

National Air Toxics Trends Study In Grand Junction, Colorado

January through December 2004



January 2006

Prepared by the

**Colorado Department of Public Health & Environment
Air Pollution Control Division
Technical Services Program**

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Executive Summary

Executive Summary

This report discusses results for ambient air toxics monitoring conducted at Grand Junction, Colorado, during the year 2004. Twenty-four hour long samples were collected on a once every six day basis for a year as part of the U.S. Environmental Protection Agency's (EPA) National Air Toxics Trends Study (NATTS). The Grand Junction monitoring locations for air toxics were in close proximity, at 650 South Avenue and 645 ¼ Pitkin Avenue. These sites are on the south end of the city, in a commercial /industrial area. Carbonyl and volatile organic compound (VOC) samples were taken with equipment provided by Eastern Research Group (ERG). The ERG samplers collected two different types of samples. A dinitrophenylhydrazine (DNPH) cartridge collected carbonyl samples by EPA Method TO-11A. DNPH cartridges were analyzed for twelve different carbonyls. Air was also drawn into a stainless steel canister. The canisters were analyzed for 58 VOC's by EPA method TO-15. In addition, high volume samplers collected particulate matter ten microns or less in diameter (PM₁₀) that were analyzed for eight different metals. PM₁₀ levels were also determined from these filters. Additionally, the State of Colorado, Air Pollution Control Division, operated a carbon monoxide monitor and meteorological sensors at the air toxics monitoring shelter. Thus, the total number of chemical compounds assessed was 79. Of the 79 chemicals assessed, 39 were detected less than 10 percent of the time.

Six carbonyls were present in all samples. These were formaldehyde, acetaldehyde, acetone, crotonaldehyde, butyr/isobutyraldehydes, and benzaldehyde. Tolueraldehydes and hexaldehyde were present over 96% of the time. Automobiles are believed to be the largest emission source for formaldehyde, crotonaldehyde, and acetaldehyde, either as direct emissions, or as compounds forming from photochemical reactions. The impacts from aldehydes are difficult to control because they can form as hydrocarbons emitted from automobiles and industrial processes react in the presence of sunlight. Analysis of results from the EPA national Urban Air Toxics Network indicates that formaldehyde, acetaldehyde, and acetone are problems on a nationwide scale. Thus, the situation in Grand Junction is typical of most American cities.

The most-frequently detected volatile organic compounds measured at Grand Junction – Powell are 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, acetylene, benzene, chloromethane, dichlorodifluoromethane, ethylbenzene, m,p-xylene, methyl ethyl ketone, o-xylene, propylene, styrene, toluene, and trichlorofluoromethane. Those with the highest annual means are acetylene, benzene, dichlorodifluoromethane, m,p-xylene, methyl ethyl ketone, styrene, toluene, and trichlorofluoromethane. Some compounds that were detected less frequently, and in lower amounts, may still present health risks. Results from EPA's national network indicate that 1,3-butadiene, benzene, tetrachloroethylene and carbon tetrachloride, which were detected in Grand Junction, are a problem on a nationwide scale. 1-3 butadiene and benzene are believed to result from automobile emissions, while carbon tetrachloride and tetrachloroethylene are industrially-emitted compounds. 1,2,4-Trimethylbenzene and 1,3,5-trimethylbenzene, which have contributed to cancer risk in other places, were measured in Grand Junction. Tetrachloroethylene, or perchloroethylene, was detected over forty percent of the time. This compound is used in dry cleaning. These results are consistent with EPA's national analyses, which indicate that levels of tetrachloroethylene are of concern in urban areas throughout the United States.

Of the metals, lead and manganese were detected over 96% of the time. Chromium was present in 48% of the samples. Nickel, antimony, and arsenic were at measurable levels, but less than 20 % of the time. Cadmium was detected in less than 2% of the samples, and beryllium was never seen at all. Lead and manganese were the metals detected at the highest concentrations. However, lead levels were well below the standards of 1.5 µg/m³, as a monthly (Colorado standard) or a quarterly (Federal standard) average. Manganese levels are believed to be related to smelting operations, coal-fired power plants, gasoline additives or naturally-occurring background levels in soils.

It should be noted that actual concentrations of chemicals in the air change over time. Therefore, this study is best viewed as a "snapshot" in time, indicating which chemicals should potentially be the focus of state or federal interest or regulatory action. Results of the study indicate that the main chemicals of concern in Grand Junction are the same as the ones upon which EPA is focusing nationally. No risk assessment work was performed for this report. Risk assessment analyses will be performed when additional years of data are available to provide a more complete and statistically significant analysis.

Section 1: Introduction

Introduction

This report discusses results for ambient air toxics monitoring conducted by the Colorado Department of Public Health and Environment (CDPHE) at the long-term trends site at Grand Junction, Colorado, during the year 2004. This site was established as part of the “rural” area component of the EPA National Air Toxics Trends Study. This network will monitor air toxics over a six-year period. At the end of the six years, statistical analysis will be conducted to determine whether the U.S. Environmental Protection Agency’s (EPA’s) National Air Toxics Strategy is succeeding 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 for the last three years. In order to get a statistically meaningful result, the network samples air once every six days. Stations in the network are required to maintain data recovery rates of 85% or greater for all compounds sampled.

Carbonyl and volatile organic compound (VOC) samples were taken with equipment provided by Eastern Research Group (ERG), a consulting firm contracted by EPA to provide support to the national network. The ERG samplers collected two different types of samples. A dinitrophenylhydrazine (DNPH) cartridge collected carbonyl samples by EPA Method TO-11A. DNPH cartridges were analyzed for twelve different carbonyls. Air was also drawn into a stainless steel canister. The canister samples were analyzed for 58 VOC’s by EPA method TO-15. In addition, high volume samplers collected particulate matter ten microns or less in diameter (PM₁₀) that were analyzed for eight different metals. A carbon monoxide (CO) monitor also operated at this location. The measurement of CO, which is largely from automobile traffic, is part of criteria pollutant monitoring in Grand Junction, but also allows correlation between automotive-emitted air toxics and levels of motor vehicle activity. Thus, the total number of chemical compounds assessed at this station was 80.

The results section of this report is separated into chapters by the monitoring method employed. Thus, one chapter discusses the carbonyls, one presents VOC information, and the next one summarizes the metals analyzed by the ICP method. Sections 2-4 each follow the same format. They begin with a summary of statistics for the compounds analyzed, then discuss the percentage of samples in which each chemical was detected. Some summary graphs of certain compounds are presented. The section then presents a brief discussion of quality assurance statistics, such as blank and precision results, that are available upon request to CDPHE. Following these are brief chapter summarizing PM₁₀ and CO results. Concentrations of these two substances are compared to their respective National Ambient Air Quality Standards (NAAQS). Attachment 1 discusses sources and health effects for compounds that have been of potential health significance on a national or local basis. This Attachment gives a brief summary of each chemical’s use, its air emission sources, and its concentrations in typical urban air.

Site Information

The National Air Toxics Trends Study at Grand Junction, Colorado sampled at two separate locations. These are in close proximity to one another. However, the PM₁₀ 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. Site 08-077-0017 is the Powell Building at 650 South Avenue. Site 08-077-0018 is the air quality sampling shelter, at 645 ¼ Pitkin Avenue. This site also includes the Colorado Air Pollution Control Division carbon monoxide analyzer and meteorological tower for the city of Grand Junction. As Grand Junction is located in a broad river valley, meteorological conditions should be similar across the city. Documentation regarding these sites, including maps, photographs, and aerial views, is available in Attachment 2. 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

February through December 2004

Summary Statistics - Carbonyls

Maximum and Mean – All Samples

Carbonyl data collected at the Grand Junction - Powell station from February through December 2004 are presented in this section. Carbonyls were sampled on a one-in-six day basis for eleven months, for a total of 58 samples attempted. Two samples were not valid. However, the site met the EPA goal for over 85 percent sample recovery. (See Table 2.1).

Table 2.2 summarizes the annual maximum and mean concentrations for each carbonyl compound 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. Thus, when a compound was not detected, the maximum and mean values will be the same positive value. Results show that the most prevalent carbonyls in Grand Junction air are formaldehyde, acetone, and acetaldehyde, in that order. The other nine carbonyl compounds measured occur at concentration levels significantly below those of these top three compounds.

Table 2.1 Percentage Data Recovery for Carbonyl Samples

Station	Sample Days Scheduled	Samples Recovered	Percentage Recovered
Grand Junction – Powell Site	58	56	97

It should be noted that the annual means reported in Table 2.2 were calculated by substituting one-half of the detection level for the “non-detect” days. This calculation method should not significantly affect the annual means for substances that were at measurable levels most of the time. All of the carbonyls, except for propionaldehyde, isovaleraldehyde, valeraldehyde, and 2,5-dimethylbenzaldehyde, were present at least 90 percent of the time. However, the true annual means of isovaleraldehyde and 2,5-dimethylbenzaldehyde may be well below the numbers reported here.

Percentage of Samples For Which Compound Was Detected

Table 2.2 shows that most of these compounds were present in air over 90 percent of the time. However, isovaleraldehyde and 2,5-dimethylbenzaldehyde were seen less frequently, with detections in less than five percent of the air samples taken. This frequency of occurrence is similar to that noted in the 2000 – 2001 study of similar compounds in downtown Denver. During the 2001 – 2002 Pilot project study in Grand Junction, isovaleraldehyde was detected 29% of the time, and 2,5-dimethylbenzaldehyde was detected 34%.

Graphs - Carbonyls

The carbonyl compounds measured during the study are graphed in Figures 2.1 through 2.4. Figure 2.1 shows that acetaldehyde, acetone, and formaldehyde generally had the highest maxima. According to Figure 2.2, formaldehyde spiked in September 2004. Figures 2.3 and 2.4 show that acetaldehyde and crotonaldehyde also peaked on these same dates. Other than these peaks, the values did not show much seasonal variation. The common peak dates suggest that concentrations of these three compounds have a common source.

Table 2.2 Carbonyl Compounds Data Summary

Grand Junction – Powell Site	Summary Statistics (ug/m3)		Count of Non-Detects		Percentage of Samples in Which Compound Was Detected	Minimum Detection Level (ug/m3)
	Maximum	Mean	Number	Percentage		
Formaldehyde	40.436	2.810	0	0	100	0.032
Acetaldehyde	92.785	5.843	0	0	100	0.040
Acetone	91.218	7.741	0	0	100	0.031
Propionaldehyde	2.399	0.164	23	41	59	0.020
Crotonaldehyde	3.440	0.233	0	0	100	0.018
Butyraldehyde	3.244	0.308	0	0	100	0.023
Benzaldehyde	4.067	0.255	0	0	100	0.021
Isovaleraldehyde	0.150	0.012	54	96	4	0.021
Valeraldehyde	0.546	0.051	13	23	77	0.021
Tolualdehydes	0.894	0.124	2	4	96	0.035
Hexaldehyde	1.573	0.137	1	2	98	0.017
2,5-Dimethylbenzaldehyde	0.181	0.015	54	96	4	0.025

Field Blanks – Carbonyls

Field blanks were periodically taken by attaching a blank DNPH 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, or contamination that might occur in sample installation or shipping. Most cartridges had small amounts of formaldehyde, acetaldehyde, acetone, and butyraldehyde. Detailed information regarding field blank results is available upon request.

Precision of Sample Results – Carbonyls

Periodically throughout the year, a second carbonyl cartridge was sampled simultaneously with the main sample. These additional samples, known as duplicates, were collected in order to assess the precision (repeatability) of the carbonyl sampling method. On the duplicate sampling dates, the laboratory also conducted a test of the precision of the analytical process by injecting two samples of each cartridge's liquid extract into the liquid chromatograph/ mass spectrometer. These samples are known as the laboratory replicates. Thus, this project collected two types of precision data – duplicate data, which assesses both sampling and analysis procedures, and replicate data, which assesses laboratory analytical method repeatability. Detailed information regarding precision and laboratory replicate results is available upon request.

Figure 2.1 Average and Maximum Carbonyls

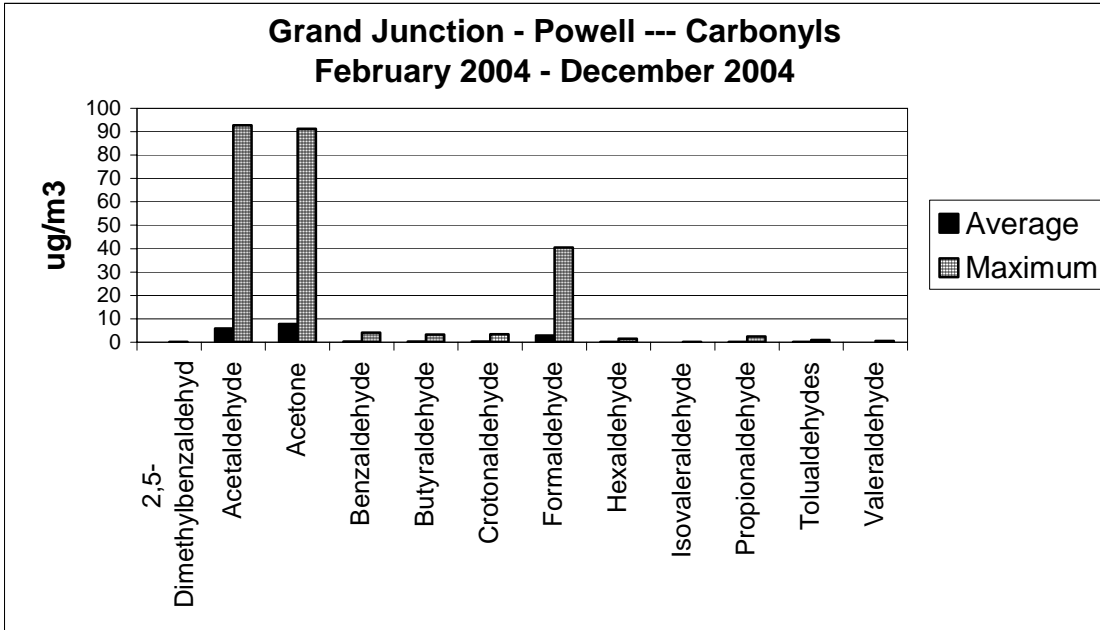


Figure 2.2 Formaldehyde

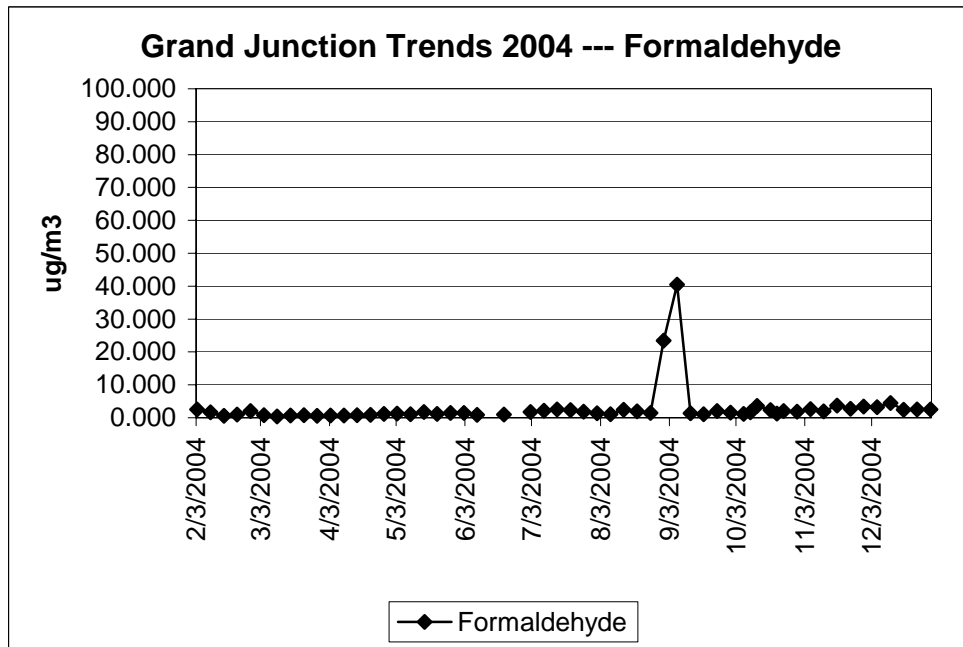


Figure 2.3 Acetaldehyde

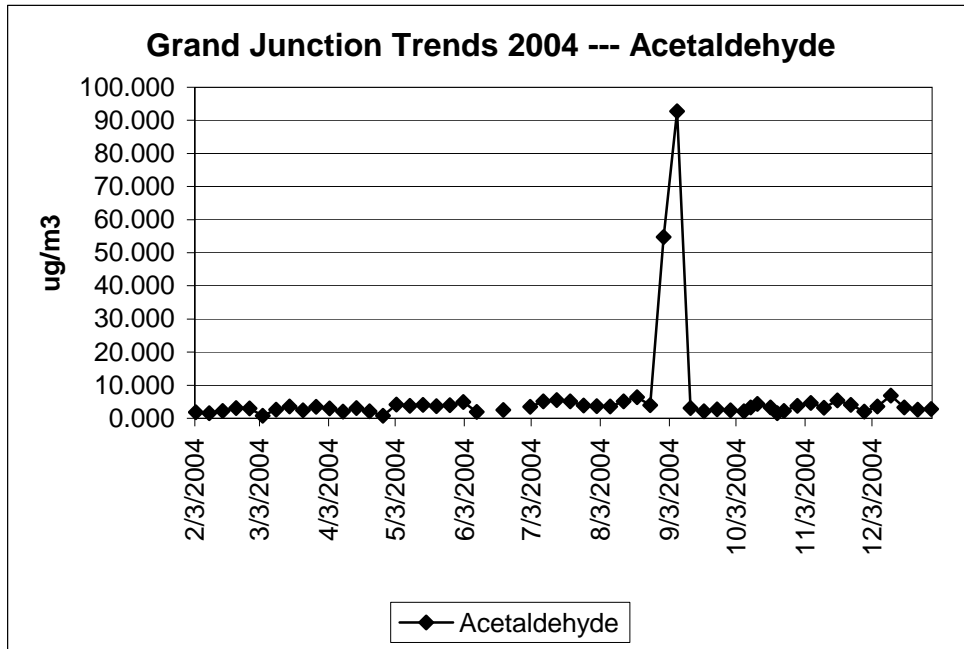
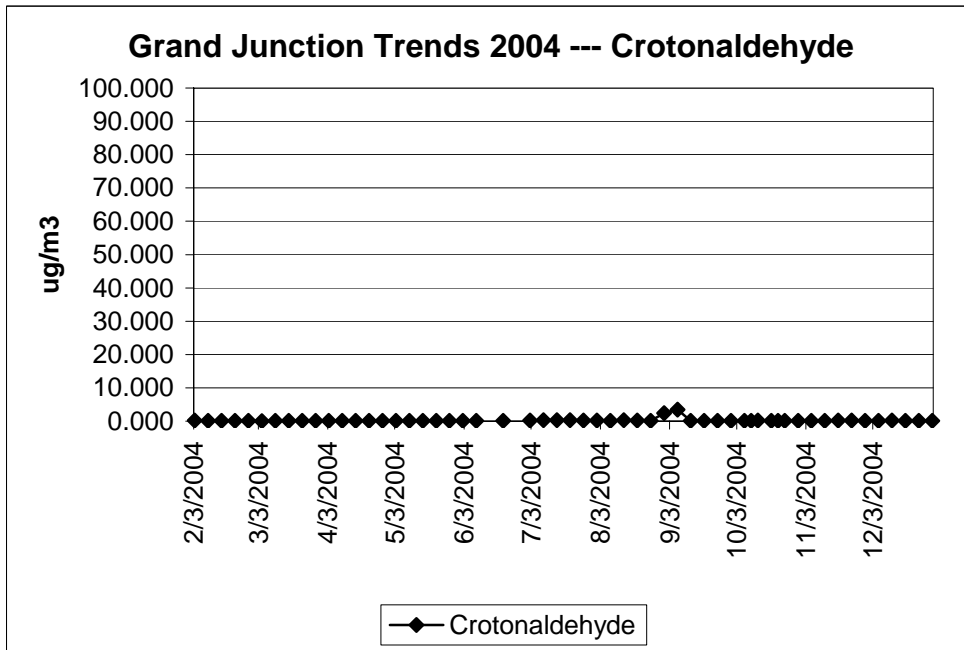


Figure 2.4 Crotonaldehyde



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

February through December 2004

Summary Statistics – Volatile Organic Compounds

Maximum and Mean – All Samples

Volatile organic compound (VOC) data collected at the Grand Junction - Powell station from February through December 2004 are presented in this section. Volatile organic compounds were sampled for eleven months on a one-in-six day basis, for a total of 58 samples attempted. Of these, three samples were missed in the field (not taken), for a percentage data recovery rate of 95% (Table 3.1).

