Utah Division of Air Quality

PM2.5 Exceptional Event – Fireworks
Ogden Monitoring Station
Rose Park Monitoring Station

Event Date – July 4, 2009
EPA Submission Date – June 14, 2010

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Definition of Event (40 CFR 50.1(j)) and Introduction

The Code of Federal Regulations (CFR) provides the definition and criteria for determining whether air quality data is impacted by an exceptional event. The 40 CFR 50.1 (j) definition states that "exceptional event means an event that affects air quality, is not reasonably controllable or preventable, is an event caused by human activity that is unlikely to recur at a particular location or a natural event, and is determined by the Administrator in accordance with 40 CFR 50.14 to be an exceptional event." The demonstration to justify data exclusion, as outlined in 40 CFR 50.14, specifies that the following evidence must be provided:

1. The event meets the definition of an exceptional event;
2. There is a clear causal relationship between the measurements under consideration and the event that is claimed to have affected air quality in the area;
3. The event is associated with a measured concentration in excess of normal historical fluctuations, including background;
4. There would have been no exceedance or violation but for the event; and
5. The fireworks event was held on July 4, Independence Day, as part of a traditional or national culture event (40 CFR 50.14 (b)(2).

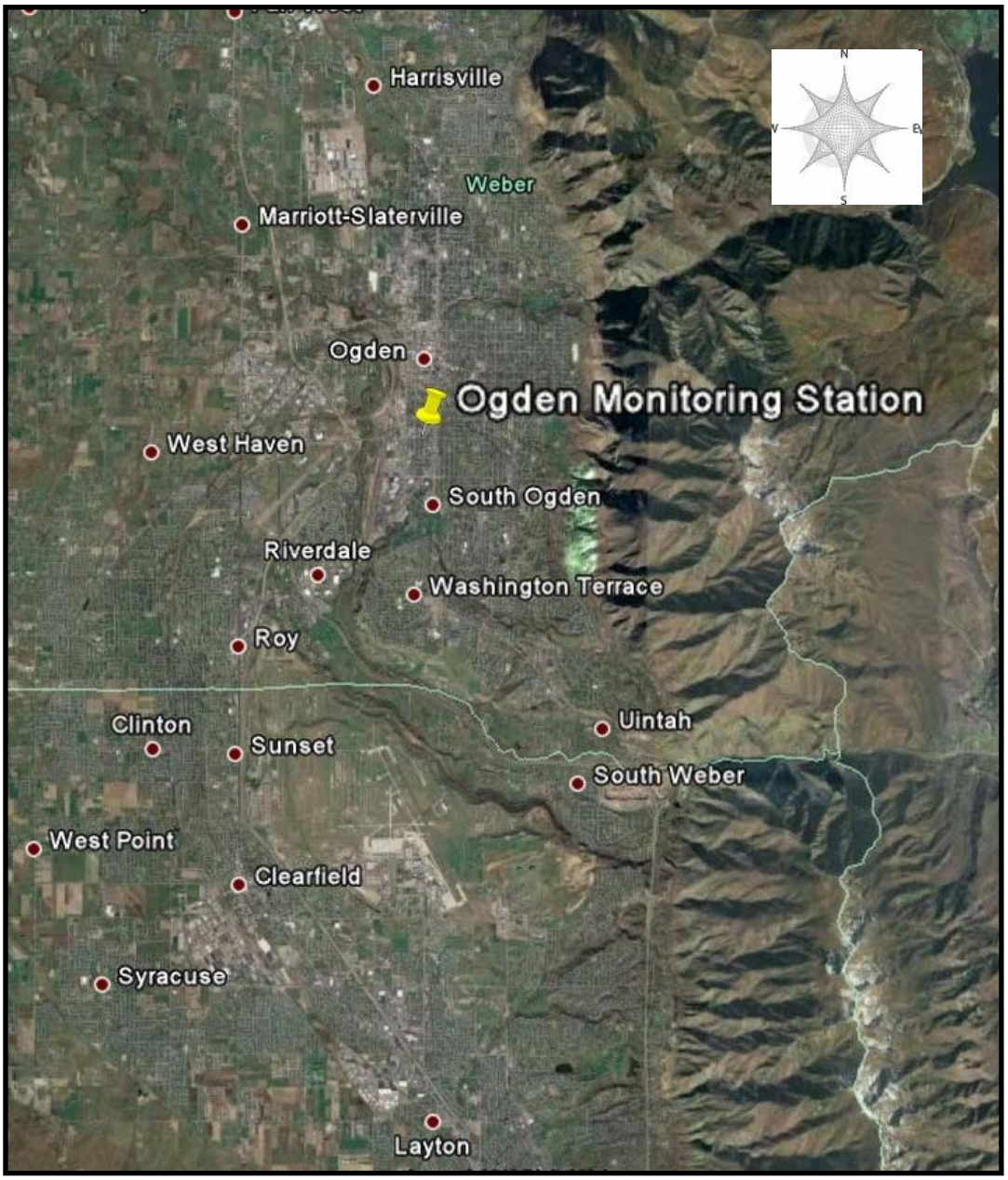
An exceedance of the 24-hr PM2.5 standard of 35 ug/m^3 occurred on July 4, 2009 at the Ogden monitoring station, located in Ogden, Utah and the Rose Park monitoring station located in Salt Lake City. The Utah Division of Air Quality (DAQ) reported a PM2.5 value of 52 ug/m^3 for Ogden and 38.6 ug/m^3 for Rose Park. The DAQ investigated the events and has determined that the exceedances are associated with fireworks events sponsored many communities celebrating the national 4th of July holiday.

Study Areas Community Event Locations

Ogden

The Ogden monitoring station (O2) is located at 3159 Grant Ave., Ogden, UT, adjacent to the Ogden Community Action Center. Ogden is located north of Salt Lake City in Weber County. The station is located adjacent to a large grass field where legal and illegal fireworks are set-off (confirmed by Ogden Fire Department).

