

# **National Air Toxics Trends Study In Grand Junction, Colorado**

**January through December 2008**



**October 2012**

**Prepared by the**

**Colorado Department of Public Health & Environment  
Air Pollution Control Division  
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# Table of Contents

<b>EXECUTIVE SUMMARY .....</b>	<b>5</b>
<b>SECTION 1: INTRODUCTION .....</b>	<b>6</b>
Introduction .....	6
Site Information.....	6
<b>SECTION 2: CARBONYLS AT GRAND JUNCTION – POWELL SITE .....</b>	<b>7</b>
Summary Statistics – Carbonyls .....	7
Maximum and Mean – All Samples.....	7
Percentage of Samples For Which Compound Was Detected .....	7
Graphs - Carbonyls .....	8
Field Blanks – Carbonyls.....	8
Precision of Sample Results – Carbonyls .....	8
<b>SECTION 3: VOLATILE ORGANIC COMPOUNDS AT GRAND JUNCTION – POWELL SITE .....</b>	<b>10</b>
Summary Statistics – Volatile Organic Compounds .....	10
Maximum and Mean – All Samples.....	10
Percentage of Samples For Which Compound Was Detected .....	13
Graphs – Volatile Organic Compounds .....	13
Precision of Sample Results – Volatile Organic Compounds .....	18
Field Blanks – Volatile Organic Compounds.....	18
<b>SECTION 4: METALS AT GRAND JUNCTION – POWELL SITE .....</b>	<b>19</b>
Summary Statistics – Metals .....	19
Percentage of Samples For Which Compound Was Detected .....	19
Maximum and Mean – All Samples.....	19
Graphs – Metals .....	20
Precision of Sample Results – Metals Compounds.....	20
Field and Filter Blanks – Metals Compounds.....	20
<b>SECTION 5: HEXAVALENT CHROMIUM AT GRAND JUNCTION – POWELL SITE.....</b>	<b>22</b>
Summary Statistics – Hexavalent Chromium.....	22
Maximum and Mean – All Samples.....	22
Percentage of Samples For Which Compound Was Detected .....	22
Graphs – Hexavalent Chromium .....	22
Precision of Sample Results – Hexavalent Chromium.....	22
Field Blanks – Hexavalent Chromium.....	23
<b>SECTION 6: CARBON MONOXIDE AT GRAND JUNCTION – POWELL SITE .....</b>	<b>24</b>
Summary Statistics – Carbon Monoxide.....	24
Maximum – All Samples .....	24
<b>SECTION 7: PARTICULATE MATTER AT GRAND JUNCTION – POWELL SITE .....</b>	<b>25</b>
Particulate Data At Grand Junction - Powell.....	25

<b>SECTION 8: PM<sub>2.5</sub> SPECIATION AT GRAND JUNCTION – POWELL SITE</b> .....	<b>28</b>
Summary Statistics – PM <sub>2.5</sub> Speciation Data.....	28
Graphs – PM <sub>2.5</sub> Speciation Data.....	29
<b>SECTION 9: POLYCYCLIC AROMATIC HYDROCARBON COMPOUNDS AT GRAND JUNCTION- POWELL SITE</b> .....	<b>32</b>
Summary Statistics - Polycyclic Aromatic Hydrocarbon Compounds.....	32
Maximum and Mean - All Samples.....	32
Percentage of Samples for Which Compound Was Detected.....	32
Graphs - Polycyclic Aromatic Hydrocarbons.....	34
Precision of Sample Results- Polycyclic Aromatic Hydrocarbons.....	34
Field and Filter Blanks-Polycyclic Aromatic Hydrocarbons.....	34
<b>SECTION 10: METEOROLOGY</b> .....	<b>37</b>
Meteorological Parameters Monitored.....	37
<b>SECTION 11: SUMMARY AND CONCLUSIONS</b> .....	<b>38</b>

## **Tables**

Table 2.1 Carbonyl Compounds Sample Summary - 2008 .....	7
Table 2.2 Carbonyl Compounds Data Summary Comparisons – 2007 – 2008.....	8
Table 3.1 VOC Detection Summary - 2008 .....	11
Table 3.2 VOC Data Summary Comparisons - 2007 – 2008 .....	12
Table 3.3 Compounds Detected in Over 90 Percent of the VOC Air Samples – 2008.....	13
Table 3.4 Volatile Organic Compounds Rarely Detected in the VOC Air Samples.....	13
Table 4.1 Metals Detection Summary - 2008.....	19
Table 4.2 Metals Data Summary Comparisons 2007 - 2008.....	20
Table 5.1 24-Hr Maximum and Annual Mean Concentrations for Hexavalent and Total Chromium – 2007 and 2008.....	22
Table 6.1 Carbon Monoxide Data Summary – 2007 and 2008 .....	24
Table 7.1 Percentage Data Recovery for PM <sub>10</sub> Samples – 2007 and 2008 .....	25
Table 7.2 Data Summary for PM <sub>10</sub> Samples – 2007 and 2008.....	25
Table 7.3 Percentage Data Recovery for PM <sub>2.5</sub> Samples – 2007 and 2008.....	26
Table 7.4 Data Summary for PM <sub>2.5</sub> Samples – 2007 and 2008.....	26
Table 8.1 Annual Maximum and Mean Concentrations for PM <sub>2.5</sub> Speciation .....	28
Table 9.1 Polycyclic Aromatic Hydrocarbons Sample Summary – 2008 .....	33
Table 9.2 Polycyclic Aromatic Hydrocarbons Means and Maxima – 2008 .....	34

## **Figures**

Figure 2.1 Maximum and Annual Mean Carbonyls 2008 .....	9
Figure 2.2 Carbonyl Sample Day Comparisons for 2008.....	9
Figure 3.1 Annual Mean and 24 Hour Maximum VOCs .....	14
Figure 3.2 Toluene, Benzene and Ethylbenzene Concentrations .....	16
Figure 3.3 Benzene, Xylenes and Trimethylbenzene Concentrations .....	16

Figure 3.4 Dichlorodifluoromethane, Trichlorofluoromethane, Chloromethane, and Carbon Tetrachloride Concentration.....	17
Figure 3.5 Acetylene, Propylene, and Benzene Concentrations.....	17
Figure 4.1 Maximum and Annual Mean Metal Concentrations - 2008.....	21
Figure 4.2 Total Chromium, Lead, and Manganese Concentrations – 2008.....	21
Figure 5.1 Average and Maximum Hexavalent Chromium Concentration - 2008 .....	23
Figure 5.2 Hexavalent Chromium Concentrations – 2008 .....	23
Figure 6.1 Carbon Monoxide on Air Toxics Sampling Days - 2008.....	24
Figure 7.1 PM <sub>10</sub> and PM <sub>2.5</sub> – 2008.....	27
Figure 8.1 Maximum and Annual Mean PM <sub>2.5</sub> Speciation – 2008.....	30
Figure 9.1 Maximum and Annual Polycyclic Aromatic Hydrocarbon Compounds - 2008.....	35
Figure 9.2 Trends of Main Polycyclic Aromatic Hydrocarbons- 2008.....	36
Figure 10-1 Grand Junction Wind Rose – 2008 .....	37

**National Air Toxics Trends Study  
In Grand Junction, Colorado**

**January through December 2008**

## **Executive Summary**

The Grand Junction air toxics monitors were originally established as a part of the Pilot Study for the National Air Toxics Trends Sites. Grand Junction was one of the five “rural” sites selected. (The Environmental Protection Agency considers this area “rural” because it is not a major metropolitan area). This report discusses the data collected at the Grand Junction monitors for 2008. Most of the compounds detected are found in urban air nationwide. There do not appear to be any compounds of local significance.

The majority of compounds can be related to motor vehicular sources. These include formaldehyde, benzene, toluene, ethylbenzene, xylenes, and styrene. Chloroflourocarbons are also present, including chloromethane, dichlorodifluoromethane, trichlorofluoromethane, and trichlorotrifluoroethane. Polycyclic aromatic hydrocarbon compounds naphthalene, phenanthrene and acenaphthene are frequently detected.

This report has two companion documents. The report, “Documentation for Grand Junction Urban Air Toxics Trends Monitoring Locations – Site Maps and Photographs” provides information concerning the two air monitoring sites discussed in this report. The document, “Air Toxics Summary: Compounds Contributing to Cancer and Non-cancer Risks – Overview of Sources and Health Effects”, provides a brief summary of many of the compounds monitored. This report discusses the chemical formula, sources, and uses of each compound. It also profiles potential health effects, such as carcinogenicity, the compound’s potential to cause birth defects, and whether it damages target organs in the body.

## **Section 1: Introduction**

### **Introduction**

The Grand Junction Air Toxics monitoring site was established as a part of the United States Environmental Protection Agency's National Air Toxic Trends Study. This network of monitors will measure air toxics for a six year period to determine the success of the National Air Toxics Strategy in reducing U.S. population exposure to cancer-causing substances in the air. The main test will be a comparison of mean concentrations of compounds for the first three years, versus the mean concentrations for the last three years. This report discusses the results from the Grand Junction site from January 2008 through December 2008.

This report is separated into sections. Sections 2 through 5, and 9 discuss the compounds monitored as a part of this study. Each section begins with summary statistics for the compounds analyzed and then the percentage of samples in which each chemical was detected. Summary graphs of certain compounds are presented. Sections 6, 7 and 8 compare the carbon monoxide, PM<sub>10</sub> and PM<sub>2.5</sub> data collected as a part of the regular monitoring conducted in Grand Junction by the Colorado Department of Public Health and Environment (CDPHE) to the national ambient air quality standards (NAAQS). This report has a companion document, "Air Toxics Summary: Compounds Contributing to Cancer and Non-cancer Risks – Overview of Sources and Health Effects", which provides a brief summary of many of the compounds monitored. The companion report discusses the chemical formula, sources, and uses of each compound. It also profiles potential health effects, such as carcinogenicity, the compound's potential to cause birth defects, and whether it damages target organs in the body.

### **Site Information**

The National Air Toxics Trends Study at Grand Junction sampled at two separate locations. These are in close proximity to one another. However, the particulate samplers are located on a roof-top, while the other parameters are monitored at a shelter at ground level. Due to the different sampling heights, staff at Region VIII of the EPA suggested the sites be separately catalogued in the national air monitoring database. The particulate samplers are located on the roof of the Powell Building at 650 South Avenue. The other monitor is located at 654¼ Pitkin Avenue. This site contains the carbon monoxide monitor, meteorological tower and the gaseous air toxic monitors. Documentation regarding these sites, including maps, photographs, and aerial views, is available in the companion report, "Documentation for Grand Junction Urban Air Toxics Trends Monitoring Locations – Site Maps and Photographs". The sites are located on the southern end of the city in an area of commercial/light industrial land use.

## Section 2: Carbonyls at Grand Junction – Powell Site

### Summary Statistics – Carbonyls

#### Maximum and Mean – All Samples

The carbonyls discussed in this section are the group of organic chemicals that contain a carbon atom double bonded to an oxygen atom. The generalized symbol for the carbonyl group is **R-C=O**, where the “R” is some other carbon compound. Twelve compounds were measured for this study. The list of these compounds and the summary of the collected data are shown in Table 2.1 and Table 2.2.

Carbonyls were sampled on an every-sixth-day basis for the year, for a total of 61 samples attempted. All samples were valid, so the site exceeded the EPA goal for over 85 percent sample recovery.

Table 2.2 summarizes the annual maximum and mean concentrations for each carbonyl compound measured during the study. The annual means were calculated by replacing all “non-detect” values with one-half of the sample minimum detection limit. This is an accepted conservative technique for calculating annual values when some of the samples were less than the laboratory’s ability to detect. The most prevalent carbonyls in the ambient air in Grand Junction are formaldehyde, acetone, and acetaldehyde. The other nine carbonyl compounds measured in this study occurred at concentration levels significantly below those of these top three compounds.

All of the carbonyls, except for isovaleraldehyde and 2, 5-dimethylbenzaldehyde, were present over 98 percent of the time. The isovaleraldehyde detection percentage of 39.3% was a decrease from 2006, when it was detected 78% of the time. (In 2007, isovaleraldehyde was detected about 33 % of the time). Note that the true annual mean of 2,5-dimethylbenzaldehyde may be well below the number reported in Table 2.2. Due to the fact that this compound was never detected, one-half of the detection limit was used for the estimated concentration of the non-detects. Actual concentrations could have been at lower levels than these estimates.

#### Percentage of Samples For Which Compound Was Detected

Table 2.1 shows that most of these carbonyl compounds were present in air all of the time. However, 2,5-dimethylbenzaldehyde was seen much less frequently, with no detections in 2007 or 2008. (For 2007 data, see the National Air Toxics Trends Study in Grand Junction, Colorado, January through December 2007 report). 2,5-dimethylbenzaldehyde was detected 34 percent of the time in the 2001 – 2002 pilot study, while it was only detected 4.8 percent of the time in 2005, and not at all in 2006 - 2008. This is a sizable reduction in detection frequency from the pilot study.

**Table 2.1 Carbonyl Compounds Sample Summary - 2008**

Grand Junction – Powell Site	CAS Number	61 Samples	
		Number of Samples Above Detection	Percentage of Samples Detected
Acetaldehyde	75-07-0	61	100
Formaldehyde	50-00-0	61	100
Acetone	67-64-1	61	100
Valeraldehyde	110-62-3	61	100
Butyraldehyde	123-72-8	61	100
Propionaldehyde	123-38-6	61	100
Crotonaldehyde	123-73-9	61	100
Hexaldehyde	66-25-1	61	100
Tolualdehydes	NA	60	98.4
Benzaldehyde	100-52-7	61	100
Isovaleraldehyde	590-86-3	24	39.3
2,5-Dimethylbenzaldehyde	5779-94-2	0	0



## Graphs - Carbonyls

The summary data for carbonyl compounds measured during 2008 are graphed in Figure 2.1. These compounds in these graphs are ordered by ranking their maximum concentration. The graphs show that acetaldehyde, acetone, and formaldehyde generally had the highest maxima. The maximums observed in 2008 were very similar to those in 2007. The means for the compounds during the two years were fairly close, with no consistent trend across compounds.

**Table 2.2 Carbonyl Compounds Data Summary Comparisons – 2007 – 2008**

Grand Junction – Powell Site	2008 Statistics ( $\mu\text{g}/\text{m}^3$ )			2007 Statistics ( $\mu\text{g}/\text{m}^3$ )		
	Maximum	Mean	Average MDL*	Maximum	Mean	Average MDL
Acetaldehyde	4.504	2.486	0.021	5.495	2.794	0.007
Formaldehyde	6.416	4.101	0.012	6.317	4.020	0.012
Acetone	11.022	5.201	0.007	9.621	5.242	0.017
Valeraldehyde	0.377	0.148	0.010	0.419	0.016	0.007
Butyraldehyde	0.655	0.313	0.007	0.761	0.359	0.006
Propionaldehyde	0.720	0.384	0.007	0.620	0.309	0.005
Crotonaldehyde	0.456	0.192	0.011	0.530	0.198	0.006
Hexaldehyde	0.311	0.126	0.012	0.213	0.104	0.004
Tolualdehydes	0.393	0.156	0.013	0.487	0.199	0.018
Benzaldehyde	0.721	0.299	0.009	0.655	0.325	0.004
Isovaleraldehyde	0.085	0.024	0.007	0.120	0.023	0.007
2,5-Dimethylbenzaldehyde	ND	ND	0.011	ND	ND	0.011

\*- Average MDL – average minimum detectable level

ND – Compound Not Detected

Figure 2.2 shows the concentrations for the compounds during the year. Unlike past years, the compounds did not show much seasonal variation. This is interesting, because it is generally believed that more formaldehyde is formed photochemically during the summer period of higher solar radiation. Formaldehyde plays a role in the formation of ozone, a chemical that peaks during the summer. In 2008, the Air Pollution Control Division started a new ozone monitor near Grand Junction, in Palisade. It will be interesting to see if ozone trends here follow those in the rest of the state.