Table 3.2 summarizes the annual maximum and mean concentrations for each of the 58 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. Thus, when a compound was not detected, the maximum and mean values will be the same positive value.

Acetonitrile data were invalidated, as the sampler had contamination issues with this compound. This was due to use of a common manifold for sampling carbonyls and VOCs. Evidently, acetonitrile used to prepare the DNPH cartridges can diffuse back through the manifold, and enter the canister sampling line. This problem, discovered at a remote site in Custer, South Dakota, as well as in Grand Junction and Denver, Colorado, led national contractor ERG to redesign their manifold system.

Table 3.1 Percentage Data Recovery for VOC Samples

Station	Sample Days Scheduled	Samples Recovered	Percentage Recovered
Grand Junction – Powell Site	58	55	94

Table 3.2 VOC Data Summary

Grand Junction – Powell Site	Summary Statistics (ug/m3)		Count of Non-Detects		Percentage of Samples in Which Compound Was Detected	Average Minimum Detection Level (ug/m3)
	Maximum	Mean	Number	Percentage		
1,1,1-Trichloroethane	0.14	0.14	55	100	0	0.27
1,1,2,2-Tetrachloroethane	0.17	0.17	55	100	0	0.34
1,1,2-Trichloroethane	0.22	0.22	55	100	0	0.44
1,1-Dichloroethane	0.10	0.10	55	100	0	0.20
1,1-Dichloroethene	0.10	0.10	55	100	0	0.20
1,2,4-Trichlorobenzene	0.67	0.67	55	100	0	1.34
1,2,4-Trimethylbenzene	1.21	1.21	2	4	96	0.29
1,2-Dibromoethane	0.19	0.19	55	100	0	0.38
1,2-Dichloroethane	0.12	0.12	55	100	0	0.24

Grand Junction – Powell Site	Summary Statistics (ug/m3)		Count of Non-Detects		Percentage of Samples in Which Compound Was Detected	Average Minimum Detection Level (ug/m3)
	Maximum	Mean	Number	Percentage		
1,2-Dichloropropane	0.16	0.16	55	100	0	0.32
1,3,5-Trimethylbenzene	1.23	0.41	3	5	95	0.20
1,3-Butadiene	1.11	0.21	16	29	71	0.13
Acetonitrile	VOID	VOID	VOID	VOID	VOID	0.22
Acetylene	10.39	2.26	1	2	98	0.05
Acrylonitrile	1.06	0.11	52	95	5	0.17
Benzene	8.50	2.25	0	0	100	0.16
Bromochloromethane	0.24	0.24	55	100	0	0.48
Bromodichloromethane	0.13	0.13	55	100	0	0.27
Bromoform	0.31	0.31	55	100	0	0.62
Bromomethane	0.50	0.11	53	96	4	0.19
Carbon Tetrachloride	0.88	0.51	9	16	84	0.38
Chlorobenzene	0.09	0.09	55	100	0	0.18
Chloroethane	0.37	0.14	54	98	2	0.26
Chloroform	0.29	0.10	54	98	2	0.20
Chloromethane	1.55	1.27	1	2	98	0.10
Chloromethylbenzene	0.13	0.13	55	100	0	0.26
Chloroprene	0.09	0.09	55	100	0	0.18
cis - 1,2-Dichloroethylene	0.12	0.12	55	100	0	0.24
cis - 1,3-Dichloropropene	0.11	0.11	55	100	0	0.23
Dibromochloromethane	0.30	0.30	55	100	0	0.60
Dichlorodifluoromethane	4.40	3.07	0	0	100	0.15
Dichloromethane	4.90	0.49	18	33	67	0.28
Dichlorotetrafluoroethane	0.28	0.11	54	98	2	0.21
Ethyl Acrylate	0.12	0.12	55	100	0	0.25
Ethyl tert-Butyl Ether	0.10	0.10	55	100	0	0.21
Ethylbenzene	3.43	1.20	0	0	100	0.17
Hexachloro 1,3-Butadiene	0.85	0.85	55	100	0	1.71
m,p- Xylene	9.51	3.73	0	0	100	0.22
m-Dichlorobenzene	0.21	0.21	55	100	0	0.42
Methyl Ethyl Ketone	40.41	2.58	5	9	91	0.44
Methyl Isobutyl Ketone	2.46	0.27	44	80	20	0.33
Methyl Methacrylate	11.59	1.29	25	45	55	0.45
Methyl tert-Butyl Ether	0.54	0.13	54	98	2	0.25
n-Octane	1.35	0.33	24	44	56	0.28
o-Dichlorobenzene	0.12	0.12	55	100	0	0.24
o-Xylene	3.78	1.55	0	0	100	0.17
p-Dichlorobenzene	0.18	0.18	55	100	0	0.36

Grand Junction – Powell Site	Summary Statistics (ug/m3)		Count of Non-Detects		Percentage of Samples in Which Compound Was Detected	Average Minimum Detection Level (ug/m3)
	Maximum	Mean	Number	Percentage		
Propylene	5.52	1.41	0	0	100	0.12
Styrene	19.98	2.19	2	4	96	0.17
tert-Amyl Methyl Ether	0.15	0.15	55	100	0	0.29
Tetrachloroethylene	1.09	0.31	32	58	42	0.34
Toluene	14.81	5.58	0	0	100	0.19
trans - 1,2-Dichloroethylene	0.10	0.10	55	100	0	0.20
trans - 1,3-Dichloropropene	0.45	0.12	54	98	2	0.23
Trichloroethylene	0.13	0.13	55	100	0	0.27
Trichlorofluoromethane	10.34	2.17	0	0	100	0.22
Trichlorotrifluoroethane	4.06	0.78	3	5	95	0.31
Vinyl Chloride	0.05	0.05	55	100	0	0.10

(Note: Acetonitrile VOID due to contamination in sampler).

Percentage of Samples For Which Compound Was Detected

Table 3.2 shows the percentage of the samples in which each VOC was detected. Fifteen of the compounds were detected in over 90 percent of the samples. These compounds are listed in Table 3.3. In contrast, 28 VOCs were never detected at all during the study. This is just less than half of the compounds that were sampled. Compounds never detected are listed in Table 3.4. It is interesting to note that vinyl chloride, which is considered to be very toxic, was not detected. Ethyl tert-butyl ether (ETBE) and tert-amyl methyl ether (TAME), which are added to automotive fuels to increase oxygen, were not detected. Methyl tert-butyl ether (MTBE), which is another fuel additive, was detected in a single sample. 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

Grand Junction – Powell Site	
1,2,4 - Trimethylbenzene 1,3,5 - Trimethylbenzene Acetylene Benzene Chloromethane Dichlorodifluoromethane Ethylbenzene m,p - xylene	Methyl Ethyl Ketone o - xylene Propylene Styrene Toluene Trichlorofluoromethane Trichlorotrifluoroethane

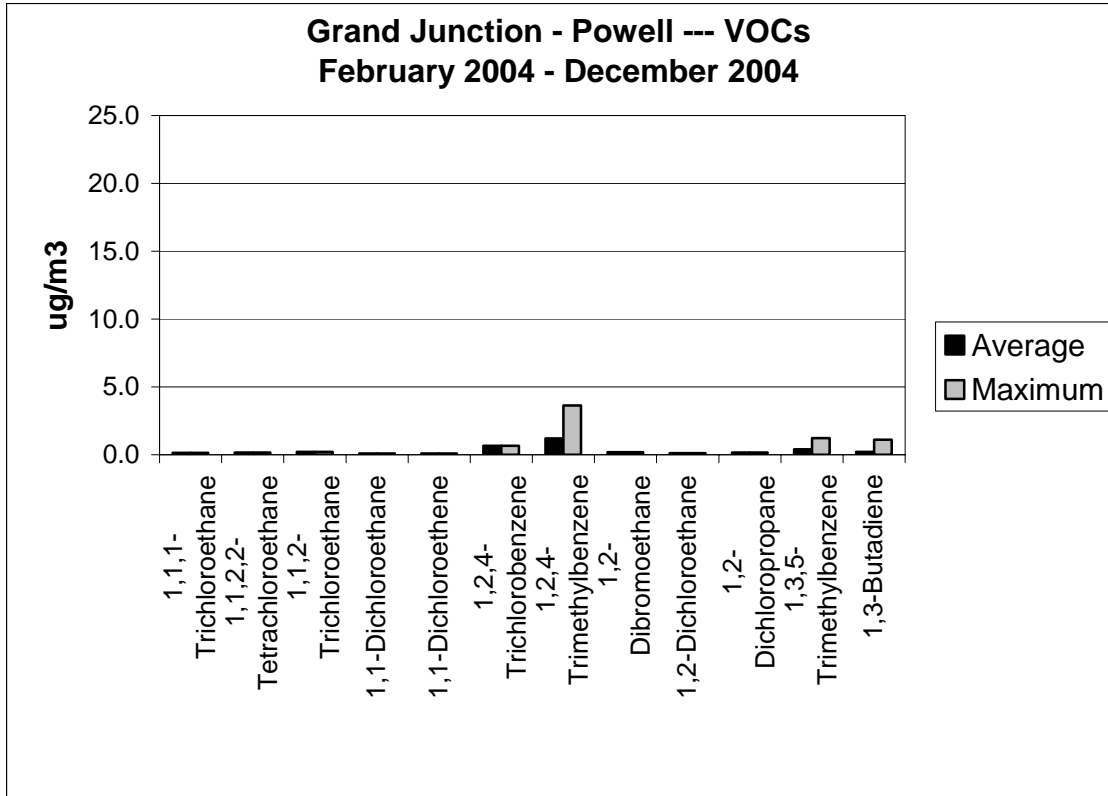
Table 3.4 Volatile Organic Compounds Never Detected in the VOC Air Samples

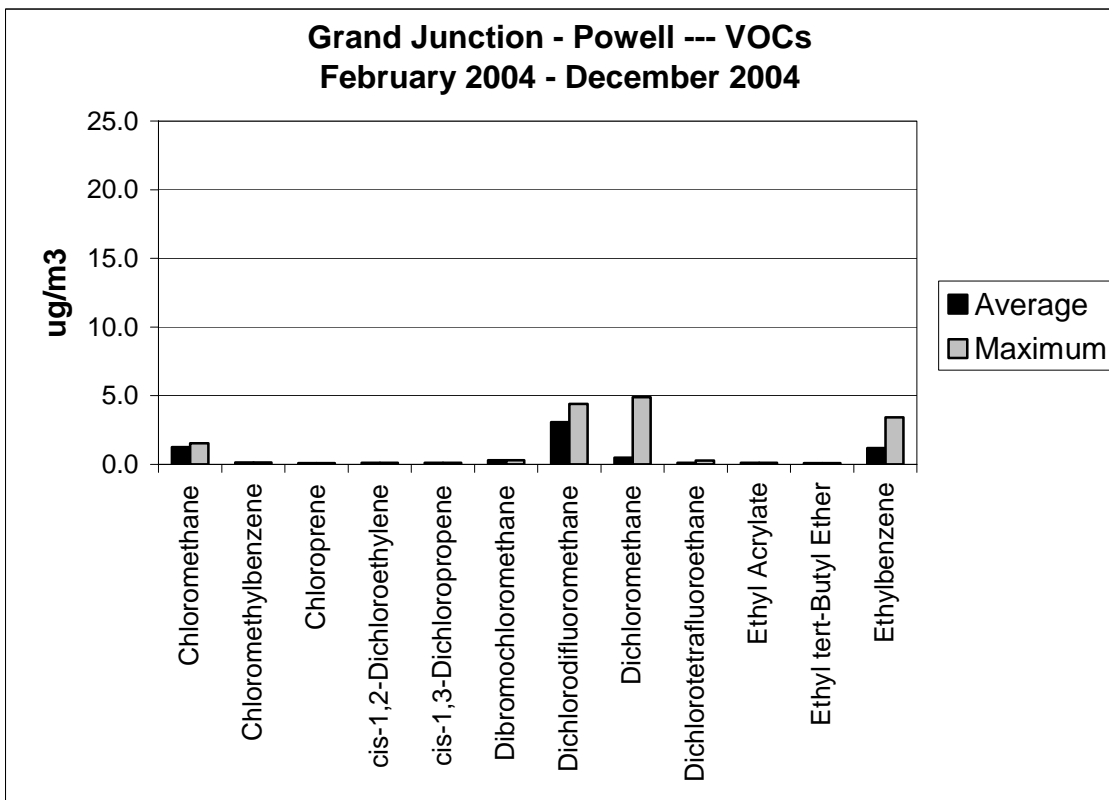
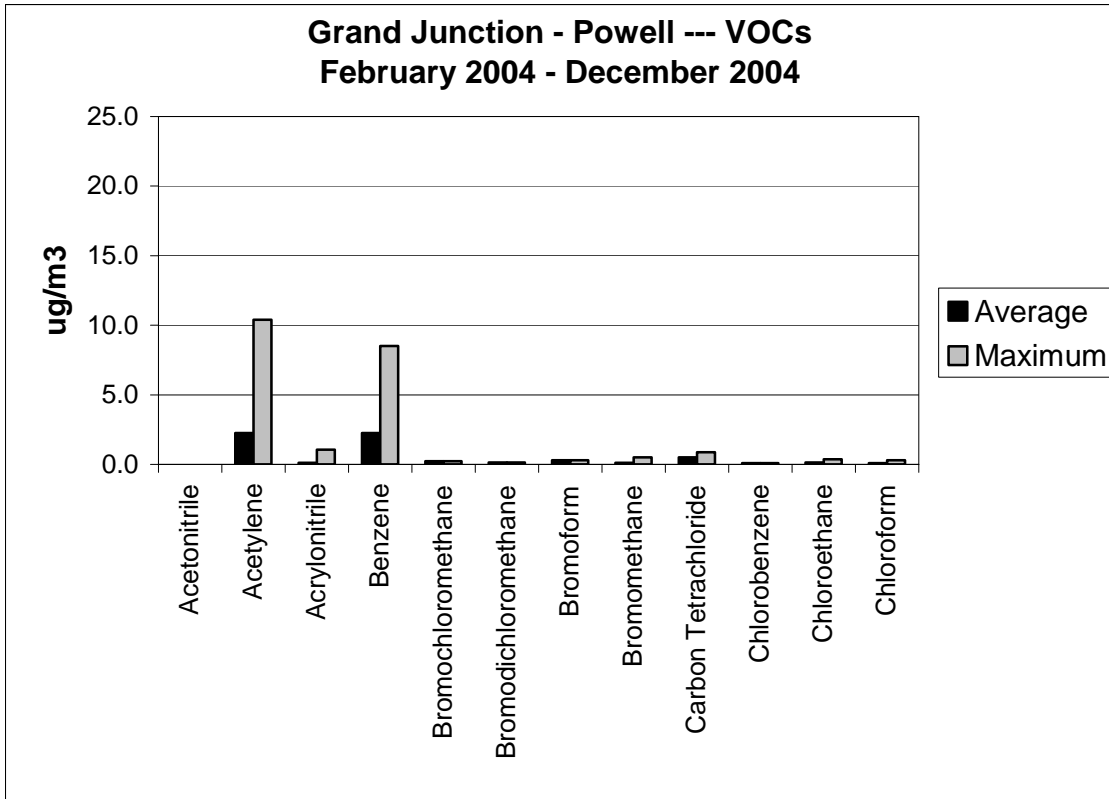
Volatile Organic Compounds Never Detected in the Air Samples		
1,1,1-Trichloroethane 1,1,2,2-Tetrachloroethane 1,1,2-Trichloroethane 1,1-Dichloroethane 1,1-Dichloroethene 1,2,4-Trichlorobenzene 1,2-Dibromoethane 1,2-Dichloroethane 1,2-Dichloropropane	Bromochloromethane Bromodichloromethane Bromoform Chlorobenzene Chloromethylbenzene Chloroprene cis – 1,2-Dichloroethylene cis – 1,3-Dichloropropene Dibromochloromethane Vinyl Chloride	Ethyl Acrylate Ethyl tert-Butyl Ether Hexachloro 1,3-Butadiene m-Dichlorobenzene o-Dichlorobenzene p-Dichlorobenzene tert-Amyl Methyl Ether trans – 1,2-Dichloroethylene Trichloroethylene