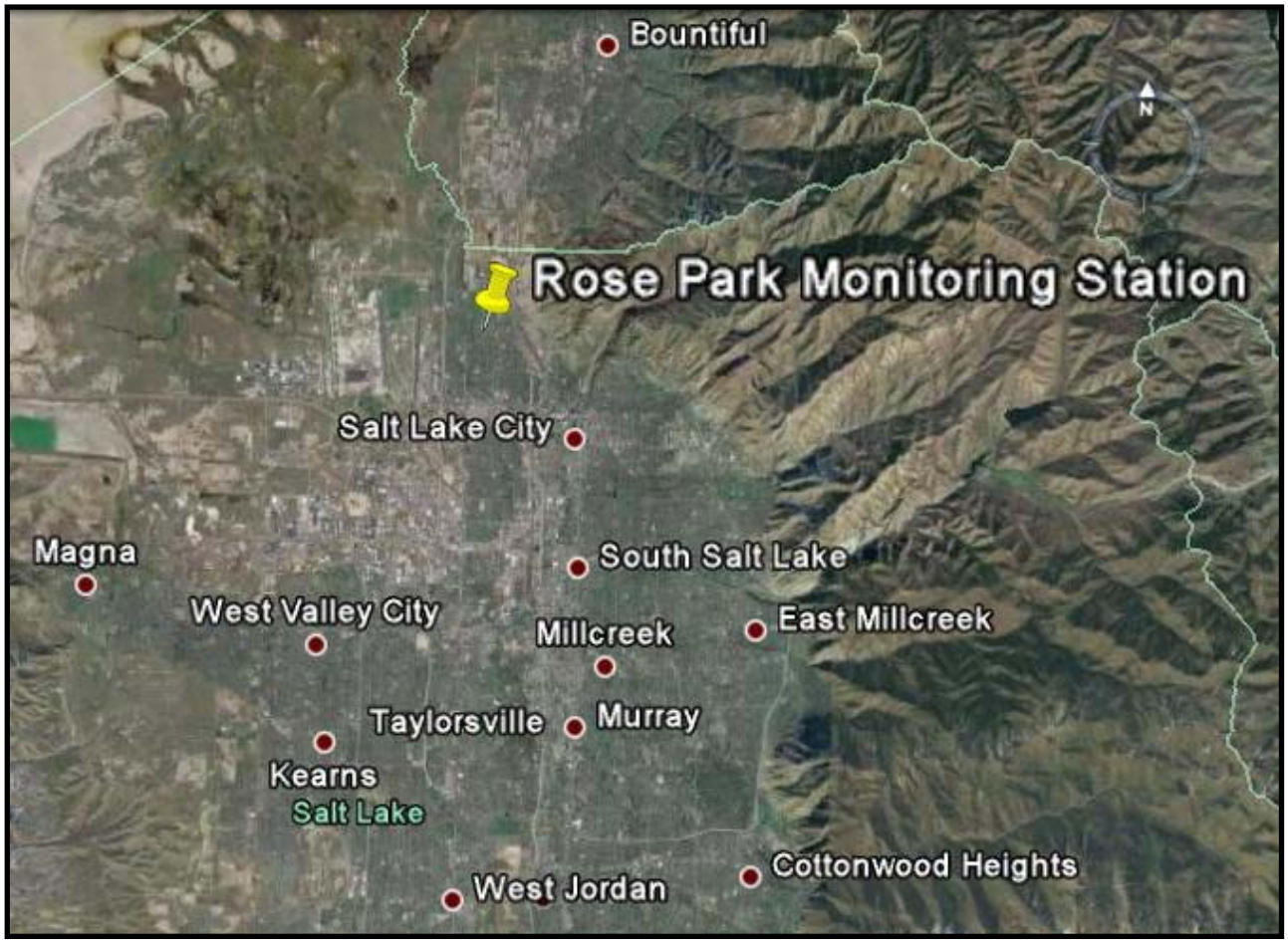
Nearby communities that are known to sponsor 4th of July fireworks events include; Riverdale (at Riverdale Park), Clinton, Sunset (at 85 W. 1800 N), Clearfield (at Fisher Park) Layton (Commons Park), and Ogden (at Pioneer Stadium).



Rose Park

Rose Park is located at 1400 West Goodwin Ave, Salt Lake City. The station is situated within a residential area and adjacent to a large grass field conducive for fireworks.

Fourth of July fireworks events occurred throughout the entire valley. DAQ was able to identify 15 legal community fireworks events in the valley and are certain that many more existed.



Affect Air Quality

Fireworks Chemistry

Fireworks consist of 75% gunpowder (potassium nitrate,KNO_3), 15% carbon and 10% sulfur. The materials react with each other when heat is applied from a fuse. Metal compounds and other elements described in Table 1, are added to generate desired color and or pyrotechnic effects.

Robenta Vecchi (Vecchi et al, 2007) reported that fireworks are one of the most unusual sources of pollution in the atmosphere; although transient, these pollution episodes are responsible for high concentrations of particles (especially metals and organic

compounds) and gases. Vecchi measured air quality after a fireworks event and concluded that elements typically emitted during pyrotechnic displays increased in 1-hr as follows: strontium (120 times), magnesium (22 times), barium (12 times), potassium (11 times), and copper (6 times). Additional elements and or concentrations of these elements are directly dependent on the selection of desired color and effect; thus, individual fireworks events will have a specific tracer element. In Vecchi's case, strontium was recognized as the best fireworks tracer because its concentration was very high during the event and at/nearly at the minimum detection limit at other time intervals. Particulate level for the case study increased 6.7 times over background levels (copper, elemental carbon and nitrogen oxides).