## Field Blanks – Carbonyls

Field blanks were collected twelve times a year by attaching a blank sample cartridge to the sampler briefly, and then removing it. The purpose of these blanks was to assess contamination that might exist in the cartridge media, sample installation or shipping. Most cartridges had small amounts of formaldehyde, acetaldehyde, acetone, and propionaldehyde. Detailed information regarding field blank results is available upon request.

## Precision of Sample Results – Carbonyls

This project collected precision data in order to assess both sampling and analytical procedures. Six times during the year, a second carbonyl cartridge was sampled simultaneously with the primary sample. These additional samples, or duplicates, were collected to assess the precision (repeatability) of the sampling method. In general, agreement between the two samples was excellent. Detailed information regarding precision results is available upon request.

Figure 2.1 Maximum and Annual Mean Carbonyls 2008

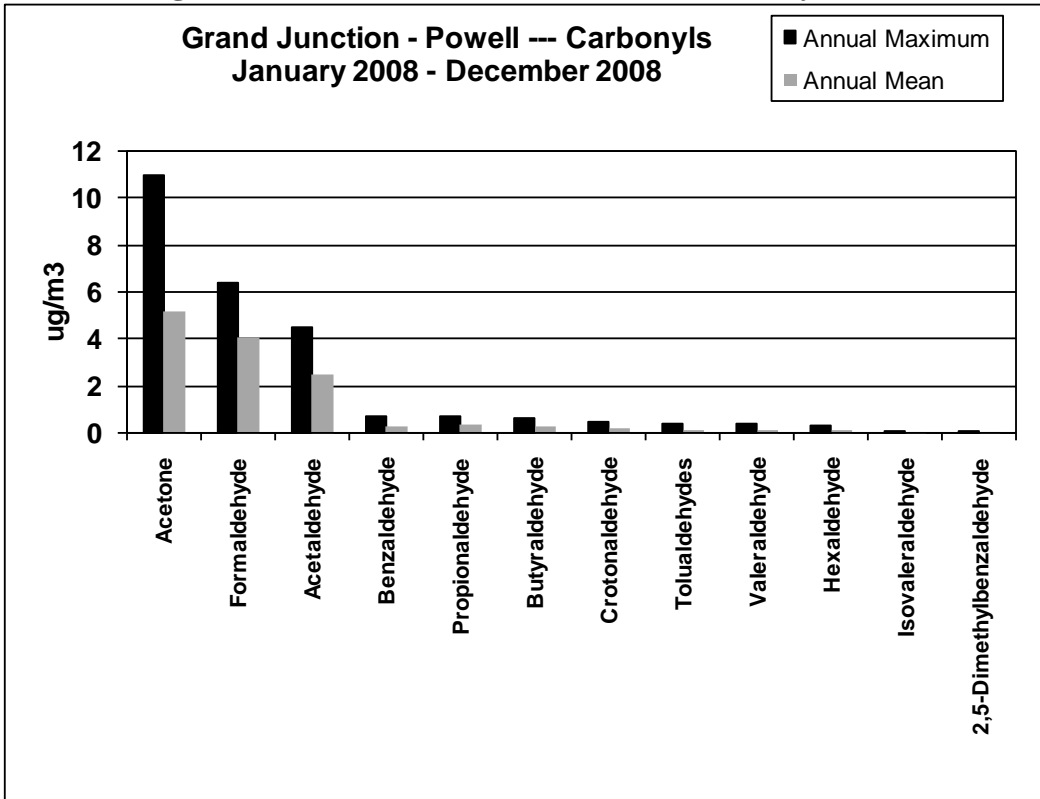
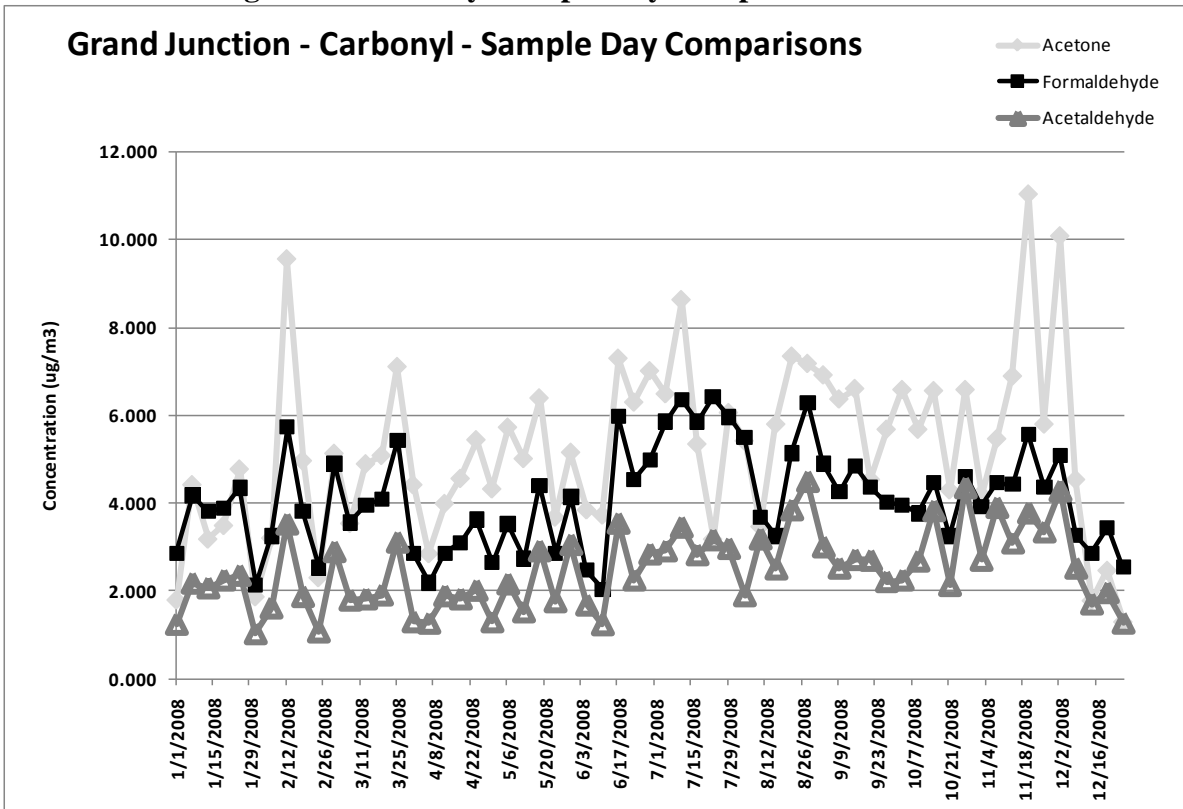


Figure 2.2 Carbonyl Sample Day Comparisons for 2008



## **Section 3: Volatile Organic Compounds at Grand Junction – Powell Site**

### **Summary Statistics – Volatile Organic Compounds**

#### **Maximum and Mean – All Samples**

Volatile organic compound (VOC) data collected at the Grand Junction - Powell station from January through December 2008 are presented in this section. There were 60 VOCs analyzed for this study. The list of these VOCs is on Table 3.1. These are the same VOCs collected by all of the sites participating in the national air toxics study. Volatile organic compounds were sampled on an every-sixth-day basis, for a total of 62 possible days. One sample was not collected, giving 61 samples for the year (98.4% recovery).

Table 3.2 summarizes the annual maximum and mean concentrations for each of the 60 volatile organic compounds measured during the study. It should be noted that the annual means and maximums were calculated by replacing all “non-detect” values with one-half of the sample detection limit. This is an accepted conservative technique for calculating annual values when some of the samples were less than the laboratory’s ability to measure.

**Table 3.1 VOC Detection Summary - 2008**

Grand Junction - Powell Site	CAS Number*	61 Samples Taken	
		Number of Samples Detected	Percentage of Samples Detected
1,1,1-Trichloroethane	71-55-6	61	100.0
1,1,1,2-Tetrachloroethane	79-34-5	1	1.6
1,1,2-Trichloroethane	79-00-5	1	0.0
1,1-Dichloroethane	75-34-3	0	0.0
1,1-Dichloroethene	75-35-4	0	0.0
1,2,4-Trichlorobenzene	120-82-1	0	0.0
1,2,4-Trimethylbenzene	95-63-6	61	100.0
1,2-Dibromoethane	106-93-4	0	0.0
1,2-Dichloroethane	107-06-2	0	0.0
1,2-Dichloropropane	78-87-5	0	0.0
1,3,5-Trimethylbenzene	108-67-8	61	100.0
1,3-Butadiene	106-99-0	61	100.0
Acetonitrile	75-05-8	59	96.7
Acetylene	74-86-2	61	100.0
Acrolein	107-02-8	60	98.4
Acrylonitrile	107-13-1	3	4.9
Benzene	71-43-2	61	100.0
Bromochloromethane	74-97-5	0	0.0
Bromodichloromethane	75-27-4	0	0.0
Bromoform	75-25-2	0	0.0
Bromomethane	74-83-9	60	98.4
Carbon Disulfide		61	100.0
Carbon Tetrachloride	56-23-5	61	100.0
Chlorobenzene	108-90-7	0	0.0
Chloroethane	75-00-3	55	90.2
Chloroform	67-66-3	59	96.7
Chloromethane	74-87-3	61	100.0
Chloromethylbenzene	100-44-7	0	0.0
Chloroprene	126-99-8	2	3.3
cis-1,2-Dichloroethylene	156-59-4	0	0.0
cis-1,3-Dichloropropene	10061-01-5	0	0.0
Dibromochloromethane	124-48-1	0	0.0
Dichlorodifluoromethane	75-71-8	61	100.0
Dichloromethane	75-09-2	61	100.0
Dichlorotetrafluoroethane	76-14-2	58	95.1
Ethyl Acrylate	140-88-5	0	0.0
Ethyl tert-Butyl Ether	637-92-3	0	0.0
Ethylbenzene	100-41-4	61	100.0
Hexachloro-1,3-butadiene	87-68-3	0	0.0
m,p-Xylene	100-01-6	61	100.0
m-Dichlorobenzene	541-73-1	0	0.0
Methyl Ethyl Ketone	78-93-3	60	98.4
Methyl Isobutyl Ketone	108-10-1	54	88.5
Methyl Methacrylate	80-62-6	37	60.7
Methyl tert-Butyl Ether	1634-04-4	2	3.3
n-Octane	111-65-9	60	98.4
o-Dichlorobenzene	95-50-1	0	0.0
o-Xylene	95-47-6	61	100.0
p-Dichlorobenzene	106-46-7	39	63.9
Propylene	115-07-1	61	100.0
Styrene	100-42-5	61	100.0
tert-Amyl Methyl Ether	994-05-8	1	1.6
Tetrachloroethylene	127-18-4	60	98.4
Toluene	108-88-3	61	100.0
trans-1,2-Dichloroethylene	156-60-5	0	0.0
trans-1,3-Dichloropropene	10061-02-6	0	0.0
Trichloroethylene	79-01-6	17	27.9
Trichlorofluoromethane	75-69-4	61	100.0
Trichlorotrifluoroethane	76-13-1	61	100.0
Vinyl chloride	75-01-4	5	8.2

\* "CAS Number" refers to the Chemical Abstract System Number. This is an alternate way of referencing organic chemicals, which can have multiple names.

**Table 3.2 VOC Data Summary Comparisons - 2007 – 2008**

Grand Junction - Powell Site	CAS Number*	2008 Statistics (µg/m <sup>3</sup> )			2007 Statistics (µg/m <sup>3</sup> )		
		Maximum**	Mean**	Average MDL	Maximum**	Mean**	Average MDL
1,1,1-Trichloroethane	71-55-6	0.15	0.09	0.03	0.18	0.09	0.09
1,1,2,2-Tetrachloroethane	79-34-5	0.03 #	0.03 #	0.06	ND	ND	0.11
1,1,2-Trichloroethane	79-00-5	ND	ND	0.04	ND	ND	0.10
1,1-Dichloroethane	75-34-3	ND	ND	0.03	ND	ND	0.07
1,1-Dichloroethene	75-35-4	ND	ND	0.02	ND	ND	0.09
1,2,4-Trichlorobenzene	120-82-1	ND	ND	0.22	ND	ND	0.31
1,2,4-Trimethylbenzene	95-63-6	1.42	0.50	0.08	1.78	0.64	0.06
1,2-Dibromoethane	106-93-4	ND	ND	0.05	0.08 #	0.05 #	0.11
1,2-Dichloroethane	107-06-2	ND	ND	0.04	0.07 #	0.04 #	0.09
1,2-Dichloropropane	78-87-5	ND	ND	0.05	ND	ND	0.09
1,3,5-Trimethylbenzene	108-67-8	0.43	0.16	0.08	0.54	0.21	0.06
1,3-Butadiene	106-99-0	0.60	0.15	0.01	0.58	0.16	0.04
Acetonitrile	75-05-8	360.97	6.61	0.04	42.31	1.7	0.06
Acetylene	74-86-2	10.20	2.02	0.01	6.48	1.46	0.03
Acrolein	107-02-8	2.66	0.68	0.05	2.48	0.63	0.06
Acrylonitrile	107-13-1	5.51	0.13	0.02	0.22	0.04	0.06
Benzene	71-43-2	4.47	1.62	0.03	4.22	1.46	0.08
Bromochloromethane	74-97-5	ND	ND	0.03	ND	ND	0.10
Bromodichloromethane	75-27-4	ND	ND	0.05	0.13 #	0.06 #	0.12
Bromoform	75-25-2	ND	ND	0.05	ND	ND	0.16
Bromomethane	74-83-9	0.47	0.06	0.02	0.12	0.05	0.10
Carbon Disulfide	75-15-0	46.71	10.94	0.01	17.16	8.71	0.07
Carbon Tetrachloride	56-23-5	1.40	0.68	0.03	0.84	0.53	0.09
Chlorobenzene	108-90-7	ND	ND	0.04	0.06 #	0.03 #	0.06
Chloroethane	75-00-3	0.13	0.03	0.01	0.11	0.03	0.05
Chloroform	67-66-3	0.50	0.11	0.03	0.17	0.09	0.09
Chloromethane	74-87-3	3.96	1.42	0.02	1.56	1.22	0.05
Chloromethylbenzene	100-44-7	ND	ND	0.06	ND	ND	0.07
Chloroprene	126-99-8	0.17 #	0.02 #	0.03	0.11 #	0.03 #	0.05
cis-1,2-Dichloroethylene	156-59-4	ND	ND	0.03	0.16 #	0.04 #	0.07
cis-1,3-Dichloropropene	10061-01-5	ND	ND	0.03	ND	ND	0.08
Dibromochloromethane	124-48-1	ND	ND	0.04	ND	ND	0.13
Dichlorodifluoromethane	75-71-8	4.87	2.79	0.02	3.50	2.70	0.09
Dichloromethane	75-09-2	78.51	3.43	0.06	1.39	0.38	0.05
Dichlorotetrafluoroethane	76-14-2	0.17	0.11	0.02	0.18	0.12	0.14
Ethyl Acrylate	140-88-5	ND	ND	0.09	ND	ND	0.07
Ethyl tert-Butyl Ether	637-92-3	ND	ND	0.02	ND	ND	0.04
Ethylbenzene	100-41-4	1.31	0.47	0.03	1.53	0.61	0.06
Hexachloro-1,3-butadiene	87-68-3	ND	ND	0.18	0.26 #	0.19 #	0.38
m,p-Xylene	100-01-6	4.39	1.53	0.08	5.47	2.05	0.10
m-Dichlorobenzene	541-73-1	ND	ND	0.09	0.12 #	0.05 #	0.10
Methyl Ethyl Ketone	78-93-3	4.10	0.98	0.08	2.61	0.99	0.12
Methyl Isobutyl Ketone	108-10-1	0.49	0.17	0.07	0.56	0.17	0.07
Methyl Methacrylate	80-62-6	8.31	0.49	0.05	10.16	1.34	0.06
Methyl tert-Butyl Ether	1634-04-4	0.01 #	0.01 #	0.02	0.05 #	0.02 #	0.04
n-Octane	111-65-9	0.88	0.20	0.02	0.65	0.24	0.04
o-Dichlorobenzene	95-50-1	ND	ND	0.09	ND	ND	0.11
o-Xylene	95-47-6	1.56	0.56	0.03	1.88	0.73	0.06
p-Dichlorobenzene	106-46-7	0.14	0.04	0.07	0.30	0.07	0.10
Propylene	115-07-1	2.91	1.88	0.03	5.25	0.91	0.06
Styrene	100-42-5	27.22	1.26	0.09	2.88	0.58	0.06
tert-Amyl Methyl Ether	994-05-8	0.03 #	0.03 #	0.05	0.05 #	0.02 #	0.05
Tetrachloroethylene	127-18-4	1.43	0.33	0.04	1.20	0.32	0.08
Toluene	108-88-3	11.16	2.90	0.09	29.10	4.22	0.07
trans-1,2-Dichloroethylene	156-60-5	ND	ND	0.02	ND	ND	0.07
trans-1,3-Dichloropropene	10061-02-6	ND	ND	0.03	ND	ND	0.08
Trichloroethylene	79-01-6	0.26	0.03	0.02	0.14	0.06	0.10
Trichlorofluoromethane	75-69-4	3.15	1.51	0.02	1.99	1.46	0.12
Trichlorotrifluoroethane	76-13-1	1.00	0.68	0.05	5.06	0.83	0.16
Vinyl chloride	75-01-4	0.03	0.01	0.01	0.04	0.03	0.06

