Iowa Toxics Sampling 2003
Results from Selected Pollutants

Air Quality Bureau
Iowa Department of Natural Resources

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Summary
During the 2003 calendar year the Department operated four toxic monitoring sites in three Iowa cities, selected either because they were heavily populated or heavily industrialized. At each site, two types of toxic samples were taken. Air samples were taken in specially treated stainless steel canisters, in order to capture volatile organic compounds (VOC's) with low molecular weight. Air was also sampled through cartridges in order to investigate the concentration of carbonyl compounds. Both of types of samples were prepared and analyzed at the University of Iowa air toxics analysis lab in Iowa City. The canisters were analyzed according to two different protocols. The EPA's speciated non-methane organic compound (SNMOC) protocol was used to analyze the canister contents using a gas chromatograph and flame ionization detector in order to identify compounds known to be involved in the formation of ozone. EPA's TO-15 protocol was also used to analyze the canister contents with a gas chromatograph and mass spectrometer (GCMS) to quantify low molecular weight toxics commonly found in urban air and identified on EPA's Urban Air Toxics Monitoring Program, (UATMP) list of target compounds. Analysis of carbonyl cartridge extracts was performed using High Performance Liquid Chromatography and an ultraviolet detector according to EPA's method TO-11A. This report includes data from three toxic pollutants (formaldehyde, benzene, and acetaldehyde) that have historically exceeded levels the EPA has determined would pose a greater than one in one million increased cancer risk for a lifetime of exposure.

Sample Collection
Monitors were operated in Des Moines, Cedar Rapids, and Davenport. Toxic samples were collected by the Local County Health Departments in Des Moines and Cedar Rapids; Davenport samples were collected by the University of Iowa Hygienic Laboratory.

Scope
Section 112 of the Clean Air Act identifies 188 hazardous air pollutants (HAPS) produced in sufficient quantities to warrant regulatory action. EPA has selected 32 of these HAP's along with diesel particulate matter for a periodic nation-wide review, the national air toxics assessment (NATA). Of the 33 pollutants assessed in the NATA, 17 were quantified in this study, 15 on the TO-15 list and 2 on the TO-11A list. Toxic metals (quantified using EPA method IO 3.5) and Polycyclic Aromatic Hydrocarbons (quantified using EPA method TO-13A) were not measured by this study, nor were other toxics such as mercury and dioxin. Data in this report is limited to two carbonyl compounds, formaldehyde and acetaldehyde and one volatile organic compound, benzene. These three compounds have historically been present in Iowa at levels greater than the EPA determined one in one million increase in cancer risk for a lifetime exposure.

Sampling Schedules
Samples were gathered on a schedule of one sample every twelfth day. Every sixth day monitoring for carbonyl compounds was conducted at the two Des Moines sites during the ozone season (April through October). If a scheduled sample was missed, an unscheduled sample was substituted for the missing data point if that sample was taken before the next scheduled sampling day. In calculations of average pollutant levels and cancer risk the additional samples from the Des Moines sites were averaged to estimate the one in twelve average and avoid introduction of a seasonal bias to the data.

Data Capture
The data capture rate is defined as the ratio of the number of samples taken (including scheduled and valid substitute samples) divided by the number of scheduled samples. The Linn County monitoring site did not begin operation until July and data capture at this site was only 48%. The Des Moines and Davenport sites exhibited data capture ranging from 87% to 100% with the lowest percentage resulting from 27 of 31 possible canisters collected at the Indian Hills School site in Des Moines.

Data Handling
All data used in this report was measured at concentrations above the method detection limit (MDL). It was not necessary to perform any data substitutions where measured concentrations below the MDL, would be replaced with a numerical value of half of the MDL, following EPA data-handling guidelines.

This report characterizes only the cancer risk associated with exposure to the toxic contaminants measured, and does not quantify other "non-cancer" risks such as neurological or reproductive damage associated with the measured

exposure levels. The cancer risk associated with a given exposure level was quantified only when an Air Unit Cancer Risk was available in EPA's Integrated Risk Information System (IRIS) database. Pollutants were selected for inclusion in this report, based on the screening criteria that the excess cancer risk resulting from a lifetime exposure to the average contaminant concentration measured was greater than the EPA benchmark of one in a million excess risk.

Precision Data

Precision data is reported for the total number of collocated pairs of canisters or cartridges collected. Precision statistics shown in this report have been calculated according to 40 CFR Part 58, Appendix A using the methodology applicable to collocated fine particulate data pairs.

Results of the Analysis

Formaldehyde, acetaldehyde, and benzene were measured at levels above the EPA benchmark at all Iowa sites. Formaldehyde levels measured during the study period are associated with a much higher cancer risk than any other pollutant measured in this study. Formaldehyde levels at the downtown Des Moines site were somewhat higher than at any other monitoring locations. Formaldehyde levels at the more suburban site in Des Moines were similar to those measured in Cedar Rapids and Davenport.

IRIS specifies different levels of certainty associated with its cancer risk factors. Benzene is classified as a known human carcinogen (Class A). Formaldehyde is a Class B1 carcinogen, and acetaldehyde is classified as a Class B2 carcinogen. Class B contains probable human carcinogens; Class B1 pollutants are associated with limited evidence of carcinogenicity in humans but sufficient evidence of carcinogenicity in animals, whereas a B2 classification indicates only sufficient evidence of carcinogenicity in animals (1).

A primary contaminant is directly emitted into the ambient air from its source. A secondary contaminant is formed from a chemical reaction of other contaminants already present in the atmosphere from natural or anthropogenic sources.

Benzene is a primary contaminant, with emissions largely attributed to vehicular traffic. Formaldehyde and acetaldehyde are both primary and secondary contaminants. Motor vehicle emissions contribute to primary emissions by incomplete combustion of fuel; secondary formation results from photochemical oxidation of exhaust pipe pollutants. Secondary formation of these pollutants is enhanced in the summertime due to suitable weather conditions such as higher temperature and greater hours of sunlight. Formaldehyde is also produced in large quantities by natural events such as forest or brush fires (2).