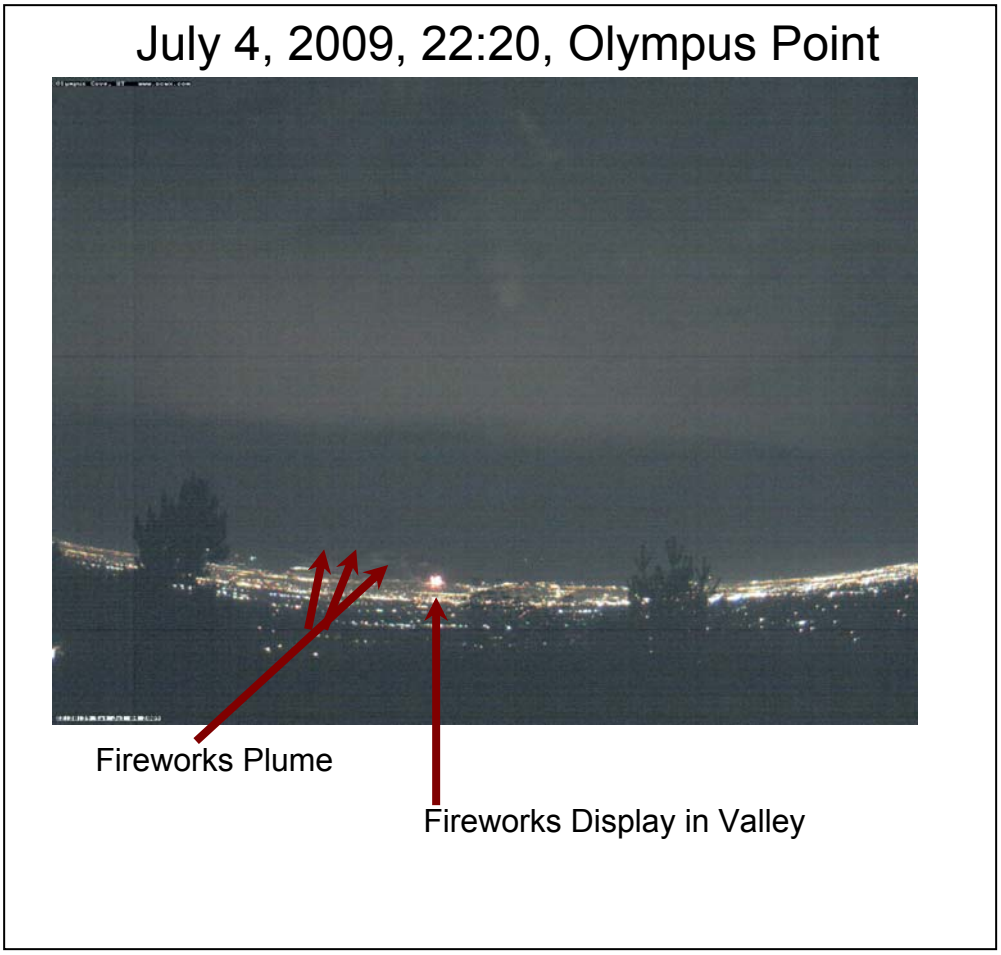
Table 1 – Fireworks Chemistry

Ogden PM2.5 Speciation (ug/m^3)	Rose Park PM2.5 Speciation (ug/m^3)	Element /Compound	Oxidizer	Colorant	Propellant or Fuel	Stabilizer	Smoke	Glitter Effect
0.8	0.5	Aluminum		√				
0.07	0.05	Antimony						√
1	0.6	Barium		√		√		
0.2	0.2	Calcium		√				
Not Tested	Not Tested	Carbon			√			
3.6	2.4	Chlorine	√					
0.3	0.2	Copper		√				
0.07	0.08	Iron		√				
Not Tested	Not Tested	Lithium		√				
1.6	1.1	Magnesium		√				
13.2	**9.5**	**Potassium**	√					
0	0	Phosphorus			√			√
0.2	0.2	Sodium		√				
0.3	0.1	Strontium	√					
4.5	**3.2**	**Sulfur**			√			
0.03	0.01	Titanium		√				
0.07	0.04	Zinc					√	
Not Tested	Not Tested	Chlorates	√					
0.6	0.6	Nitrates	√					
Not Tested	Not Tested	Perchlorates	√					

PM2.5 samples for both stations were speciated and the data shown in Table 1. Carbon could not be analyzed due to the Teflon filter, but the levels of potassium and sulfur, amongst other elements, are very high and would be expected to be so because they represent the fundamental components of fireworks.

Air Quality

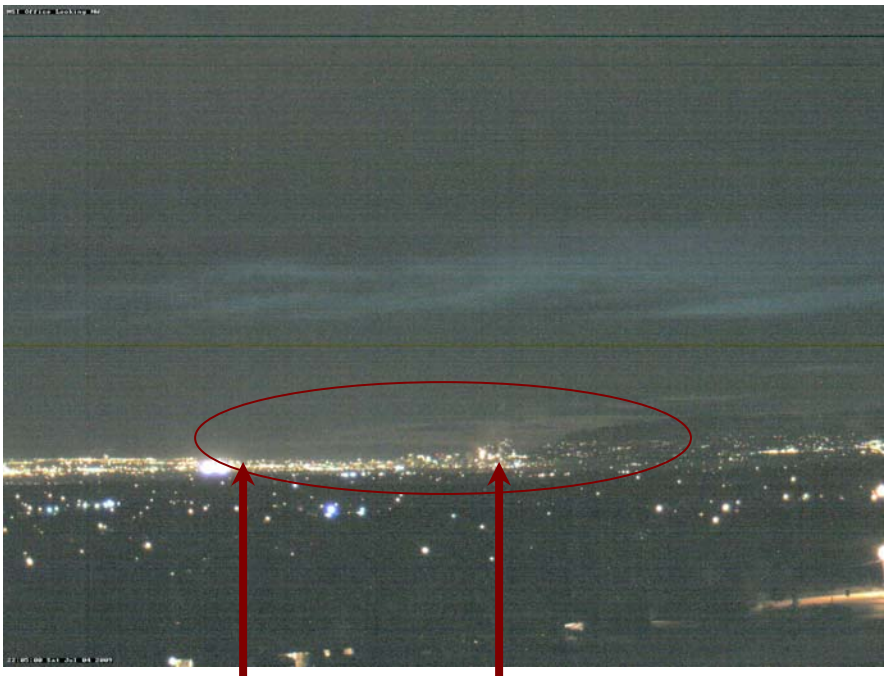
Photographs taken by Meteorological Solutions Inc. (MSI) at Olympus Cove and the MSI Salt Lake City office show the fireworks, fireworks plumes and fireworks hazes in the valley.