\* "CAS Number" refers to the Chemical Abstract System Number. This is an alternate way of referencing organic chemicals, which can have multiple names.

\*\* ND – Non-Detect. All samples were less than the detection limit for this compound.

# - Compound detected only once or twice during the year.

## Percentage of Samples For Which Compound Was Detected

Table 3.1 shows the percentage of the samples in which each VOC was detected. Twenty-eight of the compounds were detected in over 90 percent of the samples. These compounds, that are almost always present, are listed in Table 3.3. Twenty-six of these compounds were detected over 90 percent of the time in 2007, as well.

Twenty-two VOCs were not detected at all during the year 2008. These are shown in Table 3.4. The list of compounds in Table 3.4 includes many compounds that are chiefly emitted by stationary sources. Evidently, these source types are not present in the immediate vicinity of the station.

**Table 3.3 Compounds Detected in Over 90 Percent of the VOC Air Samples – 2008**

<p><b>Compounds Detected Over 90 % of the Time in 2008 and 2007 (26)</b></p>	<p>1,1,1-Trichloroethane 1,3,5 - Trimethylbenzene 1,2,4 – Trimethylbenzene 1,3 - Butadiene Acetylene Acetonitrile Acrolein Benzene Carbon Disulfide Carbon Tetrachloride Chloromethane Dichloromethane Dichlorodifluoromethane</p>	<p>Dichlorotetrafluoroethane Methyl Ethyl Ketone n-Octane Ethylbenzene m,p - xylene o - xylene Propylene Styrene Toluene Trichlorofluoromethane Trichlorotrifluoroethane Bromomethane Tetrachloroethylene</p>
<p><b>Compounds Detected Over 90% of the Time in 2008, that Were Not Detected This Often in 2007 (2)</b></p>	<p>Chloroethane</p>	<p>Chloroform</p>

**Table 3.4 Volatile Organic Compounds Rarely Detected in the VOC Air Samples**

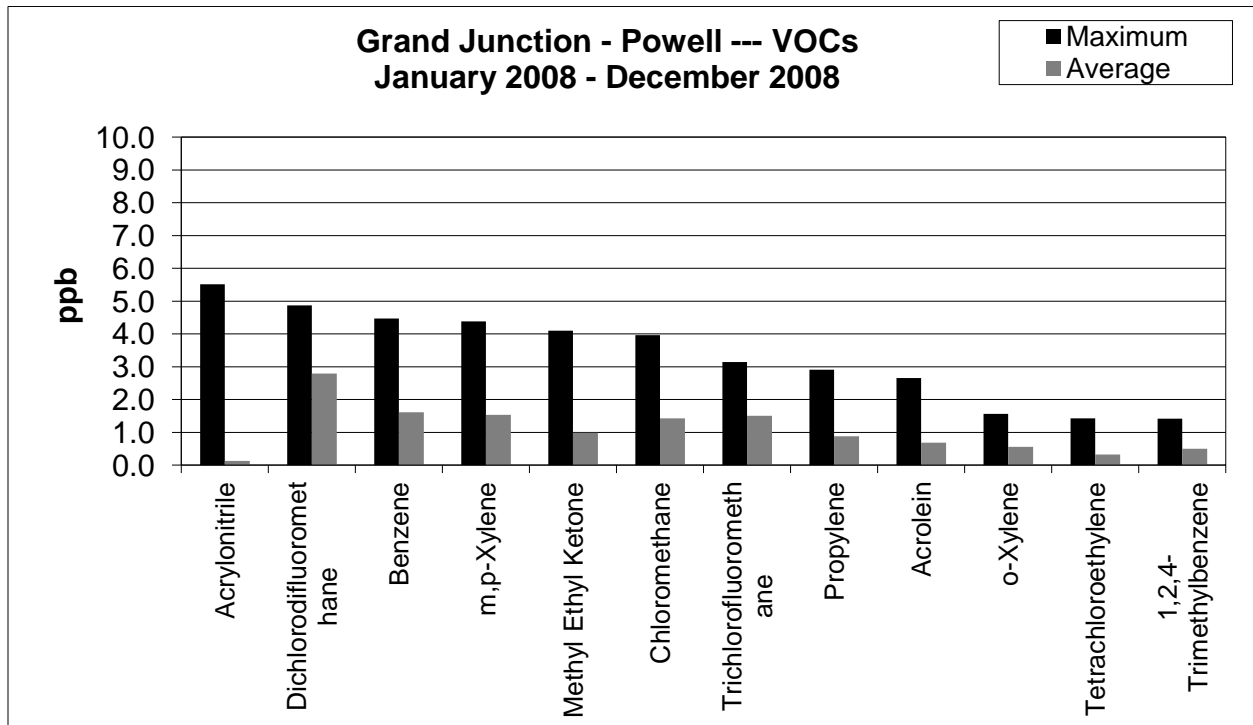
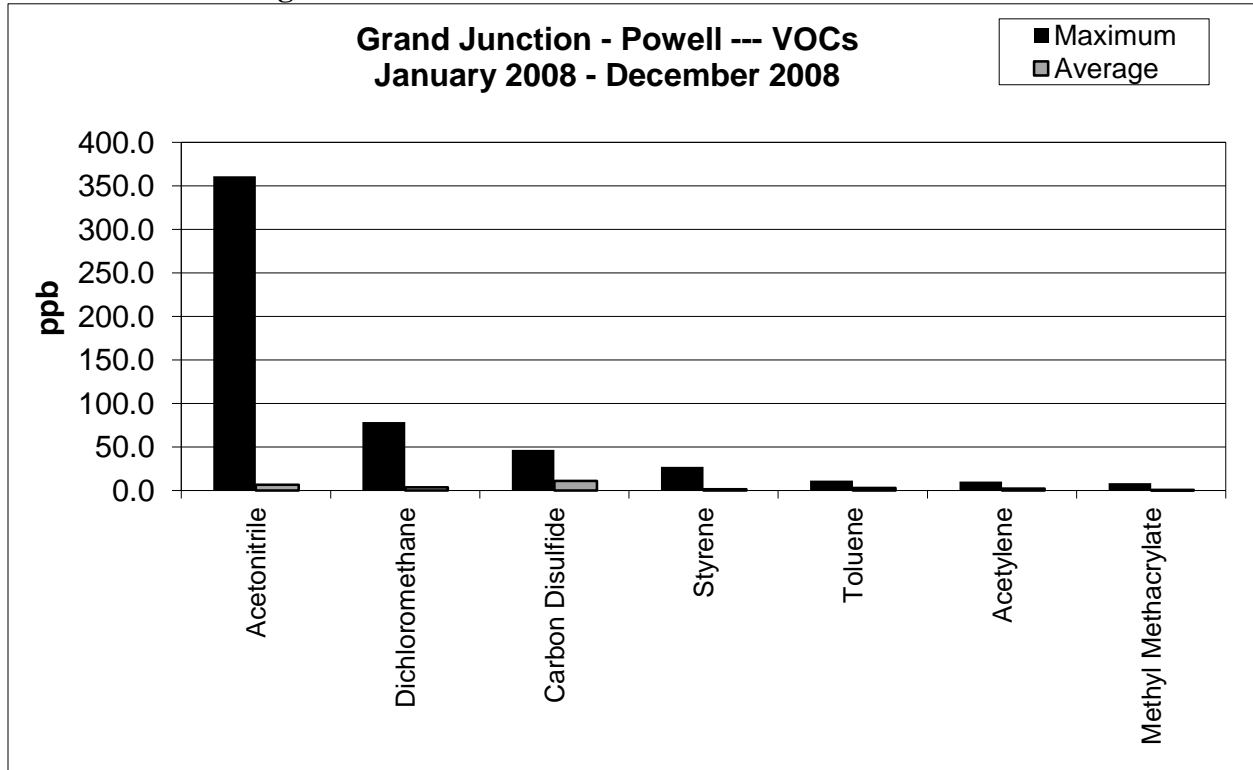
<p><b>Compounds Not Seen In 2008 (22)</b></p>	<p>1,1,2-Trichloroethane 1,1-Dichloroethane 1,2-Dichloroethane 1,1-Dichloroethene 1,2-Dichloropropane 1,2,4 – Trichlorobenzene Hexachloro -1,3 -butadiene</p>	<p>1,2 - Dibromoethane Bromochloromethane Bromodichloromethane Bromoform Chloromethylbenzene cis – 1,3-Dichloropropene cis – 1,2 - Dichloroethylene</p>	<p>Dibromochloromethane Ethyl Acrylate o-Dichlorobenzene trans – 1,2-Dichloroethylene trans – 1,3-Dichloropropene Chlorobenzene m-Dichlorobenzene Ethyl tert-butyl Ether</p>
-----------------------------------------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

## Graphs – Volatile Organic Compounds

Figure 3.1 has four graphs showing the 24-hour maximum and annual mean concentrations for each of the 38 compounds that were detected during the year. These graphs are ordered from highest to lowest 24-hour maximum. Note that the graphs scales vary from a full-scale level at 400 ug/m<sup>3</sup>, to a full-scale value of 1.0 ug/m<sup>3</sup>.

Figures 3.2 and 3.3 show that benzene, toluene, ethylbenzene, xylenes, and the trimethylbenzenes show close relationships, with similar peaks and valleys. These compounds are all present in petroleum. Figure 3.4 shows that four chlorofluorocarbon compounds tend to trend together. In Figure 3.5, acetylene and propylene trend together. The close relationship with benzene suggests an automotive source. However, unlike the other two compounds, acetylene is highest in the winter. This may be because acetylene is also emitted from wood burning.

Figure 3.1 Annual Mean and 24 Hour Maximum VOCs



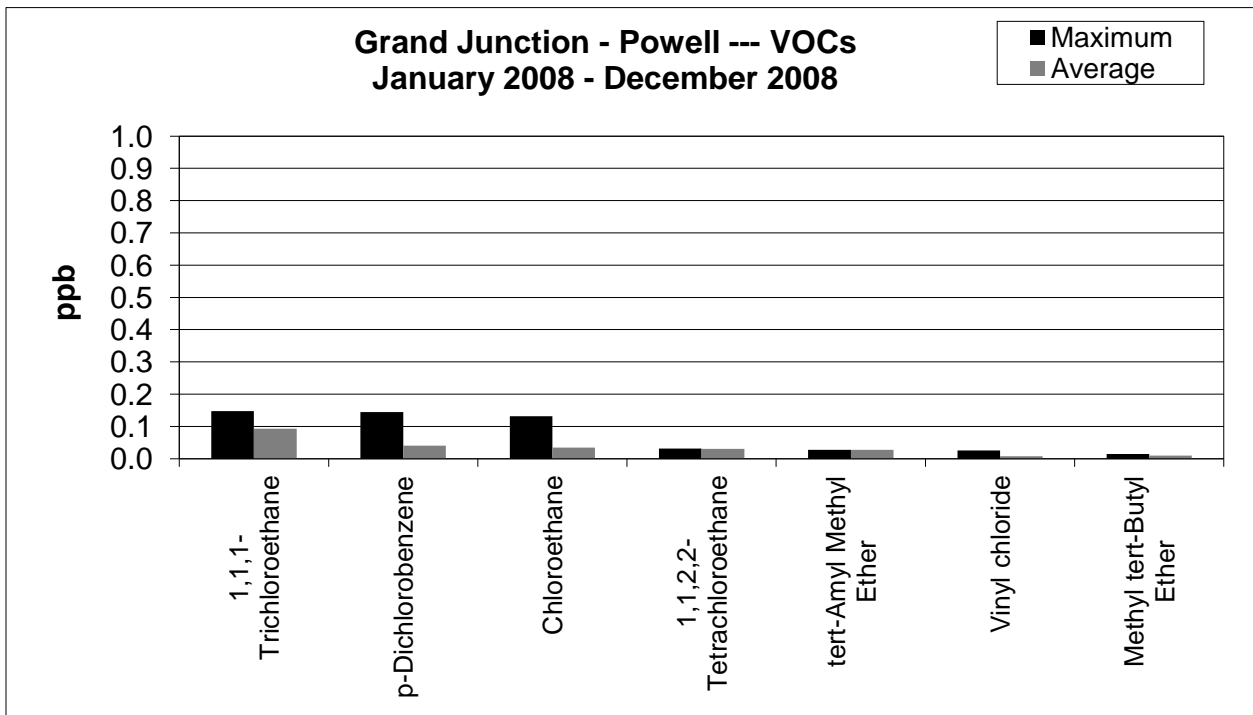
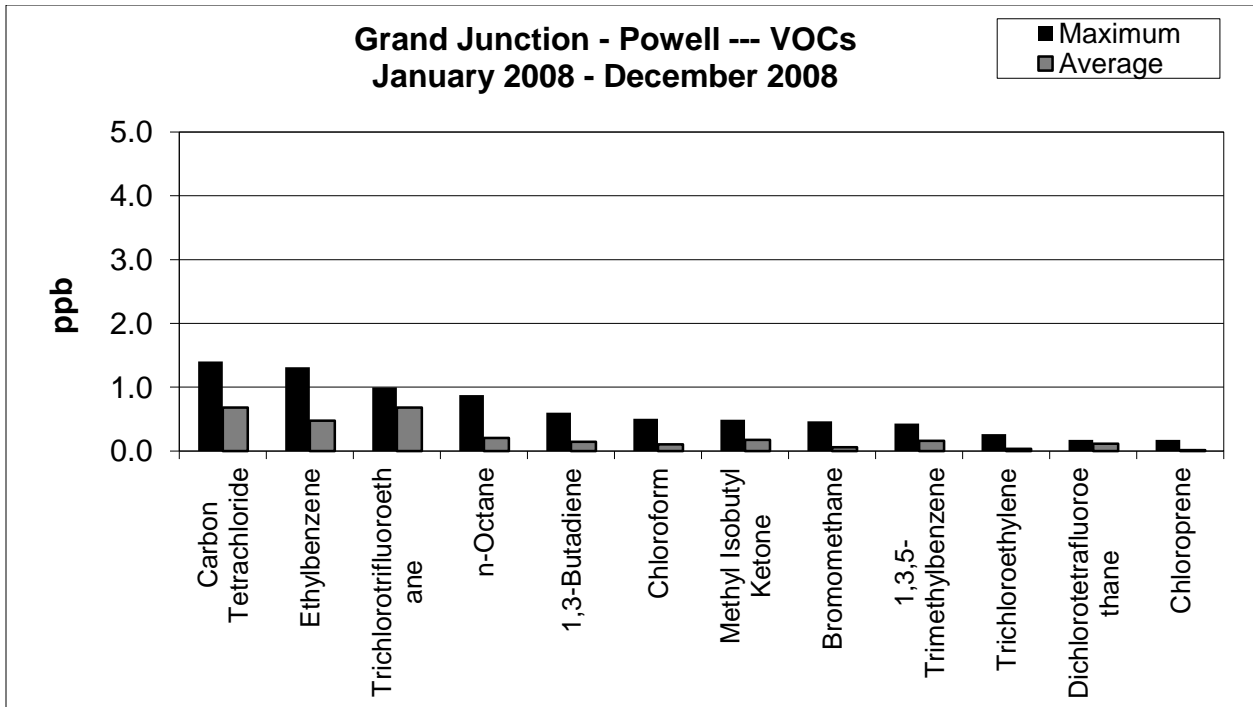