In interpreting the results of risk assessment contained in this type of report, EPA has encouraged States to compare the risks caused by toxic outdoor air pollution to other risks experienced in everyday life. The highest excess lifetime cancer risk identified in this report is 4.3 excess cancers per 100,000 people (4.3×10^{-5}), associated with average measured formaldehyde levels in the outdoor air at the urban Des Moines monitoring site. For comparison, the lifetime risk of dying in a car accident is a 1.7×10^{-2}, or almost 400 times higher, and the lifetime risk of being killed by lightning is 1.2×10^{-5}, or approximately 3 ½ times less than developing cancer at this level of formaldehyde exposure (6).

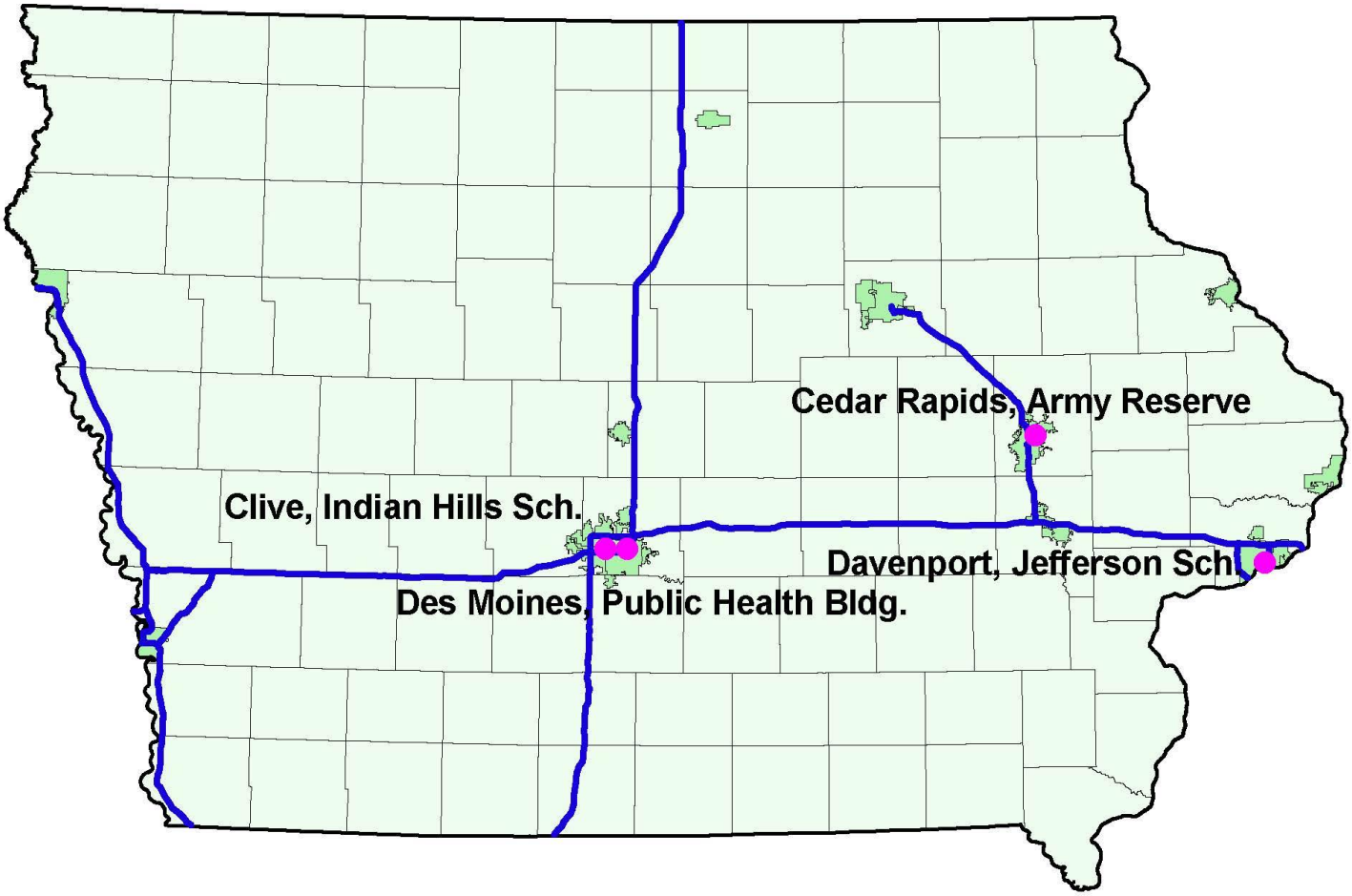
References:

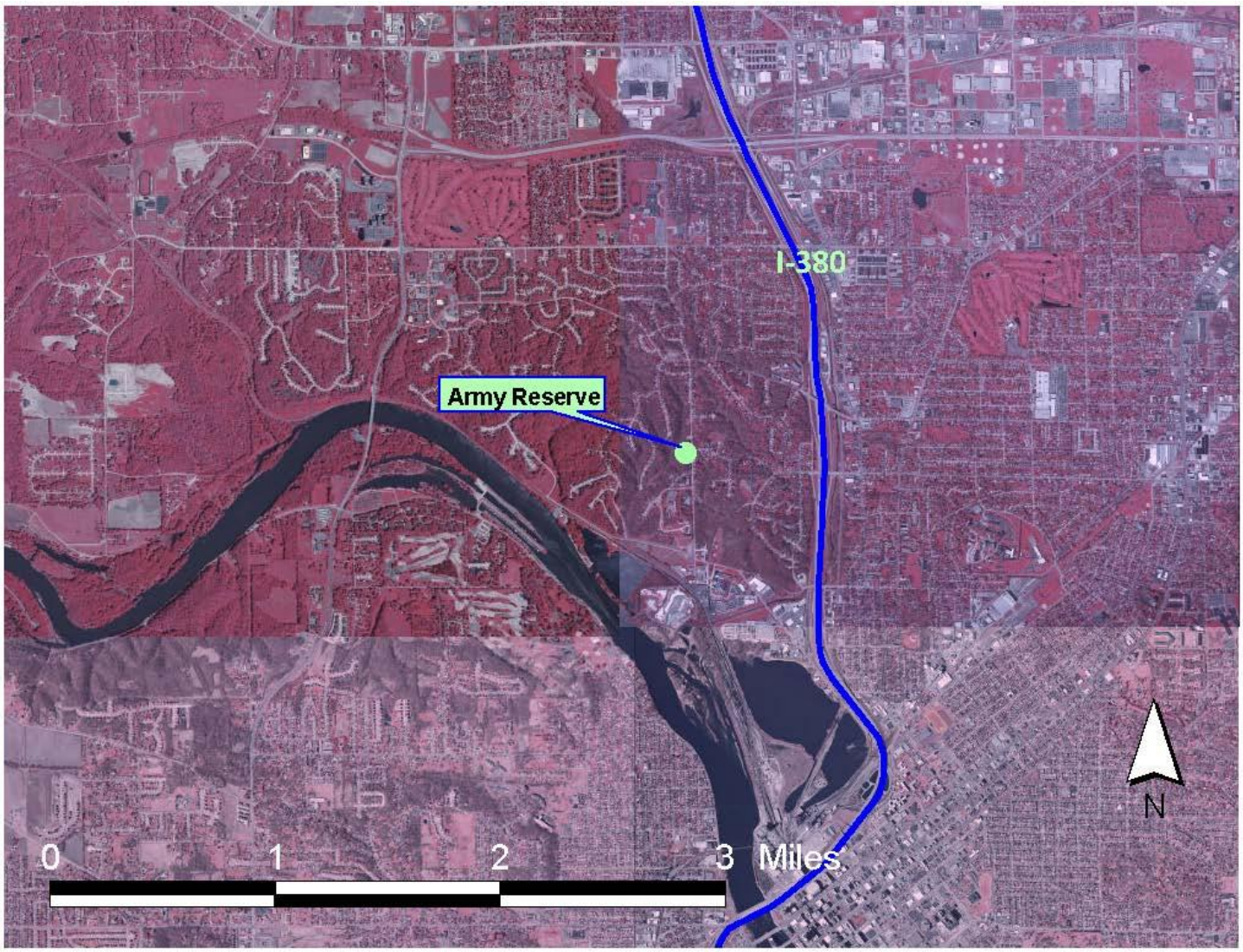
1. Integrated Risk Information System: http://www.epa.gov/iris
2. Canada EPA: http://www.ec.gc.ca
3. http://www.epa.gov/oar/aqtrnd99/toc.html - chapter 5 - toxics
4. http://www.epa.gov/oar/aqtrnd99/brochure/brochure.pdf - toxics chapter
5. http://www.epa.gov/ttn/atw/3_90_023.html
6. http://www.nsc.org/lrs/statinfo/odds.htm

Air Toxics Monitoring Network 2003

Site ID	Site Label	City	Address	County
191130037	Cedar Rapids, Army Reserve	Cedar Rapids	1599 Wenig Rd. NE	Linn
191530030	Des Moines, Public Health Bldg	Des Moines	19th St. & Carpenter St.	Polk
191532510	Des Moines, Indian Hills School	Des Moines (Clive)	9401 Indian Hills Drive	Polk
191630015	Davenport, Jefferson Elementary	Davenport	10th St. & Vine	Scott