Fireworks Haze at 22:35

Fireworks and Haze at 22:20

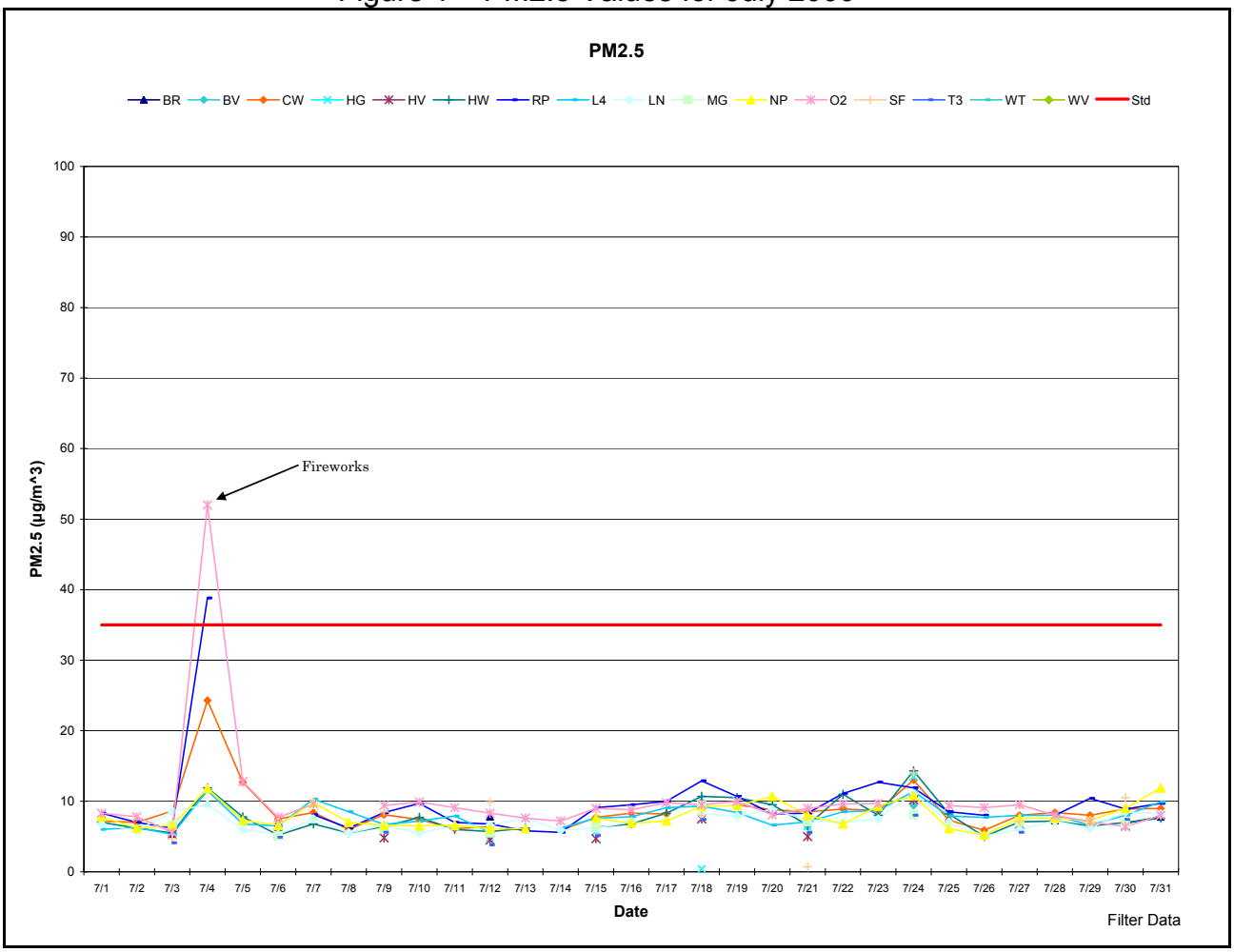
July 4, 2009, 22:05, MSI



Normal Historical Fluctuation

Figure 1 presents the PM2.5 values for the Utah monitoring network for July 2009. The only elevated values near/over the standard were due to this fireworks event.

Figure 1 – PM2.5 Values for July 2009



Ogden

Table 2 presents the annual mean and maximum values for the 24-hr PM2.5 at the Ogden station from it's inception in 2001 until the end of 2009. The annual mean ranges from 9.9 – 14.6 ug/m^3. The observed value for this event is 52 ug/m^3.