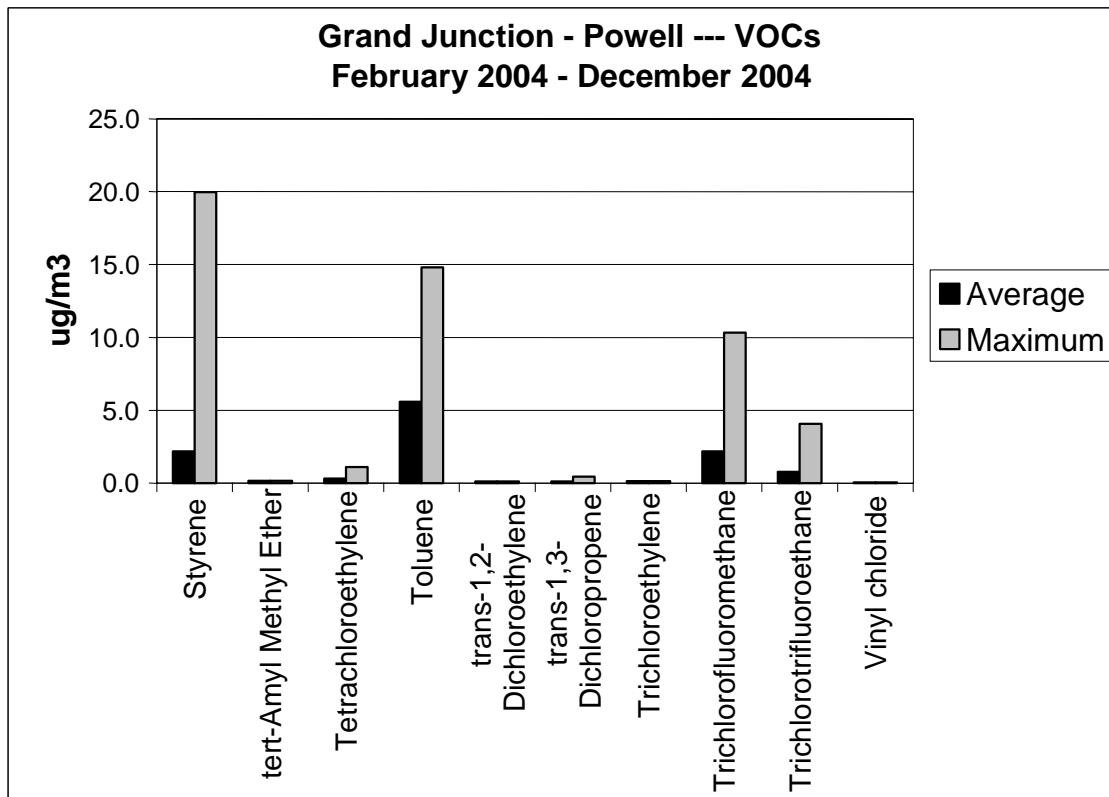
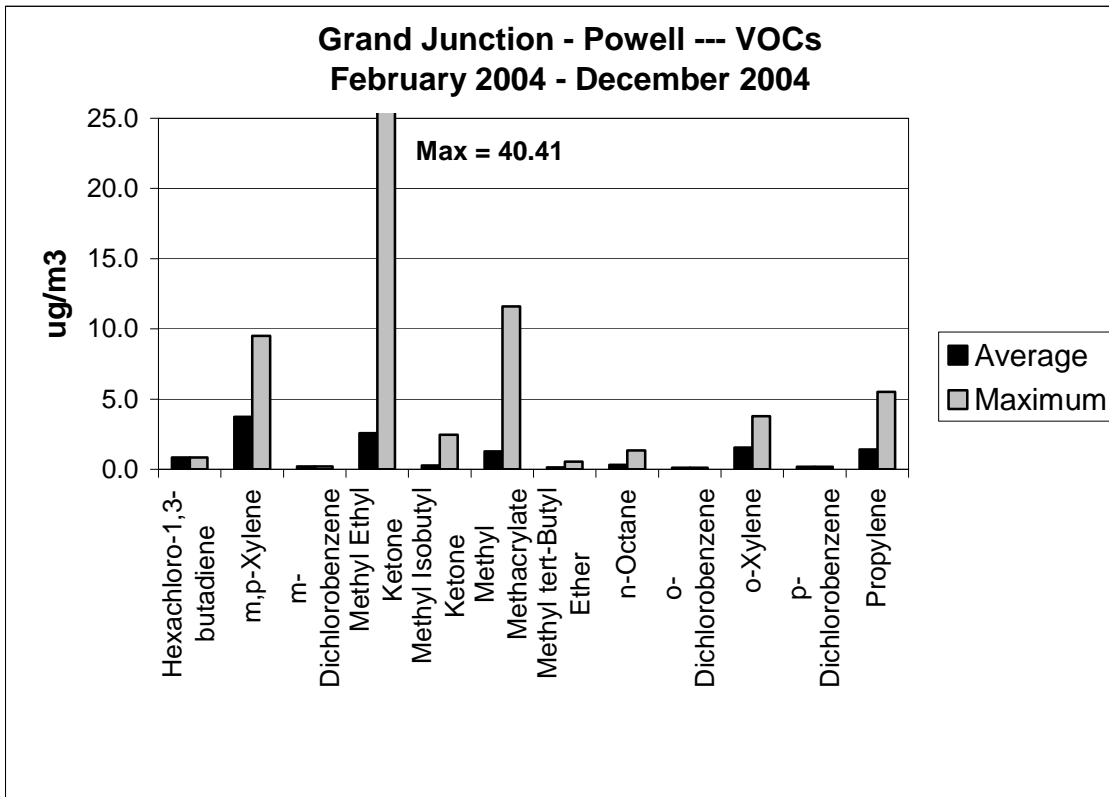
Graphs – Volatile Organic Compounds

The following graphs show average and maximum concentrations for each compound. All compounds had mean concentrations below 6 ug/m³. The compounds showing the highest maximum values were acetylene, benzene, m,p-xylene, methyl ethyl ketone, methyl methacrylate, propylene, styrene, toluene, and trichlorofluoromethane.

Figure 3.1 Average and Maximum VOCs







1,3-Butadiene (Figure 3.2) was always low, but peaked at the end of the year. Benzene (Figure 3.3) also peaked from mid-October through December. Carbon tetrachloride (Figure 3.4) was always less than 1 ug/m³. Tetrachloroethylene (Figure 3.5) was detected about one-quarter of the time. 1,3,5-trimethylbenzene (Figure 3.6) and 1,2,4-trimethylbenzene (Figure 3.7) tracked fairly well, but the 1,2,4 isomer was at higher levels.