Iowa Toxics Monitoring Network 2003




I-380
Army Reserve
0
1
2
3 Miles
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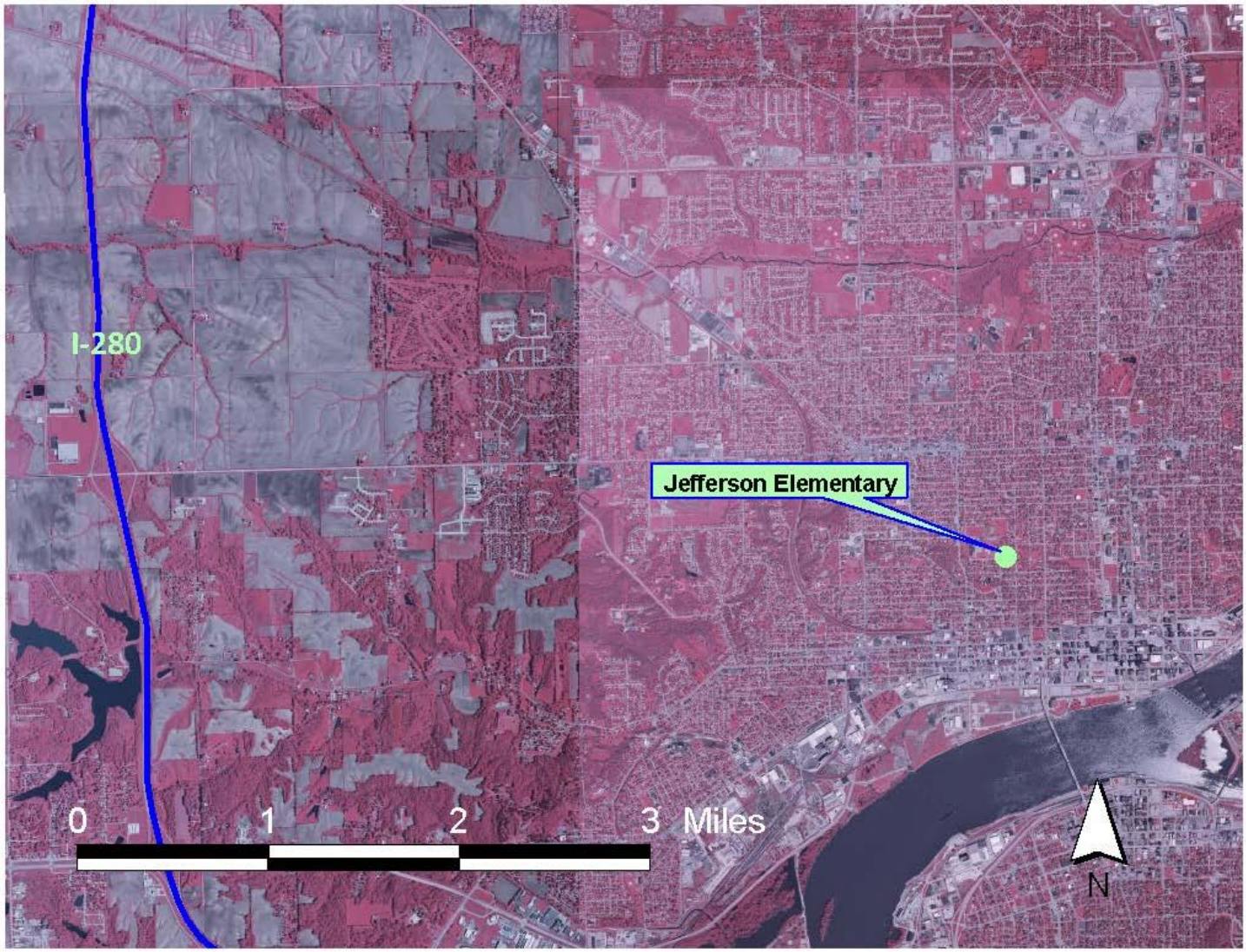
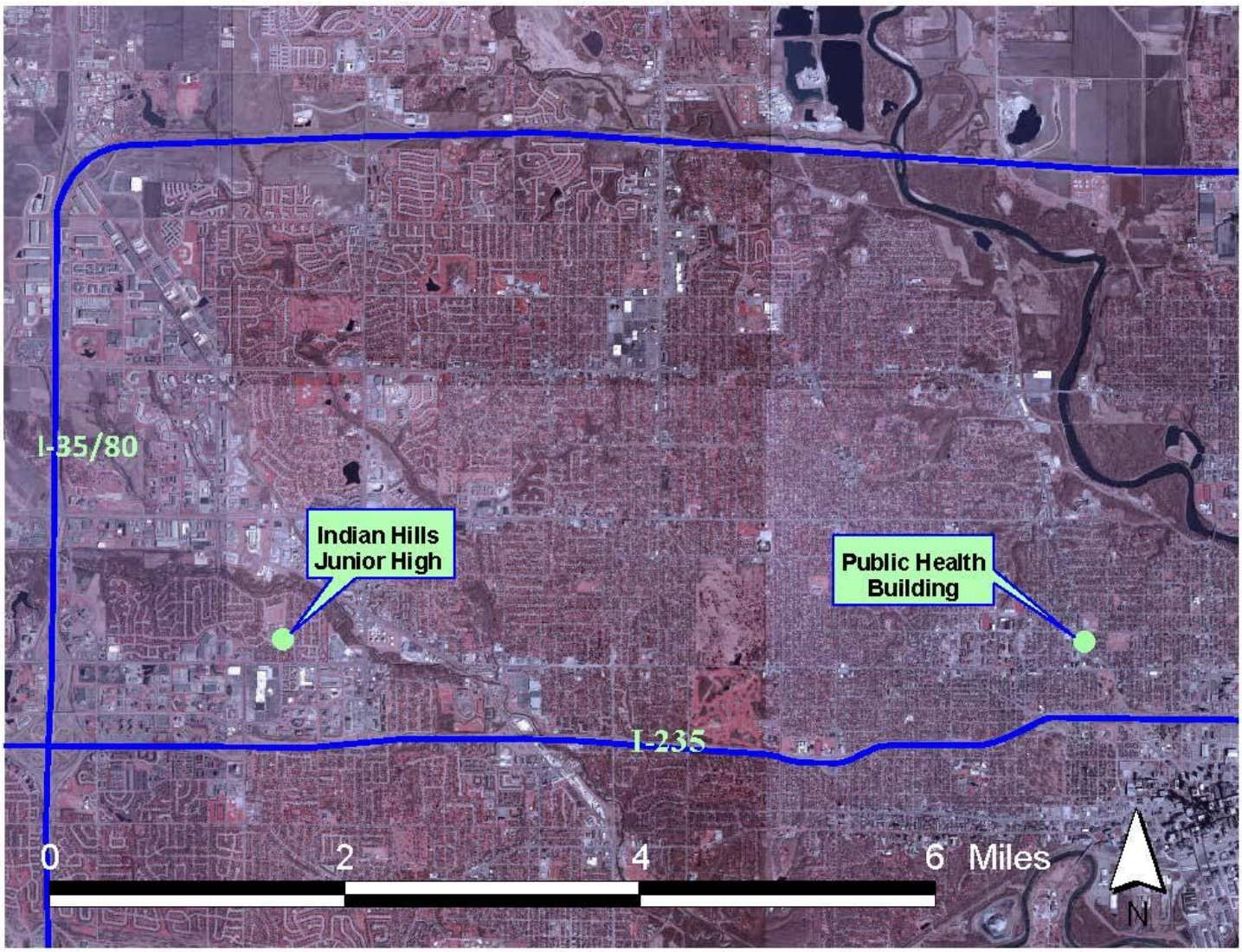
Davenport Toxics Monitoring 2003



Des Moines Toxics Monitoring 2003



Cancer Risk Summary (Excess Cancers Per MillionPeople)

Site / Pollutant	Cedar Rapids Army Reserve	Des Moines Public Health Building	Des Moines Indian Hills School	Davenport Jefferson Elementary
Formaldehyde	32.0	40.1	23.8	27.6
Acetaldehyde	3.9	3.0	2.6	3.2
Benzene	3.9	7.8	4.9	5.2

Note: Values indicated are the Excess Cancer Risks that would result from a lifetime of exposure to the average pollutant concentration measured at the site.