Figure 3.2 Toluene, Benzene and Ethylbenzene Concentrations

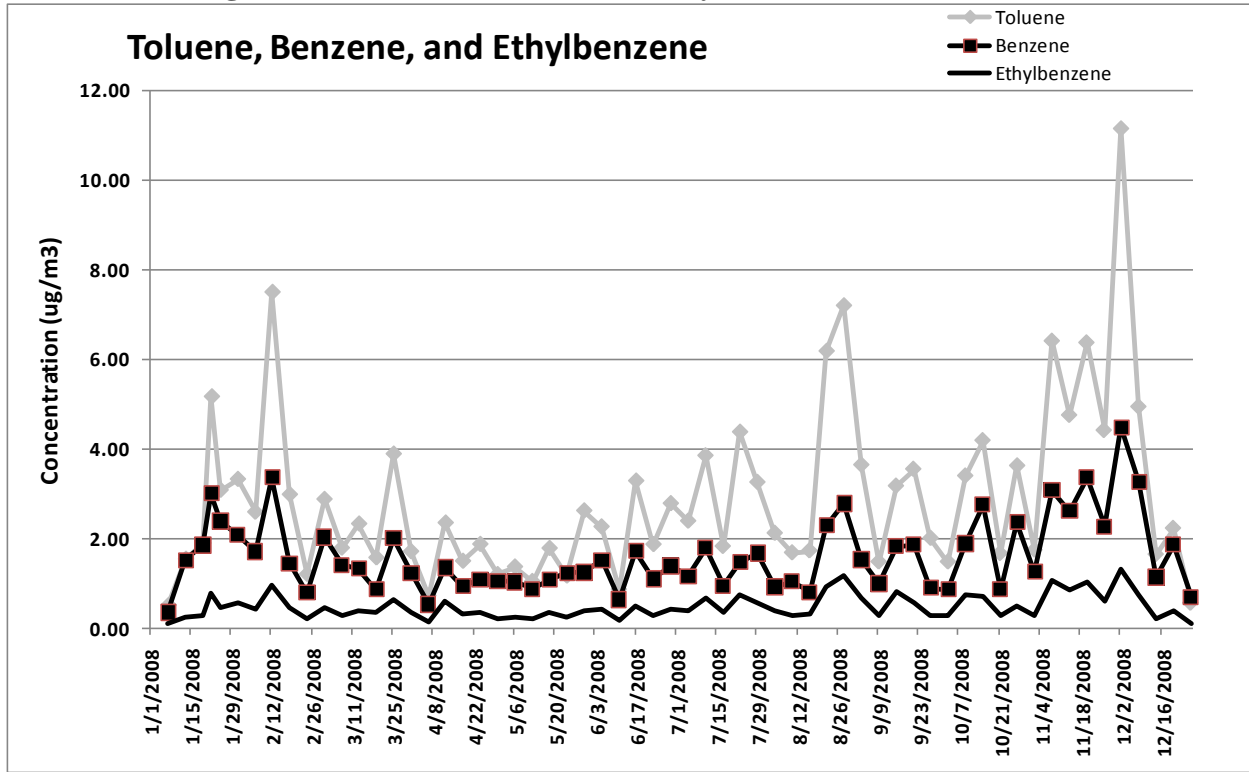
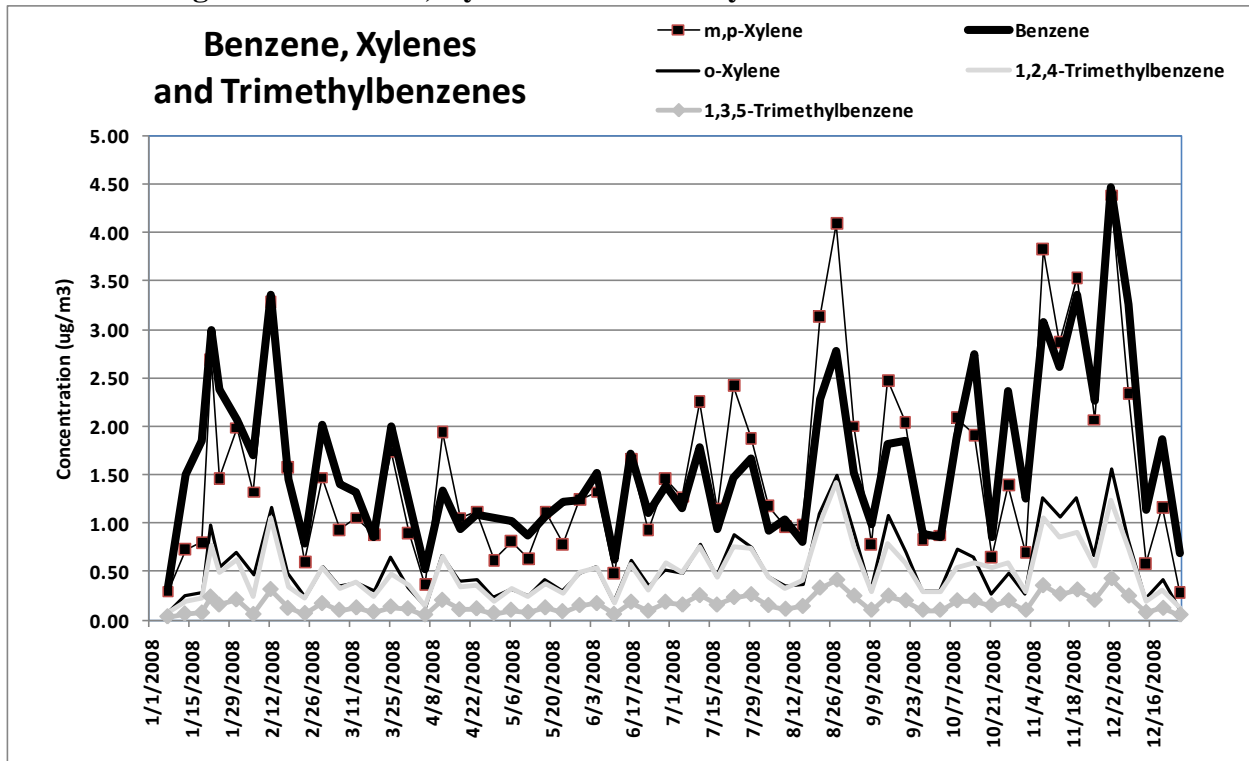
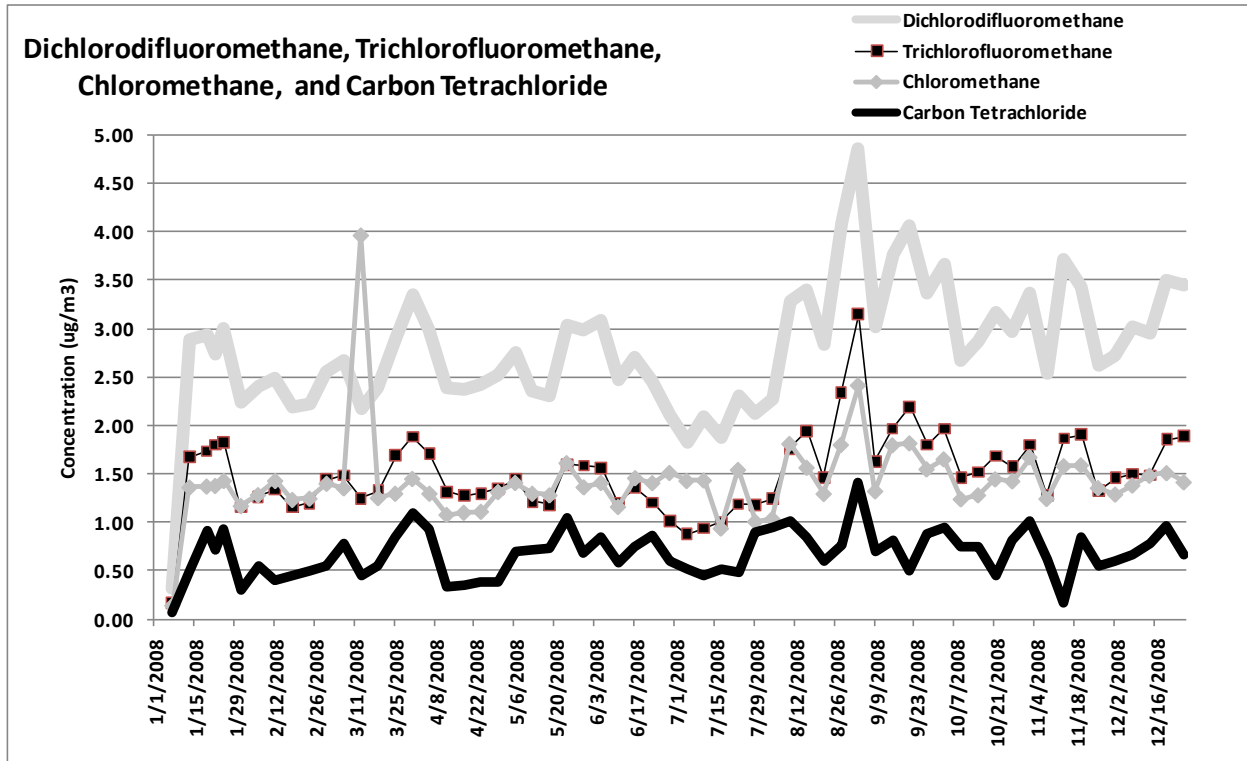


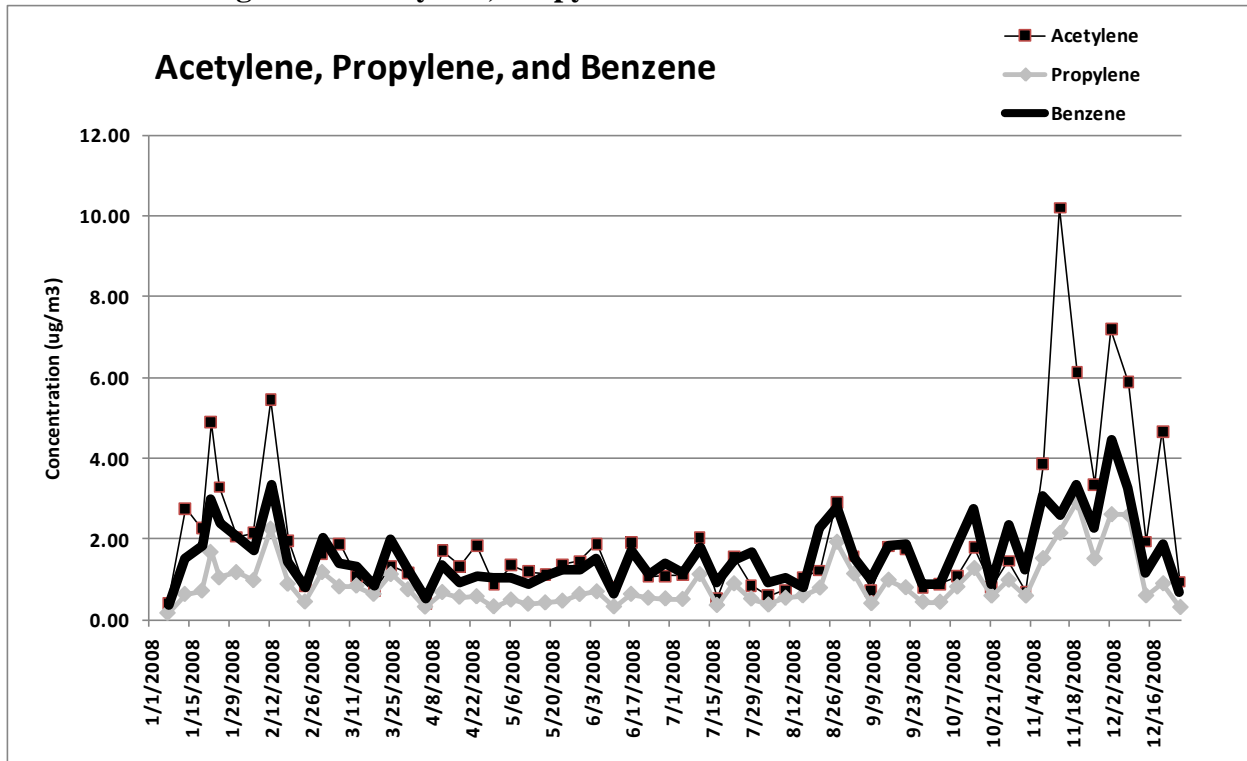
Figure 3.3 Benzene, Xylenes and Trimethylbenzenes Concentrations



**Figure 3.4 Dichlorodifluoromethane, Trichlorofluoromethane, Chloromethane And Carbon Tetrachloride Concentrations**



**Figure 3.5 Acetylene, Propylene and Benzene Concentrations**



## **Precision of Sample Results – Volatile Organic Compounds**

On six sampling dates, a second canister was sampled simultaneously with the primary sample. These additional samples, known as duplicates, were collected in order to assess the precision (repeatability) of the canister sampling method. In general, repeatability for the two collocated samples was excellent. Information regarding precision and accuracy results is available upon request to the Air Pollution Control Division.