Table 2 – Ogden 24-hr PM2.5

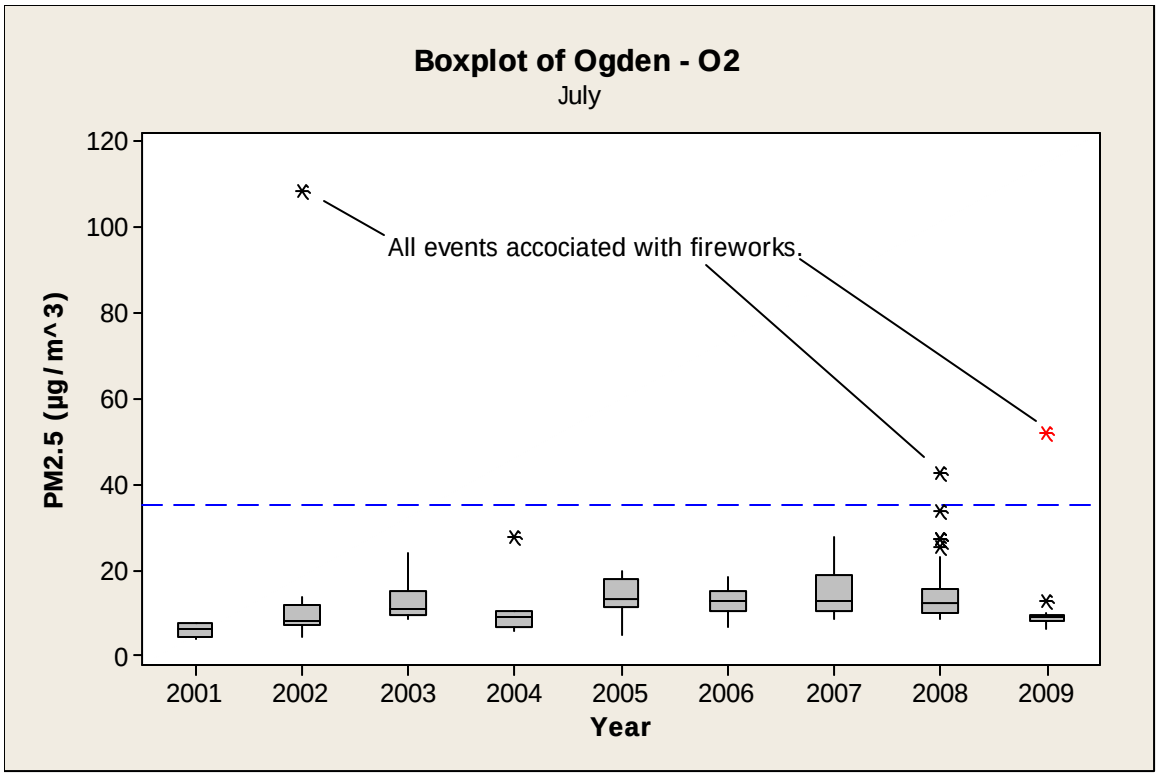
Year	Observations	Annual Mean (ug/m^3)	Annual Max (ug/m^3)
2001	50	12.4	66.6
2002	119	14.6	108.3 (4th of July)
2003	118	9.9	38.3
2004	118	13.9	74.2
2005	115	10.5	42.4
2006	120	9.8	47.6
2007	121	11.7	76.8
2008	358	9.9	46.7
2009	343	10.2	56.4

Ranking

Guidance found at 72 Federal Register 55 March 22, 2007, pages 13560-81, states that a lesser amount of documentation would likely be necessary for "extremely high" concentrations (e.g. > 95th %ile) than for concentrations that were closer to "typical levels" (e.g. < 75th %ile.). Data from the Ogden monitor since 2001 was used to calculate the %ile. When all data points were aligned in descending order July 4, 2009, lands above the 99th %ile.

Boxplot

Because this event accrued during the July, a time of the year when high PM2.5 values are not typically measured, it may be more valuable to only focus on other PM2.5 values during the same time of the year. The boxplot presents the historical PM2.5 values for July of each year. The event value is marked in red. The blue dashed line represents the current PM2.5 standard.



All events that exceed the current PM2.5 standard are associated with Fireworks events. Analyses of the boxplot graph permit us to conclude that the event concentration is outside of normal historical variation.

Rose Park

Table 3 presents the annual mean and maximum values for the 24-hr PM2.5 at the Rose Park station from it's inception in 2007 until the end of 2009. The annual mean had a limited range of 10.1 – 11 ug/m^3. The observed value for this event is 38.6 ug/m^3.

Table 3 – Rose Park 24-hr PM2.5

Year	Observations	Annual Mean (ug/m^3)	Annual Max (ug/m^3)
2007	275	10.9	78.2
2008	405	11	54.6
2009	424	10.1	64.3

Ranking

Guidance found at 72 Federal Register 55 March 22, 2007, pages 13560-81, states that a lesser amount of documentation would likely be necessary for "extremely high" concentrations (e.g. > 95th %ile) than for concentrations that were closer to "typical levels" (e.g. < 75th %ile.). Data from the Rose Park monitor since 2007 was used to calculate the %ile. When all data points were aligned in descending order July 4, 2009, lands above the 98th %ile.

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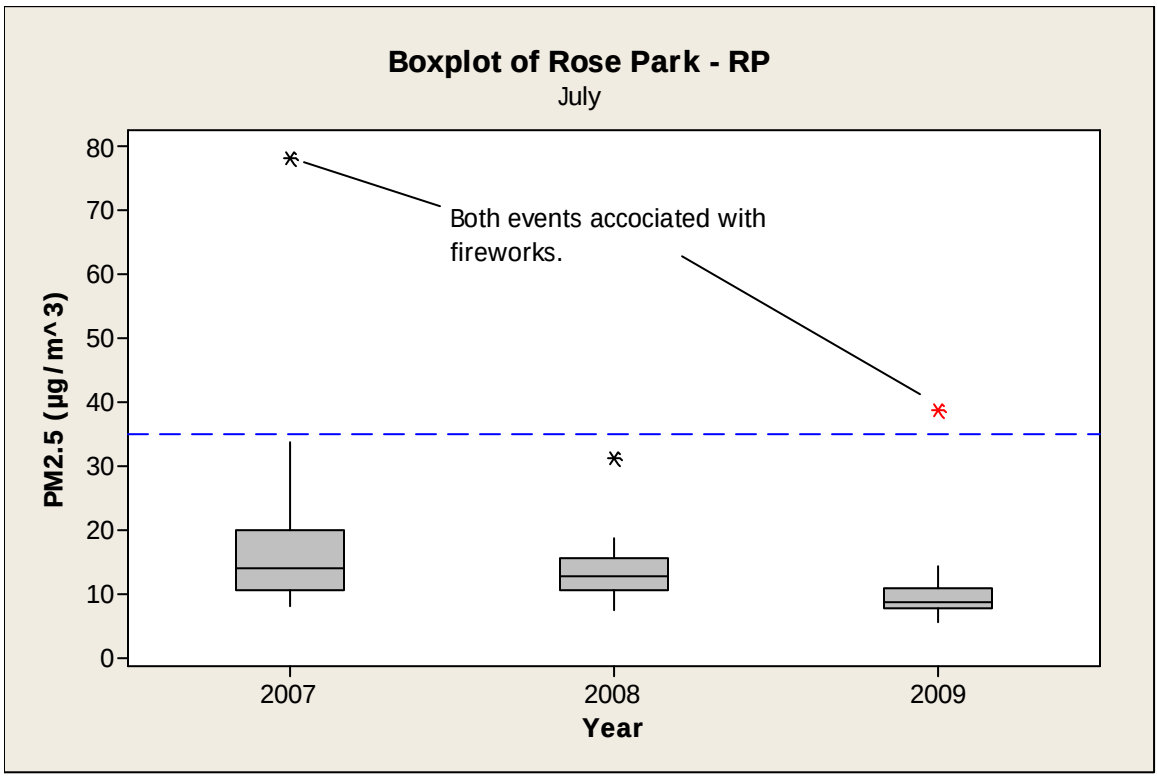