Concentration Summary (ppb)

Site / Pollutant	Cedar Rapids Army Reserve	Des Moines Public Health Building	Des Moines Indian Hills School	Davenport Jefferson Elementary
Formaldehyde	2.1(+/- 0.8)	2.6 (+/- 0.5)	1.6 (+/- 0.5)	1.8 (+/- 0.4)
Acetaldehyde	1.09 (+/- 0.27)	0.83 (+/- 0.16)	0.72 (+/- 0.11)	0.90 (+/- 0.14)
Benzene	0.16 (+/- 0.05)	0.32 (+/- 0.09)	0.20 (+/- 0.04)	0.21 (+/- 0.03)

Note: Values indicated are the average concentrations in parts per billion measured at each site in 2003. Data from enhanced summer monitoring at the Des Moines sites was averaged to prevent seasonal bias. Values listed in

parentheses represent the 95% Confidence Interval for the mean.

Percent Data Capture

Site / Pollutant	Cedar Rapids Army Reserve	Des Moines Public Health Building	Des Moines Indian Hills School	Davenport Jefferson Elementary
Formaldehyde	48%	96%	96%	100%
Acetaldehyde	48%	94%	96%	100%
Benzene	48%	97%	87%	97%

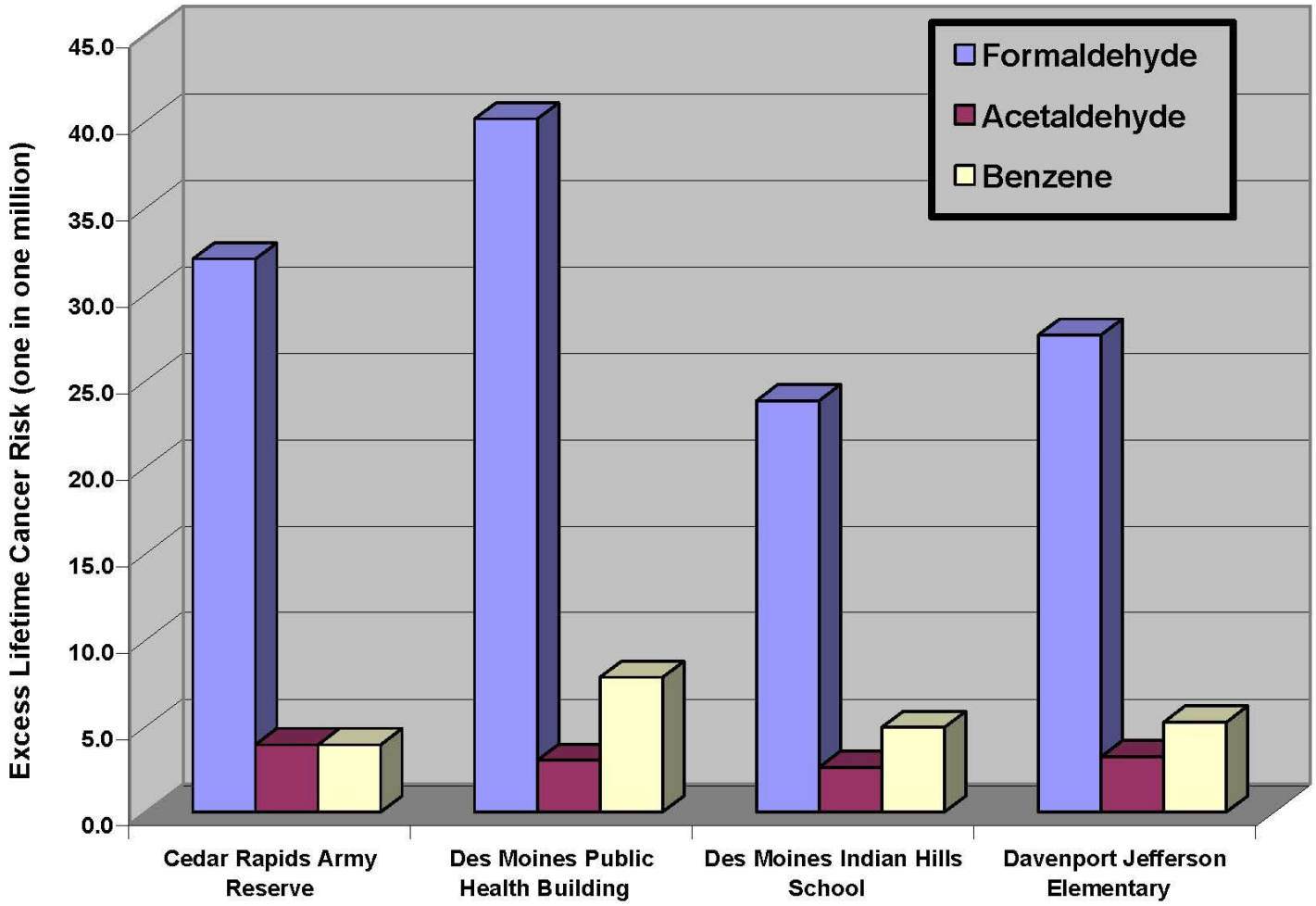
Low percent data capture at the Cedar Rapids site was a result of monitoring not beginning until July.