## **Field Blanks – Volatile Organic Compounds**

The volatile organic compound sampling method involves sampling in stainless steel canisters with specially-treated interior surfaces. The canisters are re-used. After a full canister is analyzed, it is pumped out repeatedly to a high vacuum. This procedure cleans it for the next use. Periodically, one canister from each cleaning batch is tested to make sure the method is performing adequately. The test canister is filled with ultra-pure air, and then analyzed. If it shows no contamination, the batch is released for use. If contamination is found, the entire batch is sent through the cleaning process for a second time. The canisters arrive in the field closed, and under 20 to 30 inches of vacuum. Therefore, field blanks are not used in this method. The canisters are “blanked” at the laboratory prior to shipping to the field.

## Section 4: Metals at Grand Junction – Powell Site

### Summary Statistics – Metals

#### Percentage of Samples For Which Compound Was Detected

During the study, metals were sampled on the every-sixth-day schedule, for a total of 61 samples attempted. Of these, 52 were recovered, for a percentage data recovery of 85.2. This meets the EPA’s goal of 85 % annual data recovery for this study.

Table 4.1 shows the percentage of the samples in which each metal was detected. Chromium (total) and manganese were detected in about 90% or more of the samples. Lead and nickel were present about two-thirds of the time. This is a decrease from the 2007 percentage of over 90 for lead. Arsenic and beryllium were never detected. Cadmium and antimony were seen less than 20% of the time.

**Table 4.1 Metals Detection Summary - 2008**

Grand Junction – Powell Site	CAS Number	52 Samples Taken	
		Number of Samples Above Detection Limit	Percentage of Samples Above Detection Limit
Antimony	7440-36-0	10	19.8
Arsenic	7440-38-2	0	0.0
Beryllium	7440-41-7	0	0.0
Cadmium	7440-43-9	9	17.3
Chromium (total)	7440-47-3	49	94.2
Lead	7439-92-1	35	67.3
Manganese	7439-96-5	52	100.0
Nickel	7440-02-0	37	71.2

#### Maximum and Mean – All Samples

Table 4.2 summarizes the annual maximum and mean concentrations for each of the metals measured during the study. Annual means were calculated by using one-half of the detection limit in place of the non-detect samples. This is an accepted conservative technique for calculating annual values when some of the samples were less than the laboratory’s ability to measure. Results show that manganese and total chromium were the compounds with the highest mean concentrations in ambient air. The other metals were present at lower concentrations. The 2008 annual mean levels are generally less than 2007, except for antimony and manganese, which were about the same for the two years.

**Table 4.2 Metals Data Summary Comparisons 2007 - 2008**

Grand Junction – Powell Site	CAS Number	2008 Statistics ( $\mu\text{g}/\text{m}^3$ )			2007 Statistics ( $\mu\text{g}/\text{m}^3$ )		
		Maximum	Mean	Average MDL	Maximum	Mean	Average MDL
Antimony	7440-36-0	0.00760	0.00108	0.00130	0.00355	0.00099	0.00071
Arsenic	7440-38-2	0.00292	0.00243	0.00486	0.00473	0.00422	0.00845
Beryllium	7440-41-7	0.00022	0.00019	0.00038	0.00197	0.00068	0.00103
Cadmium	7440-43-9	0.00055	0.00014	0.00023	0.00103	0.00024	0.00041
Chromium (total)	7440-47-3	0.01574	0.00875	0.00197	0.03590	0.01683	0.00402
Lead	7439-92-1	0.01160	0.00248	0.00025	0.02568	0.00426	0.00026
Manganese	7439-96-5	0.04416	0.01474	0.00023	0.03511	0.01523	0.00060
Nickel	7440-02-0	0.00865	0.00143	0.00024	0.00386	0.00144	0.00234

Note that antimony, arsenic, beryllium, and cadmium have means that are less than the MDL. These values are a function of the method of calculating the annual mean using one-half of the minimum detectable limit for “non-detect” samples. Table 4.1 shows that arsenic and beryllium were never detected in the 52 samples. Cadmium was detected only 9 out of 52 samples.

### Graphs – Metals

The metal compounds measured during the study are graphed in Figure 4.1. This figure shows that manganese and total chromium were the metals at highest concentration. Total chromium was lower in 2008 than in 2007. Figure 4.2 shows that lead was at a low level for most of the year. Manganese peaked in the spring and in November.

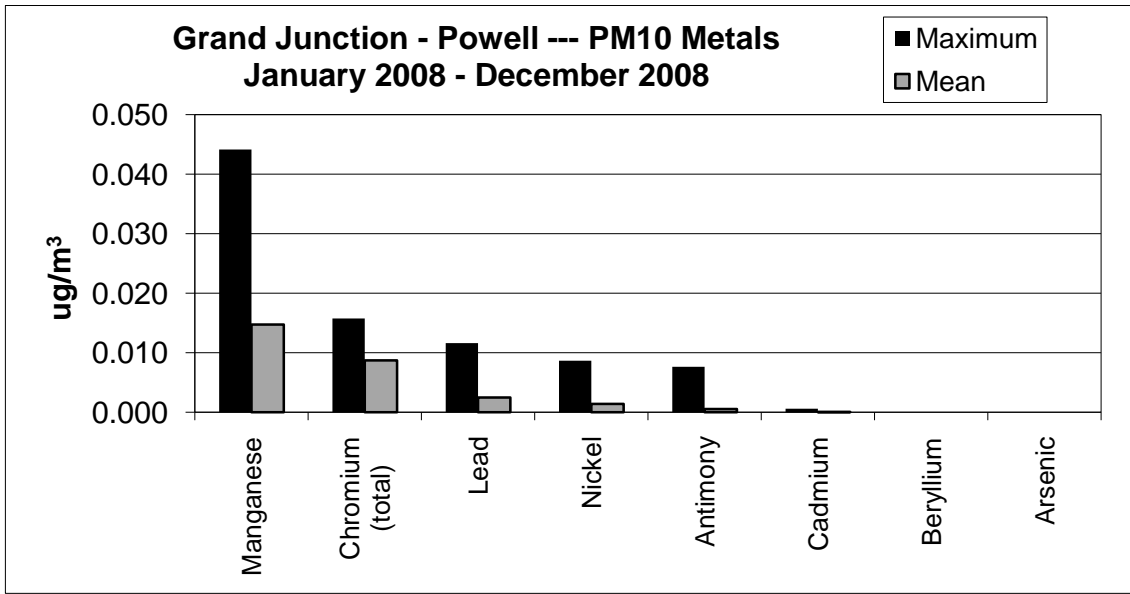
### Precision of Sample Results – Metals Compounds

Precision samples were not run in 2008. In the past, duplicates for all compounds showed good agreement.

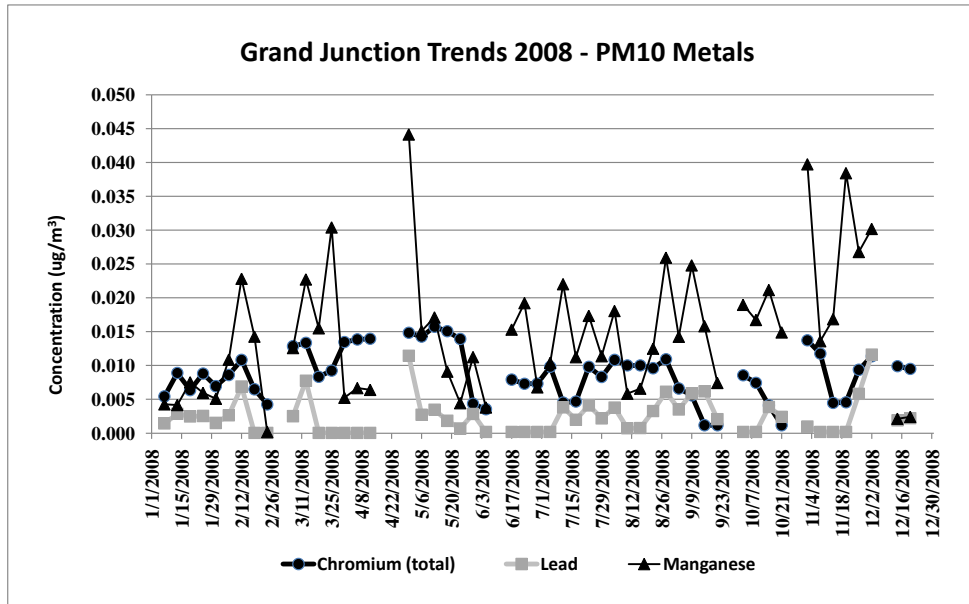
### Field and Filter Blanks – Metals Compounds

Periodically the laboratory analyzes a “blank”, or unused, filter for metals. The purpose of this extra analysis is to determine if there was any contamination of the filter during manufacturing or during laboratory processing. In 2008, the laboratory analyzed 24 “filter blanks”, filters which never left the laboratory. Chromium, lead, manganese and nickel showed up consistently in the blanks. In 2004, total chromium contamination was a problem for national air toxics network. These chromium contamination findings were believed to be related to the use of metal knives in cutting individual filters from the giant sheets prepared at the factory. At the extremely low levels of metals in ambient air that the national air toxics network is assessing, such filter contamination is a concern. The national project team evaluated new filter materials and sampling methods, and recommended changing to Teflon filters, and low volume PM<sub>10</sub> samplers, in early 2005. Unfortunately, large amounts of chromium continue to show up in the blanks of the 2008 filters. Blank amounts are subtracted, but the chromium variability is still a problem.

**Figure 4.1 Maximum and Annual Mean Metal Concentrations - 2008**



**Figure 4.2 Total Chromium, Lead, and Manganese Concentrations – 2008**



## Section 5: Hexavalent Chromium at Grand Junction – Powell Site

### Summary Statistics – Hexavalent Chromium

#### Maximum and Mean – All Samples

Hexavalent chromium data collected at the Grand Junction – Powell station from January 2008 through December 2008 are presented in this section. In 2005, a new hexavalent chromium sampler was added to the Grand Junction site. The technical steering committee made this decision for the nationwide air toxics monitoring network. The previous method only measured total chromium and could not distinguish between the trivalent ( $\text{Cr}^{3+}$ ) and hexavalent ( $\text{Cr}^{6+}$ ) forms. These two forms are quite different in their health effects; the  $\text{Cr}^{6+}$  form is a carcinogen, while the  $\text{Cr}^{3+}$  form is not. This new method is described in the document, “Hexavalent Chromium Method Development: Final Report, Work Assignment 5-03” by Eastern Research Group, Morrisville, North Carolina, September 30, 2005. Note that, due to its sensitivity, this method gives results in nanograms per cubic meter of air ( $\text{ng}/\text{m}^3$ ), a unit one thousand times lower than the micrograms per cubic meter ( $\text{ug}/\text{m}^3$ ) used elsewhere in this report.

During the year-long period, hexavalent chromium was sampled on an every-sixth-day basis, with three extra samples in November, for a total of 65 samples attempted. Of these, 61 were recovered, for a percentage data recovery of 93.8. Table 5.1 summarizes the annual maximum and mean concentrations for hexavalent chromium during 2007 and 2008. The annual mean was calculated by using one-half of the minimum detection limit in place of the non-detect samples. This is an accepted conservative technique for calculating annual values when some of the samples were less than the laboratory’s ability to measure.

**Table 5.1 24-Hr Maximum and Annual Mean Concentrations for Hexavalent and Total Chromium – 2007 and 2008**

Grand Junction – Powell Site	CAS Number	Maximum $\text{ng}/\text{m}^3$	Mean $\text{ng}/\text{m}^3$	Cr <sup>6+</sup> 59 Samples Taken – 2005 Cr <sup>6+</sup> 60 Samples Taken - 2006		Minimum Detection Level $\text{ng}/\text{m}^3$
				Number Above Detection	Percentage Above Detection	
Hexavalent Chromium - 2008	1854-02-99	0.6850	0.0208	40	65.6	0.0065
Total Chromium - 2008	7440-43-3	15.74	8.75	49	94.2	1.97
Hexavalent Chromium - 2007	1854-02-99	0.0928	0.0155	43	72.9	0.0074
Total Chromium - 2007	7440-43-3	35.90	16.83	49	100.0	4.02

#### Percentage of Samples For Which Compound Was Detected

Hexavalent chromium was at detectable levels for sixty-five percent of the time. Total chromium (measured from the  $\text{PM}_{10}$  filters) was almost always present.

#### Graphs – Hexavalent Chromium

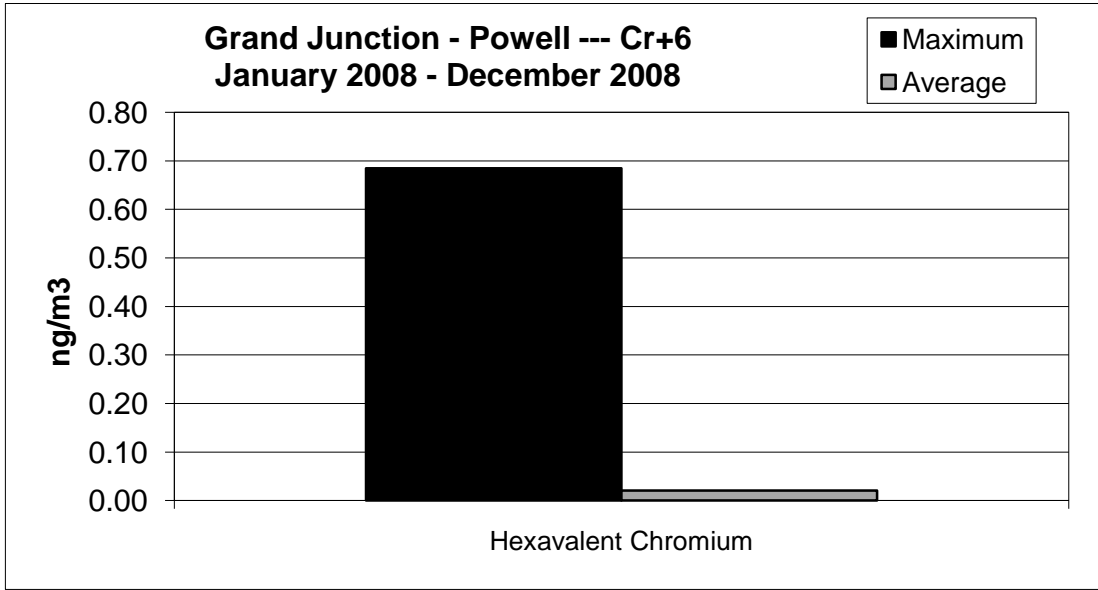
Figure 5.1 shows annual maximum and mean hexavalent chromium concentrations for 2008. Figure 5.2 shows hexavalent chromium concentrations during the calendar year. Most concentrations were less than  $0.060 \text{ ng}/\text{m}^3$  for the year. The maximum concentration, which appears to be an outlier, occurred on July 5, 2008. This sample was collected from midnight July 4 to midnight July 5. As hexavalent chromium is used in fireworks<sup>1</sup>, this is believed to be due to emissions from holiday celebrations.