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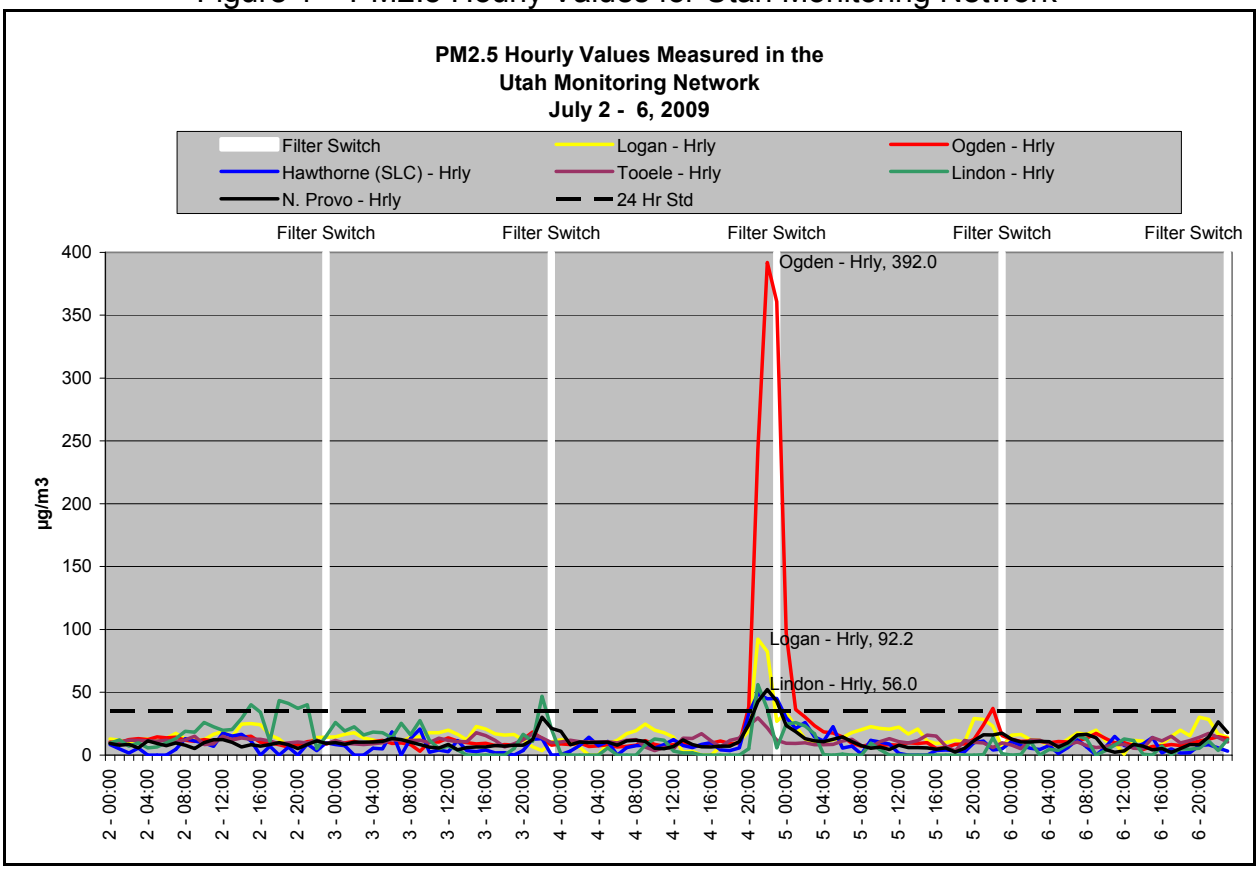
Causal Relationship (40 CFR 50.14)

