at 7 a.m. local time. The St. Louis, Missouri weather station was reporting haze at the time indicated with the ∞ symbol to the left of the station plot. Chart 2 also indicates haze in the area through at least the 6 a.m. report. Visibilities during this time frame dropped significantly. The midnight report indicated visibility up to 10 miles dropping down to 6 miles at 3 a.m. and 4 miles at 6 a.m. By the afternoon, visibilities increased back towards 10 miles and wind speed increased from calm up to near 10 mph.

Figure 2.

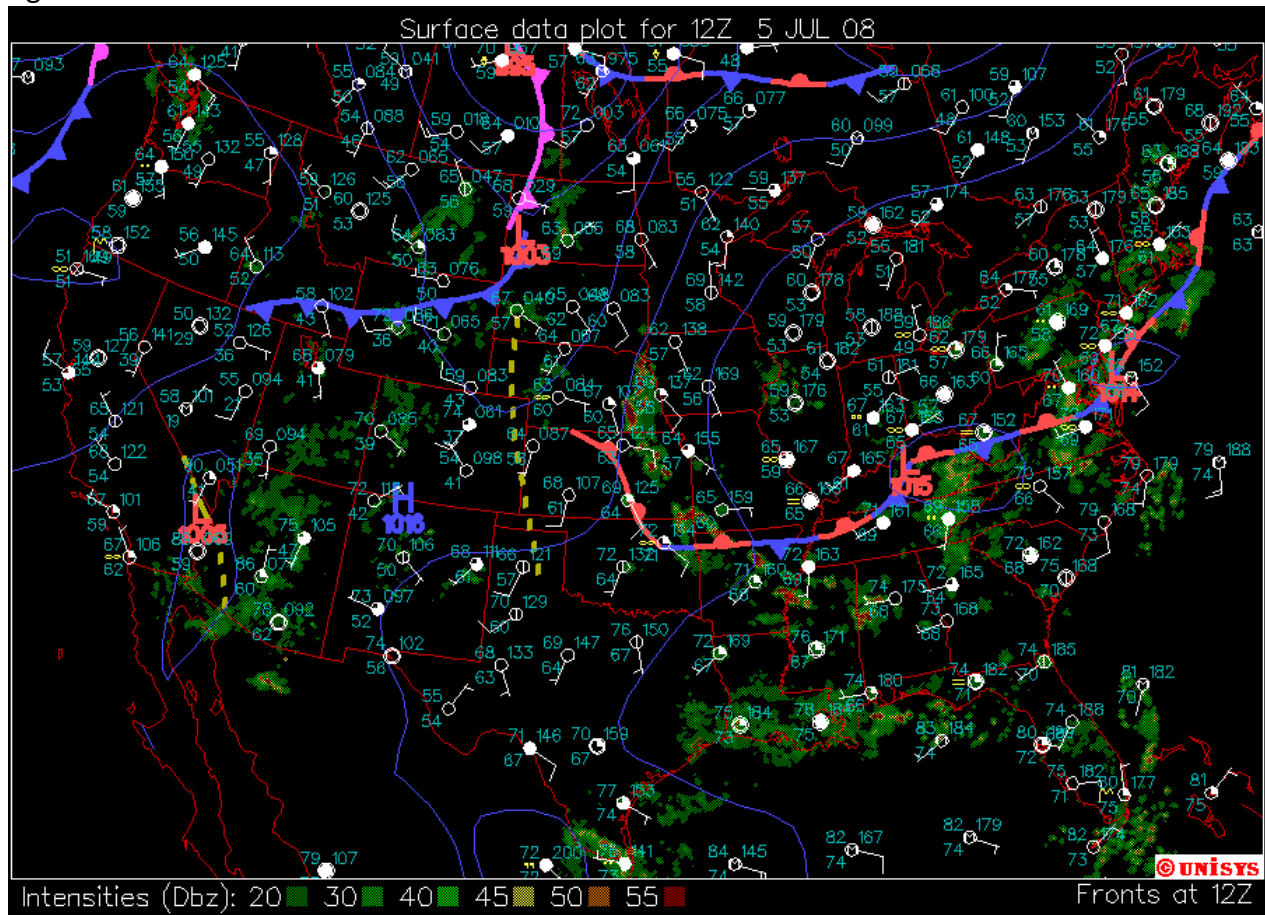


Chart 2.

NWS Monitoring Site: St. Louis, MO					
Date	Hour Ending	Visibiltiy (Miles)	Wind Direction (deg)	Wind Speed (mph)	Weather Remarks
7/5/08	03:00	6.00	0	0.0	Haze
	06:00	4.00	0	0.0	Haze
	09:00	7.00	110	7.0	
	12:00	9.00	0	0.0	
	15:00	10.00	150	6.0	
	18:00	10.00	120	6.0	
	21:00	8.00	110	6.0	
	24:00	9.00	150	7.0	