#### Precision of Sample Results – Hexavalent Chromium

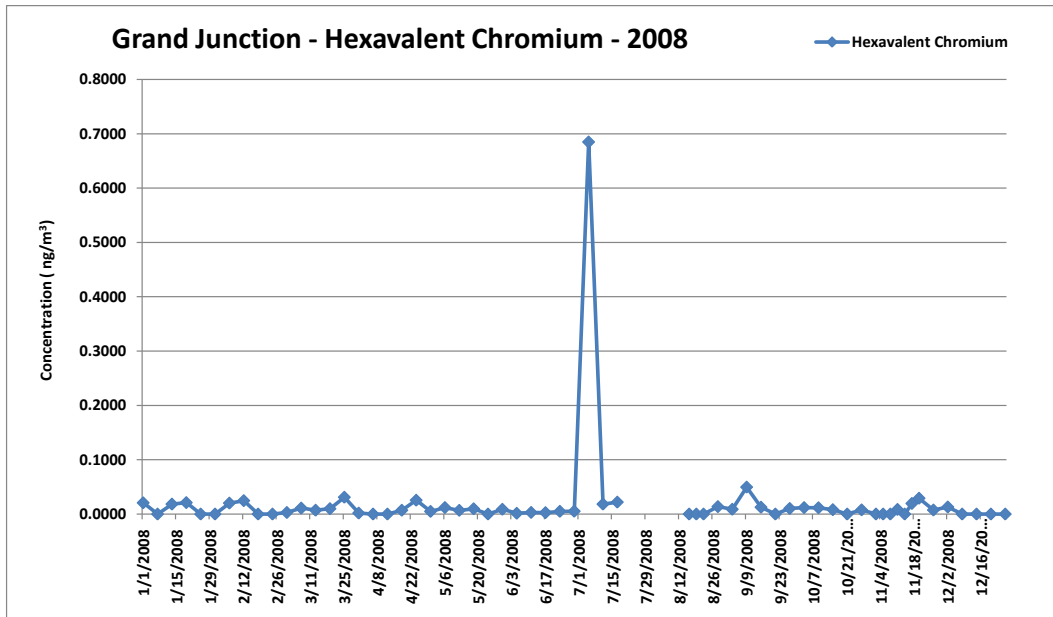
Six times during the year, a laboratory split sample was analyzed. In general, most duplicate samples showed good agreement.

1. Tox Town, National Library of Medicine, Chromium fact sheet, found on the web at [http://toxstown.nlm.gov/text\\_version/chemicals.php?id=10](http://toxstown.nlm.gov/text_version/chemicals.php?id=10)

**Figure 5.1 Average and Maximum Hexavalent Chromium Concentration - 2008**



**Figure 5.2 Hexavalent Chromium Concentrations – 2008**



**Field Blanks – Hexavalent Chromium**

Once a month a filter was transported to the field, placed on a sampler, and immediately removed, without having any air passed through it. These “field blanks” were taken to assess whether contamination in the field or the sampling materials is significant. Out of 11 field blanks taken, none showed detectable levels of hexavalent chromium. Unlike the total chromium samples discussed in Section 4, hexavalent chromium samples are not potentially compromised by high blank levels. This is good, because the concentrations of hexavalent chromium are more relevant to risk assessment than the amount of total chromium is.



## Section 6: Carbon Monoxide at Grand Junction – Powell Site

### Summary Statistics – Carbon Monoxide

#### Maximum – All Samples

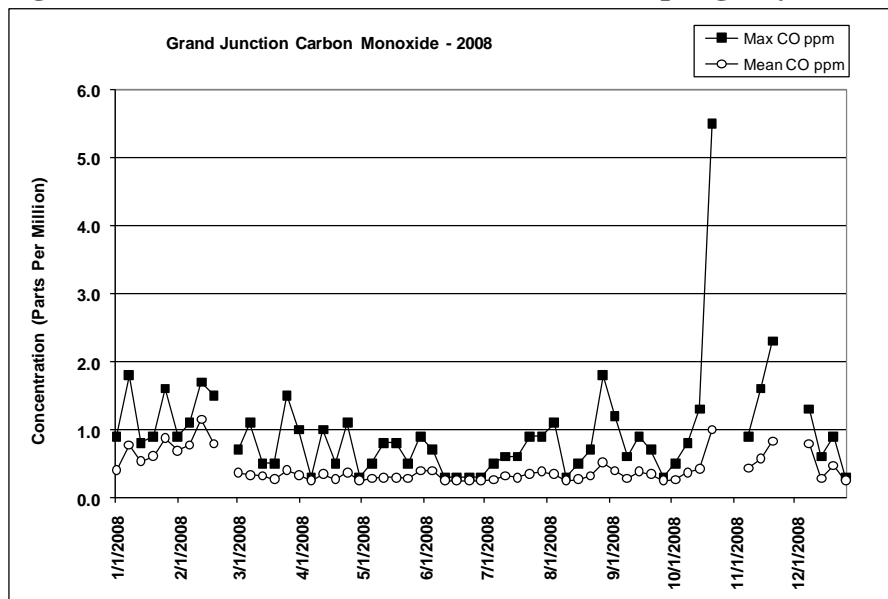
The Colorado Department of Public Health and Environment operates a carbon monoxide monitor at the Grand Junction – Powell station. This monitor was installed on January 29, 2004 as a part of the Colorado Department of Public Health & Environment’s statewide air quality measurement network. Results of the statewide carbon monoxide monitoring network are discussed in “Colorado: 2008 Air Quality Data Report” by the Air Pollution Control Division. The National Toxics Trends Study urges the collection of carbon monoxide data because of its value as a tracer of automotive emissions. Table 6.1 shows the most recent annual NAAQS statistics for this area. The one-hour maximum and second maximum were higher in 2008 than in 2007. This is due to unusually high values during a two-day period, October 30 and 31, 2008.

**Table 6.1 Carbon Monoxide Data Summary – 2007 and 2008**

Grand Junction – Powell Site	1 Hour Average (ppm)			8 Hour Average (ppm)		
	Federal Standard	Maximum	2 <sup>nd</sup> Maximum	Federal Standard	Maximum	2 <sup>nd</sup> Maximum
Carbon Monoxide - 2008	35	7.1	6.8	9	2.6	1.5
Carbon Monoxide - 2007	35	2.9	2.8	9	1.8	1.8

Figure 6.1 summarizes daily means and daily one-hour maximum carbon monoxide samples for the dates that air toxics sampling took place. (Air toxics were sampled once every-sixth-day). The national air toxics monitoring network hopes to use contemporaneous carbon monoxide data as an indication of motor vehicle activity. In the future, levels of air toxics compounds that are mobile source-related will be analyzed for increases or decreases over time. The carbon monoxide data should provide some indication of whether overall vehicular emissions are increasing or decreasing over time.

**Figure 6.1 Carbon Monoxide on Air Toxics Sampling Days - 2008**



## Section 7: Particulate Matter at Grand Junction – Powell Site

### Particulate Data At Grand Junction - Powell

The Colorado Department of Public Health and Environment operates samplers for particulate matter 10 microns or less in diameter (PM<sub>10</sub>) and particulate matter 2.5 microns or less in diameter (PM<sub>2.5</sub>) at the Grand Junction - Powell and Grand Junction - Pitkin stations. These samplers serve to indicate the status of Grand Junction regarding the National Ambient Air Quality Standards (NAAQS) for PM<sub>10</sub> and PM<sub>2.5</sub>. Results of the statewide particulate matter monitoring network are discussed in “Colorado: 2008 Air Quality Data Report” by the Air Pollution Control Division. The National Air Toxics Trends Study chose to monitor air toxics in Grand Junction because of the availability of PM<sub>2.5</sub> speciation data, which gives insight into air toxics in particulate matter. Table 7.1 shows the percentage PM<sub>10</sub> data recovery for the year. This table includes both the air toxics network low-volume, filter-based PM<sub>10</sub> sampler, and the Division’s continuous Beta Attenuation PM<sub>10</sub> monitor. The difference is that the low-volume sampler requires that filters be installed manually, and is run midnight-to-midnight every 3 days. The continuous method is always running, but the 24 hour midnight-to-midnight daily value is determined to assess compliance with the National Ambient Air Quality Standards.

Table 7.2 shows the most recent annual PM<sub>10</sub> NAAQS statistics for this area. 2008 was a bit higher than 2007, when comparing results within the individual methods. The continuous method, which ran all the time, caught higher maximum concentrations than the filter-based method, which ran only one-third of the time. Tables 7.3 and 7.4 give the same information for PM<sub>2.5</sub>. Note that the PM<sub>10</sub> data are at standard conditions, while the PM<sub>2.5</sub> data are at local conditions. This is because the national version of the PM<sub>10</sub> standard requires that “standard” conditions of temperature and pressure be used. This corrects for the fact that air temperatures and pressure is different at various altitudes, by adjusting the air volume to what it would be at sea level. The federal standard for PM<sub>2.5</sub> does not require this correction, so “local” conditions of temperature and pressure are used (no altitude correction is done). Even though one of the 2007 daily maximum PM<sub>10</sub> values on the continuous monitor was greater than 150 ug/m<sup>3</sup>, Grand Junction is in compliance with the national ambient air quality standards for particulate matter. This is because the PM<sub>10</sub> standard is based on exceedances over a three-year period. Therefore, an occasional exceedance does not violate the standard.

**Table 7.1 Percentage Data Recovery for PM<sub>10</sub> Samples – 2007 and 2008**

Station	Year	Samples Recovered	Samples Scheduled	Percentage Recovered
Grand Junction – Powell Site – Low Volume Sampler	2008	117 Days	123 Days	95.1
Grand Junction - Powell Site – Low Volume Sampler	2007	107 Days	123 Days	87.0
Grand Junction – Powell Site – Continuous Sampler	2008	8509 Hours	8784 Hours	96.9
Grand Junction - Powell Site – Continuous Sampler	2007	8553 Hours	8760 Hours	97.6

Not included is a continuous PM<sub>2.5</sub> monitor that began operation in 2008, but did not sample for the whole year.

**Table 7.2 Data Summary for PM<sub>10</sub> Samples – 2007 and 2008**

Grand Junction – Powell Site	Year	Annual Arithmetic Mean (µg/m <sup>3</sup> at Standard Conditions)		24 Hour Maximum (µg/m <sup>3</sup> at Standard Conditions)		
		Standard	Annual Mean	Standard	Maximum	2 <sup>nd</sup> Maximum
PM <sub>10</sub> Low Volume Sampler	2008	50	28.7	150	116	103
PM <sub>10</sub> Low Volume Sampler	2007	50	( 29.6 )	150	84.7	68.8
PM <sub>10</sub> Continuous Sampler	2008	50	35.4	150	149	110
PM <sub>10</sub> Continuous Sampler	2007	50	36.8	150	181	124

( ) Indicates less than 75% Data Recovery for Fourth Quarter 2007

**Table 7.3 Percentage Data Recovery for PM<sub>2.5</sub> Samples – 2007 and 2008**

Station	Year	Samples Recovered	Sample Days Scheduled	Percentage Recovered
Grand Junction - Powell Site	2008	118	124	95.2
Grand Junction - Powell Site	2007	116	126	92.1

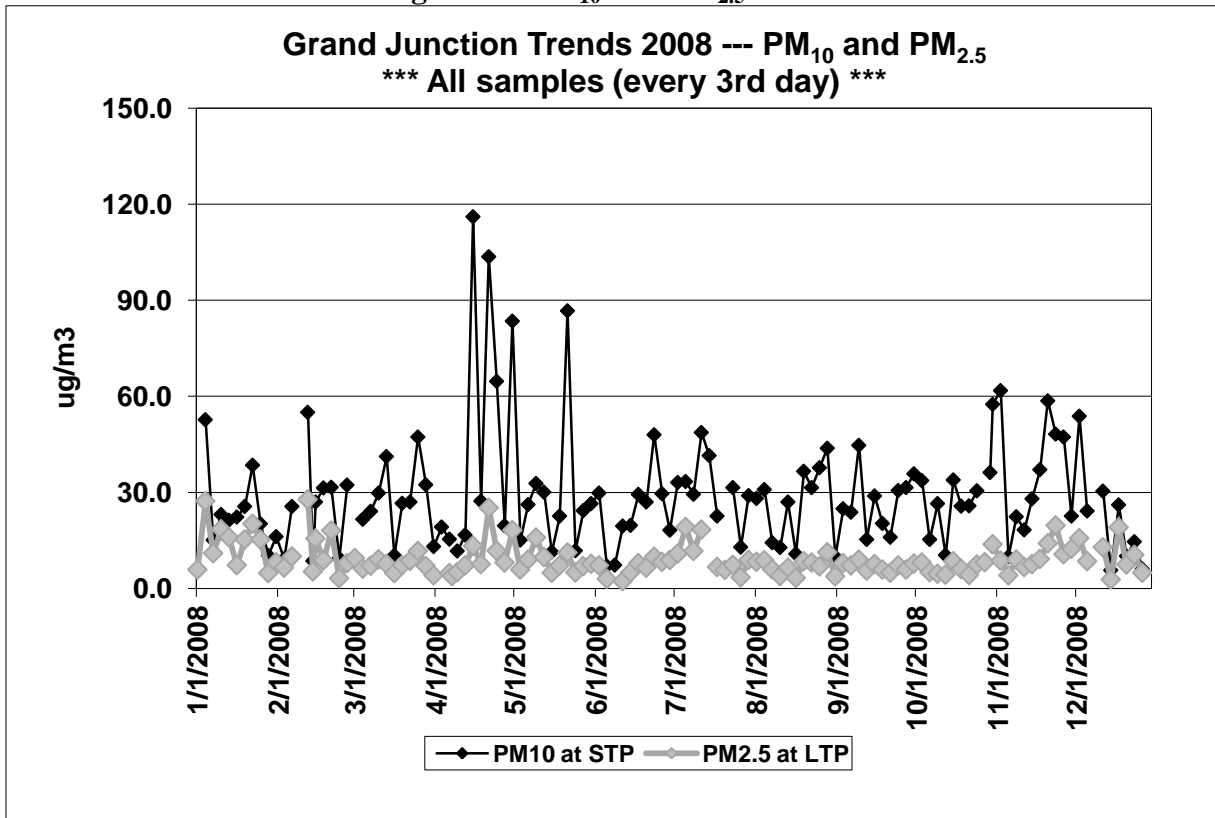
Data are not presented for the PM<sub>2.5</sub> continuous sampler. It started operating in July 2008, but had only 47 sample days for the year.

**Table 7.4 Data Summary for PM<sub>2.5</sub> Samples – 2007 and 2008**

Grand Junction – Powell Site	Year	Annual Arithmetic Mean (µg/m <sup>3</sup> at Local Conditions)		98 <sup>th</sup> Percentile (µg/m <sup>3</sup> at Local Conditions)	
		Standard	Annual Mean	Standard	98 <sup>th</sup> Percentile
PM <sub>2.5</sub>	2008	15	9.11	35	25.2
PM <sub>2.5</sub>	2007	15	9.49	35	25.7

Figure 7.1 is a graph of PM<sub>10</sub> from the filter sampler versus PM<sub>2.5</sub> values, for each day sampled. The two pollutants behaved differently, with PM<sub>10</sub> showing peaks and valleys, and PM<sub>2.5</sub> staying fairly constant. This difference in behavior is likely due to the underlying sources. PM<sub>10</sub> is dominated by surface disturbance of earth materials (street sand, windblown dust), while PM<sub>2.5</sub> particles are generated by combustion (automobile tailpipe emissions, coal burning, etc). The PM<sub>10</sub> levels are subject to change due to daily weather conditions, whereas the PM<sub>2.5</sub> combustion source is more constant.