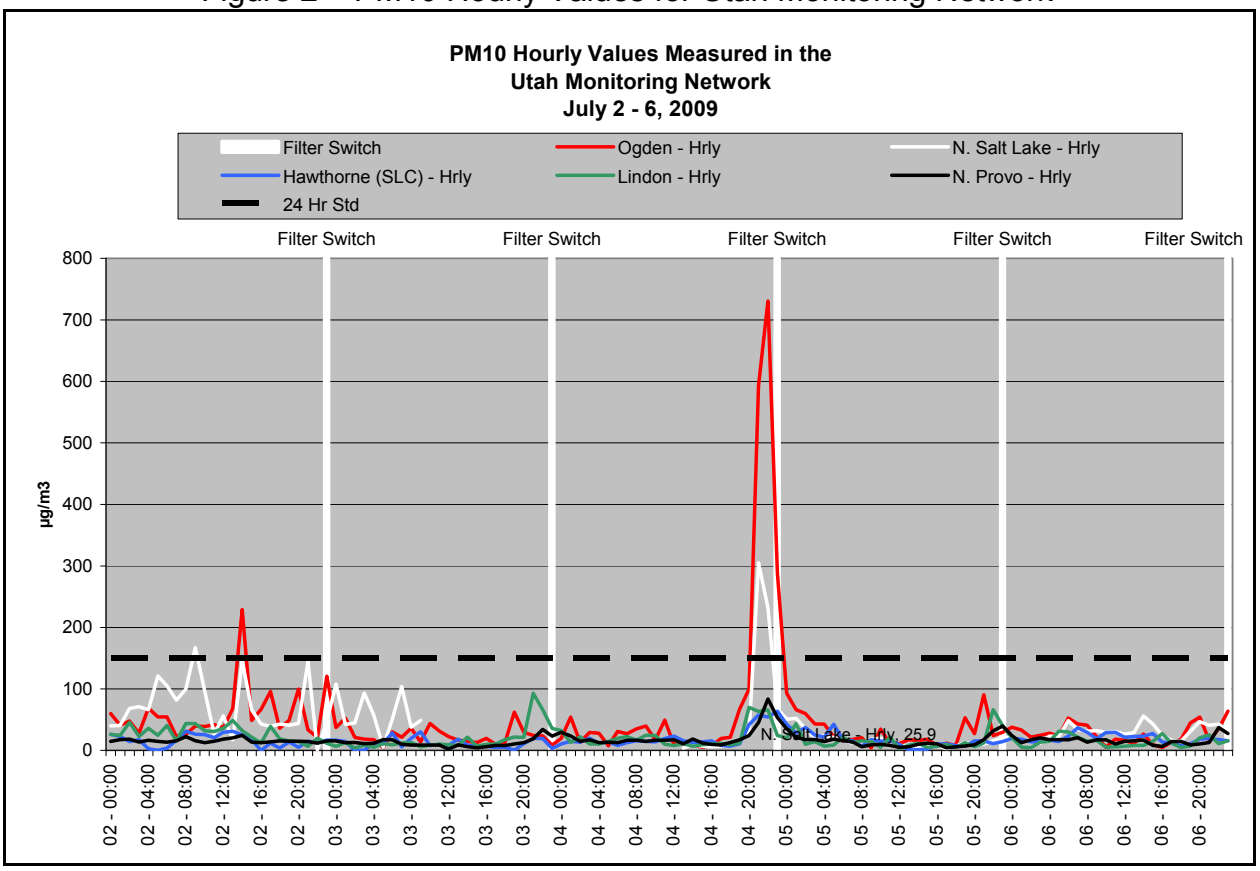
Figure 1 shows the PM2.5 hourly values for the Utah monitoring network from July 2 to July 6, 2009. The entire network levels increased starting at 19:00 on July 4, peaked at 22:00 and receded by 23:00, with some carry over into the next day due to the filter change at midnight.

Figure 1 – PM2.5 Hourly Values for Utah Monitoring Network



The PM10 hourly values for the network in Figure 2 shows the same pattern as PM2.5. The ambient air particulate levels increases correspond to the time that fireworks are set-off and the resultant plumes disperse.

Figure 2 – PM10 Hourly Values for Utah Monitoring Network



No Exceedance or Violation But For the Event

Figure 3 shows the PM2.5 24-hr values for the Utah monitoring network from July 2 to July 6, 2009. The only exceedances occurred during the national holiday.