Annual Toxics Precision Statistics

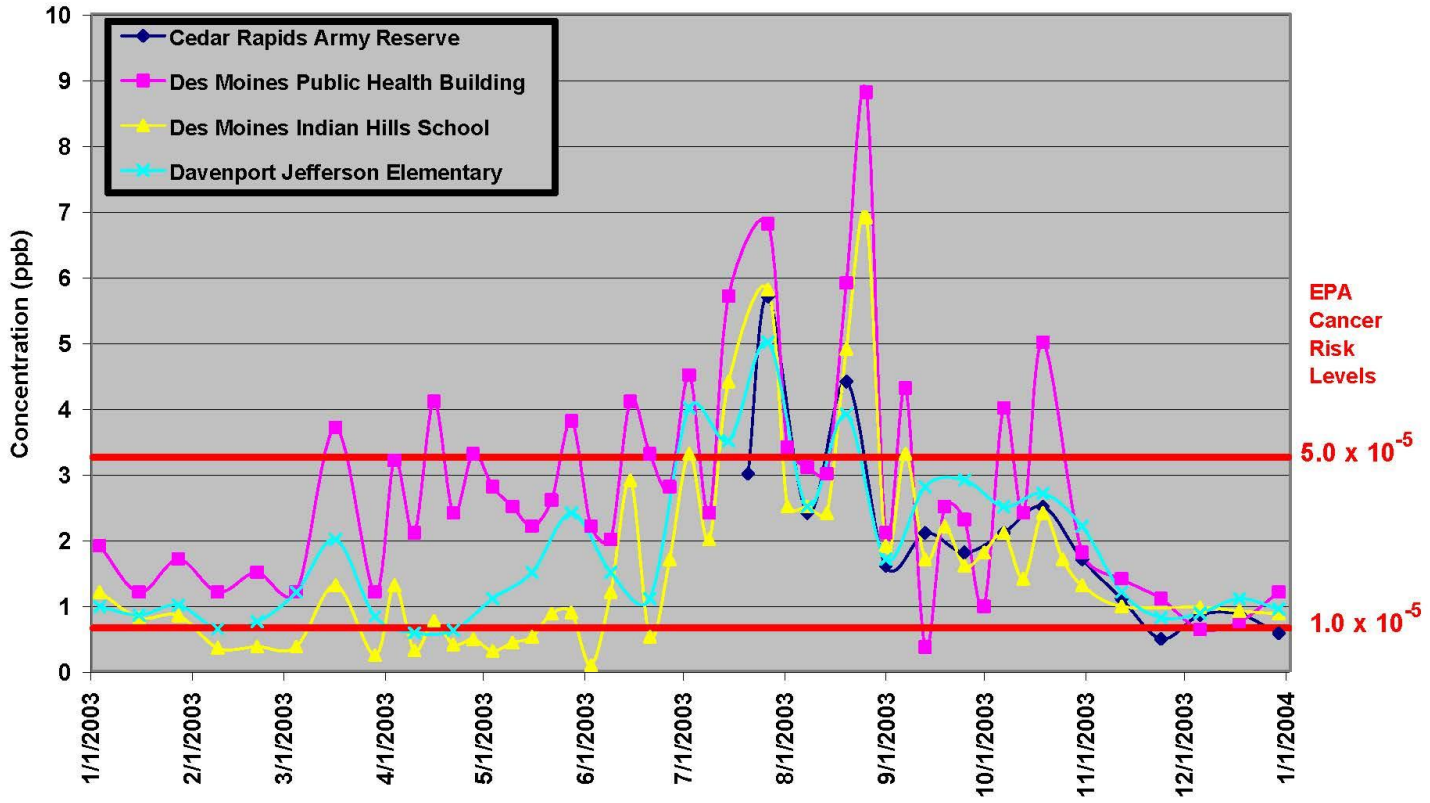
Statistic / Pollutant	# pairs	Coefficient of Variation	Lower 90% Confidence Limit	Upper 90% Confidence Limit
Formaldehyde	17	2.9%	2.3%	4.1%
Acetaldehyde	17	3.9%	3.1%	5.5%
Benzene	40	9.7%	8.2%	11.9%

Note: Statistics generated from collocated sample pairs. CV and Confidence Limits Calculated According to 40 CFR Part 58 (PM 2.5 method).

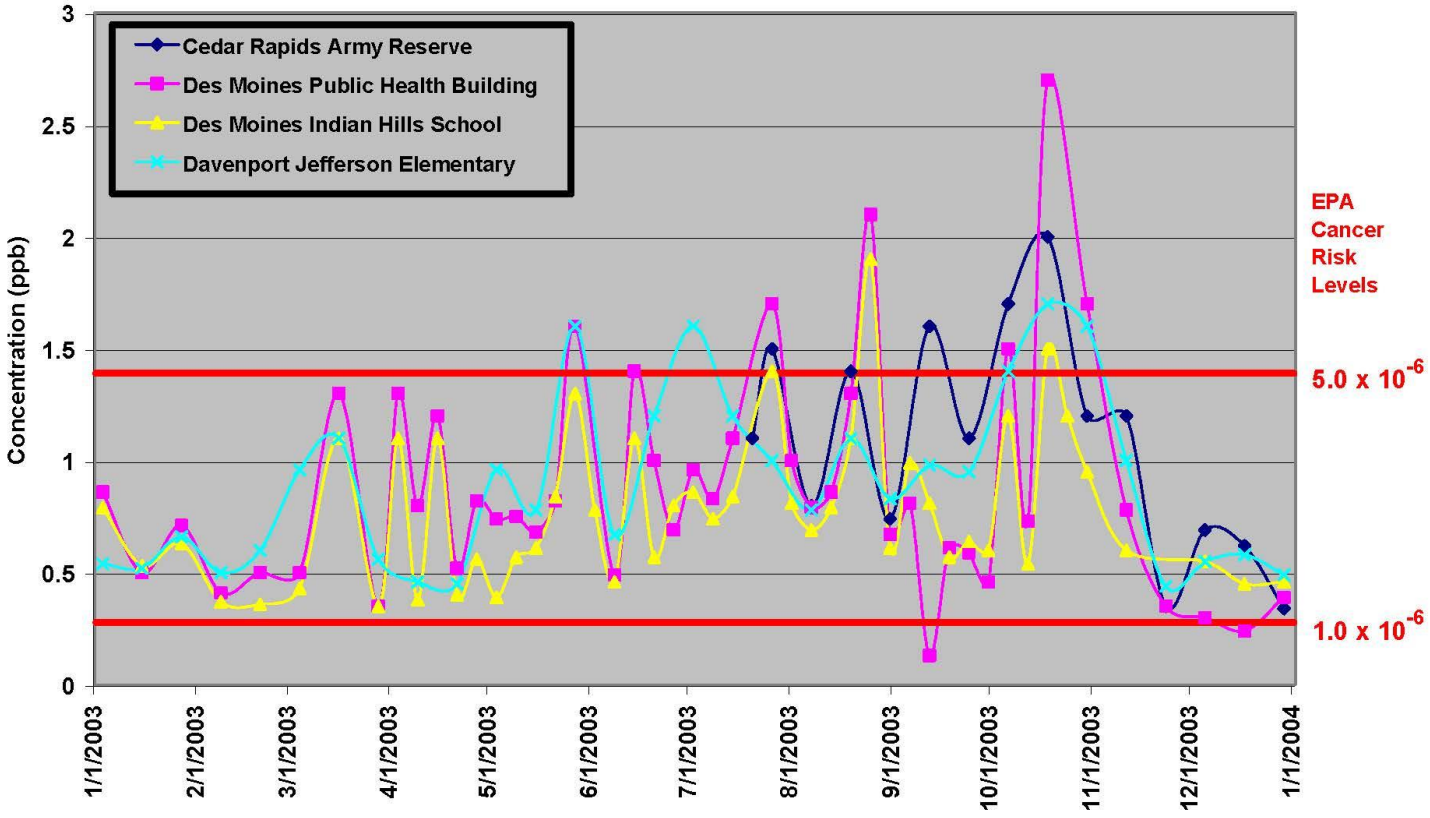
2003 Cancer Risk Over the EPA Benchmark in Iowa