Figure 7.1 PM<sub>10</sub> and PM<sub>2.5</sub> – 2008



## Section 8: PM<sub>2.5</sub> Speciation at Grand Junction – Powell Site

### Summary Statistics – PM<sub>2.5</sub> Speciation Data

A primary reason for locating the National Air Toxics Trend Station at Grand Junction was the availability of contemporaneous PM<sub>2.5</sub> sample speciation data, which gives insight into air toxics in particulate matter. These data are summarized below. A number of elements and ions are detected, at low levels, in the air. Given the low levels observed, the differences between 2008 and 2007 are not very significant.

**Table 8.1 Annual Maximum and Mean Concentrations for PM<sub>2.5</sub> Speciation**

<b>Metal/Compound</b>	<b>2008 Maximum ug/m<sup>3</sup></b>	<b>2008 Mean ug/m<sup>3</sup></b>	<b>2007 Maximum ug/m<sup>3</sup></b>	<b>2007 Mean ug/m<sup>3</sup></b>
Antimony	0.04320	0.00344	0.03500	0.00190
Aluminum	0.47800	0.08480	0.36600	0.08213
Arsenic	0.00269	0.00032	0.00268	0.00046
Barium	0.13300	0.00294	0.19600	0.00434
Bromine	0.00472	0.00202	0.00378	0.00156
Cadmium	0.01870	0.00089	0.00959	0.00050
Calcium	0.49300	0.10641	0.36600	0.10827
Cerium	0.00911	0.00016	0.05120	0.00118
Cesium	0.00630	0.00044	0.05600	0.00131
Chlorine	0.12900	0.01569	0.14700	0.01387
Chromium (Total)	0.01190	0.00077	0.01130	0.00086
Cobalt	0.00283	0.00068	0.00216	0.00017
Copper	0.05850	0.00306	0.01540	0.00299
Europium	NA	NA	0.01120	0.00025
Gallium	NA	NA	0.00327	0.00031
Gold	0.00432	0.00023	0.00245	0.00023
Hafnium	NA	NA	0.00490	0.00018
Indium	0.02800	0.00128	0.04080	0.00215
Iridium	NA	NA	0.00688	0.00040
Iron	0.41100	0.11673	0.34100	0.12586
Lanthanum	0.02180	0.00072	0.00222	0.00006
Lead	0.00688	0.00072	0.01720	0.00115
Magnesium	0.16200	0.01314	0.08710	0.00868
Manganese	0.00959	0.00213	0.00733	0.00220
Mercury *	0.00653	0.00082	0.00654	0.00040
Molybdenum	NA	NA	0.00339	0.00020
Nickel	0.00875	0.00044	0.00517	0.00070
Niobium	0.00175	0.00018	0.00245	0.00014
Phosphorus	0.00677	0.00012	0.00922	0.00016
Potassium	1.90000	0.10756	0.28200	0.07442
Rubidium	0.00362	0.00029	0.00215	0.00039
Samarium	0.00805	0.00033	0.00841	0.00062
Scandium	0.00280	0.00011	0.00829	0.00019
Selenium	0.00299	0.00036	0.00402	0.00044
Silicon	1.65000	0.27918	0.99800	0.25895
Silver	0.02220	0.00128	0.01170	0.00072

<b>Metal/Compound</b>	<b>2008 Maximum ug/m<sup>3</sup></b>	<b>2008 Mean ug/m<sup>3</sup></b>	<b>2007 Maximum ug/m<sup>3</sup></b>	<b>2007 Mean ug/m<sup>3</sup></b>
Sodium	0.09090	0.00973	0.11800	0.01601
Strontium	0.03080	0.00095	0.00236	0.00039
Sulfur	0.84400	0.24163	0.74100	0.23780
Tantalum	0.00595	0.00022	0.00689	0.00028
Terbium	0.00198	0.00010	0.00643	0.00033
Tin	0.03610	0.00327	0.03850	0.00406
Titanium	0.03160	0.00459	0.06170	0.01012
Tungsten	0.00736	0.00032	0.00909	0.00075
Vanadium	0.01260	0.00073	0.01710	0.00233
Yttrium	0.00198	0.00010	0.00210	0.00016
Zinc	0.04280	0.00940	0.06010	0.01053
Zirconium	0.00700	0.00035	0.00350	0.00031
Organic Carbon	8.56000	4.45557	10.80000	4.33724
Ammonium	4.25000	0.49240	2.96000	0.45840
Elemental Carbon	3.15000	0.82175	4.11000	0.97595
Nitrate	10.10000	0.97642	7.90000	0.91510
Potassium Ion	1.84000	0.07273	0.17700	0.04283
Sodium Ion	0.49600	0.06497	0.17400	0.04950
Sulfate	2.39000	0.74249	1.76000	0.75172

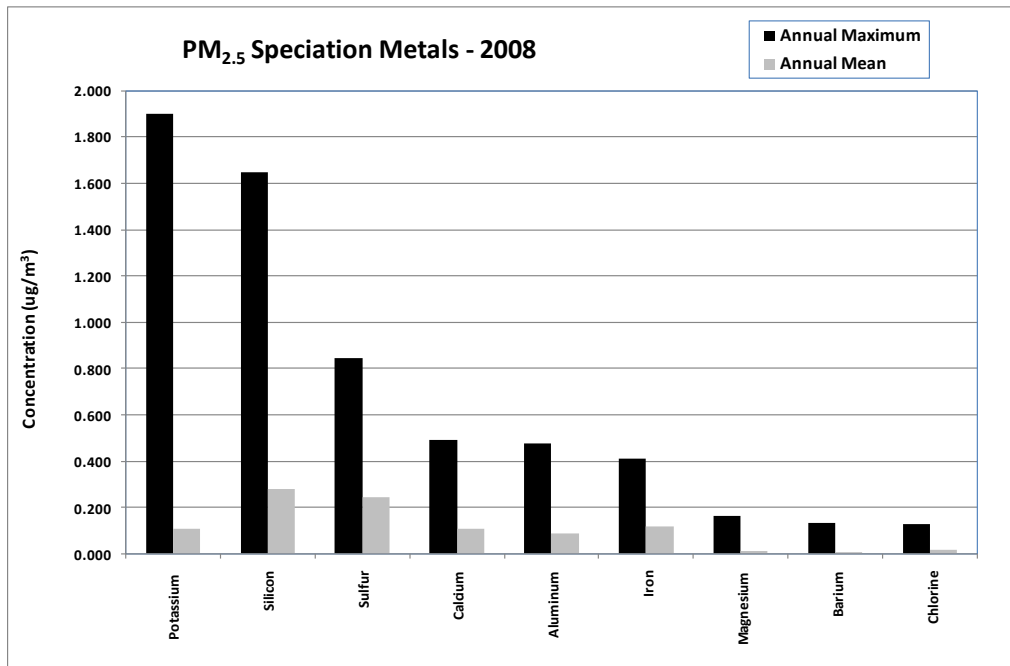
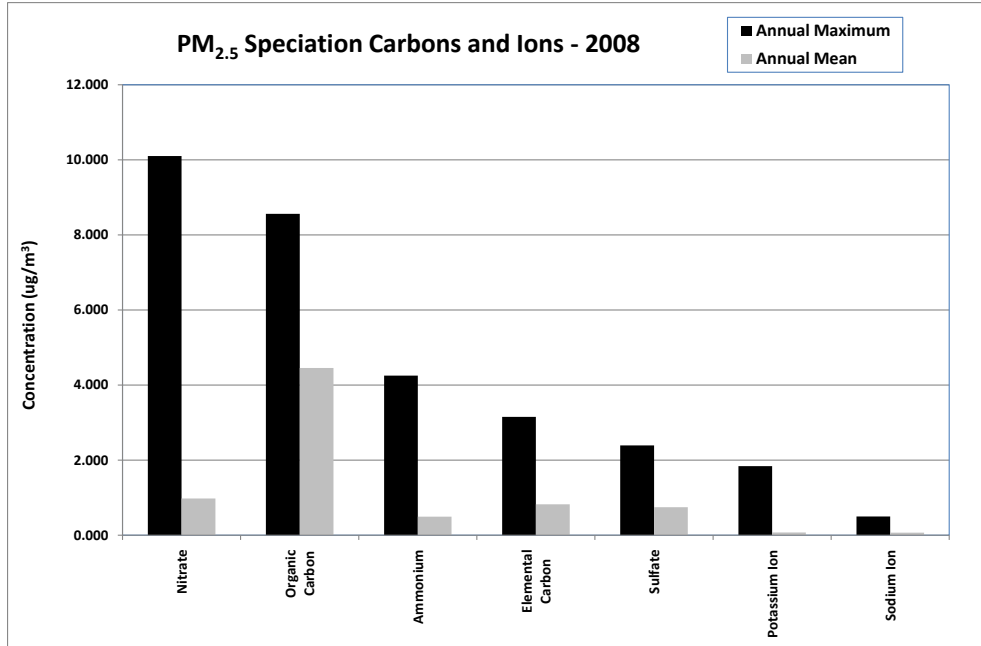
\* Mercury is highly volatile. Therefore, the use of filter sampling methods likely underestimates ambient concentrations.  
NA – Not Analyzed.

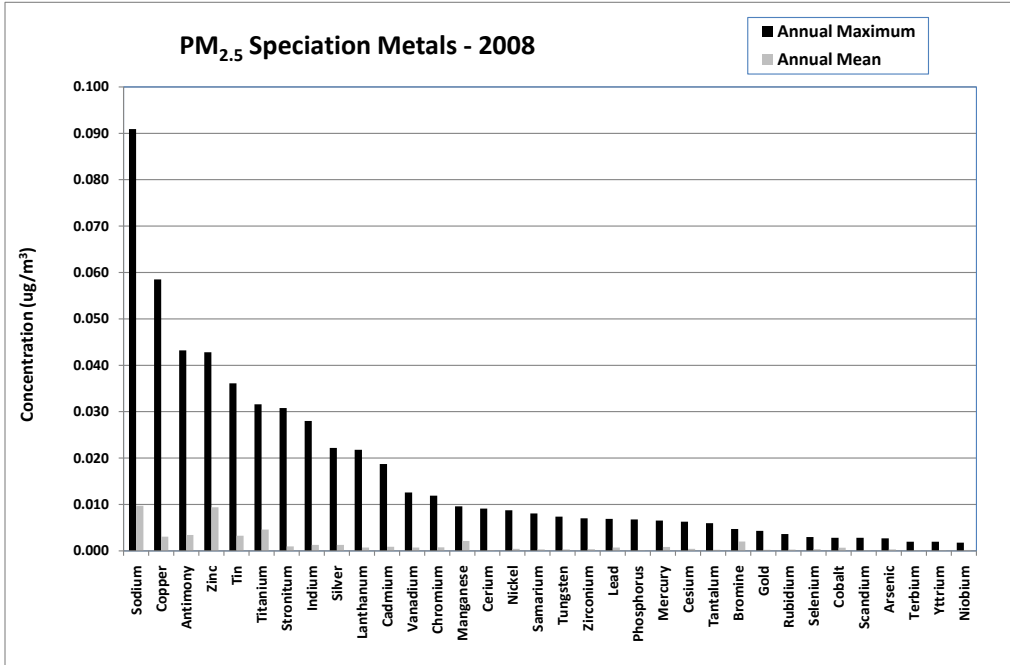
## Graphs – PM<sub>2.5</sub> Speciation Data

Graphs of mean and maximum concentration for various elemental species indicate that those with the highest concentrations were aluminum, barium, calcium, chlorine, iron, magnesium, potassium, silicon, and sulfur. These elements are all present in the earth's crust, which suggests that geological material is an important component of PM<sub>2.5</sub> at this location. The crustal material could be from wind-blown dust, street sand, or electric power plant fly ash. Wind-blown dust and street sand are usually in the PM<sub>10</sub> particulate matter size fraction, but fly ash occurs in the PM<sub>2.5</sub> size fraction.

Carbon is present in soot from burning. Nitrate and sulfate form as the gases nitrogen dioxide and sulfur dioxide condense. These components, along with ammonium, play an important role in visibility degradation (visible haze). Ammonium nitrate and ammonium sulfate particulate matter absorbs light, so the view appears hazy when these are in the air.

**Figure 8.1 Maximum and Annual Mean PM<sub>2.5</sub> Speciation – 2008**







## Section 9: Polycyclic Aromatic Hydrocarbon Compounds at Grand Junction – Powell Site

### Summary Statistics – Polycyclic Aromatic Hydrocarbon Compounds

#### Maximum and Mean – All Samples

In April 2008, the Grand Junction National Air Toxics Trends Site added a sampler for polycyclic aromatic hydrocarbon (PAH) compounds. A good definition of these chemicals is:

*Polycyclic aromatic hydrocarbons (also known as polynuclear aromatic hydrocarbons) are composed of two or more aromatic (benzene) rings which are fused together when a pair of carbon atoms is shared between them ..... The resulting structure is a molecule where all carbon and hydrogen atoms lie in one plane. Naphthalene (C<sub>10</sub>H<sub>8</sub>; MW = 128.16 g), formed from two benzene rings fused together, has the lowest molecular weight of all PAHs. The environmentally significant PAHs are those molecules which contain two (e.g., naphthalene) to seven benzene rings (e.g., coronene with a chemical formula C<sub>24</sub>H<sub>12</sub>; MW = 300.36 g). In this range, there is a large number of PAHs which differ in number of aromatic rings, position at which aromatic rings are fused to one another, and number, chemistry, and position of substituents on the basic ring system. (Source: Ambient Water Quality Criteria For Polycyclic Aromatic Hydrocarbons (PAHs) Ministry of Environment, Lands and Parks, Province of British Columbia. By N. K. Nagpal, Ph.D., Water Quality Branch, Water Management Division. British Columbia, Canada, Ministry of Environment. February, 1993).*

Twenty-two compounds were measured for this study. The list of these compounds and the summary of the collected data are shown in Table 9.1 and Table 9.2. Sampling of polycyclic aromatic hydrocarbon compounds in the Grand Junction study began in April 2008, and continued on an every-sixth-day basis for the rest of the year, for a total of 45 samples attempted. All samples were valid, so the site exceeded the EPA goal for over 85 percent sample recovery during the sampling period. Of course, the first quarter of the year (winter) is not represented in these samples.

Table 9.2 summarizes the annual maximum and mean concentrations for each polycyclic aromatic hydrocarbon compound measured during the study. The annual means were calculated by replacing all “non-detect” values with one-half of the sample minimum detection limit. This is an accepted conservative technique for calculating annual values when some of the samples were less than the laboratory’s ability to detect. The most prevalent PAH compounds in the ambient air in Grand Junction are naphthalene, phenanthrene and acenaphthene. The other nineteen polycyclic aromatic hydrocarbon compounds measured in this study occurred at concentration levels significantly below those of these top three PAHs.

#### Percentage of Samples For Which Compound Was Detected

Table 9.1 shows that most of these PAH compounds were present in air for the majority of the time. However, perylene and dibenz (a,h) anthracene were seen much less frequently. Sampling for these compounds began in April 2008, so there are no previous data for comparison.