Figure 3.2 1,3-Butadiene

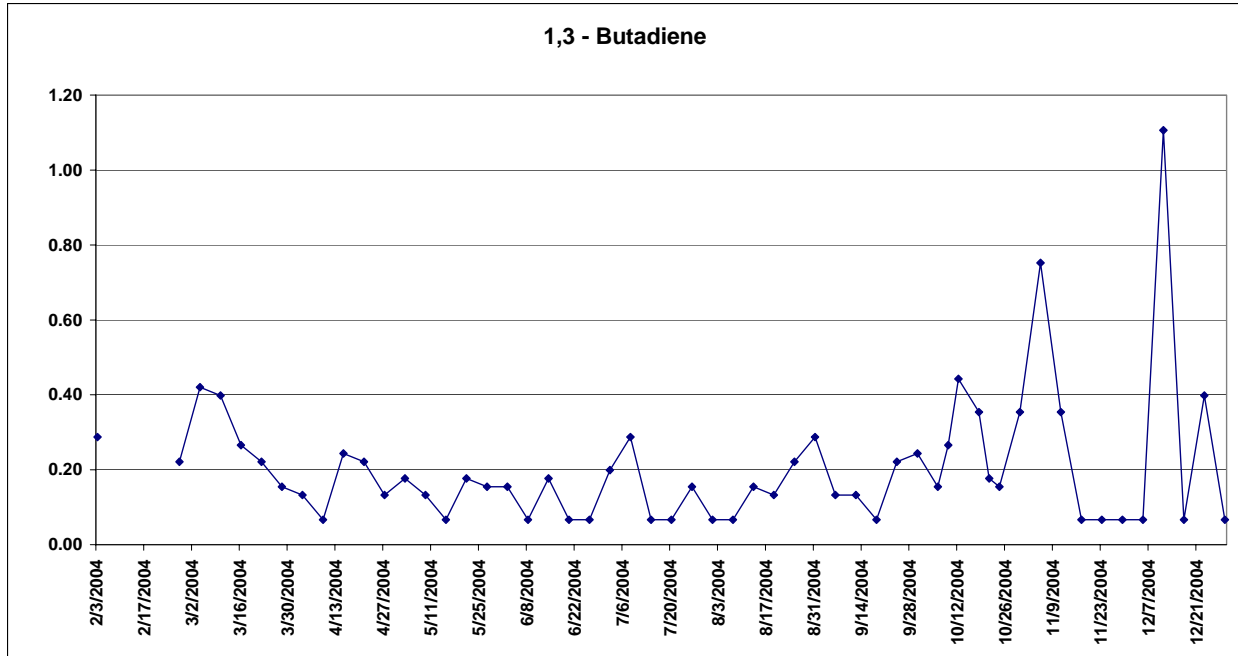


Figure 3.3 Benzene

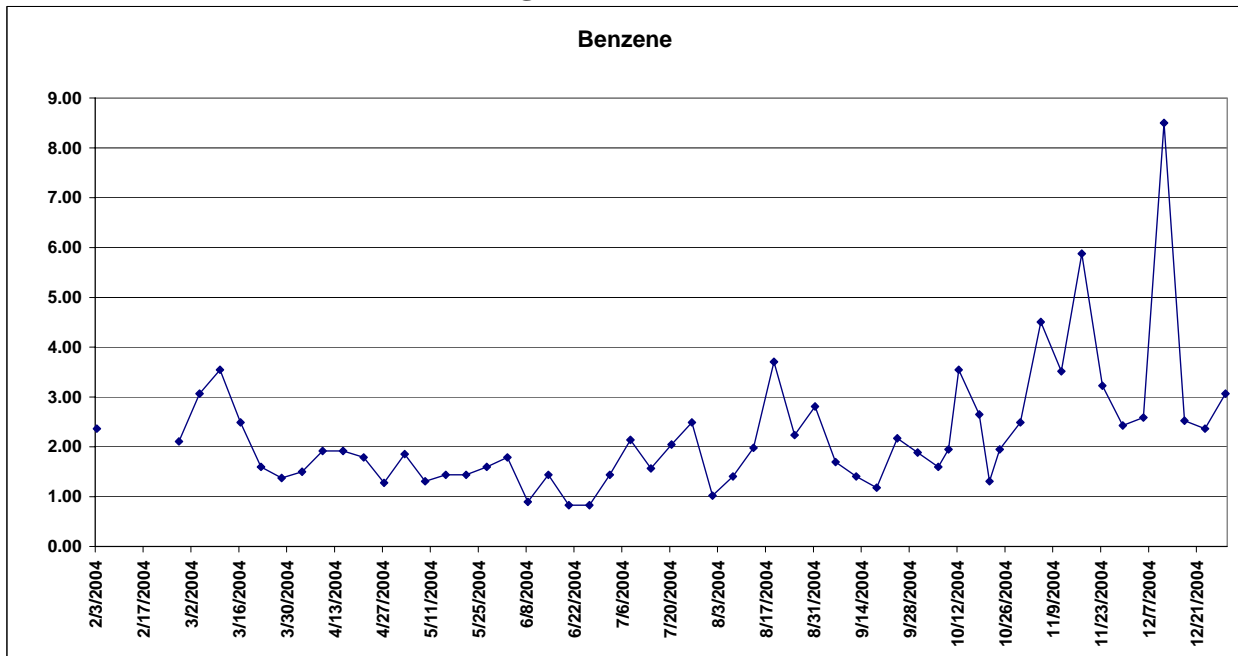


Figure 3.4 Carbon Tetrachloride

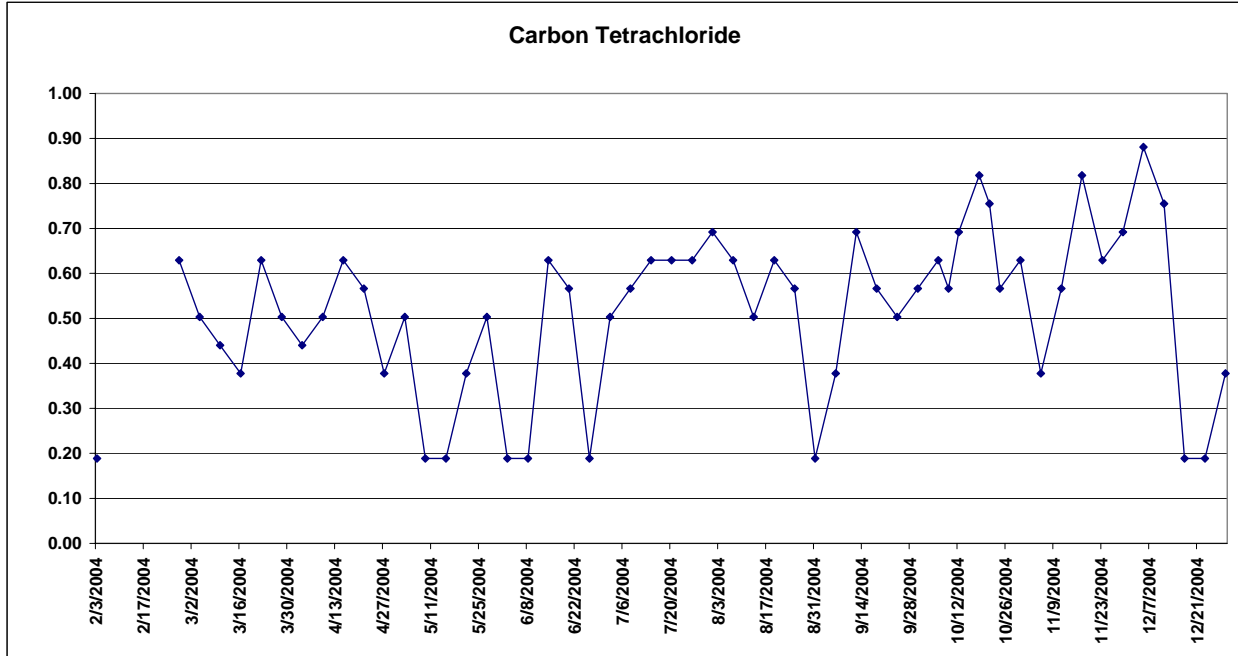


Figure 3.5 Tetrachloroethylene

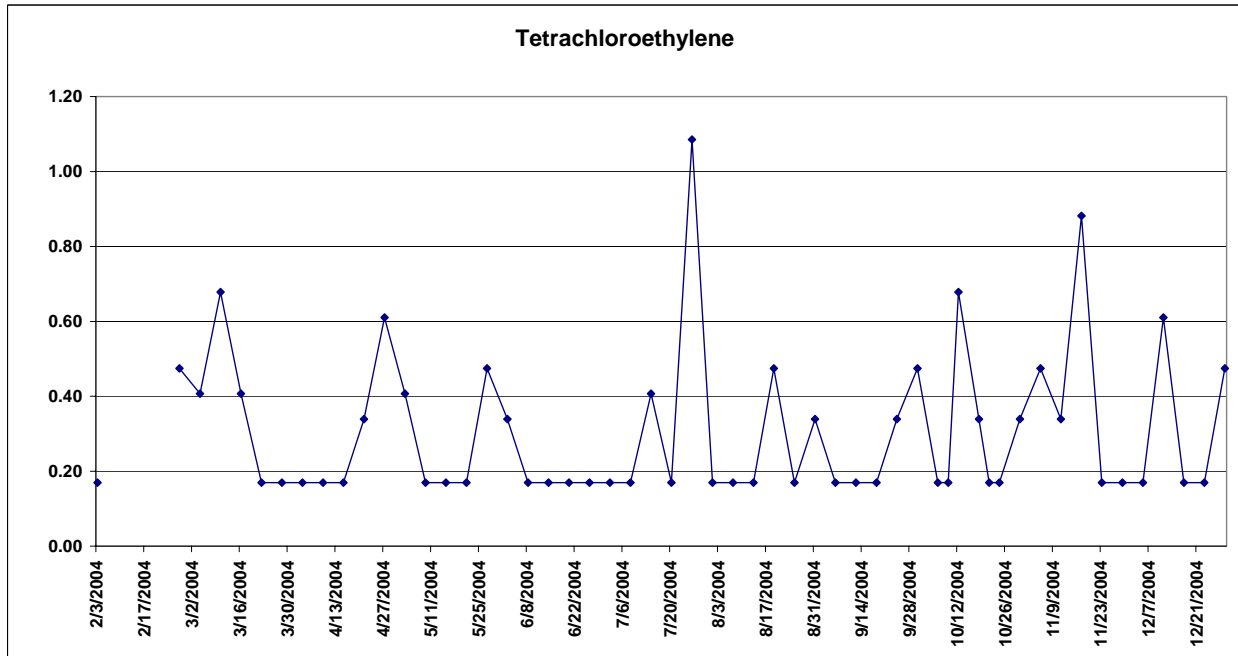


Figure 3.6 1,3,5-Trimethylbenzene

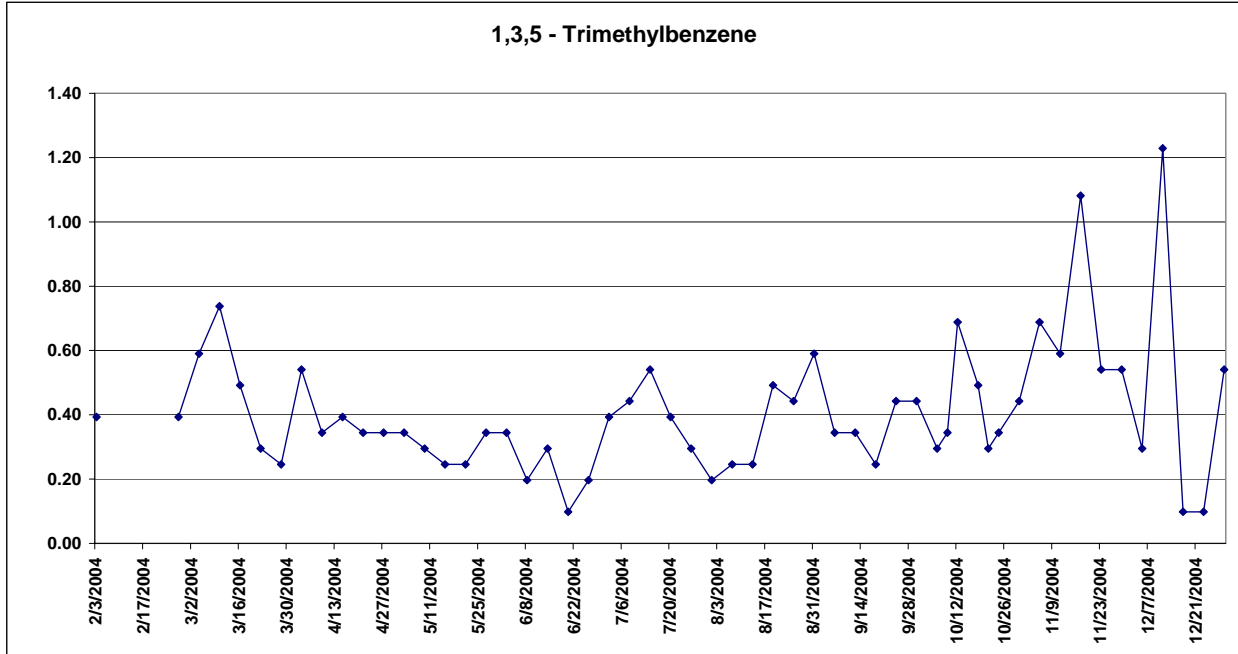
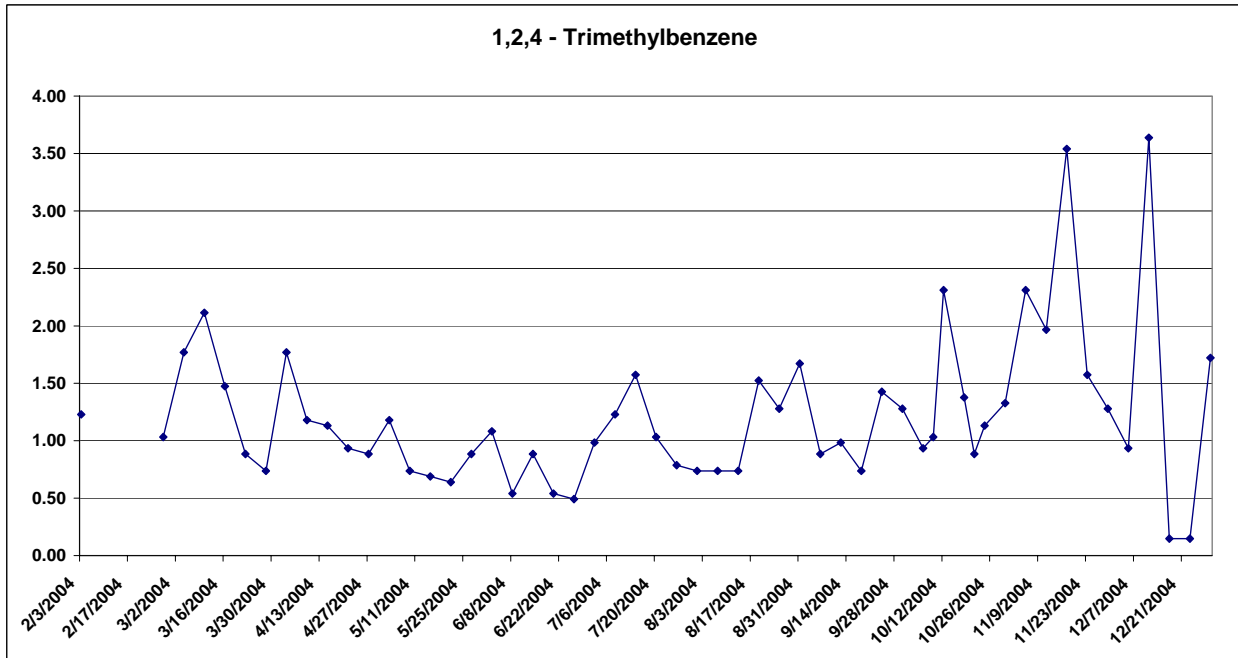


Figure 3.7 1,2,4-Trimethylbenzene



Precision of Sample Results – Volatile Organic Compounds

Periodically throughout the year, a second canister was sampled simultaneously with the main sample. These additional samples, known as duplicates, were collected in order to assess the precision (repeatability) of the canister sampling method. On the duplicate sampling dates, the laboratory also conducted a test of the precision of the analytical process by injecting two samples of each canister's air into the gas chromatograph/mass spectrometer.

These samples are known as the laboratory replicates. Thus, this project collected two types of precision data – duplicate data, which assesses both sampling and analysis procedures, and replicate data, which assesses laboratory analytical method repeatability. 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

January through December 2004

Summary Statistics – Metals

Maximum and Mean – All Samples

Metals data collected at the Grand Junction – Powell station from January 2004 through December 2004 are presented in this section. (Note that metals collection started a month earlier than VOC or carbonyl sampling). During the year-long period metals were sampled on a one-in-six day basis, for a total of 63 samples attempted. Of these, 60 were recovered, for a percentage data recovery of 95 (Table 4.1).

Table 4.2 summarizes the annual maximum and mean concentrations for each of the metals measured during the study. Annual means and maximums 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. Thus, when a compound was not detected, the maximum and mean values will be the same positive value. Results show that manganese, lead, and chromium were the compounds with the highest mean concentrations in ambient air. Beryllium was never at detectable levels. Cadmium was only measurable in one sample. Lead and manganese were present in almost every sample.

Table 4.1 Percentage Data Recovery for Metals Samples

Station	Samples Recovered	Sample Days Scheduled	Percentage Recovered
Grand Junction – Powell Site	60	63	95

Table 4.2 Annual Maximum and Mean Concentrations for Metals

Grand Junction – Powell Site	Summary Statistics (ug/m3)		Count of Non-Detects		Percentage of Samples in Which Compound Was Detected	Minimum Detection Level (ng/filter)
	Maximum	Mean	Number	Percentage		
Antimony	0.0074	0.0004	50	83	17	125
Arsenic	0.0019	0.0003	50	83	17	200
Beryllium	0.0001	0.0001	60	100	0	225
Cadmium	0.0010	0.0001	59	98	2	100
Chromium (total)	0.0137	0.0019	31	52	48	525
Lead	0.0112	0.0049	1	2	98	175
Manganese	0.0275	0.1300	2	3	97	275
Nickel	0.0069	0.0006	49	82	18	250

Percentage of Samples For Which Compound Was Detected

Table 4.2 shows the percentage of the samples in which each metal was detected. None of the metals were detected in all samples, though lead and manganese were in nearly all the samples. Only beryllium was never detected and cadmium was only detected in one sample.

Graphs – Metals

The metal compounds measured during the study are graphed in Figure 4.1. Figure 4.1 shows that lead and manganese were the metals at highest concentration. These, along with nickel and chromium had significant mean concentrations. Figure 4.2 shows that lead, manganese, and chromium trended up and down together. Figure 4.3 indicates that cadmium, arsenic, and antimony had only sporadic detections. Figure 4.4 shows intermittent levels of nickel, but no detections of beryllium.

Figure 4.1 Average and Maximum Metals

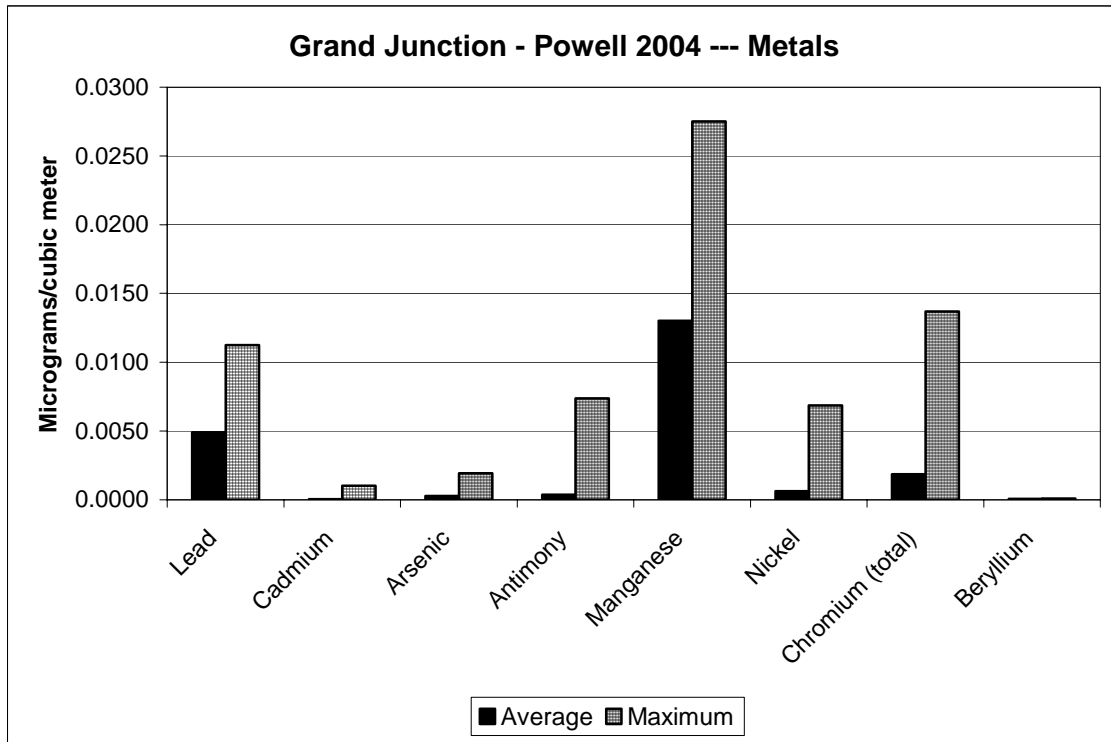


Figure 4.2 Lead, Manganese, and Chromium

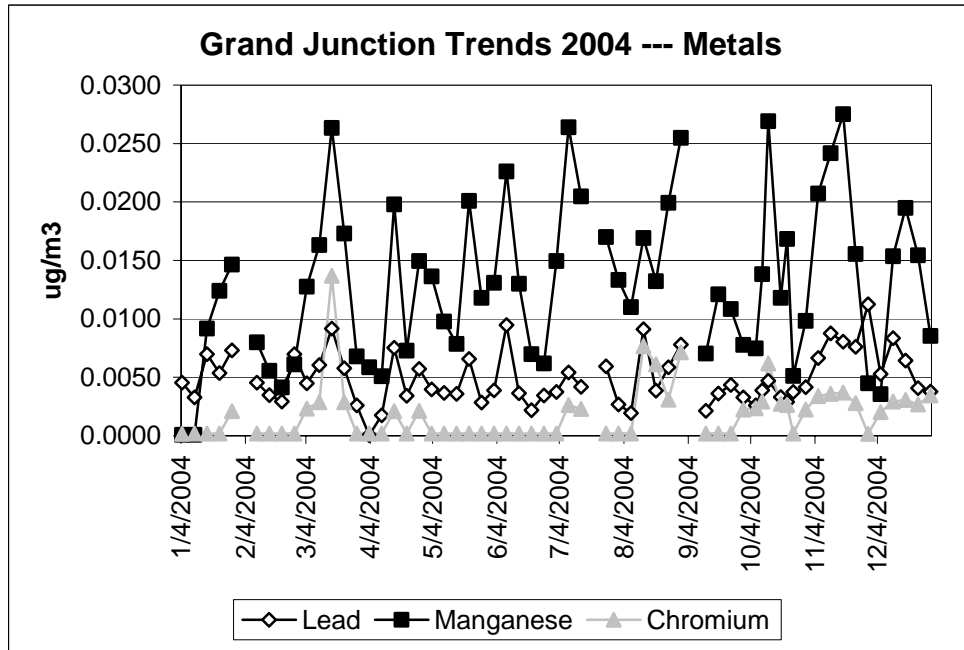


Figure 4.3 Cadmium, Arsenic, and Antimony

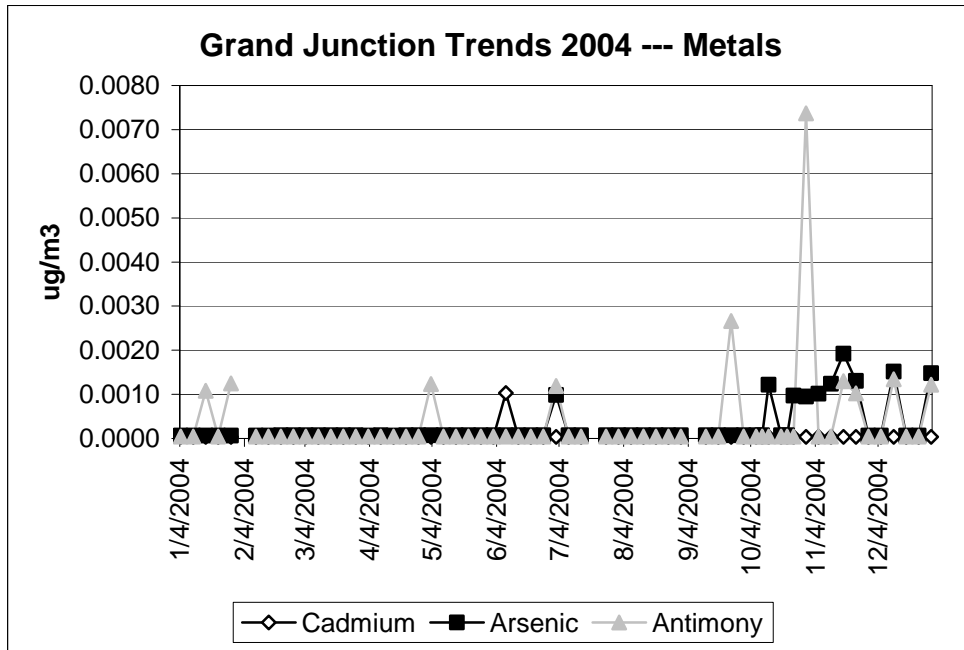
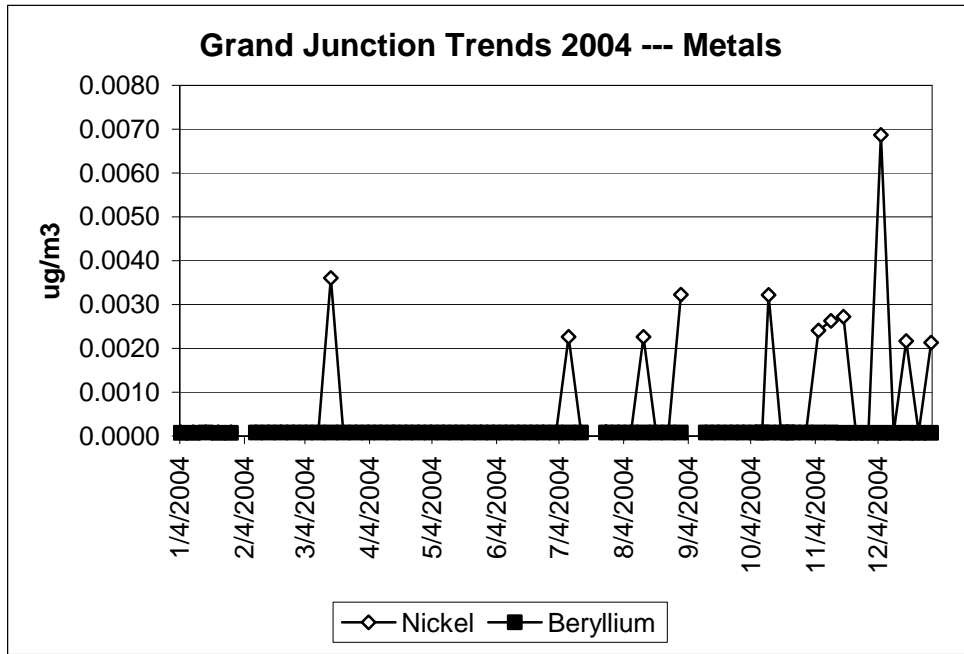


Figure 4.4 Nickel and Beryllium



Precision of Sample Results – Metals Compounds

Once every 12 days, a second PM₁₀ sampler was run simultaneously with the main one. These additional samples, known as duplicates, were collected in order to assess the precision (repeatability) of the metals sampling method. In general, duplicates for the highest-concentration compounds, lead and manganese, showed good agreement.

Field Blanks – Metals Compounds

Occasionally, 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. Chromium was the only metal at detectable levels in the blanks, with one sample at 3123 ng/filter. For the other two blanks taken, chromium was not detectable. Chromium contamination has also been a problem for national air toxics network samples taken in past years. These chromium contamination findings are 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 project team for the nation-wide project plans to evaluate new filter materials and sampling methods in the future, in hopes of alleviating this problem. In any case, these “blank levels” were subtracted from the measured concentrations for each sample date, so that levels reported in air would not include filter contamination.

**Section 5: Carbon Monoxide at Grand Junction – Powell
Site**

January through December 2004

Summary Statistics – Carbon Monoxide

Maximum – All Samples

As part of its routine air monitoring network, 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, and serves to indicate the status of Grand Junction regarding the National Ambient Air Quality Standard (NAAQS) for carbon monoxide. Results of the statewide carbon monoxide monitoring network are discussed in detail in the report, “Colorado: 2004 Air Quality Data Report”, Air Pollution Control Division. Table 5.1 shows the most recent annual NAAQS statistics for this area.

Table 5.1 Carbon Monoxide Data Summary

Grand Junction – Powell Site	1 Hour Average (ppm)			8 Hour Average (ppm)		
	Federal Standard	Maximum	2 nd Maximum	Federal Standard	Maximum	2 nd Maximum
Carbon Monoxide	35	3.9	3.7	9	2.1	2.1

Figure 5.1 is a graph of carbon monoxide values for the year. The vast majority of hourly concentrations were below 3.0 parts per million (ppm).