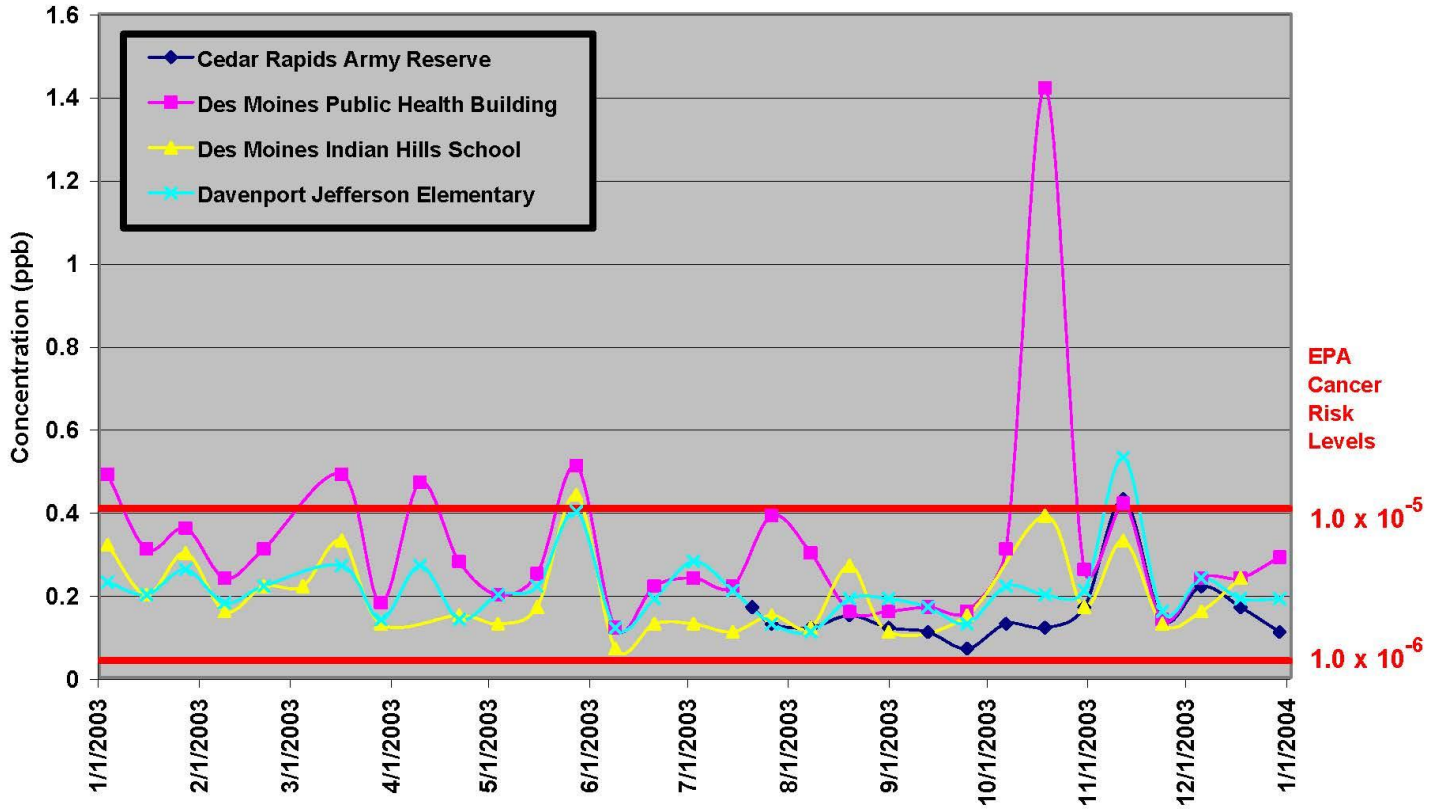
Formaldehyde Cancer Risk in Iowa In 2003



Acetaldehyde Cancer Risk in Iowa 2003



Benzene Cancer Risk in Iowa 2003



Raw Data - Formaldehyde
(Concentration in ppb)

Date	Cedar Rapids Army Reserve	Des Moines Public Health Building	Des Moines Indian Hills School	Davenport Jefferson Elementary
1/3/03		1.9	1.2	0.98
1/15/03		1.2	0.81	0.85
1/27/03		1.7	0.84	1
2/8/03		1.2	0.35	0.64
2/20/03		1.5	0.37	0.75
3/4/03		1.2	0.37	1.2
3/16/03		3.7	1.3	2
3/28/03		1.2	0.24	0.83
4/3/03		3.2	1.3	
4/9/03		2.1	0.31	0.58
4/15/03		4.1	0.76	
4/21/03		2.4	0.4	0.62
4/27/03		3.3	0.48	
5/3/03		2.8	0.3	1.1
5/9/03		2.5	0.43	
5/15/03		2.2	0.52	1.5
5/21/03		2.6	0.87	
5/27/03		3.8	0.89	2.4
6/2/03		2.2	0.083	