Figure 3 - PM2.5 24-hr Values for Utah Monitoring Network

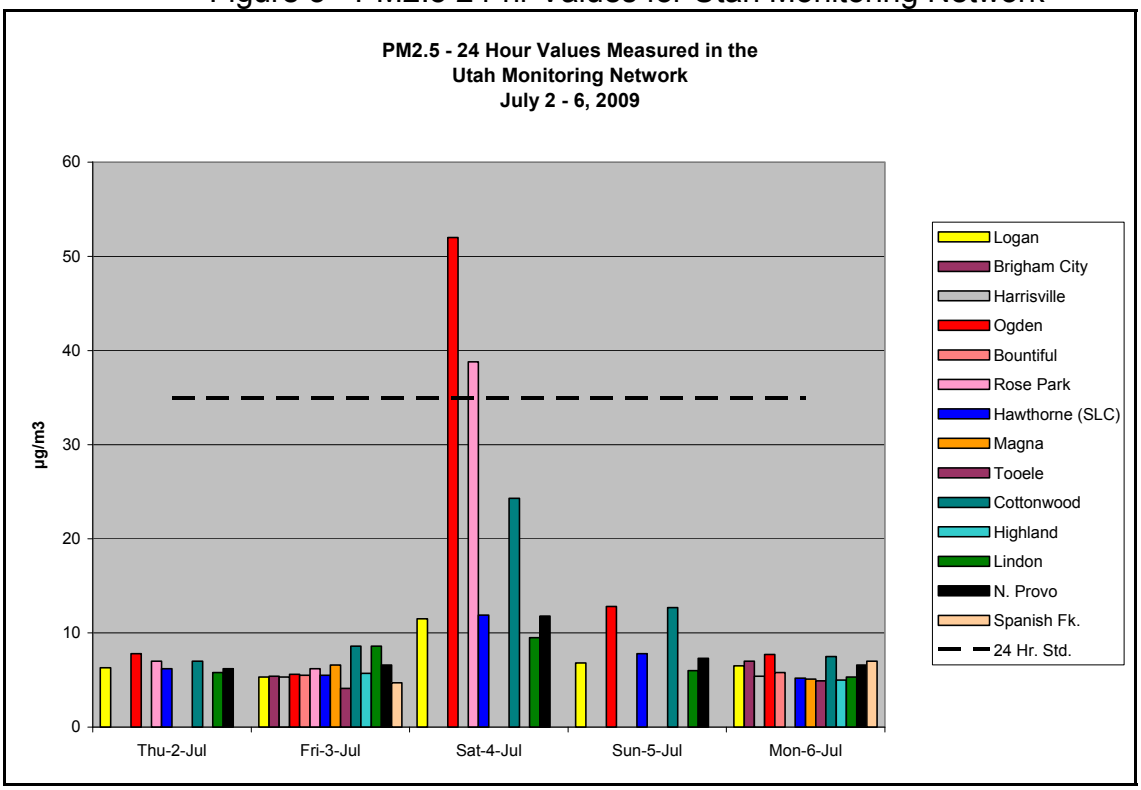


Figure 4 – Common Fireworks Elements

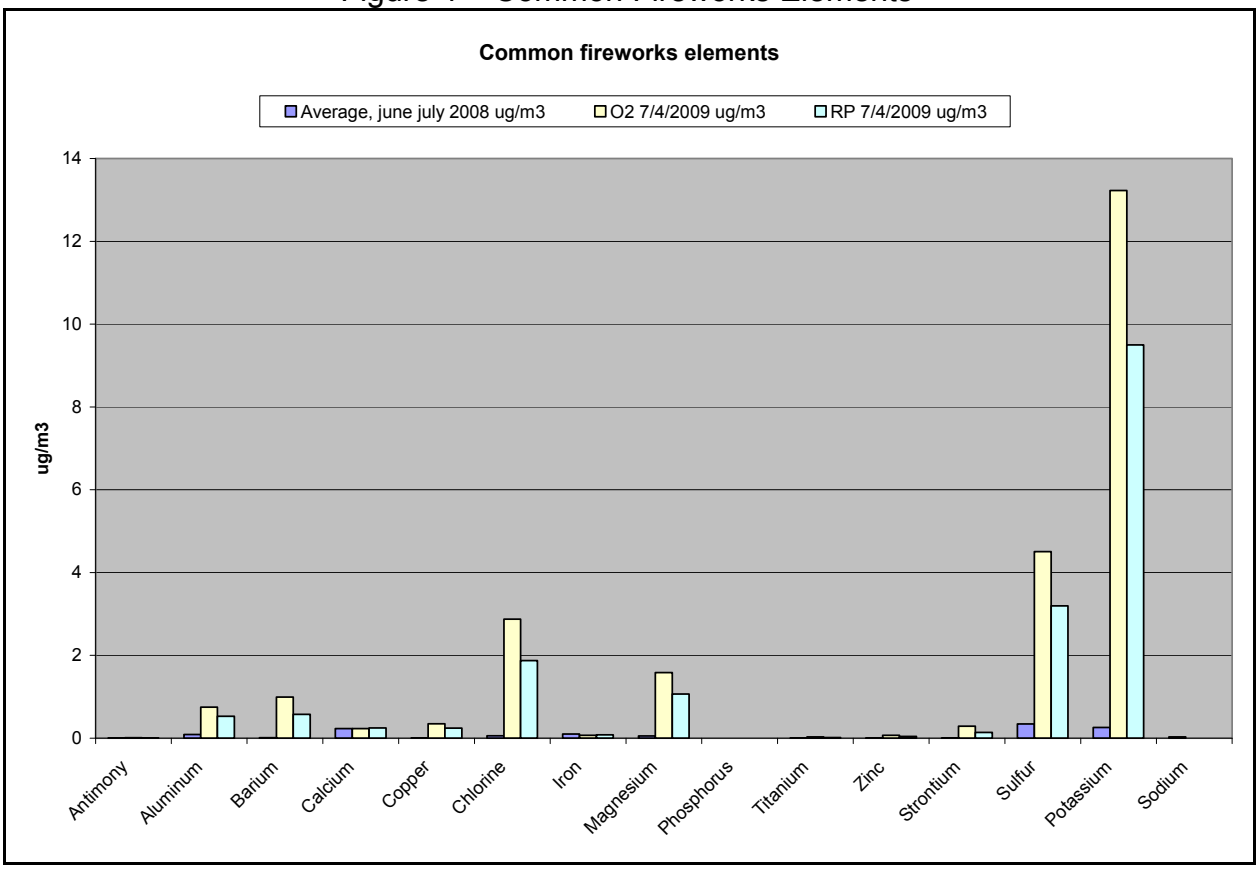


Figure 4 shows a plot of common fireworks elements. The purple represents the average concentrations for the elements during June and July of 2008 for the network that included the Bountiful, Hawthorne, and Lindon monitoring stations. Some elements were not detected and those that were, are very low. The yellow represents the composition of elements for the Ogden station while the blue represents Rose Park in 2009. There is a clear and obvious relationship of increased elemental concentrations, especially chlorine, magnesium, sulfur and potassium, which clearly defines these events as fireworks related.

If it were not for the fireworks events, there would not have been any exceedance in the network.

Mitigation (40 CFR 51.930)

Ogden City Ordnance

According to the Fire Marshals Office, the city continues to vigorously pursue illegal use of fireworks and observed a substantial reduction of such in 2009.

Utah Air Quality Public Notifications

In order to improve the presentation of air quality information to the public, DAQ has improved our air quality forecasting webpage. The web page now shows the air quality forecast for today and the next two days. The Air Monitoring Center (AMC) provides air pollution information based on daily air quality status. The AMC data is used to determine the relationship of existing pollutant concentrations to the National Ambient Air Quality Standards. There is a three tiered air quality alert system: Green, Yellow (alert days), and Red (actions days) that is used to implement winter and summer controls on the use of wood and coal burning stoves, fire places, and motor vehicles. There are five health advisory categories: good, moderate, unhealthy advisories A and B, and very unhealthy. The AMC advisory is calculated for five major pollutants including ground-level ozone, particulate pollution (particulate matter), carbon monoxide, sulfur dioxide, and nitrogen dioxide. The new index now also incorporates recommendations for actions to take on days when concentrations are in the red zone, to mitigate the effects of pollution for affected groups and recommendations for industry and citizens that help reduce pollution levels. The outreach program information consolidated in the three day forecast includes the Summer and Winter Control Programs and Choose Clean Air information.

The web site includes information on fireworks events, explaining the type of air quality impact from fireworks and warning sensitive populations to stay indoors.

Public Comment (Preamble V.G.)

The DEQ established a 30-day comment period from May 1, 2010, through May 31, 2010. One comment was received supporting public messaging about air quality impact from fireworks. As indicated in the Mitigation section above, public messaging is included on the DEQ website, http://www.airquality.utah.gov/Public-Interest/Public-Commen-Hearings/Exceptional_Events/fireworks.htm.

The announcement of the comment period was published eight times in the Salt Lake Tribune between April 17 and May 1, 2010. The proof of publication can be found in Appendix 1.

References

Roberta Vecchi, Vera Bernardoni, Diana Cricchio, Alessandra D'Alessandro, Paola Fermo, Franco Lucarelli, Silvia Nava, Andrea Piazzalunga and Gianluigi Valli, 2007. The impact of fireworks on airborne particles. *Atmospheric Environment, Vol 42, Issue 6, feb 2008, pgs., 1121-1132*.

Appendix 1

Proof of Publication