Figure 5.1 Carbon Monoxide

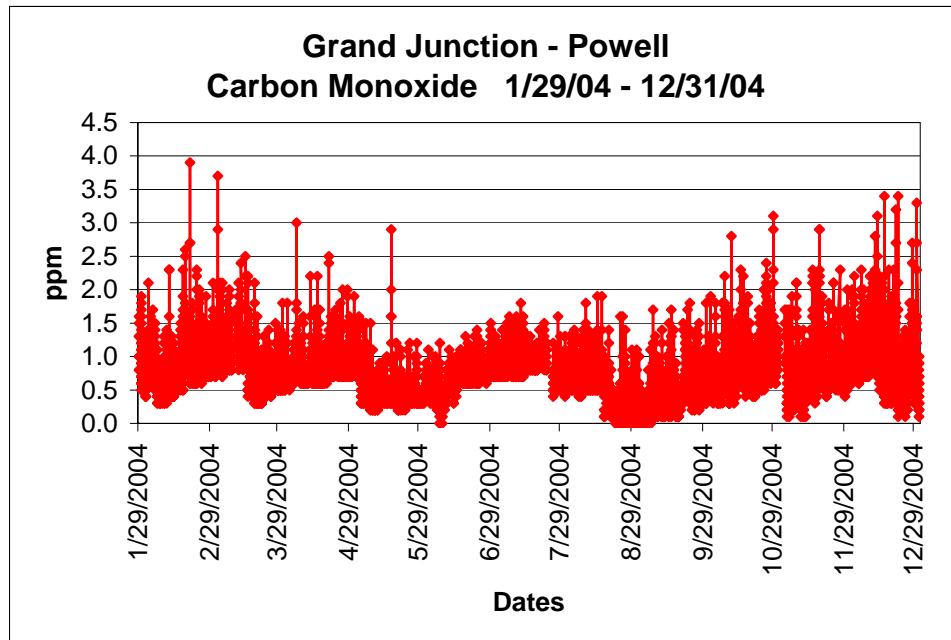
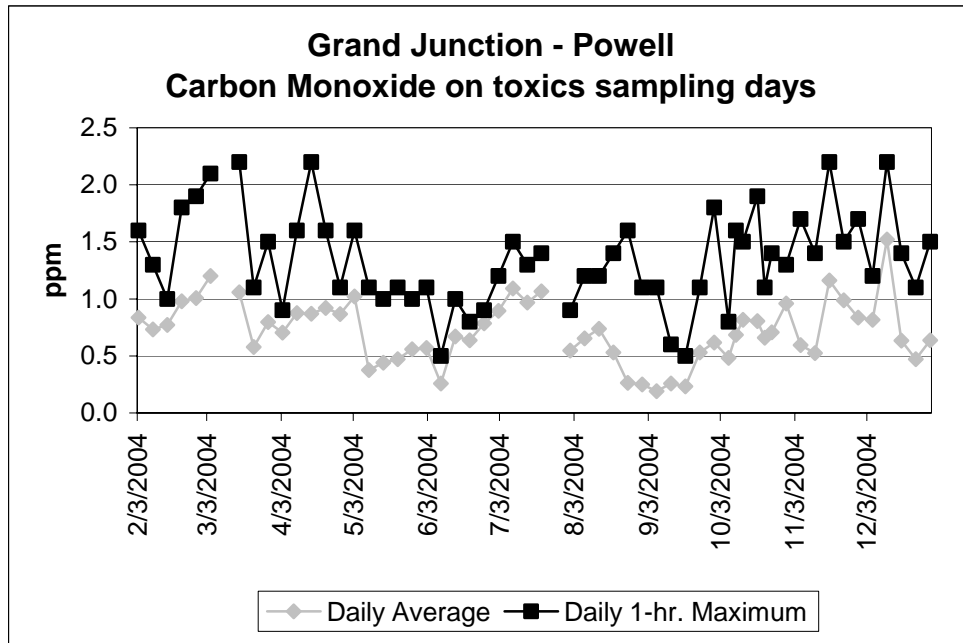


Figure 5.2 summarizes hourly means and maximum carbon monoxide samples for the dates that air toxics sampling took place. (Air toxics were sampled once every 6 days). Compared to Figure 5.1, this graph indicates that the air toxics sampling dates did not capture the dates with the worst carbon monoxide values. However, the daily averages of the air toxics sampling dates adequately reflect the full year of carbon monoxide sampling, with values generally centering around 1 ppm. 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 5.2 Carbon Monoxide on Air Toxics Sampling Days



Section 6: PM₁₀ at Grand Junction – Powell Site

January through December 2004

PM₁₀ Data At Grand Junction - Powell

As part of its routine air monitoring network, the Colorado Department of Public Health and Environment operates a sampler for particulate matter 10 microns or less in diameter (PM₁₀) at the Grand Junction – Powell station. This sampler serves to indicate the status of Grand Junction regarding the National Ambient Air Quality Standard (NAAQS) for PM₁₀. Results of the statewide particulate matter monitoring network are discussed in detail in the report, “Colorado: 2004 Air Quality Data Report”, Air Pollution Control Division. Table 6.1 shows the percentage data recovery for the year. Table 6.2 shows the most recent annual NAAQS statistics for this area.

Table 6.1 Percentage Data Recovery for PM₁₀ Samples

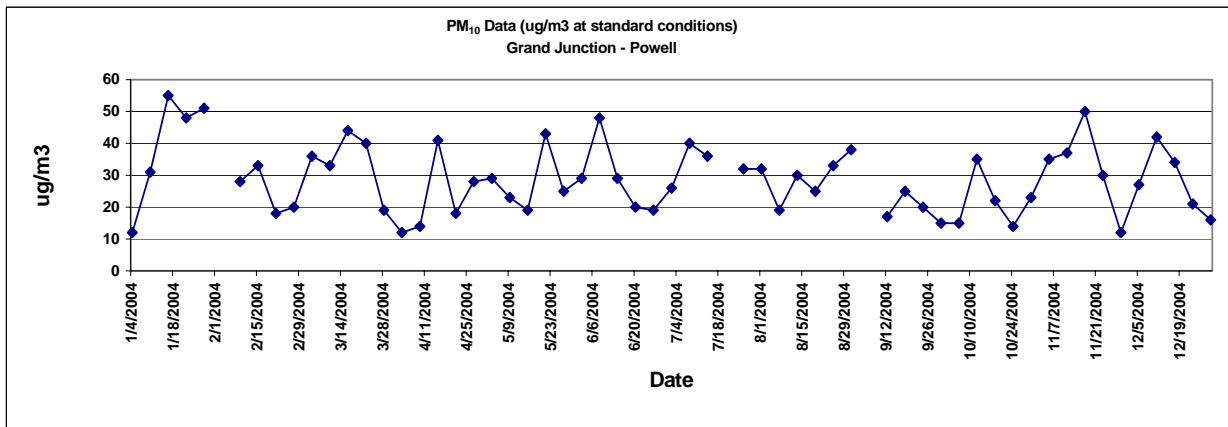
Station	Samples Recovered	Sample Days Scheduled	Percentage Recovered
Grand Junction - Powell Site	58	61	95

Table 6.2 Data Summary for PM₁₀ Samples

Grand Junction – Powell Site	Annual Arithmetic Mean (ug/m3 at Standard Conditions)		Second 24 Hour Maximum (ug/m3 at Standard Conditions)		
	Standard	Annual Mean	Standard	Maximum	2 nd Maximum
PM ₁₀	50	29	150	102	60

Note: This Table is based on all samples taken at the site, on a 1/3 day schedule. The rest of the data in this section are based only on the samples taken on the National Air Toxics Monitoring Project Schedule of 1/6 days.

Figure 6.1 PM₁₀ Data



Note: This graph is based only on the samples taken on the National Air Toxics Monitoring Project Schedule of 1/6 days. It does not include the first and second 24 hour maxima in the table above, as those were taken on non-network monitoring dates (i.e. CDPHE scheduled dates, based on 1/3). Considering the complete data set, the 58 ug/m3 maximum shown above is actually the third maximum for the year 2004.

Section 7: Overall Summary and Conclusions

Summary and Conclusions

This report discusses results for ambient air toxics monitoring conducted at Grand Junction, Colorado, during the year 2004. Twenty-four hour long samples were collected on a once every six day basis for a year as part of the U.S. Environmental Protection Agency's (EPA) National Air Toxics Trends Study. The Grand Junction monitoring locations for air toxics were in close proximity, at 650 South Avenue and 645¼ Pitkin Avenue. These sites are on the south end of the city, in a commercial /industrial area.

Carbonyl and volatile organic compound (VOC) samples were taken with equipment provided by Eastern Research Group (ERG), a consulting firm contracted by EPA to provide support to the national network. The ERG samplers collected two different types of samples. A dinitrophenylhydrazine (DNPH) cartridge collected carbonyl samples by EPA Method TO-11A. DNPH cartridges were analyzed for twelve different carbonyls. Air was also drawn into a stainless steel canister. The canisters were analyzed for 58 VOC's by EPA method TO-15. In addition, high volume samplers collected particulate matter ten microns or less in diameter (PM₁₀) that were analyzed for eight different metals. PM₁₀ levels were also determined from these filters. Additionally, the state of Colorado Air Pollution Control Division operated a carbon monoxide monitor at the air toxics monitoring shelter. Thus, the total number of chemical compounds assessed was 79. Of the 79 chemicals assessed, 39 were detected less than 10 percent of the time.

Six carbonyls were present in all samples. These were formaldehyde, acetaldehyde, acetone, crotonaldehyde, butyr/isobutyraldehydes, and benzaldehyde. Tolualdehydes and hexaldehyde were present over 96% of the time. Automobiles are believed to be the largest emission source for formaldehyde, crotonaldehyde, and acetaldehyde, either as direct emissions, or as compounds forming from photochemical reactions. The impacts from aldehydes are difficult to control, because they can form as hydrocarbons emitted from automobiles and industrial processes react in the presence of sunlight. Analysis of results from the EPA national Urban Air Toxics Network indicates that formaldehyde, acetaldehyde, and acetone are problems on a nationwide scale. Thus, the situation in Grand Junction is typical of most American cities.

The most-frequently detected volatile organic compounds measured at Grand Junction – Powell are listed below. Those with the highest annual means are listed in the second table.

Table 7.1 Compounds Detected in Over 90 Percent of the VOC Air Samples

Grand Junction – Powell Site	
1,2,4 - Trimethylbenzene 1,3,5 - Trimethylbenzene Acetylene Benzene Chloromethane Dichlorodifluoromethane Ethylbenzene m,p - xylene	Methyl Ethyl Ketone o - xylene Propylene Styrene Toluene Trichlorofluoromethane Trichlorotrifluoroethane

Table 7.2 VOC Compounds with Means Greater than 2 ug/m³

Acetylene	m,p - xylene	Styrene
Benzene	Methyl Ethyl Ketone	Toluene
Dichlorodifluoromethane		Trichlorofluoromethane

Some compounds that were detected less frequently, and in lower amounts, may still present health risks. Results from EPA's national network indicate that 1,3-butadiene, benzene, tetrachloroethylene and carbon tetrachloride, which were monitored here, a problem on a nationwide scale. 1,3-butadiene and benzene are believed to result from automobile emissions, while carbon tetrachloride and tetrachloroethylene are industrially-emitted compounds. 1,2,4-Trimethylbenzene and 1,3,5-trimethylbenzene, which have contributed to cancer risk in other places, were measured in Grand Junction.

Tetrachloroethylene, or perchloroethylene, was detected over forty percent of the time. This compound is used in dry cleaning. These results are consistent with EPA's national analyses, which indicate that levels of tetrachloroethylene are of concern in urban areas throughout the United States.

Of the metals, lead and manganese were detected over 96% of the time. Chromium was present in 48% of the samples. Nickel, antimony, and arsenic were at measurable levels, but less than 20 % of the time. Cadmium was detected in less than 2% of the samples, and beryllium was never seen at all. Lead and manganese were the metals detected at the highest concentrations. However, lead levels were well below the standards of $1.5 \mu\text{g}/\text{m}^3$, as a monthly (Colorado standard) or a quarterly (federal standard) average. Manganese levels are believed to be related to smelting operations, coal-fired power plants, gasoline additives or naturally-occurring background soil levels.

In conclusion, a number of compounds related to vehicular emissions are present in Grand Junction air. These are formaldehyde, acetaldehyde, benzene, crotonaldehyde, and 1,3-butadiene. Carbon tetrachloride and tetrachloroethylene, which are from industrial sources, also may be a concern. These compounds appear to be at problem levels throughout the urban areas of the United States. Manganese may also be of concern.

It should be noted that actual concentrations of chemicals in the air change over time. Therefore, this study is best viewed as a "snapshot" in time, indicating which chemicals should potentially be the focus of state or federal interest or regulatory action. Results of the study indicate that the main chemicals of concern in Grand Junction are the same as the ones upon which EPA is focusing nationally. No risk assessment work was performed for this report. Risk assessment analyses will be performed when additional years of data are available to provide a more complete and statistically significant analysis.

ATTACHMENT-1

Compounds Contributing to Cancer and Non-cancer Risks: Overview of Sources and Health Effects

Chemicals can be released to the environment as a result of their use and manufacture. Some chemicals may also form, as other chemicals react with sunlight and one another in outdoor air. A brief summary of the potential sources and health effects of some prevalent chemicals in the ambient air is provided below. This information is adopted from the following main sources: EPA Air Toxic Website, EPA Office of Pollution Prevention and Toxics (OPPT), EPA Integrated Risk Information System (IRIS), Agency for Toxic Substances and Disease Registry (ATSDR), New Jersey Department of Health and Senior Services, Occupational Safety and Health Administration (OSHA), National Institute of Occupational Safety and Health (NIOSH), and the California Air Resources Board (CARB).

Carbonyls

Three of the twelve carbonyl compounds sampled are discussed below. These three are believed to be significant health risk drivers, at the nation-wide level.

Acetaldehyde

Acetaldehyde is a hydrocarbon with the formula CH_3CHO . It is thus closely related to formaldehyde, HCHO . Like formaldehyde, it exists in the atmosphere as a gas with a pungent odor. Acetaldehyde is ubiquitous in the ambient environment. It is mainly used as an intermediate in the synthesis of other chemicals, such as acetic acid, acetic anhydride, chloral, and glyoxal. It is employed in the food processing industry as a food and fish preservative, a flavoring agent, and in gelatin fibers. The tanning and paper industries use acetaldehyde, as do the perfume and dye manufacturers (CARB Acetaldehyde Fact Sheet).

Acetaldehyde can be released to the environment as a product of incomplete combustion in fireplaces and wood stoves, forest and wild fires, pulp and paper production, stationary internal combustion engines and turbines, vehicle exhaust, and petroleum refineries. Waste water processing is also a source. It is important to note that residential fireplaces and woodstoves are the two highest sources of emissions, followed by various industrial emissions.

Although it is used in industry, the California Air Resource Board believes that the largest sources in outdoor air are combustion and production from photochemical reactions (CARB Acetaldehyde Fact Sheet). Acetaldehyde itself can break down in these complex reactions between air pollutants and sunlight, forming formaldehyde.

The health effects of acetaldehyde are very similar to those of its chemical relative formaldehyde. It irritates the eyes and mucous membranes. It can paralyze the respiratory muscles, act as a narcotic to prevent coughing, and speed up pumping of the heart. Exposure can lead to headaches and sore throat. (Kirk Othmer, Vol 1, page 107). It should be noted that most of these health effects have been observed in factory workers, who are exposed to acetaldehyde concentrations thousands of times greater than those occurring in outdoor air. Acetaldehyde is believed to be a probable human carcinogen, leading to cancer of the nose and throat. Acetaldehyde has been shown to cause birth defects in animals, but no human research is available. (CARB Acetaldehyde Fact Sheet).

EPA's Technology Transfer Network Air Toxic Website provides information on the potential health effects of acetaldehyde. According to this source, the primary acute effects of acetaldehyde are irritation of the eyes, skin, and respiratory tract in humans. At higher exposure levels, erythema, coughing, pulmonary edema, and necrosis may happen. Chronic toxicity symptoms in humans resemble those of alcoholism.

The EPA has established a Reference Concentration (RfC) for inhalation exposure to acetaldehyde based on degeneration of the olfactory epithelium in rats. No information is available on the reproductive and developmental effects of acetaldehyde in humans. Animal studies data indicate that acetaldehyde may be a potential developmental toxin. EPA has classified acetaldehyde as a Group B2, probable human carcinogen, based on increased incidence of nasal tumors in male and female rats and laryngeal tumors in male and female hamsters after inhalation exposure.

The California Air Resources Board observed an annual mean of 1.33 ppb acetaldehyde in its state-wide network during 1996 (CARB Acetaldehyde Fact Sheet). The mean observed in this Grand Junction study, 3.2 ppb, is a bit above the California data, but acetaldehyde in Grand Junction occurs at levels typical of large urban areas. Acetaldehyde levels are therefore a national problem related primarily to the use of motor vehicles.

Crotonaldehyde

Crotonaldehyde with the chemical formula of C_4H_6O is also known as propylene aldehyde, betamethyl-acrolein, crotonin aldehyde and butenal. Crotonaldehyde is a colorless liquid with a pungent, suffocating odor.

Crotonaldehyde can be emitted to the environment from the combustion of gasoline, the burning of wood, paper, cotton, plastic, and tobacco. It can also be released through industrial use. It is found naturally in emissions of some vegetables and volcanoes.

According to the ATSDR Medical Management Guidelines inhaled crotonaldehyde is highly toxic. It is irritating to the upper respiratory tract even at low concentrations. Crotonaldehyde vapor is heavier than air. Therefore, higher levels of crotonaldehyde vapors would be found nearer to the ground. The mechanism of toxicity of crotonaldehyde is not known, but it is highly reactive. Crotonaldehyde is also a skin irritant and can cause eye irritation and damage to the cornea. After an acute, relatively high concentration exposure, people may become sensitized to crotonaldehyde. Except for rare cases of sensitization, no health effects have been reported in humans exposed to relatively low concentrations of crotonaldehyde. No studies have been found that address reproductive or developmental effects of crotonaldehyde in humans. The compound has been shown to cause degeneration of spermatocytes in mice. No teratogenic effects from acute exposures have been reported.