**Table 9.1 Polycyclic Aromatic Hydrocarbon Compounds Sample Summary - 2008**

Grand Junction – Powell Site	CAS Number	45 Samples	
		Number of Samples Above Detection	Percentage of Samples Detected
9-Fluorenone	486-25-9	35	77.8
Acenaphthene	83-32-9	45	100.0
Acenaphthylene	208-96-8	36	80.0
Anthracene	120-12-7	31	82.2
Benzo (a) anthracene	56-55-3	39	86.7
Benzo (a) pyrene	50-32-8	26	57.8
Benzo (b) fluoranthene	205-99-2	44	97.8
Benzo (e) pyrene	192-97-2	38	84.4
Benzo (g,h,i) perylene	191-24-2	37	82.2
Benzo (k) fluoranthene	207-08-9	34	75.6
Chrysene	218-01-9	45	100.0
Coronene	197-07-1	31	68.9
Cyclopenta (c,d) pyrene	27208-37-3	9	20.0
Dibenz (a,h) anthracene	53-70-3	2	4.4
Fluoranthene	206-44-0	45	100.0
Fluorene	86-73-7	45	100.0
Indeno (1,2,3-c,d) pyrene	193-39-5	21	46.7
Naphthalene	91-20-3	45	100.0
Perylene	198-55-0	11	24.4
Phenanthrene	85-01-8	45	100.0
Pyrene	129-00-0	45	100.0
Retene	483-65-8	42	93.3

**Table 9.2 Polycyclic Aromatic Hydrocarbon Compounds Means and Maxima - 2008**

PAH Compound	2008 Maximum ng/m <sup>3</sup>	2008 Mean ng/m <sup>3</sup>
9-Fluorenone	5.88	1.53
Acenaphthene	62.20	8.41
Acenaphthylene	17.20	2.12
Anthracene	2.78	0.63
Benzo (a) anthracene	1.40	0.20
Benzo (a) pyrene	1.33	0.18
Benzo (b) fluoranthene	2.08	0.36
Benzo (e) pyrene	1.01	0.19
Benzo (g,h,i) perylene	1.62	0.26
Benzo (k) fluoranthene	0.59	0.10
Chrysene	1.89	0.35
Coronene	0.86	0.15
Cyclopenta (c,d) pyrene	1.29	0.16
Dibenz (a,h) anthracene	0.15	0.06
Fluoranthene	6.65	2.52
Fluorene	15.50	5.15
Indeno (1,2,3-c,d) pyrene	1.25	0.21
Naphthalene	499.00	111.88
Perylene	0.23	0.07
Phenanthrene	28.80	11.98
Pyrene	5.62	1.81
Retene	4.95	0.67

### Graphs – Polycyclic Aromatic Hydrocarbon Compounds

The polycyclic aromatic hydrocarbon compounds measured during the study are graphed in Figure 9.1. This figure shows that naphthalene, acenaphthene and phenanthrene were the PAH compounds at highest concentration. Figure 9.2 shows that only naphthalene had much variation in concentration over the year. It peaked in November and December 2008.

### Precision of Sample Results – Polycyclic Aromatic Hydrocarbon Compounds

Precision samples were not run in 2008. Assessing precision requires a collocated sampler at the site, and the National Air Toxics Trends Study chose to take precision samples at other locations in the nationwide network.

### Field and Filter Blanks – Polycyclic Aromatic Hydrocarbon Compounds

Periodically the laboratory analyzes a “blank”, or unused, filter for PAH compounds. The purpose of this extra analysis is to determine if there was any contamination of the filter during manufacturing or during laboratory processing. In 2008, the laboratory analyzed 9 “filter blanks”, filters which never left the laboratory. Naphthalene and phenanthrene were detected at low levels in every filter blank. Fluoranthene and pyrene were detected in half of the blank samples. Acenaphthene, anthracene, and chrysene each showed up in a single blank.

Figure 9.1 Maximum and Annual Polycyclic Aromatic Hydrocarbon Compounds – 2008

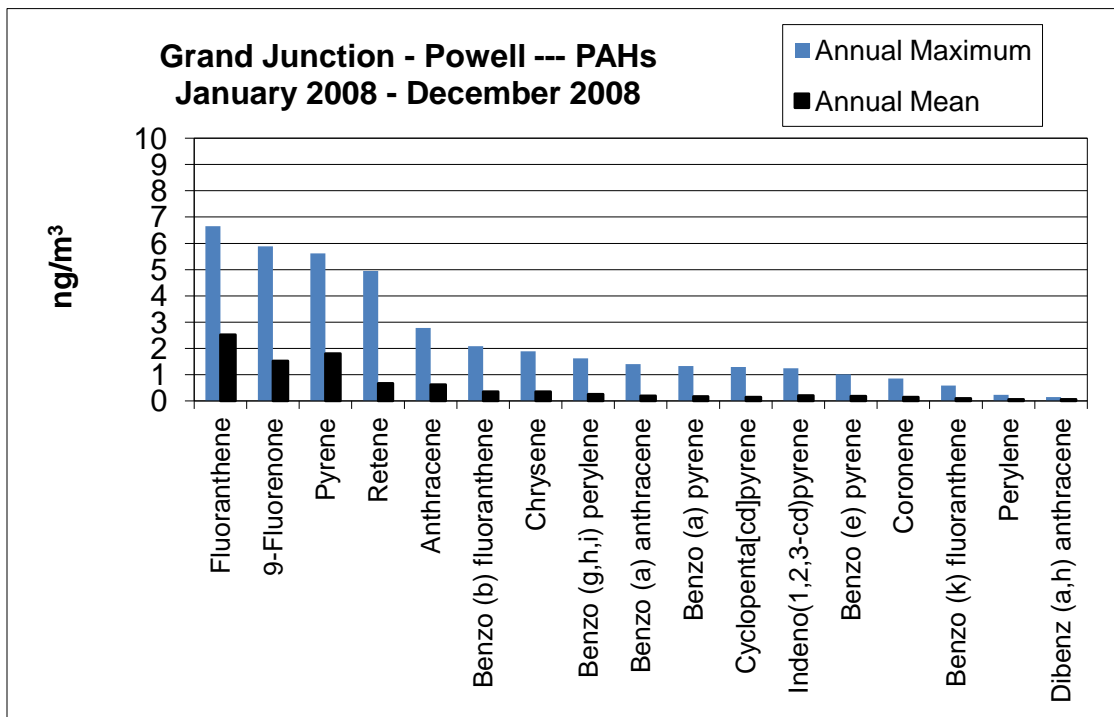
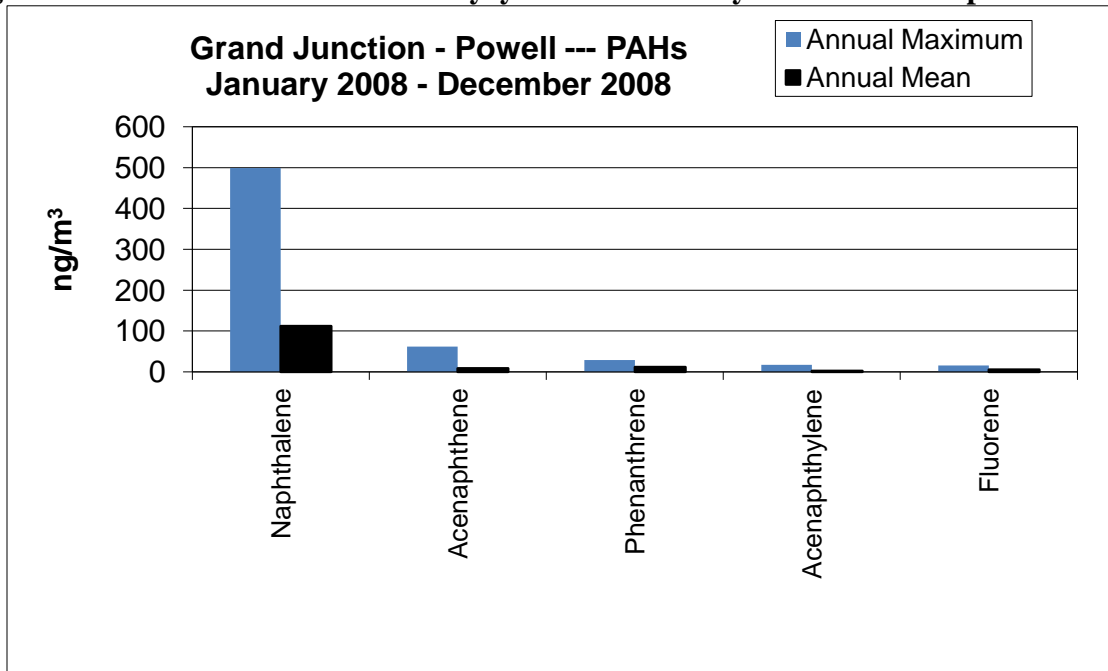
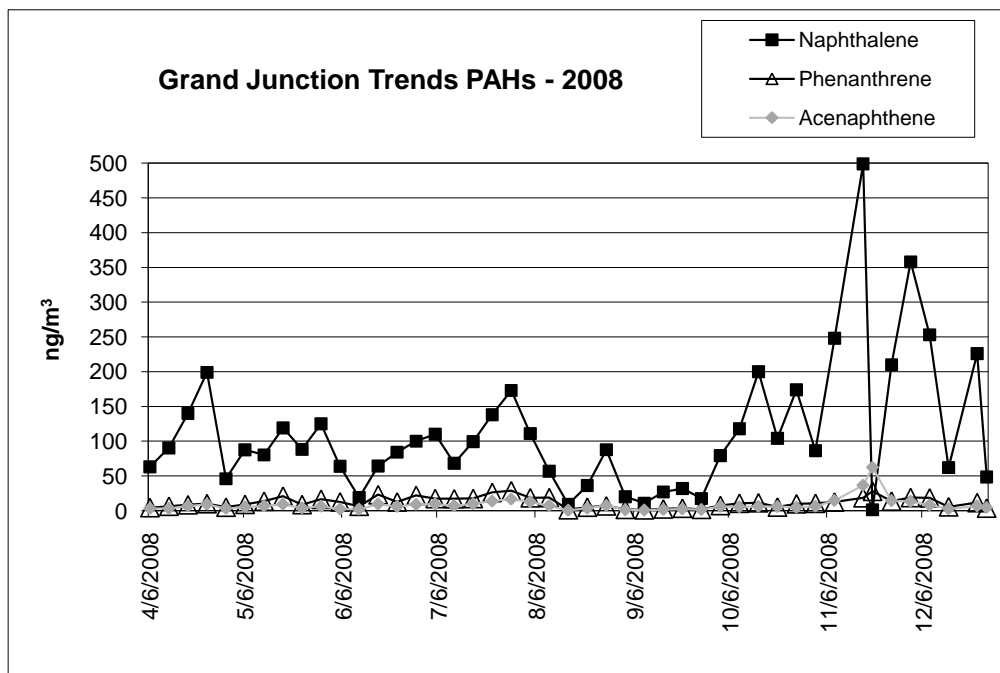


Figure 9.2 Trends of Main Polycyclic Aromatic Hydrocarbon Compounds – 2008



# Section 10: Meteorology

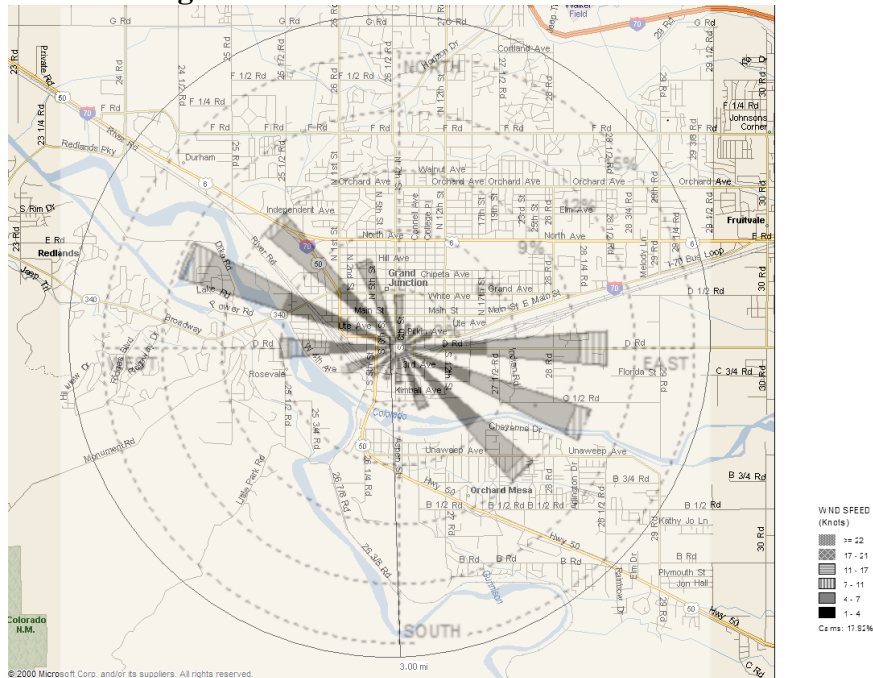
## Meteorological Parameters Monitored

A meteorological tower at the Powell shelter site measures wind speed, wind direction, relative humidity and temperature. The year 2008 wind rose is shown below. The “arms” of this diagram show the percentage of the time that the wind blew from each direction. The shading on each arm indicates the wind speeds associated with each direction. Each of the concentric rings, moving outward, signifies an additional three percent of the time. For example, just below 12% of the winds are from the west-northwest. Wind speeds in the ranges of 1-4 mph or 4-7 mph are the most frequent.

The wind rose shows that winds follow a daily pattern typical of river valleys. At night, the winds come from the southeast quarter, flowing down river. During the day, heating of the air causes flow reversals, and flow comes from the northwest.

A look at the highest concentration days for each pollutant indicated that some days showed maxima for more than one air pollutant. February 12, March 25, November 20, and December 2, 2008 were high for a number of pollutants. The fact that most of these dates are in the fall or winter period indicates that local temperature inversions, which limited air mixing, allowed pollutants of all types to build up in the area.

Figure 9-1 Grand Junction Wind Rose – 2008



## Section 11: Summary and Conclusions

The National Air Toxics Trends Study in Grand Junction for 2008 showed similar results to prior years. The highest carbonyls in air were formaldehyde, acetaldehyde, and acetone. Twenty-six volatile organic compounds are ubiquitous, having been detected in 90% of the air samples for 2007 and 2008. These are: acetonitrile, acetylene, acrolein, benzene, 1,3 – butadiene, bromomethane, carbon disulfide, carbon tetrachloride, chloromethane, dichloromethane, dichlorodifluoromethane, dichlorotetrafluoroethane, ethylbenzene, methyl ethyl ketone, n-octane, propylene, styrene, tetrachloroethylene, toluene, 1,1,1-trichloroethane, trichlorofluoromethane, trichlorotrifluoroethane, 1,2,4-trimethylbenzene, 1,3,5 – trimethylbenzene, m,p-xylenes, and o-xylene. For the metals, chromium, lead, and manganese showed the highest concentrations. Hexavalent chromium is an extremely small fraction of the chromium in air. The highest polycyclic aromatic hydrocarbons in air were naphthalene, acenaphthene, and phenanthrene.

The study will continue in 2009. One of the major goals of this study is to run the site for six years, and then compare the mean concentrations for each pollutant during the first three years to the means for the next three years. The Environmental Protection Agency is conducting this study at a number of locations around the country. The purpose is to assess whether air pollution control strategies aimed at reducing air toxics have succeeded. These interim results, when compared to levels measured during the 2001 Pilot study, suggest that levels are decreasing.



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**Colorado Department  
of Public Health  
and Environment**