Date	Cedar Rapids Army Reserve	Des Moines Public Health Building	Des Moines Indian Hills School	Davenport Jefferson Elementary
6/8/03		2	1.2	1.5
6/14/03		4.1	2.9	
6/20/03		3.3	0.52	1.1
6/26/03		2.8	1.7	
7/2/03		4.5	3.3	4
7/8/03		2.4	2	
7/14/03		5.7	4.4	3.5
7/20/03	3			
7/26/03	5.7	6.8	5.8	5
8/1/03		3.4	2.5	
8/7/03	2.4	3.1	2.5	2.5
8/13/03		3	2.4	
8/19/03	4.4	5.9	4.9	3.9
8/25/03		8.8	6.9	
8/31/03	1.6	2.1	1.9	1.7
9/6/03		4.3	3.3	
9/12/03	2.1	0.36	1.7	2.8
9/18/03		2.5	2.2	
9/24/03	1.8	2.3	1.6	2.9
9/30/03		0.98	1.8	
10/6/03	2.1	4	2.1	2.5
10/12/03		2.4	1.4	
10/18/03	2.5	5	2.4	2.7
10/24/03			1.7	
10/30/03	1.7	1.8	1.3	2.2
11/11/03	1.1	1.4	0.98	1.2
11/23/03	0.49	1.1		0.81
12/5/03	0.85	0.63	0.97	0.88
12/17/03	0.86	0.75	0.91	1.1
12/29/03	0.57	1.2	0.87	0.94

Raw Data - Acetaldehyde
(Concentration in ppb)

Date	Cedar Rapids Army Reserve	Des Moines Public Health Building	Des Moines Indian Hills School	Davenport Jefferson Elementary
1/3/03		0.86	0.79	0.54
1/15/03		0.5	0.53	0.52
1/27/03		0.71	0.63	0.66
2/8/03		0.41	0.37	0.5
2/20/03		0.5	0.36	0.6
3/4/03		0.5	0.43	0.96
3/16/03		1.3	1.1	1.1
3/28/03		0.35	0.35	0.56
4/3/03		1.3	1.1	
4/9/03		0.8	0.38	0.46
4/15/03		1.2	1.1	
4/21/03		0.52	0.4	0.45
4/27/03		0.82	0.56	
5/3/03		0.74	0.39	0.96
5/9/03		0.75	0.57	
5/15/03		0.68	0.61	0.78
5/21/03		0.82	0.84	
5/27/03		1.6	1.3	1.6
6/2/03			0.78	
6/8/03		0.49	0.46	0.67
6/14/03		1.4	1.1	
6/20/03		1	0.57	1.2
6/26/03		0.69	0.8	
7/2/03		0.96	0.86	1.6
7/8/03		0.83	0.74	
7/14/03		1.1	0.84	1.2
7/20/03	1.1			
7/26/03	1.5	1.7	1.4	1
8/1/03		1	0.81	
8/7/03	0.8	0.79	0.69	0.78
8/13/03		0.86	0.79	
8/19/03	1.4	1.3	1.1	1.1
8/25/03		2.1	1.9	
8/31/03	0.74	0.67	0.61	0.83
9/6/03		0.81	0.99	
9/12/03	1.6	0.13	0.81	0.98
9/18/03		0.61	0.57	
9/24/03	1.1	0.59	0.64	0.95
9/30/03		0.46	0.6	
10/6/03	1.7	1.5	1.2	1.4
10/12/03		0.73	0.54	

Date	Cedar Rapids Army Reserve	Des Moines Public Health Building	Des Moines Indian Hills School	Davenport Jefferson Elementary
10/18/03	2	2.7	1.5	1.7
10/24/03			1.2	
10/30/03	1.2	1.7	0.95	1.6
11/11/03	1.2	0.78	0.6	1
11/23/03	0.35	0.35		0.44
12/5/03	0.69	0.3	0.55	0.55
12/17/03	0.62	0.24	0.45	0.58
12/29/03	0.34	0.39	0.46	0.49

Raw Data - Benzene
(Concentration in ppb)

Date	Cedar Rapids Army Reserve	Des Moines Public Health Building	Des Moines Indian Hills School	Davenport Jefferson Elementary
01/03/03		0.49	0.32	0.23
01/15/03		0.31	0.2	0.2
01/27/03		0.36	0.3	0.26
02/08/03		0.24	0.16	0.18
02/20/03		0.31	0.22	0.22
03/04/03			0.22	
03/16/03		0.49	0.33	0.27
03/28/03		0.18	0.13	0.14
04/09/03		0.47		0.27
04/21/03		0.28	0.15	0.14
05/03/03		0.2	0.13	0.2
05/15/03		0.25	0.17	0.22
05/27/03		0.51	0.44	0.4
06/08/03		0.12	0.07	0.12
06/20/03		0.22	0.13	0.19
07/02/03		0.24	0.13	0.28
07/14/03		0.22	0.11	0.21
07/20/03	0.17			
07/26/03	0.13	0.39	0.15	0.13
08/07/03	0.12	0.3	0.12	0.11
08/19/03	0.15	0.16	0.27	0.19
08/31/03	0.12	0.16	0.11	0.19
09/12/03	0.11	0.17		0.17
09/24/03	0.07	0.16	0.15	0.13
10/06/03	0.13	0.31		0.22
10/18/03	0.12	1.42	0.39	0.2
10/30/03	0.17	0.26	0.17	0.21
11/11/03	0.43	0.42	0.33	0.53

Date	Cedar Rapids Army Reserve	Des Moines Public Health Building	Des Moines Indian Hills School	Davenport Jefferson Elementary
11/23/03	0.14	0.14	0.13	0.16
12/05/03	0.22	0.24	0.16	0.24
12/17/03	0.17	0.24	0.24	0.19
12/29/03	0.11	0.29		0.19