The Department of Health and Human Services has determined that crotonaldehyde may be a possible carcinogen. The EPA IRIS has classified crotonaldehyde as a possible carcinogen based on the fact that there is no human data, but an increased incidence of hepatic tumors in male rats. The possible carcinogenicity of crotonaldehyde is supported by genotoxic activity and the expected reactivity of croton oil and aldehyde. The EPA IRIS, however, has not derived a cancer toxicity value for the compound. The EPA HEAST (Health Effects Summary Tables) has established an oral cancer toxicity value for crotonaldehyde. The Agency for Research on Cancer has determined that crotonaldehyde is not classifiable as to its carcinogenicity to humans.

Information concerning typical concentrations of crotonaldehydes in air could not be located.

Formaldehyde

Formaldehyde is a hydrocarbon compound with the formula $HCHO$. It exists in the atmosphere as a colorless gas with a pungent odor. It is used in the manufacture of urea-formaldehyde resins which are used in particleboard and plywood products. Therefore, high levels of airborne formaldehyde can also be found in indoor air as a result of release from various consumer products such as building materials and home furnishings. Another source of formaldehyde in indoor air is smoking. It is also employed in chemical manufacturing of pharmaceuticals, herbicides, and sealants. Textile finishes, such as used for "permanent press" clothes, contain formaldehyde (Kirk-Othmer, Vol 11, pages 245 - 246).

EPA's Technology Transfer Network Air Toxic Website provides information on the potential sources and health effects of formaldehyde. According to this source, the major sources of formaldehyde emissions to the

ambient air include power plants, manufacturing facilities, incinerators, forest and wild fires, stationary internal combustion engines and turbines, pulp and paper plants, petroleum refineries, and automobile traffic. In urban areas, combustion of automotive fuel is the dominant source for much of the year. However, formaldehyde can also form photochemically in the air, as other hydrocarbons and oxides of nitrogen from automobile traffic break down to form ozone. Complicating the situation is the fact that the complex ozone-producing atmospheric reactions may both create and destroy formaldehyde, as the chains of chemical reactions proceed along various pathways.

The Agency for Toxic Substances and Disease Registry (ATSDR), lists a number of possible health effects that may occur from inhalation of formaldehyde. Formaldehyde is an irritant. The major acute toxic effects via inhalation exposure are eye, nose, and throat irritation and effects on the nasal cavity. At 0.4 – 3 ppm, it may cause the eyes to tear. Other effects observed in humans from exposure to high levels of formaldehyde are coughing, wheezing, chest pain, and bronchitis (EPA's Technology Transfer Network Air Toxic Website). Formaldehyde is believed to be carcinogenic (cancer-causing) to humans. However, the body can quickly break down formaldehyde, so it does not accumulate in fatty tissue. Currently, ATSDR believes that formaldehyde does not cause birth defects in humans (ATSDR Toxicological Profile for Formaldehyde). Thus, the main concerns with this compound are its irritant properties and its potential ability to cause cancer of the nose and throat.

Chronic inhalation exposure to formaldehyde in humans has been associated with respiratory symptoms and eye, nose, and throat irritation. EPA has not established an inhalation Reference Concentration (RfC) for formaldehyde. However, the ATSDR has established an inhalation reference concentration called a Minimal Risk Level (MRL) for formaldehyde based on respiratory effects in humans. Developmental effects, such as birth defects, have not been observed in animal studies. EPA has classified formaldehyde as a Group B1, probable human carcinogen, based on limited evidence in humans and sufficient evidence in animals. Occupational studies have shown statistically significant increases in incidence of lung and nasopharyngeal cancer. This evidence is considered limited because of possible exposure to other agents. Animal studies have reported an increased incidence of nasal squamous cell carcinoma by inhalation exposure. Please see EPA IRIS for a detailed discussion on the carcinogenicity of formaldehyde.

ATSDR states that typical levels of formaldehyde in urban air are 10 – 20 ppb. ATSDR cites concentrations of 0.2 ppb for rural areas, and 2-6 ppb for suburban areas (ATSDR Toxicological Profile for Formaldehyde). The mean level observed in Grand Junction during this study, 2.3 ppb, is within the "suburban" range.

Volatile Organic Compounds

Volatile organic compounds commonly present included 1,3 – butadiene, benzene, carbon tetrachloride, tetrachloroethylene, 1,3,5 – trimethylbenzene and 1,2,4 - trimethylbenzene. Some health summary and source information regarding these compounds is given below.

Benzene

Benzene is a hydrocarbon compound with the formula C_6H_6 . It exists in the atmosphere as a colorless gas with a sweet odor. It is used in chemical manufacturing of medicines, detergents, explosives, shoes, dyes, leather, resins, paints, plastics and inks (CARB Fact Sheet on Benzene). It is also present in gasoline.

The largest sources of benzene in ambient air are automobiles, gasoline service stations, refineries, and chemical plants. Burning of vegetative matter in forest fires and woodstoves is also a source. In ambient air, benzene reacts with hydroxyl (OH^\cdot) radicals within a few hours. Since hydroxyl radicals are common in outdoor air, this chemical transformation prevents the build-up of large concentrations of benzene.

Benzene is a serious concern from a toxicological standpoint. Unlike many of the compounds discussed here, benzene is a proven human carcinogen. It damages the blood-forming capacity of the body, leading to anemia or leukemia. Like the other volatile organic compounds, breathing large amounts can cause lightheadedness, headache, vomiting, convulsions, coma and death. It also irritates the skin and eyes, exerting a drying effect. However, these health effects are usually seen in workplaces, where levels are thousands of times higher than those

in outdoor air. Experiments with laboratory animals suggest that benzene exposure may be associated with numerous cancers. It may cause bone marrow damage and bone formation problems for a developing fetus (ATSDR Toxicological Profile for Benzene). Thus, EPA has had concern about whether levels of benzene in outdoor air are associated with cancer and leukemia. While no link with outdoor air concentrations has been unequivocally proven, EPA has acted to reduce air concentrations of this pollutant.

The EPA has established a Reference Concentration for inhalation exposure to benzene based on decreased lymphocyte count in an occupational epidemiologic study. Benzene is classified as a “known” human carcinogen for all routes of exposure by the EPA IRIS based on the increased incidence of leukemia in epidemiologic and case studies.

The Agency for Toxic Substances and Disease Registry (ATSDR) cites national 1984 to 1986 data from 300 cities, which indicate an average benzene level of 1.8 ppb for urban and suburban areas (ATSDR Toxicological Profile for Benzene). The Grand Junction – Powell site mean of 0.7 ppb observed in this study is somewhat lower.

1,3-Butadiene

1,3-Butadiene is a hydrocarbon compound with the formula C_4H_6 . It exists in the atmosphere as a colorless gas with an odor similar to gasoline. It is used in making rubber and plastics. The most important use is in tire production. It is also used in the production of chemicals such as 1,4-hexadiene (NIOSH Current Intelligence Bulletin 41).

According to the California Air Resources Board, most emissions of 1,3-butadiene come from combustion of fuels in diesel and gas-powered motor vehicles. Other sources that they list include petroleum refining, tire wear, residential wood heating, and forest fires. Rubber and chemical production plants also have emissions. Breathing of cigarette smoke is another source of 1,3-butadiene exposure (ATSDR Fact Sheet)

1,3-Butadiene is of concern toxicologically because it is characterized as carcinogenic to humans based on the new EPA guidelines for cancer risk assessment and it also has adverse effects on reproduction and fetal development. Exposure to high concentrations can cause irritation and central nervous system effects such as eye irritation, cough, sore throat, headache, drowsiness, nausea, unconsciousness, and death. Rats and mice exposed to this compound in laboratory tests developed multiple cancers within single individuals. The animals had damaged testes and ovaries, and offspring of the animals had skeletal problems. Other effects seen in animals at low levels of inhalation exposure for one year include kidney and liver disease, and damaged lungs (ATSDR Fact Sheet). Generally, the acute health effects have not been seen at concentrations existing in outdoor air. However, EPA considers that the levels of 1,3-butadiene in air may represent a significant portion of the cancer risk related to ambient airborne chemicals.

The EPA has established a Reference Concentration for inhalation exposure to 1,3-butadiene based on ovarian atrophy in mice. The EPA has characterized 1,3-butadiene as carcinogenic to humans by inhalation based on the following total evidence: sufficient evidence from epidemiologic studies showing increased lymphohematopoietic cancers and leukemia; tumors at multiple sites in animal studies, and strong evidence suggesting that the carcinogenic effects are mediated by genotoxic metabolites of 1,3-butadiene.

ATSDR estimates that urban and suburban areas have an average concentration of 0.3 ppb 1,3-butadiene, while rural areas have 0.1 ppb (ATSDR Toxicological Profile for 1,3-Butadiene). The annual average at Grand Junction - Powell is 0.09 ppb.

Carbon Tetrachloride

Carbon tetrachloride, also known as tetrachloromethane or methane tetrachloride, is a chlorinated hydrocarbon with the formula CCl_4 . It exists in the atmosphere as a gas. It has a sweet odor. The primary uses of carbon tetrachloride were as a dry cleaning solvent, a grain fumigant, as a refrigerant, and as an aerosol propellant. Carbon tetrachloride has a long atmospheric half-life, so it can travel to the higher reaches of the atmosphere and

damage the earth's ozone layer. Due to its toxicity and ozone-damaging qualities, most uses of carbon tetrachloride have been banned. It is still in use in industrial settings for producing refrigerants.

Carbon tetrachloride is emitted to the air from industrial sources and from petroleum refineries (California Air Resources Board Toxic Air Contaminant Identification List Summary for Carbon Tetrachloride). Carbon tetrachloride is also a common indoor air contaminant due to releases from building materials and products, such as cleaning agents, used in homes (Air Toxic Website). There are no natural sources of carbon tetrachloride; it is produced by man (ATSDR Toxicological Profile for Carbon Tetrachloride).

As is true for many of the chlorinated hydrocarbons, breathing large concentrations of carbon tetrachloride has central nervous system effects including lightheadedness, coma, convulsions, double vision, intoxication, and death. It can also cause vomiting. In animal studies, it had effects on the liver and kidney. Male rats exposed to carbon tetrachloride had lower sperm production. Female rats exposed to it had stunted offspring with birth defects. These health effects are generally observed in occupational settings, where people had exposure to very high levels over a number of years.

EPA has not established a Reference Concentration for carbon tetrachloride. The CalEPA has established a Reference Exposure Level for carbon tetrachloride based on liver effects in guinea pigs. Carbon tetrachloride has been associated with liver and kidney cancer in animals. EPA considers it a Class B2 Carcinogen (probable human carcinogen) based on liver tumors in animals.

The California Air Resources Board has monitored carbon tetrachloride at a number of locations, and found a mean value of 0.078 ppb (California Air Resources Board Toxic Air Contaminant Identification List Summary for Carbon Tetrachloride). The 0.08 ppb annual mean observed at Grand Junction – Powell is at the same level.

Tetrachloroethylene

Tetrachloroethylene, also known as perchloroethylene, is a chlorinated hydrocarbon with the formula C_2Cl_4 . It exists in the atmosphere as a gas. It has a "chloroform-like" odor (NIOSH Pocket Guide to Chemical Hazards, Tetrachloroethylene). The primary uses of tetrachloroethylene are as a dry cleaning solvent, metal cleaning solvent, or for chemical production. Tetrachloroethylene is used in paints, inks, aerosols, glues, polishes, silicones and rubber products (CARB Fact Sheet on Tetrachloroethylene and OPPT Chemical Fact Sheet on Tetrachloroethylene).

Most emissions of tetrachloroethylene come from degreasing, dry cleaning, or chemical production facilities. There are microorganisms that can produce tetrachloroethylene (ATSDR Toxicological Profile For Tetrachloroethylene).

As is true for many of the chlorinated hydrocarbons, breathing large concentrations of tetrachloroethylene has central nervous system effects including lightheadedness, coma, convulsions, double vision, intoxication, and death. It also can cause vomiting. In animal studies, it had effects on the liver and kidney. It also is an irritant to eyes, lungs, and skin. However, many of these health effects were observed in occupational settings, where exposure is much higher than in outdoor air. Some animal studies suggest that tetrachloroethylene exposure may lead to leukemia (NIOSH Registry of Toxic Effects of Chemical Substances Information for Tetrachloroethylene). Tetrachloroethylene has been associated with liver and kidney cancer in animals.

The ATSDR has established a Minimal Risk Level (MRL) based on nervous system effects in humans. It is important to note that EPA is currently re-evaluating the toxic potential of tetrachloroethylene, including its carcinogenicity, and therefore no relevant information is available in IRIS. In the interim, EPA recommends the use of CalEPA toxicity values as provisional values. The CalEPA cancer toxicity value is derived by considering data on liver tumors in male and female mice and mononuclear cell leukemia in male and female rats. EPA is currently working to revise the toxicity assessment for tetrachloroethylene.

The California Air Resources Board has monitored tetrachloroethylene at a number of locations within their state, and found a mean value of 0.019 ppb during 1996 (California Air Resources Board Toxic Air

Contaminant Identification List Summary for Tetrachloroethylene). The annual mean at Grand Junction - Powell was 0.05 ppb. These levels are greater than the network-wide mean value for California. However, this compound was detected less than half the time.

1,3,5-Trimethylbenzene and 1,2,4-Trimethylbenzene

1,3,5-trimethylbenzene and 1,2,4-trimethylbenzene are isomers of the hydrocarbon formula C₉H₁₂. In pure form they are colorless liquids. They are used in chemical manufacturing of medicines, detergents, dyes, paints and inks. Trimethylbenzenes are a large component of distilled petroleum. They are also used as gasoline additives.

The largest sources of trimethylbenzenes in ambient air are likely to be automobiles, gasoline service stations, refineries, and chemical plants. In ambient air, trimethylbenzenes have a half-life of less than a day (EPA OPPT Chemical Summary For 1,2,4-Trimethylbenzene).

Health effects of trimethylbenzenes are similar to those of benzene. It damages the blood-clotting capacity of the body. Like the other volatile organic compounds, breathing large amounts can cause lightheadedness, headache, vomiting, convulsions, coma and death. It also irritates the skin and eyes, exerting a drying effect. Long-term exposure can lead to cough, reduced lung capacity, and bronchitis. However, these health effects are usually seen in workplaces, where levels are thousands of times higher than those in outdoor air. It is not known whether these compounds are carcinogenic. Some animal experiments suggest that they may cause bone formation problems for a developing fetus (EPA OPPT Chemical Summary For 1,2,4-Trimethylbenzene).

The Environmental Protection Agency cites national data indicating that average atmospheric concentrations of 1,2,4-trimethylbenzene are 0.58 ppb in rural areas, and 1.20 ppb in cities (EPA OPPT Chemical Summary For 1,2,4-Trimethylbenzene). The Grand Junction - Powell site had a mean value of 0.09 ppb. As the EPA citation is for 1988, it is likely that concentrations have gone down in recent years.

Metals

Arsenic and manganese are discussed below. Levels of lead observed in Grand Junction were below the Colorado state standard of 1.5 ug/m³ for a monthly average.

Arsenic

Arsenic is a metal-like element that occurs naturally in the earth's crust. Its chemical symbol is As. It exists in the atmosphere as particulate matter, in compounds formed from combination with other atoms such as oxygen, chlorine, and sulfur (ATSDR Public Health Statement for Arsenic). In the past, arsenic was used as a pesticide for orchard crops. Today, the chief use is in chromated copper arsenate (CCA) used to "pressure-treat" wood, to preserve it from decay in marine or in-ground usage. It is also used in metal alloy, glass-making, and electrical semi-conductors.

Emission sources of arsenic include smelters, coal-fired power plants, wood-burning, metals operations, mining operations, and incinerators. Arsenic occurs naturally in many soils, so wind-blown dusts from exposed land can contain it. Mine tailings piles generally contain enriched levels of arsenic, resulting in emissions of arsenic in the particulate emissions that occur under windy conditions. Soils contaminated by smelter fall-out can also be a source of emissions during high winds. Burning wood treated with CCA also leads to arsenic emissions.

Arsenic's toxicity has led to its use as a poison. Orally ingesting large amounts can be fatal. The effects of inhalation are similar to the oral effects. Arsenic disturbs the gastro-intestinal system, leading to abdominal pain, vomiting, and diarrhea. It affects the central nervous system, leading to nerve damage in the legs and arms. It can damage the liver and kidney. Arsenic also has effects on the skin, causing dark patches (hyperpigmentation), and skin cancer. Arsenic also irritates the eyes, lungs, and skin. These effects have been observed in situations of occupational exposure that are significantly higher than concentrations seen in outdoor air. Exposure can lead to effects in the blood, such as anemia.

EPA has not established a Reference Concentration for arsenic. The Cal EPA has established a chronic reference level based on the developmental effects in mice; and other target organs included the cardiovascular system and nervous system. Arsenic exposure is known to cause lung cancer. EPA classifies arsenic in Group A, the known human carcinogens, based on an increased lung cancer mortality in multiple human populations exposed primarily through inhalation.

The Agency for Toxic Substances and Disease Registry (ATSDR) states that remote areas have concentrations of 0.001 to 0.003 $\mu\text{g}/\text{m}^3$ arsenic in air, while urban locations range from 0.020 to 0.100 $\mu\text{g}/\text{m}^3$ (ATSDR Toxicological Profile on Arsenic). The mean level of 0.0003 $\mu\text{g}/\text{m}^3$ at Grand Junction – Powell site falls below the cited rural range. It is likely that national levels of arsenic have decreased in recent years.

Manganese

Manganese is a metal that occurs naturally in the earth's crust. Its chemical symbol is Mn. It exists in the atmosphere as particulate matter, in compounds formed from combination with other atoms. Manganese is used as an additive in metal processing and steel production. It is also used in ceramics, matches, glass, dyes, batteries, and as a pigment in paints (California Air Resources Board Fact Sheet on Manganese). It is also employed in wood preservatives. Organic forms of manganese are used as pesticides and for disease prevention in crops such as fruits, vegetables, and cotton.

Emission sources of manganese include petroleum refineries, steel producers, cement producers, coal-fired power plants, wood-burning, metals operations, mining operations, and incinerators. Manganese occurs naturally in some soils, so wind-blown dusts from exposed land can contain it. Soils contaminated by smelter fall-out can also be a source of emissions during high winds.

Manganese is considered an essential micronutrient in the human body. The body tends to regulate manganese concentrations, so oral exposure to small amounts naturally present in food is rarely a problem. Exposure of manganese by inhalation can lead to health effects. Manganese health effects on the respiratory system include lung irritation, chemical pneumonia, cough, and bronchitis. Manganese may damage the central nervous system. The disease known as "manganism", which results from manganese poisoning, includes psychological and nervous system damage. Individuals with manganism have a mask-like face, depression, uncontrollable laughter, and lethargy. The central nervous system effects include trouble with tremors, balance and walking that is similar to that of Parkinson's disease. Central nervous system damage can occur at exposure levels below those that lead to manganism. Examples are decreases in visual reaction time, hand steadiness, and eye-hand coordination. Manganese also affects the gastro-intestinal tract and the kidneys. However, it should be noted that these health effects have been observed in workers with long-term exposure to manganese fumes and dusts in industrial settings. These exposures were at levels hundreds or thousands of times higher than manganese levels in outdoor air.

EPA classifies manganese as Group D, unclassifiable as to carcinogenic potential. This is because there is little evidence to link it to cancer health effects. EPA has established a Reference Concentration for manganese based on an impairment of neurobehavioral function in humans in occupational exposure studies.

The California Air Resources Board monitored manganese in 1996. They report a network-wide average of 0.0212 $\mu\text{g}/\text{m}^3$ total manganese (CARB Fact Sheet on Manganese). The 0.0130 annual mean measured at Grand Junction is below the California average.

References for Attachment-1

References for Carbonyls Section

Agency For Toxic Substances and Disease Registry. (ATSDR) “Toxicological Profiles” for Various Compounds. Web Address: <http://www.atsdr.cdc.gov/toxprofiles/>

Toxicological Profile for Formaldehyde, dated July 1999.

California Air Resources Board. (CARB)

Web Address: <http://www.arb.ca.gov/toxics/catable.htm>

Acetaldehyde, dated September 1997.

United States Environmental Protection Agency. (EPA). Technology Transfer Network Air Toxics Website. “Dose-Response Assessment for Assessing Health Risks Associated With Exposure To Hazardous Air Pollutants”, Table 1, December 2, 2002.

Web Address: <http://www.epa.gov/ttn/atw/toxsource/summary.html>

Kirk-Othmer Encyclopedia of Chemical Technology. Third Edition. (Kirk-Othmer)

John Wiley and Sons, New York, New York. USA. 1978.

Acetaldehyde, Volume 1, Pages 97 – 112.

Formaldehyde, Volume 11, Pages 231 – 250.

References for Volatile Organic Compounds Section

Agency For Toxic Substances and Disease Registry. (ATSDR) “Toxicological Profiles” for Various Compounds. Web Address: <http://www.atsdr.cdc.gov/toxprofiles/>

Toxicological Profile for Benzene, dated September 1997.

Toxicological Profile for 1,3-Butadiene, dated April 1993.

Toxicological Profile for Carbon Tetrachloride, dated May 1994.

Toxicological Profile for Tetrachloroethylene, dated September 1997.

California Air Resources Board. (CARB)

Web Address: <http://www.arb.ca.gov/toxics/catable.htm>

Benzene, dated September 1997.

1,3-Butadiene, dated September 1997.

Carbon Tetrachloride, dated September 1997.

Tetrachloroethylene, dated September 1997.

Eastern Research Group. (ERG) “2002 Urban Air Toxics Monitoring Program (UATMP): Final Report”.

Prepared under EPA Contract Number 68-D-99-007. October 2003.

United States Environmental Protection Agency. Technology Transfer Network, Clearinghouse of Inventories and Emission Factors (CHIEF). Compilation of Air Pollution Emission Factors, AP-42, Fifth Edition, Volume 1. (EPA CHIEF).

Web Address: <http://www.epa.gov/ttn/chief/ap42/index.html>.

Chapter 1: External Combustion Sources. Section 1.10: Residential Wood Stoves.

United States Environmental Protection Agency. (EPA) Technology Transfer Network Air Toxics Website. Health Effects Worksheets For Various Substances.

Web Address: <http://www.epa.gov/ttn/atw/hlthef>

Carbon Tetrachloride, dated December 1999.

Tetrachloroethylene, dated December 1999.

United States Environmental Protection Agency. (EPA) Office of Pollution Prevention and Toxics. Chemicals in the Environment: OPPT Chemical Fact Sheets.

Web Address: <http://www.epa.gov/opptintr/chemfact/index.html>

Perchloroethylene Fact Sheet, dated August 1994.

Perchloroethylene Chemical Summary, dated August 1994.

1,2,4-Trimethylbenzene Fact Sheet, dated August 1994.

1,2,4-Trimethylbenzene Chemical Summary, dated August 1994.

United States Environmental Protection Agency. (EPA) Integrated Risk Information System. Full IRIS Summary Of Various Substances.

Web Address: <http://www.epa.gov/iris/subst/>

Benzene, dated April 17, 2003.

United States Environmental Protection Agency. (EPA) 2002 Urban Air Toxics Monitoring Program (UATMP), Final Report. October 2003. EPA Contract No. 68-D-99-007, by Eastern Research Group.

National Institute For Occupational Safety and Health. (NIOSH) Current Intelligence Bulletins.

Current Intelligence Bulletin 41: 1,3-Butadiene. Dated February 9, 1984.

Web Address: http://www.cdc.gov/niosh/84105_41.html

National Institute For Occupational Safety and Health. (NIOSH) International Chemical Safety Cards.

1,3-Butadiene. Dated 2000. Web Address: <http://www.cdc.gov/niosh/ipcsneng/neng0017.html>

Carbon Tetrachloride. Dated 2000. Web Address: <http://www.cdc.gov/niosh/ipcsneng/neng0024.html>

Tetrachloroethylene, dated 2001. Web Address: <http://www.cdc.gov/niosh/ipcsneng/neng0076.html>

1,3,5-Trimethylbenzene. Dated 2002. Web Address: <http://www.cdc.gov/niosh/ipcsneng/neng1155.html>

1,2,4-Trimethylbenzene. Dated 2002. Web Address: <http://www.cdc.gov/niosh/ipcsneng/neng1433.html>

Trimethylbenzene (Mixed Isomers). Dated 2002. Web Address:

<http://www.cdc.gov/niosh/ipcsneng/neng1389.html>

National Institute For Occupational Safety and Health. (NIOSH) Pocket Guide to Chemical Hazards.

Carbon Tetrachloride. Web Address: <http://www.cdc.gov/niosh/npg/npgd0107.html>

Tetrachloroethylene. Web Address: <http://www.cdc.gov/niosh/npg/npgd0599.html>

1,3,5-Trimethylbenzene. Web Address: <http://www.cdc.gov/niosh/npg/npgd0639.html>

1,2,4-Trimethylbenzene. Web Address: <http://www.cdc.gov/niosh/npg/npgd0638.html>

National Institute For Occupational Safety and Health. (NIOSH) Registry of Toxic Effects of Chemical Substances. (RTECS)

Carbon Tetrachloride, dated October 2002.

Web Address: <http://www.cdc.gov/niosh/rtecs/fg4ac4a0.html>

New Jersey Department of Health and Senior Services. "Hazardous Substance Fact Sheets" for Various Substances.

Web Address: <http://www.state.nj.us/health/eoh/rtkweb/rtkhsfs.htm>

Benzene, dated January 2001.
1,3-Butadiene, dated July 1998.
Carbon Tetrachloride, dated August 1998.
Tetrachloroethylene, dated March 2002.
Trimethylbenzene (Mixed Isomers), dated May 2003.

Occupational Safety and Health Administration. (OSHA) “OSHA Comments from the January 19, 1989 Final Rule on Air Contaminants Project”. (Rule remanded by court and not currently in force).

Perchloroethylene (Tetrachloroethylene). Web Address: <http://www.cdc.gov/niosh/pel88/127-18.html>

References for Metals

Agency For Toxic Substances and Disease Registry. (ATSDR) “Toxicological Profiles” for Various Compounds.
Web Address: <http://www.atsdr.cdc.gov/toxprofiles/>

Arsenic, dated September 2000.
Manganese, dated September 2000.

California Air Resources Board. (CARB)

Web Address: <http://www.arb.ca.gov/toxics/catable.htm>

Arsenic and Compounds, dated September 1997.
Manganese Compounds, dated September 1997.

United States Environmental Protection Agency. (EPA) Integrated Risk Information System. Full IRIS Summary Of Various Substances.

Web Address: <http://www.epa.gov/iris/subst/>

Arsenic, inorganic. Dated April 10, 1998. Web address: <http://www.epa.gov/iris/subst/0278.html>
Manganese. Dated December 1, 1996. Web address: <http://www.epa.gov/iris/subst/0373.htm>

United States Environmental Protection Agency. (EPA). Technology Transfer Network Air Toxics Website. Health Effects Worksheets for Various Substances.

Web Address: <http://www.epa.gov/ttn/atw/hlthef>

Arsenic Compounds, dated December 1999.
Manganese Compounds, dated December 1999.

National Institute for Occupational Safety and Health. (NIOSH) Criteria For a Recommended Standard.... Occupational Exposure to Inorganic Arsenic, 1975.

Web Address: <http://www.cdc.gov/niosh/pdfs/75-149a.pdf>

National Institute for Occupational Safety and Health. (NIOSH) Documentation for Immediately Dangerous to Life or Health Concentrations (IDLHs).

Arsenic, dated August 16, 1996. Web address: <http://www.cdc.gov/niosh/idlh/7440382.html>
Manganese compounds (as Mn), dated August 15, 1996.
Web address: <http://www.cdc.gov/niosh/idlh/7439965.html>

National Institute for Occupational Safety and Health. (NIOSH) International Chemical Safety Cards.

Arsenic. Dated 1999. Web Address: <http://www.cdc.gov/niosh/ipcsneng/neng0013.html>
Manganese. Dated 2002. Web Address: <http://www.cdc.gov/niosh/ipcsneng/neng0232.html>

National Institute for Occupational Safety and Health. (NIOSH) Pocket Guide to Chemical Hazards.

Arsenic. Web Address: <http://www.cdc.gov/niosh/npg/npgd0038.html>

Manganese Compounds and fume (as Mn). Web Address: <http://www.cdc.gov/niosh/npg/npgd0379.html>

National Institute for Occupational Safety and Health. (NIOSH) Registry of Toxic Effects of Chemical Substances (RTECS).

Arsenic, dated October 2002. Web Address: <http://www.cdc.gov/niosh/rtecs/cg802c8.html>

Manganese, dated October 2002. Web Address: <http://www.cdc.gov/niosh/rtecs/008d8678.html>

New Jersey Department of Health and Senior Services. “Hazardous Substance Fact Sheets” for Various Substances. Web Address: <http://www.state.nj.us/health/eoh/rtkweb/rtkhsfs.htm>

Arsenic, dated June 1998.

Manganese, dated September 1999.

Occupational Safety and Health Administration. (OSHA) “OSHA Comments from the January 19, 1989 Final Rule on Air Contaminants Project”. (Rule remanded by court and not currently in force).

Manganese Fume. Web Address: <http://www.cdc.gov/niosh/pel88/7439-96.html>

ATTACHMENT-2

Documentation for Grand Junction Urban Air Toxics Trends Monitoring Locations

REGIONAL MAP (5 - 30 miles)

AQS ID: **08-077-0017**

Site Name: **Grand Junction – Powell Building**

650 South Avenue, Grand Junction, CO 81501

GPS: Zone 12, 710962 E, 4326741 N, elev. 1396m

39° 03' 51" N, 108° 33' 42" W

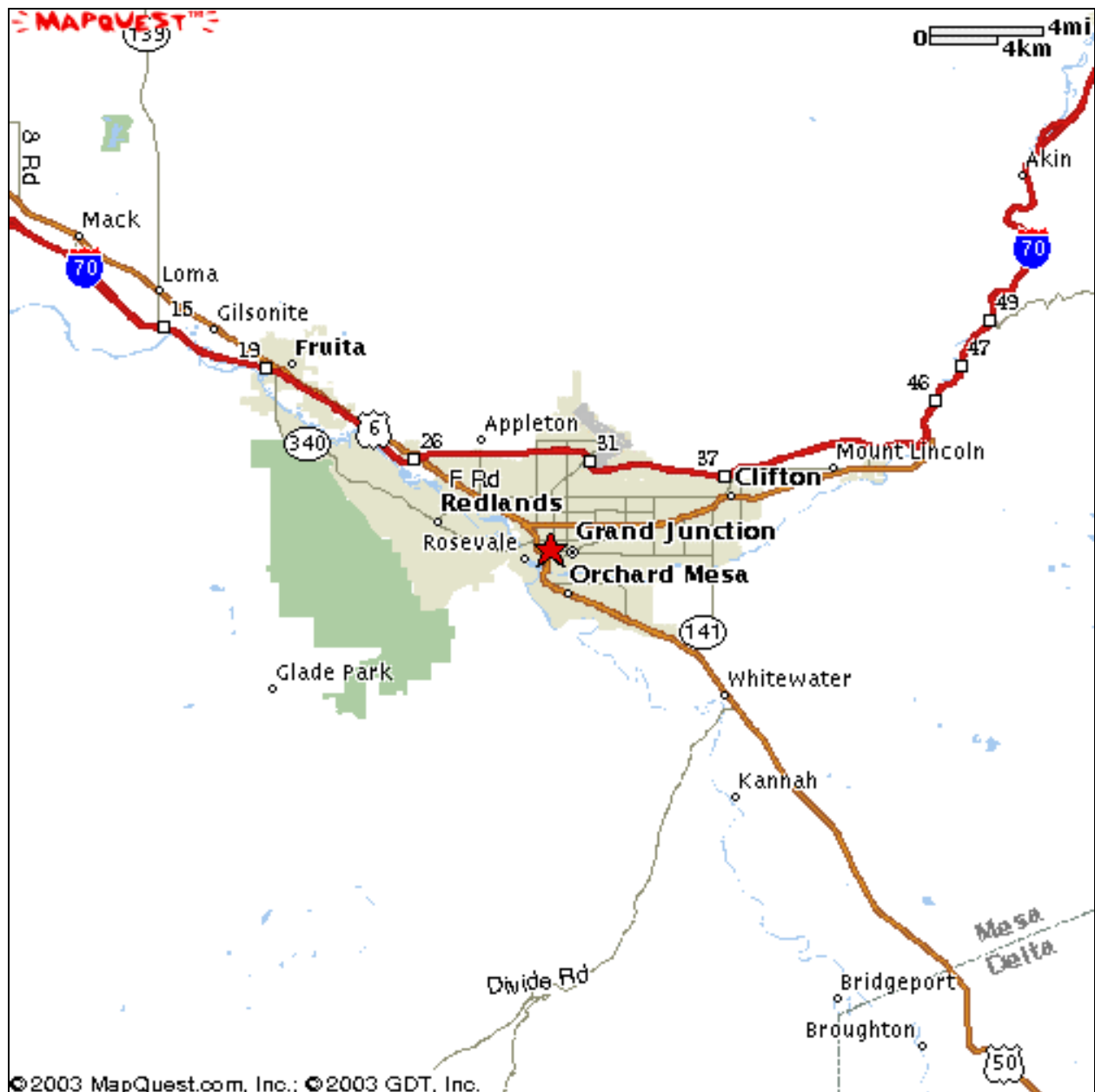
AQS ID: **08-077-0018**

Site Name: **Grand Junction – Powell (shelter)**

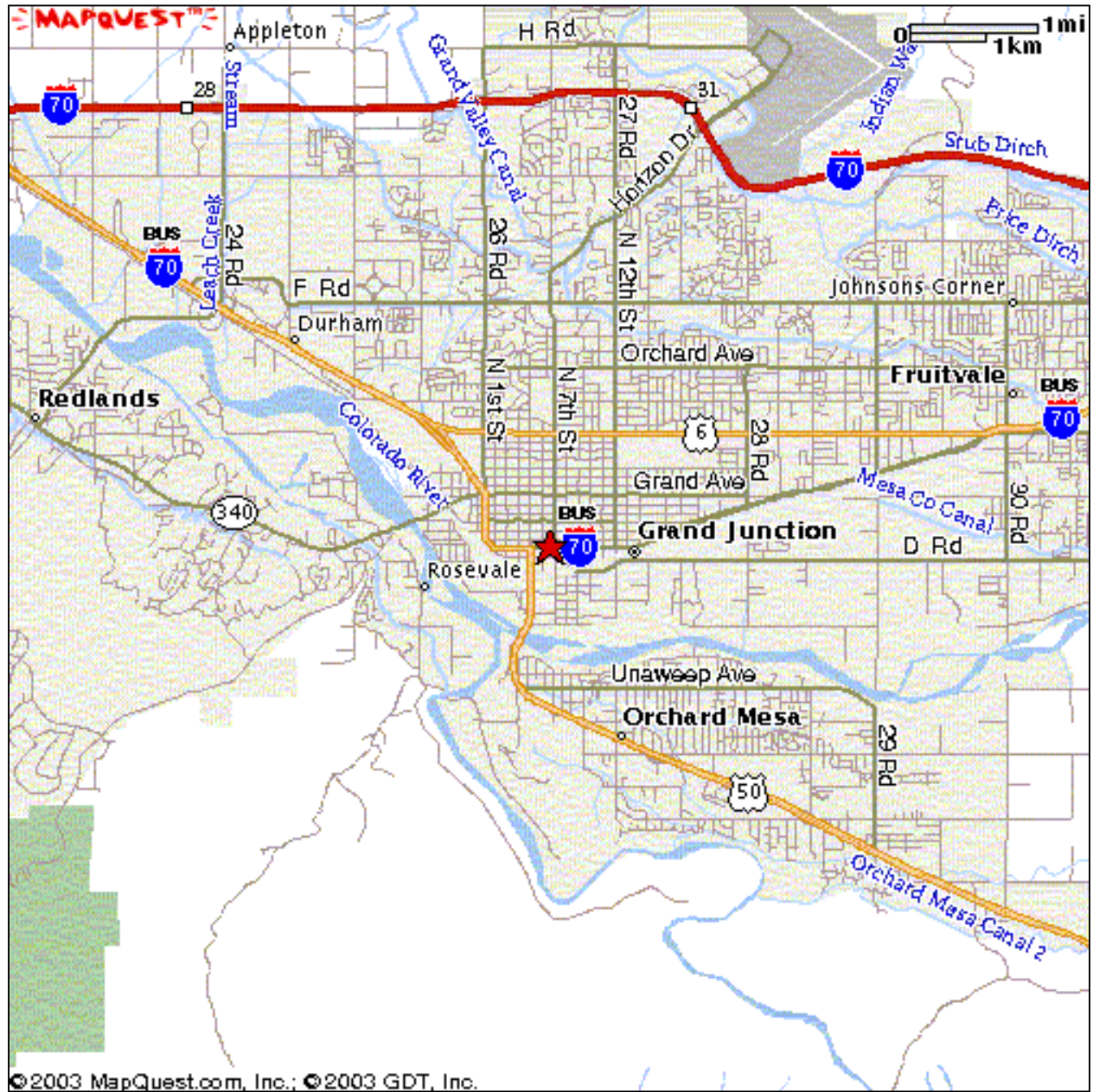
645 ¼ Pitkin Avenue, Grand Junction, CO 81501

GPS: Zone 12, 710962 E, 4326741 N, elev. 1396m

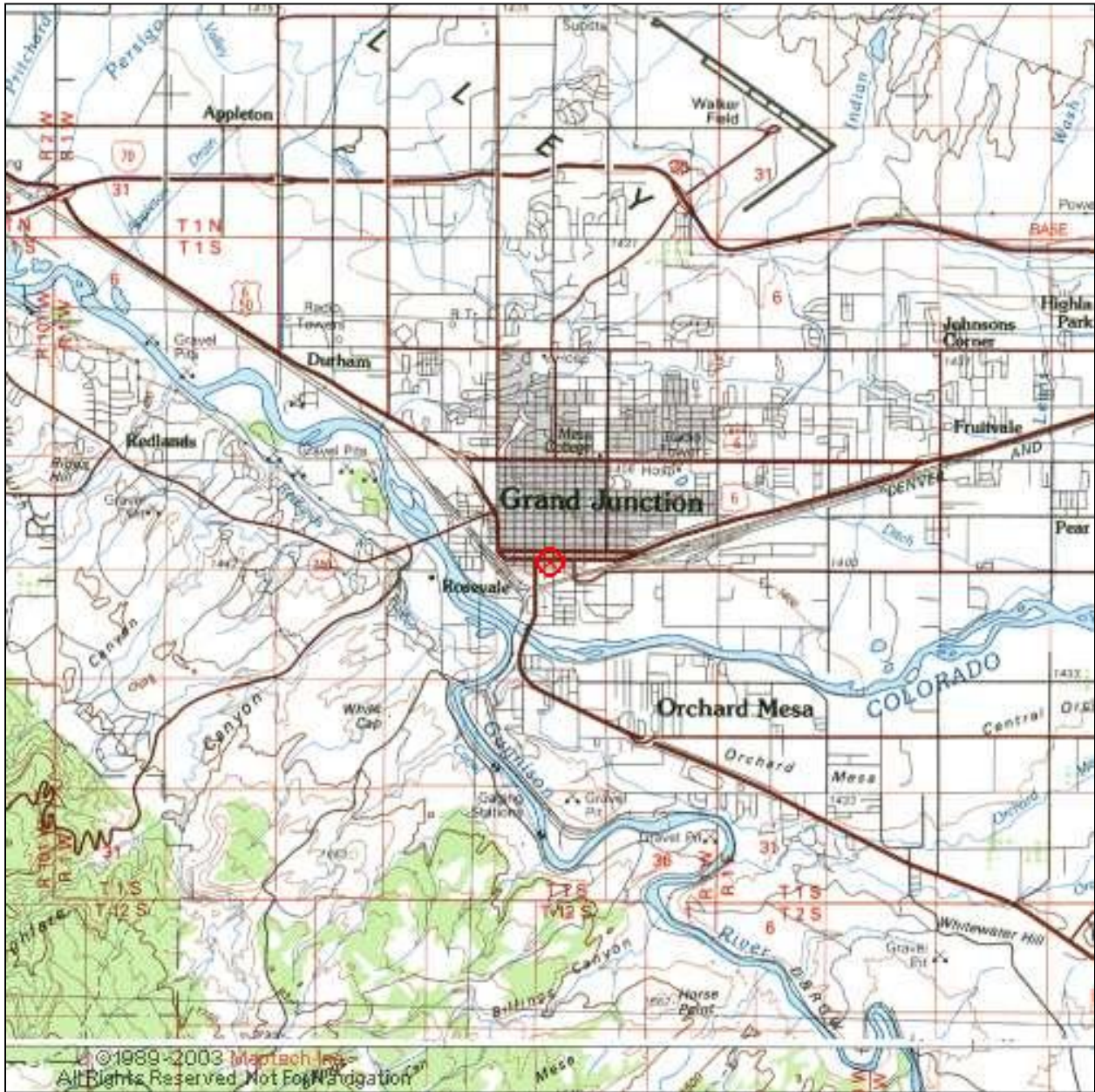
39° 03' 51" N, 108° 33' 42" W



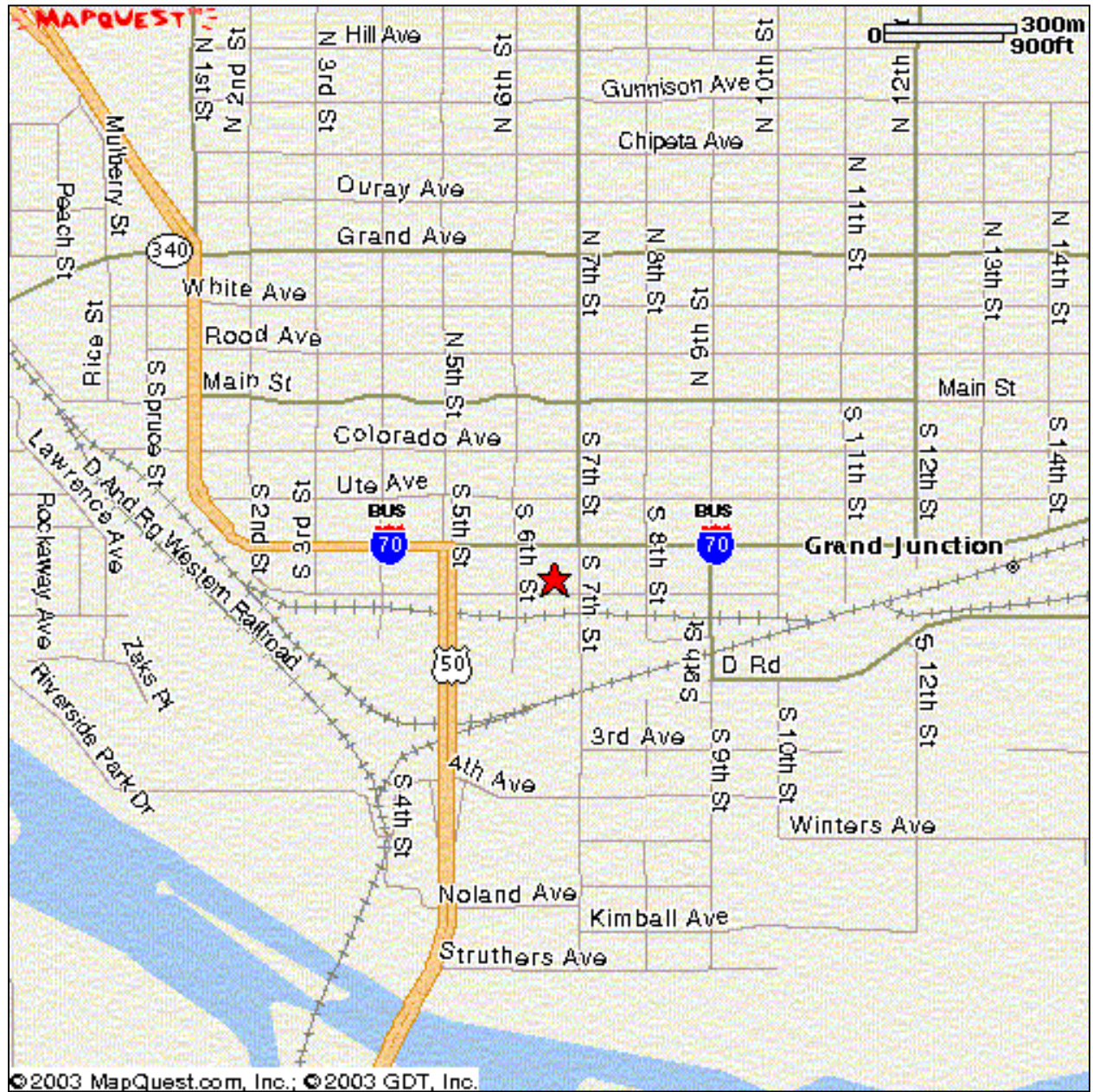
REGIONAL MAP (5 - 30 miles)



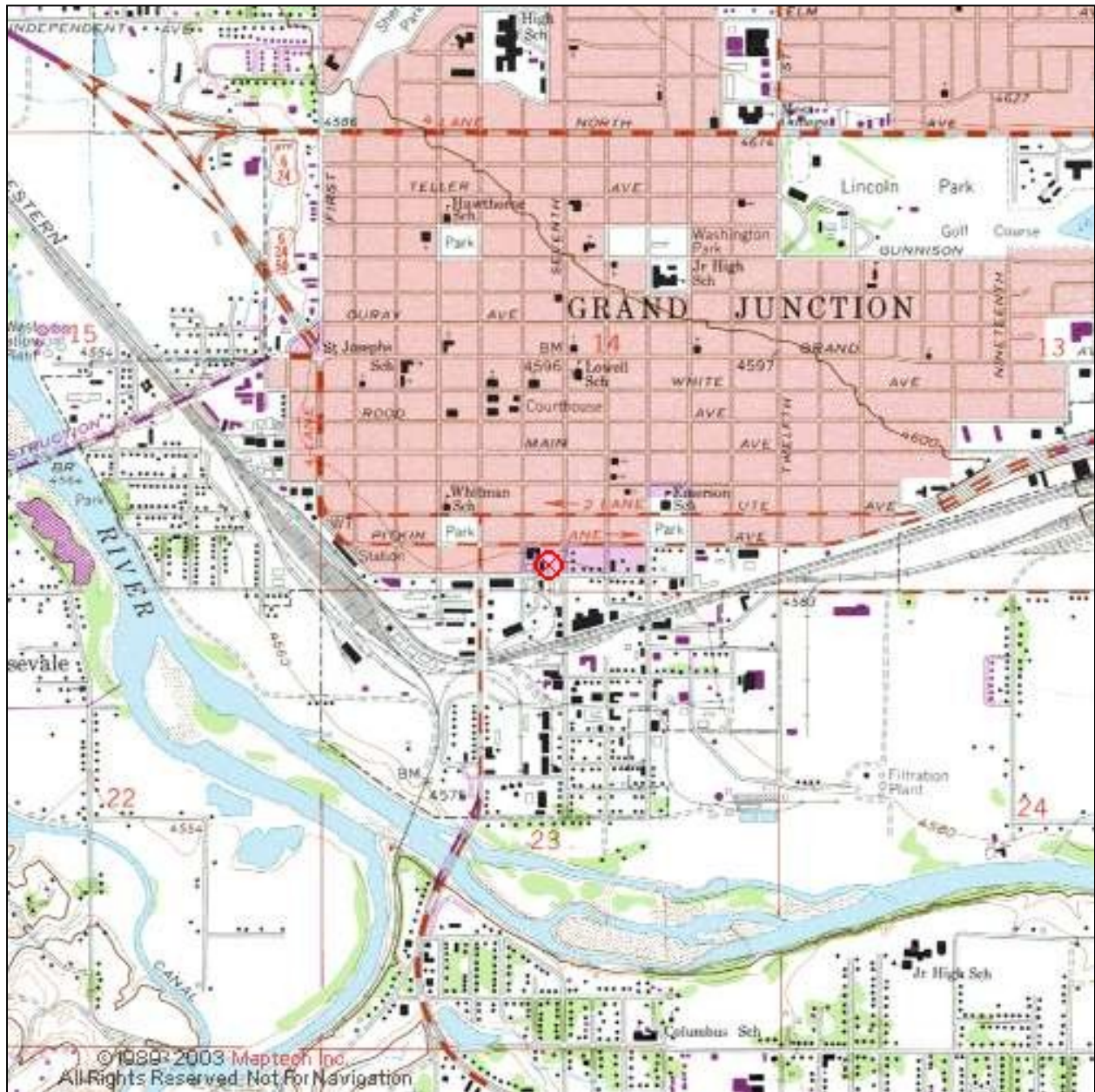
REGIONAL MAP (5 - 30 miles)



SITE MAP (1/4 - 1 mile)



SITE MAP (1/4 - 1 mile)



SITE MAP (1/4 - 1 mile)

AIRS ID: **08-077-0017**

Site Name: **Grand Junction – Powell Building**



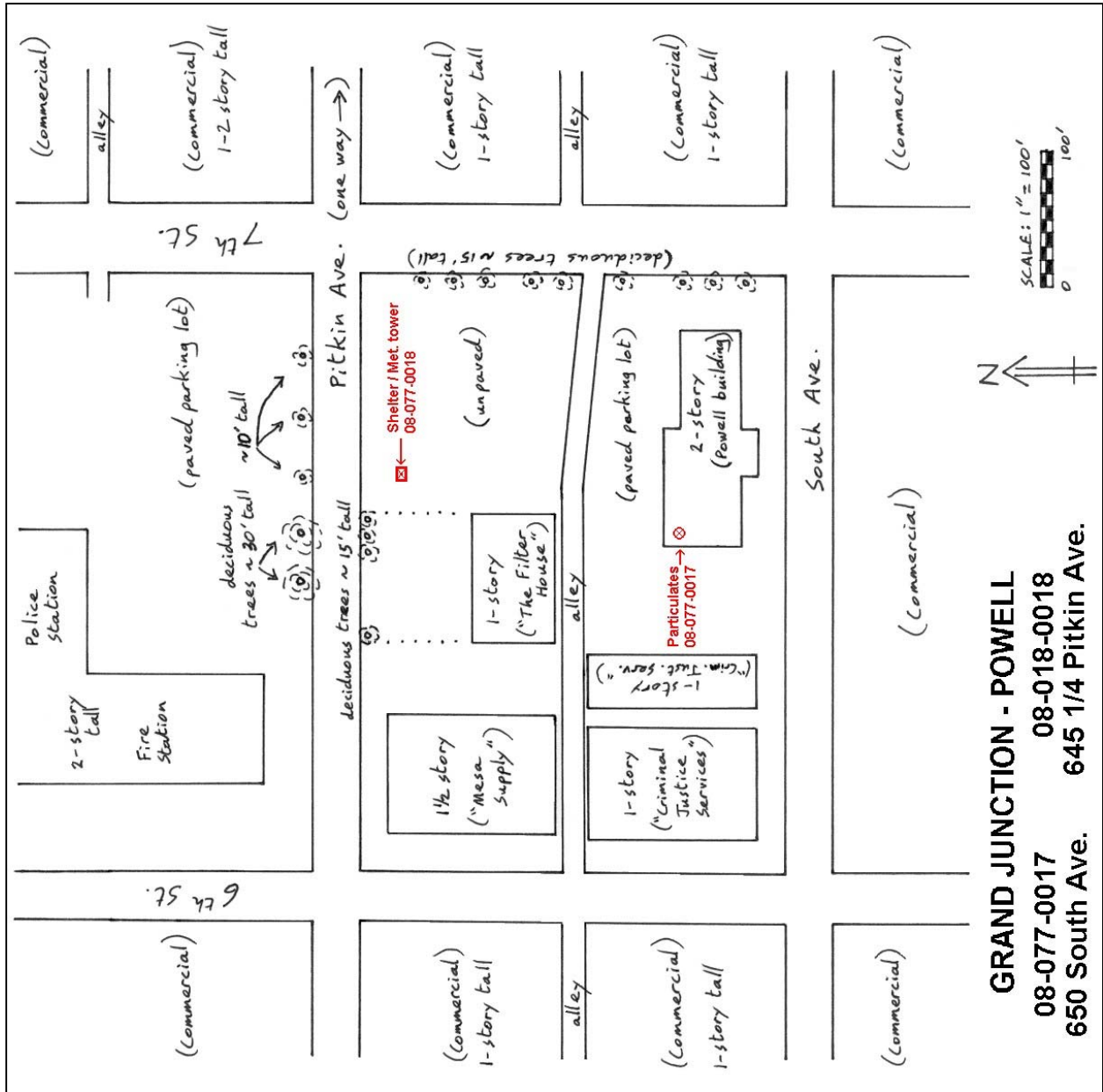
SITE MAP (1/4 - 1 mile)

AIRS ID: 08-077-0018

Site Name: Grand Junction – Powell (shelter)



SITE MAP (1/4 - 1 mile)



GRAND JUNCTION - POWELL
 08-077-0017 08-018-0018
 650 South Ave. 645 1/4 Pitkin Ave.

AQS ID: 08-077-0017

Site Name: Grand Junction – Powell Building

Photo Date: 01/21/2004

Site Photo: Looking South (from gaseous shelter)



Site Photo: Looking Northwest



AQS ID: 08-077-0017

Site Name: Grand Junction – Powell Building

Photo Date: 01/21/2004

Looking NORTH



Looking NORTHEAST



AQS ID: 08-077-0017

Site Name: Grand Junction – Powell Building

Photo Date: 01/21/2004

Looking EAST



Looking SOUTHEAST



AQS ID: 08-077-0017

Site Name: Grand Junction – Powell Building

Photo Date: 01/21/2004

Looking SOUTH



Looking SOUTHWEST



AQS ID: 08-077-0017

Site Name: Grand Junction – Powell Building

Photo Date: 01/21/2004

Looking WEST



Looking NORTHWEST



AQS ID: 08-077-0018

Site Name: Grand Junction – Powell (shelter)

Photo Date: 01/21/2004

Site Photo: Looking North (from particulate samplers)



Site Photo: Looking Northwest



AQS ID: 08-077-0018

Site Name: Grand Junction – Powell (shelter)

Photo Date: 01/21/2004

Looking NORTH



Looking NORTHEAST



AQS ID: 08-077-0018

Site Name: Grand Junction – Powell (shelter)

Photo Date: 01/21/2004

Looking EAST



Looking SOUTHEAST



AQS ID: 08-077-0018

Site Name: Grand Junction – Powell (shelter)

Photo Date: 01/21/2004

Looking SOUTH



Looking SOUTHWEST



AQS ID: 08-077-0018

Site Name: Grand Junction – Powell (shelter)

Photo Date: 01/21/2004

Looking WEST



Looking NORTHWEST





**Colorado Department
of Public Health
and Environment**